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ENGINEERING DATA TRANSMITTAL

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Page 1 of 1

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Restoration of Secondary Containment in Double Shell Tank Pits

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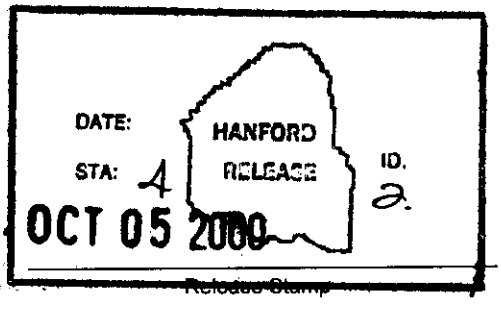

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Revision 0

RESTORATION OF SECONDARY CONTAINMENT IN DOUBLE-SHELL TANK PITS

prepared for

CH2M HILL HANFORD GROUP, INC.

Contract No. 4412, Release 47
Report No. 990922301-001
Revision 0

September 2000

prepared by

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September 2000

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Acronyms

ALARA	as low as reasonably achievable
DF	decontamination factor
DST	Double-shell tank
Ecology	Washington State Department of Ecology
SPC	special protective coating
VOC	Volatile organic content
WVT	water vapor transmission

1.0 DECISION ANALYSIS SUMMARY

Cracks found in many of the double-shell tank (DST) pump and valve pits bring into question the ability of the pits to provide secondary containment and remain in compliance with State and Federal regulations. This study was commissioned to identify viable options for maintain/restoring secondary containment capability in these pits.

The basis for this study is the decision analysis process which identifies the requirements to be met and the desired goals (decision criteria) that each option will be weighed against. A facilitated workshop was convened with individuals knowledgeable of Tank Farms Operations, engineering practices, and safety/environmental requirements. The outcome of this workshop was the validation or identification of the critical requirements, definition of the current problem, identification and weighting of the desired goals, baselining of the current repair methods, and identification of potential alternate solutions. The workshop was followed up with further investigations into the potential solutions that were identified in the workshop and through other efforts. These solutions are identified in the body of this report.

Each of the potential solutions were screened against the list of requirements and only those meeting the requirements were considered viable options. To expand the field of viable options, hybrid concepts that combine the strongest features of different individual approaches were also examined. Several were identified. The decision analysis process then ranked each of the viable options against the weighted decision criteria, which resulted in a recommended solution.

The recommended approach is based upon installing a sprayed on coating system.

Three coatings systems all preliminarily offer acceptable results:

- Polyurea Systems,
- CeRam-Kote 2000®[1], and
- Sherwin Williams® Kem®Cure[2] Tank Lining.

Overall, all are viable. However, more study and testing is recommended to validate vendor claims on physical and chemical compatibility and to provide a uniform basis for comparing the three systems.

2.0 PROBLEM STATEMENT

The principal access to the single and double shell underground storage tanks for waste transfers is through the pump and valve pits located on top or near the tanks. These concrete pits with barrier coatings provide a secondary containment function to prevent waste spills and leaks from reaching the environment. The past practice of no or minimal repairs is no longer acceptable. The degraded or cracked coatings do not provide an impervious waste barrier to the concrete (Washington Administrative

[1] CeRam-Kote 2000® is a registered trademark of Freecom, Inc, of Big Springs, Texas.
[2] Sherwin Williams® and Kem® Cure are registered trademarks of the Sherwin Williams Company, Cleveland, Ohio.

Code 303-173) and therefore a leakage pathway to the environment is possible. It has been determined that, over time, components of the waste may diffuse through the concrete and contaminate the adjacent soil. In addition to diffusion, cracks in the concrete and barrier coating create potential direct leak paths to the environment. Many of the cracks probably occurred early in the life of the structure because of normal curing and aging effects in the concrete. Figure 2-1 shows examples of these cracks. Other causes for cracking are impacts from heavy loads (cover block impact, equipment impacts), separation cracks located at embedment interfaces (thermal and mechanical) (see Figure 2-2), and thermal cycling during operations. Settling of the soil beneath the concrete is not suspected to be a source of cracking.

The current practices employed to repair pump and valve pit secondary containment defects (cracks in concrete and epoxy liner, paint spalling/peeling, etc.) is via manual entry into the pit to effect repairs. Aside from the dose to workers, the incremental costs to implement these repairs are approximately $500,000 per pit based on the most recent work in ay pits by ongoing projects (actual cost accrual without site adders).

Examples of types of Damage in Concrete and their current condition are shown in Table 2.1:

Table 2.1. Examples of Types of Damage in Concrete.

Damage	Current Condition	Description
Curing induced	Stable	Hairline: 2mm through wall and floor
Cracks mechanical- pipe motion	Unstable	Cracks outline penetration – risers, pipes, and drains
Crack mechanical- impacts (wrench)	Stable	Spalling, chips, grout seal damage,
Cracks thermal- waste transfers	Unstable	Tend to be radial around penetration with some long linear cracks
Cracks from equipment installation– jumpers/pumps	Unstable	Include with mechanical impacts
Crushed concrete (protect rebar)	Unstable	
Embedment interfaces	Unstable	Gouges, dents, holes, outline cracks
Cracks from moisture/freezing	Unstable	May have cracks larger than 2mm

Examples of Damage Found in the Coatings include:

- Cracks in the coating that do not go into the concrete – differential growth between coating and concrete,
- Scratches and chips,
- Peeling, spalling – attributed to aging of coating and deficiencies in surface preparation,

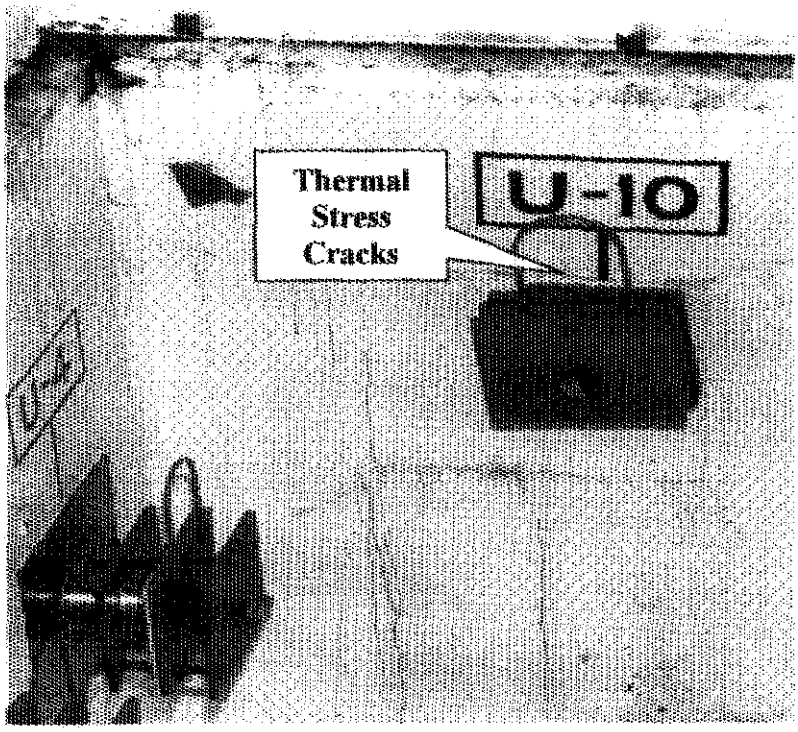

Figure 2-1. Crack Across Joint.

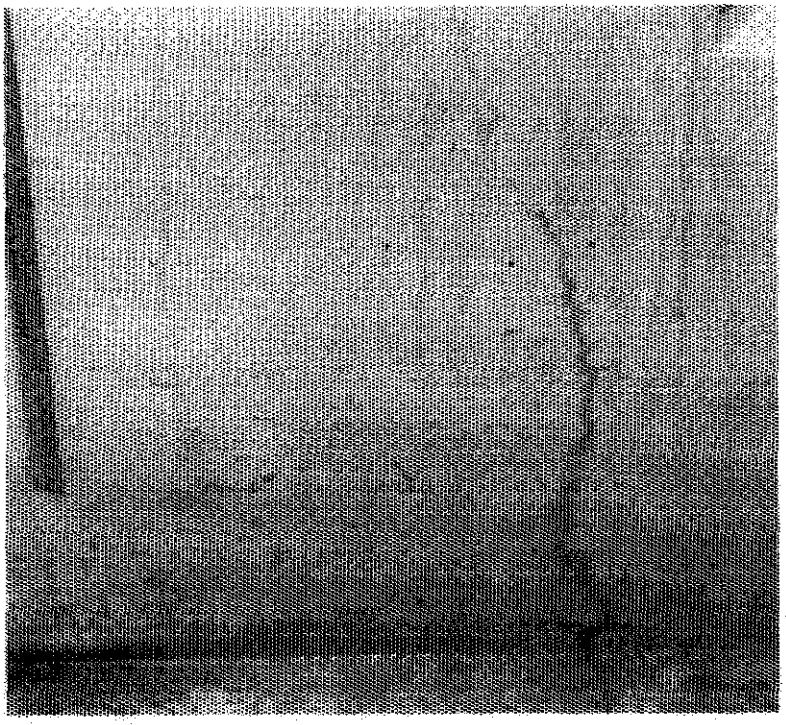

Figure 2-2. Cracks Around Embedment.

- Oxidation – chalking paint,
- Abraded surface,
- Staining (rusty water trails),
- Oily films (oils and greases from equipment leaks), and
- Damage from decon solutions.

3.0 OBJECTIVE/APPROACH

The objective of this effort was to perform an analysis that identifies and evaluates potential coatings, sealants, and liners that might be suitable for maintaining and restoring secondary containment capabilities in the included pits. The analysis will address the benefits and drawbacks of each viable option regarding performance and cost the analysis will also consider issues of health, safety, environment, effects of radiation on the system, and other applicable issues. The report recommends the option(s) that represent the most significant improvements above the current practices employed to maintain/restore secondary containment from a system performance, cost, and schedule standpoint. The current methods to re-establish secondary containment are outlined in Appendix A.

The scope of this task will be to maintain/restore secondary containment within the pit structure. The pit structure is defined as including the floor and walls of the pit up to the front edge of the ledge that supports the cover blocks.

The analysis utilized the *Alternative Generation and Analysis Process*, HNF-IP-0842, Revision 3.3. The Alternative Generation and Analysis Process is a systematic approach to identify viable options and then use decision analysis techniques to select the preferred alternative that best satisfies the decision criteria.

4.0 REQUIREMENTS, CONSTRAINTS, AND ASSUMPTIONS

4.1 From Washington State Department of Ecology (Ecology), Guidance for Assessing Dangerous Waste Secondary Containment Systems, Pub #95-420

The purpose of secondary containment is to capture and contain releases and spills from primary containment structures, facilitate timely cleanup of these releases and spills, and prevent releases of these wastes to the environment. Secondary containment is widely used for containers and tanks that store, accumulate, and treat dangerous waste.

Note: This document provides guidance for assuring compliance with WAC 173-303-GAC.

Requirements:

1. The base of the secondary containment system must be free of cracks or gaps and be sufficiently impervious to contain leaks, spills, and accumulated rainfall until the collected material is detected and removed.

2. Unless the containers storing dangerous wastes are elevated or otherwise protected from contact with accumulated liquids, the base of the secondary containment system must be sloped or otherwise designed and operated to drain and remove liquids from leaks, spills, and accumulated rainfall.

3. The secondary containment system must prevent any migration of wastes or accumulated liquid out of the secondary containment system to the soil, groundwater, or surface water at any time during the use of the tank system.

4. The secondary confinement system must be constructed of materials that are compatible with the wastes to be placed in the tank system.

5. The secondary confinement system must have sufficient strength to withstand stresses due to static head during a release, pressure gradients, climatic conditions, nearby vehicle traffic, and other stresses resulting from daily operations must be provided.

6. The secondary confinement system must be provided with an impermeable interior coating or lining which is chemically compatible with the waste to be contained, that will prevent the stored waste from migrating into the concrete if a release occurs must be provided.

7. The secondary confinement system must be capable of preventing a release from the tank from migrating laterally or vertically into the surrounding soil.

8. The liner must be free of cracks or gaps.

Note: Ecology does not feel concrete will meet the requirements for secondary confinement without a barrier or liner.

4.2 Requirements from HNF-SD-W314-TI-013, Revision 1, *Requirements Analysis Study for Special Protective Coating Project Development Specification*

Requirements that are presented in the Ecology section will not be repeated in this section.

Requirements:

1. Stainless steel liners will not be coated with special protective coating (SPC).

2. The SPC system shall be compatible with the waste radionuclides listed under the W-314 column in Table B-2 (Appendix B).

3. The top coating of the SPC system shall demonstrate relative ease of decontamination with a minimum Decontamination Factor (DF) of 100. The DF after initial water wash shall be a minimum of 20.

4. The SPC system shall develop the ability to resist the development of "holidays" with time.

5. The SPC system shall successfully fill or bridge cracks of 1.0 – 1.5 mm (0.040 to 0.060 inches) caused by thermal movement and stresses within concrete.

6. The SPC system shall be volatile organic content (VOC) compliant with a maximum VOC of 2.9 lbs/gallon (350 grams/liter).

7. The SPC system shall have minimum acceptable tensile properties as tabulated in Tables B-3, B-4, and B-5 (Appendix B).

8. The top coating shall demonstrate appropriate abrasion resistance properties. The acceptable abrasion resistance values of the installed coating are tabulated in Table B-6 (Appendix B). The weight loss values are for 1000 cycles when a CS-17 wheel is used with a 1000g load in accordance with ASTM D 4060.

9. The SPC system shall be capable of resisting the migration of liquid waste/water into the pit wall. The permeability shall be measured as follows:

   - The maximum water vapor transmission (WVT) rate for a top coating shall be 8 $gm/m^2/24$ hours.

   - The maximum water absorption rate for a top coating and joint sealant shall be 0.5% per 24 hours.

10. The SPC system shall display an adhesion property to the underlying concrete and previous coated surfaces. Minimum pull-off strength shall be 6,200 Kpa (900 psi).

11. The color of the topcoat shall be white or near white such that nozzle labels and markers can be painted over the topcoat.

12. Paint (coating) used for identification marking on the SPC topcoat shall be compatible with the SPC system.

13. The SPC system shall have a design life of 12 years when installed per the manufacturer's recommendations.

14. The SPC system shall be repairable for cracks appearing through the applied coated surface to the substrate for chips and flaking due to mechanical damage.

15. The SPC System must be compatible with an ambient air temperature range of 48.90°C (120°F) to –35.50°C (-32°F), with a maximum 24-hour differential of 29.90°C (52°F).

16. The SPC System must be compatible with a relative humidity range of 0 to 100 percent (the rate of change is negligible).

17. The SPC System must be able to withstand contact with the wastes [pH 7 to 14, temperature 27° to 93°C (50° to 200°F)].

18. The materials used in the pit shall be capable of operating in the following radiation environment:

Total accumulated dose:	6×10^7 rads
Dose rate:	1×10^1 r/hr

19. Any materials with unusual fire characteristics, such as urethane foams, and any materials that develop significant quantities of toxic or other harmful products of combustion, shall not be used as interior finishes or other interior application without the approval of the cognizant U.S. Department of Energy fire protection authority. The use of foamed plastics in construction shall be prohibited unless it fully complies with Factory Mutual 1-57.

4.3 Requirements From the July 24, 2000, Workshop and Other Sources

1. The tank pit liners/coatings must meet flammable gas requirements during installation and after it is fully cured.

2. The SPC system must meet environmental requirements during and following installation.

5.0 DECISION CRITERIA

Decision criteria are desirable characteristics, that are "like to have" traits. Unlike requirements, if a product or system does not meet a decision criteria, that product or system is not disqualified from consideration. A product or system that falls short on a decision criteria will receive a lower score than one that performs better in this area.

The decision criteria identified in Table 5-1 resulted from discussions held during the July 24, 2000, workshop. These criteria were utilized in the analysis as the basis for identifying the superior candidate for recommendation. The list on Table 5-1 is a consolidation of 20 desired traits that were identified during the workshop. These 20 traits were then consolidated under 8 decision criteria to form a manageable evaluation matrix. Each of the decision criteria were ranked in importance by using a pair-wise comparison technique. The final ranking established the weight each of the criteria. During the evaluation of the concept options, the decision criteria will be used to identify the superior option.

Table 5-1. Decision Criteria.

Decision Criteria	Weight
• As Low As Reasonably Achievable (ALARA) Considerations - Dose to workers to implement the repair is minimized - Can be deconned to low levels - Does not require (or minimizes) pit entry	8
• Cost - Costs to implement the repair are minimized	7
• Good Installation Characteristics - Installation of the repair minimizes the number of workers required and the time necessary to complete repair - Minimizes interactions with waste during installation and during use - Solution does not require removal of in-pit hardware	6
• Good lifetime - The repair will have a long lifetime- retains adhesion to the concrete it is applied to, tolerates additional concrete movement, maintains its integrity and physical characteristics	5
• Good physical characteristics - Good resistance to degradation when exposed to chemical wastes - Good elasticity to resist thermal effects and future cracks in concrete base - Ability to tolerate movement at joints - Improved toughness characteristics	4
• Good operating characteristics - Fire resistant and does not generate toxic fumes in the event of a fire - Minimizes interactions with waste during operation - Minimizes residual odors/smell in the pit or the origin of the smell can credibly be explained and shown not to be harmful - Satisfactorily deconned using water alone - Ease of inspection (defects in the coating easily show up)	3
• Minimizes Schedule	2
• Waste Generation - Waste generated is minimized	1

6.0 ANALYSIS OF ALTERNATIVES

The options identified in this study were researched to understand the performance characteristics of the system along with an assessment of safety, health, environmental characteristics/impacts, and costs to implement. The decision analysis process is premised upon the basis that all viable options must meet the requirements that have been identified in Section 4.0. Those that do not are discarded from further consideration. In the remaining sections of this report, each option is described as to how this application would be used to maintain/restore secondary containment capability in the tank pits. If the option does not meet key criteria, a brief discussion will be presented on which criteria are not being met and why the requirement(s) are not met. In some cases, it may appear that requirements are being violated, however discussions found with the specific option will explain why this is not the case. A specific example can be found with the requirement:

> "The SPC system shall display an adhesion property to the underlying concrete and previously coated surfaces. Minimum pull-off strength shall be 6,200 Kpa (900 psi)."

Coating systems probably do not require such high adhesion strengths, since the weak link in this system will be the concrete itself. The rule of thumb is that the tensile strength of concrete is 8 percent of the compressive strength. When typically using 3,000 lb. concrete, the tensile strength will be around 240 psi. Therefore, this study looked for material systems that could ensure that the concrete would fail before the coating could be pulled off the Amercoat®[3] or concrete surface.

Following a screening for compliance to requirements, the viable options were examined from a strengths and weaknesses viewpoint. In other words, no repair system was found to be strong in all areas and perhaps a mix and match approach would identify a superior hybrid system. The combination of the original concepts found to be viable and the hybrid concepts formed the basis for conducting the decision analysis.

6.1 Discussion of Alternatives

The potential candidates fall into two classes: liners and coating systems. In each class, a number of different materials and configurations were examined.

6.1.1 Liner Systems

Stainless steel liners seem to be the most logical solution based upon their inherent durability, long lifetime, and ability to resist chemical attack. The approach for establishing secondary containment is to build a box made from stainless steel. The box would be built in sections that could be lowered into the pit and then assembled in place. The seams would be sealed by metal inert gas welding. Though this approach will meet the requirements spelled out for secondary containment, its downfall resides in the complexity of installation in existing structures and the difficulty in establishing a seal around existing

[3] Amercoat® is a registered trademark of Ameron Protective Coatings Division, Brea, California.

penetrations. Entry into a pit would be unavoidable, which means that this concept will not score well in the decision criteria matrix.

The use of fiberglass as a liner system would have similar installation considerations that have been mentioned for stainless steel. However, fiberglass is not as durable, its lifetime is more limited than a metal liner, and its fire resistance is less. A particular concern associated with fiberglass would be its susceptibility to impact damage from dropped items and the difficulty in forming seals around existing penetrations. These limitations make fiberglass an inferior choice over metal liners. Fiberglass will not be considered further for secondary containment.

Thermal setting plastics were given cursory consideration as a liner material. Of the candidate materials examined, none were found that could resist sodium hydroxide in the concentrations expected to be present in the pits. Thermal setting plastics are discarded from further consideration.

6.1.2 Coating Systems

On a structurally sound base material, coating systems offer a good option for establishing a secondary containment. However, the pit structures contain numerous cracks and other defects, which may or may not be stable. All coating systems must be installed on a structurally stable base, however, some were able to tolerate small defects in the concrete.

Some types of coatings could also accommodate limited movement at crack interfaces, if bond breakers are applied at the crack. Bond breakers are tapes and/or sub-coatings that are applied over a crack that prevents the coating from adhering in the area immediately adjacent to the edge of a crack. The bond breaker allows the crack movement to be absorbed over a greater area of the coating. The more significant damage to the concrete structure was found in the region located above the cover block ledge (Figure 6-1). This damage tended to be crushing damage that had cracks extending from it. A number of repair methods were documented in American Concrete Institute reports on crack repair. The use of injectable polyurethanes and epoxies appear to be the superior choice for repair and have been used successfully to repair underground pit structures.

None of the coating systems that were identified were discounted because of toxic or hazardous components present during installation. It was assumed that special precautions would be taken through engineered and/or administrative controls in accordance with manufacturers' recommendations to mitigate any potential problems.

6.1.2.1. Powder Coat Option

Powder coating is often used to protect materials from heat and chemical attack because it forms a smooth, waterproof, and chemical resistant finish that is very durable. The process of powder coating involves spraying a mist of electrostatically charged resin and pigment particles that are then attracted to the base material to be coated. This process depends on the base material being electrostatically grounded so that the charged powder particles will stick to the base and can then be cured into the final

Figure 6-1. Damage Caused By Coverblock.

finish. Therefore, the base material must be metal, or have enough metal in it to attract the charged powder particles. Non-metallic base materials, such as concrete and old epoxy paint, would not be able to be grounded and would therefore not attract the charged powder being sprayed. After the spraying process, the curing process for the powder coat takes place. This requires that the surface to be coated be heated to a minimum of 325 °F, and in most cases the surface must be heated to temperatures exceeding 400 °F. Once applied, this coating would satisfy most of the requirements specified for this project, but since the application process cannot be performed with concrete, it is being rejected from consideration as a possible candidate.

6.1.2.2. Ceramic Coatings

Ceramic coatings are often used for temperature and wear protection in areas where normal coatings cannot be used. The most promising of these products found is CeRam-Kote 2000, a sprayed-on ceramic epoxy coating system that is meant for use in extremely harsh environments.

This product meets many, if not all, of the requirements for this project. It can be applied using either an airless or conventional spray system. Having an epoxy base, this coating will most likely cure and be smooth and easily decontaminated, and it will not develop "holidays" during the application or curing process. CeRam-Kote has acceptable elastic properties, which allow it to be stretched at least 30 percent longer than its original length. This indicates CeRam-Kote will be able to bridge existing cracks in the

concrete base, it will also be able to stretch if more cracking should occur in the future. The WVT and water absorption values for CeRam-Kote are extremely low. The VOC of this product is 1.56 lb./gal. which is below the 2.9 lb./gal. requirement. The coating is extremely abrasion resistant and also has a very high tensile strength. The adhesion strength of this product is greater than any other that was found (it exceeded 4,000 psi in pull-off tests). The product is available in a range of colors that includes white, tan, and gray. If cracks should appear in the future, all that need be done is to sand the area surrounding the crack and apply another coat over the affected area. This product is able to withstand extremely high or low temperatures, whether wet or dry, and is compatible with a humidity range of 0-100 percent. The coating is recommended for immersion service with a 70 percent NaOH solution.

This product has uncertainties that must also be mentioned. It is not known how the coating would react to radiation, as it has never been tested in a radioactive environment, however, epoxy compounds typically have excellent resistance to radiation exposure. A filler or backing material may be required to fill larger cracks in the pit walls and floors before the coating is applied. No product literature was provided to show CeRam-Kote will have a operating life of 12 years once installed the basic properties of epoxies, however, suggest that an operating life in excess of 12 years is a reasonable expectation. Also it is not known how much preparation would be needed to make the coating adhere well to a previous coating of Amercoat® epoxy paint. Most likely the surface would need to be thoroughly cleaned and then abraded in some fashion (such as sandblasting, sanding, or etching) before the product could be applied. Despite these uncertainties, this epoxy ceramic product seems to meet requirements and will be considered further.

Aside from this one product, which is an epoxy-ceramic mixture, there are many other types of ceramic coatings. Most are a ceramic enamel type of coating that, once applied, have outstanding heat resistant properties. Such coatings are used in high temperature conditions such as stove pipes, automotive engine and exhaust systems, and space shuttle exteriors. The heat handling capabilities of ceramic coatings of this type far exceed anything that would be encountered in the Hanford tank pits. Aside from this one attribute, these ceramic coatings fail to meet many of the project requirements. Ceramic coatings like this do not meet the water absorption or decontamination requirements, and require high temperatures to cure. Ceramic epoxy coatings are rejected from further consideration.

