METHOD 9090

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 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 exposed to the expected chemical environment for minimum periods of 120 days at room temperature and an elevated temperature. Whenever possible the use of longer exposure times is recommended. A comparison of the membrane's physical properties before and after these contact periods is used to estimate the properties of the liner when exposed to the waste over time.

3.0 Interferences (Not applicable)

4.0 Apparatus and Materials

4.1 Exposure tanks of a size sufficient to contain the samples with provisions for supporting the samples so that they do not touch bottom or sides of the tank, or each other, and for stirring the liquid in the tank. The tanks should be compatible with the waste fluid; you will need at least five gallons of

waste for each liner test and you may use stainless steel 316 tanks or polyethylene tanks. The tank shall be equipped with a means of maintaining the solution at temperatures of room temperature (23 ± 1°C) and 50 ± 2°C and for preventing evaporation of the solution (e.g., cover equipped with a reflux condenser or seal the tank with a teflon gasket and place a pressurized cover) with both sides of the liner material exposed to the chemical environment. If the liner has a side which is not exposed to the waste in actual use and which is not designed to withstand exposure to the chemical environment, then such a liner may be treated with only the barrier surface exposed.

1. Sample - the portion or unit(s) selected to represent lot.
2. Specimen - a piece of material appropriately shaped and prepared so that it is ready to use for a test.

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.

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, the following guidance document should be referred to:

> Permit Applicants' Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities; Final Draft; 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.

7.2 Perform the following tests on unexposed samples of the polymeric membrane liner material. 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.

1. Tear resistance, machine and transverse directions, five specimens each direction for nonreinforced liner materials only.
2. Puncture resistance, five specimens, FTMS 101C, Method 2065.
3. Tensile properties, machine and transverse directions, five tensile specimens in each direction. See Figure 4 for

tensile dumbbell cutting pattern dimensions for nonreinforced liner samples.

4. Hardness, Duro A (Duro D if Duro A reading is greater than 80), ASTM D2240.
5. Elongation at break. This test is only to be performed on membrane material which does not have a fabric or other nonelastomeric support on its reverse (away from waste) face.
6. Modulus of elasticity, machine and transverse directions, five 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, ASTM D792.
10. Ply adhesion, machine and transverse directions, five specimens each direction for fabric reinforced liner materials only, ASTM D413.
11. Hydrostatic resistance test, ASTM D751 Method A.
12. Environmental stress cracking, ASTM D1693, for semicrystalline materials only. The standard test fluids are replaced by waste liquids.

7.3 Cut five pieces of the lining material for each test condition of a size to fit sample holder or at least 8in. by 10in. 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 floodcoated along the exposed edges with a solution recommended by the liner manufacturer. This 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, mil or mm - average of the four corners.
2. Mass, g - to one-hundreth of a gram.
3. Length, cm - average of the lengths of the two sides and through the center liner.
4. Width, cm - average of the widths of the two ends and through the center liner.

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

7.4 Label the liner samples and hang in the waste fluid. 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 (23 $\pm$ 1°C) and 50$\pm$2°C. The waste fluids may require to be renewed or replenished to make the results of this method more indicative of actual performance or to maintain concentration of constituents.

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 7.6 and 7.7). Place wet sample in a labeled container of fresh waste fluid at room temperature

(23 ± 1°C) for 1 hour to effect cooling period before testing. Wipe off as much waste as possible and rinse well with water. Place wet sample in a labeled polyethylene bag to prevent the sample from drying out. The sample should be tested within 24 hours of removal from the immersion.

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 7.3.

1. Gauge thickness, mil or mm.
2. Mass, g.
3. Length, cm.
4. Width, cm.

7.7 Perform the following tests on the exposed samples. Die out test specimens following suggested cutting patterns. 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 semicrystalline liners.

