METHOD 9090A

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 (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 materials.)

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 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).

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.

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 content 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 Step 7.7, after 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 a 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 $\pm$ 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 hours 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, the 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).

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

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, Step 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 Agency suggests the use of the Toxicity Characteristic Leaching Procedure (TCLP) that was finalized in the Federal Register on June 29, 1990, Vol. 55, No. 126, p. 26986.

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 Institute of Standards and Technology 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 minute. 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

1. None required.

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. jaw 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, ppi Elongation at fabric break, % Tensile at ultimate break, ppi Elongation at ultimate break, ppi 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, lb Elongation, in.	Gage, mil Stress, lb Elongation, in.	Gage, mil Stress, lb Elongation, in.	Gage, mil Stress, lb 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.

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 known 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.

aAlso supplied reinforced with fabric.

EPDM (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 copolyester 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.

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

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

A blend of polyethylene and ethylene and propylene polymer resulting in a thermoplastic elastomer.

T-EPDM (Thermoplastic EPDM)

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

FIGURE 1. SUGGESTED PATTERN FOR CUTTING TEST SPECIMENS FROM NONREINFORCED CROSSLINKED OR THERMOPLASTIC IMMERSED LINER SAMPLES.

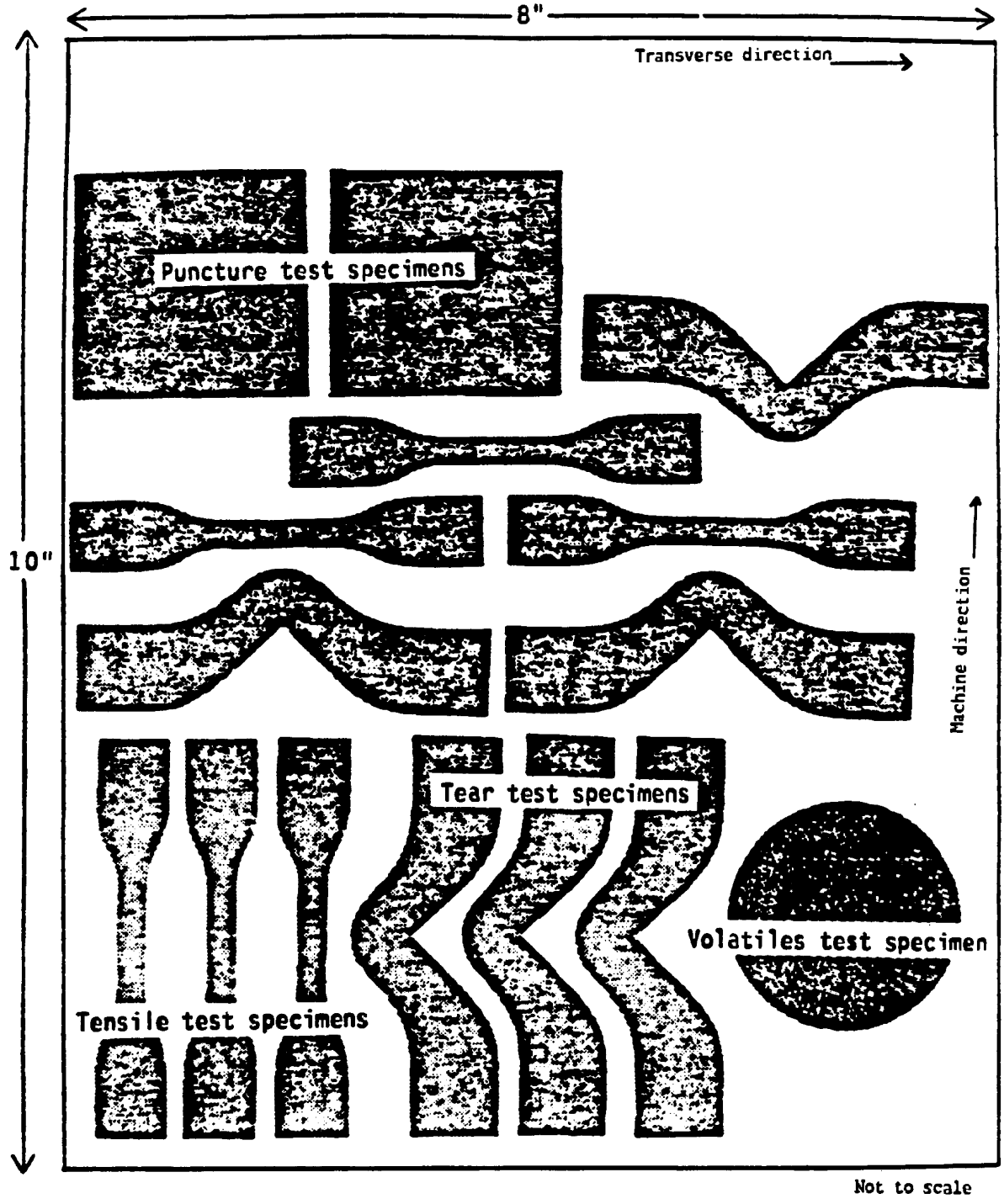


FIGURE 2. SUGGESTED PATTERN FOR CUTTING TEST SPECIMENS FROM FABRIC REINFORCED IMMERSED LINER SAMPLES.

