Improve Your Security Glazing Lamination Processes

Webinar Presented by Curbell Plastics

Agenda

- What is Security Glazing?
- Standards for Security Glazing
- Types of Security Glazing
- Lamination of Glass and Polycarbonate (GCP)
- Considerations for Installation of a Glass/Plastic Laminate
- SentryGlas® Interlayer
- Applications for Security Glazing

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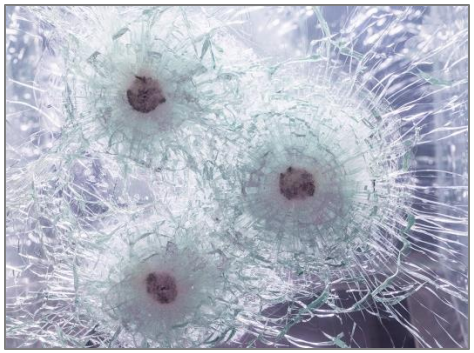
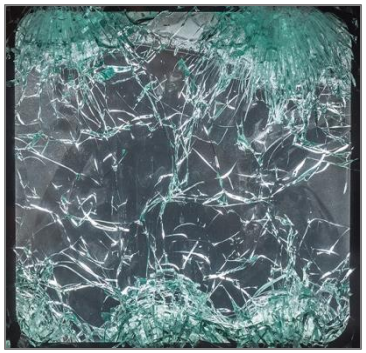
Security Glazing

Security glazing is any glass or glazing system that mitigates a threat

- Bullet Resistant (UL 752 or NIJ)
- Blast Resistant (GSA or DoD Forced Protection/Antiterrorism standards)
- Burglary (Forced Entry) Resistant (UL 972 or ASTM F1233)
- Hurricane Resistant (Dade County, South Florida or IBC)

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UL 752 and NIJ 018.01 Ballistic Charts

Underwriters Laboratories UL 752

Rating	Ammunition	Weight (grains)	Weight (grams)	Min fps	Max fps	Number of Shots
Level 1	9mm Full Metal Copper Jacket with Lead Core	124	8.0	1175	1293	3
Level 2	.357 Magnum Jacketed Lead Soft Point	158	10.2	1250	1375	3
Level 3	.44 Magnum Lead Semi-Wadcutter Gas Checked	240	15.6	1350	1485	3
Level 4	.30 Caliber Rifle Lead Core Soft Point (.30-06 Caliber)	180	11.7	2540	2794	1
Level 5	7.62mm Rifle Lead Core Full Metal Copper Jacket Military Ball (.308 Caliber)	150	9.7	2750	3025	1
Level 6	9mm Full Metal Copper Jacket with Lead Core	124	8.0	1400	1540	5
Level 7	5.56mm Rifle Full Metal Copper Jacket with Lead Core (.223 Caliber)	55	3.56	3080	3383	5
Level 8	7.62mm Rifle Lead Core Full Metal Copper Jacket Military Ball (.308 Caliber)	150	9.7	2750	3025	5
Level 9	.30-06 Caliber Rifle, Steel Core, Lead Point Filler, FMJ (APM2)	166	10.8	2715	2987	1
Level 10	.50 Caliber Rifle, Lead Core FMCJ Military Ball (M2)	709.5	45.9	2810	3091	1
Shotgun	12-Gauge Riffle Lead Slug 12-Gauge 00 Buckshot (12 pellets)	1 oz. 1.5 oz.	28.3 42	1585 1200	1744 1320	3 3

National Institute of Justice (NIJ) 018.01

Rating	Ammunition	Weight (grains)	Weight (grams)	Min/Max fps	Number of Shots
Level I	.22 Long Rifle High Velocity Lead .38 Special Round Nose Lead	40 158	2.6 10.2	1050 +/-40 850 +/-50	5 5
Level II	.357 Magnum Jacketed Soft Point 9mm Full Metal Jacket	158 124	10.2 8.0	1395 +/-50 1175 +/-40	5 5
Level IIA	.357 Magnum Jacketed Soft Point 9mm Full Metal Jacket	158 124	10.2 8.0	1250 +/-50 1090 +/-40	5 5
Level III	7.62mm (.308 Winchester) Full Metal Jacket	150	9.7	2750 +/-50	5
Level IIIA	.44 Magnum Lead Semi-Wadcutter Gas Checked 9mm Full Metal Jacket	240 124	15.55 8.0	1400 +/-50 1400 +/-50	5 5
Level IV	.30-06 Armor Piercing	166	10.8	2850+/-50	1

