



BULLET PROOF GLASS AND BULLET RESISTANCE BARRIER

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BULLET PROOF GLASS - Meaning

Bullet resistant glass refers to any type of glass that is built to stand up against being penetrated by bullets. Although the public uses the term ‘bullet proof glass’, generally within the industry itself it is referred to as bullet-resistant glass, because there is no feasible way to create consumer-level **glass** that can truly be proof against bullets.

Bullet proof glass is usually constructed using a strong but **transparent** material such as polycarbonate thermoplastic and by using layers of **Laminated Glass**. The desired result is a material with an appearance and light-transmitting behavior of **standard glass** but offers varying degrees of protection from small arms.



BULLET PROOF GLASS - Through the Ages

1903

Discovery

Edouard Benedictus, a French chemist, drops a flask filled with cellulose nitrate on the ground. While it breaks it does not shatter.

1909

Shatter-Proof Glass Patent Created in France

Benedictus patents his invention in France as "shatter proof glass."

1914

Shatter-Proof Glass Patented in USA

Benedictus obtains the US Patent for his invention.

1915

Bullet Resistant Glass Used in WWI

Used in gas mask eyeholes and fighter plane windows



BULLET PROOF GLASS - Through the Ages



1920

Bullet Resistant Glass used in Banks

Was put in place in bank teller stations, and voice transmission systems allowed patrons to communicate with the tellers.

1930

First Used in Expensive Cars

Used in cars, though not widely due to its price.

1953

Polycarbonates Discovered

Polycarbonates, a group of clear and easily moldable plastics, were discovered by scientists H. Schnell (in Germany) and D. W. Fox (in the US). As Mr. Fox worked for GE, polycarbonates began to be used in commercial products in the late 1950's.



BULLET PROOF GLASS - Through the Ages



1982

First Patent for Bulletproof Glass

Invented by Jacques Sauret and Gerard Grosse, this was the first patent exclusively for bulletproof glass.

1994

Patent Granted for Modern Bulletproof Glass

Filed by William P. Stephinson, this patent is alternating sheets of slightly flexible glass and polycarbonates.

Period: 1935 till date

Used in Security and Safety Applications (Oval Office, Popemobile, etc.)

Some of these include the Presidential Limousine, the Popemobile, the Oval Office, and the Supreme Court. Now it is widely use in many area.



BULLET PROOF GLASS - Through the Ages



Advancement

The field of bullet proof glass is constantly developing, and there are a number of military projects underway to create lighter-weight, more defensive forms of bullet proof glass. One of the most promising is the use of aluminum oxynitride in the outer layer, in place of a polymer layer. Aluminium Oxynitride is 4 times stronger than silica glass and 85% as strong as sapphire.

U.S. military researchers are moving quickly to develop this new class of transparent armor incorporating aluminum oxynitride (Trade name: ALON) as the outside "strike plate" layer. It performs much better than traditional glass/polymer laminates. Aluminum oxynitride "glass" can't defeat threats like the .50 caliber armor piercing rounds using material that is not prohibitively heavy. This more resistant-glass that can be used in military assault vehicles and aircraft.



UNDERSTANDING - BULLET PROOF GLASS

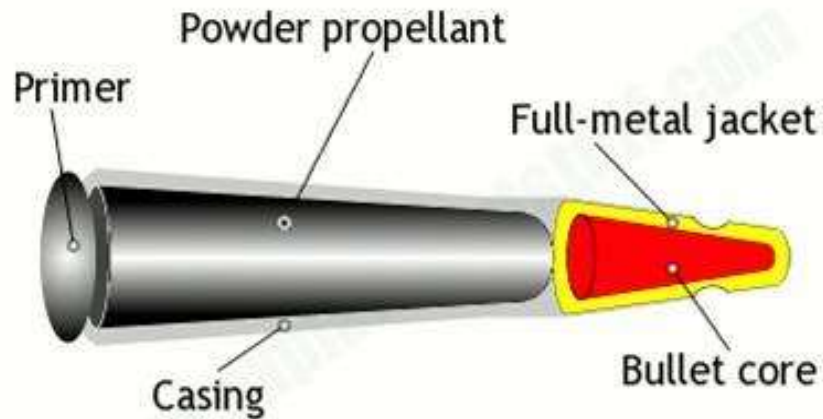
Need to understand

- Bullet
- Glass
- Barrier



WHAT'S INSIDE A BULLET

- Bullets are arranged in three system
 - The primer (like a fuse)
 - The propellant (chemical explosive)
 - The bullet proper (tapering metal cylinder)



