JUN 23 1998

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

622367

2. To: (Receiving Organization) Packaging Engineering		3. From: (Originating Organization) Packaging Engineering		4. Related EDT No.: NA	
5. Proj./Prog./Dept./Div.: 03E00		6. Design Authority/ Design Agent/Cog. Engr.: J. E. Mercado		7. Purchase Order No.: NA	
8. Originator Remarks: The attached document is being submitted for approval and release.				9. Equip./Component No.: NA	
				10. System/Bldg./Facility: NA	
11. Receiver Remarks: 11A. Design Baseline Document? ☐ Yes ☒ No				12. Major Assem. Dwg. No.: NA	
				13. Permit/Permit Application No.: NA	
				14. Required Response Date: NA	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	HNF-2893	NA	0	Chemical Compatibility Study of Cooley L18KU, Herculite, and Elephant Mat With Hanford Tank Waste	N/A	1,2	1	

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval 2. Release 3. Information		4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)		1. Approved 2. Approved w/comment 3. Disapproved w/comment		4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged	

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority				1	1	DW Crass		6/23/98	R3-47
		Design Agent				1	1	DE Legare		6/23/98	R3-47
1	1	Cog.Eng.: JE Mercado	<i>J. E. Mercado</i>	6/16/98	H1-15	1	1	WA McCormick	<i>WA McCormick</i>	6/22/98	H1-15
1	1	Cog. Mgr.: JG Field	<i>J. G. Field</i>	6/16/98	H1-15	1	1	JG McFadden	<i>JG McFadden</i>	6/16/98	H1-15
		QA:				3		ME McKinney			S2-48
		Safety:									
		Env.:									

18. J. E. Mercado <i>J. E. Mercado</i> Signature of EDT 6/16/98 Date		19. Authorized Representative Date for Receiving Organization		20. J. G. Field <i>J. G. Field</i> Design Authority/ Cognizant Manager 6/16/98 Date		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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Chemical Compatibility Study of Cooley L18KU, Herculite, and Elephant Mat With Hanford Tank Waste

J. E. Mercado

Waste Management Federal Services, Inc., Northwest Operations
Richland, Washington 99352
for Fluor Daniel Hanford, Inc.
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: EDT 622367 UC: 513
Org Code: 03E00 Charge Code: D6309
Project 772028, 40007001
B&R Code: EW3130010 Total Pages: 11

Key Words: LLCE, flexible receiver bag

Abstract: An independent chemical compatibility review of various wrapping and absorbent/padding materials was conducted to evaluate resistance to chemicals and constituents present in liquid waste from the Hanford underground tanks. These materials will be used to wrap long-length contaminated equipment when such equipment is removed from the tanks and prepared for transportation and subsequent disposal or storage. The materials studied were Cooley L18KU, Herculite, and Elephant Mat. The study concludes that these materials are appropriate for use in this application.

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Janis Randal 6-23-98
Release Approval Date

Approved for Public Release

CONTENTS

1.0 SUMMARY	1
2.0 BACKGROUND	1
3.0 MATERIAL EVALUATION	2
3.1 COOLEY L18KU	2
3.2 HERCULITE	2
3.3 ELEPHANT MAT	3
4.0 RESULTS	3
5.0 CONCLUSIONS AND RECOMMENDATIONS	4
6.0 REFERENCES	5
APPENDIX: HERCULITE PRODUCTS, INC., CHEMICAL RESISTANCE GUIDE	6

CHEMICAL COMPATIBILITY STUDY OF COOLEY L18KU, HERCULITE, AND ELEPHANT MAT WITH HANFORD TANK WASTE

1.0 SUMMARY

An independent chemical compatibility review of various wrapping and absorbent/padding materials, referred to herein as the flexible receiver bag material, was conducted to evaluate resistance to the chemicals and constituents present in liquid waste from the Hanford underground tanks. These materials will be used to wrap long-length contaminated equipment (LLCE) when such equipment is removed from the tanks and prepared for transportation and subsequent disposal or storage. The materials studied were Cooley L18KU; Herculite (a trademark of Herculite Products, Inc.); and Elephant Mat (a trademark of New Pig Corporation). The study concludes that these materials are appropriate for use in this application. Several assumptions are necessary to support this conclusion.