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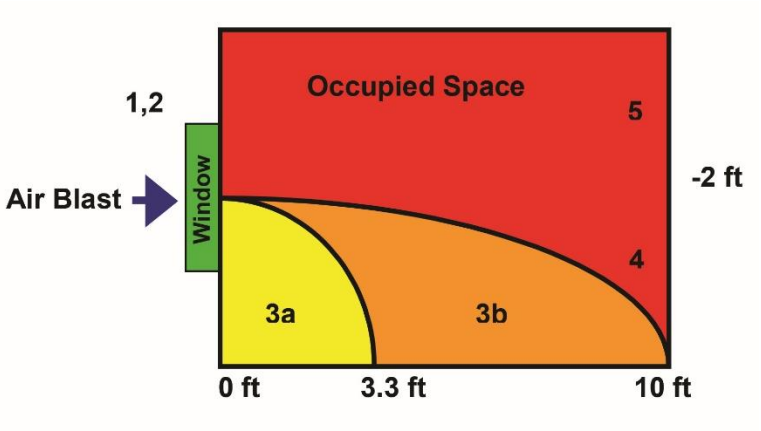
GSA–TS01-2003 for Blast Resistant Glazing

Blast Resistance Standards

The graph and table show the performance criteria for blast resistant glazing.

Note: Ballistic and forced entry protection can also be specified and achieved in a blast resistant product.



GSA Test Protocol GSA-TS01-2003

Performance Condition	Protection Level	Hazard Level	Glazing System Response
1	Safe	None	Glazing does not break. No visible damage to glazing or frame.
2	Very High	None	Glazing cracks but is retained by the frame. Dusting or very small fragments near sill or on floor acceptable.
3a	High	Very Low	Glazing cracks. Fragments enter space and land on floor no further than 3.3 ft from the window.
3b	High	Low	Glazing cracks. Fragments enter space and land on floor no further than 10 ft from the window.
4	Medium	Medium	Glazing cracks. Fragments enter space and land on floor and impact a vertical witness panel at a distance of no more than 10 ft from the window at a height greater than 2 ft above the floor.
5	Low	High	Glazing cracks and window system fails catastrophically. Fragments enter space and impact a witness panel at a distance of no more than 10 ft from the window at a height greater than 2 ft above the floor.

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UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings

Table 2-1 Levels of Protection – New and Existing Buildings – UFC 4-010-01

Level of Protection	Potential Building Damage Performance(2)	Potential Door and Glazing Hazards (3,4)	Potential Injury
Below AT Standards(1)	Severe damage. Progressive collapse likely. Space in and around damaged area will be unusable.	*Windows will fail catastrophically and result in lethal hazards. *(High hazard rating)* *Doors will be thrown into rooms. *(Category V)*	Majority of personnel in collapse region suffer fatalities. Potential fatalities in areas outside of collapsed area likely.
Very Low	Heavy damage – Onset of structural collapse, but progressive collapse is unlikely. Space in and around damaged area will be unusable.	*Glazing will fracture, come out of the frame, and is likely to be propelled into the building, with potential to cause serious injuries. *(Low hazard rating)* *Doors will become dislodged from the structure but will not create a flying debris hazard. *(Category IV)*	Majority of personnel in damaged area suffer serious injuries with a potential for fatalities. Personnel in areas outside damaged area will experience minor to moderate injuries.
Low	Moderate damage – Building damage will not be economically repairable. Progressive collapse will not occur. Space in and around damaged area will be unusable.	*Glazing will fracture, potentially come out of the frame, but at a reduced velocity, does not present a significant injury hazard. *(Very low hazard rating)* **Doors will experience non-catastrophic failure but will have permanent deformation and may be inoperable. *(Category III)*	Majority of personnel in damaged area suffer minor to moderate injuries with the potential for a few serious injuries, but fatalities are unlikely. Personnel in areas outside damaged areas will potentially experience minor to moderate injuries.
Medium (5)	Minor damage – Building damage will be economically repairable. Space in and around damaged area can be used and will be fully functional after cleanup and repairs.	*Glazing will fracture, remain in the frame and results in a minimal hazard consisting of glass dust and slivers. *(Minimal hazard and No Hazard ratings)* *Doors will be operable but will have permanent deformation. *(Category II)*	Personnel in damaged area potentially suffer minor to moderate injuries, but fatalities are unlikely. Personnel in areas outside damaged areas will potentially experience superficial injuries.
High (5)	Minimal damage. No permanent deformations. The facility will be immediately operable.	*Innermost surface of glazing will not break. *(No Break hazard rating)* * Doors will be substantially unchanged and fully operable. *(Category I)*	Only superficial injuries are likely.

