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June 21, 1990

Mr. Richard Brazell, PE
New York State Department of
Environmental Conservation
615 Erie Blvd. West
Syracuse, New York 13204

Re: HDPE Compatibility Testing

Dear Mr. Brazell:

Per your recent request, enclosed are laboratory reports provided to us by Paramount Technical Products regarding the compatibility of High Density Polyethylene (HDPE) with a variety of organic chemicals. Some of these chemical compounds are the same as those identified at the Clark Site.

The reports provide specific information including but not limited to the type of HDPE (i.e. thickness), test methods, chemicals used for testing, test results and conclusions.

If you require additional information regarding this matter, please feel free to contact me.

Very truly yours,

DUNN GEOSCIENCE CORPORATION

Thomas M. Johnson
Associate Hydrogeologist

cc w/o attachment:

M. Palenscar
D. Hill
T. Tansey
M. Shanley
N. Levine
A. Kryzan

cc w/ attachment:

J. Stewart

METHOD 9090 September 1986

COMPATIBILITY TEST FOR WASTES AND MEMBRANE LINERS

1.0 SCOPE AND APPLICATION

1.1 Method 9090 is intended for use in determining the effects of chemicals in a surface impoundment, waste pile, or landfill on the physical properties of flexible membrane liner (FML) materials intended to contain them. Data from these tests will assist in deciding whether a given liner material is acceptable for the intended application.

2.0 SUMMARY OF METHOD

2.1 In order to estimate waste/liner compatibility, the liner material is immersed in the chemical environment for minimum periods of 120 days at room temperature (23 ± 2°C) and at 50 ± 2°C. In cases where the FML will be used in a chemical environment at elevated temperatures, the immersion testing shall be run at the elevated temperatures if they are expected to be higher than 50°C. Whenever possible, the use of longer exposure times is recommended. Comparison of measurements of the membrane's physical properties, taken periodically before and after contact with the waste fluid, is used to estimate the compatibility of the liner with the waste over time.

3.0 INTERFERENCES (Not Applicable)

4.0 APPARATUS AND MATERIALS

NOTE: In general, the following definitions will be used in this method:

1. Sample --- a representative piece of the liner material proposed for use that is of sufficient size to allow for the removal of all necessary specimens.
2. Specimen - a piece of material, cut from a sample, appropriately shaped and prepared so that it is ready to use for a test.

4.1 Exposure tank: of a size sufficient to contain the samples, with provisions for supporting the samples so that they do not touch the bottom or sides of the tank or each other, and for stirring the liquid in the tank. The tank should be compatible with the waste fluid and impermeable to any of the constituents they are intended to contain. The tank shall be equipped with a means for maintaining the solution at room temperature (23 ± 2°C) and 50 ± 2°C and for preventing evaporation of the solution (e.g., use a cover equipped with a reflux condenser, or seal the tank with a Teflon gasket and use an airtight cover). Both sides of the liner material shall be exposed to the chemical environment. The pressure inside the tank must be the same as that outside the tank. If the liner has a side that (1) is not exposed to the waste in actual use and (2) is not designed to

withstand exposure to the chemical environment, then such a liner may be treated with only the barrier surface exposed.

4.2 Stress-strain machine suitable for measuring elongation, tensile strength, tear resistance, puncture resistance, modulus of elasticity, and ply adhesion.

4.3 Jig for testing puncture resistance for use with FTMS 101C, Method 2065.

4.4 Liner sample, labels and holders made of materials known to be resistant to the specific wastes.

4.5 Oven at 105 ± 2°C.

4.6 Dial micrometer.

4.7 Analytical balance

4.8 Apparatus for determining extractable content of liner materials.

NOTE: A minimum quantity of representative waste fluid necessary to conduct this test has not been specified in this method because the amount will vary depending upon the waste composition and the type of liner material. For example, certain organic waste constituents, if present in the representative waste fluid, can be absorbed by the liner material, thereby changing the concentration of the chemicals in the waste. This change in waste composition may require the waste fluid to be replaced at least monthly in order to maintain representative conditions in the waste fluid. The amount of waste fluid necessary to maintain representative waste conditions will depend on factors such as the volume of constituents absorbed by the specific liner material and the concentration of the chemical constituents in the waste.

5.0 REAGENTS (Not Applicable)

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 For information on what constitutes a representative sample of the waste fluid, refer to the following guidance document:

Permit Applicants' Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities: Final Draft: Chap. 5, pp. 15-17: Chap. 6, pp. 18-21: and Chap. 8, pp. 13-16, May, 1984.

7.0 PROCEDURE

7.1 Obtain a representative sample of the waste fluid. If a waste sample is received in more than one container, blend thoroughly. Note any signs of stratification. If stratification exists, liner

samples must be placed in each of the phases. In cases where the waste fluid is expected to stratify and the phases cannot be separated, the number of immersed samples per exposure period can be increased (e.g., if the waste fluid has two phases, then 2 samples per exposure period are needed) so that test samples exposed at each level of the waste can be tested. If the waste to be contained in the land disposal unit is in solid form, generate a synthetic leachate (see Step 7.9.1).

7.2 Perform the following tests on unexposed samples of the polymeric membrane liner material at 23 ± 2°C and 50 ± 2°C (see Steps 7.9.2 and 7.9.3 below for additional tests suggested for specific circumstances). Tests for tear resistance and tensile properties are to be performed according to the protocols referenced in Table 1. See Figure 1 for cutting patterns for nonreinforced liners, Figure 2 for cutting patterns for reinforced liners, and Figure 3 for cutting patterns for semicrystalline liners. (Table 2, at the end of this method, gives characteristics of various polymeric liner material).

1. Tear resistance, machine and transverse directions, three specimens each direction for nonreinforced liner materials only. See Table 1 for appropriate test method, the recommended test speed, and the values to be reported.

2. Puncture resistance, two specimens, FTMS 101C, Method 2065. See Figure 1, 2, or 3, as applicable, for sample cutting patterns.

3. Tensile properties, machine and transverse directions, three tensile specimens in each direction. See Table 1 for appropriate test method, the recommended test speed, and the values to be reported. See Figure 4 for tensile dumbbell cutting pattern dimensions for nonreinforced liner samples.

4. Hardness, three specimens, Duro A (Duro D if Duro A reading is greater than 80), ASTM D2240. The hardness specimen thickness for Duro A is 1/4 in., and for Duro D it is 1/8 in. The specimen dimensions are 1 in. by 1 in.

5. **Elongation at break.** This test is to be performed only on membrane materials that do not have a fabric or other nonelastromeric support as part of the liner.

6. Modulus of elasticity, machine and transverse directions, two specimens each direction for semicrystalline liner materials only, ASTM D882 modified Method A (see Table 1).

7. Volatiles content, SW 870, Appendix III-D.

8. Extractables content, SW 870, Appendix III-E.

9. Specific gravity, three specimens, ASTM D792, Method A.

Table 1. - Physical testing of exposed membranes in liner-waste liquid compatibility test

Type of compound and construction	Crosslinked or vulcanized	Thermoplastic	Semicrystalline	Fabric-reinforced[a]
Tensile properties method	ASTM D412	ASTM D638	ASTM D638	ASTM D751, Method B
Type of specimen	Dumbbell[b]	Dumbbell[b]	Dumbbell[b]	1-in. wide strip and 2-in separation
Number of specimens	3 in each direction	3 in each direction	3 in each direction	3 in each direction
Speed of test	20 ipm	20 ipm	2 ipm	12 ipm
Values to be reported	Tensile strength, psi Elongation at break, % Tensile set after break, % Stress at 100 and 200% elongation, psi	Tensile strength, psi Elongation at break, % Tensile set after break, % Stress at 100 and 200% elongation, psi	Tensile strength at yield, psi Elongation at yield, % Tensile set at break, psi Elongation at break, psi Tensile set after break, % Stress at 100 and 200% elongation, psi	Tensile at fabric break, Elongation at fabric br Tensile at ultimate brea Elongation at ultimate b Tensile set after break, Stress at 100 and 200% elongation, psi
Modulus of elasticity method	c	c	ASTM D882, Method A	c
Type of specimen	—	—	Strip: 0.5 in. wide and 6. in long at a 2 in. jaw separation	—
Number of specimens	—	—	2 in each direction	—
Speed of test	—	—	0.2 ipm	—
Values reported	—	—	Greatest slope of initial stress - strain curve, psi	—
Tear resistance method	ASTM D624	ASTM 1004	ASTM D1004	d
Type of specimen	Die C	e	e	—
Number of specimens	3 in each direction	3 in each direction	2 in each direction	--
Speed of test	20 ipm	20 ipm	2 ipm	—
Values reported	Stress, ppi	Stress, ppi	Maximum stress, ppi	--
Puncture resistance method	FTMS 101C, Method 2065	FTMS 101C, Method 2065	FTMS 101C, Method 2065	FTMS 101C, Method 2065
Type of specimen	2 in. square	2 in. square	2 in. square	2 in. square
Number of specimens	2	2	2	2
Speed of test	20 ipm	20 ipm	20 ipm	20 ipm
Values reported	Gage, mil Stress, J[b] Elongation, in.	Gage, mil Stress, J[b] Elongation, in.	Gage, mil Stress, J[b] Elongation, in.	Gage, mil Stress, J[b] Elongation, in.

[a]Can be thermoplastic, crosslinked, or vulcanized membrane.
[b]See Figure 4.
[c]Not performed on this material.
[d]No tear resistance test is recommended for fabric-reinforced sheetings in the immersion study.
[e]Same as ASTM D624, Die C.