WHAT HAPPENS WHEN BULLET IS FIRED

- Primer ignites the propellant – (main explosives)
- It generates lot of gas very quickly and gas shoots from the back of bullet and increasing pressure and focusing gun barrel at high speed (300 m/s)
- Gun barrel have spiraling grooves that makes bullet spin it leaves
- A spinning bullet is like gyroscope & it follows straight path
- But due to different force acting on bullet,
- It follows downward curve

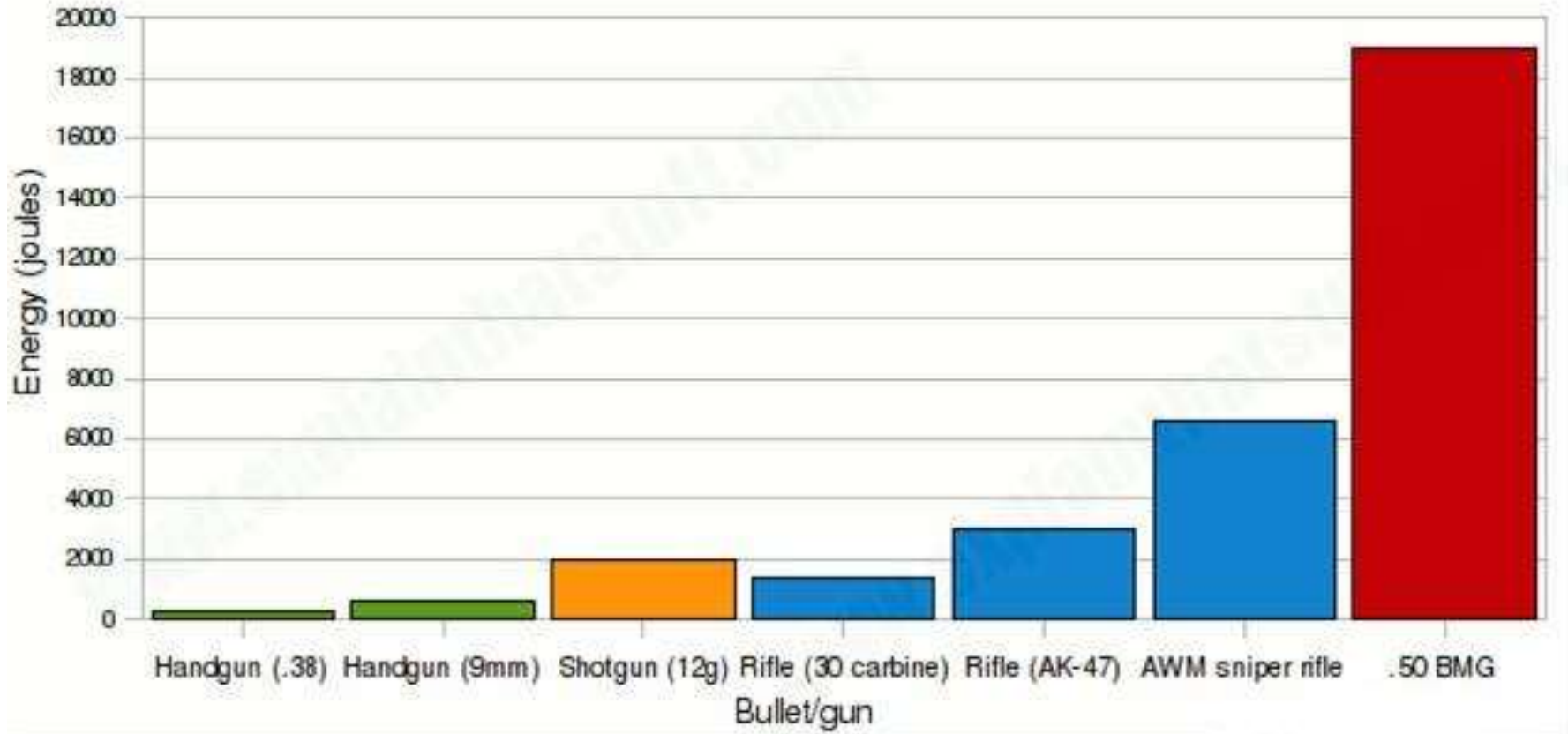


KINETIC ENERGY OF BULLET

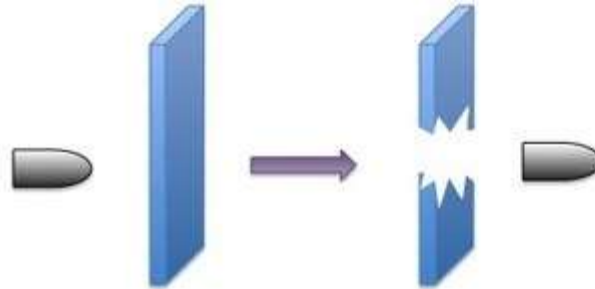
- Kinetic energy is the energy of motion.
- There are different form of energy.
- Bullet has translational kinetic energy.
- This depends upon mass (m) and speed (v) of the bullet.