1. This is not a level of protection and should never be a design goal. It only defines a realm of more severe structural response, and may provide useful information in some cases.
2. For damage / performance descriptions for primary, secondary, and non-structural members, refer to PDC Technical Report 06-08.
3. Glazing hazard ratings are from \1\ ASTM F2912 /1/.
4. Door damage level categories are from ASTM F2247 and \1\ F2927 /1/.
5. Beyond minimum standards.

Forced Entry UL 972 and ASTM F1233

- UL 972 Standard for Burglary Resisting Glazing Material
  - 5 lb. ball drop
  - 8 ft drop height – indoor
  - 10 ft drop height – outdoor
- ASTM F1233 Standard Test Method for Security Glazing Materials And Systems
  - Combined threats (ballistic, forced entry and containment)
  - Glazing systems test
  - Uses tools, techniques and time
- Not to be confused with detention/prison glazing
  - ASTM F1915 Standard Test Methods for Glazing for Detention Facilities

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Hurricane Impact – Windborne Debris Resistant

- Dade/Broward County – 1992 /South Florida Building Code – 1994
- International Building Code IBC
  - ASTM E1996 – Specification for Hurricane Impact and Windborne Debris
  - ASTM E1886 – Test Method for Hurricane Impact and Windborne Debris

ASTM E1996 Wind Zones and Missile Types

		Enhanced Protection (Essential Facilities)		Basic Protection	
System Height		<30 FT	>30 FT	<30 FT	>30FT
Wind Zone 1	130 mph </= basic wind speed <140 mph + Hawaii	D	D	C	A
Wind Zone 2	140 mph </= basic wind speed <150 mph at greater than 1 mile from the coast	D	D	C	A
Wind Zone 3	Basic wind speed >/= 150 or >140 within 1 mile of the coastline	E	D	D	A

ASTM E1996 Missiles

Level	Missile	Speed f/s	Comment
A	2 g +/- 5% steel ball	130	Small missile
B	2 lb +/- .25 lb 2 x 4 lumber	50	Some residential skylights
C	4.5 lb +/- .25 lb 2 x 4 lumber	40	Lower wind zones only
D	9 lb +/- .25 lb 2 x 4 lumber	50	Large missile
E	9 lb +/- .25 lb 2 x 4 lumber	80	Essential facilities only

ASTM E1996 – Cyclic Static Air Pressure Loading

Loading Sequence	Loading Direction	Air Pressure Cycles	Number of Cycles
1	Positive	0.2 to 0.5 P	3500
2	Positive	0.0 to 0.6 P	300
3	Positive	0.5 to 0.8 P	600
4	Positive	0.3 to 1.0 P	100
5	Negative	0.3 to 1.0 P	50
6	Negative	0.5 to 0.8 P	1050
7	Negative	0.0 to 0.6 P	50
8	Negative	0.2 to 0.5 P	3350

