Transparent armor systems for defense, law enforcement and naval platforms

Delivering high-end security glass products for over 50 years.





The technology leader producing state-of-the-art specialty glass.

AGP has focused on the development and improvement of products for Defense and safety applications with the utmost consideration for survivability of platforms utilized by armed and naval forces.

Delivering thousands of units of transparent armor systems with features designed to provide the greatest protection and durability. By combining decades of experience with a strategic global presence, AGP will exceed your expectations.

Defense

Transparent armor systems
for land and naval platforms

Security Glass

Bullet-resistant glass for
commercial armored vehicles

eGlass

High-tech glazing solutions
for the future of mobility

Global Presence

**AGP is trusted by more than 1.000 clients around the world.
We offer local support in over 20 countries.**

AGP serves military, naval, law enforcement, government, corporate and private clients through the combined resources of four manufacturing plants and business units covering the Americas, Europe, Australia, Asia, Middle East, India and Africa. AGP's strategic global presence allows the company to immediately respond to the needs of customers wherever they may be.

AGP's modern facilities have consistently received new investments to expand production capacities and manufacture the most complex products. These investments have enabled AGP to successfully achieve accreditation for Quality and Processes management systems of the most rigorous international standards. AGP also counts with in-house Ballistic Laboratories for internal performance tests and R&D.

PRODUCTION FACILITIES
Belgium, Brazil, Colombia, Peru, USA*

R&D TECH CENTERS
Germany, USA*
*Planned

BUSINESS UNITS
Argentina, Australia, Egypt, Germany, Guatemala, India, Japan, Korea, Mexico, Nigeria, Philippines, Spain, South Africa, United Arab Emirates, USA, Venezuela

- Commercial Units
- AGP Pertners
- Production Facilities
- 2018 Tech Centers

Over 100.000 m² of industrial facilities producing state-of-the-art specialty glass

AGP / SOLIVER BELGIUM

Expertise:
automotive safety glass, architectural glazing, transparent armor systems

Certifications:
iatf 16949 – iso 9001 – iso 14001

AGP BRAZIL

Expertise:
flat and curved bullet-resistant glass

Certifications:
iatf 16949 – iso 9001

AGP COLOMBIA

Expertise:
flat and curved bullet-resistant glass and specialty glass

Certifications:
iatf 16949 – iso 9001 – iso 14001

AGP PERU

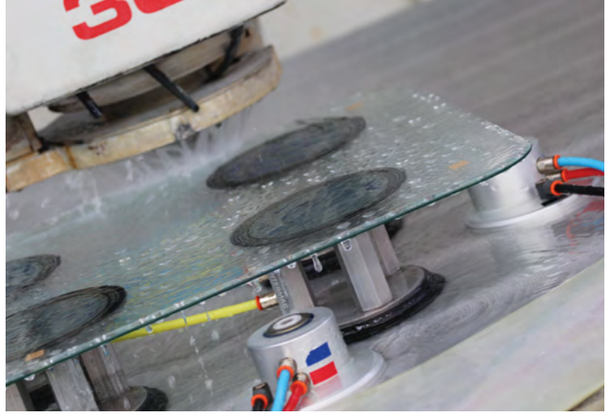
Expertise:
flat and curved bullet-resistant glass, transparent armor systems, impact- resistant glass

Certifications:
iatf 16949 – iso 9001 – iso 14001 – iso 45001

AGP EGLASS PERU

Expertise:
automotive high-tech specialty safety glass

Certifications:
iatf 16949 – iso 9001 – iso 14001 – iso 45001



Ballistics

AGP produces transparent armor for military applications that meet and/or exceed the specifications requested in the VPAM APR 2006, CEN EN 1063, STANAG 4569 / AEP-55 and NIJ 0108.01 standards, among others.

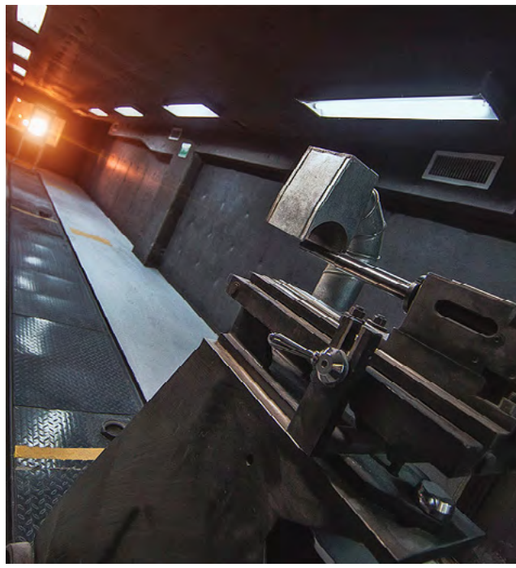
AGP Defense is also able to address custom ballistic requirements, which include designing transparent armor systems that maintain their ballistic integrity in extreme environments and against multi-hit threats.

In the last ten years, AGP has sold more than 500.000 pieces of flat and curved bullet-resistant glass. AGP is currently producing an average of 10.000 pieces per month.

