NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING

Flexible Membrane Lining

(No.)

CODE 521-A

DEFINITION

Installing fixed lining of impervious material or treating the soil in a pond mechanically or chemically to impede or prevent excessive water loss.

SCOPE

This standard applies to the sealing of ponds with flexible membrane linings made of plastic, rubber, or similar materials.

PURPOSE

To reduce seepage losses in ponds to an acceptable level.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where water loss from a pond through leakage is or will be of such proportion as to prevent the pond from fulfilling its planned purposes, or where leakage will damage land or crops and cause waste of water or environmental problems.

DESIGN CRITERIA

Ponds to be lined shall be constructed to meet NRCS standards for Ponds (378), Waste Treatment Lagoons (359), Waste Storage Ponds (425), or Wildlife Watering Facilities (648), as appropriate.

Flexible membrane linings shall be suitably constructed of high-quality materials and shall be certified by the manufacturer to be suitable for this use. Pigmented polyvinyl or polyethylene plastics, rubber, and similar materials that are highly resistant to bacteriological deterioration shall be acceptable base materials.

All plastic membranes shall have a cover of earth or earth and gravel not less than 5 in. (127mm) thick. Rubber membranes need not be covered unless livestock will travel the areas. In these areas, a minimum cover of 9-in. (228 mm) shall be used on all types of flexible membranes. The soil material in the bottom 3-in. (76 mm) of the cover shall not be coarser than silty sand.

The quality of all membranes shall meet or exceed the attached specifications for materials for polyethylene and rubber (Tables 1 through 8). Polyvinyl chloride membranes shall meet the requirements of ASTM Specification D-3083 and Table 4. Minimum nominal thickness shall be:

Soil material not coarser than-	Plastic Sheeting	Reinforced	Unreinforced
	----------mil----------		
Sands (SM, SP, SW)	8	20	30
Gravel (GC, GM, GP, GW)	12	30	30

PLANS AND SPECIFICATIONS

Plans and specifications for sealing ponds with flexible membrane linings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

NATURAL RESOURCES CONSERVATION SERVICE
ENGINEERING STANDARD

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Installation

Subgrade Preparation

The area to be lined shall be drained and allowed to dry until the surface is firm and can support personnel and equipment that must travel over it during installation of the lining.

All banks and fills within the area to be lined must be sloped no steeper than 1 horizontal to 1 vertical for exposed lining and 2-1/2 to 1 for buried linings.

The foundation area for flexible membrane linings shall be smooth and free of projections that might damage the lining. Stumps and roots shall be removed. Rocks, hard clods, and other such material shall be removed or shall be rolled so as to provide a smooth surface or shall be covered with a cushion of fine soil material.

Where needed, an effective sterilant shall be applied to the subgrade at the rate recommended by the manufacturer.

An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be 8 to 10 inches (203 to 254 mm) deep and about 12 inches (304 mm) wide.

All lining material shall be free of damage or defect. Each package delivered to the job site shall be marked with the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material. All applicable ASTM Standards will be clearly marked on material or package.

Placement

Membranes shall be loosely spread over the subgrade. Polyethylene film requires about 5 percent slack for satisfactory results.

All field splices shall be made in accordance with the manufacturer's recommended technique, using materials furnished for the purpose. The joints shall be watertight and maintain their integrity throughout the expected life of the lining.

Approximately 8 in (203 mm) of the top of the lining shall be placed in the anchor trench and anchored with compacted backfill.

For covered membranes, the materials to be used as a protective cover shall be free of clods, sharp rocks, sticks, and other objects that may puncture the lining. The cover shall be placed to the specified depth without damage to the membrane.

Materials

All materials are to meet the requirements indicated in Tables 1, 2, 3, 4, 5, 6, 7, and 8 as appropriate.

Table 1—Requirements for Polyethylene and Ethylene Co-Polymer Plastic Film

Test Description	Requirements: Type I Polyethylene	Requirements: Type II co-polymer	Test Method
Tensile strength, each direction, minimum average, lb/in.^{2}	1,800	2,000	ASTM-D-882, Method "A"
Ultimate elongation, each minimum average, pct	500	500	ASTM-D-882, Method "A"
Impact resistance, minimum average, g/mil	45	65	ASTM-D-1709, Method "B"
Water Vapor permeability, perm-mil	0.7	1.5	ASTM-E-96
Tear resistance, each direction, minimum, g/mil	80	80	ASTM-D-1922
Soil burial			
Tensile strength change, each direction, Maximum, pct	5	5	ASTM-D-3083
Elongation loss, each direction, maximum, pct	20	20	
Luminous transmittance, maximum, pct	1.0	1.0	National Bureau of Standards Publication PS-17

