Civilian Armored Vehicle Forum

Transparent Armor – Current developments and issues

Geneva, 25.10.2023

Christoph A. Schulz

AGP

LEADING MANUFACTURER OF
TRANSPARENT ARMOR SYTEMS AND
HIGH-TECH SPECIALTY GLASS

1) Bullet Resistant Glass – what it is / functionality

2) Challenges with Bullet Resistant Glass

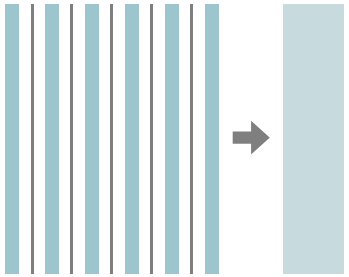
3) What is important from an End-User perspective

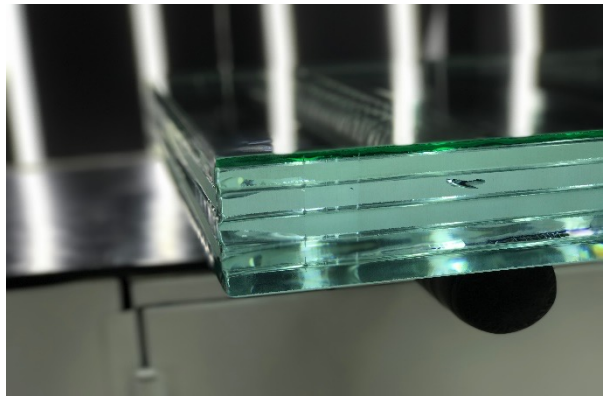
4) AGP Group

Bullet Resistant Glass – what it is / functionality

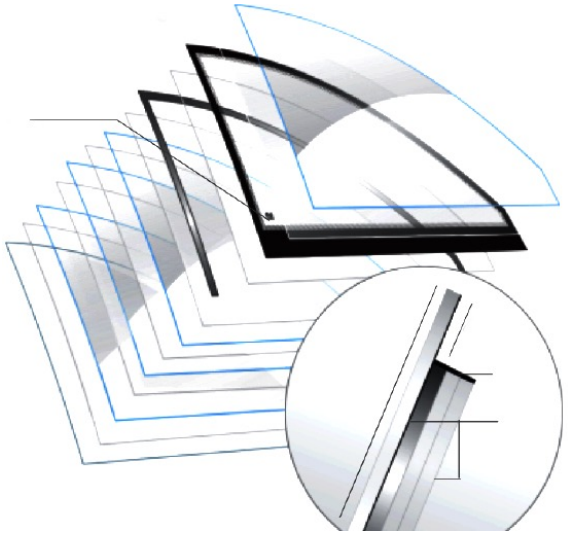
A complex composite

GLASS COMPOSITION WITH FIVE GLASS LAYERS: 71 mm and 160 Kg/s.q.m.