R&D and technology

Among the priorities of the R&D Team, which combines experts from Germany, France, USA, Colombia and Brazil, is the advancement of transparent armor products capabilities. These include researching and testing new materials as well as designing new products to increase safety, durability and performance.

By using its R&D experience, AGP has been able to develop products with reduced weight, superior ballistic integrity and lower costs when compared to standard bullet-resistant glass designs. AGP works closely with clients, academic institutions and advanced materials manufacturers to develop customized products that meet the needs of the end user.



Applications

TRANSPARENT ARMOR SYSTEMS
FOR MILITARY ARMORED VEHICLES

SPECIALTY GLASS AND WINDOWS FOR
NAVAL AND COAST GUARD VESSELS

IMPACT-RESISTANT GLAZING FOR
LAW ENFORCEMENT VEHICLES

BULLET-RESISTANT GLASS FOR
COMMERCIAL ARMORED VEHICLES

Integrated Management Systems

At AGP, guaranteeing the quality of the products is a top priority of the manufacturing plants. Processes have been certified according to the latest quality management systems

INTEGRATED MANAGEMENT SYSTEM
Quality Management System **ISO 9001:2015 AND IATF: 16949**
Safety & Control Management System **BASC**
Environmental Management System **ISO 14001:2015**
Health & Safety Management System **ISO: 45001:2018**

In-house testing laboratories

AGP also understands that the superior performance and durability of transparent armor in extreme conditions must be maintained. Consequently, AGP has invested in state-of-the-art quality laboratories for conducting comprehensive testing on all the production runs to guarantee that only the best quality products are delivered to their clients.

SOME EXAMPLES OF IN-HOUSE TESTING INCLUDE:

- Ballistic resistance
- Abrasion and chemicals resistance of spall-shields
- Weathering tests and accelerated aging trials
- Mechanical resistance and adhesion of laminated glass
- Luminous transmittance testing

More specific testing is outsourced to accredited laboratories to ensure compliance with international standards.

Climatic chambers for weathering tests and accelerated aging trials

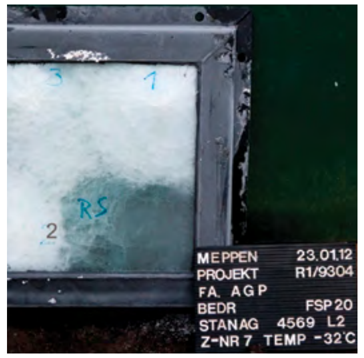
Raw materials and manufacturing control samples are tested for each production run

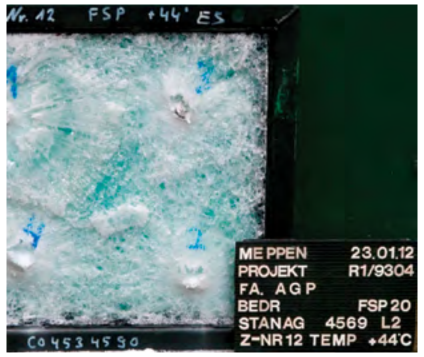
Bullet-resistant glass qualified for extreme environmental conditions

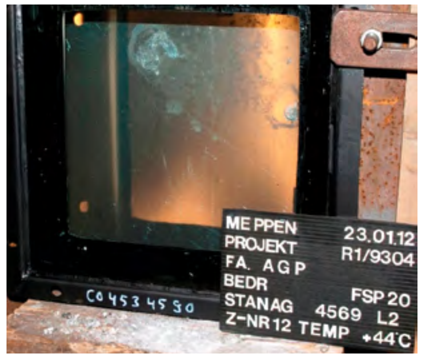
AGP products for military use have been qualified in accordance with the methods described in the STANAG 4370, TL2350-0006 and MIL-STD-810 standards.

TESTING APPROVED BY NATO FORCES	RESULT
Light Transmission as per TL2350-006 Method	APPROVED
Temperature Shock Test as per MIL-STD-810G 503.5 Method	APPROVED
Solar Radiation Test as per MIL-STD-810G 505.5-II Method	APPROVED
Vibration Test as per MIL-STD-810G 514.6 / ITOP 1-2-601 Method	APPROVED
Humidity Test as per MIL-STD-810G 507.5 Method	APPROVED
Shock Test as per MIL-STD-810G 516.6 Method	APPROVED
Sand and Dust Test as per MIL-STD-810G 510.5 Method	APPROVED
Ballistic Test as per STANAG 4569	APPROVED

AGP is a certified vendor qualified by Germany's Federal Office of Defense Technology & Procurement (BAAINBw – Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr)







Final quality inspection of finished products includes reports and individual Certificates of Conformity:

APPEARANCE

Overall appearance is inspected in accordance with the agreed-upon quality inspection criteria

GEOMETRY

Dimensions and geometrical tolerances are measured piece by piece

OPTICS

Distortion and double-image on armored transparencies are controlled for better optics