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Types of Security Glazing

Monolithic

- **UL 752 Level I and II Acrylic – Bullet Resistant**
  - Level I 1.250” thickness – with/without a AR Hardcoat
  - Level II 1.375” thickness – with/without a AR Hardcoat
- **Polycarbonate**
  - UL 972 Forced Entry
  - Hurricane and Windborne Debris

UL 752 Level I or II Bank Teller Windows

UL 972 Forced Entry &
Hurricane and Windborne Debris

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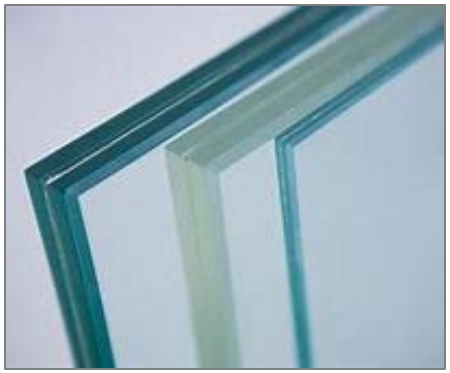
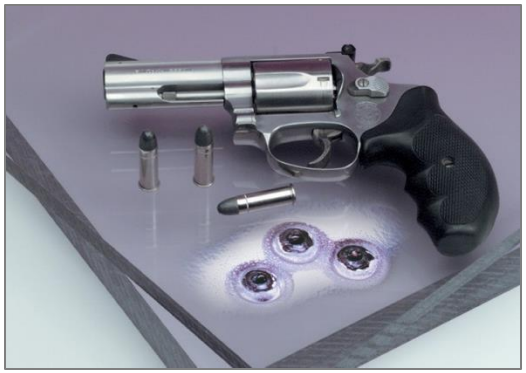
Types of Security Glazing

Laminated

- Glass/PVB
- All Plastic – TUFFAK® Hygard®
- Glass/Plastic
  - Symmetrical
  - Asymmetrical





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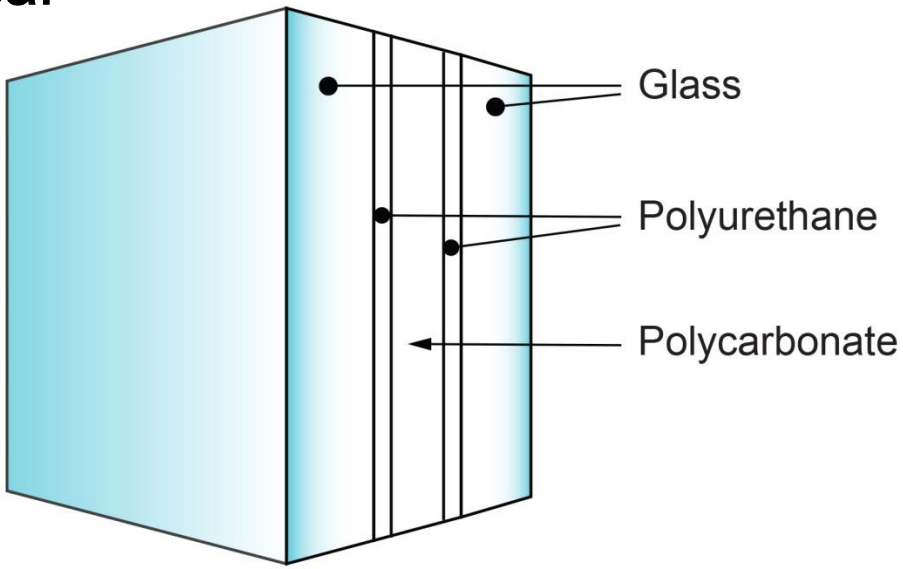
Laminated Security Glazing

Symmetrical



- Least difficult glass/plastic to laminate
- Typical use is detention center/prison window
- Make up is typically 1/4” glass/TPU interlayer/1/2” polycarbonate/TPU interlayer/1/4” glass
- Mainly used because of fire concerns