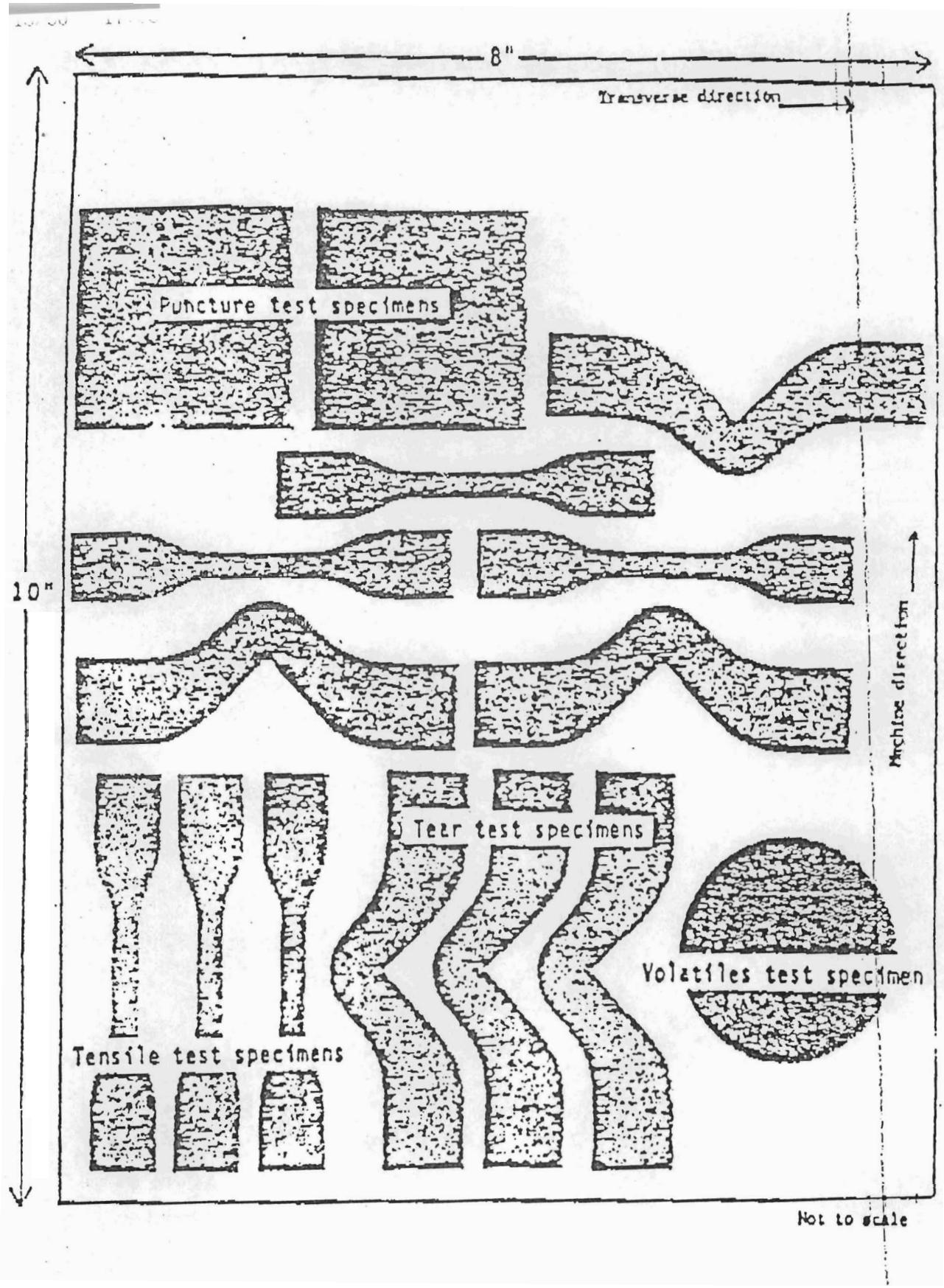


Figure 1 . Suggested pattern for cutting test specimens from nonreinforced crosslinked or thermoplastic immersed liner samples.

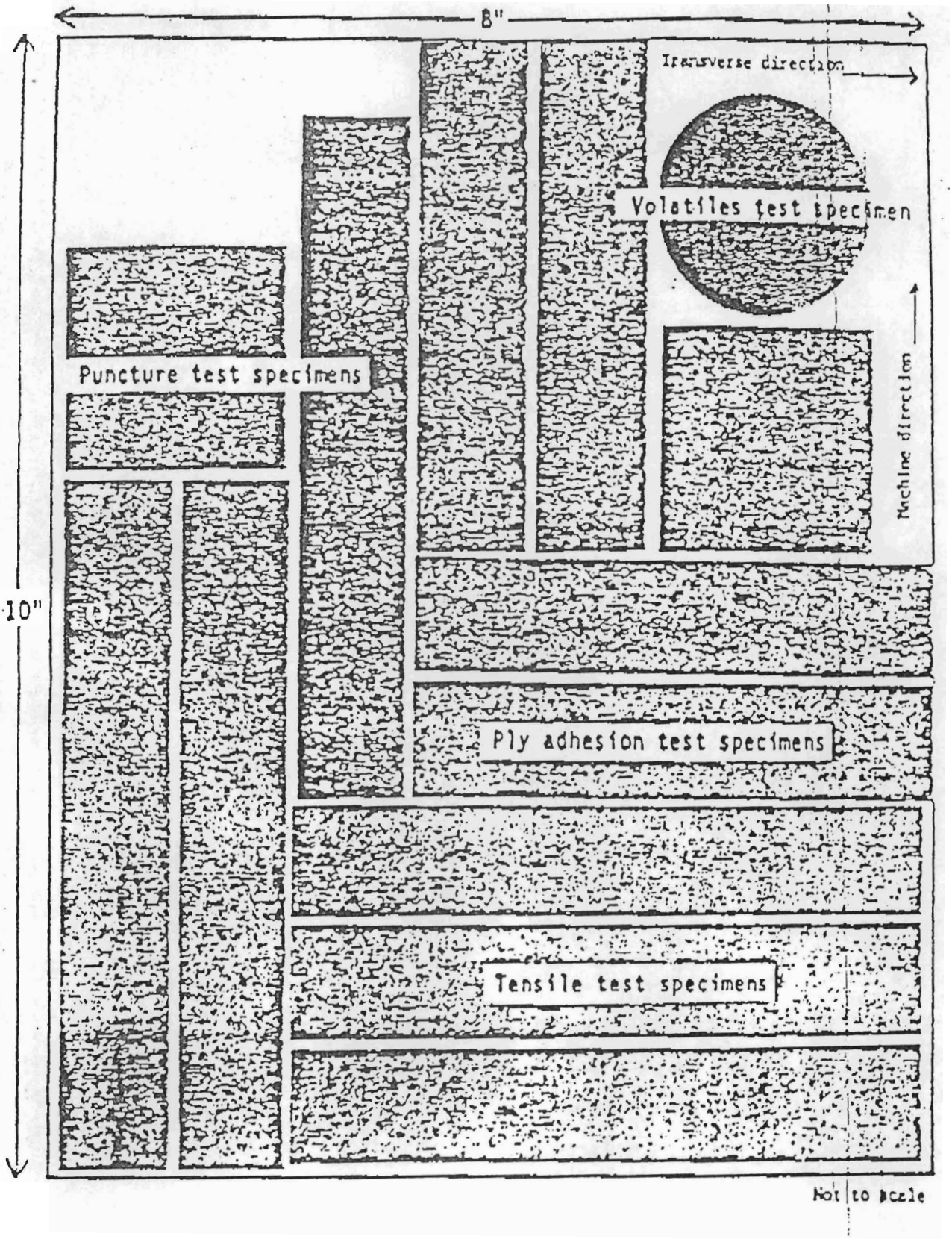


Figure 2 . Suggested pattern for cutting test specimens from fabric reinforced immersed liner samples. Note: To avoid edge effects, cut specimens 1/8 - 1/4 inch in from edge of immersed sample.