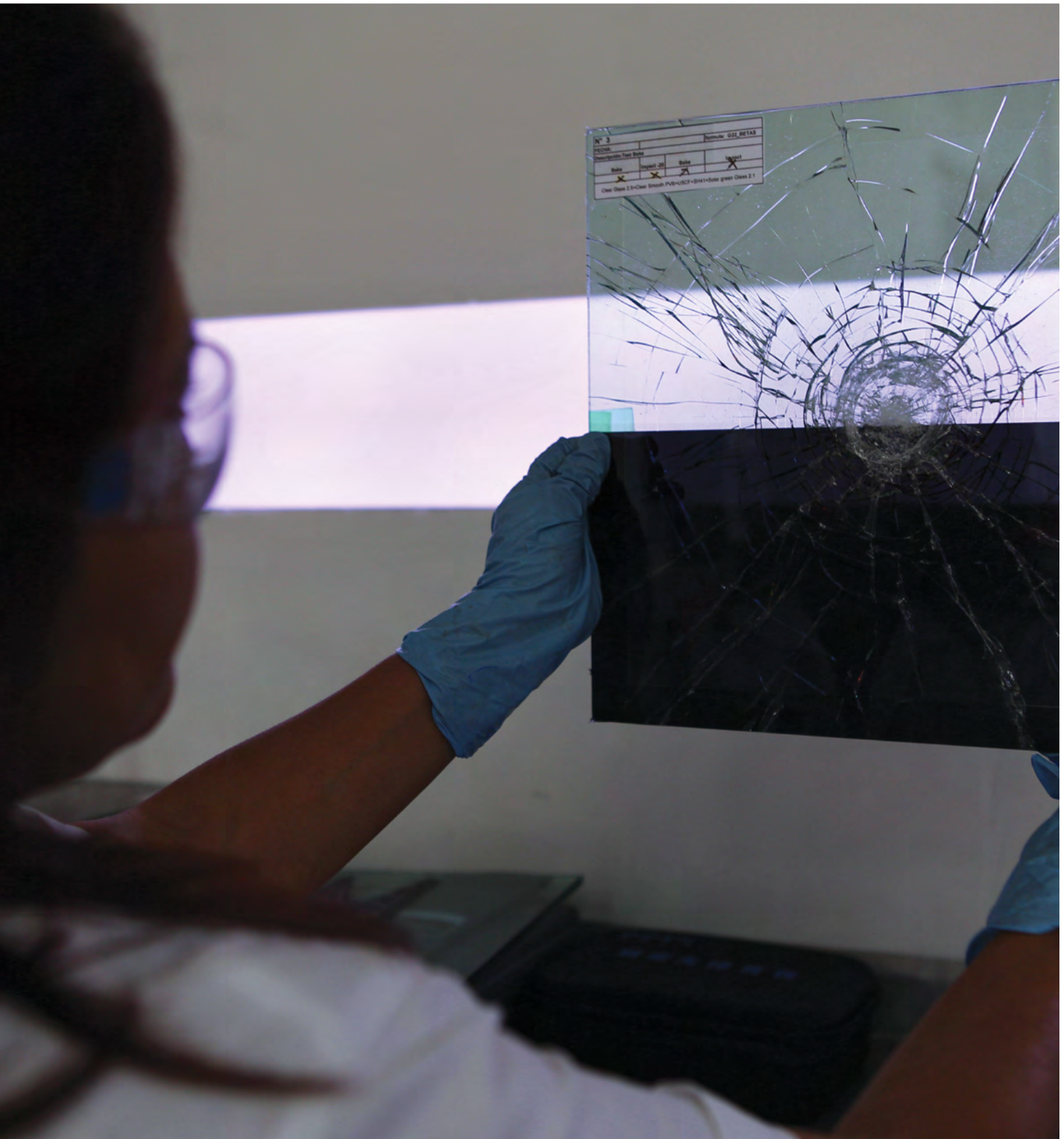
Fully-traceable products

Every single piece of glass produced by AGP has its own specific process file to guarantee fulfillment of all technical specifications. All documentation is linked to a unique serial number which allows full traceability and after-sales tracking.

A unique serial number for each individual piece of glass allows full traceability:

- Technical specifications
- Product certifications
- Quality records and inspection reports
- Certificates of Conformity
- Details of manufacturing plant and production date

PRODUCTS AND SOLUTIONS



Transparent armor that meets all international ballistic standards

All bullet-resistant glass compositions are qualified in accordance with international ballistic standards. AGP also develops compositions in accordance with client criteria that require customized solutions concerning shooting patterns and different qualification temperatures.

AGP counts with in-house ballistic laboratories and works with accredited institutions for testing and certification.