- The tank waste will not be sustained at an elevated temperature ($> 49^{\circ}\text{C}$ [120°F]) during the process of removing the LLCE.
- The LLCE will be pressure washed and allowed to drain in a vertical position to remove the majority of waste on the exterior before being lowered and placed in the disposal/storage container.
- Because the LLCE is placed on a skid when positioned in the LLCE container, the flexible receiver bag is not subjected to excessive abrasion during the operation.
- The flexible receiver bag is no longer required to provide the primary containment boundary after packaging in the LLCE container.

2.0 BACKGROUND

The LLCE includes instrument trees, piping, and pumps, which have been placed in the tanks over many years. During the process of removing the LLCE from a tank, the LLCE will be pressure-washed; the concentrations of available reactants on the exterior of the LLCE is expected to be low. However, it may not be possible to remove all of the material from the LLCE because of the nature of the equipment, so some liquid may leak out in handling or storage. Because of the washing operation, drain leakage is only expected when the LLCE is lowered to a horizontal position. It is assumed that the tank waste will be at ambient or near ambient temperatures during the equipment removal and subsequent operations.

Three polymer textiles have been selected as candidates for wrapping LLCE for transportation and storage. The brand names of the materials are Cooley L18KU, Herculite, and Elephant Mat. In the intended application, the Elephant Mat will be used as an absorbent padding inside the flexible receiver bag constructed of Cooley L18KU or Herculite. The polymers used in the construction of the three products include nylon, polyester, polyvinylchloride (PVC), and polypropylene.

This study supplements the chemical compatibility evaluation that was performed for the high-density polyethylene LLCE container (Veith 1996).

3.0 MATERIAL EVALUATION

The chemical properties of each material were evaluated with respect to manufacturer data and other sources for material properties.

3.1 COOLEY L18KU

Cooley

L18KU is a PVC-coated membrane. The base fiber is nylon and polyester, and the coating is PVC. (Cooley 1995).

Additional data on PVC, nylon, and polyester were obtained from the following various sources.

Flinn and Trojan

PVC--Resistant to acids and alkalies; attacked by organic solvents.

Polyester--Attacked by acids, alkalies, and organic solvents (Flinn and Trojan 1981).

Merck

Nylon--Soluble in phenol, cresols, xlenol, and formic acid. Insoluble in alcohols, esters, ketones, and hydrocarbons (Merck & Co. 1989).

RyanHerco

PVC--Resistant to most solutions of acids, alkalies, and salts and to organic compounds miscible with water. Not resistant to aromatic and chlorinated hydrocarbons.

Specifically, PVC is unsuitable for acetone, benzene, carbon tetrachloride, cyclohexanol, dibutyl phthalate, ethyl acetate, ethylene dichloride, concentrated sulphuric acid, toluene, trichloroethylene, and xylene (RyanHerco 1997).

CRC

PVC--Poor resistance to ketones, esters, oils, and aliphatic and aromatic hydrocarbons (CRC 1981).

3.2 HERCULITE

Herculite Products, Inc.

This material is described as a laminated vinyl-synthetic fabric. The precise composition is proprietary. Resistant to inorganic salts, alkalies, and weak acids. The fabric is resistant to strong acids, alcohols, aliphatic hydrocarbons, and oils for short periods depending on concentrations, temperatures, and exposure times. The fabrics are not recommended for use with ketones and esters (Herculite 1997). Herculite Products, Inc., compatibility table is included in the appendix.

3.3 ELEPHANT MAT

New Pig Corporation

Elephant Mat is over 95% polypropylene with polyester stitching. Susceptible to strong oxidizing agents. May be affected by acids and bases (Pig MSDS).

Additional data on polypropylene was obtained from the following various sources.

Merck

Polypropylene—*Practically insoluble in cold organic solvents . . . resistant to acids, alkalies; attacked by strong oxidizers, e.g., hydrogen peroxide.* (Merck & Co. 1989, p. 1207)

Flinn and Trojan

Polypropylene—Consistent with Merck (Flinn and Trojan 1981).

GRI

Polypropylene—Unsuitable for barium fluoride, acetate solvents, carbon tetrachloride, cyclohexane, gasoline, hydrogen peroxide, methyl chloride, concentrated nitric acid, nitric oxide, toluene, and trichloroethylene (GRI 1990).

RyanHerco

Polypropylene—Chemical resistance similar to that of polyethylene but suitable for higher temperatures. Polyethylene is resistant to aqueous solutions of acids, alkalies, and salts as well as many organic solvents. Unsuitable for concentrated oxidizing acids.