6.1.2.3. Sherwin Williams Industrial and Marine Coatings

Sherwin Williams offers an extensive line of products meant for coating both concrete and metal products. Most of their products offer protection from chemical attack, but one product appeared to fit the needs of this project better than all the others. Sherwin Williams® Kem®Cure Tank Lining is a two-component hybrid coating comprised of organic thermoset polymer and inorganic silicon oxide. It is meant for immersion and secondary containment use in situations that require resistance to alkalis, corrosion, flexing and stressing, impact, abrasion, and thermal shock.

This product meets or exceeds all the requirements of this project and in addition can be applied with a brush, roller, airless spray, or conventional spray methods. The coating has a gloss finish, which would most likely be easily decontaminated with water. If applied and allowed to cure properly, the product will be free of "holidays," cracks, and voids. The coating has a 8.2 percent elongation capability that

meets requirements, but may be inadequate to accommodate future expansion and cracks. Further testing is needed. The VOC content is 0.9 lb/gal, which is well below the 2.9 lb./gal. allowed for this project. The tensile strength of this product is 13,240 psi and the flexural strength is 13,443 psi. Water absorption was 0.09% after 33 days at 88°F. The adhesion strength of the product was 2,850 psi. The coating is easily repaired for cracks after it has been applied by sanding the cracked area and applying another coat over the sanded area. The product can also withstand conditions of –40 °F to 500 °F and is compatible with highly alkaline environments.

This product has several drawbacks. It is only available in two colors, off-white or gray, and not pure white. It may be necessary to use a filler material or other method of covering the existing cracks before the product could be applied. Surface preparation before application would most likely involve some sort of abrading of the surface that the product is to be applied to. The fact that this is a thermoset polymer material means that in order to achieve the fastest curing times, the coating must be heated after application. Otherwise, even with proper ventilation, the coating could take up to 14 days to fully cure. The recommended method of allowing the coating to cure is to heat the applied coating to 180 °F for a minimum of four hours. This could be achieved by placing a heat lamp or other heat source in the pit. After the coating has cured, it will meet or exceed the requirements for this project. This product meets all requirements and will be considered further.

6.1.2.4. Polyurea

Polyurea is a fast set, rapid curing, 100 percent solids, and flexible, two-component polyurea elastomer spray coating material. Polyurea is used by itself or in conjunction with other materials to produce coatings, liners, and resilient surfaces on concrete substrates. The material has an extremely fast gel time that makes it suitable for applications in cold or hot environments. The polyurea produces an extremely tough film at all thicknesses. Single or multiple pass applications produce films from 10 mils to 1,000 mils without appreciable sag or runs. Polyurea is inert, it will not hydrolyze, leach, or contaminate other materials and is relatively moisture and temperature insensitive, allowing application in the most problematic ambient conditions.

Polyurea is a coating material designed specifically for industrial applications receiving constant or intermittent attack from contained materials, subsurface hydrostatic pressure, most corrosive substances, and abrasive action. The material is flexible (200% elongation), accommodating movement of the substrate, yet strong enough to remain intact under adverse conditions. Polyurea is recommended for liner/coating, repair of other films, damaged concrete, or new concrete construction.

Polyurea coatings do not meet the abrasion resistant properties identified in the subject requirements. The requirements are meant to ensure a protective coating that could withstand contact (scraping, etc.) with heavy equipment utilized during all types of operation in and around the pits. Further, it was found that the polyurea exhibits relatively weak resistance to tear/cutting damage when solid objects are dropped.

Polyurea coatings do not display the adhesion properties identified in the subject requirements. The requirements are meant to ensure the coating adheres to the existing epoxy and concrete so that the liner

would not "pull-off" and leave the surface unprotected. However, the data suggests that the polyurea will bond to the existing epoxy at a higher value (approximately. 600 psi) than the strength the epoxy to concrete can produce.

The above information is a summary of the product evaluation found in Appendix C.

In addition to the information provided in the product literature, local vendors of polyurea coating products provided demonstrations of material application. The demonstrations simulated surface conditions and configurations that have been observed in the tank pits. Some of the more notable observations during the demonstration was the ability of polyurea to adhere to various surfaces with varying levels of contamination (coated with sugar/glycol solution) and the ability to bridge and/or fill racks up to ½" in cement blocks without surface preparation or prior crack filling. The vendor added that nails could be fastened to the wall prior to applying the coating to reduce the uncertainties associated with lack of adhesion due to poor surface preparation. This material will be considered further.

Note: A number of vendors were identified as potential suppliers of polyurea. It became apparent that all were using blends of the same basic materials and each could probably supply a product that addressed our needs. Therefore, it is probably appropriate to solicit the best price through the procurement process using a performance specification to ensure adequate performance.

6.1.2.5. Epoxy Coatings

Amercoat®351 is manufactured by Ameron, Inc., and is a solventless, high performance epoxy based coating that can be applied with standard airless equipment. It is suitable for use with highly caustic chemicals (such as the tank waste) for coating concrete. A glass flake additive can also be used with the coating to increase film buildup, further reinforce mechanical properties, and lower moisture permeability. Dry film thickness per coat is 8 to 12 mils and 12 to 25 mils with the glass flake additive. The coating is a two part epoxy system where the resin and the cure must be mixed immediately prior to application.

The Ameron epoxy will meet many but not all requirement that have been specified for secondary containment. The coating cures to a gloss finish that is decontaminable based upon prior demonstrations and on site usage of epoxy coatings. Amercoat®351 will meet abrasion specification (41mg. wt. Loss). The adhesion properties at 1,200 psi exceed the tensile strength of the base concrete. There are no VOCs per the vendor's literature. This type of epoxy is compatible with caustics up to 50 percent solutions at 160 °F.

On the negative side, the Amercoat®351 claims no elongation capability and typically hard finish epoxies do not exhibit elongation ability. Another shortcoming is that this coating may not be able to withstand contact with 200 °F wastes.

Discussions with Ameron Inc. technical representatives indicated that the coating can be applied over Amercoat®33 if it is in good condition (i.e., not peeling), without acid etching or priming (Gilbert 1996).

The surface would need to be cleaned and patched and then mechanically abraded before applying the first coat of Amercoat®351. A total of three coats, each 8 to 12 mils thick, would be used. If the existing coating is in good condition, another option would be to clean and patch the existing surface and apply one coat of Amerlock®[4]400 (5 to 8 mils thick), which is a self- priming topcoat for use over existing coatings, and then apply two coats of Amercoat®351. Amercoat® is the baseline and considered representative of typical epoxies.

6.2 Hybrid Approaches

As mentioned earlier, no single concept possessed strengths in all categories covered by the decision criteria. However, some were strong in most areas with significant weaknesses in a few areas and, hence, it appeared reasonable to combine concepts that exploited the strengths of one concept to correct the weakness of another.

In this study, the most promising containment approaches were based upon using stainless steel to form a box within the pit and to use sprayed on coatings such as polyurea/epoxies that could be applied directly on the walls and floor. The use of stainless steel met all stated requirements, but falls short in the area of ease of installation, ALARA, and overall costs (due largely to the difficulty associated with fabricating a metal box within an existing structure in the presence of a radiation field). On the other hand, the sprayed on coating, such as the polyureas and epoxies also had deficiencies. As a class, they most likely require surface preparation (which may be difficult in radiation environment), long-term adhesion is a question, and they were weak in areas where an impact was possible. All other concepts failed to meet minimum requirements for reasons discussed in the previous section.

A range of hybrid options are possible using a combination of the strengths of stainless steel and sprayed on coatings. On one end of the range, a prefabricated stainless steel box is cut into modular sections designed to fit in a particular pit. The sections are lowered into place in sequential order such that the joints make a reasonably tight fit. The joints are then sealed using a polyurea.

Because close fitting joints are difficult to achieve in an existing structure without undue handling (and hence radiation exposure), a less demanding approach focusing upon using stainless steel "wall paper" to provide a prepared surface onto which a coating, such as polyurea, could be applied and considered. The stainless steel "wall paper" would be held in place by nails driven by a powder actuated gun and the floor would be allowed to float. The entire pit would then be sprayed with a coating system, such as polyurea. In this case, the "wall paper" stainless plates would be easily installed, loose fitting plates.

At the other end of the range, stainless steel would only be used for the floor and the floor and walls would be sprayed with a coating system. The metal floor would address the inherent weakness of coating systems to impact and cutting damage. If a nick or cut should occur, it would be unlikely to damage the stainless steel underneath and secondary containment integrity would be maintained. Since the floor receives the most exposure to dropped equipment or even heavy items being set down, a more durable floor system would be appropriate. Further, if the original floor could not be significantly

[4] Amerlock is a registered trademark of Ameron Protective Coatings Division, Brea, California.

decontaminated, a thicker plate could set in place to help reduce the radiation source from the floor. In any event the floor plate would be prepared to optimize coating system adhesion.

6.3 Decision Analysis Process and Results

6.3.1 Secondary Containment Restoration Systems

A decision analysis employing weighted decision criteria was developed to identify the superior option for restoring secondary containment capability in the tank pits. The selected options will meet the requirements identified for this type of containment system. The superior option is that concept that is better than all the others in meeting or exceeding desired goals (called decision criteria) that are in many cases above and beyond the baseline requirements. The decision criteria and their relative weightings were developed during the facilitated workshop conducted July 24, 2000. The decision criteria are found in Table 5-1. The members selected to participate in that workshop provided a broad base of tank farm experience that span project management, tank farm engineering, safety, and environmental health.

Each concept is ranked relative to the other concepts to determine which is the best at meeting that particular criteria. The rankings are then multiplied by the weight for that criteria to obtain an overall score. Finally, all the scores for a candidate option are added together to obtain the total score. The highest scoring concept becomes the recommended option.

Based upon the analysis, see Table 6-1, the sprayed on coating system is the recommended system for restoring secondary containment in the tank pits. The use of a sprayed on coating is superior in the area of ALARA considerations because it minimizes the need for pit entry. It also scores well when considering installation characteristics, since the sprayed on coatings, such as polyurea, do not require prior crack repair prior to applying the coating.

The use of a steel plate on the floor is a close second in the scoring. The principle reason is the uncertainty associated with adhesion of sprayed on coatings to surfaces that have minimal preparation. The scoring process assumed that minimal surface preparation was required before the spray coating system was applied; however proper adhesion may be a concern over the design life. The use of a steel plate that has been pre-prepared on the floor will minimize this concern, but the increased effort to install a plate system caused this approach to fall behind a coating-only approach.

6.3.2 Coating Systems

The original intent of this study was to evaluate and select a superior coating system for this application. However, of the three leading candidates identified, none could clearly be identified as a recommended choice.

- Polyurea Systems
- CeRam-Kote 2000
- Sherwin Williams® Kem® Cure Tank Lining

A decision analysis was unable to distinguish the properties of one system as being favored above the others. If there were differences between products, it was not clear that they had superior characteristics with the exception of polyurea's superior elongation properties and crack filling capabilities. Based upon product literature and vendor contacts alone, it was not clear that claims of chemical and physical properties could be substantiated or that a one-to-one correlation to our conditions was appropriate. However, CeRam-Kote and the polyureas appear to offer good crack filling capability along with good elongation properties (polyurea excels in this area). All three will likely provide adequate performance for our intended application. Should only a coating system be pursued, the Polyurea System (subject to cost confirmation) is the preferred option. However, testing to confirm performance charactertics of all three candidates is recommended (more to follow).

Table 6-1. Tank Pit Secondary Containment Decision Analysis.

DECISION CRITERIA	WEIGHT	CANDIDATE OPTIONS			
		SST Box Sealed at Edges and Penetration	SST Panels on Walls and Floor, Large Gaps	SST Plate on Floor with Walls and Floor Coated	Coating System
ALARA Considerations *	8	1 8	2 16	3 24	3 24
Overall Costs	7	1 7	2 14	3 21	4 28
Installation Characteristics *	6	1 6	2 12	3 18	4 24
Good Lifetime -	5	4 20	3 15	2 10	1 5
Physical Characteristics	4	4 16	3 12	2 8	1 4
Operating Characteristics	3	4 12	3 9	2 6	1 3
Minimizes Schedule	2	1 2	2 4	3 6	4 8
Waste Generation <>	1	0	0	0	0
Score		71	82	93	96

Notes:
Number in left corner is the relative rank and center number is score (rank x weighting) (1 = Lowest, 4 = Highest)
* Uncertainty over floor surface preparation (lack of adhesion) caused polyurea to score slightly lower
\- Stainless steel is the most durable of all materials found: better lifetime with more SST
<> Waste generation was considered about equal for all concepts
\+ Both the SST plate on floor and coating system alone scored the same, since it was not clear one was a clearly superior option

7.0 ANALYSIS OF LIFE-CYCLE COSTS FOR VIABLE ALTERNATIVES

The components considered in developing life-cycle costs for the recommended options are:

- Original Installation Costs,
- Maintenance Costs,
- Removal Costs (if required) and
- Re-installation Costs (if required).

The installation costs associated with the hybrid options evaluated by decision analysis in Table 6-1 are shown in summary on Table 7-1. The detailed cost makeup for each option can be found in Appendix D. The basis for these estimates is based upon vendor quotes for materials and fabrication and engineering experience associated with on site construction.

Table 7-1. Installation Costs

Option	Cost (/pit)
1. SST Box Sealed at Edges and Penetrations	$64,735*
2. SST Panels on Walls and Floor, Large Gaps (Wall Paper Approach)	$50,600*
3. SST Plate on Floor with Walls and Floor Coated	$42,400*
4. Coating Systems	$28,700

*$2K added for pit floor photogrametry

Maintenance costs for all the options is considered to be minimal to none for all the options. However, there is a risk associated of poor adhesion of the coating system over the 12-year life requirement that may lead to early failure. In that event, the damaged sections would have to be removed and re-installed. This scenario is not anticipated for Options 1 and 2 where the coating will be applied to surfaces that have been prepared in accordance with vendor recommendations. It is options three and four where the coatings are to be applied over old epoxy surfaces that will receive minimal preparation that poses the concern.

Removal of any of the coating materials poses a unique challenge, because of the difficulty of accessing the pits and the potentially high radiation backgrounds. It is envisioned that a crew equipped with scraper knifes mounted on long poles would remove the defective coating in specific areas (especially around the top edge) and then re-apply a replacement coating. The effort required to accomplish such a task is estimated to require a crew similar in size to the original installation crew for a two-week period, which may represent a $65,000 risk in the future if repair is required. Assuming that a coating failure does not occur during the life of the pit, then installation costs would constitute the entire life-cycle cost. In that case, a straight sprayed on coating would be the least expensive followed by a sprayed coating in combination with a floor plate.

8.0 RISK FACTOR EVALUATION

There are a number of risks associated with the application of any new coating material in radioactive/contaminated pits. The hybrid solutions have these same issues where coating systems are used. In an effort to improve the coating performance from the existing practices, different materials were examined and compared to identify the best possible material for the required application. As the evaluation was performed, different concerns arose specific to the application/performance of polyurea and the other recommended sprayed on coatings in the 200 Area pits. Due to the relatively recent technology involved with these coatings, vendors do not have significant records identifying product performance in "like" applications. The lack of vendor data does not suggest that the material properties will not be satisfactory, it does, however, introduce a level of uncertainty. The material properties listed below are identified to have uncertainty associated with their performance. The material properties, the risk associated with those properties, and a possible path forward to mitigate the risks are shown below.

- A smooth/easily decontaminated surface: There is no objective evidence or data to ensure a field applied polyurea will produce a smooth, easily decontaminated surface. Small holes and other abrasions appear on the samples of polyurea obtained from the vendor (assumed to have been applied in optimal conditions). A sample of polyurea fixed to a cement block, applied in a similar manner as suggested for the pits, resulted in surface coating pits larger than the samples obtained from the vendor. The effectiveness of future decontamination efforts may be reduced with the presence of these pits.

  Path Forward: Establish a test employing application methods and conditions like that planned for the pit to examine the effects of different cure times and component mixtures on surface conditions. The polyurea would be remotely sprayed to simulated pit walls.

- A long design life: There is no objective evidence of product lifetime for any of the coating products that were examined. The polyurea products had limited data (approximately eight years) on use of their product in a nuclear application.

  Path Forward: Establish tests to expose the material to simulated environmental conditions to document how the material will respond. Of particular concern is exposure to strong caustic solutions and elevated temperatures for potentially prolonged periods.

- Good resistance to surface damage: There is concern that polyurea, and to a lesser extent the other coating systems, will not withstand the damage that may occur from operations and maintenance activities in the tank pits.

  Path Forward: Conduct tests to evaluate the damage that could be expected from operations and maintenance activities.

9.0 RECOMMENDATIONS AND ITEMS REQUIRING FURTHER RESOLUTION

- The recommended secondary containment system is a sprayed on coating system.
- Three coating systems appear to provide acceptable performance with polyurea systems being superior in the areas of elongation and crack filling capability. However, further testing is recommended to confirm vendor's performance claims.
- It is suggested that the tear-off strength requirement imposed upon coating systems be reduced to match the tensile strength of concrete.
- It is suggested that the compatibility of the three coating systems with pit environment, in particular chemical compatibility be verified through testing.
- It is suggested that the near-term and long-term adhesion ability of the three coating systems on minimally prepped epoxy, especially around floor penetrations and along top edge be verified.
- It is suggested that that the remote application techniques be reviewed to assure they will be successful.

10.0 LIST OF PARTICIPANTS AND QUALIFICATIONS

The following are a list of the participants of the facilitated workshop held July 24, 2000, along with their qualifications:

John Bailey

Mr. Bailey is currently the Lead Project Engineer for Project W-314 Phase 2. He has 25 years of nuclear facility process and project engineering and project management experience mainly in the area of nuclear waste management (waste storage tanks, pumping systems and transfer facilities). He maintains Hanford qualification cards as Facility Cognizant Engineer, Design Authority, and Project Engineer.

Todd Blaak

Mr. Blaak is currently a Cognizant Engineer for DST, Engineering, Tank Chemistry/Waste Compatibility and Transfer Systems. His background related to this effort includes the following: Member of Pit Decon team which evaluated decontaminating pits on-site and screened potential replacement coating for pits; evaluated decontamination chemicals and fixatives prior to use on-site; and knowledge of transfer systems including pit configuration.

Dave Bowers

Mr. Bowers has over 26 years of operations and engineering experience with Hanford Tank Farms. He maintains qualification cards as Facility Cognizant Engineer and Design Authority for Project W-314. He has a B.S. degree in General Science (Radiation Science and Health Physics) from Oregon State University with extensive post-graduate classes in engineering.

Nancy Butler

Ms. Butler is currently the Construction Manager for Project W-314, *Tank Farm Infrastructure Upgrades*. She is a certified Industrial Hygienist in comprehensive practice per the American Board of Industrial Hygienists. She has a B.S. in Environmental Health, M.S. in Environmental Health/Industrial Hygiene, and eight years of U.S. Department of Energy working at the Hanford Site and at the Los Alamos National Laboratory. Ms. Butler also has 10 years of environmental protection and restoration experience.

Robin Fogg

Mr. Fogg's qualifications include an M.S. in Environmental Sciences at the Harvard School of Public Health, board certifications in Industrial Hygiene (CIH) and Safety Professional (CSP), and over 24 years of field experience in industrial hygiene and safety. In his current position as Industrial Hygienist for CH2M HILL Hanford Group, Tank Farm Projects, Mr. Fogg provides industrial hygiene oversight to tank farm upgrade construction projects, including reviewing/approving work documents, auditing work activities, conducting personnel monitoring, and reviewing sampling data to ensure compliance with standards.

Bruce Groth

Mr. Groth is a Senior Engineer with ARES Corporation responsible for conducting Engineering Studies, Conceptual Design Reports, preparation of specifications, estimating, detail design and performing design reviews, in addition to other engineering duties. As a Systems Engineer, he has extensive knowledge of design requirements contained in State and Federal regulations. He has over 15 years of experience in the design and operation of nuclear facilities. He has B.S. degrees in Chemistry and Mathematics from Willamette University.

John Guberski

Mr. Guberski has a B.S. degree in Nuclear Engineering and 20 years of experience in applying environmental, nuclear safety and industrial safety regulations to commercial power plants or industrial facilities. He has seven years of direct responsibility for environmental compliance at an electrical cable manufacturing plant and at a Resource Conservation and Recovery Act of 1976 treatment, storage, and disposal facility. He also has prepared environmental permit applications for National Pollution Discharge Elimination System and air emissions permits.

Mike Harty

Mr. Harty has a B.S. degree in Environmental Engineering and Health Physics from Washington State University. He has 26 years of engineering/operations experience with the majority of the Hanford Site, primarily Plutonium Uranium Extraction Facility, Plutonium Finishing Plant, and Tank Farms.

Paul Patterson

Mr. Patterson has over 15 years as a consultant, facilitator, and writer supporting various Hanford Site and Idaho National Engineering Laboratory projects. He has facilitated and supported safety and regulatory identification processes, hazard analysis sessions, and alternatives generation studies; authored documents resulting from the facilitated processes, including hazard analysis reports and a Safety Requirements document analysis; participated in operational readiness reviews; designed and developed training and qualification programs; presented specialized training programs; designed and facilitated specialized group processes for conflict resolution, team building, communication, and interpersonal skills development.

Eric Shen

Mr. Shen has over 26 years of experience leading and managing project teams to develop remote mechanical systems and facilities in support of the space reactor program, tank waste recovery, spent nuclear fuel recovery, and the next generation fusion test facilities. He has a BSME degree from Colorado State University and is a registered Professional Engineer in both Colorado and Washington.

Dave Sparks

Mr. Sparks has been a Field Crew Manager in Tank Farms for 10 years. He has been a member of many "Pit Decon" teams during the past seven years. He has a thorough knowledge of the tank farm "pits" and transfer systems. The Nuclear Chemical Operators that work in his group do all pit jumper changes and pit decon activities.

11.0 REFERENCES

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12.0 TRADEMARKS

Amercoat®33, Amercoat®351 , Amerlock®400, and NuKlad 114 are registered trademarks of Ameron Protective Coatings Division, Brea, California.

CeRam-Kote 2000 is a registered trademark of Freecom, Inc., Big Springs, Texas.

Sherwin Williams® Kem Cure® Tank Lining is a registered trademark of the Sherwin Williams Company, Cleveland, Ohio.

Appendix A
Current Practices for Crack and Coating Repair

Current Practices For Crack And Coating Repair

For cracks (hairline or less in width), chips and spalling: local repair is the current approach. This includes:

- Preparation for coating repair: Wash, apply fixative, remove cover blocks, remove the jumpers and miscellaneous equipment, cover penetration openings, high pressure water wash (whole pit), install shielding (lead blankets), remove dirt and debris, inspect the pit for damage (photos), prep for Amerlock® 400 (flush and rough up surface) and
- Apply two coats by roller: Poured in then spread around. (This approach poses a problem on future projects; no entry is possible in an pit and entry is discouraged in other pits.)

For cracks greater than hairline, the steps include:

- Determine if pit is structurally sound and agree upon repair process;
- Prep the structure and coating surfaces for repair (clear out the crack regions);
- Inspect the crack damage;
- Decide which cracks need to be cut out: Remove paint 2" on each side, clean crack out (water and vacuum), if the crack is less than 1mm, coat crack with Amercoat®400, and then fill with NuKlad 114, if the crack is greater than 1mm, use saw to create a .5-in. trapezoidal cut into crack for the entire length and then fill with a non-shrink grout);
- Allow the grout to cure to manufacturer's recommendations (Note: Additional costs incurred due to need to add water for curing and interim checks);
- Inspect the repairs;
- Prep for Amercoat® (see previous process steps for <1mm cracks);
- Apply four coats of Amerlock®400 on floors and two on the walls, minimum;
- Inspect each coat in pit; and
- Reinstall the jumpers and equipment.

Other Past Practices: Repoured the floor, reformed the damaged lips, 236-Z Canyon SS liner repair (puncture fixed with devcon), M Cell Purex (SS liner punctured repaired by welding a patch), poly bladders, pressure grouting at 225-B Cesium Cell.

