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## TEAR, TENSILE, AND PUNCTURE TESTING OF POLYESTER SAFETY FILM: DR25 SR PS5 – US UNITS

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## INTRODUCTION

This report presents the results of tear, tensile, and puncture testing conducted on one sample of Polyester Safety Film material. The testing was authorized by Lisa Joyce of Eastman Performance Films, LLC on July 23, 2019. Testing and data analysis were completed August 16, 2019. The scope of work was limited to conducting tear, tensile, and puncture tests on the submitted sample and reporting the results.

## CONCLUSIONS

### Tear Testing Conclusions

Sample	Average Tear Resistance Force [lbf]	Average Resistance to Tearing [lbf/in]
Machine Direction	15.6	2733
Transverse Direction	15.3	2690

\*See note in Test Results regarding ASTM D1004-13

### Tensile Testing Conclusions

Sample	Average Break Strength Force [lbf]	Average Tensile Strength at Break [psi]	Average Ultimate Elongation [%]	Average Yield Strength Force [lbf]	Average Yield Strength [psi]	Average Elongation at Yield [%]
Machine Direction	109	18440	140	93	15795	11
Transverse Direction	135	23439	135	87	15108	7

### Puncture Testing Conclusions

Average Puncture Strength [lbf]
96.2

### SAMPLE IDENTIFICATION

One sample, consisting of one roll of polyester safety film, was received in the lab for testing on August 7, 2019. The sample is identified as DR25 SR PS5 by the client. Specimens were sectioned using dies (tear), film cutters (tensile), and scissors (puncture). Material thickness was measured with adhesive removed as 0.0057 in.

### TEST METHOD

The specimens were allowed to condition at standard laboratory conditions of  $72 \pm 4^{\circ}\text{F}$  and  $50 \pm 5\%$  relative humidity for at least 40 hours prior to testing. The thickness of each material was determined for resistance and strength calculations. For this, representative samples were taken from each material thickness, the adhesive was removed with an organic solvent, the samples were cleaned with isopropyl alcohol and an average thickness was determined. All testing was conducted with the adhesive layer intact on the specimens. Testing was performed according to the standards detailed below, with notes of parameters and/or deviations.

Test Method	Test Method Title	Parameters and/or Deviations from Method
ASTM D1004-13	Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting	Die Cut Specimens Test Speed: 2 in/min.
ASTM D882-12	Standard Test Method for Tensile Properties of Thin Plastic Sheeting	2" Grip Separation 1" x 10" Specimens, nominal Test Speed: 20 in/min Initial Strain Rate: 10.0 in/in·min
ASTM D4830/D4830M-98(2014) <sup>e1</sup>	Standard Test Method for Characterizing Thermoplastic Fabrics Used in Roofing and Waterproofing – Section 7	3" x 3" Specimens Test Speed: 12 in/min

### CALIBRATED TEST EQUIPMENT

Honeywell Temp/RH Chart Recorder, S/N 7852 243000007, ID MM190-024, cal. 02/Jul/19, due 02/Jul/20  
 MTS Universal Test Machine, Mdl Qtest / 50LP, System #1532, ID MM210-009.3 & 6, cal. 08/Mar/19, due 08/Mar/20  
 MTS Load Cell, 2250lbf Capacity, S/N 558821, ID PT-163-071, cal. 11/Jan/19, due 11/Jan/20  
 Interface Load Cell, 225 lbf Capacity, S/N 1030173, ID PT-163-067, cal. 15/Mar/19, due 15/Mar/20  
 Mitutoyo Digital 8" Calipers, S/N 0006565, ID MM160-068, cal. 12/Jul/19, due 12/Jul/20  
 Mitutoyo Digimatic 6" Calipers, S/N 0080204, ID MM160-106, cal. 12/Jul/19, due 12/Jul/20  
 Mitutoyo Micrometer, S/N 47007254, ID PT-163-048, cal. 10/Apr/19, due 10/Apr/20  
 18" Steel Ruler, ID PT-163-043, cal. 20/Dec/18, due 20/Dec/19