Specifically, polypropylene is unsuitable for methyl acetate chloride, nitric acid, concentrated sulphuric acid, trichloroethylene, and xylene (RyanHerco 1997).

Cole-Parmer

Polypropylene—Not recommended for aromatic hydrocarbons (Cole-Parmer 1985).

4.0 RESULTS

The chemical resistance of the polymers evaluated, polyester, PVC, polypropylene, and nylon, is similar. In general, these materials are particularly vulnerable to attack by strong oxidizers and aromatic hydrocarbons.

Strong oxidizers include peroxides (O-O), chlorates (ClO₃), perchlorates (ClO₄), nitrates (NO₃), and permanganates (MnO₄). Of these ions, only nitrates appear on the list of materials in the waste tanks. However, nitrates appear only to be a problem at elevated temperatures for polypropylene, polyethylene, and PVC (Cole-Parmer 1985).

Aromatic hydrocarbons include benzenes and naphthalenes, which have been detected in the waste tanks. Specifically, phenol, nitrobenzene, phenanthrene, and naphthalene were

identified. A specific concentration was not determined in the waste, so these may be a problem if they are present in high concentrations and contact the flexible receiver bag for an extended period.

Nylon, which is used in the Cooley L18KU product, appears resistant to the chemicals of concern.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The selected materials are appropriate for the intended use in the flexible receiver bag. The materials are resistant to acids, alkalies, and salts.

The results indicate that nitrates and aromatic hydrocarbons are of particular concern for the materials used in each product evaluated. Nitrates only appear as a problem at elevated temperatures ($> 49^{\circ}\text{C}$ [120°F]), and it is assumed that the materials will not be used under these circumstances. Aromatic hydrocarbons are a potential problem, but the problem is mitigated by the operation and controls used to extract the LLCE from the waste tank and load it into the transport/storage container.

During removal of the LLCE, the accessible surfaces will be washed by a high-pressure spray wash, and little, if any, waste will remain on the exterior. This wash will be conducted as the LLCE is extracted from the tank in a vertical orientation. It is assumed that most of the waste that can drain from the interior of the LLCE while it is suspended will do so. However, some waste may be trapped in the LLCE and will not drain in this orientation. After the LLCE is extracted and in the flexible receiver bag, the LLCE will be lowered to a horizontal position. The LLCE will then be placed in the storage/disposal container. At this point, waste material trapped in the LLCE may drain into the flexible receiver bag.

The main purpose of the flexible receiver bag is to prevent the spread of contamination (radioactive and chemical), particularly while the LLCE is in a vertical position. Because of the wash and drain, it is very unlikely that a sufficient amount of waste could come in contact with the flexible receiver bag to compromise it. Therefore, the following assumptions support the conclusions.

- The tank waste will not be sustained at an elevated temperature ($> 49^{\circ}\text{C}$ [120°F]) during the process of removing the LLCE.
- The LLCE will be pressure washed and allowed to drain in a vertical position to remove the majority of waste on the exterior before being lowered and placed in the disposal/storage container.
- Because the LLCE is placed on a skid when positioned in the LLCE container, the flexible receiver bag is not subjected to excessive abrasion during the operation.
- The flexible receiver bag is no longer required to provide the primary containment boundary after packaging in the LLCE container.

No particular brand of material is recommended because there may be other factors, such as ease of application, availability, and cost, that may affect the final selection.

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APPENDIX: HERCULITE PRODUCTS, INC.,
CHEMICAL RESISTANCE GUIDE

Technical Information Bulletin

TIB-1

CHEMICAL RESISTANCE GUIDE FOR
STANDARD HERCULITE BRAND FABRICS

All Herculite® brand fabrics, including Staph-Chek® hospital and institutional fabrics, possess exceptionally high strength and durability and are resistant to deterioration even under severe environmental stresses. Herculite fabrics offer excellent chemical resistance and are resistant to inorganic salts, alkalies and weak acids. They are also resistant to strong acids, alcohols, aliphatic hydrocarbons and oils for short periods, depending on concentrations, temperatures and exposure times. The fabrics are not recommended for use with ketones and esters as these are considered solvents.

The resistance charts provided in this bulletin should serve as a general guide only. Recommendations at the listed temperatures are based on ideal conditions and all factors affecting chemical resistance must be taken into consideration. The user should pre-determine the suitability of a particular fabric style for their specific application.