NOTE: TO AVOID EDGE EFFECTS, CUT SPECIMENS 1/8 - 1/4 INCH IN FROM EDGE OF IMMERSED SAMPLE.

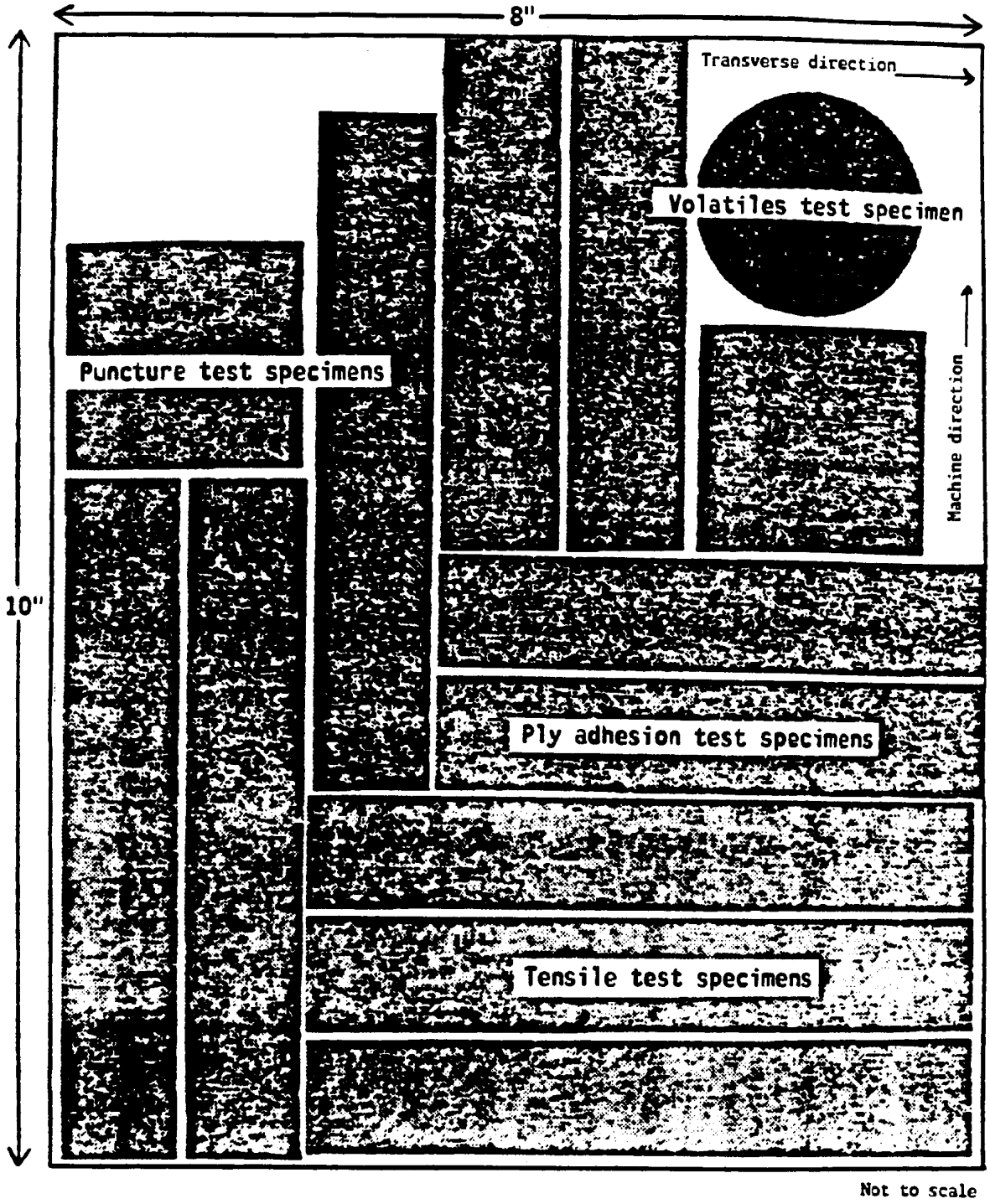


FIGURE 3. SUGGESTED PATTERN FOR CUTTING TEST SPECIMENS FROM SEMICRYSTALLINE IMMERSED LINER SAMPLES.

NOTE: TO AVOID EDGE EFFECTS, CUT SPECIMENS 1/8 TO 1/4 INCH IN FROM EDGE OF IMMERSED SAMPLE.