- Kinetic energy = $0.5 \times m \times v^2$
- Kinetic energy is directly proportional to the square of speed.
- Two fold increase in speed, kinetic energy will increase by a factor of four.
- Standard unit of kinetic energy is Joule.
- $1 \text{ Joule} = 1\text{KG} \times \text{metre}^2 / \text{sec}^2$
- Bullet proof glass has to absorb kinetic energy.



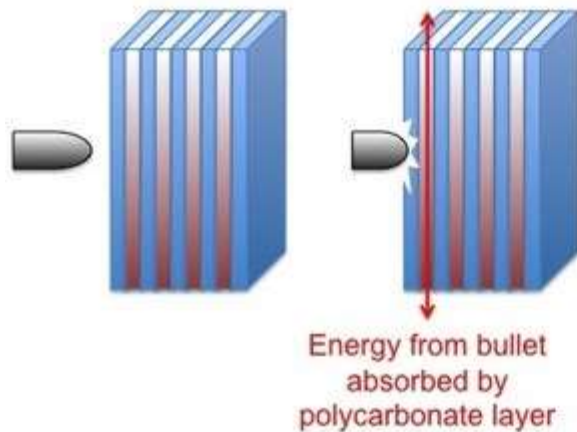
ENERGY IN BULLET



HOW BULLET PROOF GLASS WORKS



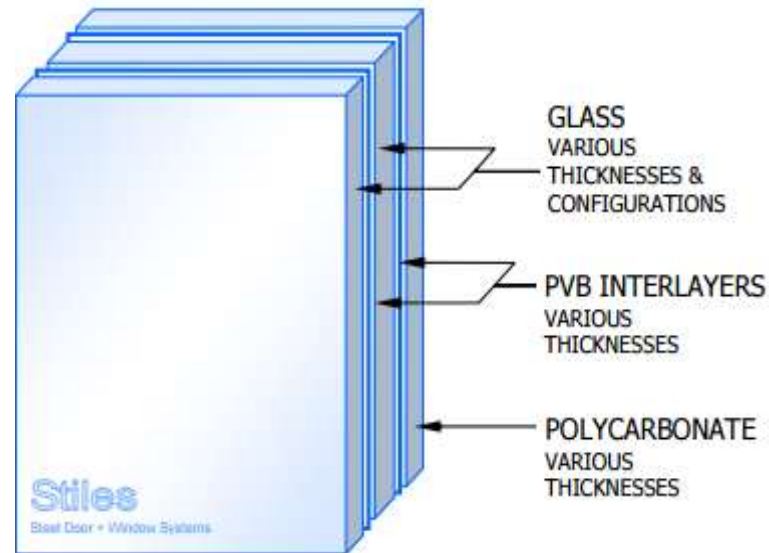
The glass is not elastic (meaning it can't move much when pushed), so all of the energy from the moving bullet is taken by the glass which exceeds the fracture strength of the glass causing it to shatter.