Table 2—Requirements for Reinforced Rubber Sheeting

Test Description	Requirements: Up to 20 mil Thick	Requirements: 20 mil thick and Greater	Test Method
Breaking strength, minimum			ASTM-D-751
Warp direction, lb/in	75	100	
Fill direction, lb/in	75	100	
Ultimate elongation, maximum			ASTM-D-751
Warp direction, pct	30	30	
Ozone resistance, procedure "B"			ASTM-D-1149 and
50 pphm, 100°F, days	7	7	ASTM-D-518
Hydrostatic strength retained after Ozone exposure, 7 days (Mullen), pct	100	100	Federal Specification CCC 191 b Method 5512 ASTM-D-518
Heat aging, 7 days at 212°F			ASTM-D-573
Tensile strength retained, pct	90	90	
Elongation retained, pct	90	90	
Tear resistance, minimum, warp or fill			ASTM-D-751 (tongue)
Direction, lb	8	8	
Hydrostatic burst (Mullen), minimum, lb/in^2	100	175	ASTM-D-751
Dimensional stability, 7 days at 212°F			(1)
Change in length or width, pct	±1.0	±1.0	
Low-temperature flexibility (optional)			Federal Specification
No cracking or flaking	-40°F	-40°F	CCC 191 b, Method 5874
Commercial field splice strength			Commercial field splice
Shear force, minimum tensile, pct	75	75	1-in.-wide strip, pulled in shear at 10 in/min after 7 days cure at room temperature

1A 1-ft2 sample, 10-in. benchmarks in warp and fill direction, placed on aluminum or stainless plate in changing air over.

Table 3--Requirements for Unreinforced Rubber Sheeting

Test Description		Requirements: Up to 20 mil Thick	Requirements: 20 mil thick and Greater	Test Method
Tensile strength, minimum	lb/in2	1,200	1,200	ASTM-D-412
Modulus at 300% elongation, minimum	lb/in	600	600	ASTM-D-412
Ultimate elongation, minimum	pct	300	300	ASTM-D-412
Shore "A" hardness		60±10	60±10	ASTM-D-2240
Ozone resistance, procedure ""A"				ASTM-D-1149
No cracks, 50 pphm, 100°F, 20% elongation	days	7	7	ASTM-D-518
Heat aging, 7 days at 212oF				ASTM-D-573
Tensile strength retained	pct	75	75	
Elongation retained	pct	75	75	
Water vapor permeability at 80oF, maximum	perm mil	0.002	0.05	ASTM-E-96 (procedure BW)
Tear resistance, minimum	lb.in2	150	150	ASTM-D-624 Die "B"
Dimensional stability, 6 days at 212oF				
Change in length or width	pct	±0.5	±0.5	
Commercial field splice strength 60 shear Force,				Commercial field splice,
Minimum tensile	pct	60	60	1-in-wide strip pulled in Shear at 10 in/min, after 7-day cure at room temperature

NOTE: Type "A" sheeting is recommended for general-purpose outdoor use. Type "B" material is recommended for use if an extreme outdoor environment requires a highly weatherable lining.

Table 4—Requirements of Polyvinyl Chloride Plastic Sheeting

Test Description		Requirements	Test Method
Tensile strength, each direction, minimum			
Average	lb/in^2	2,000	ASTM-D-882
Elongation at break, minimum	pct	250	ASTM-D-882, Method A
Volatile loss, maximum	pct	0.7	ASTM-D-1203, Method A
Tear resistance, each direction, minimum	g/mil	160	ASTM-D-1922
Resistance to soil burial			ASTM-D-3083
(percent change maximum in original value)			(120-day soil burial)
Breaking factor	pct	-5	
Elongation at break	pct	150	
Modulus at 100% elongation	**pct**	**±10**	
Bonded seam strength, percent breaking			**ASTM-D-3083**
Factor	**pct**	**80**	**Para. 9.3 (1-in. width)**

Table 5—Unreinforced Chlorsulfonated Polyethylene

Test Description	Minimum Requirements	Test Method
Tensile strength, minimum pounds per square inch....pct	1,000	ASTM-D-412
Ultimate elongation, minimum....pct	250	ASTM-D-412
Ozone resistance, 50 pphm, 20% strain, 100oF, 8,000 hr....pct	±0	ASTM-D-1149
Heat aging, 14 days at 212oF....		ASTM-D-412
Tensile strength, minimum pounds per square inch....pct	1,000	
Elongation at break....pct	150	
Tear resistance, minimum ....lb/in	**250**	**ASTM-D-624 Die B**
Commercial field splice....		**ASTM-D-882, Method A**
Strength, shear force, minimum tensile ....pct	**60**	**7 days cure**
Weight change after 7 days at 70°C in water, Maximum ....pct	**5**	**ASTM-D-471**

Table 6.—Reinforced Chlorsulfonated Polyethylene

Test Description	Minimum Requirements **30 mils thick and greater**	Test Method
Breaking strength, minimum....		ASTM-D-751
Rubber ....lb/in	100	
Fabric ....lb/in	75	
Ultimate elongation, maximum....		ASTM-D-751
Rubber ....pct	150	
Fabric ....pct	20	
Ozone resistance, 50 pphm, 20% strain at 100oF, 8,000 hr....pct	±0	ASTM-D-1149
Hydrostatic strength after ozone exposure, ...		Fed. Spec. CCC 191b
7 days (Mullen), percent retained ....pct	100	Method 5512, ASTM-D-518
Heat aging, 14 days at 212oF of original		
Tensile strength....pct	90	
Elongation percent retained of original....pct	90	
Tear resistance, pounds minimum		ASTM-D-751
Warp or fill direction ....pct	10	(Tongue)
Puncture resistance, pounds minimum ....pct	120	FTMS 101B, Method 2031
Commercial field splice		
Strength—shear force, percent of minimum Break....pct	75	ASTM-D-882, 7 days cure