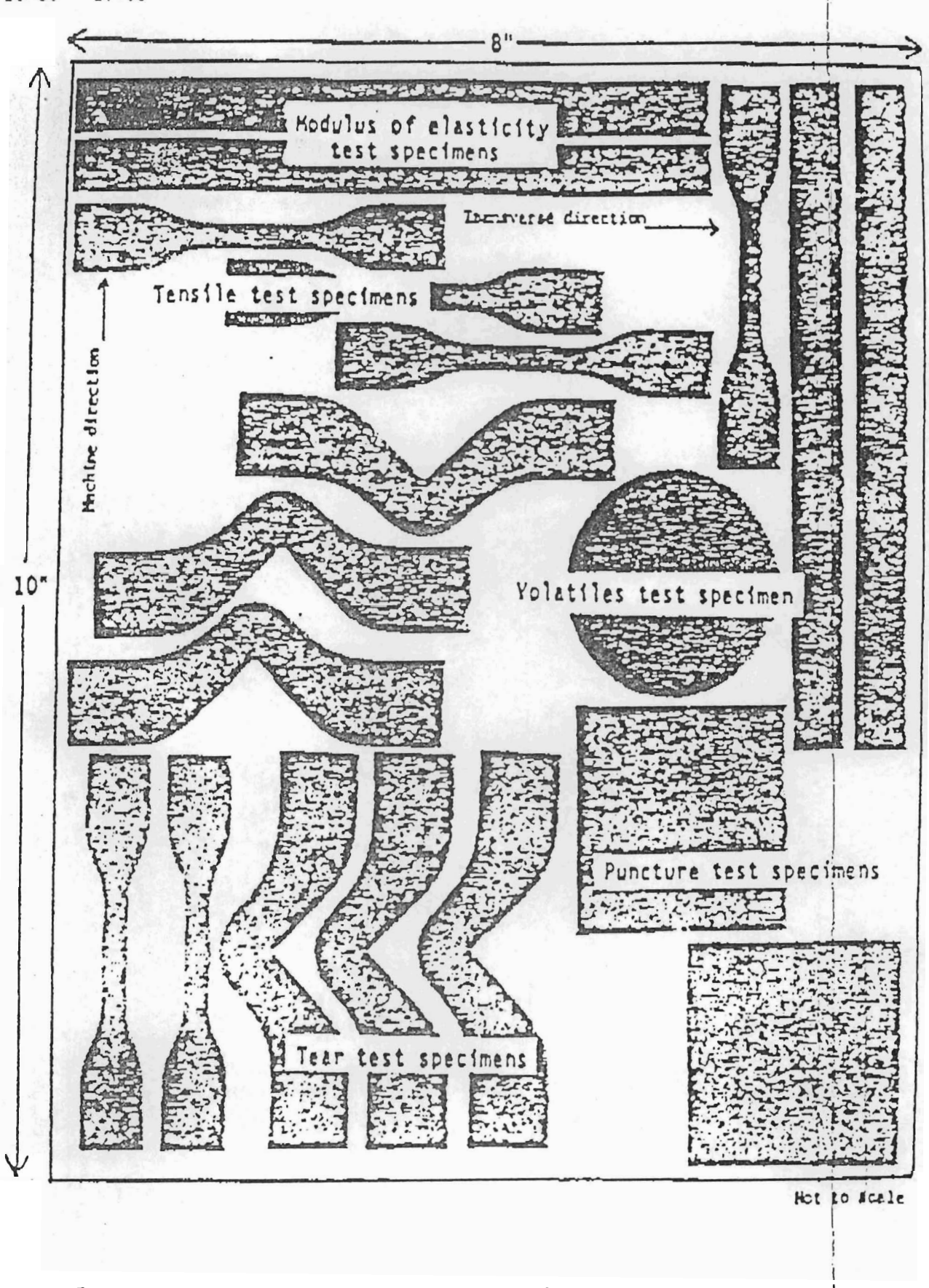
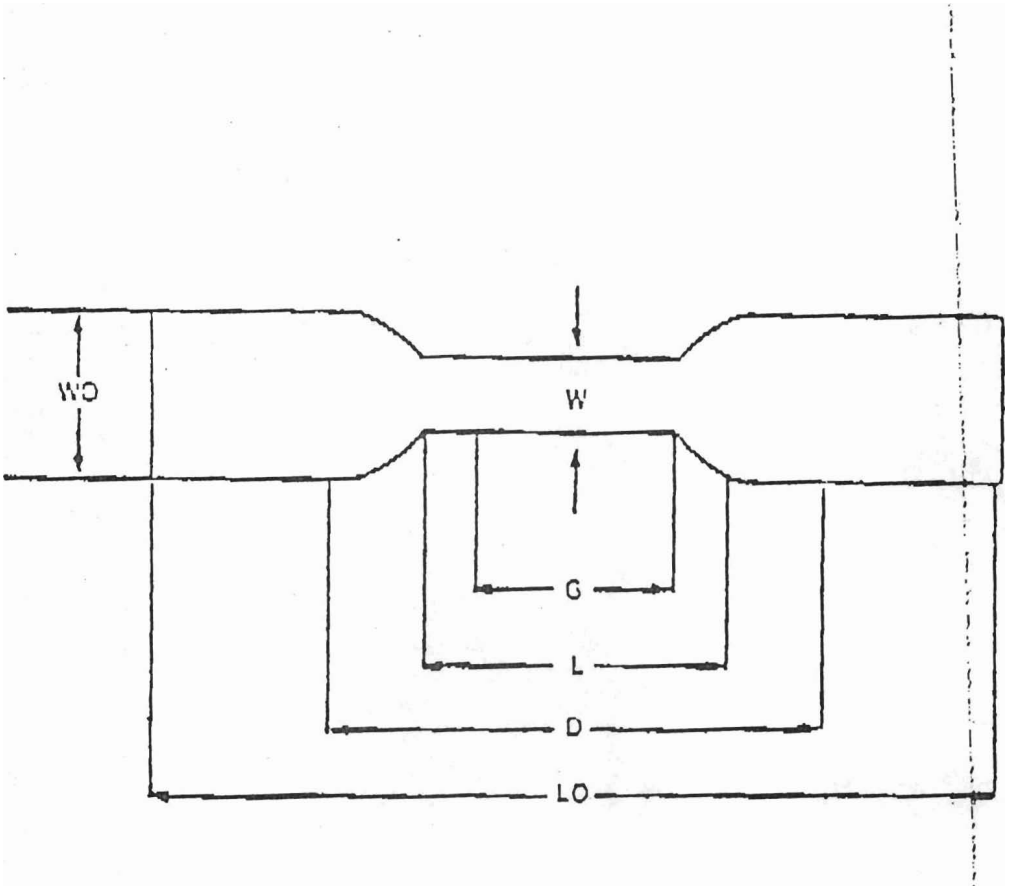


Figure 3 . Suggested pattern for cutting test specimens from semicrystalline immersed liner samples. Note: To avoid edge effects, cut specimens 1/8 - 1/4 inch in from edge of immersed sample.



W	-	Width of narrow section	0.25 inches
L	-	Length of narrow section	1.25 inches
WO	-	Width overall	0.625 inches
LO	-	Length overall	3.50 inches
G	-	Gage length	1.00 inches
D	-	Distance between grips	2.00 inches

Figure 4. Die for tensile dumbbell (nonreinforced liners) having the following dimensions.

10. Ply adhesion, machine and transverse directions, two specimens each direction for fabric reinforced liner materials only, ASTM D413 Machine Method, Type A -- 180 degree peel.

11. Hydrostatic resistance test, ASTM D751 Method A, Procedure 1.

7.3 For each test condition, cut five pieces of the lining material of a size to fit the sample holder, or at least 8 in. by 10 in. **The fifth sample is an extra sample.** Inspect all samples for flaws and discard unsatisfactory ones. Liner materials with fabric reinforcement require close inspection to ensure that threads of the samples are evenly spaced and straight at 90°. Samples containing a fiber scrim support may be flood-coated along the exposed edges with a solution recommended by the liner manufacturer, or another procedure should be used to prevent the scrim from being directly exposed. The flood-coating solution will typically contain 5-15% solids dissolved in a solvent. The solids can be the liner formula or the base polymer.

Measure the following:

1. Gauge thickness, in. -- average of the four corners.

2. Mass, lb. -- to one-hundredth of a lb.

3. Length, in. -- average of the lengths of the two sides plus the length measured through the liner center.

4. Width, in. -- average of the widths of the two ends plus the width measured through the liner center.

NOTE: Do not cut these liner samples into the test specimen shapes shown in Figure 1, 2, or 3 at this time. Test specimens will be cut as specified in 7.7, <u>after</u> exposure to the waste fluid.

7.4 Label the liner samples (e.g., notch or use metal staples to identify the sample) and hang in the waste fluid by a wire hanger or weight. Different liner materials should be immersed in separate tanks to avoid exchange of plasticizers and soluble constituents when plasticized membranes are being tested. Expose the liner samples to the stirred waste fluid held at room temperature and at 50 ± 2°C.

7.5 At the end of 30, 60, 90, and 120 days of exposure, remove one liner sample from each test condition to determine the membrane's physical properties (see Steps 7.6 and 7.7). Allow the liner sample to cool in the waste fluid until the waste fluid has a stable room temperature. Wipe off as much waste as possible and rinse briefly with water. Place wet sample in a labeled polyethylene bag or

aluminum foil to prevent the sample from drying out. The liner sample should be tested as soon as possible after removal from the waste fluid at room temperature, but in no case later than 24 hrs. after removal.

7.6 To test the immersed sample, wipe off any remaining waste and rinse with deionized water. Blot sample dry and measure the following as in Step 7.3:

1. Gauge thickness, in.

2. Mass, lb.

3. Length, in.

4. Width, in.

7.7 Perform the following tests on the exposed samples (see Steps 7.9.2 and 7.9.3 below for additional tests suggested for specific circumstances). Tests for tear resistance and tensile properties are to be performed according to the protocols referenced in Table 1. Die-cut test specimens following suggested cutting patterns. See Figure 1 for cutting patterns for nonreinforced liners, Figure 2 for cutting patterns for reinforced liners, and Figure 3 for semicrystalline liners.

1. Tear resistance, machine and transverse directions, three specimens each direction for materials without fabric reinforcement. See Table 1 for appropriate test method, and recommended test specimen and speed of test, and the values to be reported.

2. Puncture resistance, two specimens, FTMS 101C, Method 2065. See Figure 1, 2, or 3, as applicable, for sample cutting patterns.

3. Tensile properties, machine and transverse directions, three specimens each direction. See Table 1 for appropriate test method, the recommended test specimen and speed of test, and the values to be reported. See Figure 4 for tensile dumbbell cutting pattern dimensions for nonreinforced liner samples.

4. Hardness, three specimens, Duro A (Duro D if Duro A reading is greater than 80), ASTM 2240. The hardness specimen thickness for Duro A is 1/4 in., and for Duro D is 1/8 in. The specimen dimensions are 1 in. by 1 in.

5. Elongation at break. This test is to be performed only on membrane materials that do not have a fabric or other nonelastomeric support as part of the liner.

6. Modulus of elasticity, machine and transverse directions, two specimens each direction for semicrystalline liner materials only, ASTM D882 modified Method A (see Table 1).