1. Tear resistance, machine and transverse directions, two or three specimens each direction for materials without fabric reinforcement.
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.
4. Hardness, Duro A (Duro D if Duro A reading is greater than 80), ASTM D2240.
5. Modulus of elasticity, machine and transverse directions, two specimens each direction for semicrystalline liner materials only, ASTM D882 modified Method A (see Table 1).
6. Volatiles content, SW 870 Appendix III-D.
7. Extractables content, SW 870 Appendix III-E.
8. Ply adhession, machine and transverse directions, two specimens each direction for fabric reinforced liner materials only, ASTM D413.
9. Hydrostatic resistance test, ASTM D751 Method A.

7.8 Results and reporting

7.8.1 Plot the curve for each property over the time period 0 to 120 days.

7.8.2 Report all raw, tabulated, and plotted data. Recommended methods for collecting and presenting information is described in the documents listed under 6.1, and 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.

4. Percent retention of physical properties.
5. Change, in points, of hardness reading.
6. Percent volatiles of unexposed and exposed liner material.
7. Percent extractables of unexposed and exposed liner material.

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.

TABLE 1. PHYSICAL TESTING OF EXPOSED MEMBRANES IN LINER-WASTE LIQUID COMPATIBILITY TEST

Type of compound and construction	Crosslinked or vulcanized	Thermoplastic	Semi-crystalline	Fabric-reinforced[a]
Tensile properties				
Method	ASTM D412	ASTM D638	ASTM D638	ASTM D751, Mtd 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 stress at yield, psi Elongation at yield, % Tensile strength at break, psi Elongation at break, % 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, % Tensile set after break, % Stress at 100 and 200% elongation, ppi
Modulus of elasticity				
Method	[c]	[c]	ASTM D882, Mtd 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 D1004	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 3.
[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]

Family of polymers produced by 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]

Family of polymers that are produced by polyethylene reacting with chlorine and sulfur dioxide and usually containing 25 to 43% chlorine and 1.0 to 1.4% sulfur.

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.

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

A blend of polyvinyl chloride and chlorosulfonated polyethylene.

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

An alloy of thermoplastic unvulcanized nitrile rubber and polyvinyl chloride.

TABLE 2. (Continued)

Vulcanized Materials (XL)

Butyl rubber[a]

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

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 (Crosslinked chlorinated polyethylene)[a]

See chlorinated polyethylene.

CO, ECO (Epichlorohydrin polymers)[a]

Synthetic rubber including two epichlorohydrin-based elastomers which 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.

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

Partially Crystalline Materials (CX)

HDPE (High density polyethylene)

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

TABLE 2. (Continued)

HDPE - A (High density polyethylene/rubber alloy)

A blend of high-density polyethylene and rubber.

LLDPE (Linear low-density polyethylene)

A low-density polyethylene produced in a low pressure, solvent free process and having linearity and attributes of HDPE.

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.

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

A blend of polyethylene and poly(ethylene/propylene).

T-EPDM (Thermoplastic EPDM)

