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## TEAR, TENSILE, AND PUNCTURE TESTING OF POLYESTER SAFETY FILM: R20 SR PS9 – US UNITS

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Date: August 28, 2019  
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 Report Number: ESP031580P.6R0  
 Client Purchase Order Number: 45508066

### REVISION NOTES

Revision	Page #, Section, Description	Date
0	Original Release	08/28/19

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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	29.6	2964
Transverse Direction	28.8	2878

\*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	166	16070	171	158	15288	10
Transverse Direction	207	20570	137	147	14592	7

### Puncture Testing Conclusions

Average Puncture Strength [lbf]
143.4

## 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 R20 SR PS9 by the client. Specimens were sectioned using dies (tear), film cutters (tensile), and scissors (puncture). Material thickness was measured with adhesive removed as 0.0100 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	0.0100	28.2	2818	
	2	0.0100	28.7	2873	
	3	0.0100	30.6	3056	
	4	0.0100	28.3	2833	
	5	0.0100	31.3	3126	
	6	0.0100	30.9	3087	
	7	0.0100	27.9	2790	
	8	0.0100	29.0	2895	
	9	0.0100	30.4	3041	
	10	0.0100	31.2	3123	
	<b>Average</b>			<b>29.6</b>	<b>2964</b>
	Standard Deviation			1.3	135
Transverse Direction	1	0.0100	30.4	3043	
	2	0.0100	28.1	2813	
	3	0.0100	29.8	2975	
	4	0.0100	27.3	2732	
	5	0.0100	29.1	2907	
	6	0.0100	28.7	2867	
	7	0.0100	28.7	2867	
	8	0.0100	28.2	2816	
	9	0.0100	30.7	3072	
	10	0.0100	26.9	2692	
	<b>Average</b>			<b>28.8</b>	<b>2878</b>
	Standard Deviation			1.2	124

\*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	1.006	0.0100	160	15854	171	
	2	1.029	0.0100	170	16471	199	
	3	1.039	0.0100	166	15941	160	
	4	1.013	0.0100	164	16168	185	
	5	1.068	0.0100	170	15918	140	
	<b>Average</b>				<b>166</b>	<b>16070</b>	<b>171</b>
	Standard Deviation				4	253	23
Transverse Direction	1	1.020	0.0100	223	21808	145	
	2	0.995	0.0100	192	19337	140	
	3	1.012	0.0100	209	20632	95	
	4	1.012	0.0100	191	18825	145	
	5	1.004	0.0100	223	22250	160	
	<b>Average</b>				<b>207</b>	<b>20570</b>	<b>137</b>
	Standard Deviation				16	1494	25

Sample	Specimen	Width [in]	Thickness [in]	Yield Strength Force [lbf]	Tensile Strength at Yield [psi]	Elongation at Yield [%]	
Machine Direction	1	1.006	0.0100	154	15330	10	
	2	1.029	0.0100	156	15160	11	
	3	1.039	0.0100	159	15306	11	
	4	1.013	0.0100	155	15261	10	
	5	1.068	0.0100	164	15381	10	
	<b>Average</b>				<b>158</b>	<b>15288</b>	<b>10</b>
	Standard Deviation				4	83	1
Transverse Direction	1	1.020	0.0100	148	14549	7	
	2	0.995	0.0100	146	14715	7	
	3	1.012	0.0100	147	14534	7	
	4	1.012	0.0100	147	14560	7	
	5	1.004	0.0100	147	14603	7	
	<b>Average</b>				<b>147</b>	<b>14592</b>	<b>7</b>
	Standard Deviation				1	73	0

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	144.0
2	141.5
3	147.4
4	144.7
5	139.6
<b>Average</b>	<b>143.4</b>
Standard Deviation	3.0