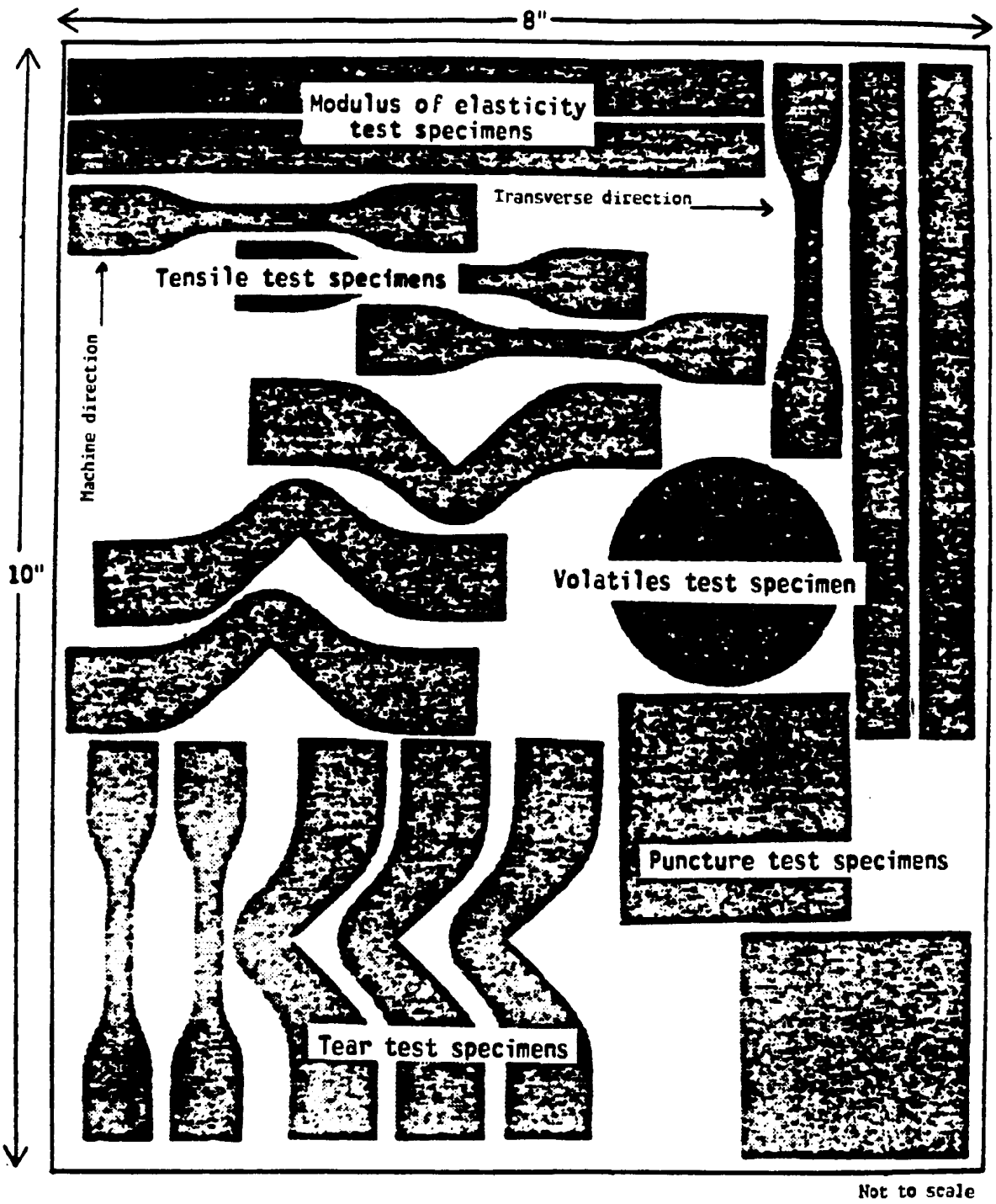
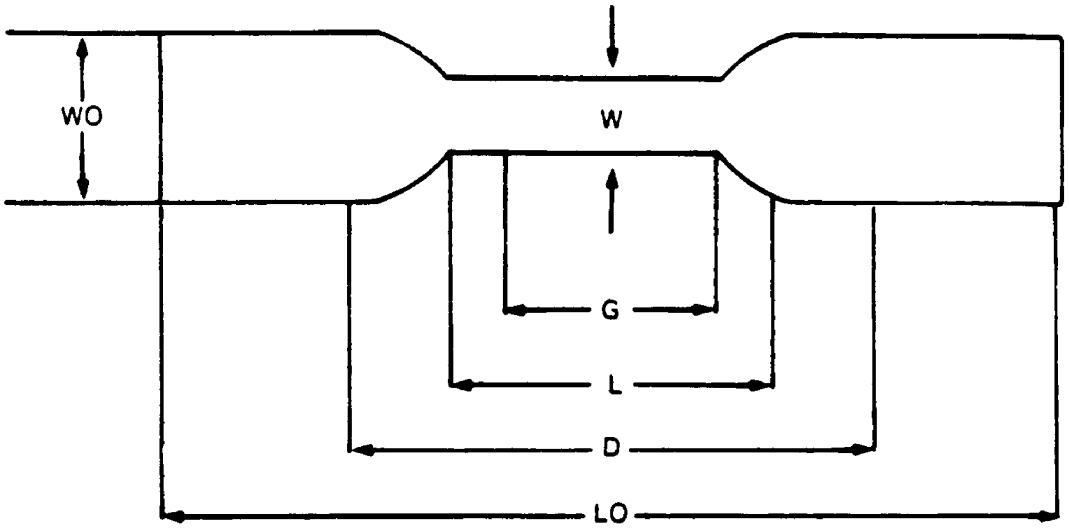
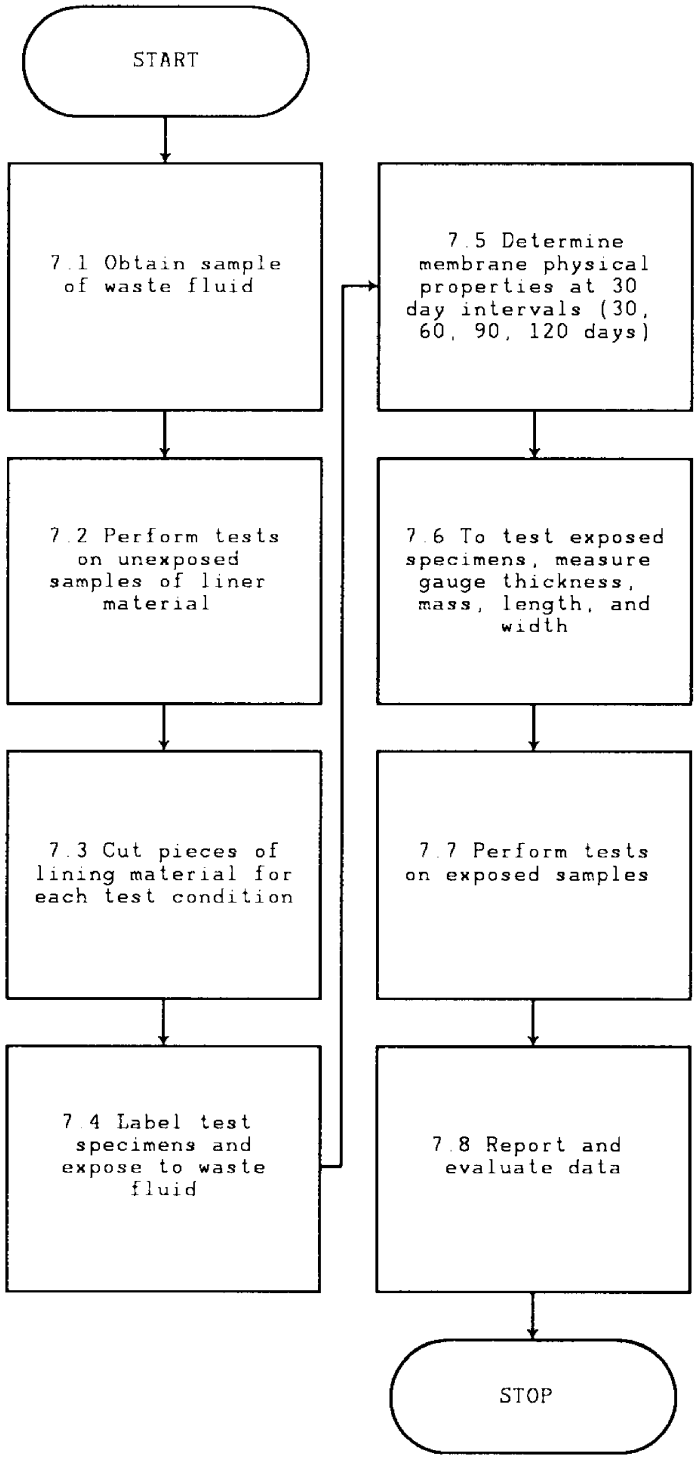


FIGURE 4. DIE FOR TENSILE DUMBBELL (NONREINFORCED LINERS)
HAVING THE FOLLOWING DIMENSIONS:



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 gaps	2.00 inches


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
7.5 Determine membrane physical properties at 30 day intervals (30, 60, 90, 120 days)
7.6 To test exposed specimens, measure gauge thickness, mass, length, and width
7.7 Perform tests on exposed samples
7.8 Report and evaluate data
STOP