Appendix B
Properties Tables

Table B-1. Chemical Composition Range (2 Sheets)

RETRIEVED WASTE				
SPECIES	DST		SST	
	Anion/Cation		Anion/Cation	
	Min mol/L	Max mol/L	Min mol/L	Max mol/L
Ag	0	0.0013	-	-
Al	0.05	1.1	0.029	0.5
As	0	0.0066	-	-
B	0	0.013	-	-
Ba	0	0.0004	0	0.0014
Bi	-	-	0	0.076
Ca	0.0014	0.1	0	0.17
Cd	0	0.0074	0	0.0007
Cr	0.0067	0.28	0.0001	0.091
Cu	0	0.02	-	-
Fe	0.0004	0.26	0.0057	0.89
Hg	0	2.8E-05	0	0.0001
K	0.044	0.55	0.0002	0.0095
La, Nd	0	0.0066	0	0.001
Mg	0.0004	0.046	-	-
Mn	0.0003	0.16	0.0009	0.41
Mo	0	0.0029	-	-
Na	1.6	10.7	1.6	7.1
Ni	0.0002	0.008	0	0.042
Pb	0	0.004	0	0.12
Pd, Rh	0	0.0063	0	0
Si (SiO_2)	0.0024	0.028	0.0004	0.46
Ti	0	0.002	-	-
U	0	0.0092	-	-
Zr (ZrO_2)	0	0.3	0	0.065
Acetate	-	-	0	0.0055
Citrate	0	0.03	0.0042	0.06
EDTA	0	0.016	0	0.011

Table B-1. Chemical Composition Range (2 Sheets)

RETRIEVED WASTE				
SPECIES	DST		SST	
	Anion/Cation		Anion/Cation	
	Min mol/L	Max mol/L	Min mol/L	Max mol/L
HEDTA	0	0.021	-	-
Fe $(CN)_6$	-	-	0	0.025
Cl	0.003	0.17	0	0.022
CO_3	0.03	0.69	0.014	0.38
F	0.014	1	0.001	0.71
Fission Product	0	0.0001	-	-
NO_2	0.1	1.8	0.0086	0.83
$NO_x(NO_3)$	0.15	3.6	0.64	5.1
OH	0.24	4.4	0.25	6.9
PO_4	0	0.4	0.0007	3.8
SO_4	0.003	0.16	0.01	0.22
TOC	0	2	-	-

Notes:

DST = Double-Shell Tank
EDTA = Ethylenediametetraacetic acid
HEDTA = N-(hydroxyetheyl)-ethylenediaminetriacetic acid
SST = Single-Shell Tank
TOC = Total Organic Carbon

Basis: *This is the cross-site transfer system chemical composition from the "Recommended Waste Composition Changes to the MWTS FDC-Rev. 1," Waste Management Engineering internal memo 22170-93-012 to J. M. Light, June 23, 1993, Westinghouse Hanford Company, Richland, Washington. The waste composition from the cross-site transfer system is the worst-case for the W-314 transfer piping.*

Table B-2. Radionuclide Concentrations

NUCLIDE	Nuclide concentrations (Bq/L)		
	All Liquids[a]	All Solids[a]	W-314[b]
^{14}C	2.3 E + 05	1.6 E + 05	2.3 E + 05
^{60}Co	9.5 E + 06	4.9 E + 08	1.7 E + 08
^{79}Se	[c]	1.7 E + 04	1.7 E + 04
^{90}Sr	1.1 E + 10	2.9 E + 12	9.6 E + 11
^{90}Y	1.1 E + 10	2.9 E + 12	9.6 E + 11
^{99}Tc	1.7 E + 07	1.2 E + 10	4.0 E +09
^{106}Ru	9.9 E + 02	7.2 E + 04	2.4 E + 04
^{126}Sb	3.4 E + 04	1.8 E + 08	5.9 E + 07
^{129}I	2.0 E + 04	6.4 E + 06	2.1 E + 06
^{134}Cs	6.1 E + 06	9.4 E + 06	7.2 E + 06
^{137}Cs	8.8 E + 10	1.0 E + 11	9.2 E + 10
^{144}Ce	9.1 E + 00	3.4 E + 02	1.2 E + 02
^{147}Pm	3.6 E + 07	[c]	3.6 E + 07
^{154}Eu	2.4 E + 09	1.1 E + 10	5.2 E + 09
^{155}Eu	5.9 E + 07	5.0 E + 06	5.9 E + 07
^{237}Np	2.3 E + 05	9.9 E + 08	3.3 E + 08
^{238}Pu	1.8 E + 06	1.9 E + 08	6.4 E + 07
^{239}Pu[d]	3.6 E + 07	1.6 E + 09	5.5 E + 08
^{241}Pu	2.6 E + 08	3.8 E + 09	1.4 E + 09
^{241}AM	4.2 E + 07	1.1 E + 10	3.7 E + 09
^{242}Cm	1.1 E + 01	2.0 E + 02	7.3 E + 01
^{244}Cm	4.2 E + 05	6.1 E + 07	2.0 E + 07

Notes:

[a] From Table 1a, Van Keuren, J. C., 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for use in Safety Analysis Consequence Assessments,* WHC-SD-WM-SARR-016, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

[b] W-314 values represent a bounding mixture for design of 67% liquid and 33% solid, except for ^{14}C and ^{155}Eu where the maximum liquid value was used as it is higher than the mix and for ^{79}Se and ^{147}Pm where data is not available

[c] No available data.

[d] The ^{239}Pu activity concentration also includes ^{240}Pu.

Table B-3. Tensile Properties of Coatings

Properties	Rigid Coating (Epoxy)	Flexible Coating (Elastomeric)
Tensile Strength	N/A	Maximum 20,700 KPa
Elongation at break at 24°C (75°F)	Minimum 5 percent	Minimum 400 percent at 30 days

Table B-4. Tensile Properties of Joint Sealants

Properties	Flexibilized Epoxy	Fluoroelastomer, Polysulfide, Polyurethane
Tensile Strength	Minimum 3,500 KPa (500 psi)	Minimum 10,400 KPa (1,500 psi)
Elongation at break at 24°C (75°F)	Minimum 100 Percent	Minimum 100 Percent

Table B-5. Tensile Properties of Fillers

Properties	Solid Epoxy Mastic
Tensile Strength	Minimum 3,500 KPa (500 psi)
Elongation at break at 24°C (75°F)	Minimum 20 Percent

Basis: *The tensile strength and percent elongation at break are measures of the tensile properties of coating and sealant materials. The acceptable values are in accordance with the requirements outlined in Chemical Resistant Decontaminable Coating Guide Specification GSO9855.SP. The requirements are based on available data from manufacturers of the type of coatings currently used at the Hanford Site.*

Table B-6. Abrasion Resistance Properties of Coatings

Properties	Rigid Coating (Epoxy)	Flexible Coating (Elastomeric)
Abrasion Resistance	Weight loss less than 100 mg	Weight loss less than 10 mg

Appendix C
Product Evaluations and Vendor Literature

C1.0 POLYUREA PRODUCT EVALUATION

The objective of this product evaluation was to assess the characteristics associated with polyurea to determine its feasibility for use on 200 Area pits, supporting the Waste Feed Delivery System. The material was evaluated specifically for use as a secondary confinement barrier for pump pits and valve pits throughout the 200 Area Tank Farms.

Polyurea is a fast set, rapid curing, 100 percent solids, and flexible, two-component polyurea elastomer spray coating material. Polyurea is used by itself or in conjunction with other materials to produce coatings, liners, and resilient surfaces on concrete substrates. The material has an extremely fast gel time that makes it suitable for applications in cold or hot environments. The polyurea produces an extremely tough film at all thicknesses. Single or multiple pass applications produce films from 10 mils to 1000 mils without appreciable sag or runs. Polyurea is inert, it will not hydrolyze, leach, or contaminate other materials and is relatively moisture and temperature insensitive, allowing application in the most problematic ambient conditions.

Polyurea is a coating material designed specifically for industrial applications receiving constant or intermittent attack from contained materials, subsurface hydrostatic pressure, most corrosive substances, and abrasive action. The material is flexible, accommodating movement of the substrate, yet strong enough to remain intact under adverse conditions.

Polyurea is recommended for liner/coating, repair of other films, damaged concrete, or new concrete construction. The following are a sample of simple profiles regarding use of the polyurea material in chemical and nuclear applications:

- Great Western Chemical Tank Farm – Two 30,000-gallon tanks were sprayed at 40 mils thick to provide a chemical resistant protective coating/secondary containment. The polyurea material was chosen because it is fast setting, abrasion resistant, bird proof, seamless, and creates a one-piece, well-adhered liner.

- SRS Savanna River Site Nuclear Waste Processing Plant – Three square miles of low level contaminated concrete were sprayed (encapsulation of existing coating) to protect the surface from spreading contamination.

- Waste Isolation Pilot Plant (WIPP) – Polyurea was used on wash pads (concrete slabs) with heavy traffic to provide a radiological safe environment.

To evaluate the applicability/feasibility of the product for the application required, a detailed assessment was performed using requirements derived from WSDOE, *Guidance for Assessing Dangerous Waste Secondary Containment Systems,* Pub #95-420 and HNF-SD-W314, Rev 1, *Requirements Analysis Study for Special Protective Coating Project Development Specification.* The following data is developed from a direct correlation between the material and the requirements and specification information contained in the aforementioned documents.

Based on material information supplied by a number of vendors (documentation attached, phone conversations referenced), the following properties of polyurea satisfy requirements contained in WSDOE, *Guidance for Assessing Dangerous Waste Secondary Containment Systems,* Pub #95-420 and HNF-SD-W314, Rev 1, *Requirements Analysis Study for Special Protective Coating Project Development Specification.*

1. The polyurea coating system shall develop the ability to resist the development of "holidays" in time.

2. The polyurea coating system has successfully bridged cracks up to 1.2 mm: These cracks did not propagate through the polyurea coating.

3. The polyurea coating system provides a tensile strength of 2,500 psi and an elongation of 265 percent. Although these values do not completely meet the requirements referenced, types of polyurea can be mixed with additives to enhance its performance in this area. **Based on conversation with NUCOTE vendor – John Meyer, dated July 27, 2000.**

4. The polyurea coating system is hydrophobic and therefore absorbs far less water than .05 % per 24 hrs. The highest WVT rate tested for polyurea was 0.934 gm/m^2/24 hr. This coating is compatible with a relative humidity range of 0 to 100 percent

5. The polyurea coating system has high temperate stability with a service temperature of –60 °F to 300 °F.

6. The polyurea coating system is generally suitable for continuous contact with substances with PH ranging from 4 to 11. The use at the 200 Area pits will not consist of continuous contact. The polyurea is suitable for application concerning the NAOH environment and the corresponding PH range. **Based on conversation with NUCOTE vendor – John Meyer, dated July 27, 2000**.

7. Polyurea is 100 percent solids and contains no solvents or VOCs. It has a flame spread rating of "10," a smoke density rating of "5," and a National Fire Protection Agency classification of "A." The polyurea exhibits no unusual fire characteristics. **Based on conversation with NUCOTE vendor – John Meyer, dated July 27, 2000**.

8. Polyurea can be applied in numerous colors, a number of which suitable for painting over.

9. Documented evidence exists to show the durability of polyurea is good in applications from 3 to 8 years old. Vendor claims that Polyurea has a design life of about 30 years. **Based on conversation with NUCOTE vendor – John Meyer, dated July 27, 2000**.

10. Polyurea can be applied over itself to repair damage to the coating. Although this satisfies the requirements, the logistics of using polyurea repeatedly could prove to be difficult.

11. Polyurea is based on the use of aromatic isocyranate component, and other aromatic species are polymerized into the B component. Aromatics resonate in energized environments including

radionuclides in levels listed in the provided specification. Aromatics have been used in gamma as well as slow and fast neutron environments – polyurea should provide an adequate level of containment with respect to the radionuclides associated with the pump pits and valve pits.

12. The polyurea coating material was tested concerning the ease of decontamination. The coating material was decontaminated to a maximum DF of 40 (97.5 percent removal) with ambient water. Further washes with ambient and hot decontamination solution increased the maximum DF to 43 (97.7 percent). Note: These values include contamination removal from previous steps.

13. Polyurea is capable of operating in radiation environments consistent with those found at the Waste Feed Delivery System valve pits and pump pits at the 200 Area. Tests conducted on specific types of polyurea showed the physical properties, when exposed to radiation levels comparable to those in the 200 Area pits, remained suitable for application.

The following polyurea characteristics identified below were determined not to meet the requirements identified in WSDOE, *Guidance for Assessing Dangerous Waste Secondary Containment Systems,* Pub #95-420 and HNF-SD-W314, Rev 1, *Requirements Analysis Study for Special Protective Coating Project Development Specification.* These characteristics, although outside the "envelope" of compliance, do not necessarily disqualify the coating from consideration. The coating could be used with other methods to mitigate the deficiencies and provide an adequate pit surface liner. The following unsatisfied requirements and corresponding potential mitigation for each, may result in a combination of coating techniques that provide the desired protective liner for the 200 Area valve/pump pits:

1. Polyurea coatings do not meet the abrasion resistant properties identified in subject requirements. The requirements are meant to ensure a protective coating that could withstand contact (scraping, tool dropping, etc.,) with heavy equipment utilized during all types of operation in and around the pits. The potential for contact with the liner would be greatest at the floor (or other horizontal surfaces) as other areas would deflect or resist the force generated by lowered or fallen objects. To mitigate the deficiency, a protective barrier (plate) could be placed on the floor underneath the polyurea coating, therefore minimizing the potential for abrasion in areas most susceptible to damage.

2. Polyurea coating do not display the adhesion properties identified in subject requirements. The requirements are meant to ensure the coating adheres to the existing epoxy and concrete so that the liner would not "pull-off" and leave the surface unprotected. Vendor data suggests the polyurea would bond to the existing epoxy at a higher value (approx. 600 psi) than the weathered epoxy would adhere to the concrete. **Based on conversation with NUCOTE vendor – John Meyer, dated July 27, 2000**. Therefore, the polyurea coating would provide an adequate liner as all the epoxy is not anticipated to fail. Furthermore, areas of the concrete without the existing epoxy would be exposed and provide "anchors" for the polyurea, subsequently enhancing the adhesion properties of the liner.

To provide a more conservative design with respect to polyurea adhesion, individual pieces of steel could be prepared, lowered, and attached to the pit to maximize the surface to polyurea bond.

C1.1 Surface Preparation

Polyurea general application surface preparations include: cleaning, washing (power wash), application of a primer, and finally a surface coat. These are the recommended preparations with regards to a favorable environment. These processes can be modified, both for coating properties and differing surface configurations. Vendor literature, as well as phone conversation confirmation, exists which documents situations where no priming in necessary, "substrate priming is not required on all substrates." Based on discussions with an approved/certified polyurea applicator (Cascade Industries), the application strategy for the 200 Area pits is suggested to be as follows: 1) Power wash at highest pressure allowable, apply a light coat of primer, then apply the polyurea coating.

C1.2 Removal

Polyurea removal is performed by physically cutting (hydraulic cutter, mechanical knife, etc.) the coating from the substrate. Discussions with an approved applicator resulted in data suggesting that an entire surface coating could not be removed without significant effort and time. However, removal of small isolated pieces of the coating, already free from the substrate, could be accomplished remotely (knife on a pole) and in a timely fashion. Regardless of the data received from the vendor, there is some uncertainty associated with removal of the polyurea coating with respect to radioactive/contaminated pits.

C1.3 Vendor References

1. VERSEFLEX Incorporated, Kansas City, KS 66101, (800) 321-0906

2. SPECIALTY PRODUCTS Inc., Lakewood, WA 98499, (800) 627-0773

3. NUKOTE THERMAL SYSTEMS, Renton, WA 98057, (425) 204-5607

EnviroLastic® AR 200 HD

Heavy Duty, Ultra Fast Cure Elastomeric Coating & Lining

Manufacturer:

EnviroChem Technologies
P.O. Box 6499
Fort Worth, Texas 76115-0499
(817) 923-6466 • Fax (817) 923-6470
E-Mail: info@envirolastic.com

Product Description:

EnviroLastic® AR 200 HD is a heavy duty version of EnviroChem's polyurea systems. It is designed to be used where a more dense, hard, and abrasion resistant system is required. Because of its physical properties, **AR 200 HD** is slightly more chemical resistant than the standard systems. Ultra fast set times (6 seconds) also allow for a "stipple" finish to be achieved, if desired.

Like all of EnviroChem's polyurea line, **AR 200 HD** is a 100% solids, ultra fast cure, spray applied, seamless, waterproof, elastomeric coating and lining system, which exhibits extraordinary performance characteristics for a wide range of applications. It can be applied at thicknesses of 10 mil to 250 mil, or greater, in a single application.

EnviroLastic® AR 200 HD is the optimum choice where a tough, flexible, impact / abrasion resistant, waterproof surfacing system is required in extremely short down times with no VOCs and no odor.

Limitations:

- **AR 200 HD** is an aromatic. Physical properties will not change, but light colors will change in UV light.
- Consult EnviroChem for corrosive environment applications.
- Do not install in moisture / vapor conditions > 3lbs. MVT, >5% moisture content.

Advantages:

- Fast Cure. Short down time.
- No VOCs and no odor.
- High strength.
- Seamless and flexible.
- Bridges moving cracks to 1/16".
- Waterproofs.
- Accepts vehicular traffic.
- Added color stability.
- Enhanced adhesion properties.
- Application at -20°F to 350°F.
- Resists thermal shock.
- Resistant to many chemicals.
- Can be topcoated for added chemical resistance.
- USDA approved.

Typical Uses:

- Floor and Wall Systems
- Tank Linings
- Containment Areas
- Loading Docks / High Traffic Areas
- Digesters
- Food & Beverage Processing Areas
- Cold Storage Areas
- Mechanical Rooms
- Chemical Plants
- Fertilizer Plants
- Pulp and Paper Mills
- Petrochemical Facilities

PHYSICAL PROPERTIES	TEST METHOD	VALUE
Elongation	D-638	200%
Tensile Strength	D-638	3,000 psi
Shore Hardness	D-2240	D-55
Tear Strength (pli)	D-624	480 pli
Moisture Vapor Transmission	E-96	0.02 perm
Abrasion Resistance (wt. loss mg.) 1000 g., 1000 rev. H-18 1000 g., 1000 rev. CS 17	 D-4060 D-4060	 170 mg. 4 mg.
100 Modulus (psi)	D-638	1,965 psi
Coefficient of Thermal Expansion	C-531	4 x 10^{-4} (in/in/°C)
Flash Point, components		> 200° F
Flame Spread	E-108	Class A (Comparable to UL 790)
Gel Time / Tack Free		6 / 12 seconds
Flexibility Testing: Gardner Impact, in.-lbs. (on 1/32" steel panels) Direct and Indirect	 D-2794	 >160 in.-lbs.
Mandrel Bend: Conical Bend (on 1/32" steel panels) 1/4" Mandrel, 25°C (free film, 35 - 50 mils) 1/4" Mandrel, -20°C (free film, 35 -50 mils)	 D-522 D-1737 D-1737	 Pass Pass Pass

Installation:

The following is meant as a guide. Consult EnviroChem or an EnviroChem Certified Applicator for job specific specifications.

Project Conditions: Surface must be structurally sound, dry, and uncontaminated. Concrete must be minimum 3,500 psi and free of voids, bugholes, honeycombs, and delaminations. Always perform Calcium Chloride test as per ASTM E-1907 (do not proceed with MVT >3 lbs. or moisture content >5%). Do not apply over light weight concrete, metal pan decks, or sandwich slab membranes. Honor all expansion joints. For steel, all welds must be continuous and ground smooth or filled. Weld splatters, burrs, etc. must be removed. Consult EnviroChem before coating over existing coatings.

Substrate Repairs:
Concrete: Route and seal all cracks > 1/16" with EnviroChem JS or approved urethane sealant. Pre-fill all bugholes with epoxy and aggregate or polymer modified cement approved by EnviroChem. Repair concrete as per ICRI Technical Guidelines 03730 and 03731.
Steel: Adhere to NACE Standard RP 0178 latest revision.

Surface Preparation: Remove all dirt, grease, oil, contamination, etc. by high pressure waterblast (preferably hot) with appropriate degreaser or detergents. Monitor for "bleed back". For surface profile, mechanical methods such as sandblasting or shotblasting are preferred.
Concrete: Sandblast or shotblast to remove all laitance and achieve a profile equal to 80 – 100 grit sandpaper. Refer to ICRI Guide 03732 or NACE No. 6 / SSPC-SP-13.
Steel: Provide a "Near White Metal" blast to SSPC-SP-10 / NACE 2, with a 3 mil profile for immersion service, 2 mil for less severe conditions.

Mixing:

Agitate resin blend (B) component THOROUGHLY with a drum mixer before use to disperse pigment and assure homogeneity. Do not thin. Do not mix "A" and "B" resins together. (CAUTION – doe not agitate in air and moisture.)

Application:

Correct equipment is critical to installation. Use only heated, plural component equipment capable of producing 3,000 psi at 160°F and 2 gpm consistently, such as Gusmer H-3500.

Prime with **EnviroPrime WB** or as recommended by EnviroChem. All cracks must receive a 5" x 30 mil detail coat. Continue spraying to achieve the required mil thickness with 50% overlaps. Blower apply approved aggregate, if required. Top coat if specified.

Repairs and Maintenance:

Small repairs and modifications can be made using **EnviroLastic JS 80** or Hand Mix material. For traffic areas, keeping **EnviroLastic®** clean will increase life.

Bond Strength:

(primed substrate)

Concrete		
	ASTM D-4541 *(concrete failure)*	550 psi
Steel		
	ASTM D-4541	1750 psi

Other Test Data Available:

- Salt Spray Corrosion
- QUV Weatherometer

Colors:

Black, White, Light Grey, Medium Grey, Charcoal Grey, Tan, and Tile Red. See standard color chart. Custom colors available at additional charge. See limitations on color retention.

Clean Up and Disposal

Clean up "B" side with soap & water, EnviroChem **Tack Coat** or EnviroChem CitriKlean. Mix "A" side with water. Dispose of in accordance with local and federal disposal regulations.

Safety:

Read and understand the MSDS provided with all shipments. Always use products with adequate ventilation and use required PPE. For confined space use fresh air supply. For open air, use half face, twin cartridge respirators approved for MDI. Always protect eyes and skin. Strictly adhere to Society of Plastics Industry Safety Standards.

Shelf Life and Storage:

Twelve months in sealed unopened containers. Keep away from extreme heat, freezing, and moisture.

Availability:

Because of the technical nature of the material and equipment required that will assure you of a professional installation, **EnviroLastic®** is only available through an international network of trained applicators on a limited basis. For an approved applicator near you, contact EnviroChem Technologies.

Warranty Reference:

The technical data and other printed information furnished is true and correct to the best of our knowledge. If a product fails to meet this warranty, EnviroChem Technologies, at its option, will replace the product or refund the purchase price of the material.

Your Approved EnviroChem Contractor is:

Eric Shen

From: John F. Unsworth [john@envirolastic.com]
Sent: Monday, September 25, 2000 2:48 PM
To: eshen@arescorporation.com
Subject: Fw: Undeliverable Mail

-----Original Message-----
From: Postmaster <postmaster@envirolastic.com>
To: john@envirolastic.com <john@envirolastic.com>
Date: Monday, September 25, 2000 4:26 PM
Subject: Undeliverable Mail

>Unknown host: eshen@ariescorp.com
>
>
>Original message follows.
>
>Received: from host [209.166.9.161] by envirolastic.com
> (SMTPD32-6.00) id A2E92040282; Mon, 25 Sep 2000 16:26:01 -0500
>Message-ID: <005f01c02737$1206e460$0900000a@host>
>Reply-To: "John F. Unsworth" <john@envirolastic.com>
>From: "John F. Unsworth" <john@envirolastic.com>
>To: <eshen@ariescorp.com>
>Subject: Consent letter
>Date: Mon, 25 Sep 2000 16:24:59 -0500
>MIME-Version: 1.0
>Content-Type: multipart/alternative;
> boundary="----=_NextPart_000_005A_01C0270D.26684680"
>X-Priority: 3
>X-MSMail-Priority: Normal
>X-Mailer: Microsoft Outlook Express 4.72.3110.1
>X-MimeOLE: Produced By Microsoft MimeOLE V4.72.3110.3
>
>This is a multi-part message in MIME format.
>
>------=_NextPart_000_005A_01C0270D.26684680
>Content-Type: text/plain;
> charset="iso-8859-1"
>Content-Transfer-Encoding: quoted-printable
>
>Hello Eric-
>Please let this serve as my permission to use any and all information =
>that I have provided you to use in any papers or reports that you are =
>doing. This includes spec data, specifications, test results, etc.
>If you have any questions please do not hesitate to call me at =
>800-734-0222
>
>Sincerely,
>John F. Unsworth
>Partner
>
>For Aberdine, try 630-543-0870 or 630-705-2504
>For ACI, try 248-848-3700
>Eric, I'm sure they will give permission. I hope to have the up-dated =
>spec data on the AR 425 in the morning.
>
>------=_NextPart_000_005A_01C0270D.26684680
>Content-Type: text/html;
> charset="iso-8859-1"
>Content-Transfer-Encoding: quoted-printable
>
><!DOCTYPE HTML PUBLIC "-//W3C//DTD W3 HTML//EN">

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Email

PRODUCT DATA SHEET: CERAM-KOTE 2000

Description:

CeRam-Kote 2000 is a thin-film, spray-applied and air-dried ceramic epoxy coating system engineered to provide excellent chemical immersion service protection to all metals, fiberglass reinforced plastics, concrete and plastic substrata. CeRam-Kote 2000 is highly cross-linked to provide superior chemical resistance. The product may be force-cured with heat for enhanced performance in extremely harsh environments. CeRam-Kote 2000 is available in three colors: white, grey and tan.

Suggested Uses:

Secondary Containment	Internals in Tanks
Harsh Chemical Environments	Non-UV Areas
Hydrocarbon Service	Blow Out Preventers
Clarifiers	Petrochemical Environments
Internals in Vessels and Piping	Internals in Valves
Fuel Tanks	Hydrocarbon Service
Wastewater Treatment Clarifiers	Wastewater Treatment Pumps
Brine Tanks	Wastewater Treatment Lift Stations

TECHNICAL DATA

Volume Solids:	80% +/- 2%
Weight Solids:	90% +/- 2%
VOC:	1.56 lb/gal (187 g/l)
Number of Coats:	One coat, two passes, with each pass 5-6 mils (125-150 microns)

Dry Film Thickness:
CeRam-Kote 2000 should be applied holiday free at a minimum of 8 mils (200 microns) DFT with a preferred thickness of 10 mils (250 microns) DFT.