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

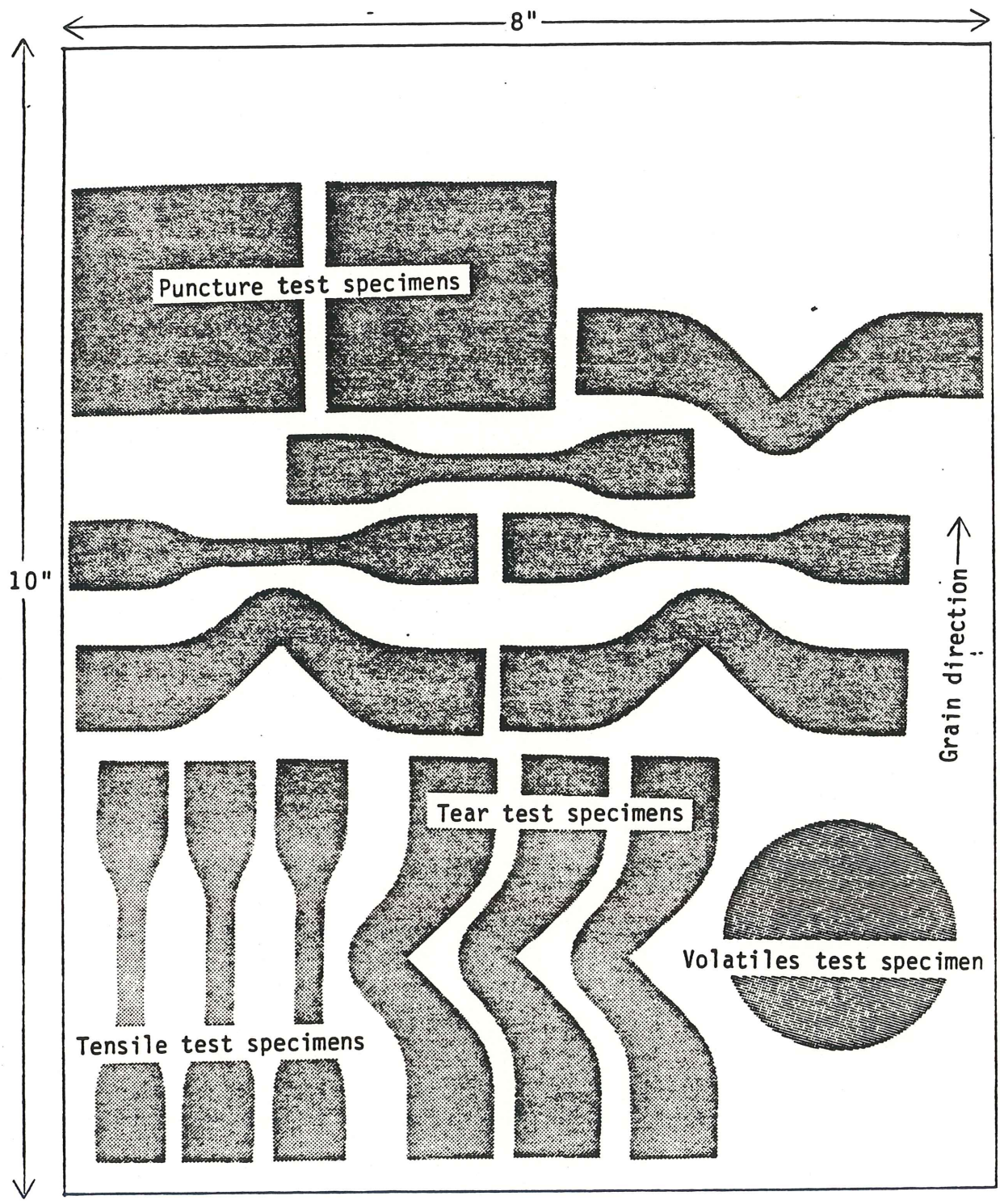


Figure 1 . Suggested pattern for cutting test specimens from nonreinforced crosslinked or thermoplastic immersed liner samples.