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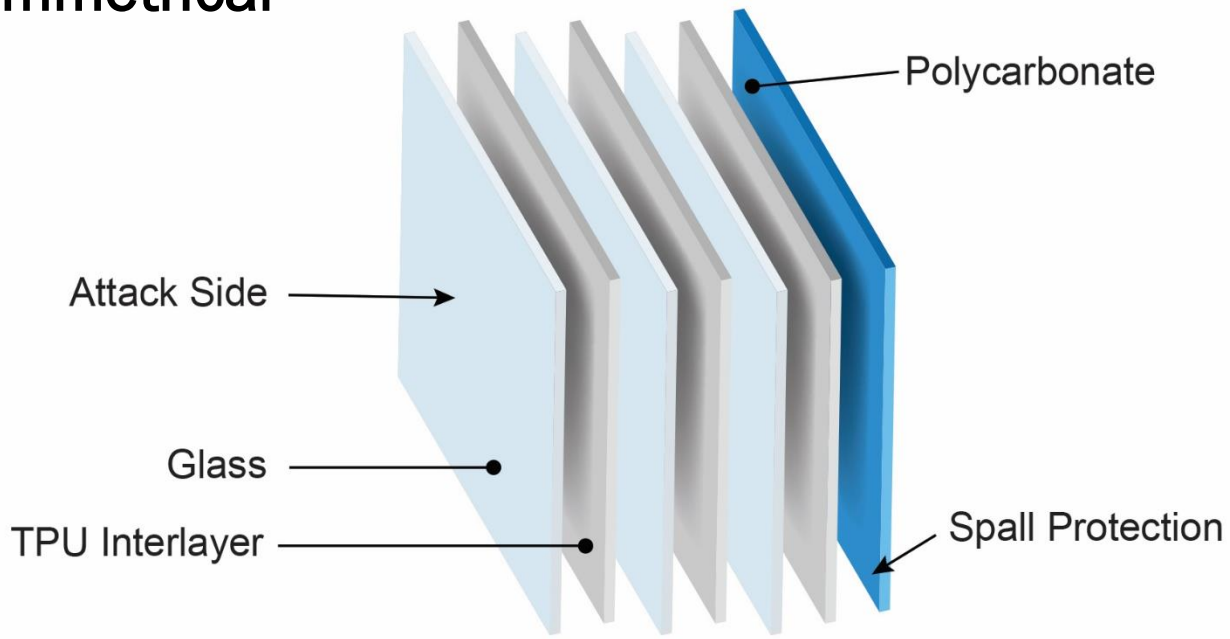
Laminated Security Glazing

Asymmetrical



- Most difficult to laminate – (shrinkage, temperature, bowing)
- Polycarbonate acts as a spall shield to stop the glass
- Glass is always on the attack side – Polycarbonate on the inside
- Used for higher level security threats ballistics/bomb blasts
- A mix of interlayers can be used (PVB and TPU)

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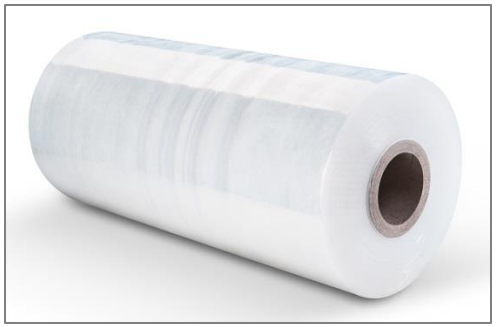
Lamination of Glass and Polycarbonate (GCP)

Thermoplastic Components

- Optical aliphatic polyether polyurethane
  - Dureflex® A4700 – 25 and 50 mil
- Optical grade polycarbonate
  - TUFFAK® OP
- General purpose polycarbonate
  - TUFFAK® GP
- AR-1 - one side abrasion resistant polycarbonate
  - TUFFAK® AR-1