Cure Time:
A two-pass film of 8-10 mils DFT (200-250 microns) air dries to a dry touch finish within five (5) hours at 72°F (22.2°C) and dries to a 70% cure in fourteen (14) hours. Cure times lengthen at lower temperatures and shorten at higher temperatures. The coating should be fully cured before placing into service.

Surface Preparation:
Bonding strength depends on proper preparation of the surface to be protected for long-term performance of the product. The substrate should be free of oil, grease and salt/chloride contamination. Specifications call for a white metal (NACE 1, SSPC-SP5, Swedish Standards SA-3) finish with a 1-2.5 mil (25 - 62.5 microns) anchor profile. Surface preparation should be no

less than a near white metal (NACE 2, SSPC-SP10, Swedish Standards SA 2 ½) finish. Cleanliness is the most important step to produce a coated surface that will perform and last. Call Freecom, Inc. for surface preparation recommendations of materials such as aluminum, brass, plastic, fiberglass and/or concrete.

Mixing Ratio: Four (4) parts of Part A to one (1) part of Part B by volume.
Seven (7) parts of Part A to one (1) part of Part B ratio by weight.

Mixing:
CeRam-Kote 2000 contains a high loading of ceramic particles which must be placed into full suspension with the epoxy resin prior to application. CeRam-Kote 2000 is packaged in two cans, Part A (base) and Part B (curing agent). Shake Part A (base) with a Cyclone air-powered shaker or mix Part A with an Edsan's Jiffler Mixer until all ceramic powders are suspended in the resin. Time required to place ceramics into suspension varies according to temperature and length of material storage time. At 72°F (22.2°C), generally a four (4) to six (6) minute shake will place the ceramic powders into suspension. Regardless of time needed, shake all ceramic material into suspension prior to proceeding. Failure to properly mix will keep CeRam-Kote 2000 from performing or curing properly. Check the can to assure all solids are in suspension prior to proceeding to the mixing step.

Combine Part A (base) and Part B (curing agent) and shake again until both parts are thoroughly mixed. Shaking time is temperature dependent, but a two (2) to four (4) minute shake at 72°F (22.2°C) should thoroughly mix the components. However, caution must be used to prevent heat buildup. No induction time is needed before application.

Pot Life & Shelf Life:
Pot life for CeRam-Kote 2000 at 72°F (22.2°C) is approximately six (6) to eight (8) hours. Colder temperatures will increase the pot life and warmer temperatures will decrease the pot life. Keep cans out of direct sunlight to prevent heat buildup. CeRam-Kote 2000 has an indefinite shelf life. Preferred storage/usage is a dry enclosed area under 85°F (29°C) /used within two (2) years. However, if stored more than two years above 85°F (29°C), call Freecom Technical Support prior to use.

Thinning:
Use MEK, Isopropanol (99%), or Acetone for any viscosity. Never thin CeRam-Kote 2000 more than 5% by volume. Thinning dilutes the high solids of CeRam-Kote 2000, creates excessive overspray and may affect the performance of the coating.

Application:
Spray apply for best results using conventional, airless, HVLP or cup gun. The air source must be dry. The compressed air source should be outfitted with air dryers as needed to supply moisture-free air. Use pressure feed equipment such as high volume, low pressure equipment or Binks 2001 spray equipment with a 563CVT needle, 63CVT fluid nozzle and 63PB air nozzle. Airless: use reversible carbide tip with orifice size of 0.019-0.021 inches. If applying with roller, use short nap, such as ¼" (.244 mm).

After thoroughly shaking CeRam-Kote 2000, strain it with a standard paint strainer and pour CeRam-Kote 2000 into the spray equipment.

Apply a first pass of five (5) to six (6) mils (125-150 microns) WFT and allow sufficient time for solvent to flash off. At 72°F (22.2°C), 30-40 minutes is sufficient. Apply a second pass of five (5) to six (6) mils (100 - 125 microns) for a total DFT of eight (8) to ten (10) mils (200-250 microns). Cure time is temperature dependent.

Apply additional mils without incurring runs or sags if the finished product requires thicker coverage. Whenever possible, apply second coat in a cross-coat method.

Climate:
Use CeRam-Kote 2000 only if the substrate temperature and ambient air temperature is above 40°F (4.4°C). No coating should be permitted when substrate is wet from rain or dew, when surfaces are less than 5°F (3°C) above the dew point and holding or when relative humidity is greater than 85%. Moisture will inhibit the catalyst reaction and CeRam-Kote 2000 will not cure or perform properly.

Holiday Detection:
CeRam-Kote 2000 is classified as a thin-film coating and should be tested for defects and holidays using a 67½ volt, wet sponge spark detector set at 80,000 ohms resistance, such as a Tinker and Rasor model M-1.

Repairs:
If application of the coating is less than seventy-two (72) hours old and has not been exposed to contamination, repair by wiping with MEK and then re-apply CeRam-Kote 2000. If contaminated or more than 72 hours old, first sand with appropriate grit sandpaper, then repeat repair process.

Cleanup:
Purge and clean spray equipment within thirty (30) minutes of the final spray. Flush equipment with MEK until solvent sprays clear. Disassemble and clean equipment to manufacturer's recommendations. Material left in spray equipment could solidify and damage equipment. Use precautionary measure applicable to any catalyzed material.

Safety:
See individual product label for safety and health data. A Material Safety Data Sheet is available upon request.

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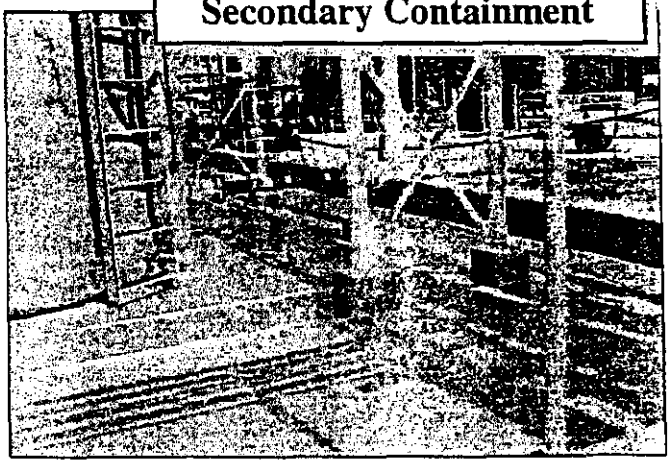
CERAM-KOTE 2000
CHEMICAL-RESISTANT Coating

Performance Profiles

Distributor: D&E Distributing
Customer: Chemical plant in Gainesville. Florida. USA
Applicator: Tri-State Contractors of Florida

Secondary Containment



- Several years of spills of hydrochloric acid and related wastewater had deteriorated secondary containment concrete
- Company needed protection of concrete from corrosion and erosion
- No previous coatings were able to withstand the environment
- CeRam-Kote 2000 was selected for its corrosion resistance and ceramic content
- Concrete was repaired before CeRam-Kote 2000 was applied by roller. There were no application problems
- A spill soon after application had no apparent effect to Ce-Ram-Kote 2000 or the concrete it was protecting

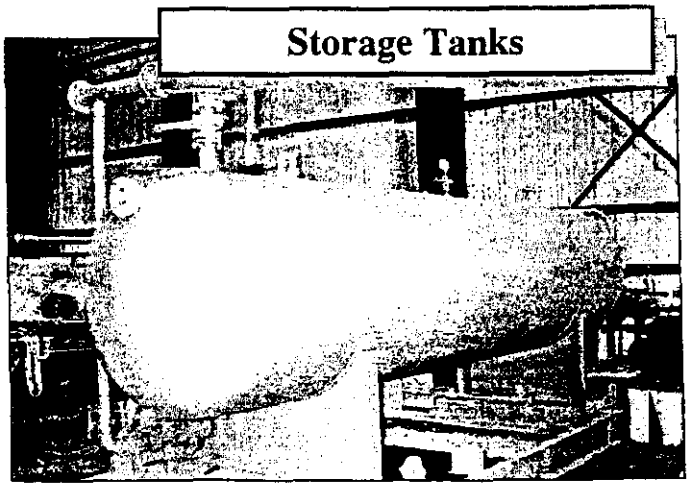
Customer: City of Big Spring. Texas. USA
Applicator: Freecom. Inc.

Vac-Con Debris Tanks

- Corrosive waste matter and severe abrasion of 60 mph suction intake velocity caused standard factory finish on interior of debris tank to break down. Original coating became difficult to clean and the tank began to corrode
- CeRam-Kote was requested for the tank due to previous success on wastewater applications with the city
- CeRam-Kote 2000 was recommended for the application due to its high performance. chemical resistance and cleanability
- Recent inspection by City personnel reported the coating "looked like the day it was applied and was very easy to clean"

Customer: Fina Refinery. Big Spring. Texas. USA
Applicator: Spencer's Coating Specialist Co.

Storage Tanks



- Tank was internally coated six years earlier with CeRam-Kote 54® to prolong the life of the tank. Tanks store a mixture of toluene/kerosene and/or water at 150-180°F.
- Due to satisfaction of CeRam-Kote 54® in many applications at the refinery. CeRam-Kote was again requested
- CeRam-Grout GC was applied to the properly prepared bottom third of the tank to protect against corrosion pitting
- Then CeRam-Kote 2000 was applied to the entire I.D. of the tank
- Satisfaction with the application has resulted in two more tanks coated internally with CeRam-Grout GC and CeRam-Kote 2000

FREECOM, INC. • P.O. BOX 2119 • BIG SPRING, TEXAS 79721 • 915-263-8497 • 800-346-4299 • 915-263-5269 FAX
www.ceram-kote.com • E-mail address: freecom@ceram-kote.com

SSPC

CeRam-Kote 2000

Chemical Resistance Chart for Immersion Service at 72°F (22° C)

KEY
Y = Recommended N = Not Recommended

Substance Exposed To:	CeRam-Kote 2000 Application
1,2 Dichloroethane	Y
Acetic acid 10%	N
Aniline	Y
Benzene	Y
Brine (Saturated)	Y
Bromine water 5%	N
Butyl acetate	Y
Calcium chloride (Saturated)	Y
Calcium hypochlorite 15%	Y
Calcium sulfate	Y
Carbon dioxide	Y
Carbonic acid	N
Citric Acid 5%	Y
Clorox	N
Coconut oil	Y
Detergent (Mr. Clean)	Y
Diesel fuel	Y
Ethanol	Y
Ethanolamine	N
Ethyl benzene	Y
Ethylene glycol	Y
Formaldehyde 37%	Y
Gasoline (93 Octane)	Y
Hexane	Y
Hydraulic fluid	Y
Hydrochloric acid 10%	N
Hydrochloric acid 20%	N
Hydrochloric acid 37%	N
Hydrofluoric acid 10%	N
Isopropanol	Y
Lactic acid 5%	N
Magnesium chloride	Y
Methyl ethyl ketone	Y

Substance Exposed To:	CeRam-Kote 2000 Application
Methyl isobutyl ketone	Y
Methylene chloride	N
Motor oil	Y
n-Decyl alcohol	Y
Nitric acid 15%	N
Nitric acid 30%	N
Paraffin wax	Y
Peanut oil	Y
Petroleum ether	Y
Phosphoric acid 20%	N
Phosphoric acid 30%	N
Phosphoric acid 50%	N
Phosphoric acid 70%	N
Polyethylene glycol	Y
Potash	Y
Potassium hydroxide 10%	Y
Potassium hydroxide 20%	Y
Potassium hydroxide 50%	Y
Propane	Y
Seawater	Y
Sodium chlorate 50%	Y
Sodium hydroxide 10%	Y
Sodium hydroxide 20%	Y
Sodium hydroxide 50%	Y
Sodium hydroxide 70%	Y
Sodium sulfate 15%	Y
Sodium sulfate (Saturated)	Y
Soduim sulfide	Y
Sugar	Y
Sulfuric acid 15%	N
Sulfuric acid 30%	N
Sulfuric acid 65%	N
Sulfuric acid 75%	N

KEY
Y = Recommended N = Not Recommended

Substance Exposed To:	CeRam-Kote 2000 Application
Sweet crude	Y
Tall oil	Y
Tetrachloroethylene	Y
Triethanolamine	Y
Turpentine	Y

Substance Exposed To:	CeRam-Kote 2000 Application
Urea	Y
Vegetable oil	Y
Vinegar	N
Water (Distilled)	Y
Xylene	Y

These tests have been conducted on cold rolled steel 1"x 6"x ¼" panels that have been surface prepared to SSPC-SP5 (NACE 1) white metal blast and spray coated with 8-10 mil DFT (200-250 microns) of CeRam-Kote 2000. The coated panels were post-cured at 200°F (93.3°C) for 2 hours. All testing was done at ambient temperatures [72°F (22°C)].

Under certain corrosive conditions, pigment might change color without affecting physical properties of the coating.

This information is provided to assist the specifier in the selection of an appropriate coating for an end use situation. No warranty is expressed or implied since the surface proparation, thickness of application and environmental conditions at the time of coating are beyond Freecom, Inc.'s control. The onus is on the user to determine if the product is fit for purpose. Should more information be required please contact Freecom, Inc.

CeRam-Kote 2000

Chemical Resistance Chart for Secondary Containment & Splash and Spill at 72°F (22° C)

KEY
Y = Recommended N = Not Recommended

Substance Exposed To:	CeRam-Kote 2000 Application
1,2 Dichloroethane	Y
Acetic acid 10%	Y
Aniline	Y
Benzene	Y
Brine (Saturated)	Y
Bromine water 5%	N
Butyl acetate	Y
Calcium chloride (Saturated)	Y
Calcium hypochlorite 15%	Y
Calcium sulfate	Y
Carbon dioxide	Y
Carbonic acid	Y
Citric Acid 5%	Y
Clorox	Y
Coconut oil	Y
Detergent (Mr. Clean)	Y
Diesel fuel	Y
Ethanol	Y
Ethanolamine	Y
Ethyl benzene	Y
Ethylene glycol	Y
Formaldehyde 37%	Y
Gasoline (93 Octane)	Y
Hexane	Y
Hydraulic fluid	Y
Hydrochloric acid 10%	Y
Hydrochloric acid 20%	Y
Hydrochloric acid 37%	N
Hydrofluoric acid 10%	N
Isopropanol	Y
Lactic acid 5%	Y
Magnesium chloride	Y
Methyl ethyl ketone	Y

Substance Exposed To:	CeRam-Kote 2000 Application
Methyl isobutyl ketone	Y
Methylene chloride	N
Motor oil	Y
n-Decyl alcohol	Y
Nitric acid 15%	Y
Nitric acid 30%	Y
Paraffin wax	Y
Peanut oil	Y
Petroleum ether	Y
Phosphoric acid 20%	Y
Phosphoric acid 30%	Y
Phosphoric acid 50%	Y
Phosphoric acid 70%	Y
Polyethylene glycol	Y
Potash	Y
Potassium hydroxide 10%	Y
Potassium hydroxide 20%	Y
Potassium hydroxide 50%	Y
Propane	Y
Seawater	Y
Sodium chlorate 50%	Y
Sodium hydroxide 10%	Y
Sodium hydroxide 20%	Y
Sodium hydroxide 50%	Y
Sodium hydroxide 70%	Y
Sodium sulfate 15%	Y
Sodium sulfate (Saturated)	Y
Soduim sulfide	Y
Sugar	Y
Sulfuric acid 15%	Y
Sulfuric acid 30%	Y
Sulfuric acid 65%	Y
Sulfuric acid 75%	Y

KEY
Y = Recommended N = Not Recommended

Substance Exposed To:	CeRam-Kote 2000 Application
Sweet crude	Y
Tall oil	Y
Tetrachloroethylene	Y
Triethanolamine	Y
Turpentine	Y

Substance Exposed To:	CeRam-Kote 2000 Application
Urea	Y
Vegetable oil	Y
Vinegar	Y
Water (Distilled)	Y
Xylene	Y

These tests have been conducted on cold rolled steel 1"x6"x¼" panels that have been surface prepared to SSPC-SP5 (NACE 1) white metal blast and spray coated with 8-10 mil DFT (200-250 microns) of CeRam-Kote 2000. The coated panels were post-cured at 200°F (93.3°C) for 2 hours. All testing was done at ambient temperatures [72°F (22°C)].

Under certain corrosive conditions, pigment might change color without affecting physical properties of the coating.

This information is provided to assist the specifier in the selection of an appropriate coating for an end use situation. No warranty is expressed or implied since the surface proparation, thickness of application and environmental conditions at the time of coating are beyond Freecom, Inc.'s control. The onus is on the user to determine if the product is fit for purpose. Should more information be required please contact Freecom, Inc.

MATERIAL SAFETY DATA SHEET

Section 1. Product and Company Information

MANUFACTURER: Freecom. Inc.
P.O. Box 2119
Big Spring, Texas 79721-2119

TELEPHONE: For information purposes 8:00 a.m. to 5:00 p.m. CDT
(915) 263-8497 (800) 346-4299

EMERGENCY: (915) 263-8497 (800) 346-4299

DATE OF PREPARATION: July 9, 1999

SUPERCEDES MSDS DATED: January 13, 1999

PRODUCT NAME: CeRam-Kote 2000

Section 2. Composition and Ingredient Information

Common Name	Chemical Name	CAS Number	Weight %
PART-A CeRam-Kote 2000 (Base)			
Ceramic Filler	Ceramic Filler	67762-90-7	43 to 78
		1344-28-1	
		14807-96-6	
Proprietary #1* & #2*	Epoxy Resin	28064-14-4	8 to 32
Isopropanol	2-propanol	67-63-0	4 to 10
Methyl Ethyl Ketone	2-butanone	78-93-3	4 to 7
PART-B CeRam-Kote 2000 (Curing Agent)			
Benzyl Alcohol		100-51-6	>45
4,4'--Methylenebicyclohexamine		1761-71-3	<2
Benzene-1,3-Dimethaneamine		1477-55-0	<40

*The specific chemical identity of this ingredient is declared proprietary information under 29 CFR 1910.1200, section (i) Trade Secret. Hazard information is provided in this MSDS for this ingredient.

Section 3. Physical Data

Description	CeRam-Kote 2000 (catalyzed)	PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
Specific Gravity (kg/l)	1.78	1.8369	1.07
Boiling Point	>250° F	241° F	>200° C (392° F)
Vapor Density (Air = 1)	>Air	3.2	>Air
Solubility in Water	N/A	Insoluble	Miscible
Viscosity (centapoise)	700 to 1,500	800 to 1,200	300 to 450
pH	Slightly Alkaline	Slightly Acidic	Alkaline
Appearance and odor	aromatic odor	aromatic odor	Translucent, ammonical odor
Density – packaged (on average)	14.13 lb/gal (6.42 kg)	12.5 lb/gal (5.68 kg)	1.63 lbs/quart (0.74 kg)
Total Volatiles	9 to 11	10 to 12	Nil
Non-Volatiles	89 to 91	88 to 90	100%
VOC content	1.56 lbs/gal (187 g/l) less water	1.8 lb/gal (215.7g/l) less water	0 lbs/gal (0 g/l)

Section 4. Fire Fighting Measures

Description	PART A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
Flashpoint	< 70°F (21.1°C)	>200°F (93.3°C)
Flammable Limits	LFL: 1.0% UFL: 7.0%	N/A
Auto Ignition Temperature	750°F (399°C) -IPA	N/A
Extinguishing Media	Foam, CO_2, dry chemical, water fog	Foam, CO_2, or dry chemical. A water spray can also be used.
Unusual Fire and Explosion Hazards	Do not apply to hot surfaces. Keep away from heat, sparks or open flame. Keep containers tightly closed. Closed containers may explode when exposed to extreme heat. Do not store or mix with strong oxidants.	Decomposition and combustion products may be toxic.
Fire Fighting Instructions	Use air-supplied rescue equipment for enclosed areas. Full stream water may be unsuitable as extinguishing method, but is helpful in keeping nearby containers cool. Avoid spreading burning liquid with water used for cooling.	Use self contained breathing apparatus.
Hazardous Combustion Products	Primary combustion products are carbon monoxide, carbon dioxide and low molecular weight hydrocarbons. Other undetermined compounds could be released in small quantities.	Carbon monoxide, carbon dioxide, aldehydes and nitrogen oxides.

Section 5. Reactivity Data

Description	PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000
Stability	Avoid high heat.	Stable.
Incompatibility	Avoid organic peroxides and oxidizers.	Avoid strong oxidizing agents, acids, copper and its alloys.
Hazardous Decomposition Products	Various hydrocarbon fragments. See section 4 of MSDS for combustion products statement.	Carbon monoxide, carbon dioxide, aldehydes, and nitrogen oxides.
Hazardous Polymerization	May occur. Avoid excessive heat, contamination and prolonged storage above 70°F	Will not occur.

Section 6. Health and Safety

	PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
Primary Routes of Exposure	Inhalation, skin, eye	Dermal
Potential Health Effects	**Acute (short term):** This product if inhaled may cause nose, throat, and mucous membrane irritation and possible central nervous system effects including headaches, nausea, vomiting, dizziness, drowsiness, loss of coordination, impaired judgment and general weakness. It may cause moderate irritation to the skin with dryness, cracking and possible dermatitis with prolonged or repeated contact. Direct eye contact with this product may cause immediate irritation to the eyes with redness, burning, tearing and blurred vision. It may cause mouth, throat and gastrointestinal irritation, nausea, vomiting and diarrhea if ingested. Aspiration of material into the lungs can cause chemical pneumonitis which can be fatal. **Chronic (long term):** Prolonged or repeated skin contact may result in irritation, dermatitis marked by rough, dry, cracking skin. Contact with the epoxy resin may cause sensitization. In lab animals, overexposure by inhalation to MIBK has been reported to cause liver and kidney abnormalities, and lung and brain damage. Kidney disorders have been reported from human ingestion of isopropanol.	**Overexposure effects:** Direct or prolonged skin or eye contact can cause skin and eye burns. Swallowing liquid can burn mouth and cause nausea, vomiting, diarrhea, abdominal pain and collapse. Can cause allergic skin and respiratory reactions after repetitive exposure. Animal studies on component (s) have shown effects on liver and fetus.
Medical Conditions Aggravated by Exposure	Persons with a history of chronic respiratory disease, skin disease or central nervous system disorders may be at increased risk for worsening their conditions from exposure to this product.	Persons with a history of allergic conditions may be at increased risk for worsening their conditions from exposure to this product.

Section 7. First Aid Measures

Description	CeRam-Kote 2000 (Mixed) and/or PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
Inhalation	Remove individual to fresh air. If breathing is difficult, administer oxygen and obtain medical aid.	Remove to fresh air. Give oxygen if breathing is difficult.
Eyes	Flush with running water for at least 15 minutes. Seek medical attention.	Immediately flush eyes with water for at least 15 minutes. Get immediate medical assistance.
Skin	Wash with flowing water. Remove contaminated clothing and launder before re-wearing. If irritation persists, seek medical attention.	Promptly wash thoroughly with mild soap and water.
Ingestion	DO NOT induce vomiting. Seek medical attention.	DO NOT induce vomiting. Seek medical attention.

Section 8. Exposure Controls and Personal Protection

Exposure controls

INGREDIENT	OSHA PEL (8-HR TWA)	ACGIH TLV (8-HR TWA)
***Proprietary #1, #2**	5 mg/m^3 (respirable fraction) 15 mg/m^3 (total fraction)	10 mg/m^3
Methyl Ethyl Ketone	200 PPM, STEL 300 PPM	200 PPM, STEL 300 PPM
Isopropanol	400 PPM	400 PPM, STEL 500 PPM
Ceramic Filler	2 mg/m^3	2 mg/m^3
Benzyl Alcohol	N/E	N/E
4,4—Methylenebicyclohexamine	N/E	N/E
Benzene-1,3-Dimethaneamine	N/E	N/E

Personal Protection

Description	CeRam-Kote 2000(Mixed) and/or PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
Engineering controls	General dilution ventilation and/or exhaust ventilation should be provided as necessary to maintain exposures below regulatory limits.	Good general mechanical ventilation is recommended. Local exhaust recommended.
Respiratory Protection	If irritation occurs, or if the TLV or PEL is exceeded, use a NIOSH/OSHA approved air purifying respirator with organic vapor cartridges or canisters, or supplied air respirators. Use respiratory protection in accordance with your company's respiratory program, local regulations or OSHA regulations under 29 CFR 1910.134.	Organic chemical cartridge respirator, if needed.
Dermal Protection	Loose fitting long sleeved shirt, long pants and chemical resistant gloves such as neoprene or natural rubber gloves.	Wear impervious rubber gloves.
Eye Protection	Chemical protective goggles.	Splash-proof chemical goggles.

Section 9. Spills, Leaks, and Disposal

Description	CeRam-Kote 2000 (Mixed) and/or PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
Land Spill	Prevent material from entering sewers or waterways. Remove all sources of ignition (flames, hot surfaces, and electrical static or frictional sparks). Ventilate area. Absorb with inert materials (vermiculite or sand) and place in a closed container for disposal as solid waste. Wash area well with trisodium phosphate and water.	Avoid all personal contact. Take up with absorbent material. Shovel into closeable containers. Flush contaminated area with water.
Water Spill	Material is mostly insoluble. The material will sink. Notify local environmental, health and wildlife authorities, and water intake operators. Contain with booms and minimize spread on water. Disperse any remaining residue to reduce aquatic harm.	This product is miscible in water. That means it is totally dissolved when mixed with water. Due to this property, this is considered a marine pollutant; however, when mixed with Part A, and after the product cures, it is totally inert.
Air Release	Spills of this material may release volatile organic compounds into the air. Spills should be cleaned or covered to prevent volatilization.	This product reacts with air by absorbing the moisture out of the air. Take up with absorbent material. Shovel into closeable containers. Flush contaminated area with water.
Disposal Considerations	Characteristic hazardous waste (D001) due to ignitability.	Not a hazardous waste under RCRA (40 CFR 261).