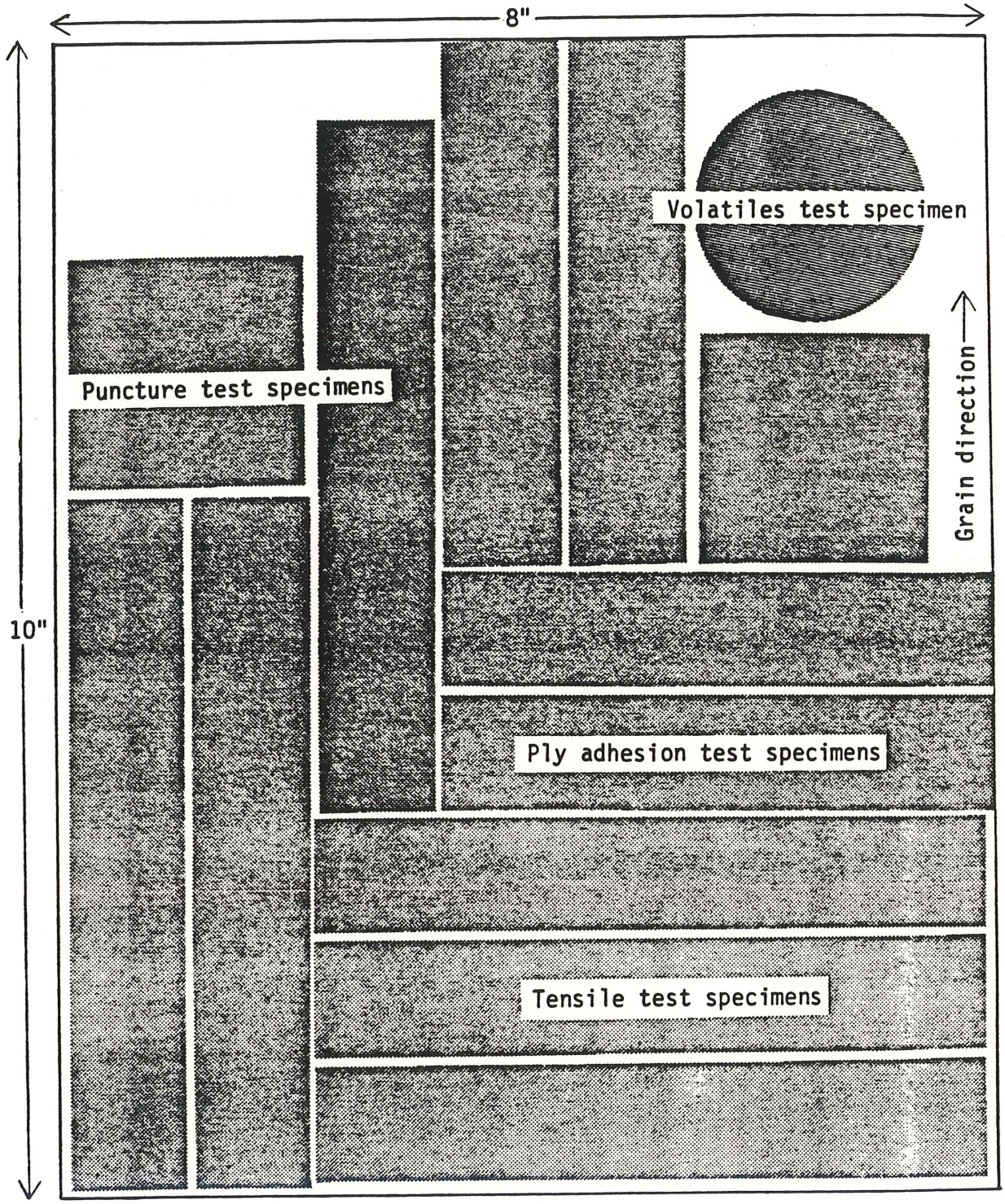


Figure 2 . Suggested pattern for cutting test specimens from fabric reinforced immersed liner samples. Note: To avoid edge effects, cut specimens 1/8 - 1/4 inch in from edge of immersed sample.