The first layer of glass may shatter when the bullet hits it, however the next layer of polycarbonate is more elastic so it moves when the bullet hits it which dissipates the energy of the bullet horizontally. This takes the energy away from the bullet slowing it down. If enough energy is taken from the bullet it will eventually stop it from passing through.

PROCESS OF MANUFACTURING

- Bullet Proof Glass' purpose is to place barrier in front of your body.
- Barrier will dissipate Bullet Energy.
- These are laminated glass, which is a sandwich of Glasses with a inter layer like Poly Vinyl Butyl and Poly Carbonate in between.

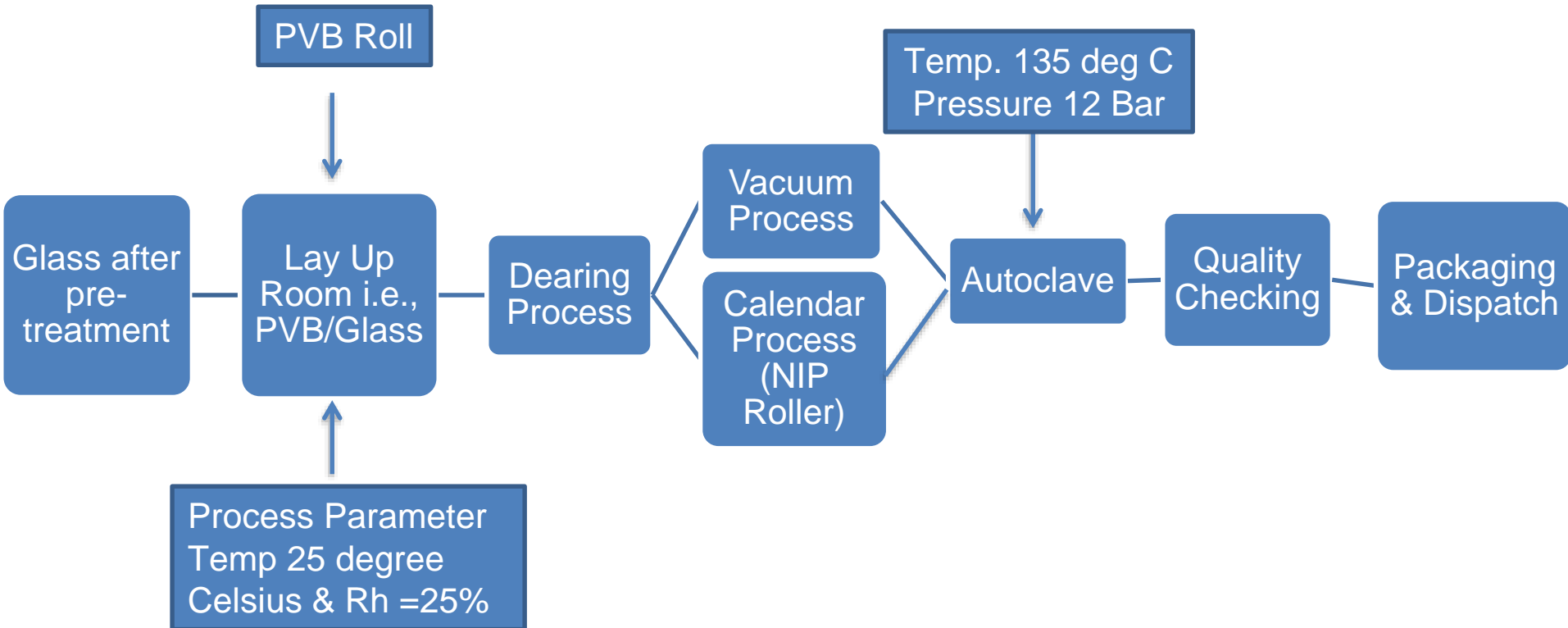


PROCESS OF MANUFACTURING

- Bullet Glass is thicker (15mm to 70 mm) and is heavy depending upon the threat level.
- Bullet proof glass two type i.e.—Straight or curved glass
- Straight bullet proof glass is easier to make.
- Curved bullet proof glass you have to make mould.
- Bullet Glass is energy absorbing glass.