In some applications involving exposure to acids, the fabric resistance will be improved one rating over that shown in the chart when using 14 oz. and heavier fabrics with the edges sealed by CVV® adhesive. This will prevent exposure of the reinforcement to the acids. These applications are denoted by an asterisk (*).

Herculite Products, Inc. manufactures numerous other fabric styles for use where special exposure conditions exist. For example, Sanilite® fabrics, which have FDA/USDA approval, are designed for food contact applications. Where increased oil resistance is needed, such as in oil booms and tank liners, Herculite Oil Resistant fabrics are available.

Should there be any question in the user's mind, Herculite's Technical Service Department personnel will be pleased to advise the proper fabric selection for each application.

CHEMICAL RESISTANCE GUIDE FOR STANDARD HERCULITE BRAND FABRICS

R — Recommended L — Limited Exposure NR — Not Recommended

	72°F	150°F		72°F	150°F
INORGANIC ACIDS AND ACID-MIXTURES			ALKALIES AND BASES (Cont'd)		
Aqua Regia	NR	NR	Magnesium Hydroxide	R	R
Arsenic Acid Solution	R	NR	Potassium Hydroxide (50%)	R	NR
Boric Acid Solution	R	R	Potassium Hydroxide (10%)	R	R
Bromic Acid	R	NR	Sodium Hydroxide (50%)	R	NR
Chromic Acid (40%)	L*	NR*	Sodium Hydroxide (10%)	R	R
Fluoboric Acid	L*	L*			
Fluosillicic Acid	L*	L*	INORGANIC SALTS AND COMPOUNDS		
Hydrobromic Acid (20%)	L*	NR	Aluminum Chloride	R	R
Hydrochloric Acid (35%)	L*	NR	Aluminum Fluoride	R	NR
Hydrochloric Acid (10%)	R	L*	Aluminum Sulfate	R	R
Hydrofluoric Acid (48%)	L	NR	Ammonia (Liquid)	NR	NR
Hydrofluoric Acid (10%)	R	NR	Ammonium Bifluoride	R	R
Nitric Acid (68%)	L	NR	Ammonium Chloride	R	R
Nitric Acid (25%)	R	NR	Ammonium Fluoride (25%)	R	R
Nitric Acid (10%)	R	L*	Ammonium Nitrate	R	R
Oleum	NR	NR	Ammonium Sulfate	R	R
Perchloric Acid (70%)	NR	NR	Ammonium Sulfide	R	R
Perchloric Acid (10%)	R	NR	Antimony Trichloride	R	R
Phosphoric Acid (75%)	R	NR	Barium Chloride	R	R
Phosphoric Acid (10%)	R	R	Barium Sulfate	R	R
Selenic Acid	R	NR	Barium Sulfide	R	NR
Sulfuric Acid (99%)	L	NR	Bromine (Liquid)	NR	NR
Sulfuric Acid (50%)	L*	NR	Bromine (Water)	R	NR
Sulfuric Acid (10%)	R	R	Calcium Chloride	R	R
			Calcium Hypochlorite (10%)	L*	NR
			Calcium Hypochlorite (1%)	R	L*
			Calcium Nitrate	R	R
ALKALIES AND BASES					
Aluminum Hydroxide	R	R	Calcium Sulfate	R	R
Ammonium Hydroxide (28%)	R	NR	Chlorine, Water	R	R
Ammonium Hydroxide (10%)	R	R	Chlorine Dioxide (15%)	R	NR
Barium Hydroxide	R	R	Copper Nitrate	R	R
Calcium Hydroxide	R	R			