8. Extractables content, SW 870, Appendix III-E.

9. Ply adhesion, machine and transverse directions, two specimens each direction for fabric reinforced liner materials only, ASTM D413 Machine Method, Type A -- 180 degree peel.

10. Hydrostatic resistance test, ASTM D751 Method A, Procedure 1.

7.8 Results and reporting:

7.8.1 Plot the curve for each property over the time period 0 to 120 days and display the spread in data points.

7.8.2 Report all raw, tabulated, and plotted data. Recommended methods for collecting and presenting information are described in the documents listed under Step 6.1 and in related agency guidance manuals.

7.8.3 Summarize the raw test results as follows:

1. Percent change in thickness.

2. Percent change in mass.

3. Percent change in area (provide length and width dimensions).

4. Percent retention of physical properties.

5. Change, in points, of hardness reading.

6. The modulus of elasticity calculated in pounds-force per square inch.

7. Percent volatiles of unexposed and exposed liner material.

8. Percent extractables of unexposed and exposed liner material.

9. The adhesion value, determined in accordance with ASTM D413, Section 12.2

10. The pressure and time elapsed at the first appearance of water through the flexible membrane liner for the hydrostatic resistance test.

7.9 The following additional procedures are suggested in specific situations:

7.9.1 For the generation of a synthetic leachate, the

Procedure (TCLP) that was proposed in the Federal Register on June 13, 1986, Vol. 51, No. 114, p. 21685.

7.9.2 For semicrystalline membrane liners, the Agency suggests the determination of the potential for environmental stress cracking. The test that can be used to make this determination is either ASTM D1693 or the National Bureau of Standards Constant Tensile Load. The evaluation of the results should be provided by an expert in this field.

7.9.3 For field seams, the Agency suggests the **determination of seam strength in shear and peel modes.** To determine seam strength in peel mode, the test ASTM D413 can be used. To determine seam strength in shear mode for nonreinforced FMLs, the test ASTM D3083 can be used, and for reinforced FMLs, the test ASTM D751, Grab Method, can be used at a speed of 12 in. per min. The evaluation of the results should be provided by an expert in this field.

8.0 QUALITY CONTROL

8.1 Determine the mechanical properties of identical nonimmersed and immersed liner samples in accordance with the standard methods for the specific physical property test. Conduct mechanical property tests on nonimmersed and immersed liner samples prepared from the same sample or lot of material in the same manner and run under identical conditions. Test liner samples immediately after they are removed from the room temperature test solution.

9.0 METHOD PERFORMANCE

9.1 No data provided.

10.0 REFERENCES

10.0 None required.

TABLE 2. POLYMERS USED IN FLEXIBLE MEMBRANE LINERS

Thermoplastic Materials (TP)

CPE (Chlorinated polyethylene)[a]

A family of polymers produced by a chemical reaction of chlorine on polyethylene. The resulting thermoplastic elastomers contain 25 to 45% chlorine by weight and 0 to 25% crystallinity.

CSPE (Chlorosulfonated polyethylene)[a]

A family of polymers that are produced by the reaction of polyethylene with chlorine and sulfur dioxide, usually containing 25 to 43% chlorine and 1.0 to 1.4% sulfur. Chlorosulfonated polyethylene is also know as hypalon.

EIA (Ethylene interpolymer alloy)[a]

A blend of EVA and polyvinyl chloride resulting in a thermoplastic elastomer.

PVC (Polyvinyl chloride)[a]

A synthetic thermoplastic polymer made by polymerizing vinyl chloride monomer or vinyl chloride/vinyl acetate monomers. Normally rigid and containing 50% of plasticizers.

PVC-CPE (Polyvinyl chloride - chlorinated polyethylene alloy)[a]

A blend of polyvinyl chloride and chlorinated polyethylene.

TN-PVC (Thermoplastic nitrile-polyvinyl chloride)[a]

An alloy of thermoplastic unvulcanized nitrile rubber and polyvinyl chloride.

Vulcanized Materials (XL)

Butyl rubber[a]

A synthetic rubber based on isobutylene and a small amount of isoprene to provide sites for vulcanization.

EDPM (Ethylene propylene diene monomer)[a,b]

A synthetic elastomer based on ethylene, propylene, and a small amount of nonconjugated diene to provide sites for vulcanization.

CM (Cross-linked chlorinated polyethylene)

No definition available by EPA.

CO, ECO (Epichlorohydrin polymers)[a]

Synthetic rubber, including two epichlorohydrin-based elastomers that are saturated, high-molecular-weight aliphatic polyethers with chloromethyl side chains. The two types include homopolymer (CO) and a copolymer of epichlorohydrin and ethylene oxide (ECO).

CR (Polychloroprene)[a]

Generic name for a synthetic rubber based primarily on chlorobutadiene. Polychloroprene is also known as neoprene.

Semicrystalline Materials (CX)

HDPE (High density polyethylene)

A polymer prepared by the low-pressure polymerization of ethylene as the principal monomer.

HDPE (A (High density polyethylene/rubber alloy)

A blend of high-density polyethylene and rubber.

LLDPE (Liner low-density polyethylene)

A low-density polyethylene produced by the copolymerization of ethylene with various alpha olefins in the presence of suitable catalysts.

PEL (Polyester elastomer)

A segmented thermoplastic copolymer elastomer containing recurring long-chain ester units derived from dicarboxylic acids and long-chain glycols and short-chain ester units derived from dicarboxylic acids and low-molecular-weight diols.

PE-EP-A (Polyethylene ethylene/propylene alloy)

An ethylene-propylene diene monomer blend resulting in a thermoplastic elastomer.

T-EPDM (Thermoplastic EPDM)

An ethylene-propylene diene monomer blend resulting in a thermoplastic elastomer.

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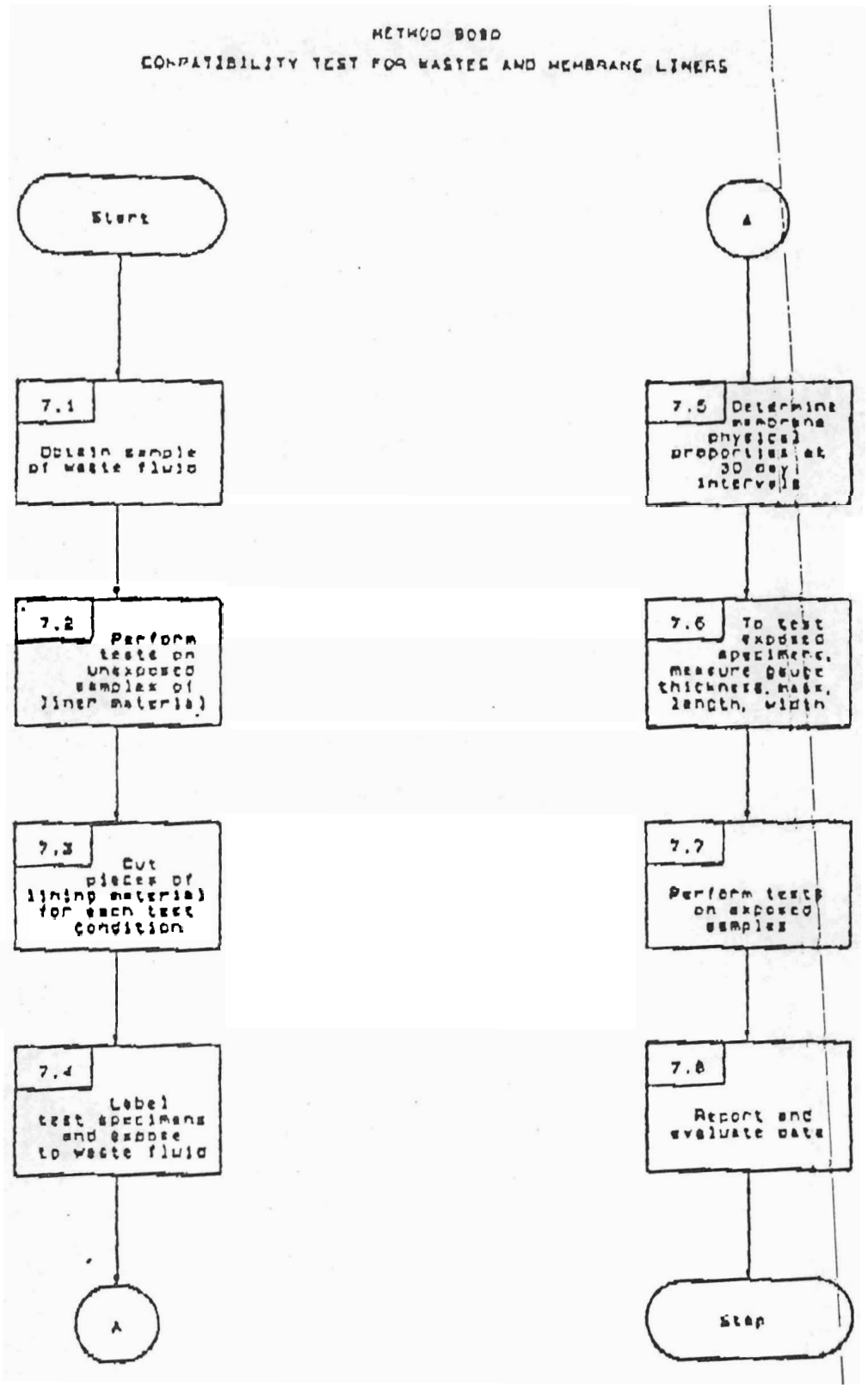
[a] Also supplied reinforced with fabric.
[b] Also supplied as a thermoplastic.