TPU Film

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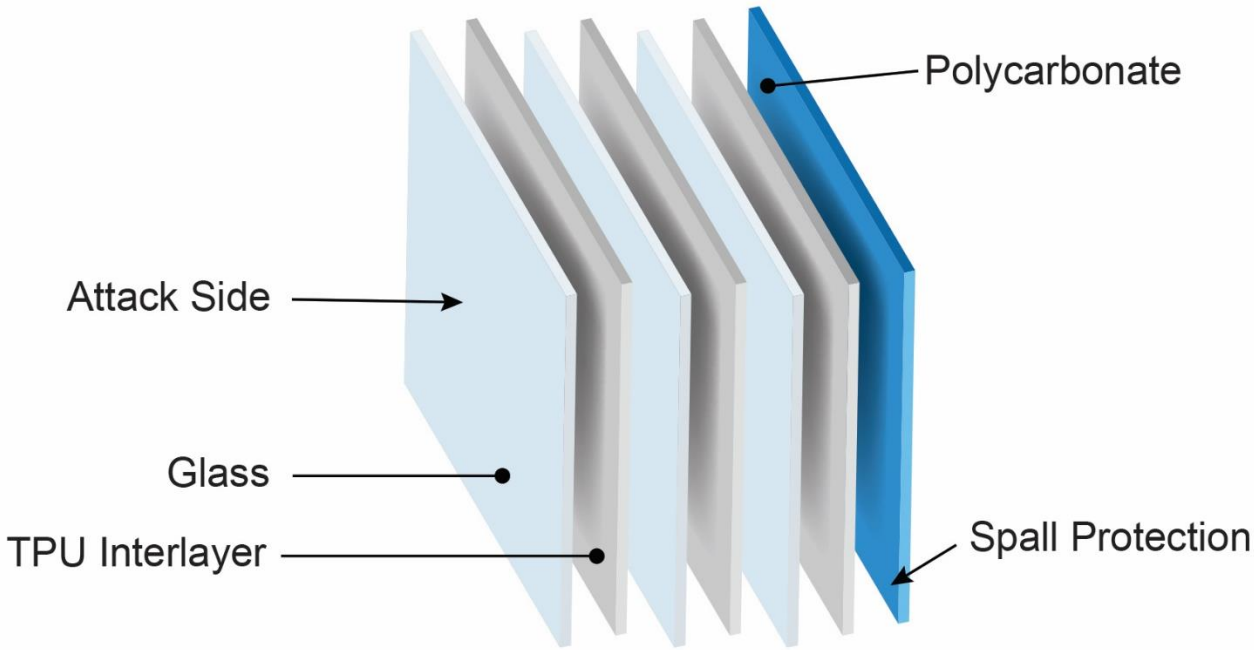
Lamination of Glass and Polycarbonate (GCP)

Glass Component (annealed, heat or chemically strengthened)

- Interlayer is PVB for glass to glass



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Lamination of Glass and Polycarbonate (GCP)

Other items for glass/plastics lamination

- Autoclave
- Breather/Bleeder Cloth
- Nylon Bagging Film
- Sealing Tape
- Tacky Tape

Nylon Bagging Film

Tacky Tape

Autoclave

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Lamination of Glass and Polycarbonate (GCP)

TPU (Interlayer) Procedures

- Mount TPU roll in clean room
- The embossed or rougher surface to the glass
- Matt or smoother side to the polycarbonate surface
- Don’t over stretch the TPU

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Lamination of Glass and Polycarbonate (GCP)

Lamination Lay-up

- Cut polycarbonate to the same size as the glass (this may change based upon your process)
- Cut the TPU slightly oversized
- Clean the glass/polycarbonate
- Use tacky rollers if necessary
- Trim the TPU edges
- Tape the sides to prevent sliding

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Lamination of Glass and Polycarbonate (GCP)

Vacuum Bagging

- Blanket breather material – assists in de–airing
- Nylon 6/6 bagging material – 3 mil thickness – rated above 250° F
- If laminate is asymmetric – A press plate is recommended
  - Must be smooth surface (contact may mark off on the polycarbonate)
  - Can be glass or other suitable material
  - Use minimum of 1/4” to 1/2” glass
  - Use a release liner between coated polycarbonate and press plate
- Seal bag edges with high temperature silicone butyl tape
- Attached vacuum valve

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Lamination of Glass and Polycarbonate (GCP)

Autoclave Cycles

Processing

- Processing time is gauge dependent
- Thinner – shorter time, thicker longer
- Check vacuum once rack has been loaded in the autoclave

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Lamination of Glass and Polycarbonate (GCP)

Autoclave Cycles Cont.