CHEMICAL RESISTANCE GUIDE FOR STANDARD HERCULITE BRAND FABRICS

R — Recommended L — Limited Exposure NR — Not Recommended

	<u>72°F</u>	<u>150°F</u>		<u>72°F</u>	<u>150°F</u>
<u>INORGANIC SALTS AND COMPOUNDS</u>			<u>INORGANIC SALTS AND COMPOUNDS (cont'd.)</u>		
Ferric Chloride	R	R	Sodium Sulfate	R	R
Ferric Nitrate	R	R	Sodium Sulfide	R	L
Ferric Sulfate	R	R	Sodium Sulfite	R	R
Ferrous Chloride	R	R	Stannic Chloride	R	R
Ferrous Sulfate	R	R			
Hydrogen Peroxide (10%)	R	NR	Stannous Chloride (25%)	R	NR
Hydrogen Peroxide (30-50%)	L*	NR	Sulfur Dioxide (Gas)	R	NR
Hydrogen Sulfide	R	NR	Trisodium Phosphate	R	R
Iodine	NR	NR	Zinc Chloride	R	R
Magnesium Chloride	R	R	Zinc Sulfate	R	R
Magnesium Sulfate	R	R			
			<u>PLATING SOLUTIONS AND SALTS</u>		
Nitrous Oxide	NR	NR	Cadmium, Copper, Gold, Lead, Nickel		
Ozone	R	NR	Rhodium, Silver, Tin, Zinc Solutions	L*	L*
Phosphorous (Yellow)	NR	NR	Chromium Solutions	L*	NR
Phosphorous (Pentoxide)	NR	NR			
Phosphorous Trichloride	NR	NR			
			<u>ORGANIC COMPOUNDS</u>		
Potassium Bromate	R	R	Acetic Acid (Glacial)	NR	NR
Potassium Bromide	R	R	Acetic Acid (10%)	R	NR
Potassium Chlorate	R	R	Allyl Alcohol	L	NR
Potassium Cyanide	R	R	Benzaldehyde	NR	NR
Potassium Ferricyanide	R	R	Benzoic Acid	R	R
Potassium Fluoride	R	R	Butyl Alcohol	L	NR
Potassium Nitrate	R	R	Butyric Acid	NR	NR
Potassium Permanganate (10%)	R	L	Carbon Disulfide	NR	NR
Potassium Sulfate	R	R	Carbon Tetrachloride	NR	NR
Silver Nitrate	R	R	Chloroacetic Acid	NR	NR
Sodium Bisulfite	R	R	Citric Acid	R	NR
Sodium Chlorate	R	R	Cresylic Acid (50%)	R	NR
Sodium Fluoride	R	R	Dextrose	R	R
Sodium Hypochlorite (10%)	L*	NR	Ethyl Alcohol	L	NR
Sodium Hypochlorite (1%)	R	L*	Ethylene Glycol	L	NR
Sodium Nitrate	R	R			

CHEMICAL RESISTANCE GUIDE FOR STANDARD HERCULITE BRAND FABRICS

R — Recommended L — Limited Exposure NR — Not Recommended

	72°F	150°F		72°F	150°F
ORGANIC COMPOUNDS			MISCELLANEOUS COMPOUNDS		
Fatty Acids	L	NR	Alums	R	NR
Formaldehyde	L	NR	Beer	R	—
Formic Acid	R	R	Beet (Sugar Liquor)	R	R
Glucose	R	R	Brine	R	L
Glycerine	R	NR	Bleach (16% Chlorine)	L*	NR
Glycol	L	NR	Castor Oil	L	L
Kerosene	L	NR	Corn Syrup	R	NR
Lactic Acid (28%)	R	NR	Cottonseed Oil	L	NR
Maleic Acid	L	NR	Fruit Pulp & Juice	R	R
Methyl Alcohol	L	NR	Gasoline	L	NR
Oleic Acid	L	NR	Milk	R	R
Oxalic Acid	L	NR	Mineral Oil	L	NR
Phenol	L	NR	Molasses	R	R
Picric Acid	L	NR	Photographic Chemicals	R	R
Propyl Alcohol	L	NR	Tanning Liquors	L	NR
Stearic Acid	L	NR	Water (Demineralized)	R	R
Tannic Acid	R	NR	Water (Sea)	R	R
Tartaric Acid	R	NR	Wines	R	—
Tetraethyl Lead	NR	NR			
Turpentine	L	NR			
Urea	R	R

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 1107 Broadway, New York, New York 10010
 212/681-7550

TIS-1

Printed in U.S.A.

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Packaging Engineering	Date June 16, 1998
Project Title/Work Order		EDT No. 622367
Chemical Compatibility Study of Cooley L18KU, Herculite, and Elephant Mat With Hanford Tank Waste (HNF-2893, Rev. 0)		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
D. W. Crass	R3-47	X			
J. G. Field	H1-15	X			
D. E. Legare	R3-47	X			
W. A. McCormick	R3-47	X			
J. G. McFadden	H1-15	X			
M. E. McKinney	S2-48	X			
J. E. Mercado	H1-15	X			
Central Files	B1-07	X			
HNF-2893 File	H1-15	X			
Work Control (D. Kelly)	H1-15				X