Section 10. Transport Information

Description	PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
DOT/IATA/IMDG Shipping Names	Resin Solution	Amines, liquid, corrosive, n.o.s. [Benzene-1,3-diamethaneamine (MXDA)]
Hazard Class or Division	3.2	8
Secondary	None	None
UN Identification Number	UN 1866	UN 2735
Packing Group	III	III
Label(s) required	Flammable (3)	Corrosive (8)
Quantity Limitations (Air only)		
Passenger Aircraft	60 liters (15 gallons)	5 liters (1.25 gallons)
Cargo Aircraft	220 liters (58 gallons)	60 liters (15 gallons)
Packing Instructions		
Passenger Aircraft	309	818
Cargo Aircraft	310	820

Section 11. Regulatory Information

Description	PART-A: CeRam-Kote 2000 (Base)	PART-B: CeRam-Kote 2000 (Curing Agent)
ERG Number	26	N/A
TSCA Status	Each ingredient is on the inventory	Chemical components listed on inventory
SARA Title III	Sec 304: N/A Sec 313: N/A	Sec 313: none
Clean Air Act	N/A	N/A

SHERWIN WILLIAMS®

Industrial and Marine Coatings

TRM.30

KEM® CURE TANK LINING

PART A	B69WQ2101	OFF WHITE
PART A	B69AQ2102	GRAY
PART B	B60VQ2100	HARDENER

PRODUCT INFORMATION

Revised 1/99

PRODUCT DESCRIPTION

KEM CURE TANK LINING is a two component, multifunctional, hybrid coating comprised of organic thermoset polymer and inorganic silicon oxide. Designed for coating steel, stainless steel, concrete and other surfaces for immersion or secondary containment use. Kem Cure Tank Lining provides superior resistance to:

- Acids, alkalies, and solvents
- Impact
- Corrosion
- Flex stressing
- Abrasion
- Ambient cure or low heat force cure
- Thermal shock, -40°F to 500°F
- Suitable for use in USDA inspected facilities
- FDA approved 21 CFR-175.300

RECOMMENDED USES

For use on prepared surfaces as an internal protective lining, secondary containment, or as a high performance, long-life, corrosion resistant coating.

- Reactor vessels
- Heat Exchangers
- Pickling Baths
- High temperature surfaces
- Holding Tanks
- FGD systems
- Scrubbers
- Blowers
- Tanks
- Pumps
- Valves
- Agitators

PRODUCT CHARACTERISTICS

Finish: Gloss

Color: Off White and Gray

Volume Solids: 89.6% ± 2%, mixed

Weight Solids: 95.5% ± 2%, mixed

VOC: 108 g/L; 0.90 lb/gal, mixed

Mix Ratio: 2 premeasured units

Recommended Spreading Rate:

Wet mils:	8.0 - 9.0
Dry mils:	7.0 - 8.0
Coverage:	180 - 204 sq ft/gal approximate

Drying Schedule @ 8 mils wet, @ 50% RH:

	Minimum Recoat	To Cure
@ 68°F	20 hours	13 days
@ 77°F	16 hours	11 days
@ 86°F	14 hours	9 days
@ 95°F	12 hours	7 days
@ 104°F	10 hours	6 days

Maximum recoat time is 48 hours at temperatures between 60 - 85°F and 24 hours above 85°F.

If maximum recoat time is exceeded, abrade surface before recoating.

Drying time is temperature, humidity and film thickness dependent.

For elevated temperature cure, increase the substrate temperature by 50°F per hour until the final cure temperature is reached. The most common cure temperature is 180°F; at this temperature, the cure time is a minimum of 4 hours.

Pot Life: 2 hours @ 77°F, 50% RH

Sweat-in-time: Mix thoroughly for 3-5 minutes

Shelf Life: 12 months, unopened, at 77°F

Flash Point: 127°F Closed Cup, mixed

Reducer/Clean Up: MEK, R6K10

PERFORMANCE CHARACTERISTICS

System Tested: (unless otherwise indicated)
Substrate: Steel
Surface Preparation: SSPC-SP10
2 cts. Kem Cure Tank Lining @ 7.0 mils dft/ct

Tensile Strength:
Method: ASTM D538
Result: 13,240 psi

Flexural Strength:
Method: ASTM D790
Result: 13,443 psi

Flexural Modulus:
Method: ASTM D790
Result: 979 ksi

Water Absorption:
Method: ASTM D570 (33 days at 88°F)
Result: 0.09%

Vapor Transmission of Water:
Method: at 90°C for 7 days
Result: 0.0000 gm. (per sq ft per 7 days per inch of thickness)

Coefficient of Thermal Expansion:
Method: ASTM D696, -50°C to 150°C, (in./in./°C x 10^{-6})
Result: 19

Adhesive Strength:
Result: 2850 psi

Elongation:
Result: 8.2%

Hardness:
Result: 70 - 75 Barcol

Impact Resistance:
Method: ASTM D2794
Result: 61 inch lbs

continued on back

SHERWIN WILLIAMS®

Industrial and Marine Coatings

TRM.30

KEM® CURE TANK LINING

PART A	B69WQ2101	OFF WHITE
PART A	B69AQ2102	GRAY
PART B	B60VQ2100	HARDENER

PRODUCT INFORMATION

RECOMMENDED SYSTEMS

Steel:
2 cts. Kem Cure Tank Lining @ 7.0 - 8.0 mils dft/ct

Stainless Steel:
2 cts. Kem Cure Tank Lining @ 7.0 - 8.0 mils dft/ct

Concrete & Masonry:
1 ct. Corobond 100 Epoxy Primer/Sealer @ 4.0 - 6.0 mils dft
1-2 cts. Kem Cati-Coat Epoxy Filler/Sealer @ 10.0 - 30.0 mils dft/ct, as required to fill voids and bugholes to provide a continuous substrate.
2 cts. Kem Cure Tank Lining @ 7.0 - 8.0 mils dft/ct

The systems listed above are representative of the product's use. Other systems may be appropriate.

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure good adhesion.

Refer to product Application Bulletin for detailed surface preparation information.

Minimum recommended surface preparation:

Iron & Steel, immersion:	SSPC-SP5, 3-4 mil profile
Stainless Steel, immersion:	SSPC-SP5, 3-4 mil profile
Concrete & Masonry:	Cures, clean, dry, sound, brush blasted

COLOR AVAILABILITY/TINTING

Do not tint.

Color: Off White and Gray

APPLICATION CONDITIONS

Temperature:	60°F minimum, 110°F maximum (air, surface, and material)
	At least 5°F above dew point
Relative humidity:	70% maximum

Refer to product Application Bulletin for detailed application information.

ORDERING INFORMATION

Packaging: 1 gallon and 5 gallon kits

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

SHERWIN WILLIAMS®

Industrial and Marine Coatings

TRM.30A
KEM® CURE TANK LINING

PART A	B69WQ2101	OFF WHITE
PART A	B69AQ2102	GRAY
PART B	B60VQ2100	HARDENER

APPLICATION BULLETIN

Revised 1/99

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Iron & Steel (Immersion service):
Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. Minimum surface preparation is White Metal Blast Cleaning per SSPC-SP5. Blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (3-4 mils). Remove all weld spatter and round all sharp edges by grinding to a minimum 1/4" radius. Prime any bare steel the same day as it is cleaned.

Stainless Steel (immersion service):
Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. Minimum surface preparation is White Metal Blast Cleaning per SSPC-SP5. Blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (3-4 mils). Remove all weld spatter and round all sharp edges by grinding to a minimum 1/4" radius. Prime any bare steel the same day as it is cleaned.

Poured Concrete

New
Surfaces must be clean, dry, sound and offer sufficient profile to achieve adequate adhesion. Minimum cure is 28 days at 75°F. Remove all form release agents, curing compounds, salts, efflorescence, laitance, and other foreign matter by sandblasting, shotblasting, mechanical scarification, or suitable chemical means. Follow with 16% muriatic acid etch at the rate of 75 sq ft/gal. Refer to ASTM D4260. Rinse thoroughly to achieve a final pH between 6.0 and 10.0. Allow to dry thoroughly prior to coating.

Old
Surface preparation is done in much the same manner as new concrete, however, if the concrete is contaminated with oils, grease, chemicals, etc., they must be removed by cleaning with a strong detergent. Refer to ASTM D4258. Form release agents, hardeners, etc. must be removed by sandblasting, shotblasting, mechanical scarification, or suitable chemical means. If surface deterioration presents an unacceptably rough surface, Kem Cati-Coat Epoxy Surfacer is recommended to patch and resurface damaged concrete.
Fill all cracks, voids and bugholes with Corobond Crack Filler.

Always follow the ASTM methods listed below:
ASTM D4258 Standard Practice for Cleaning Concrete.
ASTM D4259 Standard Practice for Abrading Concrete.
ASTM D4260 Standard Practice for Etching Concrete.
ASTM D4263 Plastic Sheet Method for Checking Moisture in Concrete.

Immersion Service:
In addition to the above surface preparation, Brush Blasting of the concrete surface is required.

APPLICATION CONDITIONS

Temperature:	60°F minimum, 110°F maximum (air, surface, and material) At least 5°F above dew point
Relative humidity:	70% maximum

APPLICATION EQUIPMENT

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compatible with the existing environmental and application conditions.

Reducer ..... MEK, R6K10

Airless Spray
Pump ..... 30:1 to 45:1 unit
Pressure ..... 3000 psi
Hose ..... 3/8" ID
Tip ..... .017" - .023"
Filter ..... 50 - 60 mesh
Reduction ..... as needed, up to 5% maximum

Conventional Spray
Gun ..... Binks 95
Fluid Nozzle 66SK
Atomization Pressure ... 50 - 70 psi
Fluid Pressure ..... 45 - 60 psi
Reduction ..... as needed, up to 5% maximum
Dual water and oil extractors required

Brush
Brush ..... Natural Bristle
Reduction ..... as needed, up to 5% maximum

Roller
Cover ..... 3/8" woven with phenolic core
Reduction ..... as needed, up to 5% maximum

If specific application equipment is listed above, equivalent equipment may be substituted.

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SHERWIN WILLIAMS®

Industrial and Marine Coatings

TRM.30A

KEM® CURE TANK LINING

PART A	B69WQ2101	OFF WHITE
PART A	B69AQ2102	GRAY
PART B	B60VQ2100	HARDENER

APPLICATION BULLETIN

APPLICATION PROCEDURES

Surface preparation must be completed as indicated.

Mixing Instructions:
Mix component A thoroughly with power agitation. Make certain no pigment remains on the bottom of the can. If thinning , slowly add MEK and continue mixing until thoroughly mixed (approximately 2 - 3 minutes). Do not use more than 5% by volume (1 quart) of MEK per 5 gallons of resin Part A. Slowly add part B and mix thoroughly for 3 - 5 minutes. Do not overwork material. After mixing, pour material through a 60 mesh filter into a clean container. Always mix complete kits.

Apply paint to the recommended film thickness and spreading rate as indicated below:

Recommended Spreading Rate:

Wet mils:	8.0 - 9.0
Dry mils:	7.0 - 8.0
Coverage:	180 - 204 sq ft/gal approximate

Drying Schedule @ 8 mils wet, @ 50% RH:

	Minimum Recoat	To Cure
@ 68°F	20 hours	13 days
@ 77°F	16 hours	11 days
@ 86°F	14 hours	9 days
@ 95°F	12 hours	7 days
@ 104°F	10 hours	6 days

Maximum recoat time is 48 hours at temperatures between 60 - 85°F and 24 hours above 85°F.
If maximum recoat time is exceeded, abrade surface before recoating.
Drying time is temperature, humidity and film thickness dependent.
For elevated temperature cure, increase the substrate temperature by 50°F per hour until the final cure temperature is reached. The most common cure temperature is 180°F; at this temperature, the cure time is a minimum of 4 hours.

Pot Life: 2 hours @ 77°F, 50% RH

Sweat-in-time: Mix thoroughly for 3-5 minutes

PERFORMANCE TIPS

Stripe coat by brush all crevices, welds, and sharp angles to prevent early failure in these areas.

When using spray application, use a 50% overlap with each pass of the gun to avoid holidays, bare areas, and pinholes. If necessary, cross spray at a right angle

Spreading rates are calculated on volume solids and do not include an application loss factor due to surface profile, roughness or porosity of the surface, skill and technique of the applicator, method of application, various surface irregularities, material lost during mixing, spillage, overthinning, climatic conditions, and excessive film build.

Excessive reduction of material can affect film build, appearance, and adhesion.

Do not apply the material beyond recommended pot life.

In order to avoid blockage of spray equipment, clean equipment before use or before periods of extended downtime with MEK, R6K10,

Always mix complete kits.

Drying time is temperature, humidity, and film thickness dependent.

Do not mix previously catalyzed material with new.

After abrasive blasting, it is recommended to vacuum the surface with a bristle nozzle to remove all grit, dust, and embedded abrasive.

Direct or indirect forced air heating or inductive heating is acceptable. Use only propane or methane for direct heating. Do not use kerosene, diesel fuel, or heating oil.

Perform final heat cure, if required, after completing a high voltage (5,000 volts) holiday test and repairs and touch-ups have been performed.

For elevated temperature cure, increase the substrate temperature by 50°F per hour until the final cure temperature is reached. The most common cure temperature is 180°F; at this temperature, the cure time is a minimum of 4 hours.

Refer to Product Information sheet for additional performance characteristics and properties.

CLEAN UP INSTRUCTIONS

Clean spills and spatters immediately with MEK, R6K10. Clean tools immediately after use with MEK, R6K10. Follow manufacturer's safety recommendations when using any solvent.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

97 — SECTION I — PRODUCT IDENTIFICATION

MATERIAL SAFETY DATA SHEET

THE SHERWIN-WILLIAMS CO.
101 PROSPECT AVE. N.W.
CLEVELAND, OH 44115

EMERGENCY TELEPHONE NO. (216) 566-2917
INFORMATION TELEPHONE NO. (216) 566-2902
DATE OF PREPARATION 5 - MAY - 97

KEM CURE™ Tank Lining

B69-KC

— SECTION II — CAS No.	HAZARDOUS INGREDIENT (percent by weight)	ACGIH TLV <STEL>	OSHA PEL <STEL>	Units	Vapor Pressure (mm Hg)	B69AQ2102 Part A Gray	B69WQ2101 Part A Off-White	B60VQ2100 Part B Catalyst
Unknown	Polysiloxirane.	Not Established			0.0	<92	<92	
Unknown	Cycloaliphatic Polyamine	Not Established						100
78-93-3 §	Methy Ethyl Ketone	200 <300>	200 <300>	PPM	70.0	<3	<3	
108-10-1 §	Methyl Isobutyl Ketone	50 <75>	50 <75>	PPM	16.0	<3	<3	
13463-67-7	Titanium Dioxide	10	10[5]	Mg/M3 [Resp.	as Dust Fraction]	<5	<5	
	Weight per Gallon (lbs.)					13.0	13.0	8.65
	Solids by Weight (%)					90-95	90-95	100
	Solids by Volume (%)					90-95	90-95	100
	VOC Less Water & Federally Exempt Solvents - lbs./gal.					0.9	0.9	0.0
	Photochemically Reactive					No	No	No
	Flash Point (°F)					152	152	None
	Flammability Classification (Flammable - Combustible - Not Applicable)					Combustible	Combustible	Not Applicable
	DOL Storage Category					3A	3A	3B
	HMIS (NFPA) Rating (health - flammability - reactivity)					2 2 0	2 2 0	3* 1 0

Numbers In Boxes Are Percent By Weight

§ Ingredient subject to the reporting requirements of the Superfund Amendments and Reauthorization Act (SARA) Section 313, 40 CFR 372.65 C

→→→ *MSDS Text Page Follows* →→→

KEM CURE™ Tank Lining — B69-KC

Section III — PHYSICAL DATA

PRODUCT WEIGHT –	See TABLE	*EVAPORATION RATE* –	Slower than Ether
SPECIFIC GRAVITY –	1.04-1.56	*VAPOR DENSITY* –	Heavier than Air
BOILING RANGE –	174-242 °F	*MELTING POINT* –	N.A.
VOLATILE VOLUME –	0-10 %	*SOLUBILITY IN WATER* –	N.A.

Section IV — FIRE AND EXPLOSION HAZARD DATA

FLAMMABILITY CLASSIFICATION *FLASH POINT* See TABLE *LEL* NAp *UEL* NAp
See TABLE

EXTINGUISHING MEDIA
Carbon Dioxide, Dry Chemical, Foam

UNUSUAL FIRE AND EXPLOSION HAZARDS
Keep containers tightly closed. Isolate from heat, electrical equipment, sparks, and ope flame. Closed containers may explode when exposed to extreme heat. Application to hot surfaces requires special precautions. During emergency conditions overexposure to decomposition products may cause a health hazard. Symptoms may not be immediately apparent. Obtain medical attention.

SPECIAL FIRE FIGHTING PROCEDURES
Full protective equipment including self-contained breathing apparatus should be used. Water spray may be ineffective. If water is used, fog nozzles are preferable. Water may be used to cool closed containers to prevent pressure build-up and possible autoignition or explosion when exposed to extreme heat.

Section V — HEALTH HAZARD DATA

ROUTES OF EXPOSURE
Exposure may be by INHALATION and/or SKIN or EYE contact, depending on conditions of use. To minimize exposure, follow recommendations for proper use, ventilation, and personal protective equipment.

ACUTE Health Hazards

EFFECTS OF OVEREXPOSURE
B60VQ2100 Part B Hardener may cause burns on contact with skin or eyes.
B69AQ2101 and B69WQ2102 may cause irritation of eyes, skin and upper respiratory system and nervous system depression. Extreme overexposure to B69AQ2101 and B69WQ2102 may result in unconsciousness and possibly death.

SIGNS AND SYMPTOMS OF OVEREXPOSURE
Redness and itching or burning sensation may indicate eye or excessive skin exposure.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
May cause allergic skin or respiratory reaction in susceptible persons.

EMERGENCY AND FIRST AID PROCEDURES

If INHALED:	If affected, remove from exposure. Restore breathing. Keep warm and quiet. Get medical attention.
If on SKIN:	Wash affected area thoroughly with soap and water. Remove contaminated clothing and launder before re-use.
If in EYES:	Flush eyes with large amounts of water for 15 minutes. Get medical attention promptly.
If SWALLOWED:	Never give anything by mouth to an unconscious person. DO NOT INDUCE VOMITING. Give conscious patient several glasses of water. Get medical attention.

CHRONIC Health Hazards
No ingredient in these products is an IARC, NTP, or OSHA listed carcinogen.
Methyl Ethyl Ketone may increase the nervous system effects of other solvents.
Prolonged overexposure to solvent ingredients in Section II may cause adverse effects to the urinary and reproductive systems.
Rats exposed to titanium dioxide dust at 250 mg./m3 developed lung cancer, however, such exposure levels are not attainable in the workplace.

Section VI — REACTIVITY DATA

STABILITY – Stable
CONDITIONS TO AVOID
Elevated temperatures.
INCOMPATIBILITY
Acids, alkalis, and strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS
By fire: Carbon Dioxide, Carbon Monoxide
HAZARDOUS POLYMERIZATION – Will Not Occur

Section VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Remove all sources of ignition. Ventilate and remove with inert absorbent.

WASTE DISPOSAL METHOD
Waste from these products is not hazardous as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261.
Incinerate in approved facility. Do not incinerate closed container. Dispose of in accordance with Federal, State, and Local regulations regarding pollution.

Section VIII — PROTECTION INFORMATION

PRECAUTIONS TO BE TAKEN IN USE
Use only with adequate ventilation. Avoid breathing vapor and spray mist. Prevent contact with skin and eyes. Wash hands after using.
These coatings may contain materials classified as nuisance particulates (listed "as Dust" in Section II) which may be present at hazardous levels only during sanding or abrading of the dried film. If no specific dusts are listed in Section II, the applicable limits for nuisance dusts are ACGIH TLV 10 mg./m3 (total dust), 3 mg./m3 (respirable fraction), OSHA PEL 15 mg./m3 (total dust), 5 mg./m3 (respirable fraction).

VENTILATION
Local exhaust preferable. General exhaust acceptable if the exposure to materials in Section II is maintained below applicable exposure limits. Refer to OSHA Standards 1910.94, 1910.107, 1910.108.

RESPIRATORY PROTECTION
If personal exposure cannot be controlled below applicable limits by ventilation, wear a properly fitted organic vapor/particulate respirator approved by NIOSH/MSHA for protection against materials in Section II.
When sanding or abrading the dried film, wear a dust/mist respirator approved by NIOSH/MSHA for dust which may be generated from this product, underlying paint, or the abrasive.

PROTECTIVE GLOVES
To prevent skin contacat, wear butyl rubber gloves which are recommended by glove supplier for protection against materials in Section II.

EYE PROTECTION
To prevent eye contact, wear safety spectacles with unperforated sideshields.

OTHER PROTECTIVE EQUIPMENT
Use of barrier cream on exposed skin is recommended.

Section IX — PRECAUTIONS

DOL STORAGE CATEGORY – See TABLE

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Keep container closed when not in use. Transfer only to approved containers with complete and appropriate labeling. Do not take internally. Keep out of the reach of children.

Section X — OTHER REGULATORY INFORMATION

TSCA CERTIFICATION
All chemicals in these products are listed, or are exempt from listing, on the TSCA Inventory.

The above information pertains to these product as currently formulated, and is based on the information available at this time. Addition of reducers or other additives to these products may substantially alter the composition and hazards of the products. Since conditions of use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information.

RPP6855, Rev. 0

Technical Data
POLYSHIELD SS-100™

RPP-6855, Rev. 0

PRODUCT DESCRIPTION

POLYSHIELD SS-100™ is a state-of-the-art, high performance, sprayed, plural component pure polyurea elastomer. This system is based on amine-terminated polyether resins, amine chain extenders and MDI prepolymers. It provides a flexible, tough, resilient monolithic membrane with good water and chemical resistance.

RECOMMENDED USES

- Earthen containment lining used with or without geotextile fabric.
- Liner for concrete tanks, ponds, lagoons, reservoirs, dikes, irrigation ditches, tunnels, barges, etc.
- Membrane covering used with geotextile fabrics to encapsulate contaminates in landfill applications.
- Replace or repair failed existing sheet membrane liners.
- Steel tanks, silos and steel pipes.
- Protective elastomer for sprayed-in-place urethane foam.
- Encapsulant for styrofoam and other types of flotation.
- Encapsulant for asbestos & lead paint.
- Truckbed and undercarriage liner.
- Protective coatings for decorative products such as props, waterfalls, signage, statues, highway markings, etc.

FEATURES

- POLYSHIELD SS-100™ is a seamless membrane that can be handled and walked on within 1 minute or less from the time it is sprayed.

Unlike polyurethanes and epoxies, POLYSHIELD SS-100™ is Hycrophobic and therefore affected very little by damp or cold surfaces. It can be sprayed directly on water or ice and has been sprayed at -40° F (-40 °C) with minimal effect on tack free time.

- Due to its almost instantaneous gel time, POLYSHIELD SS-100™ can be built up to any thickness in one application including vertical and overhead surfaces. Eliminates need for multi-coat applications.
- POLYSHIELD SS-100™ has high temperature stability with a working temperature of up to 250° F (121 °C) with intermittent temperatures up to 300° F (149 °C).
- POLYSHIELD SS-100™ is 100% solids. No solvents, no V.O.C.'s.

COLORS

- It should be noted that POLYSHIELD SS-100™ is an aromatic polyurea, therefore, as with all aromatics over a period of time color change as well as superficial oxidation will occur.
- Aliphatic urethane and other suitable top coats can be used where long-term aesthetics are of critical importance.

Typical Physical Properties

	WET
Solids	
By weight	100%
By volume	100%
V.O.C.	0
Coverage	100 sq. ft./16 dry mils /gal.
Weight per gal	8.55 lbs (3.87 kg) Approx. Combined weight
Viscosity	
A component cps	500 approx @ 77° F (25 °C)
B component cps	550 approx @ 77° F (25 °C)
Cure times	
Gel	Less than two seconds
Tack free	8 - 12 seconds
Post cure	12 hours
Recoat	0 - 12 hours
Clean up solvent	DPM, NMP, Polyclean
Thinner	Not used
	***DRY**
Stress/Tensile strength	2500 psi ± 100 (172 bar)
Elongation	265% ± 50
Permeability MVT @ 30 mils (0.8mm)	0.024 US Perms (1.4 ng/Pa s m²)
Hardness	50 ± 5 shore D
Hardness	90 ± 5 shore A
100% Modulus	1600 ± 100 psi (110 bar)
300% Modulus	1925 ± 100 psi (132 bar)
Tear resistance	430 ± 50 PLI
Service temperature	-60° F to 300° F (-50 °C to 150 °C)
Abrasion resistance	
1 kg, 1000 rev, H-18 wheels	110 mg lost
Flame Spread at 20 mils	10
Smoke Density at 20 mils	5
Weatherability	no evidence of failure after 3000 hrs (QUV)

Samples for tests sprayed w/Gusmer H-II @ 1000 psi (69 bar) Primaries/Hose Heat 140° F (60 °C) D Gun w/62 chamber.