**TEST RESULTS**

## Tear Results

Sample	Specimen	Thickness [in]	Tear Resistance Force [lbf]	Resistance to Tearing [lbf/in]	
Machine Direction	1	0.0057	15.5	2719	
	2	0.0057	15.6	2730	
	3	0.0057	16.4	2877	
	4	0.0057	14.5	2537	
	5	0.0057	15.2	2662	
	6	0.0057	14.2	2498	
	7	0.0057	14.7	2587	
	8	0.0057	17.6	3090	
	9	0.0057	16.5	2888	
	10	0.0057	15.7	2746	
	<b>Average</b>			<b>15.6</b>	<b>2733</b>
	Standard Deviation			1.0	180
Transverse Direction	1	0.0057	15.2	2670	
	2	0.0057	15.9	2781	
	3	0.0057	14.8	2603	
	4	0.0057	16.8	2945	
	5	0.0057	13.2	2313	
	6	0.0057	15.9	2793	
	7	0.0057	15.8	2768	
	8	0.0057	16.2	2841	
	9	0.0057	14.8	2597	
	10	0.0057	14.8	2591	
	<b>Average</b>			<b>15.3</b>	<b>2690</b>
	Standard Deviation			1.0	177

\*ASTM D1004-13 subsection 1.1.1 states, "Although resistance to tear can be expressed in newtons per microns, (pounds-force per mil) of specimen thickness, this is only advisable where correlation for the particular material being tested has been established. In most cases, comparison between films of dissimilar thickness is not valid."

Nominal thickness of sample material was used for Resistance to Tearing calculations.

## TEST RESULTS CONTINUED

### Tensile Results

Sample	Specimen	Width [in]	Thickness [in]	Break Strength Force [lbf]	Tensile Strength at Break [psi]	Ultimate Elongation [%]
Machine Direction	1	1.036	0.0057	99	16752	140
	2	0.998	0.0057	102	17931	121
	3	1.041	0.0057	115	19303	157
	4	1.039	0.0057	108	18235	127
	6	1.058	0.0057	120	19977	155
	<b>Average</b>			<b>109</b>	<b>18440</b>	<b>140</b>
	Standard Deviation			9	1251	16
Transverse Direction	2	1.012	0.0057	143	24780	165
	4	0.995	0.0057	128	22520	128
	5	1.000	0.0057	135	23601	128
	6	1.046	0.0057	136	22773	138
	7	0.995	0.0057	133	23519	117
	<b>Average</b>			<b>135</b>	<b>23439</b>	<b>135</b>
	Standard Deviation			5	883	18

Sample	Specimen	Width [in]	Thickness [in]	Yield Strength Force [lbf]	Tensile Strength at Yield [psi]	Elongation at Yield [%]
Machine Direction	1	1.036	0.0057	92	15620	10
	2	0.998	0.0057	91	15950	10
	3	1.041	0.0057	94	15909	12
	4	1.039	0.0057	92	15448	10
	6	1.058	0.0057	97	16049	12
	<b>Average</b>			<b>93</b>	<b>15795</b>	<b>11</b>
	Standard Deviation			2	251	1
Transverse Direction	2	1.012	0.0057	87	15026	8
	4	0.995	0.0057	86	15219	8
	5	1.000	0.0057	85	14971	6
	6	1.046	0.0057	90	15153	8
	7	0.995	0.0057	86	15172	7
	<b>Average</b>			<b>87</b>	<b>15108</b>	<b>7</b>
	Standard Deviation			2	105	1

All strength calculations were determined using the measured specimen width and nominal thickness without the adhesive, shown above.

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**TEST RESULTS CONTINUED**

## Puncture Results

Specimen	Puncture Strength [lbf]
1	96.3
2	95.9
3	96.4
4	95.7
5	96.5
<b>Average</b>	<b>96.2</b>
Standard Deviation	0.3