METHOD 9080
COMPATIBILITY TEST FOR WASTES AND MEMBRANE LINERS
Start
7.1
Obtain sample of waste fluid
7.2
Perform tests on unexposed samples of liner material
7.3
Cut pieces of lining material for each test condition
7.4
Label test specimens and expose to waste fluid
A
A
7.5
Determine membrane physical properties at 30 day intervals
7.6
To test exposed specimens, measure gauge thickness, mass, length, width
7.7
Perform tests on exposed samples
7.8
Report and evaluate data
Stop

LABORATORY REPORT #208
MARCH 21, 1983

SUBJECT:

Chemical compatibility of HD 40 mil to five water samples.

WASTEWATER SAMPLES CODE:

"A" - Potlining waste - contains fluoride, cyanide, caustic PH.

"B" - Tarrywaste - contains phenol, fluoride, acid PH, other aromatic.

"C" - Oily diatomaceous earth waste - contains oils and grease, slightly acid PH.

"D" - Waste based coating sludge waste organics.

"E" - Mixture of 25% of each of "A" through "D".

SUMMARY:

HD 40 mil material proves to be resistant to all solutions submitted.

TEST METHOD:

ASTM D638 Type IV dumb-bells were used for tensile and elongation. Crosshead speed for tensile test was 2"/min. 1" x 6" strips were used for dimensional and weight change during immersion testing for each solution. Tensile bars of the liner material and welds were prepared for immersion testing. A control for comparison was also prepared. Tensile tests were conducted after 7 and 30 days immersion. Welds were tested after 30 days. Samples were placed in solution at 23°C.

TEST RESULTS:

Tensile (liner material)

7-Day Immersion

Sample	Yield PPI/PSI	Break PPI/PSI	% Elong Break
A	113/2616	199/4581	860
B	112/2626	200/4682	877
C	112/2564	177/4061	800
D	116/2637	191/4343	840
E	119/2637	205/4563	847

30-Day Immersion

A	120/2800	184/4298	787
B	123/2758	200/4495	857
C	119/2771	192/4426	800
D	112/2721	176/4273	780
E	120/2759	179/4111	757

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March 21, 1983

Tensile

Control	Yield PPI/PSI	Break PPI/PSI	% Elong Break
	118/2683	193/4382	870

Seam (Welds)	Peel		Shear	
30-Day Immersion Sample	Break	Failure Type	Yield	Break
A	84	sheet	102	82
B	90	sheet	104	86
C	94	sheet	100	82
D	78	sheet	90	84
E	88	sheet	98	82
Control	90	sheet	100	80

Weight and Dimensional Change

Solution		Initial	7 Days	30 Days
A	Thickness (mils) (1)	40	40	40
	Weight (grams)	2.7703	2.7720	2.7722
	Thickness (mils) (2)	40	40	40
	Weight (grams)	2.6107	2.6123	2.6115
B	Thickness (mils) (1)	40	40	40
	Weight (grams)	2.8395	2.8431	2.8437
	Thickness (mils) (2)	40	40	40
	Weight (grams)	2.7990	2.8021	2.8034
C	Thickness (mils) (1)	38	38	38
	Weight (grams)	2.5529	2.5566	2.5578
	Thickness (mils) (2)	40	40	40
	Weight (grams)	2.9389	2.9480	2.9483
D	Thickness (mils) (1)	40	40	40
	Weight (grams)	2.6119	2.6145	2.6140
	Thickness (mils) (2)	40	40	40
	Weight (grams)	2.4964	2.4988	2.4986
E	Thickness (mils) (1)	40	40	40
	Weight (grams)	2.6881	2.6900	2.6905
	Thickness (mils) (2)	40	40	40
	Weight (grams)	2.7864	2.7896	2.7894

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CONCLUSION:

The wastewater solutions did not affect the HD material visually, nor did it change the tensile properties. The small differences in data recorded are typical values for this type of high density polyethylene.

Gloria Garber
Lab Technician

QUALITY CONTROL DATA

MATERIAL: HD 40 mil

DATE: MARCH 21, 1983

BATCH #: 303

FOR: LAB PROJECT #208

TEST PARAMETER		TEST RESULTS	ASTM TEST METHOD
Tensile			
	Yield PSI	2642	D638 Type IV
	Break PSI	4500	
	% Elong. Break	787	
Density		.938	D1505
Melt Index		.20	D1238 E
Tear Resistance (lbs)		36.5	D1004
Dimensional Stability		<.50	D1204
Puncture Resistance (lbs)		200	FTMS 101B 2031

****

Gloria Garber

Gloria Garber
Lab Technician

March 21, 1983

Date

LABORATORY REPORT #227

SEPTEMBER 16, 1983

SUBJECT: Chemical capatability of HD 40 and 80 mil liner and seam.

CHEMICAL: Aromatic waste containing inorganics.

TEST METHOD: Samples were immersed in the solution at 23°C and removed for testing at 30, 60, 90, and 120 days. 1" x 4" strips of the liner were used for weight and dimensional change. ASTM D638 type IV dumb-be were used for tensile, elongation and weld testing. A test speed of 2"/min. was used with a 2 1/2" gri separation.

RESULTS: See next page.

WEIGHT AND DIMENSIONAL CHANGE

40 mil	Initial	30 days	60 days	90 days	120 days
MD thickness	39	39	39	39	39
Weight	2.4246	2.4257(+.05)	2.426(+.06)	2.4259(+.05)	2.4256(+.04)
MD thickness	39	39	39	39	39
Weight	2.5628	2.5644(+.06)	2.562(+.09)	2.5647(+.07)	2.5644(+.06)
40 mil					
TD thickness	38	38	38	38	38
Weight	2.6684	2.6707(+.09)	2.6705(+.08)	2.6699(+.05)	2.6698(+.05)
TD thickness	38	38	38	38	38
Weight	2.5363	2.5382(+.07)	2.5381(+.07)	2.5372(+.04)	2.5373(+.04)
80 mil					
MD thickness	90	90	90	90	90
Weight	5.8678	5.8698(+.03)	5.8708(+.05)	5.8708(+.05)	5.8737(+.10)
MD thickness	88	88	88	88	88
Weight	4.7387	4.7404(+.04)	4.7414(+.06)	4.7410(+.05)	4.7466(+.17)
80 mil					
TD thickness	90	90	90	90	90
Weight	5.6870	5.6907(+.07)	5.6900(+.05)	5.6917(+.08)	5.6917(+.08)
TD thickness	90	90	90	90	90
Weight	5.7380	5.7413(+.05)	5.7408(+.05)	5.7412(+.06)	5.7418(+.07)

Data in () = % change

HD 40 MIL

TENSILE STRENGTH - D638

MD	Control	30 days	60 days	90 days	120 days
Yield PSI	2703	2532 (-6)	2737 (+1.3)	2724 (+0.8)	2667 (-1.3)
Break PSI	4752	4593 (-3)	4907 (+3)	4082 (-14)	4454 (-6)
% Elongation Break	803	807 (+.5)	763 (-5)	720 (-10)	703 (-12)
TD					
Yield PSI	2909	2677 (-8)	2879 (-1)	2833 (-2.6)	2889 (-0.7)
Break PSI	4699	5132 (+9)	4812 (+2.4)	4105 (-12)	5037 (+7)
% Elongation Break	777	870 (+12)	777 (0)	680 (-12)	817 (+5)

HD 40 MIL

SEAM STRENGTH (1/4")

Peel					
Yield PSI	84	73 (-13)	72 (-14)	88 (+5)	70 (-16)
Shear					
Break PSI	103	89 (-14)	99 (-4)	100 (-3)	103 (0)
% Elongation Break	87	84 (-3)	93 (+7)	91 (+5)	92 (+6)

Data in () = % change

HD 80 MIL

TENSILE STRENGTH - D638

	Control	30 days	60 days	90 days	120 days
MD					
Yield PSI	2888	2776 (-3.8)	2952 (+2)	3020 (+4.6)	2818 (-2)
Break PSI	4860	4719 (-3)	4677 (-3.8)	4862 (+.04)	4582 (-5.7)
% Elongation Break	900	880 (-2)	863 (-4)	860 (-4)	847 (-6)
TD					
Yield PSI	2995	2831 (-5)	3020 (+0.8)	3107 (+4)	3011 (+.5)
Break PSI	4808	4933 (+2.6)	4800 (-.2)	4802 (-.12)	4674 (-2.8)
% Elongation Break	823	837 (+1.7)	837 (+1.7)	843 (+2)	773 (-6)

HD 80 MIL

SEAM STRENGTH (1/4")

Peel					
Break PPI	167	162 (-3)	157 (-6)	172 (+3)	172 (+3)
Shear					
Yield PPI	225	216 (-4)	248 (+10)	220 (-2)	236 (+5)
Break PPI	173	165 (-4.6)	185 (+7)	196 (+13)	167 (-3)

Data in () = % change

DISCUSSION: There was no significant change in weight or samples thickness after 120 days immersion. The tensi properties of the 80 mil liner and seams remained initially the same throughout the total test period. The test results for the 40 mil thickness were more erratic, however, were within the usual variance of the tensile test.

CONCLUSION: With no significant changes occurring in the chemical resistance testing the HD liner can be considered a good prospect for the containment of the waste product submitted.

Gloria Garber

Gloria Garber, Lab Technician.

LABORATORY REPORT #227A

MARCH 31, 1986

SUBJECT: Chemical capability of HD 40 and 80 mil liner and seam.

CHEMICAL: Aromatic waste containing inorganics.

TEST METHOD: Samples were immersed in the solution at 23°C and removed for testing after 2 years, 10 months. 1" x 4" strips of the liner were used for weight and dimensional change. ASTM D638 type IV dumb-bells were used for tensile, elongation and weld testing. A test speed of 2"/min. was used within 2 1/2" grip separation.