*Processing parameters as well as pigment types and quantity will change physical properties of cured elastomer.

GENERAL APPLICATION INSTRUCTIONS

- Apply POLYSHIELD SS-100™ to only clean, dry, sound surfaces free of loose particles or other foreign matter. A primer may be required, subject to type and/or condition of the substrate. Consult technical service personnel for specific primer recommendations and substrate preparation procedures.
- POLYSHIELD SS-100™ can be sprayed over a broad range of ambient and substrate temperatures. The limitations are in the ability of the application equipment to provide adequate material pressure and heat. Contact technical service personnel for specific recommendations, pricing and availability of spray and auxiliary equipment.
- It is recommended that POLYSHIELD SS-100™ be sprayed in multi-directional (north-south/east-west) passes to insure uniform thickness.
- The polyol "B" component must be thoroughly power mixed each day, prior to use. Contact an SPI technician regarding proper mixing equipment.

RECOMMENDED EQUIPMENT AND SETTINGS

- Standard 1:1 ratio, heated, plural component equipment developing minimum of 1000 psi (69 bar) dynamic pressure will adequately spray POLYSHIELD SS-100™.
- Pre-heater temperature should be at 160-170° F (71-76 °C).
- Hose temperature should be at 160-170° F (71-76 °C). A hose thermometer inserted under the insulation near the gun should read a minimum of 145-155° F (63-68 °C).

PN SERVICES

May 22, 2000
2506-001MAB

Ms. Shere Bush
Specialty Products, Inc.
2410 104th St. Ct.S.
Ste. D
Lakewood, WA 98499

Subject: Decontaminability Testing – Specialty Products coating

Dear Ms. Bush:

Project Introduction

This letter is a fulfillment of the request of Specialty Products (Purchase Order 2531).

Technical Introduction

The selected test option calls for drying a contamination solution unto a prepared (coated) sample. The sample is then washed with a sequential series of washes with 1) water, 2) ambient temperature decontamination solution and finally 3) hot decontamination solution.

Method

The Test was conducted in accordance with ASTM D4256-89[1] with minor changes noted below in the "Results" section. Laboratory notes and results were recorded in a Laboratory Notebook or on GammaVision ™ data printouts.

Results

The total decontamination factor (DF) is the ratio of the original activity to the activity after treatment. Note that these values include contamination removal by the previous steps. The decontamination factors are given for each of ^{137}Cs, ^{60}Co and Total Count. ^{60}Co is typical of a transition metal ion in that it tends to be less soluble in water than an alkali metal like ^{137}Cs. The Total Count is essentially the average of the two, since the initial activity of the two radionuclides was essentially the same and the only activities on the sample are ^{137}Cs and ^{60}Co.

1 ASTM 4256-89 "Standard Test Method for Determination of the Decontaminability of Coatings Used in Light-Water Nuclear Power Plants

PN Services • 2939 Richardson Road • Richland, Washington 99352 • Telephone: (509) 375-3535 • Fax: (509) 375-5230

	Total Decontamination Factors								
Sample	Water			Ambient Decon solution			Hot Decon solution		
	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count
Concrete Block	26	68	40	28	70	35	29.4	74	43
Steel Plate	15	31	22	16	30	22	16	31	22

	Total Percent Removal								
Sample	Water			Ambient Decon solution			Hot Decon solution		
	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count
Concrete Block	96.2	98.5	97.5	96.5	98.6	97.2	96.6	98.6	97.7
Steel Plate	93.4	96.8	95.4	93.7	96.7	95.4	93.8	96.8	95.6

The stepwise decontamination factor is the ratio of the activity remaining after the previous step to the activity after treatment. The stepwise decontamination factors may not reflect the complete ability of a decontamination method, due to the activity reduction of previous steps.

	Stepwise Decontamination Factors								
Sample	Water			Ambient Decon solution			Hot Decon solution		
	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count
Concrete Block	26	67	40	1.1	1.0	0.9	1.0	1.1	1.2
Steel Plate	15	31	22	1.0	1.0	1.0	1.0	1.0	1.0

	Stepwise Percent Removal								
Sample	Water			Ambient Decon solution			Hot Decon solution		
	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count	^{137}Cs	^{60}Co	Total Count
Concrete Block	96.2	98.5	97.5	7.0	2.6	-13	3.2	5.6	17.3
Steel Plate	93.4	96.8	95.8	4.3	-3.3	1.4	2.6	2.0	2.3

The used water wash was tested to help confirm the loss of radioactivity from the samples and did confirm the loss of both ^{137}Cs and ^{60}Co. Due to the dilution factor in the wash water and the decreasing amount of activity on the samples, only the water wash was tested.

The samples are "decontaminated" by dipping them in stirring water or decon solution. After the water wash the samples were lightly tissue-wiped on the uncontaminated side after rinsing the uncontaminated side (per the ASTM method). No major contamination was detected.

It was noted in the preparation of the ambient decon solution that the makeup water was closer to 15 °C than the method-required 24 ± 3°C. The water solution (for the water wash) had not been checked for temperature, as the ambient air temperature was close to 24 °C. This may have caused the slightly low values for ^{137}Cs removal for the water wash.

Although the ASTM method calls for this report to include "Procedures and conditions relating to the test specimen preparation", since PN Services did not prepare the samples, this information is not included.

The specimens were stained brown on the areas where the last of the contaminating solution had dried. The stains were in a doughnut shaped pattern. The brown color could indicate attack by un-neutralized nitric acid, but the samples clearly had white crystalline solids on them after the contamination solution had dried (before the water wash), which would indicate that neutralization by sodium hydroxide had occurred.

The immersed portions of the samples were slightly darker than the un-immersed part, after the ambient decontamination solution immersion.

Changes from the letter of the ASTM procedure were made for a number of reasons. Due to the size of the steel plate sample, the decontamination was done in a 2L glass crystallizing dish (vs the 600 mL polyethylene beaker of step 10.2.1). Both samples were decontaminated in the same bath. Section 9.2 states that "...immediately adjust to pH 4 with 8M ammonium hydroxide (NaOH)." The correct chemical formula for ammonium hydroxide is NH_4OH. We were left to make a decision about whether to use NaOH or NH_4OH. Since Hanford solutions are likely to contain NaOH – sodium hydroxide, this was used as the neutralizing agent. Also, measuring the pH of a 0.2 mL solution was not possible so the solution was neutralized with an equivalent amount of 8 M NaOH solution.

Discussion and Hypotheses

The differences between the plate and block samples could be accounted for by: 1) the higher ratio of front (unrinsed/unwiped) area to wipe-able area for the plate, 2) the block was more easily positioned in the gamma detector than the plate, which was just slightly wider than the shelf jig. The higher ratio of front area to wiped area for the plate may have had the effect of making the front surface available for recontamination. Positioning the plate in the gamma counter shelf jig was difficult. If the initial (freshly contaminated) count were done with the plate tilted slightly further away from the detector than the other counts, the decontamination ratio would be lowered due to the lowered initial count.

A possible reason for the differences between ^{137}Cs and ^{60}Co is that since the solution was neutralized, the ^{60}Co may have been in an insoluble hydroxide compound, and therefore not as subject to binding with the coating. A pH neutral solution of Cs still has ionic Cs in it, which would be attracted to ion exchange sites.

Conclusions

The coating material was decontaminated to a minimum decontamination factor (DF) of 21.6 (95.4 % removal) with ambient water. Further washes with ambient and hot decontamination solution increased the minimum DF to 22.4 (95.5 % removal).

The coating material was decontaminated to a maximum decontamination factor of 40 (97.5% removal) with ambient water. Further washes with ambient and hot decontamination solution increased the maximum DF to 43 (97.7 % removal).

I can be reached by phone at (509) 372-7814, or via E-mail at beck.ma@wcsmail.com.

Kindest regards,

Mark A. Beck

Mark A. Beck
Chemist II

cc: File
Peter Newton, PN Services
Alan Jordan, PN Services

SPECIALTY PRODUCTS, INC.
2410 104th St. Ct. S., Suite D
Lakewood, WA 98499
(253) 588-7101 (800) 627-0773
Fax (253) 588-7196
E-mail info@specialty-products.com
www.specialty-products.com

Adhesion Study with POLYUREA HT®
Comparing A.E.-4 to P.E.P. (Penetrating Epoxy Primer) on Same Surfaces

8/99

SURFACE	WITH A.E.-4 FAILURE MODE	PRIMED WITH P.E.P. FAILURE MODE
Stainless Steel	1000 PSI Dolly Glue & Coating Adhesion Failure	700 PSI Coating Adhesion Failure
Glass	1050 PSI Glass Failure	750 PSI Glass Failure
Concrete Block	350 PSI Concrete Cohesion Failure	450 PSI Concrete Cohesion Failure
Mild Steel With Severe Rust	700 PSI Rust Cohesion Failure	1050 PSI Glue Failure
Red Brick	900 PSI Coating Adhesion Failure	1050 PSI Coating Adhesion Failure
Ceramic Tile	900 PSI Tile Cohesion Failure	850 PSI Tile Cohesion Failure

Surfaces were washed with soap and water. No further surface preparation was performed.

This study indicates adhesion enhancement using P.E.P. on substrates that are porous. Due to its deep penetrating characteristics, P.E.P. may also be beneficial on certain porous and semi-porous substrates to displace oxygen; thereby, reducing the potential of corrosion and cathodic disbondment.

SPECIALTY PRODUCTS, INC.
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Tech Bulletin 0294-4

Baily
Horty
Salyme

ADHESION TESTS
POLYSHIELD SS-100™
on CONCRETE (VARIOUS)

Adhesion testing was performed according to ASTM D-4541 using an Elcometer 106 tester.

Sample Number	Pull-off Force Pounds/square inch	Failure Mode
1. Concrete block	125 average	Substrate removal
2. Concrete paver with SPI Urethane (2 component) primer	300	Test glue failure
3. Concrete paver after 60 days cure	150	Substrate removal
4. Concrete paver POLYSHIELD SS-100™ sprayed over wet concrete	225	From substrate

POLYSHIELD SS-100™ TEST RESULTS
The above data is per our ASTM TECH BULLETIN 1294
Referenced item is: 17.

NOTE: All reported test results are based on laboratory prepared samples. It is advisable that you perform actual application testing to ensure desired performance when considering a POLYSHIELD SS-100™ products.

Warning: Polyurea products manufactured from these chemicals may present a fire hazard if improperly used. Each user of such products should determine whether there is potential hazard in a specific application and take the necessary precautions.

RPP-6855, Rev. 0

SPECIALTY PRODUCTS, INC.
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Bailey Hanby Sandoval

May 9, 2000

Bechtel
3350 George Washington Way
Richland, WA 99352
Attn: Michael A Hughes

Shutdown control splash

Dear Michael,

This letter provides assurance that the Polyshield SS-100™ formulation which is going to be used for the encapsulation of the various valves and flanges per subcontract 0200W-SC-G0053 will meet the following requirements (as stated in the Scope of Work, 0200W-SW-G0053, section 4.0):

1. The physical and chemical characteristics of the Polyshield SS-100™ formulation provides an encapsulation life of 25 years when exposed to a solution containing any of the following: 75 Years
   - Approximately 2-4% HNO_3 as residual valve leakage. Tests conducted on Polyshield SS-100™, according to ASTM D3912 with 11.5% HNO_3, after 40 days indicates virtually no effect, slight color change on white test speciman.
   - Residual solution with trace amounts of Pu nitrate ($Pu(No_3)_4$), Aluminum Nitrate ($Al(NO_3)_3$), Ferrous Sulfamate ($Fe(NH_2SO_3)_2$), Sodium Dichromate ($Na_2Cr_2O_7$), HCl, Hexone, and UNH.
2. The $Pu(NO_3)_4$ will not be able to permeate through the Polyshield SS-100™ formulation.
3. The Polyshield SS-100™ formulation is not porous and does not dissolve in, or absorb the $Pu(NO_3)_4$
4. The Polyshield SS-100™ formulation is UL/FM rated per ASTM E-84 with a NFPA classification of A.

If I can be of further assistance, or if you require additional information, please do not hesitate to contact me at.

Sincerely,

Mike Cork
Research Director

MC:pl

The Society of the Plastic Industry, Inc. MEMBER
NACE MEMBER
SSPC MEMBER
NATIONAL ROOFING CONTRACTORS ASSOCIATION MEMBER

Brady
Hardy
Salyano

HUNTSMAN

Technical Bulletin

Chemical Resistance Testing for Polyurea Spray Elastomers
Chemical Resistance ASTM D 3912

Chemical	12 Month Exposure
Methanol	S. swelling, < 48 hours
Gasoline	Slight surface change, no hardness loss
Diesel fuel	No visible damage
Toluene	S. swelling, < 24 hours
MTBE	Slight surface change
5 % MTBE/Gasoline	Slight surface change
Motor Oil	Slight surface change, no hardness loss
Hydraulic Fluid	Slight surface change, no hardness loss
2-Methylbutane	No visible damage
Water	
Room temperature	No visible damage
82 °C, 14 days	No visible damage
10 % NaCl/Water	
Room temperature	No visible damage
50 °C, 14 days	No visible damage
10 % Sugar/Water	No visible damage
Sulfuric Acid	
5 %	No visible damage
10 %	No visible damage
3 %, 50 °C, 14 days	No visible damage
Hydrochloric Acid	
5 %	No visible damage
10 %	No visible damage
Phosphoric Acid	
10 %	No visible damage
Ammonium Hydroxide	
10 %	No visible damage
20 %	No visible damage
Sodium Hydroxide	
10 %	No visible damage
20 %	No visible damage
50 %	Slight surface discolor, no hardness loss
1 %, 50 °C, 14 days	Slight surface discolor, no hardness loss
Potassium Hydroxide	
10 %	No visible damage
20 %	No visible damage
Acetic Acid	
10 %	No visible damage

1995

VersaFlex INCORPORATED

VersaFlex FSS 45DC *Spray Polyurea, Concrete*

Manufacturer

***VersaFlex* Incorporated**
22 North 6th Street
Kansas City, KS 66101
Phone: (800) 321-0906
FAX: (913) 321-9007

Product Description

***VersaFlex* FSS 45DC** is a fast set, rapid curing, 100% solids, flexible, two component polyurea elastomer spray coating material. **FSS 45DC** is used by itself or in combination with other materials to produce coatings, liners, wearing courses, and resilient surfaces on concrete substrates. Its extremely fast gel time makes it suitable for applications down to -20°F without special conditioning of the component resins and isocyanates. **FSS 45DC** produces an extremely tough film at all thicknesses. Single or multiple pass applications produce films from 10 mils to 1000 mils without appreciable sag or runs. **FSS 45DC** may be applied in all positions and to any suitably prepared substrate.

FSS 45DC is inert, it will not hydrolyze, leach, or contaminate other materials, and is bondable and paintable.

FSS 45DC is relatively moisture and temperature insensitive, allowing application in the most problematic ambient conditions.

Uses

***VersaFlex* FSS 45DC** is a superior coating material designed specifically for industrial applications receiving constant or intermittent attack from contained materials, subsurface hydrostatic pressure, most corrosive substances, and abrasive action. **FSS 45DC** is flexible, accommodating movement of the substrate, yet strong enough to remain intact under all conditions except major structural dislocations. With or without reinforcements **FSS 45DC** may be used in transitional areas with confidence. **FSS 45DC** may be used in interior or exterior applications.

FSS 45DC is recommended for repair of other films, damaged concrete, or new construction and in cold weather conditions, cold storage facilities, freezers, and food processing plants where time and temperature are serious concerns. **FSS 45DC** is ideal for applications in:

- Industrial Facilities
- Parking Garage Decks
- Warehouse Floors
- Below Grade Waterproofing
- Above Grade Dampproofing
- Manufacturing Facilities
- Water and Waste Water Treatment
- Cold Storage Facilities
- Food Processing Facilities
- Pulp and Paper Mills
- Bottling and Canning Facilities
- Walkways and Balconies
- Secondary Containment
- Refineries
- Fertilizer and other Process Plants
- Mining Operations
- Landfill Containment
- Freezers
- Airports

Advantages

- 100% Solids, Meets VOC Regulations
- Flexible, 520% Elongation
- Excellent Thermal Stability
- Heat of Deflection 250°F, no load
- Glass Transition Temperatures -40°F and 250°F
- Generally Suitable for Use when pH ranges from 4 -11
- Good Resistance to a Wide Range of Chemical Attack
- Non-catalysed, Non-reactive
- Low Permeance Rate
- Seamless Elastomer
- Remains Flexible in Cold Temperatures
- Return Project to Service in 60 Minutes
- Cures From -20°F to 225°F
- Odorless, No Toxic Vapors
- USDA Approved

Limitations

FSS 45DC should not be used for direct contact with extremely high or low pH attack. Composite systems are available. Consult ***VersaFlex***.

Typical Physical Properties

Cured Film Properties	Test Method	Typical Value
Solids Content		100%
Shore A Hardness	ASTM D2240	45D
Elongation	ASTM D638	520%
Tensile Strength, psi	ASTM D638	2145
100% Modulus, psi	ASTM D638	960
300% Modulus, psi	ASTM D638	1450
Tear Strength, pli, Die C	ASTM D624	430
Taber abrasion, mg wt loss (1000 gms, 1000 revs, H-18 wheels)	ASTM D4060	180
Moisture Vapor Transmission, perms	ASTM E96	0.025
Gel Time		8 Seconds
Tack Free		25 Seconds
Open to Traffic		60 Minutes

Coverage Rates

Theoretical Square Feet Per Gallon

Mils	10	15	50	60	80	100	125
	160	107	32	27	20	16	13

Note: 1604 mil inches per gallon. Totally dependent on substrate texture and condition.

Packaging

- One Hundred Ten Gallon Kit: 55 gallons of 'A' side and 55 gallons of 'B' side.
- Ten Gallon Kit: 5 gallons of 'A' side and 5 gallons of 'B' side.

Mixing

FSS 45DC must be spray applied using approved equipment. Use 1:1 ratio pump, with appropriate material heaters, as required for individual application. For information contact ***VersaFlex.***

Colors

Standard color is charcoal gray, light gray, or black. Other colors available upon request. Consult ***VersaFlex***.

Shelf Life

One year, in original, unopened factory containers, under normal storage conditions of 55°F to 95°F.

Clean-up

Cured product may be disposed of without restriction. Excess liquid 'A' and 'B' material should be mixed together and allowed to cure, then disposed of in the normal manner. Product containers that are "drip free" may be disposed of according to local, state and federal laws.

Safety

Read Material Safety Data Sheets provided with all shipments. Additional copies are available upon request from ***VersaFlex*** or your local dealer.

Basic safety for personal protection is:

- Long-sleeve overalls or disposable Tyvex overalls.
- Rubber gloves.
- Splash shield or safety glasses with splash guards.
- Rubber or leather boots.
- Do not use near high heat or open flame.
- Do not take internally.
- Keep out of the reach of children.

Surface Preparation and Installation

Regard ***VersaFlex*** specifications for **FSS 45DC Spray Polyurea**, for detailed preparation and installation procedures. Substrate priming is not required on all substrates, consult ***VersaFlex*** for recommendations.

3145 Broadway • Kansas City, MO 64111 • 800-561-6191 • Fax: 816-561-6164

Chemical Resistance

• Recommended	R
• Recommended Conditionally (washdown within 1 hour of spillage)	C
* Not Recommended	N
• Suitable for immersion and/or splash and spillage conditions	1
• Suitable for occasional/intermittent contact for up to 72 hours	2

Test Procedure: **ASTM D3912** 25°C Exceeds 1 Year

Test Media	Result
Acetic Acid 10%	C
Ammonium Hydroxide 10%/20%	R
Diesel Fuel	R
Gasoline	R
Hydraulic Fluid	R
Hydrochloric Acid 5%/10%	R
Methanol	R
Motor Oil	R
MTBE	1
MTBE/Gasoline 5%	R
NaCl/Water 10%	R
Phosphoric Acid 10%	R
Potassium Hydroxide 10%/20%	R
Sodium Hydroxide 10%/20%/50%	R
Sugar/Water 10%	R
Sulfuric Acid 5%/10%	R
Skydrol	2
Toluene	C
Water	R
2-Methylbutane	R

Exposure to UV will cause discoloration, no change in physical properties

Test Procedure: **ASTM D1308** 25°C Exceeds 1 Year

Test Media	Result
Acetone	C
Antifreeze	R
Benzene	R
Benzoic Acid	R
Butyl Alcohol	R
Butyl Cellosolve	R
Carbon Dioxide	R
Calcium Hypochlorite	N
Chlorine (5000 ppm in water)	2
Citric Acid	R
Cylloexanol	R
Dichloacetic Acid	C
Dimethyl Formamide	N
Ethanol	2
Ethylene Glycol	1
Gasoline	R
Hexane	R
Hydraulic Oil	R
Hydrochloric Acid <35%	R
Lactic Acid 10%	1
Methylene Chloride	C
Methyl Ethyl Ketone	C
Methanol	R
Mineral Spirits	R
Monobutyl Ether	R
Nitric Acid 20%	C
Phenol	2
Skydrol	2
Sodium Bicarbonate	R
Sodium Chloride	R
Sodium Hydroxide 50%	R
Sodium Hypochlorite 10%	2
Stearic Acid	R
Sulfuric Acid 70%	N
Trichloroethylene	C
Trisodium Phosphate	R
Toluene	C
Vinegar	R
Xylene	C

Warranty - *VersaFlex* Incorporated will refund the price of or replace, at its election, product it finds to be defective provided the product has been used properly. Except as expressly stated above, the Company makes no warranty of merchantability and no warranty of fitness for any particular purpose, nor does it make any warranty, expressed or implied, of any nature whatsoever with respect to the product or its use.

In no event shall the company be liable for delay caused by defects, for loss of use, for indirect, special or consequential damages, or for any charges or expenses of any nature incurred without its written consent.

Art Weiss
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Conyers, GA 30012
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VersaFlex
INCORPORATED

8/1/00

Use of Polyurea as Primary Containment Liner in High pH Environment

Regarding: *VersaFlex* FSS 45DC spray polyurea to contain high pH (7 - 14) liquids and slurry materials.

Reference #1: Contained material: Sodium Chlorate - ph 13
Container: Tile Lined Steel Tank and Mild Steel Tank Interior Roof

The initial installation was undertaken at Weyerhaeuser (then: Avenor) Dryden, Ontario pulp plant in June 1998. The completed installation has been in constant service since that time. The tank is inspected on a semi-annual basis. Four such inspections have taken place to date. The system is performing without flaw or repair. The owner has subsequently released several more tile line steel tanks and stainless steel tanks for lining.

❖

Reference #2: Contained material: White Liquor (Sodium Chlorate) - pH 12
Container: Steel White Liquor Settling Tank

This installation occurred at Kimberly Clark Winslow, ME in August 1998.

❖

Reference #3: Contained material: Bleaching Chemicals - pH 12
Container: Concrete Holding Tank

This installation at Repap, Mirimichi, New Brunswick occurred in August 1998.

The above installations are in active service and are all primary containment for the mentioned high pH materials. *VersaFlex* recommends use of its polyurea materials in these types of circumstances on a continuing basis. We have warranted many such installations at the request of the various owners.

Respectfully submitted,

Art Weiss
Technical Supervisor

General Polymers

Technical Data Sheet

FX 387
Elastomeric Coating

Product Description

FX 387 Elastomeric Coating is a high quality, fast curing, 100% solids resin system. This two component system requires application via plural component spray equipment. The final result is a tough, highly flexible, tear and impact resistant coating exhibiting excellent waterproofing and chemical resistant qualities. FX 387 can be put into service within hours of application.

Features

- No VOC's
- No Odor
- Moisture insensitive
- Waterproofing
- Fast Cure
- Chemical Resistant
- Able to be applied below 10°F
- High Strength and Flexibility
- Low Component Viscosity

Uses

Secondary containment areas
Waste water tanks
[illegible]
Pipe coatings
Basins
Reservoirs
Ground cover (over Geotextile)

Typical Physical Properties @ 73°F

Colors	Available in standard colors. Custom colors upon request.
Mix Ratio A/B	1/1
Gel time	10 sec.
Tack free time	45 sec.
Viscosity	
Part A	300 cps
Part B	300 cps
Flame spread (after 24 hr. cure) ASTM E-108	Class A
Tensile Strength ASTM D-638	3200 psi
Elongation ASTM D-638	440 %
100 Modulus ASTM D-638	1100 psi
[illegible] ASTM D-638	1900 psi
Hardness, Shore "D" ASTM D-2240	45
Tear strength ASTM D-624	580 pli
Taber Abrasion ASTM D-4060	180 mg

Safety

Read and understand the provided Material Safety Data Sheets. Use adequate ventilation and all required personal protective equipment. For confined space only use fresh air supply and Tyvek suit. For open air use an organic vapor respirator with dual cartridges. A full face respirator is recommended for added eye protection.

Mixing

Slowly premix the part B with drill and Jiffy blade, taking care to not entrap air into the product. Continue mixing until you no longer see any striations. Part A does not require premixing.

Substrate Preparation

Ground: For ground cover it is recommended that all surfaces be covered with geotextile cloth and secured with stakes every 24 inches on center before spraying.