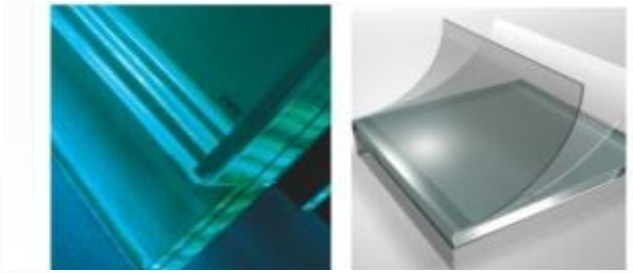


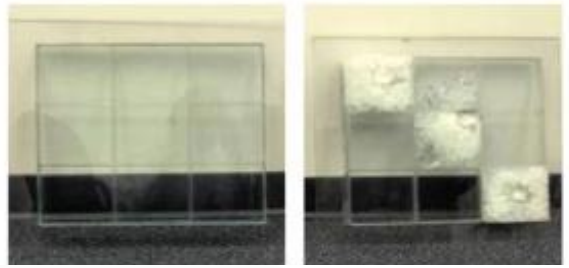


- 11 MATERIALS
- 22 SURFACES
- 20 SURFACES FACING EACH OTHER

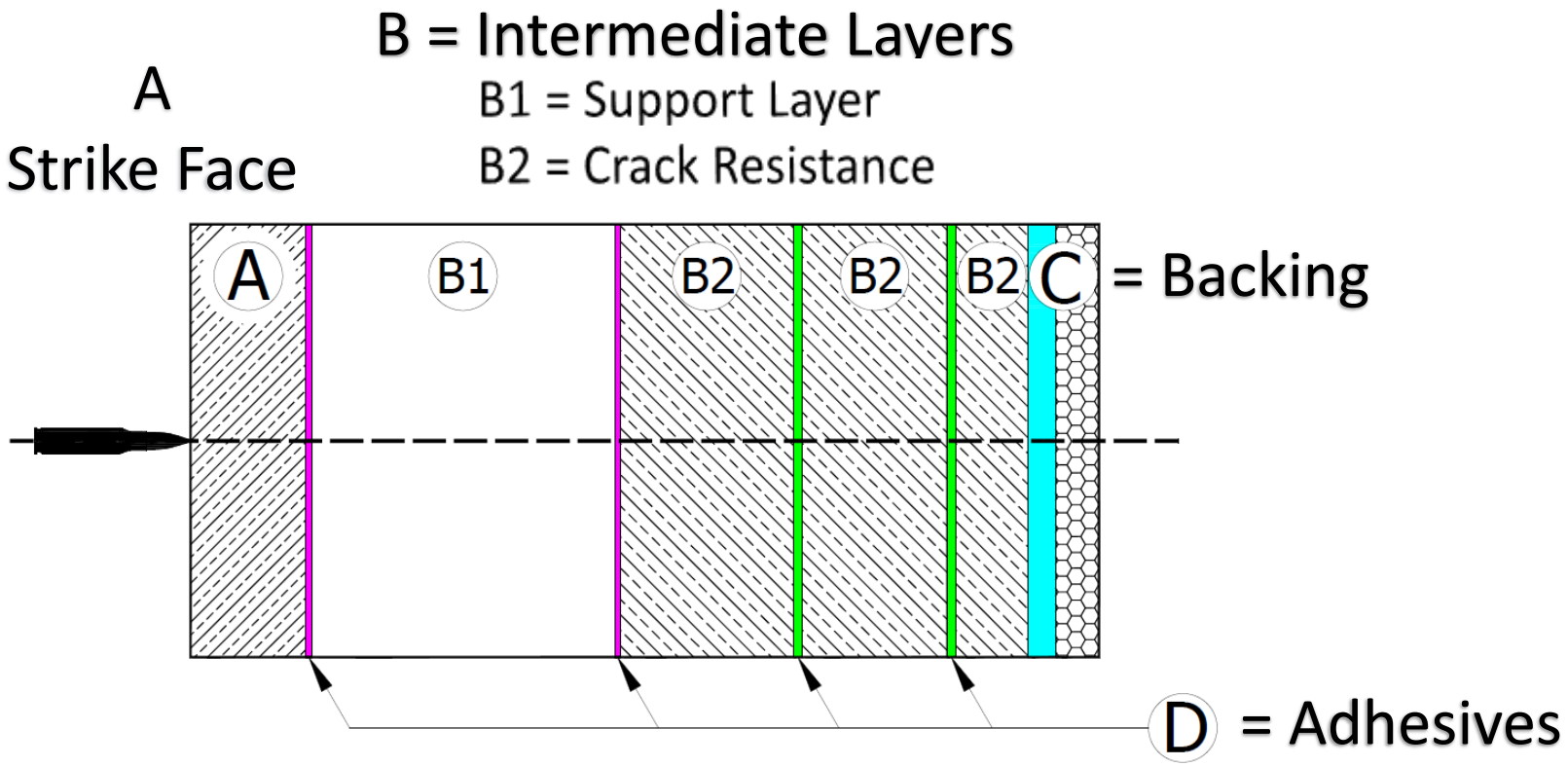


1. OUTER GLASS
2. PACKAGE
3. EDGES
4. OFFSET
5. BLACK BAND AND DOT MATRIX
6. SUN BAND (Windshields)
7. HEATING MAT
8. GUN PORTS