NIJ NATIONAL INSTITUTE of JUSTICE

mit Sicherheit VPAM

cen

NATO OTAN

Advanced edge sealing options

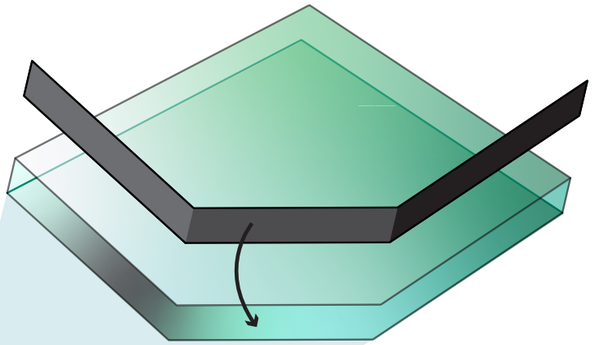
With Edge Plus® you are guaranteed durability

AGP'S EDGE PLUS® is a laminated material that seals the edge of the bullet-resistant glass which prevents penetration of moisture and chemical agents into the laminate, thus enhancing its durability.

SUPERIOR PERFORMANCE

POLYMER	Sika 256	U-438	Sulfuric Acid	Toluene	Ethyl Acetate	Ketones	Acetic Acid
EDGE PLUS®	✓	✓	✓	✓	✓	✓	✓
STANDARD	○	●	○	●	○	○	●

✓ Resistant; ○ Limited resistance; ● Not resistant



Silicones are used for assembly of BRG's

- × O_2 OXIDATION
- × H_2O STEAM

SOLVENTS

- × MEK
- × TOLUENE
- × ACETONE
- × METHANOL
- × GASOLINE

Premium transparent armor options: outstanding performance and remarkable weight

Compositions for extreme temperatures

AGP's high performance options incorporate the latest technologies and materials that keep the ballistic integrity of the transparent armor, thus providing complete ballistic protection in the harshest hot or cold environmental conditions. Compositions for different ballistic levels are tested in temperatures ranging from -50 to +70 °C and different soak times.

-50° -40° -30° -20° -10° 0° 10° 20° 30° 40° 50° 60° 70°

Lightweight bullet-resistant glass

Lightweight transparent armor that is produced with special materials and processes for reducing the weight and thickness of the glass, while maintaining its ballistic performance.

Newer technologies will use glass-ceramics and transparent ceramics to achieve remarkable reduction of weight.

Armored fast patrol boat

AGP DURA: Superior Service Life

AGP DURA is a patented product that has been developed from 50 years of experience in glass lamination. State-of-the-art production processes and materials are used to manufacture a laminate that incorporates three new materials that cover the polycarbonate spall-shield.

Advantages of AGP Dura line:

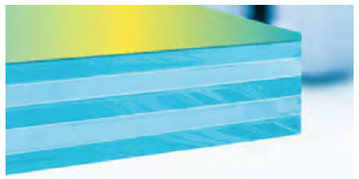
- Increased durability and lifespan of the bullet-resistant glass from protecting the polycarbonate
- Protection against scratches maintains clear visibility and appearance without increasing weight or thickness
- Can be designed to meet extreme temperature requirements

Product warranty can be extended in most cases

TRADITIONAL BRG

Standard combination of glass and polycarbonate spall-shield

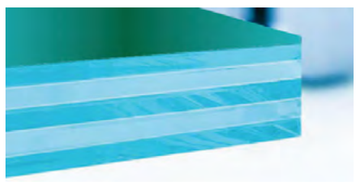
1–2 years



DURA -P

New polymers that enhance the resistance against chemical reactions

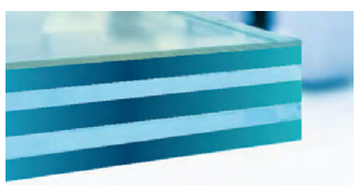
3–4 years



DURA -G

Ultrathin glass cover for enhanced resistance against scratches

3–4 years



DURA -NPC

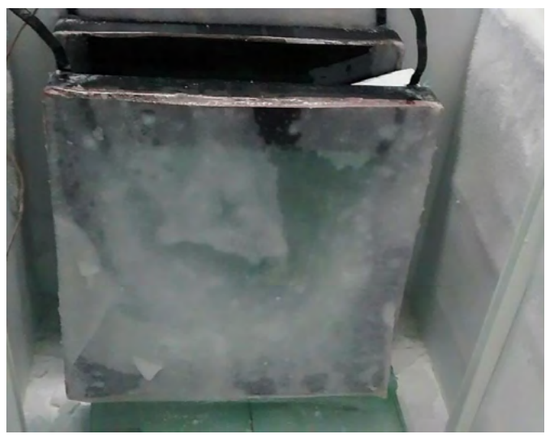
A formula without polycarbonate that provides outstanding durability

5+ years

Heating systems for land and naval platforms

Wired and invisible heating systems:

The heating mats, cables and connection systems are designed in accordance with required power densities and inputs up to 440 V.



To achieve better defrosting capabilities and appearance, AGP developed Heatplex, a transparent heating system that defrosts bullet-resistant glass faster than standard technologies for high voltages. For marine systems, the heating elements are designed and tested in accordance to ISO 3434.

Design, production and integration of frames, windows and components

Manufacturing capabilities

Turn-key solutions, providing best-in-class support from development up to the delivery. Build-to-print and design-build capability, including project development in AutoCAD, Rhinoceros and Inventor, Structural Analysis and Finite Element Modeling with ANSYS.

The process is supported by a high level of multidisciplinary professionals in Engineering, Quality Assurance, Manufacturing and Logistics.