PROCESS DIAGRAM OF BULLET PROOF GLASS



PROCESS OF CURVED BULLET PROOF GLASS

- **STEP 1:** Making of glass moulds –
 - Moulds are an exact copy of curved glass with all curvature and bends. This mould is used in the bending process.
- **STEP 2:** Cutting and layout –
 - To cut the glass as per requirement along with sheet of polycarbonate and polyurethane bonding inter layers.
- **STEP 3:** Glass Bending –
 - Place the cut flat glass as per STEP 2 and set these on moulds in the bending ovens.
- **STEP 4:** Clean room assembly –
 - These bent glasses and layer of polyurethane bending interlayer are assembled in proper configuration.

PROCESS OF CURVED BULLET PROOF GLASS

- **STEP 5:** Vacuum bag assembly –
 - After stringent inspection, the full layup is then inserted into vacuum bag and sealed.
- **STEP 6:** Autoclaving –
 - These are sent to autoclave and autoclave binds all of layers of polyurethane, glass and bonding interlayers.
- **STEP 7:** Final inspection and packing –
 - Curved bullet glass are removed from the autoclave. It is checked against the moulds and original glass to see that glass fit properly. These are packed and ready for dispatch.



QUALITY TESTING STANDARD

- Standard EN-1063 classifies two types weapon ie., handguns & rifles and shotguns (S G Classes)
- There are 9 category of weapon tested.
- Glass is classified as bullet resistance. If it stops all the bullets on three sheets tested.
- Also to record if any splinters ie., (S) or (NS) behind the glazing.
- Classes BR1 to BR7 contain glasses offering increasing level of protection. There is no correlation between SG and BR classes.



QUALITY TESTING STANDARD

- Standard EN 1063 – Security Glazing

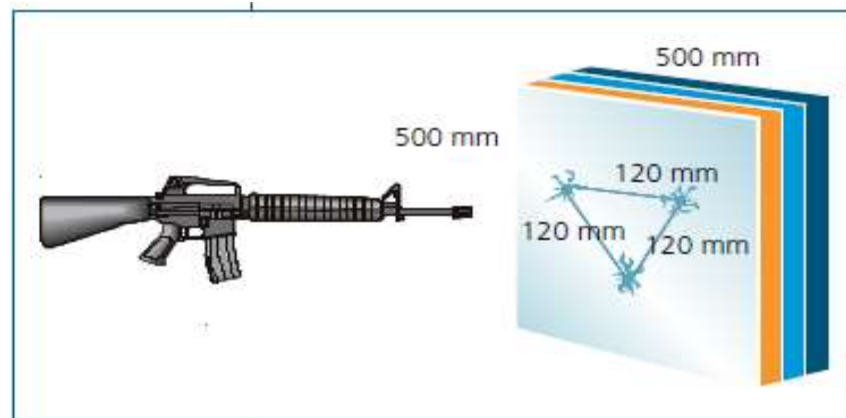
Classification of resistance against firearm attacks - Class EN 1063