TEST RESULTS:

TENSILE STRENGTH & ELONGATION

40 MIL HDPE AT 23°C

MD	YIELD STRENGTH (PSI)	BREAK STRENGTH (PSI)	BREAK ELONGATION (%)
Control	2703	4752	803
2 Years, 9 1/2 Mths	2641	4512	735
% Change	-2.3	-5.1	-8.5
TD			
Control	2909	4699	777
2 Years, 9 1/2 Mths	2931	5435	855
% Change	+.8	+15.7	+10

80 MIL HDPE at 23°C

MD			
Control	2888	4860	900
2 Years, 9 1/2 Mths	2914	4938	878
% Change	+1	-1.6	-2.4
TD			
Control	2995	4808	823
2 Years, 9 1/2 Mths	3070	4709	800
% Change	+2.5	-2.1	-2.8

SEAM (WELDS) 40 MIL

	PEEL (BREAK (PSI))	SHEAR (YIELD (PSI))
Control	84	103
2 Years, 9 1/2 Mths	86	100
% Change	+2.4	-2.9

SEAM (WELDS) 80 MIL

	PEEL (BREAK (PSI))	SHEAR (YIELD PSI))
Control	167	225
2 Years, 9 1/2 Mths	166	264
% Change	-.6	+17.3

THICKNESS CHANGE AT 23°C (40 MIL)

	CONTROL	2 YRS. 1/2 MTS.	% CHANGE
MD	.39"	.37"	-5.1
TD	.38"	.37"	-2.6

THICKNESS CHANGE AT 23°C (80 MIL)

MD	.89"	.88"	-1.1
TD	.90"	.86"	-4.4

WEIGHT CHANGE AT 23°C (40 MI)

MD	2.4937	2.4977	+.2
TD	2.6024	2.6031	+.03

WEIGHT CHANGE AT 23°C (80 MIL)

MD	5.3033	5.3151	+.2
TD	5.7125	5.7166	+.07

CONCLUSION:

After almost 3 years of immersion, no significant change in properties has occured.

CERTIFIED BY;

Sengthong Phouangsavanh
Sengthong Phouangsavanh
Lab Technician

Mark Cadwallader
Mark Cadwallader
Director of Research & Development

LABORATORY REPORT #667

FEBRUARY 19, 1985

Chemical Resistance Tests With Aromatic Liquor

TEST METHOD:

HD 100 mil liner was prepared for immersion testing in aromatic liquor at 23°C and 50°C. ASTM D638 tensile type IV dumb-bells and speed of 2 ipm were used for these tests. 1" x 3" strips were used for weight and dimensional change.

Upon completion of 7 day immersion period, all samples were wiped dry and immediately tested after removal from the test solution.

The immersion test will be continued up to 90 days with samples being removed after 30, 60 and 90 days.

TEST RESULTS:

Tensile Strength & Elongation

100 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2790	15	4652	867
7 Day	3073	15	4564	870
% Change	+10	0	-2	+3.5
TD				
Control	2917	15	4821	813
7 Day	2991	15	4403	833
% Change	+3	0	-9	+2.5

100 mil HDPE at 50°C

MD				
Control	2790	15	4652	867
7 Day	2978	15	4336	830
% Change	+7	0	-7	-4.3
TD				
Control	2917	15	4821	813
7 Day	3037	15	4510	830
% Change	+4	0	-6.5	+2

Weight Change at 23°, 100 mil HDPE

	Control	7 Day	% Change
MD	4.428	4.3530	-2
TD	4.559	4.7070	+3.2

Weight Change at 50°C, 100 mil HDPE

	Control	7 Day	% Change
MD	4.348	4.4402	+2
TD	4.701	4.5656	-3

Thickness Change at 23°C, 100 mil HDPE

	Control	7 Day	% Change
MD	.94"	.94"	0
TD	.96"	.96"	0

Thickness Change at 50°C, 100 mil HDPE

	Control	7 Day	% Change
MD	.95"	.95"	0
TD	.96"	.96"	0

CONCLUSION:

After 7 days immersion in aromatic liquor at 23°C and 50°C, [redacted] HD did not appear to have been affected.

S. Sengthong

S. Sengthong
Lab Technician

LABORATORY REPORT #667-A

MARCH 12, 1985

Chemical Resistance Tests With Aromatic Liquor

TEST METHOD:

.HD 100 mil liner was prepared for immersion testing in aromatic liquor at 23°C and 50°C. ASTM D638 tensile type IV dumb-bells and speed of 2 ipm were used for these tests. 1" x 3" strips were used for weight and dimensional change.

Upon completion of 30 day immersion period, all samples were wiped dry and immediately tested after removal from the test solution.

The immersion test will be continued up to 90 days with samples being removed after 60 and 90 days.

TEST RESULTS:

Tensile Strength & Elongation

100 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2790	15	4652	867
30 Day	2978	15	4585	870
% Change	+6.7	0	+1	+.3
TD				
Control	2917	15	4821	813
30 Day	2960	15	4573	790
% Change	+1.5	0	-5	-3

100 mil HDPE at 50°C

MD				
Control	2790	15	4652	867
30 Day	2946	15	4036	735
% Change	+6	0	-13	-15
TD				
Control	2917	15	4821	813
30 Day	3102	15	4936	800

Weight Change at 23°, 100 mil HDPE

	Control	30 Day	% Change
MD	4.428	4.4400	+.3
TD	4.559	4.6057	+1.0

Weight Change at 50°C, 100 mil HDPE

	Control	30 Day	% Change
MD	4.348	4.3584	+.3
TD	4.701	4.7119	+.2

Thickness Change at 23°C, 100 mil HDPE

	Control	30 Day	% Change
MD	.94"	.94"	0
TD	.96"	.96"	0

Thickness Change at 50°C, 100 mil HDPE

	Control	30 Day	% Change
MD	.95"	.94"	-1.2
TD	.96"	.97"	+1.0

CONCLUSION:

After 30 days of immersion tests, HD did not appear to have been affected.

S. Sengthong

S. Sengthong
Lab Technician

LABORATORY REPORT #667B

APRIL 12, 1985

Chemical Resistance Tests With Aromatic Liquor

TEST METHOD:

HD 100 mil liner was prepared for immersion testing in the liquor at 23°C and 50°C. ASTM D638 tensile type IV dumb-bells and speed of 2 ipm were used for these tests. 1" x 3" strips were used for weight and dimensional change.

Samples were removed, wiped dry, and immediately tested after 7 days (Feb. 15, Report #667) and 30 days (March 11, Report #667A) this report deals with the test results after 60 days of immersion in the liquor.

The immersion test will be continued up to 90 days.

TEST RESULTS:

Tensile Strength & Elongation

100 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2790	15	4652	867
60 Day	2963	15	4431	860
% Change	+6.2	0	-4.8	-1
TD				
Control	2917	15	4821	813
60 Day	2966	15	4231	780
% Change	+1.7	0	-12	-4.1

100 mil HDPE at 50°C

MD				
Control	2790	15	4652	867
60 Day	3053	15	4243	855
% Change	+9.4	0	-9	-1.4
TD				
Control	2917	15	4821	813
60 Day	3057	15	4120	750
% Change	+4.8	0	-14.5	-7.7

Weight Change at 23°, 100 mil HDPE

	Control	60 Day	% Change
MD	4.428	4.4411	+.3
TD	4.559	4.6083	+1.1

Weight Change at 50°C, 100 mil HDPE

	Control	60 Day	% Change
MD	4.348	4.3624	+.3
TD	4.701	4.7139	+.3

Thickness Change at 23°C, 100 mil HDPE

	Control	60 Day	% Change
MD	.94"	.95"	+1.1
TD	.96"	.96"	0

Thickness Change at 50°C, 100 mil HDPE

	Control	60 Day	% Change
MD	.95"	.95"	0
TD	.96"	.96"	0

CONCLUSION:

Some loss in break strength was detected, accompanied by a small increase in yield strength.

S. Sengthong

S. Sengthong
Lab Technician

LABORATORY REPORT #667C

May 10, 1985

Chemical Resistance Tests With Aromatic Liquor

TEST METHOD:

HD 100 mil liner was immersed in the test liquor at 23°C and 50°C. Tensile properties and weight and thickness changes were studied following ASTM procedure.

The samples were pulled after 90 days immersion which concludes this testing.

TEST RESULTS:

Tensile Strength & Elongation

100 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2790	15	4652	867
90 Day	2875	15	4169	825
% Change	+3.1	0	-10.4	-5
TD				
Control	2917	15	4821	813
90 Day	2941	15	4454	815
% Change	+1	0	-7.6	+.2

100 mil HDPE at 50°C

MD				
Control	2790	15	4652	867
90 Day	3000	15	3478	750
% Change	+7.5	0	-25	-13.5
TD				
Control	2917	15	4821	813
90 Day	2989	15	4330	820
% Change	+2.5	0	-10.2	+1

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Weight Change at 23°, 100 mil HDPE

	Control	90 Day	% Change
MD	4.428	4.4408	+.3
TD	4.559	4.6078	+1.1

Weight Change at 50°C, 100 mil HDPE

	Control	90 Day	% Change
MD	4.348	4.3624	+.1
TD	4.701	4.7153	0

Thickness Change at 23°C, 100 mil HDPE

	Control	90 Day	% Change
MD	.94"	.95"	+.1
TD	.96"	.96"	0

Thickness Change at 50°C, 100 mil HDPE

	Control	90 Day	% Change
MD	.95"	.94"	-1.1
TD	.96"	.98"	+2.1

CONCLUSION:

There seems to be a minimal effect of the liquor on the HDPE. The significance of the property changes is questionable since there are gains as well as decreases in strength, and in only one case was the change much over 10%.