Concrete: Shotblast substrate to a profile that resembles 80 - 100 mesh sandpaper. Always perform a Calcium Chloride Test as per ASTM E-1907. Do not proceed if moisture vapor content is > 3 lbs. per 1000 sqft and call General Polymers for technical assistance. Honor all expansion joints. Rout all cracks, spalls and holes. Fill all cracks, spalls and holes with FX 375 or FX 121. Prime using FX 311.

Metal: Sand/grind or sandblast to white metal with a 3 mil profile. Prime using FX 311.

Application

Use only plural component equipment capable of producing 3000 psi at 160°F. Gusmer GX7 or equivalent type impingement gun is highly recommended. 3.5 gallon to 22 gallon per minute spray tips are approved depending on desired thickness.

Limitations

Product will discolor when exposed to UV light, this is most pronounced in light colors. Product must be applied with heated, plural component spray equipment.

Shelf Life

Product can be stored for up to 1 year in sealed un-opened containers. Store material between 40-140°F.

Warranty

The sale of General Polymers Corporation's (General Polymers) products are governed by the General Polymers' *Standard Terms and Conditions of Sale*. General Polymers has no knowledge or control concerning buyer's use of the product nor over the quality of the concrete or substrate to which they are applied. General Polymers assumes no responsibility for any loss or damage resulting from the handling or use of the products by the buyer. General Polymers makes the following **LIMITED WARRANTY** that its products have been supplied free from manufacturing defects, and will conform to General Polymers manufacturing standards. Technical data furnished by General Polymers is true and accurate to the best of our knowledge; however no guarantee of accuracy is given or implied. This Limited Warranty shall not apply in the case of improper installation, improper substrate construction, damage beyond the scope and protection of the products, exposure of the products to solvents and/or higher concentrations of acids than that for which the products are designed and loss of bond due to hydrostatic pressure, vapor pressure, capillary action or moisture from within, under or adjacent to the concrete surface.

GENERAL POLYMERS' LIABILITY SHALL NOT EXCEED REPLACEMENT OF OR RETURN OF THE PURCHASE PRICE FOR THE PRODUCTS WHICH IT MAY SELL WHICH MAY PROVE TO BE DEFECTIVE UNDER NORMAL USE AND SERVICE WITHIN ONE YEAR FROM DATE OF SALE AND WHICH UPON EXAMINATION BY GENERAL POLYMERS SHALL DISCLOSE, TO GENERAL POLYMERS' SATISFACTION, TO BE DEFECTIVE. IN NO EVENT SHALL GENERAL POLYMERS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, BUYERS LOSS OF MATERIAL OR PROFITS, INCREASED EXPENSE OF OPERATION, BODILY INJURY, LOSS OF USE OF PROPERTY, OR DOWN TIME. GENERAL POLYMERS MAKES NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THE BUYER HEREBY EXPRESSLY WAIVES ANY CLAIM TO ADDITIONAL DAMAGES.

This Limited Warranty supersedes any other warranty or other representation, whether written or oral, heretofore made between the parties.

POLYSHIELD/POLYUREA Group including SS-100™, FRP®, F.B.E.-4™
Component A
MSDS Number: 7162-599
Revision Date: 11-JUN-96

MATERIAL SAFETY DATA SHEET

EMERGENCY CONTACT:

Spills, Leaks, Fire or Exposure Call Chemtrec: (800) 424-9300

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: POLYSHIELD/POLYUREA Group including SS-100™, FRP®, F.B.E.-4™ Component A

Company: Specialty Products, Inc.
2410 104th St. Ct. S., Suite D
Lakewood, WA 98499
(253) 588-7101

SECTION 2 - COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S)	% (w/w)	ACGIH TLV	CAS NO.
4,4' - Diphenylmethane Diisocyanate (4,4' MDI)	-32	0.005 ppm	101-68-8
Modified MDI	-58	Not Listed	Not Listed
Proprietary Chemical	-5-12	Not Listed	

SECTION 3 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Health Hazards: Irritating to eyes, respiratory system and skin. Risk of serious damage to respiratory system. May cause sensitization by inhalation and skin contact. Repeated inhalation of aerosol at levels above the occupational exposure limit could cause respiratory sensitization. The onset of the respiratory symptoms may be delayed for several hours after exposure. A hyper-reactive response to even minimal concentrations of MDI may develop in sensitized persons.

Physical Hazards: Reacts slowly with water to produce carbon dioxide that may rupture closed containers. This reaction accelerates at higher temperatures.

Appearance: Clear liquid.
Odor: None.

Read the entire MSDS for a more thorough evaluation of the hazards.

SECTION 4 - FIRST AID MEASURES

General: In case of accident or if you feel unwell, seek medical advice IMMEDIATELY (show the MSDS where possible).

Inhalation: Remove patient from exposure, keep warm and at rest. Obtain medical attention. Treatment is symptomatic for primary irritation or bronchospasm. If breathing is labored, qualified personnel should administer oxygen. Apply artificial respiration if breathing has ceased or shows signs of failing.

Skin Contact: Remove contaminated clothing. Wash affected areas thoroughly with soap and water. If irritation, redness, or a burning sensation develops and persists, obtain medical advice. Contaminated clothing should be thoroughly cleaned before reuse.

Eye Contact: Immediately flush eyes with running water for a minimum of 15 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

Ingestion: DO NOT induce vomiting. Provided the patient is conscious, wash out mouth with water then give 1 or 2 glasses of water to drink. Refer person to medical personnel for immediate attention.

Note to Physicians: Symptomatic and supportive therapy as needed. Following severe exposure medical follow-up should be monitored for at least 48 hours.

SECTION 5 - FIRE-FIGHTING MEASURES

Fire and Explosion Hazards: Containers may burst under intense heat. Due to reaction with water, a hazardous buildup of pressure could result if contaminated containers are resealed.

Extinguishing Media: Carbon dioxide, dry chemical, or appropriate foam. If water is used, very large quantities are required. Reaction between water and hot isocyanate may be vigorous. Contain runoff water with temporary barriers.

Fire Fighting Procedures: As appropriate for surrounding materials/equipment.

Fire Fighting Protective Equipment: Use self-contained breathing apparatus and full protective clothing (Bunker gear).

Flash Point: >230° F (110 °C)
Flammable Limits (Lower): Not available.
Flammable Limits (Upper): Not available.
Auto Ignition Temperature: 240 °C (464° F) (4,4' - Diphenylmethane Diisocyanate)
Decomposition Temperature: Not available.
Rate of Burning: Not available.
Explosive Power: None.
Sensitivity to Mechanical Impact: None.
Sensitivity to Static Discharge: None.
Combustion Products: Carbon monoxide, carbon dioxide, nitrogen oxides and some HCN.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

For major spills, call Chemtrec (800-424-9300)

Spills, Leaks, or Releases: Cleanup should only be performed by trained personnel. People dealing with major spillages should wear full protective clothing including respiratory protection. Evacuate the area. Prevent further leakage, spillage or entry into drains. Contain and absorb large spillages onto an inert, nonflammable absorbent carrier (such as earth or sand). Shovel into open-top drums or plastic bags for further decontamination, if necessary. Wash the spillage area clean with liquid decontaminant. Test atmosphere for MDI vapor. Neutralize small spillages with decontaminant. Remove and dispose of residues. Notify applicable government authorities if release is reportable. The CERCLA RQ for MDI is 5,000 lbs. (see CERCLA in Section 15).

Preparation of Decontamination Solution: Prepare a decontamination solution of 0.2-0.5% liquid detergent and 3-8% concentrated ammonium hydroxide in water (5-10% sodium carbonate may be substituted for the ammonium hydroxide). Follow the precautions on the supplier's material safety data sheets when preparing and using solution.

Use of Decontamination Solution: Allow deactivated material to stand for at least 30 minutes before shoveling into drums. Do not tighten the bungs. Mixing with wet earth is also effective, but slower.

SECTION 7 - HANDLING AND STORAGE

Handling: Avoid personal contact with the product or reaction mixture. Use only with adequate ventilation to ensure that the defined occupational exposure limit is not exceeded. The efficiency of the ventilation must be monitored regularly because of the possibility of blockage. Avoid breathing aerosols, mists and vapors. When the product is sprayed or heated, an approved MSHA/NIOSH positive-pressure, supplied-air respirator may be required.

Storage Requirements: Keep containers properly sealed and when stored indoors, in a well ventilated area. Keep contents away from moisture. Due to reaction with water, producing CO_2 gas, a hazardous buildup of pressure could result if contaminated containers are resealed. Do not reseal contaminated containers! Uncontaminated containers, free of moisture, may be resealed only after placing under a nitrogen blanket. Do not store in containers made of copper, copper alloys or galvanized surfaces.

Storage Temperature: Ideal storage temperature is 16-38 °C (60-100° F).

Keep stocks of decontaminant (See Section 6) readily available.

SECTION 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

PREVENTIVE MEASURES:

Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

Engineering Controls: Use local exhaust ventilation to maintain airborne concentrations below the TLV. Suitable respiratory equipment should be used in cases of insufficient ventilation or where operational procedures demand it. For general guidance on engineering control measures refer to the ACGIH publication "Industrial Ventilation".

Personal Protective Equipment:

Eye Protection: Chemical safety goggles. If there is a potential for splashing, use a full face shield.

Skin Protection: The following protective materials are recommended:
Gloves - neoprene, nitrile-butadiene rubber, butyl rubber. Thin disposable gloves should be avoided for repeated or long term use. Protective clothing should be selected and used in accordance with "Guidelines for the Selection of Chemical Protective Clothing" published by ACGIH.

Respiratory Protection: Use a NIOSH/MSHA-approved positive pressure air-supplied respirator equipped with a full facepiece, or an air-supplied hood, if airborne concentrations exceed or are expected to exceed the TLV. Air purifying (cartridge type) respirators are not approved for protection against diisocyanates.

EXPOSURE GUIDELINES:

Medical supervision of all employees who handle or come in contact with respiratory sensitizers is recommended. Persons with asthmatic-type conditions, chronic bronchitis, other chronic respiratory diseases or recurrent skin eczema or sensitization should be excluded from working with this product. Once a person is diagnosed as sensitized, no further exposure to the material that caused the sensitization should be permitted.

HAZARDOUS INGREDIENT(S):

4,4'-Diphenylmethane Diisocyanate:

ACGIH TLV	0.005 ppm (8-hour, 40 hours/week)
OSHA PEL CEILING	0.02 ppm
NIOSH REL/TWA	0.005 ppm (10-hour, 40 hours/week)
NIOSH REL/CEILING	0.02 ppm (10-minute)

NOTE: The Occupational Exposure Limits listed for isocyanates do not apply to previously sensitized individuals.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Alternate Name(s): Not applicable.
Chemical Name: Not applicable (mixture).
Chemical Family: Diisocyanate
Molecular Formula: Not applicable (mixture).
Appearance: Clear liquid.
Odor: None.
Odor Threshold (ppm): 0.4 (4,4'-Diphenylmethane Diisocyanate)
pH: Not applicable.
Flash Point: >230° F (110 °C)
Vapor Pressure (mm Hg at 20 °C): Approx. 4×10^{-4}
Vapor Density (Air=1): 8.5 approx.
Boiling Point: Not applicable.
Melting Point: Not available.
Solubility (Water): (Reacts with water)
Specific Gravity: 1.1549
Evaporation Rate: Not available.

SECTION 10 - STABILITY AND REACTIVITY

Hazardous Decomposition Products: Highly unlikely under normal industrial use. See Section 5.
Chemical Stability: Stable at room temperature.
Conditions to Avoid: Avoid high temperatures. Avoid freezing.
Incompatibility with other Substances: This product will react with any materials containing active hydrogens such as water, alcohol, amines, bases and acids. The reaction with water is very slow under 50 °C (122° F) but is accelerated at higher temperatures.
Hazardous Polymerization: Polymerization may occur at elevated temperatures in the presence of alkalies, tertiary amines and metal compounds.
Teratogenicity and Fetotoxicity: No birth defects were seen in two independent animal (rat) studies. Fetotoxicity was observed at doses that were extremely toxic (including lethal) to the mother. Fetotoxicity was not observed at doses that were not maternally toxic. The doses used in these studies were maximal, respirable concentrations well in excess of the defined occupational limits.

SECTION 11 - TOXICOLOGICAL INFORMATION

TOXICOLOGICAL DATA:

Polymeric MDI:	Oral LD50 (rat) > 5.00 mg/kg Dermal LD50 (rabbit) > 5.00 mg/kg Inhalation LC50 (rat) = 490 mg/m3/4H (respirable aerosol)

POTENTIAL HEALTH EFFECTS:

Inhalation: This product is a respiratory and potential respiratory sensitizer. Repeated inhalation of vapor or aerosol at levels above the occupational exposure limit could cause respiratory sensitization. Symptoms may include irritation to the eyes, nose, throat and lungs, possibly combined with dryness of the throat, tightness of chest and difficulty in breathing. The onset of the respiratory symptoms may be delayed for several hours after exposure. A hyperreactive response to even minimal concentrations of MDI may develop in sensitized persons.

Skin Contact: Moderate irritant. Repeated and/or prolonged contact may cause skin sensitization. Animal studies have shown that respiratory sensitization can be induced by skin contact with known respiratory sensitizers including diisocyanates. These results emphasize the need for protective clothing including gloves to be worn at all times when handling these chemicals or in maintenance work.

Eye Contact: The aerosol, vapor or liquid will irritate human eyes following contact.

Ingestion: Ingestion may cause irritation of the gastrointestinal tract. Based on the oral LD50, this product is considered practically nontoxic by ingestion.

Chronic Effects: A study was conducted where groups of rats were exposed for 6 hours/day, 5 days/week for a lifetime to atmospheres of respirable polymeric MDI aerosol. Overall, the tumor incidence, both benign (6 mg/m3), there was a significant incidence of a benign tumor of the lung (adenoma) and one malignant tumor (adenocarcinoma). There were no lung tumors at 1 mg/m3 and no effects at 0.2 mg/m3. The increased incidence of lung tumors is associated with prolonged respiratory irritation and the concurrent accumulation of yellow material in the lung, which occurred throughout the study. In the absence of prolonged exposure to high concentrations leading to chronic irritation and lung damage, it is highly unlikely that tumor formation will occur.

There are reports that chronic exposure may result in permanent decrease in lung function.

Carcinogenicity: The ingredients of this product are not classified as carcinogenic by ACGIH or IARC, not regulated as carcinogens by OSHA, and not listed as carcinogens by NTP.

Mutagenicity: There is no substantial evidence of mutagenic potential.

Reproductive Effects: No adverse reproductive effects are anticipated.

SECTION 12 - ECOLOGICAL INFORMATION

Environmental Fate and Distribution: It is unlikely that significant environmental exposure in the air or water will arise, based on consideration of the production and use of the substance.

Persistence and Degradation: Immiscible with water, but will react with water to produce inert and non-biodegradable solids.

Toxicity: Polymeric MDI.
LC0 (Zebra Fish) > 1000 mg/l
EC50 (Daphnia magna) (24 hours) > 1000 mg/l
EC50 (E. Coli) > 100 mg/l

SECTION 13 - DISPOSAL CONSIDERATIONS

The generation of waste should be avoided or minimized wherever possible.

Disposal should be in accordance with local, state, provincial or national regulations. This material is not a hazardous waste under RCRA 40 CFR 261. Small quantities should be treated with a decontaminant solution (See Section 6). The treated waste is not a hazardous material under RCRA 40 CFR 261. Chemical waste, even small quantities, should never be poured down drains, sewers, or waterways.

Empty containers should be decontaminated and either passed to an approved drum recycler or destroyed.

SECTION 14 - TRANSPORT INFORMATION

DOT: Single containers less than 5,000 lbs. are not regulated.
Single containers with 5,000 lbs. or more of 4,4'-MDI are regulated as: Other Regulated Substances, Liquid, N.O.S. (Methylene Diphenyl Diisocyanate), 9 NA3082, PGIII, RQ.

Transportation Emergency Telephone Number: 1-800-424-9300 (CHEMTREC)
TDG: Not Regulated.
IMO: Not Regulated.
IATA/ICAO Class: Not Regulated.

SECTION 15 - REGULATORY INFORMATION

USA CLASSIFICATION:

OSHA Classification:
-Physical: Not regulated.
-Health: Highly toxic. Respiratory sensitizer. Skin sensitizer. Irritant
-Target Organ: Respiratory tract. Skin.

TSCA (Toxic Substances Control Act) Regulations: All ingredients are on the TSCA Chemical Substance Inventory.

EPCRA Section 313 (40 CFR 372): This product contains the following chemical(s) subject to reporting requirements: approx. 32% 4,4'-MDI.

CERCLA (Comprehensive Environmental Response, Compensation and Liability Act): 4,4-Methylene Diphenyl Diisocyanate (CAS 101-68-8) has a 5,000 lb. RQ (reportable quantity). Any spill or release above the RQ must be reported to the National Response Center (800-424-8802). *The % of 4,4'-MDI in this product is listed in Section 2 of this MSDS.*

This product does not contain nor is it manufactured with ozone depleting substances.

Other Regulations/Legislation which apply to this product:
Massachusetts Right-to-Know, Pennsylvania Right-to-Know, New Jersey Right-to-Know, CERCLA.

CANADIAN CLASSIFICATION:

This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS (Material Safety Data sheet) contains all the information required by the CPR.

Controlled Products Regulations (WHMIS) classification: D-1A: Very toxic (acute effects). D-2A: Very Toxic. D-2B: Toxic.

CEPA / Canadian Domestic Substances List (DSL): This product contains substance(s) not on the Canadian Domestic Substances List (CEPA DSL), environmental notification may be required.

SECTION 16 - OTHER INFORMATION

Glossary:	ACGIH -	American Conference of Governmental Industrial Hygienists
	IARC -	International Agency for Research on Cancer
	NTP -	National Toxicology Program
	OSHA -	Occupational Safety and health Administration

FOR YOUR PROTECTION: *The information and recommendations in this publication are, to the best of our knowledge,* reliable. The toxicity and risk characteristics of products made by Specialty Products, Inc. will necessarily differ from the toxicity and risk characteristics that occur when such products are used with other materials during a manufacturing process. The resulting risk characteristics should be determined and made known to ultimate end-users and processors. Specialty Products, Inc., MAKES NO WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

POLYSHIELD/POLYUREA Group Including SS-100™, HI-E®, HT®, FRP®, FMJ™, F.B.E.-4™, Glass Shield-100 A.E.™, J-II™ Component B
MSDS Number: 1008-599
Revision Date: 09-SEP-98

MATERIAL SAFETY DATA SHEET

EMERGENCY CONTACT:

Spills, Leaks, Fire or Exposure Call Chemtrec: (800) 424-9300

HMIS Information:

Health	3*
Flammability	1
Reactivity	0

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: POLYSHIELD/POLYUREA Group Including SS-100™, HI-E®, HT®, FRP®, FMJ™, F.B.E.-4™ Glass Shield-100 A.E.™, J-II™ Component B
Chemical Name: Mixture of amine compounds
Chemical Formula: N/A Product is a Mixture

Manufactured By: Specialty Products, Inc.
2410 104th St. Ct. S., Suite D
Lakewood, WA 98499
(253) 588-7101

SECTION 2 – HAZARDOUS INGREDIENTS

Chemical & Common Name	CAS #	Wt%	OSHA PEL	ACGIH TLV	OTHER
(Chemical Identity is Proprietary)		60-90	None established	None established	
*(Chemical Identity is Proprietary)		10-40	None established	None established	
(Chemical Identity is Proprietary)		2-20	None established	None established	

*Designates a hazardous chemical as defined by SARA Title III, Section 311, 312

SECTION 3 - PHYSICAL CHARACTERISTICS

Boiling Range:	586° F
Vapor Pressure (mm Hg):	0.9 mm @ 68° F
Specific Gravity:	0.98-1.02
Vapor Density (Air = 1):	6.2
% Volatile (Volume):	0
Volatile Organic Content (VOC):	0 grams/liter
Solubility (Specific solvents):	Moderate
Appearance and Odor:	Viscous liquid in various colors; characteristic amine odor

SECTION 4 - FIRE & EXPLOSION DATA

Flash Point: Above 275° F (135 °C)

Extinguishing Media: Dry chemical, foam, carbon dioxide, halogenated agents. Water or foam can cause frothing.

Special Firefighting Procedures: Use water to cool fire-exposed containers. Self-contained breathing apparatus, with full facepiece and protective clothing should be worn.

Unusual Fire and Explosion Hazards: None known.

Reactivity: Product is stable under normal conditions.

Hazardous Polymerization: Will not occur.

Incompatibilities (materials to avoid): Will react with acids.

Conditions to avoid: AVOID MOISTURE CONTAMINATION IN CONTAINERS. CONTAINERS SHOULD NOT BE RESEALED IF CONTAMINATION IS SUSPECTED. CO_2 CREATED PRESSURE CAN DEVELOP. DO NOT ATTEMPT TO USE CONTAMINATED MATERIAL.

Hazardous Decomposition Products: Combustion products: Toxic levels of ammonia. Oxides of nitrogen, carbon, and some aldehydes and ketones may also be produced.

SECTION 5 - HEALTH HAZARDS

PRIMARY ROUTES OF ENTRY: Eye contact, inhalation, ingestion, skin contact.

ACUTE HEALTH EFFECTS:

EYE CONTACT: Will cause irritation, burning, or chemical burns.

INHALATION: Vapors or mist are irritating and may cause nasal discharge, coughing, and discomfort in nose, throat and chest. Severe overexposure may result in difficulty breathing, headache, nausea, vomiting, and drowsiness.

INGESTION: Ingestion of this product is expected to be harmful or fatal. Oral LD50 = 485 mg/kg.

SKIN CONTACT: This product can be toxic by dermal absorption. Dermal LD50 = 700 mg/kg.

EMERGENCY FIRST AID PROCEDURES:

EYE CONTACT: Wash with clean water for at least fifteen minutes; get medical attention.

INHALATION: Move individual to fresh air. If breathing has stopped, apply artificial respiration; get medical attention immediately.

INGESTION: If person is conscious and can swallow, immediately give two glasses of water (16 oz) but do not induce vomiting. This material is corrosive. If vomiting occurs, give fluids again. Have a physician determine if condition of patient will permit induction of vomiting or evacuation of stomach. Do not give anything by mouth to an unconscious or convulsing person.

SKIN CONTACT: Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing and decontaminate shoes before reuse.

CHRONIC HEALTH EFFECTS: Prolonged or repeated overexposure may result in lung damage.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing lung or skin conditions could be aggravated by repeated exposure.

SECTION 6 - SPILL OR LEAK PROCEDURES

Steps to be taken in case material is spilled or released: Ventilate area. Avoid breathing vapor. Use of self-contained breathing apparatus may be required in confined or enclosed areas. Contain any spills with dikes or absorbents to prevent migration and entry into sewers or streams. Take up small spills with dry chemical absorption. Large spills may be taken up with pump or vacuum and finished off with dry chemical absorbent.

Waste Disposal Method: Dispose of material in accordance with all federal, state, and local regulations.

SECTION 7 - SPECIAL PROTECTION DATA

Respiratory Protection: *Wear MSHA/NIOSH-approved respirator for organic vapors. Ensure workers are trained in their proper use.*

Ventilation: Mechanical ventilation, adequate to keep exposure below TLV, is recommended.

Protective Gloves: Neoprene or nitrile rubber.

Eye Protection: Goggles or face shield.

Other Protective Clothing or Equipment: Eyewash fountain and safety shower should be accessible; impervious protective clothing.

SECTION 8 - HANDLING & STORAGE DATA

Precautions to be Taken in Handling and Storage: Store in well-ventilated, cool, dry area. Purge with nitrogen and close container when not in use.

Other Precautions: Store in original container; keep tightly closed. Do not reuse container for other purposes. **KEEP OUT OF REACH *OF CHILDREN.***

SECTION 9 - OTHER INFORMATION

TSCA Information: All ingredients are on the TSCA Chemical Substance Inventory.

WHMIS Information: Not all ingredients are confirmed on the Canadian DSL (Domestic Substances List).

AMERON Coatings

Amercoat® 351

100% solids multi-purpose epoxy

Product Data/ Application Instructions

- Solventless
- High-build
- Hot water resistant
- Chemical resistant
- Abrasion resistant
- Excellent barrier properties
- Standard airless application
- Easily cleaned

Typical Uses

- Chemical tank lining
- Water tank lining
- Pipe lining and coating
- Abrasion resistant coating
- Concrete protection

Amercoat 351 is a solventless, high performance coating that can be applied with standard airless equipment. It is suitable for use as a tank lining for a variety of fuel and clean products for non-reactive chemicals, caustic, potable water, salt water, ballast and dry bulk materials.

The abrasion resistance of Amercoat 351 allows it to be used as a lining for slurries, or as a coating for concrete in high wear services.

Amercoat 880 glass flake additive may be added to Amercoat 351 to increase film build, further reinforce mechanical properties and lower moisture permeability. For increased film build in one coat, Amercoat 884 can be added.

Amercoat 351 is an excellent barrier coat, providing long-term resistance to corrosion even under aggressive conditions. It is suitable for immersion in both salt and deionized waters up to 120°F (49°C).