- Laser, plasma and waterjet cutting
- Welding and assembly process capability (welding automation equipment)
- Surface finishing including an abrasive blasting room and painting
- Certified processes in accordance with ISO and AWS

Transparent Armor Systems

Integration of transparent armor and steel fabrications

AGP's 50 years of industrial experience in the production of transparent armor along with specialized partners bring knowledge in manufacturing and integrating steel and aluminum frames for military and naval platforms.

Reduced risk of damaging the glass and frames due to inappropriate integration procedures

Co-design capabilities for enhanced durability of the transparent armor

Turn-key solution for your platform

Specialized packaging of windows for safe transportation and storage

Optimized components and systems to be lighter and more durable

Environmental qualification testing of components

We count with strategic partnerships with large production areas for steel fabrications which include operations in South Africa, Europe, Peru and the United Arab Emirates.

Protection against blast pressure and electromagnetic waves on marine windows

VISIBLE LIGHT TRANSMITTANCE

THICKNESS	STANDARD GLASS	AGP EXTRA CLEAR
60 MM	70%	80%
80 MM	67%	79%
90 MM	65%	78%
100 MM	63%	76%

EMI SHIELDING

Special coated materials are incorporated within the glass laminates to attenuate the force of electromagnetic waves.

AGP offers root glass and windows with shielding effectiveness between 20–40 dB and with frequencies ranging from 3 MHz–40 GHz qualified in accordance to MIL-STD-285 and MIL-STD-461.

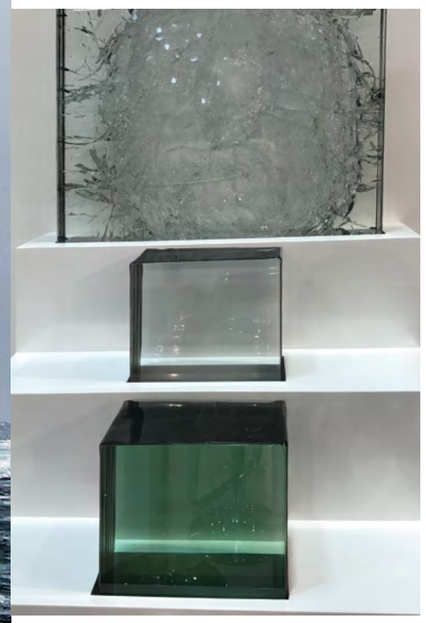
BLAST PRESSURE AND SHOCK RESISTANCE

Glass composites tested to withstand up to 2.1 bar of positive pressure. Solutions are available for bullet-resistant glass and toughened laminated glass.

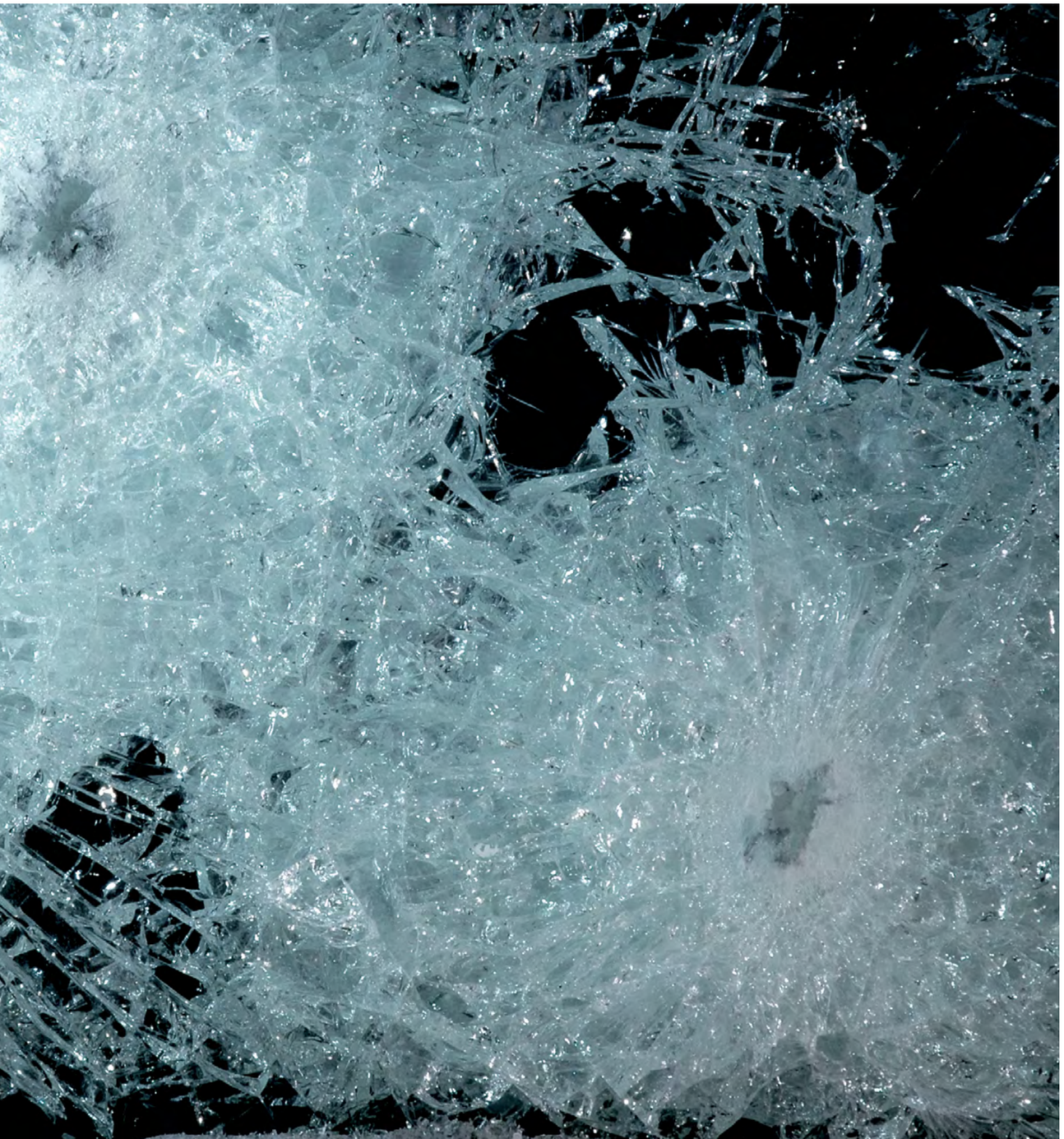
AGP's marine windows comply with ISO 3903 and MIL-STD-901D as well as ISO 614 for non-ballistic toughened laminated glass.

