Kuraray Glass Laminating Solutions

Technical Bulletin
BALLISTICS-RESISTANT GLAZING COMPOSITIONS

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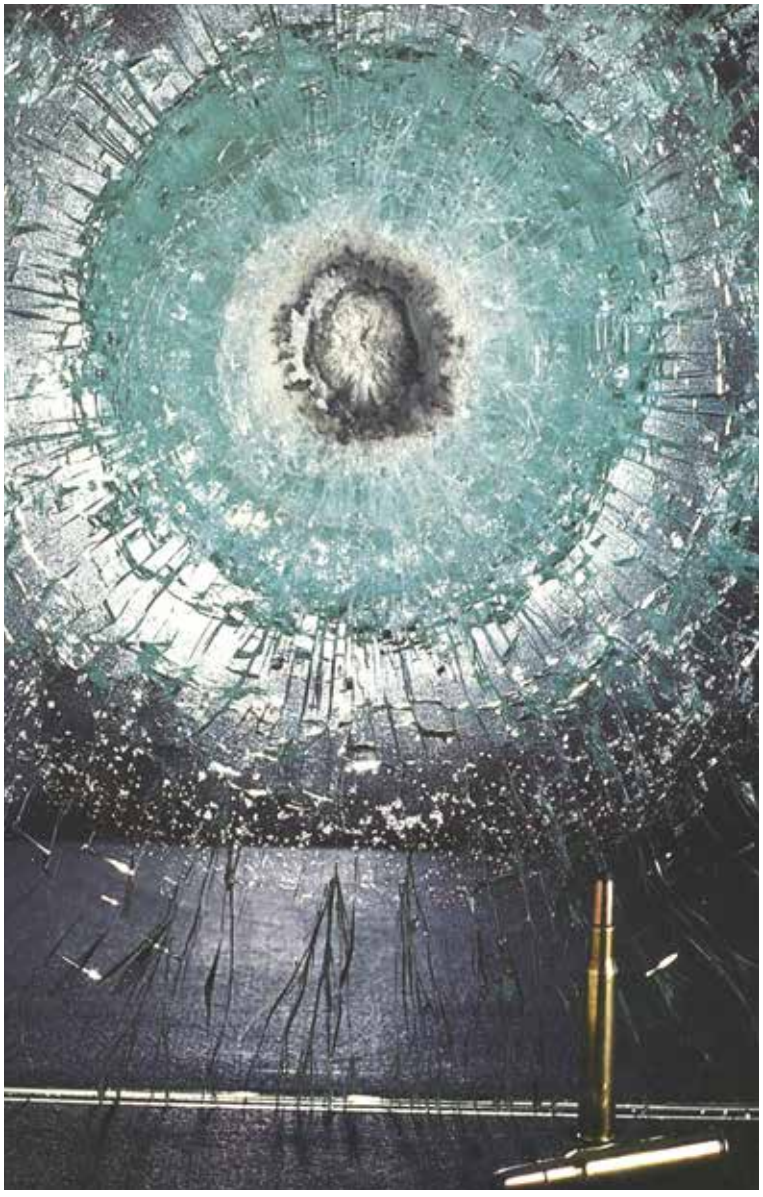

Combining Kuraray Products in Ballistics-Resistant Laminates

SentryGlas® ionoplast interlayers, Butacite® PVB interlayers and Spallshield® composites are used in a variety of architectural and automotive applications where resistance to bullet penetration and spall is desirable. When properly designed and manufactured, glass laminates made with these interlayer products can meet ballistics-resistance test standards in constructions that are lighter-weight, thinner and more durable than traditional all-glass and glass-clad polycarbonate alternatives.

Several test methods exist for assessing the ballistics resistance of glazing materials. This bulletin lists selected performance levels from three of the most frequently referenced test standards, where tests have been performed showing that Kuraray Glass Laminating Solutions products can be used in well-constructed laminates to help achieve the desired level of ballistics resistance.

For each tested construction, the glass laminate design is provided so that you can consider a suitable glass thickness and laminate configuration with which to conduct your own similar testing.

Test Standards Covered in this Bulletin

- Underwriter's Laboratories (UL) 752 Indoor Standard for Bullet Resisting Equipment
- National Institute of Justice-NIJ 0108.01 Ballistic Resistant Protective Materials
- EN 1063 Glass in Building: Security Glazing, Testing and Classification of Resistance Against Bullet Attack

Bullet resistant configurations that have been tested and found to comply with commonly specified Indoor UL Standard threat levels are shown below:

Indoor UL 752 Standard for Bullet Resisting Equipment

Threat Level	Ammunition	Nominal Bullet Mass, g (grains)	Required Velocity mps (fps)	Composition	Thickness mm (Inches)	Weight kg/m² (lbs/ft²)	Number of shots
1	9 mm Full Metal Copper Jacket with Lead Core	8.0 (124)	358 – 394 (1175 – 1293)	6 mm (¼") Annealed Glass/ 0.9 mm (35 mil) SentryGlas®/ 6 mm (¼") Annealed Glass/ 4.5 mm (177 mil) SentryGlas®/ 3 mm (⅛") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	21.6 (0.85)	44.24 (9.1)	3
2	.357 Magnum Jacketed Lead Soft Point	10.2 (158)	381 – 419 (1250 – 1375)	3 mm (⅛") Annealed Glass/ 0.9 mm (35 mil) SentryGlas®/ 5 mm (3/16") Annealed Glass/ 0.9 mm (35 mil) SentryGlas®/ 5 mm (3/16") Annealed Glass/ 4.5 mm (177 mil) SentryGlas®/ 3 mm (⅛") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	22.4 (0.88)	44.78 (9.17)	3
3	.44 Magnum, Lead Semi-Wadcutter Gas Checked	15.6 (240)	411 – 441 (1350 – 1447)	4 mm (5/32") Annealed Glass/ 0.9 mm(35 mil) SentryGlas®/ 6 mm (¼") Annealed Glass/ 0.9 mm (35 mil) SentryGlas®/ 6 mm (¼") Annealed Glass/ 4.5 mm (177 mil) SentryGlas®/ 3 mm (⅛") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	25.4 (1.00)	52.20 (10.7)	3
4	.30-60 Caliber Rifle Lead Core Soft Point	11.7 (180)	774 – 852 (2540 – 2794)	8 mm (5/16") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 10 mm (⅜") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 8 mm (5/16") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 3 mm (⅛") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	36.4 (1.43)	79.63 (16.3)	1
5	7.62 mm Rifle Lead Core Full Metal Copper Jacket, Military Ball	9.7 (150)	838 – 922 (2750 – 3025)	8 mm (5/16") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 10 mm (⅜") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 8 mm (5/16") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 3 mm (⅛") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	36.2 (1.43)	78.67 (16.1)	1
6	9 mm Full Metal Copper Jacket with Lead Core	8.0 (124)	427 – 469 (1400 – 1540)	8 mm (5/16")Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 10 mm (⅜") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 8 mm (5/16") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 3 mm (⅛") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	36.5 (1.44)	79.42 (16.3)	5

Bullet resistant configurations that comply with several of the NIJ Standard threat levels are shown below:

NIJ 0108.01 Ballistic Protective Glazing Materials

Threat Level	Ammunition	Nominal Bullet Mass, g (grains)	Required Velocity mps (fps)	Composition	Thickness mm (Inches)	Weight kg/m² (lbs/ft²)	Number of shots
I	.22 Long Rifle High Velocity Lead	2.6 (40)	320 ± 12 (1050 ± 40)	3 mm (⅛") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 0.94 mm (37 mil) Spallshield®	11.6 (0.46)	19.92 (4.1)	5
	.38 Special Round Nose Lead	10.2 (158)	259 ± 15 (850 ± 50)				
II-A	.357 Magnum Jacketed Soft Point	10.2 (158)	381 ± 15 (1250 ± 50)	4 mm (5/32") Annealed Glass/ 1 mm (39 mil) SentryGlas®/ 4 mm (5/32") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 1.7 mm (67 mil) Spallshield®	18 (0.71)	33.5 (6.9)	5
	9 mm Full Metal Jacket	8.0 (124)	332 ± 12 (1090 ± 40)				
II	.357 Magnum Jacketed Soft Point	10.2 (158)	425 ± 15 (1395 ± 50)	4 mm (5/32") Annealed Glass/ 1 mm (39 mil) SentryGlas®/ 4 mm (5/32") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 1.7 mm (67 mil) Spallshield®	18 (0.71)	33.5 (6.9)	5
	9 mm Full Metal Jacket	8.0 (124)	358 ± 12 (1175 ± 40)				
III-A	.44 Magnum Lead Semi-wadcutter Gas Checked	15.5 (240)	426 ±15 (1400 ± 50)	6 mm (¼") Annealed Glass/ 1 mm (39 mil) SentryGlas®/ 6 mm (¼") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 1.7 mm (67 mil) Spallshield®	21.4 (0.84)	42.2 (8.6)	5
	9 mm Full Metal Jacket	8.0 (124)	426 ± 15 (1400 ± 50)				
III	7.62 mm (.308 Winchester) Full Metal Jacket	9.7 (150)	838 ± 15 (2750 ± 50)	2.5 mm (3/32") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 8 mm (5/16") Annealed Glass/ 0.76 (30 mil) mm Butacite®/ 10 mm (⅜") Annealed Glass/ 0.76 (30 mil) mm Butacite®/ 8 mm (5/16") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 1.7 mm (67 mil) Spallshield®	37.9 (1.49)	81.2 (16.63)	5

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Bullet resistant configurations that comply with two of the EN 1063 Standard threat levels are shown below:

European Standard EN 1063

Threat Level	Ammunition	Required Velocity mps (fps)	Composition	Thickness in mm (Inches)	Weight kg/m² (lbs/ft²)	Number of shots
BR 4	.44 Magnum	430 – 450 (1411 – 1476)	6 mm (¼") Annealed Glass/ 1 mm (39 mil) SentryGlas®/ 6 mm (¼") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 1.7 mm (67 mil) Spallshield®	21.3 (0.84)	41.72 (8.5)	3
BR 6	7.62 x 51 mm (M80)	820 – 840 (2690 – 2755)	8 mm (5/16") Annealed Glass/ 0.76 (30 mil) mm Butacite®/ 8 mm (5/16") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 8 mm (5/16") Annealed Glass/ 0.76 mm (30 mil) Butacite®/ 6 mm (¼") Annealed Glass/ 5 mm (3/16") SentryGlas®/ 2.5 mm (3/32") Annealed Glass/ 1.7 mm (67 mil) Spallshield®	39.5 (1.55)	85.92 (17.6)	3

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