Typical Properties

Abrasion (ASTM D4060)	
1 kg/1000 cycles / cs-17 wheel	41 mg wt. loss
Adhesion, elcometer (ASTM D4541)	1200 psi
Salt spray - 12 mils/5000 hrs.	
face corrosion (ASTM B117)	None
face blistering (ASTM B117)	None
Humidity condensation (ASTM D4585)	2000 + hrs
face corrosion	None
blistering	None
Moisture Vapor Transmission (ASTM F1249)	6.07g/m²
Steam cleanable	Yes

Physical Data

Finish	Semigloss	
Color*	Gray	
**Note: When exposed to sunlight, color change will occur.*		
Components	2	
Curing mechanism	Chemical reaction between components	
Volume solids (calculated)	100%	
Dry film thickness per coat	8-12 mils (200-300 microns)	
with 880	12-25 mils	
with 884 ½ gal	20-30 mils	
with 884 1 gal	45-55 mils	
Theoretical coverage	ft²/gal	m²/L
1 mil (25 microns)	1604	39.4
8 mils (200 microns)	201	4.9
VOC mixed	lb/gal	g/L
	0.0	0.0

Temperature resistance	Wet		Dry	
	°F	°C	°F	°C
continuous	120	49	200	93
intermittent	140	60	250	121

Flash point (SETA)	°F	°C
351 cure	>212	>100
351 resin	>212	>100
Amercoat 928	175	47

Qualifications

USDA - Incidental Food Contact

Application Data

Applied over	Primed or prepared steel, concrete
Surface preparation	
steel	SSPC-SP10
concrete	ASTM D4259 or 4260
Primer	Amercoat 370
Method	Airless spray
Mixing ratio (by volume)	
351	3 parts resin to 1 part cure
351 - 4 gal mixed	2 x 1-gal can 880
351 - 4 gal mixed	1 x ½-gal can 884
351 - 4 gal mixed	1 x 1-gal can 884

Pot life (hours)	°F/°C		
	90/32	70/21	50/10
	½	1	1½

Environmental conditions		
Temperature	°F	°C
air and surface	40 to 90	4 to 32
material	50 to 90	10 to 32

Surface temperatures must be at least 5°F (3°C) above dew point to prevent condensation.

Chemical Resistance

The following is a representative list of chemicals to which Amercoat 351 may be exposed as a lining. Contact your Ameron representative for recommendations concerning specific requirements.

Alum	Gasoline, unleaded
10% Ammonium hydroxide	Kerosene
Aromatic 100	Methanol (to 120°F, 49°C)
n-Butyl acetate	Mineral oil
Carbon Tetrachloride	Nonyl phenol
Castor oil	Oxygenated salt water
50% Caustic (to 160°F, 71°C)	Palm oil (to 160°F, 71°C)
Crude oil (to 120°F, 49°C)	Salt water (to 120°F, 49°C)
Diesel fuel	20% Sodium carbonate
Diethylene glycol	Triton X-100
Ethanol (to 120°F, 49°C)	Water (to 120°F, 49°C)
Formaldehyde	Xylene

Systems Using Amercoat 351

1st Coat	2nd Coat
Amercoat 351	
Amercoat 351	Amercoat 351
Amercoat 351	Amercoat 450HS

Surface Preparation

Coating performance is, in general, proportional to the degree of surface preparation. Prior to coating, the surface must be clean, dry, undamaged and free of all contaminants, including salt deposits. Round off all rough welds and remove all weld spatter.

Steel – Abrasive blast SSPC-SP10. Blast to achieve an anchor profile of 1 to 2 mils (25-50. microns) anchor profile as indicated by a Keane-Tator Surface Profile Comparator, Testex Tape or similar device. Remove abrasive residue or dust from surface. Apply Amercoat 351 as soon as possible to keep steel from rusting. If a holding primer is required, Amercoat 83HS may be used.

Note: Apply Amercoat 351 as soon as possible after surface preparation to prevent recontamination. Do not leave blasted steel uncoated overnight. In case of contamination, remove contaminants. Spot blast if needed.

Concrete—Clean concrete surface. Abrasive blast (ASTM D4259) or acid etch (ASTM D4260) to remove all previous coatings, chalk and surface glaze or laitance. Fill small holes or voids in cast concrete wall or overhead surfaces with Nu-Klad 114A filler compound before applying Amercoat 351. Apply Amercoat 351 within 7 days after application of Nu-Klad 114A.

Adhere to all application instructions, precautions, conditions and limitations to obtain the maximum performance. For conditions outside the requirements or limitations described, contact your Ameron representative.

Drying time (ASTM D1640) (hours)	°F/°C		
	90/32	70/21	50/10
touch	8	10	16
through	12	18	60
Recoat time**			
minimum	8	12	36
maximum (days)	5	14	20

***Roughen surface if maximum recoat time is exceeded.*

Time before service @ 8 mils (days)	°F/°C		
	90/32	70/21	50/10
immersion***	4	7	14

****Cure at 50°F minimum.*

Equipment cleaner Amercoat 928

Shipping Data

Packaging	1- and 4-gal can	
cure	0.25 gal in 1-gal can	
	1.0 gal in 1-gal can	
resin	0.75 gal in 1-gal can	
	3.0 gal in 5-gal can	
Shipping weight (approx)	lb	kg
1-gal unit		
cure	2.5	1.1
resin	9.3	4.2
4-gal unit		
cure	9.0	4.1
resin	40.0	18.1

Shelf life when stored indoors at 40 to 100°F (4 to 38°C)
cure and resin 1 year from shipment date

Numerical values are subject to normal manufacturing tolerances, color and testing variances. Allow for application losses and surface irregularities.

The mixed product is nonphotochemically reactive as defined by South Coast Air Quality Management District's Rule 102 or equivalent regulations.

Low Temperature Limitations

After application the substrate and coating temperature must be at 40°F or above to avoid creating film defects from exposure to temperatures below 40°F.

Cure time required before exposure to temperatures below 40°F are as follows:

70°F	60°F	50°F	40°F
3 hrs	7 hrs	16 hrs	48 hrs

High Temperature Limitation

After application at surface temperatures of 40°F to 90°F the Amercoat 351 must cure as follows before being exposed to temperatures above 90°F to avoid sagging:

90°F	70°F	60°F	50°F	40°F
4 hrs	6 hrs	8 hrs	10 hrs	24 hrs

When surface temperatures are above 90°F use Amercoat 884 additive to maintain film build. Without the Amercoat 884 additive sagging may occur above 4 mils DFT at a substrate temperature of 140°F.

Application Equipment

The following is a guide; suitable equipment from other manufacturers may be used. Changes in pressure and tip size may be needed to achieve the proper spray characteristics.

Airless spray—Standard equipment with a ratio of 45:1, such as Graco King. Pump should be equipped with $^{3}/_{8}$ inch internal diameter high pressure spray hose for lengths of less than 50 feet. For length greater than 50 feet, spray hose should be $^{1}/_{2}$ inch internal diameter.

When Amercoat 880 is added, the tip size should be 0.035-inch or larger. Tip size when Amercoat 884 is added should be 0.027 to 0.035.

Power mixer—Jiffy Mixer

Brush or Roller—Additional coats may be required to attain proper thickness.

Application Procedure

Amercoat 351 is packaged in the correct proportions of resin and cure which must be mixed together before use.

1. Flush equipment with Amercoat 928 cleaner.
2. Stir both resin and cure to an even consistency. Add cure to resin mixing until a uniform consistency is achieved. Do not use thinners. Never mix more than can be sprayed within pot life time.

Pot life (hours)	°F/°C		
	90/32	70/21	50/10
	$^{1}/_{2}$	1	$1^{1}/_{2}$

3. Apply a wet coat in even, parallel passes. Overlap each pass 50 percent to avoid bare areas, pinholes or holidays. Cross spray at right angles if necessary.
4. Material temperature must be between 50 and 90°F. Higher temperatures shorten the pot life. Lower temperatures affect sprayability.
5. Ventilate with clean air during application. Maintain air temperature to prevent condensation on coating surface.
6. Check film thickness using a wet film thickness gauge. If films less than 8 mils (200 microns) apply additional material. Maximum dry film thickness when using Amercoat 880 is 25 mils per coat.

Note: To increase film build with one application Amercoat 884 can be added – $^{1}/_{2}$ gal can for a 4-gal unit of Amercoat 351 will increase dry film thickness to between 20-30 mils. See Amercoat 884 Product Data Sheet for specific information.

7. For immersion service, check for bare areas, pinholes and holidays with a non-destructive wet sponge holiday detector such as Tinker-Rasor Model M1 or Model AP/W. Apply additional Amercoat 351 to areas requiring touch-up within maximum recoat time.

Time before service @ 8 mils (days)	°F/°C		
	90/32	70/21	50/10
immersion**	4	7	14

***Cure at 50°F minimum.*

8. Clean equipment with Amercoat 928 immediately after use.

Repair

Spot abrasive blast to remove all rust, loose paint and other contaminants from damaged areas abraded to bare steel.

Clean and roughen coating surface if recoat time is exceeded. Apply Amercoat 351 as soon as possible after surface is cleaned to prevent contaminants on the surface.

Warranty

Ameron warrants its products to be free from defects in material and workmanship. Ameron's sole obligation and Buyer's exclusive remedy in connection with the products shall be limited, at Ameron's option, to either replacement of products not conforming to this Warranty or credit to Buyer's account in the invoiced amount of the nonconforming products. Any claim under this Warranty must be made by Buyer to Ameron in writing within five (5) days of Buyer's discovery of the claimed defect, but in no event later than the expiration of the applicable shelf life, or one year from the delivery date, whichever is earlier. Buyer's failure to notify Ameron of such nonconformance as required herein shall bar Buyer from recovery under this Warranty.

Ameron makes no other warranties concerning the product. No other warranties, whether express, implied, or statutory, such as warranties of merchantability or fitness for a particular purpose, shall apply. In no event shall Ameron be liable for consequential or incidental damages.

Any recommendation or suggestion relating to the use of the products made by Ameron, whether in its technical literature, or in response to specific inquiry, or otherwise, is based on data believed to be reliable; however, the products and information are intended for use by Buyers having requisite skill and know-how in the industry, and therefore it is for Buyer to satisfy itself of the suitability of the products for its own particular use and it shall be deemed that Buyer has done so, at its sole discretion and risk. Variation in environment, changes in procedures of use, or extrapolation of data may cause unsatisfactory results.

Limitation of Liability

Ameron's liability on any claim of any kind, including claims based upon Ameron's negligence or strict liability, for any loss or damage arising out of, connected with, or resulting from the use of the products, shall in no case exceed the purchase price allocable to the products or part thereof which give rise to the claim. In no event shall Ameron be liable for consequential or incidental damages.

Safety Precautions

Read each component's material safety data sheet before use. Mixed material has hazards of each component. Safety precautions must be strictly followed during storage, handling and use.

CAUTION – Improper use and handling of this product can be hazardous to health.

Do not use this product without first taking all appropriate safety measures to prevent property damage and injuries. These measures may include, without limitation: implementation of proper ventilation, use of proper lamps, wearing of proper protective clothing and masks, tenting and proper separation of application areas. Consult your supervisor. Proper ventilation and protective measures must be provided during application and drying to keep vapor concentrations within safe limits and to protect against toxic hazards. Necessary safety equipment must be used and ventilation requirements carefully observed, especially in confined or enclosed spaces, such as tank interiors and buildings.

This product is to be used by those knowledgeable about proper application methods. Ameron makes no recommendation about the types of safety measures that may need to be adopted because these depend on application environment and space, of which Ameron is unaware and over which it has no control.

If you do not fully understand these warnings and instructions or if you cannot strictly comply with them, do not use the product.

Note: Consult Code of Federal Regulations Title 29, Labor, parts 1910 and 1915 concerning occupational safety and health standards and regulations, as well as any other applicable federal, state and local regulations on safe practices in coating operations.

This product is for industrial use only. Not for residential use.

AMERON Coatings

Ameron Coatings • 201 North Berry Street, Brea, California 92821 • (714) 529-1951
Ameron PCG/Europe • J. F. Kennedylaan 7, 4191 MZ Geldermalsen, The Netherlands • (31) 345-587-587

Appendix D
Cost Estimates

DETAILED ESTIMATING WORKSHEET

Pit Lining Alternatives

9909223.01

Final Estimate

"Wall Paper" SST with Polyurea Coating

Description	Quantity	Unit	Material Unit Cost	Procurement fee/GRT	Total Material Cost	Installation Unit Cost	Equipment Unit Cost	Equipment Cost	Labor Cost	Total Cost	Contingency %	Contingency $	Total Cost
Fabricate Work Platform	1	ea	$600.00	$108	$708	$0	$0	$0	$2,936	$3,644	25%	$911	$4,555
Install Work Platform	1	ea	$50.00	$9	$59	$2,768	$640	$640	$2,768	$3,467	25%	$867	$4,334
Sheet Metal Fabrication	420	sf	$10.00	$756	$4,956	$0	$0	$0	$0	$4,956	25%	$1,239	$6,195
Sheet Metal Installation	420	sf	$0.00	$0	$0	$19	$5	$1,920	$7,896	$9,816	25%	$2,454	$12,270
Powder Actuated Fastener Installation	500	ea	$0.80	$72	$472	$3	$0	$18	$1,632	$2,122	25%	$530	$2,652
Polyurea Installation	420	sf	$4.00	$302	$1,982	$10	$0	$385	$4,272	$6,639	25%	$1,660	$8,299
Label Nozzle ID and Graphics	18	ea	$10.00	$32	$212	$292	$0	$0	$5,256	$5,468	25%	$1,367	$6,836
Remove Work Platform	1	ea	$0.00	$0	$0	$2,768	$0	$0	$2,768	$2,768	25%	$692	$3,460
Total													$48,600

Assumptions:

1) Crew size for sheet metal installation: 2 HPT, 1 PIC, 1 Crane Op., 2 Riggers, 3 Laborers, 1 Cement Mason, 0.25 Ind. Safety
2) Crew size for polyurea installation: 2 HPT, 1 PIC, 2 Painters, 1 Contract Painter, 0.25 Ind. Safety
3) Typical Pit is 10x10x8 feet
4) For powder actuated fasteners, assume 500 fasteners per pit

DETAILED ESTIMATING WORKSHEET

Pit Lining Alternatives

9909223.01

Final Estimate

SST Box with Polyurea Joint Sealing

Description	Quantity	Unit	Material Unit Cost	Procurement fee/GRT	Total Material Cost	Installation Unit Cost	Equipment Unit Cost	Equipment Cost	Labor Cost	Total Cost	Contingency %	Contingency $	Total Cost
Fabricate Work Platform	1	ea	$600.00	$108	$708	$0	$0	$0	$2,936	$3,644	25%	$911	$4,555
Install Work Platform	1	ea	$50.00	$9	$59	$2,768	$640	$640	$2,768	$3,467	25%	$867	$4,334
Sheet Metal Fabrication	420	sf	$20.00	$1,512	$9,912	$0	$0	$0	$0	$9,912	25%	$2,478	$12,390
Sheet Metal Installation	420	sf	$0.00	$0	$0	$31	$0	$1,920	$13,160	$15,080	25%	$3,770	$18,850
Powder Actuated Fastener Installation	500	ea	$0.80	$72	$472	$5	$0	$18	$2,720	$3,210	25%	$802	$4,012
Polyurea Installation	420	sf	$4.00	$302	$1,982	$10	$0	$385	$4,272	$6,639	25%	$1,660	$8,299
Label Nozzle ID and Graphics	18	ea	$10.00	$32	$212	$292	$0	$0	$5,256	$5,468	25%	$1,367	$6,836
Remove Work Platform	1	ea	$0.00	$0	$0	$2,768	$0	$0	$2,768	$2,768	25%	$692	$3,460
Total													$62,735

Assumptions:

1) Crew size for sheet metal installation: 2 HPT, 1 PIC, 1 Crane Op., 2 Riggers, 3 Laborers, 1 Cement Mason, 0.25 Ind. Safety
2) Crew size for polyurea installation: 2 HPT, 1 PIC, 2 Painters, 1 Contract Painter, 0.25 Ind. Safety
3) Typical Pit is 10x10x8 feet
4) For powder actuated fasteners, assume 500 fasteners per pit

DETAILED ESTIMATING WORKSHEET

Pit Lining Alternatives

9909223.01

Final Estimate

Various Coating Systems

Description	Quantity	Unit	Material Unit Cost	Procurement fee/GRT	Total Material Cost	Installation Unit Cost	Equipment Unit Cost	Equipment Cost	Labor Cost	Total Cost	Contingency %	Contingency $	Total Cost
Fabricate Work Platform	1	ea	$600.00	$108	$708	$0	$0	$0	$2,936	$3,644	25%	$911	$4,555
Install Work Platform	1	ea	$50.00	$9	$59	$2,768	$640	$640	$2,768	$3,467	25%	$867	$4,334
Surface Preparation (power wash)	420	sf	$0.00	$0	$0	$2	$0	$0	$980	$980	25%	$245	$1,225
Coating Installation	420	sf	$4.00	$302	$1,982	$10	$0	$385	$4,272	$6,639	25%	$1,660	$8,299
Label Nozzle ID and Graphics	18	ea	$10.00	$32	$212	$292	$0	$0	$5,256	$5,468	25%	$1,367	$6,836
Remove Work Platform	1	ea	$0.00	$0	$0	$2,768	$0	$0	$2,768	$2,768	25%	$692	$3,460
Total													$28,709

Assumptions:

1) Crew size for surface preparation: 2 HPT, 1 PIC, 1 Painter, 1 Contract Painter, 0.25 Ind. Safety
2) Crew size for coating installation: 2 HPT, 1 PIC, 2 Painters, 1 Contract Painter, 0.25 Ind. Safety
3) Typical Pit is 10x10x8 feet
4) Coating costs ranges from less than $1.00/sf to $4.00/sf. $4.00 was used for consistency, but this cost is only about 15% of the overall cost. Quoted costs are Chem-Cure $300/gal (180-200 sq. ft.), CeramKote $160/gal (180-200 sq. ft.)

Pit Lining Alternatives

9909223.01

Final Estimate

Floor Pan SST with Polyurea Coating

Description	Quantity	Unit	Material Unit Cost	Procurement fee/GRT	Total Material Cost	Installation Unit Cost	Equipment Unit Cost	Equipment Cost	Labor Cost	Total Cost	Contingency %	Contingency $	Total Cost
Fabricate Work Platform	1	ea	$600.00	$108	$708	$0	$0	$0	$2,936	$3,644	25%	$911	$4,555
Install Work Platform	1	ea	$50.00	$9	$59	$2,768	$640	$640	$2,768	$3,467	25%	$867	$4,334
Sheet Metal Fabrication	100	sf	$12.00	$216	$1,416	$0	$0	$0	$0	$1,416	25%	$354	$1,770
Sheet Metal Installation	100	sf	$0.00	$0	$0	$53	$0	$1,920	$5,264	$7,184	25%	$1,796	$8,980
Powder Actuated Fastener Installation	100	ea	$0.80	$14	$94	$11	$0	$18	$1,088	$1,200	25%	$300	$1,500
Surface Preparation (power wash)	420	sf	$0.00	$0	$0	$2	$0	$0	$980	$980	25%	$245	$1,225
Polyurea Installation	320	sf	$4.00	$230	$1,510	$13	$0	$385	$4,272	$6,167	25%	$1,542	$7,709
Label Nozzle ID and Graphics	18	ea	$10.00	$32	$212	$292	$0	$0	$5,256	$5,468	25%	$1,367	$6,836
Remove Work Platform	1	ea	$0.00	$0	$0	$2,768	$0	$0	$2,768	$2,768	25%	$692	$3,460
Total													$40,368

Assumptions:

1) Crew size for sheet metal installation: 2 HPT, 1 PIC, 1 Crane Op., 2 Riggers, 3 Laborers, 1 Cement Mason, 0.25 Ind. Safety
2) Crew size for polyurea installation: 2 HPT, 1 PIC, 2 Painters, 1 Contract Painter, 0.25 Ind. Safety
3) Typical Pit is 10x10x8 feet
4) For powder actuated fasteners, assume 500 fasteners per pit

PPP-68[illegible], rev 0

Backup Data for "Wall Paper Crew"

Description	Rate	Hours	Total
Sheet Metal Installation			
HPT (2)	$36.00	48	$1,728.00
PIC	$40.00	24	$960.00
Crane Operator	$36.00	24	$864.00
Riggers (2)	$36.00	48	$1,728.00
Laborers (2)	$32.00	48	$1,536.00
Ind. Hygienist	$36.00	6	$216.00
Operator	$36.00	24	$864.00
Total			**$7,896.00**
Powder Actuated Fasteners			
Cement Mason	$36.00	24	$864.00
Laborer	$32.00	24	$768.00
Total			**$1,632.00**
Polyurea Installation			
HPT (2)	$36.00	32	$1,152.00
PIC	$40.00	16	$640.00
Painters (2)	$31.00	32	$992.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	16	$576.00
Contract Painter	$48.00	16	$768.00
Total			**$4,272.00**

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Backup Data for "SST Box Crew"

Description	Rate	Hours	Total
Sheet Metal Installation			
HPT (2)	$36.00	80	$2,880.00
PIC	$40.00	40	$1,600.00
Crane Operator	$36.00	40	$1,440.00
Riggers (2)	$36.00	80	$2,880.00
Laborers (2)	$32.00	80	$2,560.00
Ind. Hygienist	$36.00	10	$360.00
Operator	$36.00	40	$1,440.00
Total			**$13,160.00**
Powder Actuated Fasteners			
Cement Mason	$36.00	40	$1,440.00
Laborer	$32.00	40	$1,280.00
Total			**$2,720.00**
Polyurea Installation			
HPT (2)	$36.00	32	$1,152.00
PIC	$40.00	16	$640.00
Painters (2)	$31.00	32	$992.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	16	$576.00
Contract Painter	$48.00	16	$768.00
Total			**$4,272.00**

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Backup Data for Coatings

Description	Rate	Hours	Total
Surface Preparation			
HPT (2)	$36.00	8	$288.00
PIC	$40.00	4	$160.00
Painter	$31.00	4	$124.00
Ind. Hygienist	$36.00	2	$72.00
Operator	$36.00	4	$144.00
Contract Painter	$48.00	4	$192.00
Total			**$980.00**
Coating Installation			
HPT (2)	$36.00	32	$1,152.00
PIC	$40.00	16	$640.00
Painters (2)	$31.00	32	$992.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	16	$576.00
Contract Painter	$48.00	16	$768.00
Total			**$4,272.00**

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Backup Data for Floor Pan

Description	Rate	Hours	Total
Surface Preparation			
HPT (2)	$36.00	8	$288.00
PIC	$40.00	4	$160.00
Painter	$31.00	4	$124.00
Ind. Hygienist	$36.00	2	$72.00
Operator	$36.00	4	$144.00
Contract Painter	$48.00	4	$192.00
Total			**$980.00**
Sheet Metal Installation			
HPT (2)	$36.00	32	$1,152.00
PIC	$40.00	16	$640.00
Crane Operator	$36.00	16	$576.00
Riggers (2)	$36.00	32	$1,152.00
Laborers (2)	$32.00	32	$1,024.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	16	$576.00
Total			**$5,264.00**
Powder Actuated Fasteners			
Cement Mason	$36.00	16	$576.00
Laborer	$32.00	16	$512.00
Total			**$1,088.00**
Coating Installation			
HPT (2)	$36.00	32	$1,152.00
PIC	$40.00	16	$640.00
Painters (2)	$31.00	32	$992.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	16	$576.00
Contract Painter	$48.00	16	$768.00
Total			**$4,272.00**

Assume 3 days for "Wall Paper Installation"

Assume 5 days for "SST Box Installation"

Assume 2 days for floor pan installation

Assume 2 days for all coating (including polyurea) installation (one day for setup and takedown, one day for work)

Stainless Steel Fabrication of $20/sf is based on information from Anne Griggs. $10/sf is for much simpler fabrication.

Powder actuated nailer costs are from R.S. Means. Equipment cost of $700 is divided by 39 pits.

Polyurea equipment costs are based on $15K for all equipment divided by 39 pits.

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General Requirements for All Tasks

Description	Rate	Hours	Total
Fabricate Work Platform			
PIC	$40.00	16	$640.00
Carpenter (2)	$36.00	48	$1,728.00
Painter	$31.00	8	$248.00
Foreman	$40.00	8	$320.00
Total			$2,936.00
Install Work Platform			
HPT (2)	$36.00	16	$576.00
PIC	$40.00	8	$320.00
Carpenters (2)	$36.00	16	$576.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	8	$288.00
Crane Operator	$36.00	8	$288.00
Riggers (2)	$36.00	16	$576.00
Total			$2,768.00
Assume 1 day to install work platform			
Remove Work Platform			
HPT (2)	$36.00	16	$576.00
PIC	$40.00	8	$320.00
Carpenters (2)	$36.00	16	$576.00
Ind. Hygienist	$36.00	4	$144.00
Operator	$36.00	8	$288.00
Crane Operator	$36.00	8	$288.00
Riggers (2)	$36.00	16	$576.00
Total			$2,768.00
Assume 1 day to remove work platform			
Label Nozzle ID and Graphics			
HPT (2)	$36.00	48	$1,728.00
PIC	$40.00	24	$960.00
Painters (2)	$31.00	48	$1,488.00
Ind. Hygienist	$36.00	6	$216.00
Operator	$36.00	24	$864.00
Total			**$5,256.00**
Assume 3 days for nozzle ID and graphics			