Table 7.—Requirements for high-density polyethylene (HDPE)

Test Description	Requirements		Test method
	80 mils	100 mils	
Minimum tensile properties (each direction)			**ASTM-D-638**
1. Tensile strength yield (pounds/inch width)	**120**	**150**	
2. Tensile strength at break (pounds/inch width)	**120**	**150**	
3. Elongation at yield (percent)	**10**	**10**	
4. Elongation at break (percent)	**500**	**500**	
5. Modulus of elasticity (pounds/sq. in.)	**80,000**	**80,000**	
Tear resistance (pounds, minimum)	**40**	**50**	**ASTM-D-1004**
Low temperature	**-40oF**	**-40oF**	**ASTM-D-746**
Dimensional stability (each Direction, percent change, maximum)	**±3**	**±3**	**ASTM-D-1204 212oF, 15 min**
Resistance to soil burial1 (percent change maximum in original value)			**ASTM-D-3083 (120-day soil burial)**
1. Tensile strength yield	**±10**	**±10**	
2. Tensile strength at break	**±10**	**±10**	
3. Elongation at yield	**±10**	**±10**	
4. Elongation of break ±10	**±10**	**±10**	
5. Modulus of elasticity	**±10**	**±10**	
Bonded seam strength2 (factory seam, breaking factor, pounds/inch width)	**108**	**135**	**ASTM-D-3083**
Environmental stress crack (minimum, hours)	**500**	**500**	**ASTM-D-1693**

[1]Test value of "after exposure" sample is based on precut sample dimension; 120-day test is required for initial certification.
[2]Factory bonded seam strength is the responsibility of the fabricator.

Table 8.—Requirements for Supported Extended Polyurethane

Property	Test Method	Supported finished material[2] Type 1	Type 2	Type 3	Type 4
Thickness	ASTM-D-751				
1. Overall (mils, minimum)		25	45	30	70
Minimum Tensile Properties	ASTM-D-751				
1. Breaking Strength—fabric TD		50	70	110	100
(pounds, minimum) MD		70	120	120	140
Breaking Strength—composites MD	90	160	130	220	
	TD	75	160	130	160
Tear Strength (pounds,	ASTM-D-751				
Minimum) composite	Tongue Method				
	8x8-in sample				
1. Initial		2.5	4.5	35	4.5
2. After Heat Aging	212°F, 30 days	2.5	4.5	35	4.5
Low Temperature Composite	ASTM-D-1204	-40°F	-40°F	-40°F	-40°F
	1/8 in mandrel				
	4 hr, Pass				
Unsupported sheet, 100 mils			Below –60°F		
Dimensional Stability	ASTM-D-1204				
(each direction percentage change maximum)	212°F, 1 hr.	-0.8	-0.5	-1.3	-0.7
Resistance to Soil Burial[1]	ASTM-D-3083				
(percent change maximum in original values)	365-day soil burial				
	30-mil sheet				
	(as modified in Appendix A)				
a. Unsupported sheet	ASTM-D-882				
1. Breaking Factor			+15		
2. Elongation at Break			-15		
3. Initial Modulus			+30		
b. Membrane Fabric Breaking Factor	ASTM-D-751	TBD	TBD	TBD	TBD
Bonded Seam Strength	ASTM-D-751				
(pounds, minimum)	(As modified in		greater than single layer		
	Appendix A, 12 in/min)				
Hydrostatic Resistance	ASTM-D-751				
(pounds per square inch, minimum)	Method A, Procedure I	80	210	250	280
Ozone Resistance	ASTM-D-1149		NA		
	(As modified in 7 days,				
	100pphm 104°F,				
	1/8 in bent loop)				
Ply Adhesion (each Direction	ASTM-D-413		NA		
Pounds/in. width minimum)	Machine Method Type A				
Volatile Loss, percent	ASTM-D-1203		0.4		
(Unsupported)	Method A 30-mil sheet				
(Puncture Resistance, pounds)	FTMS 101B	25	50	45	70
	(Method 2065)				

[1]Test value of "after exposure" sample is based on precut sample dimension; 120-day test is required for initial certification.

[2]Supporting Fabrics:

Type 1: Nylon 6.6 2.0 oz/yd^2

Type 2: Polypropylene 3.1 oz/yd^2

Type 3: Composite of 2 layers 0.5-oz/yd^2 nylon 6.6 plus 5x5 1000d polyester scrim (4.1-oz/yd^2 total)

Type 4: Polypropylene 4.4 oz/yd^2