SUPERIOR OPTICS AND LUMINOUS TRANSMITTANCE

Extra clear glass compatible with night vision goggles. Maintaining a high luminous transmittance of transparent armor is possible through the utilization of special raw materials.



TECHNICAL PAPERS



Edge barrier performance

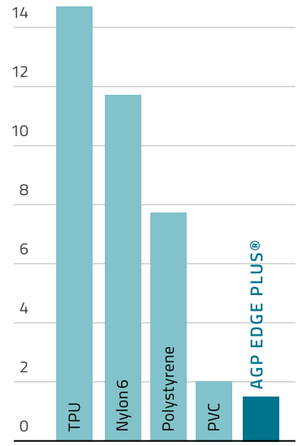
One of the major issues with the life cycle of standard transparent armor designs is the penetration of chemicals and/or moisture into the edge of the laminate. This penetration of foreign material typically results in the failure and replacement of the transparent armor due to delamination. In response to this issue, AGP has developed a state-of-the-art edge seal barrier called Edge Plus®. Edge Plus® was developed through multiple iterations of testing off-the-shelf and new material designs.

Through the use of these advanced materials and processes, AGP has developed a solution that we believe exceeds other market offerings. As referenced in the graphic to the right, Edge Plus® mitigates the ingress of moisture and chemicals into the transparent armor laminate thereby extending the life cycle of the product. In most cases, the incorporation of this material enables AGP to offer an extended warranty for our transparent armor products.

POLYMER	Sika 256	U–438	Sulfuric acid	Toluene	Ethyl acetate	Ketones	Acetic acid
Low density polyethylene	+	+	/	/	/	/	+
High density polyethylene	+	+	+	/	+	/	+
Polypropylene	+	+	/	/	/	/	/
PVC – Polyvinyl chloride	+	+	/	–	–	+	–
Polyacetal	+	/	–	/	/	/	+
Polyamides	+	–	–	+	+	+	/
Edge Plus®	+	+	+	+	+	+	+
Thermoplastic Polyurethane	/	–	/	–	/	/	–

Description for above table.

WATER VAPOR TRANSMISSION OF VARIATED POLYMERS



Water grams / 24 hours 1mm thickness / 100 in² area /100°F / 90%

Ballistic performance at extreme temperatures

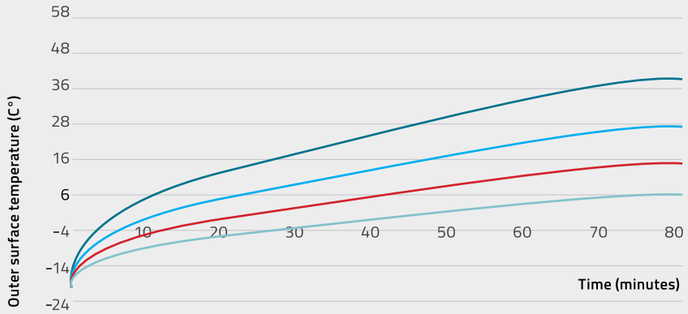
Mechanical properties of the materials in standard transparent armor compositions are typically affected negatively by extreme temperatures. The results of such extreme temperature exposure can radically reduce the ballistic performance of transparent armor. However, through the use of advanced technologies and manufacturing processes, AGP has been able to develop compositions that offer complete ballistic protection at extreme temperatures without substantial changes to weight and thickness.