Class	Type of weapon	Calibre	Type of ammunition	Mass of ammunition (g)	Test conditions			
					Range (m)	Bullet velocity (m/s)	Number of strikes	Striking distance (mm)
BR1	Rifle	0.22 Long rifle	L/RN	2.6 ± 0,1	10.00 ± 0,5	360 ± 10	3	120 ± 10
BR2	Handgun	9 mm Luger	FJ ¹ /RN/SC	8.0 ± 0,1	5.00 ± 0,5	400 ± 10	3	120 ± 10
BR3	Handgun	0.357 Magnum	FJ ¹ /CB/SC	10.2 ± 0,1	5.00 ± 0,5	430 ± 10	3	120 ± 10
BR4	Handgun	0.44 Rem. Magnum	FJ ² /FN/SC	15.6 ± 0,1	5.00 ± 0,5	440 ± 10	3	120 ± 10
BR5	Rifle	5.56 x 45 *	FJ ² /PB/SCP1	4.0 ± 0,1	10.00 ± 0,5	950 ± 10	3	120 ± 10
BR6	Rifle	7.62 x 51	FJ ¹ /PB/SC	9.5 ± 0,1	10.00 ± 0,5	830 ± 10	3	120 ± 10
BR7	Rifle	7.62 x 51 **	FJ ² /PB/HC1	9.8 ± 0,1	10.00 ± 0,5	820 ± 10	3	120 ± 10
SG1	Shotgun	Cal 12/70	Solid lead ³	31.0 ± 0,5	10.00 ± 0,5	420 ± 20	1	-
SG2		Cal 12/70	Solid lead ³	31.0 ± 0,5	10.00 ± 0,5	420 ± 20	3	120 ± 10
* twist length 178 mm approx. 10 mm ** twist length 254 mm approx. 10 mm 1 Plated steel jacket 2 Brass alloy jacket 3 Brenneke slug L Lead CB Coned bullet			FJ Full metal jacket FN Flat nose bullet HC1 Steel hard core, mass 3.7 g approx. 0.1 g, hardness > 63 HRC PB Pointed bullet RN Round nose bullet SC Soft core (with lead) SCP1 Soft core (with lead) and steel penetrator (type SS109)					



TESTING

- Standard en-1063 specifies striking distance, number of strikes and range for each type of calibre.



*Test of bullet-proof -
Class EN 1063*

BULLET RESISTANT BARRIERS

- Planning bullet resistance barrier
- Need to understand barrier end use ie.,
 - Threat level of the area.
 - Surrounding infrastructure.
 - Type of item transferred across barrier.
- Selecting appropriate glazing
 - Light transmission – material with best light transmission protect upto level 3 out of 8.
 - Strength – does it need to withstand bullet or any other like sledge hammer.
 - Weight – better protection level, glass becomes heavier.



BULLET RESISTANT BARRIERS

- Select the appropriate surrounding material like frames, door, counters, etc.
- Types of bullet resistance barrier
 - Fixed Barrier System
 - Free standing barrier system
 - Slider system



BULLET RESISTANT BARRIERS

- Fixed barrier system
 - used in convenience stores, pharmacies, simple ticket windows and where there is an active involvement of money..
 - Employees are protected by a pane of bullet glass fixed in bullet resistant frames.



BULLET RESISTANT BARRIERS

- Free standing barrier system
 - Used in banks, theatres, sports stadium & multiple consecutive stadium.
 - To protect, the employees need to use bullet proof glass at certain height and above that ordinary glass can be used.



BULLET RESISTANT BARRIERS

- Slider system
 - Used for fast food established and other stores which are open for 24 hours.
 - At night, slider system allows the employee to move the glass back and forth as necessary to facilitate business operations.



PROTECTIVE MATERIAL

- Polymers – which are soft and flexible, but if you hit hard, it will instantly become solid.
- This dissipate impact energy by spreading it over a much larger surface and absorbing it.
- Like Dow Corning Deflexion and D30 lab (orange colour plastic) (Non Newtonian Material)
- Composite Kevlar (Dupont) which is 5 times stronger than steel and can withstand bullet.
- Another product developed by Poland, Liquid armor which become solid upon impact (Non Newtonian Material)



APPLICATION OF BULLET RESISTANT GLASS

- Bullet proof glass provides security to:
 - Banks Tellers
 - Jewellery Stores
 - Museums
 - Police/Military
 - VIP Enclosures
 - Podium
 - Armour Vehicles



THANK YOU

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BulletProof_GP_new (2) - Microsoft PowerPoint Drawing Tools

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