Time/Temperature/Pressure

- Ramp up heat should be 36.5° F(2.5° C)/minute
- Temperature when using A4700 should be between 203° F(95 C) – 257° F(125° C)
- Temperature when using AR-1 polycarbonate should not exceed 250° F
- Soak time should be set at 15 minutes/6 mm of unit thickness
- Autoclave pressure should be between 130 – 150 psi
- Ramp down temperature
  - Symmetrical: decrease temperature at a rate of 36° F(2° C)/minute
  - Asymmetrical: decrease temperature at a rate of 34° F(1° C)/minute
- Autoclave pressure can be released when the laminate has reached 104° F (40° C) for 20 minutes

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Considerations for Installation of Glass/Plastic Laminates

- TPU and Polycarbonate are not compatible with PVB
- Do not allow PVB to come in contact with the polycarbonate or TPU
- Do not cut PVB and TPU on the same table
- Glass/Polycarbonate make-up can be made-up together or separately
- Only use recommended materials for installation of the glass/polycarbonate make-up
- Contact polycarbonate manufacturer for recommended:
  - Sealants
  - Gaskets
  - Setting blocks
  - Cleaning solutions
  - Cleaning process
  - Cutting

Polycarbonate Edge Crazing

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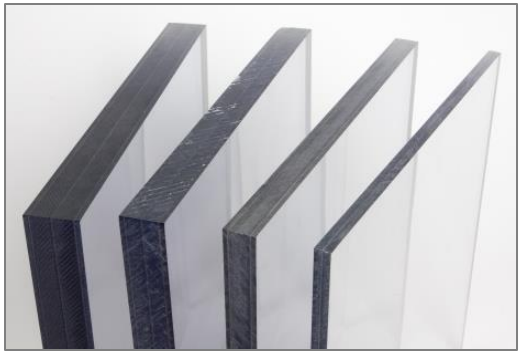
Considerations for Installation of Glass/Plastic Laminates to Prevent Failures

- Educate your laminators
  - Chemical contamination from PVB contact or cleaners
  - Cleaning the polycarbonate
  - Correct side to laminate
  - How to finish the edges without inducing stress
- Educate your installers
  - On the appropriate sealants, gaskets and setting blocks
- Educate your customers
  - Appropriate cleaning products



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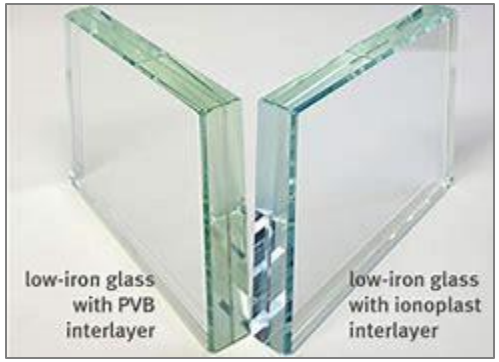
SentryGlas® Interlayer

Curbell SentryGlas® Interlayer Program

- Quick-Ship on cut-to-size and stock sheet
- 4 Locations (Pittsburgh, Phoenix, Seattle, and Hartford)
- Stock sheet sizes 48 x 96 to 84 x 144
- 60 mil and 90 mil – 35 mil in cut-to-size only
- Pricing on cut-to-size is determined by yield
- Stock sheet pricing is 5% higher than Kuraray list pricing
- Star – AA – 197 Adhesion Promoter for SentryGlas®



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Applications for Security Glazing

Banks

Hurricane Areas

Military Vehicles

Prisons

Schools

Embassies

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Thank you for your time today! Questions?

- **Ask a Plastics Expert** form on curbellplastics.com for help with your applications
- Ask about a **Customized Presentation** for your business

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