To validate this, AGP has performed multiple V50 tests comparing transparent armor developed for extreme temperatures and those without it. For example, samples with and without our low temperature protection were shot at +36 °C. The samples without our protection system showed an increase of 3% in the VSO in comparison to those without it.

A similar result was found in samples tested with our high temperature protection. The combination of both systems in a sample (protection from high and low temperatures) showed an increase in the V50 within a range of temperatures with only a slight increase in real density.

De-icing system

AGP offers a de-icing system capability for our transparent armor products through the incorporation of either a sputter-coated polymer, or a pyrolytic- coated glass. In either case, the outer surface of the glass is heated to an optimal temperature in order to reduce the presence of ice on the surface of the window.



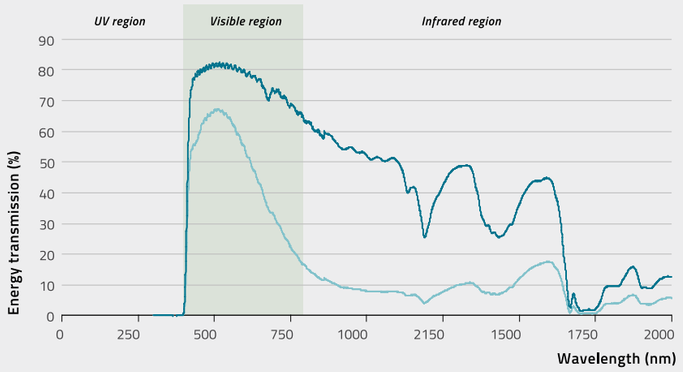
Outer surface temperature of a 56mm bullet-resistent glass (STANG 2) vs time (for 4 different densities)

Power density A
Power density B
Power density C
Power density D

The system can be designed to work within the power density profile limits of most military vehicles. The vehicle power density is directly related to temperature increase rate and final temperature of the system. The higher the power density, the steeper the slope of the temperature profile and the higher the final tempera- ture of the system. The temperature profile of the outer surface of a 56mm thick bullet-resistant glass is referenced in the graph to the left.

Light transmittance in heating systems

Equipment such as night vision cameras, goggles and sensors all operate by trans- mitting signals or waves through the windows of the vehicle. Metal coatings, which are used for de-icing or heating systems in bullet-resistant glass, usually block these signals as the metal acts as a shielding material. Therefore, the bullet- resistant glass supplier must carefully choose the type of coating material in order to minimize this IR blocking effect.



Electromagnetic spectrum of soda-lime float glass vs low iron soda-lime float glass 56mm bullet-resistant glass (Stanag 2)

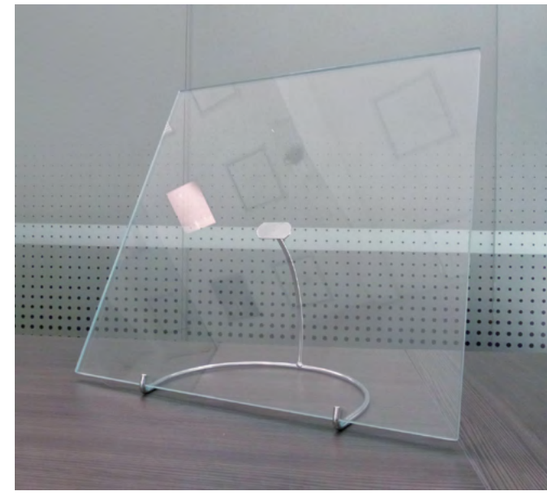
Soda-lime float glass
Low iron soda-lime float glass

As a result, AGP utilizes a special material that, when combined with low iron soda-lime glass, offers a high level of energy transmission, thus enabling the passenger and vehicle systems to operate properly.

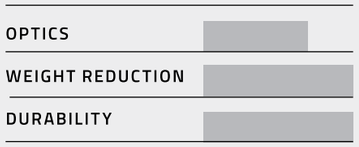
Ceramics

Ceramics have been revolutionizing the defense industry. Their high mechanical properties make them an ideal material to produce high- quality and low-weight armor. With only a small increase in density, ceramics achieve more than twice the hardness and almost four times the stiffness of glass.

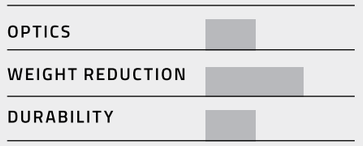
The biggest challenge for transparent ceramics so far has been to develop large bulk pieces. The only option has been to use a ceramic tile array, for which dealing with the visibility and the durability of the joints has been an unsolved issue. However, AGP now offers high quality flat and bulk transparent ceramics with sizes up to 1m². These large ceramic panels can be laminated with other performant transparent materials to fabricate the lightest armored windshield without having any joints.