S. Sengthong
S. Sengthong
Lab Technician

Mark Cadwallader
Mark Cadwallader
Director of Research and
Technical Development

LABORATORY REPORT #671
FEBRUARY 26, 1985
CHEMICAL RESISTANCE TESTS WITH LEACHATE AND TCE, TCA

TEST METHOD:

. HD 60 mil liner was prepared for immersion testing in leachate and TCE, TCA at 23°C. ASTM D638 tensile type IV dumb-bells and a speed of 2 ipm were used for these tests. 1" x 3" strips were used for weight and dimensional change.

Upon 7 day immersion period, all the samples were wiped dry and immediately tested after removal from the test solution.

The immersion test will be continued up to 90 days with samples being removed after 30, 60, and 90 days.

TEST RESULTS:

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2902	15	4780	770
7 Day	2950	15	4450	820
% Change	+2	0	-7	+6.5
TD				
Control	3005	15	4877	800
7 Day	2930	15	4413	810
% Change	-2.5	0	-9.5	+1.3

Weight Change at 23°C (1" x 3")

	Control	7 Days	% Change
MD	3.009	3.0518	+1.4
TD	3.107	3.1488	+1.3

Thickness Change at 23°C (1" x 3")

MD	.63"	.61"	-3.2
TD	.62"	.63"	+2

CONCLUSION:

After 7 days immersion in leachate and TCE, TCA at 23°C, Gundline HD did not appear to have been affected.

S. Sengthong
S. Sengthong
Lab Technician

LABORATORY REPORT #671A
APRIL 1, 1985
CHEMICAL RESISTANCE TESTS WITH LEACHATE AND TCE, TCA

TEST METHOD:

HD 60 mil liner was prepared for immersion testing in leachate spiked with TCE, TCA at 23°C. ASTM D638 testle type IV dumb-bells and a speed of 2 ipm were used for these test. 1" x 3" strips were used for weight and dimensional change.

Upon 30 day immersion period, all the samples were wiped dry and immediately tested after removal from the test solution.

The immersion test will be continued up to 90 days with samples being removed after 60 and 90 days.

TEST RESULTS:

Tensile Strength & Elongation
60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2902	15	4780	770
30 Day	2801	18	4358	805
% Change	-3.5	+20	-9	+5
TD				
Control	3005	15	4877	800
30 Day	2796	15	4377	830
% Change	-7	0	-10	+4

Weight Change at 23°C (1" x 3")

	Control	30 Days	% Change
MD	3.009	3.0544	+2
TD	3.107	3.1510	+1.4

Thickness Change at 23°C (1" x 3")

MD	.063	.062	-2
TD	.062	.065	+5

CONCLUSION:

After 30 days immersion at 23°C in leachate spiked with Trichloraethane and Trichloroethylene (5900 mg/1 and 170 mg/1 respectively), HD was not affected.

S. Sengthong

S. Sengthong
Lab Technician

LABORATORY REPORT #671B
APRIL 19, 1985

SUBJECT:

Chemical resistance tests of leachate spiked with trichloroethylene (TCE) and Trichloroethane (TCA).

TEST METHOD:

HD 60 mil liner was immersed in TCE and TCA spiked with leachate at 23°C. ASTM D638 tensile type IV dumb-bells and speed of 2 ipm were used for these tests. 1" x 3" strips were used for weight and dimensional change.

Test results are after 59 day immersion. The test will be continued for 90 days.

TEST RESULTS:

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2902	15	4780	770
59 Day	2658	15	4319	810
% Change	-8.4	0	-9.6	+5.2
TD				
Control	3005	15	4877	800
59 Day	2729	15	4346	810
% Change	-9.2	0	-11	+1.3

Weight Change at 23°C (1" x 3")

	Control	59 Days	% Change
MD	3.009	3.0623	+1.8
TD	3.107	3.1577	+1.6

Thickness Change at 23°C (1" x 3")

MD	.63"	.62"	-1.6
TD	.62"	.65"	+4.8

CONCLUSION:

After 59 days of immersion in the leachate, decrease in tensile strength occurred. Althought the decrease was uniform, its magnitude was not really significant.

Sengthong Phouangsavanh

Sengthong Phouangsavanh
Lab Technician

LABORATORY REPORT #671C
MAY 20, 1985

SUBJECT:

Chemical resistance tests of PCB - containing leachate spiked with trichloroethylene (TCE) and trichloroethane (TCA) were carried out for 90 days.

TEST METHOD:

. HD 60 mil liner was immersed in the synthetic leachate at 23°C. ASTM D638 tensile type IV dumb-bells and a speed of 2 ipm were used for these tests. 1" x 3" strips were used for weight and dimensional change.

Specimens were removed and tested at 7, 30, and 60 day intervals. This report provides data after 90 days of immersion, which includes the test.

TEST RESULTS:

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2902	15	4780	770
90 Day	2938	15	4192	825
% Change	+1.2	0	-12.3	+7.1
TD				
Control	3005	15	4877	800
90 Day	3005	15	4526	850
% Change	0	0	-7.2	+6.3

Weight Change at 23°C (1" x 3")

	Control	90 Days	% Change
MD	3.009	3.051	+1.4
TD	3.107	3.151	+1.4

Thickness Change at 23°C (1" x 3")

MD	.63"	.62"	-1.6
TD	.62"	.63"	+1.6

CONCLUSION:

No significant change in properties was detected.

Considering the results from earlier intervals, effects on the liner appear to have stabilized after 7 days of immersion. The trend is toward some minor level of leachate absorption and some minor reduction in break strength. However, this level of change is not considered significant.

Sengthong Phouangsavanh
Lab Technican

Mark Cadwallader
Director of Research & Technical
Development

NOTE:

Concentrations of the chlorinated hydrocarbons are as follows:

Tricholoroethylene & Trichloroethane - 95,000 ppb.

PCB'S – 11,000 ppb.

LABORATORY REPORT #731

MAY 8, 1985

CHEMICAL RESISTANCE TESTS WITH AROMATIC LEACHATE

SUBJECT:

Chemical Resistance Tests per E.P.A. Method 9090 were run on a leachate containing aromatic hydrocarbons

TEST METHOD:

HD 60 mil liner was immersed in the leachate at both 23°C and 50°C. The appropriate ASTM shapes were used to perform the testing required by Method 9090. Immersion will continue up to 120 days with samples being removed for testing at 30 day intervals.

TEST RESULTS: (After 30 days immersion)

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2824	15	4868	865
30 Days	2923	15	3979	715
% Change	+3.5	0	-18	-17
TD				
Control	2747	15	4835	890
30 Days	2854	14	4791	805
% Change	+4	-7	-1	-9.6

60 mil HDPE at 50°C

MD				
Control	2824	15	4868	865
30 Days	3094	15	4737	800
% Change	+9.6	0	-2.7	-7.5
TD				
Control	2747	15	4835	890
30 Days	3060	14	4749	805
% Change	+11	-7	-2	-9.6

Weight Change at 23°C (1" x 3") 60 mil HDPE

	Control	30 Days	% Change
MD	2.6319	2.6329	+.04
TD	2.6391	2.6405	+.05

Weight Change at 50°C (1" x 3") 60 mil HDPE

MD	2.6642	2.6659	+.06
TD	2.8435	2.8450	+.05

Thickness Change at 23°C (1" x 3") 60 mil HDPE

	Control	30 Days	% Change
MD	.58"	.58"	0
TD	.58"	.58"	0

Thickness Change at 50°C (1" x 3") 60 mil HDPE

MD	.58"	.58"	0
TD	.58"	.58"	0

Tear Resistance

60 mil HDPE at 23°C

	Control (lbs)	30 Days (lbs)	% Change
MD	43	43	0
TD	44	45	+2.3

60 mil HDPE at 50°C

MD	43	44	+2.3
TD	44	46	+4.5

CONCLUSION:

Significant property changes following immersion are considered to be ± 10%. Using this criteria, there could be some effect on tensile strength and elongation at break. However, considering the rest of the data, this may be an anomaly.

Lab Technician
S. Sengthong

Mark Cadwallader
Director-Research & Technical Development

LABORATORY REPORT #731A

MAY 29, 1985

CHEMICAL RESISTANCE FOR

WITH AROMATIC LEACHATE

SUBJECT:

Chemical resistance tests per E.P.A. Method 9090 were run on a leachate containing aromatic hydrocarbons

TEST METHOD:

HD 60 mil liner was immersed in the leachate at both 23°C and 50°C. The appropriate ASTM shapes were used to perform the testing required by Method 9090. Immersion will continue up to 120 days with samples being removed for testing at 30 day intervals.

TEST RESULTS: (After 60 Days)

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2824	15	4868	865
60 Days	2899	15	4910	875
% Change	+3	Ø	+1	+1.2
TD				
Control	2747	15	4835	890
60 Days	2847	14	4657	820
% Change	+3.6	-7	-3.7	-8

60 mil HDPE at 50°C

MD				
Control	2824	15	4868	865
60 Days	2819	15	4795	815
% Change	-.2	Ø	-1.5	-6
TD				
Control	2747	15	4835	890
60 Days	3067	14	4620	830
% Change	+11.6	-7	-4.4	-6.7

Weight Change at 23°C (1" x 3") 60 mil HDPE

	Control	60 Days	% Change
MD	2.6319	2.6327	+.03
TD	2.6391	2.6401	+.04

Weight Change at 50°C (1" x 3") 60 mil HDPE

	Control	60 Days	% Change
MD	2.6642	2.6731	-1.33
TD	2.8435	2.8464	+.1

Thickness Change at 23°C (1" x 3") 60 mil HDPE

MD	.58"	.57"	-2
TD	.58"	.57"	-2

Thickness Change at 50°C (1" x 3") 60 mil HDPE

MD	.58"	.58"	Ø
TD	.58"	.58"	Ø

Tear Resistance

60 mil HDPE at 23°C

MD	43	46	+7
TD	44	46	+4.6

60 mil HDPE at 50°C

MD	43	43	Ø
TD	44	44	Ø

CONCLUSION:

No significant change has resulted from immersion in leachate for 60 days.

