3M *Micro-layers* vs. 8-mil PET

3M Scotchshield's patented micro-layered polyester film offers significantly more tear and penetration resistance strength than conventional PET films. They can even outperform films twice their thickness. The following chart compares 3M Scotchshield Ultra films to the 8-mil PET.

Physical Properties and Test Performance Comparison

	8-mil PET	Ultra 400 Series *	ULTRA600
Film Thickness	.008 inches nominal	.004 inches nominal	.006 inches nominal
Multiple Layers	2	26	39
Graves Area Tear [1]	> 490 Lbs. %	> 780 Lbs. %	> 1,150 Lbs. %
Young's Modulus [2]	> 600k PSI	< 500k PSI	< 500k PSI
Tensile Strength	25,000 PSI	30,000 PSI	30,000 PSI
Break Strength	200 Lbs. per inch width	120 Lbs. per inch width	180 Lbs. per inch width
Elongation (Stretch)	130%	140%	140%
PPT (Puncture Propagation Tear) [3]	6.1 Lbs.	8.7 Lbs.	19.2 Lbs.
Safety Impact Tests **CPSC 16CFR** **ANSI Z97.1**	Category II (400 ft. lbs.) Unlimited	Category II (400 ft. lbs.) Unlimited	Category II (400 ft. lbs.) Unlimited
Adhesive Strength – After Weathering [4]	> 2,500 grams per inch Unknown	> 2,500 grams per inch > 3,500 grams per inch	> 2,500 grams per inch > 3,500 grams per inch
Abrasion Resistance[5] **(100 cycles)**	< 5% Change in Haze	< 5% Change in Haze	< 5% Change in Haze
Surface Burn Characteristics[6]	Class A Interior Use	Class A Interior Use	Class A Interior Use
Building Code Compliance	Unknown	BOCA	Not Submitted due to Ultra 400 performance
Severe Windstorm Impact & Cycling Tests [7]	FM Approval 1 system, requires 4-side mech.	FM Approval Wet glaze (3M Ultraflex)	Not Submitted due to Ultra 400 performance
Large Scale Explosive Open-Air Blast Test per GSA Security Criteria[8]	***4.0 PSI AG*** **Day-lite Level 3** **4-sided Mech. Level 3** **Wet Glaze Level 3**	***4.0 PSI AG*** **Day-lite Level 3** **4-sided Mech. Level 3** **Wet Glaze Level 3** ***4.0 PSI TTG*** **Wet Glaze Level 2**	**Higher Blast Pressure** ***5.0 PSI TTG*** **4-sided Mech. Level 2** ***9.0 PSI TTG*** **4-sided Mech. Level 2**

[9]* The **Ultra 400 Series** includes the following films: SCLARL400, S20SIAR400, S35NEAR400, & S50NEAR400

The bottom line…

Fact 1. 3M's Ultra 400 series performs equal to and better than standard 8-mil PET film.
Fact 2. 3M ULTRA600 is recommended for applications requiring even more strength.

Terms and Definitions

Multiple Layers: Multiple layering in film has proven to offer more 'give' when stressed under impact.
Ultra film's micro-layer film technology delivers significant increased strength within each mil of thickness.

Graves Area Tear: The measurement of a material to resist both initial tear as well as continued tearing.
When punctured Ultra films will continue to have high strength.

Young's Modulus: A measurement of polymer flexibility.
The lower the value the more flexible (less boardy) the film and the easier to handle and install it.

Tensile Strength: The resistance of a material to a force tending to pull it apart. Calculated from Break Strength.
Relates to how strong the product is when subjected to impact. The higher the value the more resistant the material.

Break Strength: Relates to the force needed to pull a safety film product apart. Tensile comes from this number.
Ultra films, mil per mil, have a higher Break Strength than PET films.

Elongation: Ability of a material to stretch.
Greater elongation allows the film to hold the glass together by stretching and absorbing impact energy.

Puncture Propagation Tear: Resistance to Puncture and Tear.
Greater resistance to Puncture and Tear means higher resistance to forced entry, bomb blast, storm cycling.

Safety Glazing Impact Tests: Measures film's ability to hold glass together when broken due to impact.
Min. requirement to determine a films ability to perform as a safety-glazing product on annealed glass.

Adhesive Strength: Measures the bond of the film to glass. Expressed in grams or pounds per inch.
Also very critical is the ability of the adhesive to age without losing strength.

Abrasion Resistance: Measures the ability of the film's surface to resist scratching.
The lower the % change in haze, the more durable the film is to maintain appearance after many cleanings.

Surface Burn Characteristics: Fire tests that measure film for flame-spread and smoke-developed values.
Must meet certain low levels to be used inside a Class 'A' Commercial building.

Building Code Compliance: Meets building code compliance for use as a safety glazing system.
Ultra 400 maintains a BOCA National Building Code Certificate of Compliance for use as a safety glazing system.

Severe Windstorm Tests: Standards that test window systems' ability to withstand debris impact and high-winds.
Ultra 400 Series has earned Factory Mutual (FM) Approval for use as a Windstorm Resistant Glazing System.

Large Scale Explosive Blast Tests: Standards to evaluate the hazard mitigation performance of a glazing system.
The results demonstrated that glass treated with 3M Scotchshield Ultra 400 & ULTRA600 offered significant increased protection against the dangers of flying glass caused by explosive blast loads. Several systems met GSA Criteria for Class C and Class D Level Buildings.

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[1] ASTM D-1004-94a — Initial Tear Resistance of Plastic Film and Sheeting (Graves Area)
[2] ASTM D882-95a — Tensile Properties of Thin Plastic Sheeting (this method covers Young's modulus, tensile strength, break strength, and elongation). Young's Modulus measures resistance to stretch, or give of a material. **The lower the value the more flexible the material.** For example, a rubber band would have a YM < 100k, whereas for polystyrene > 1,000k.
[3] ASTM D-2582-93 — Puncture-Propagation Tear Resistance of Plastic Film and Sheeting
[4] CPSC 1201.4 — Accelerated Weathering for Plastics using 1200 hours Xenon Lamp Exposure
[5] ASTM D-1044 — Standard Method of Test for Resistance of Transparent Plastics to Surface Abrasion
[6] ASTM E-84 — Surface Burn Characteristics of Building Materials
[7] FM Approval 4350 — Test Method for Windstorm Glazing Protection System; small missile impact, structural loading & wind cycling.
[8] ASTM F-1642-96* — Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
* GSA Security Criteria is an adaptation of this ASTM method.