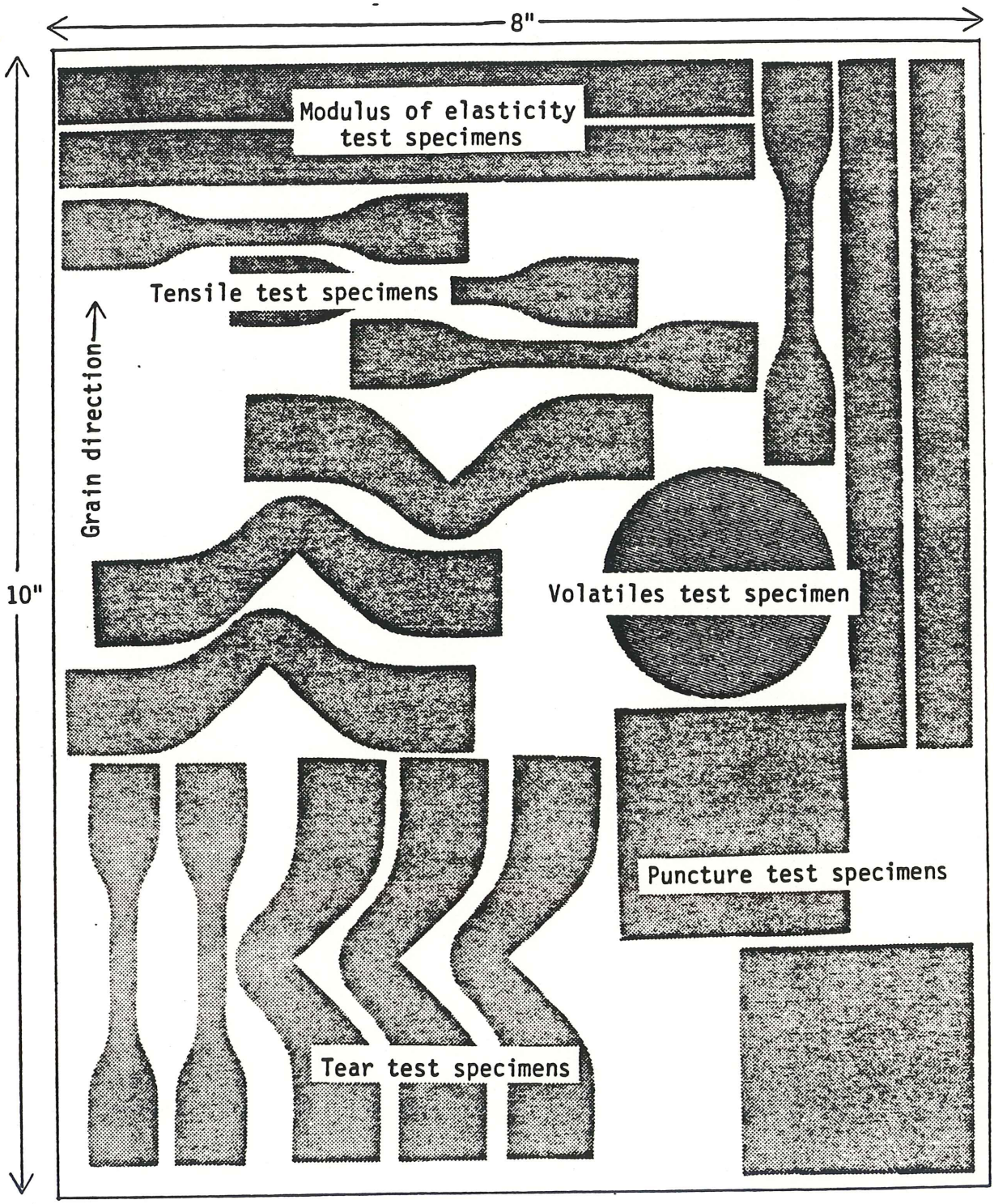
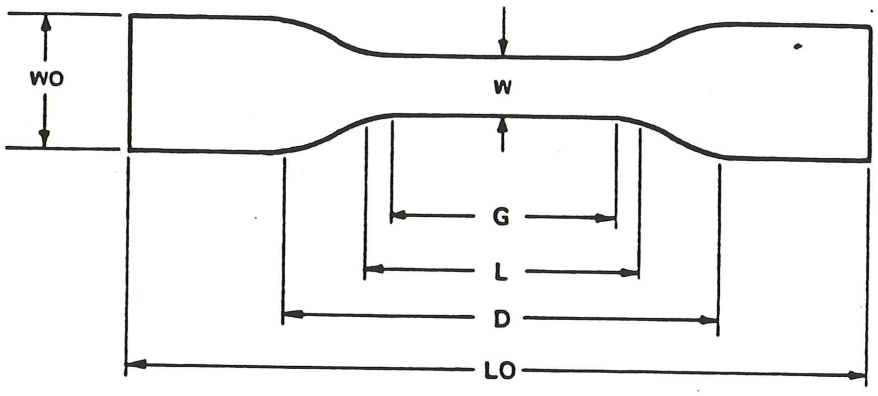


Figure 3 . Suggested pattern for cutting test specimens from semicrystalline immersed liner samples. Note: To avoid edge effects, cut specimens 1/8 - 1/4 inch in from edge of immersed sample.



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.