Lab Technician
Sengthong Phouangsavanh

Mark Cadwallader
Mark Cadwallader
Director - Research &
Technical Development

LABORATORY REPORT #731B

JUNE 28, 1985

CHEMICAL RESISTANCE FOR
WITH AROMATIC LEACHATE

SUBJECT:

Chemical resistance tests per E.P.A. Method 9090 were run on a leachate containing aromatic hydrocarbons

TEST METHOD:

HD 60 mil liner was immersed in the leachate at both 23°C and 50°C. The appropriate ASTM shapes were used to perform the testing required by Method 9090. Immersion will continue up to 120 days with samples being removed for testing at 30 days intervals.

TEST RESULTS: (After 90 Days of immersion)

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2824	15	4868	865
90 Days	2845	15	5121	910
% Change	+1	Ø	+5.2	+5.2
TD				
Control	2747	15	4835	890
90 Days	2965	14	5087	915
% Change	+8	-7	+5.2	+3

60 mil HDPE at 50°C

MD				
Control	2824	15	4868	865
90 Days	3026	15	5104	905
% Change	+7.2	Ø	+5	+4.6
TD				
Control	2747	15	4835	890
90 Days	3025	14	4187	780
% Change	+10	-7	-13	-12.4

Weight Change at 23°C (1" x 3") 60 mil HDPE

	Control	90 Days	% Change
MD	2.6319	2.6326	+.03
TD	2.6391	2.6404	+.05

Weight Change at 50°C (1" x 3") 60 mil HDPE

MD	2.6642	2.6736	+.4
TD	2.8435	2.8471	+.1

Thickness Change at 23°C (1" x 3") 60 mil HDPE

MD	.58"	.57"	-2
TD	.58"	.56"	-3.4

Thickness Change at 50°C (1" x 3") 60 mil HDPE

MD	.58"	.58"	Ø
TD	.58"	.57"	-2

Tear Resistance

60 mil HDPE at 23°C

MD	43	44	+2.3
TD	44	49	+11.4

60 mil HDPE at 50°C

MD	43	44	+2.3
TD	44	46	+4.5

Puncture at 23°C

63	66	+5

Puncture at 50°C

63	68	+8

CONCLUSION:

After 90 days of immersion no real significant change was defected.

Lab Technician
Sengthong Phouangsavanh

Mark Cadwallader

Mark Cadwallader
Director - Research & A.L.

LABORATORY REPORT #731C

JULY 29, 1985

CHEMICAL RESISTANCE TESTING WITH
AROMATIC HYDROCARBON LEACHATE

SUBJECT:

Chemical resistance tests per E.P.A. Method 9090 were run on a leachate containing 1.27% wt. aromatic hydrocarbons, present as various substituted benzenes.

TEST METHOD:

HD 60 mil liner was immersed in the leachate at both 23°C and 50°C. The appropriate ASTM shapes were used to perform the testing required by Method 9090. Immersion was for 120 days which concludes the test.

TEST RESULTS: (After 120 Days)

Tensile Strength & Elongation

60 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2824	15	4868	865
120 Days	2962	15	4303	790
% Change	+5	Ø	-11.6	-8.7
TD				
Control	2749	15	4835	890
120 Days	2983	13	4594	805
% Change	+8.6	-13	-5	-9.6

60 mil HDPE at 50°C

MD				
Control	2824	15	4868	865
120 Days	2888	15	4313	795
% Change	+2.3	Ø	-11	-8.1
TD				
Control	2747	15	4835	890
120 Days	2878	15	4889	870
% Change	+5	Ø	+1.1	-2.2

Weight Change at 23°C (1" x 3") 60 mil HDPE

	Control	120 Days	% Change
MD	2.6319	2.6328	+.03
TD	2.6391	2.6399	+.03

Weight Change at 50°C (1" x 3") 60 mil HDPE

MD	2.6642	2.6737	+.4
TD	2.8435	2.8472	+.1

Thickness Change at 23°C (1" x 3") 60 mil HDPE

MD	.58"	.58"	ø
TD	.58"	.56"	-3.4

Thickness Change at 50°C (1" x 3") 60 mil HDPE

MD	.58"	.57"	-2
TD	.58"	.57"	-2

Tear Resistance

60 mil HDPE at 23°C

MD	43	42	-2.3
TD	44	44	ø

60 mil HDPE at 50°C

MD	43	43	ø
TD	44	44	ø

Puncture at 23°C

63	65	+3.2

Puncture at 50°C

63	66	+5

CONCLUSION:

After 120 days of immersion no significant change was detected.

Lab Technician
Sengthong Phouangsavanh

Mark Cedwalader

LABORATORY REPORT #1119

DECEMBER 13, 1985

CHEMICAL RESISTANCE TESTING OF HD WITH CHLORINATED HYDROCARBON LEACHATE

SUBJECT:

Leachate containing 2 - 3% halogenated organic hydrocarbons (mostly ethylene dichloride) was used to immerse HD 100 mil liner.

TEST METHOD:

Specimens of 100 mil liner were cut in appropriate die shapes for the different physical tests. Samples were tested for control purposes, and then every 7 days of immersion up to 28 days. Samples were immersed at two different temperatures; 23°C and 50°C. Tests run were the following: Tensile Properties/Elongation - ASTM D638, Initial Tear Resistance - ASTM D1004C, Puncture Resistance - FTMS 101B Method 2065, weight change, and thickness change. Test results are tabulated below with percent change for control noted at each test interval.

TEST RESULTS:

Tensile Strength & Elongation - 100 mil HDPE at 23°C

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2686	15	4000	725
7 Days	2729	14	3797	775
% Change	+1.6	-6.7	-5.1	+7
14 Days	2627	16	3689	760
% Change	-2.2	+6.7	-7.8	+4.8
21 Days	2924	15	3893	730
% Change	+8.9	Ø	-2.7	+.7
28 Days	2797	17	3525	735
% Change	+4.1	+13	-12	+1.4
TD				
Control	2826	15	4000	715
7 Days	2865	15	4178	735
% Change	+1.4	Ø	+4.5	+2.8
14 Days	2643	17	3906	760
% Change	-6.5	+13	-2.4	+6.3
21 Days	2652	15	3942	665
% Change	-6.2	Ø	-1.5	-7
28 Days	2898	16	3560	700
% Change	+2.5	+6.7	-11	-2.1

100 mil HDPE at 50°C

MD

Control	2686	15	4000	725
7 Days	2770	15	3596	739
% Change	+3.1	Ø	-10.1	+2
14 Days	2582	17	3607	810
% Change	-3.9	+13	-9.8	+12

MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
21 Days	2509	15	4029	740
% Change	-6.6	Ø	+.7	+2.1
28 Days	2819	15	3934	743
% Change	+5	Ø	-1.7	+2.5

TD

Control	2826	15	4000	715
7 Days	2898	15	3870	715
% Change	+2.5	Ø	-3.3	Ø
14 Days	2779	16	4033	797
% Change	-1.7	+6.7	+.8	+11.5
21 Days	2619	15	3891	710
% Change	-.3	Ø	-2.7	-.7
28 Days	3047	15	4082	786
% Change	+7.8	Ø	+2.1	+10

Weight Change at 23°C

	Control	7 Days	% Change	14 Days	% Change	21 Days	% Change	28 Days	% Change
MD	4.2911	4.2922	+.03	4.2933	+.05	4.2932	+.05	4.2939	+.1
TD	4.2170	4.2183	+.03	4.2194	+.06	4.2191	+.05	4.2213	+.1

Weight Change at 50°C

MD	4.6968	4.7003	+.07	4.7027	+.1	4.7040	+.2	4.7045	+.2
TD	4.2522	4.2549	+.06	4.2585	+.1	4.2591	+.2	4.2590	+.2

Thickness Change at 23°C

MD	.96"	.96"	Ø	.96"	Ø	.95"	-1.0	.94"	-2.1
TD	.90"	.90"	Ø	.90"	Ø	.89"	-1.1	.89"	-1.1

Thickness Change at 50°C

MD	.98"	.98"	Ø	.98"	Ø	.96"	-2.0	.96"	-2.0
TD	.91"	.91"	Ø	.90"	-1.1	.90"	-1.1	.88"	-3.3

Tear Resistance at 23°C

MD	94	90	-4.3	90	-4.3	90	-4.3	96	+2.1
TD	92	95	+3.2	91	-1.1	91	-1.1	94	+2.2

Tear Resistance at 50°C

MD	94	91	-3.2	91	-3.2	90	-4.3	95	+1.1
TD	92	89	-3.3	84	-8.7	87	-5.4	95	+3.3

Puncture at 23°C

	131	124	-5.3	118	-10	118	-10	125	-4.6

Puncture at 50°C

	127	124	-2.4	117	-8	117	-7.9	125	+2.4

CONCLUSION:

The dilute solution of chlorinated hydrocarbons did not affect the HD for the entire test period. A physical property change of at least 15% from the control is considered a significant alternation in properties. Weight change revealed very little absorption.

CERTIFIED BY:

Lab Supervisor
Sengthong Phouangsavanh