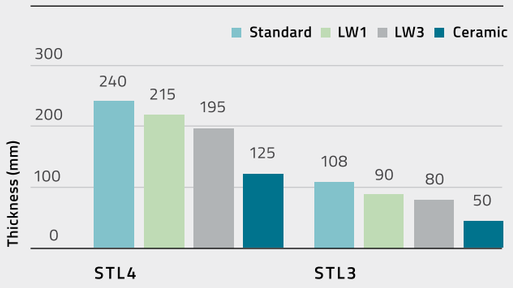
AGP Monopart ceramic (no joints)

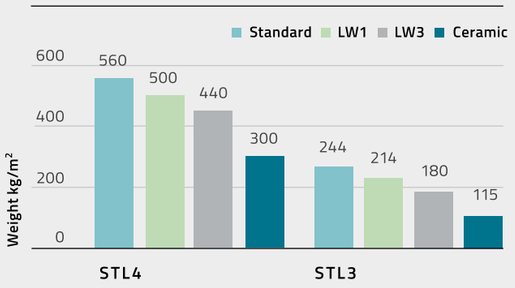


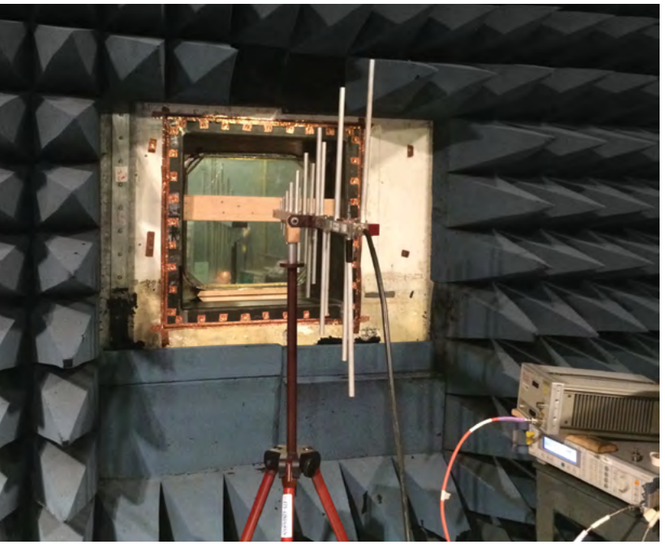
Ceramic glued tiles



Difference in weight and thickness between standard compositions and compositions with ceramics







Electromagnetic interference

AGP offers an EMI shielding solution that protects by absorption or reflection of the electronic devices of external EMI attacks.

This feature is designed with a metallic interlayer connected to a mesh, assembled to reduce the points of entry ensuring quality performance on frequencies ranging from 9kHz to 40Ghz. Using several types of antennas, the solution is tested on external labs in accordance with MIL-STD 83528 and MIL-STD 285. Especially developed to test metallic plates and glass, this solution is compatible with our heating products (Heatplex and tungsten wires) in accordance to the MIL-STD-461G. Our EMI solution works on several ballistic compositions and different shapes and sizes of the BRG.

Chemical reaction on polycarbonate spall-shield

Durability is one of the biggest issues with organic materials like polycarbonate which is usually used on the inner surface of transparent armor. Damage to this area can affect the optical and ballistic performance of the product. That is why AGP has worked to develop innovative solutions to improve the performance of the inner face.

Dura-P provides additional protection against chemical attacks as seen in the table below. Samples were tested under the ANSI SAE/Z-261 chemical resistance test done in an internal laboratory in November 2017. While cracks appeared in standard compositions under the three different threats, there was no damage to the solutions with Dura-P technology.

This technology has also increased scratch resistance and uses self-extinguishing materials that do not produce toxic fumes. It can be used on any of our products on all ballistic levels. The increased durability of the product is reflected in the additional year added to the warranty.

CHEMICAL SOLVENTS	STANDARD COMPOSITION WITH POLYCARBONATE	COMPOSITION WITH AGP DURA –P
GASOLINE	Does not conform	Conform
GLACIAL ACETIC ACID	Does not conform	Conform
THINNER	Does not conform	Conform

Chemical reactions of agents in polycarbonate

Cracks on polycarbonate due to a chemical reaction

Blast pressure

This feature is related to glass resistance when there is exposure to accidental or intentional explosions that could cause personal injuries by glass fragments. The pressure is created by air blast loadings, fire balls or brisance. Our solution has been developed with the shock tube method (CEN 13541:2012) for low pressure and long-lasting explosions, tested in a European laboratory suitable for testing the effects of large and industrial explosions (as 8000 m/s for high-grade military explosives). All our products with thicknesses above 19mm including our Dura solutions on the inner side are able to withstand blast pressure.

We have also designed a solution that reduces crack propagation on the edges and surfaces, which work to resist peak up pressures from ER1 (0,5Bar – <20ms) to ER4 (2.1Bar – 42ms).

Shock tube – copyright: Fraunhofer EMI

SOCIAL MEDIA

in AGP Group

in AGP Defense

AGP Group

www.agpglass.com

CONTACT

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NAVAL APPLICATIONS:
agpmarine@agpglass.com

LOCATIONS

MANUFACTURING PLANTS
Belgium, Brazil, Colombia, Peru

BUSINESS UNITS
Australia, Egypt, Germany, Guatemala, India, Japan, Mexico, Spain, South Africa, United Arab Emirates, USA, Venezuela