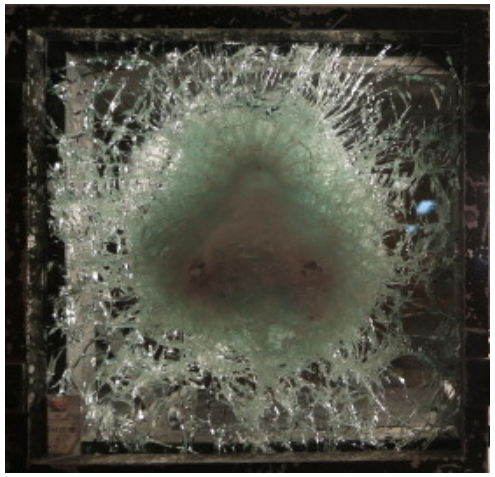




Bullet-resistant glass sections



STRIKE SURFACE



BACKING

Impact dynamics in bullet-resistant glass

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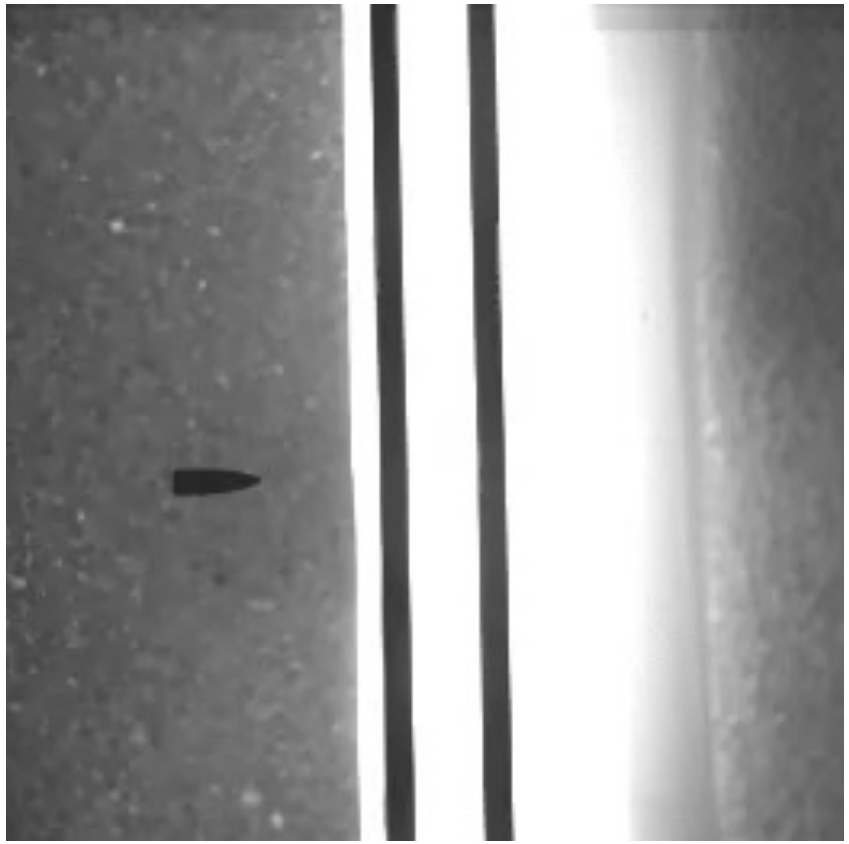
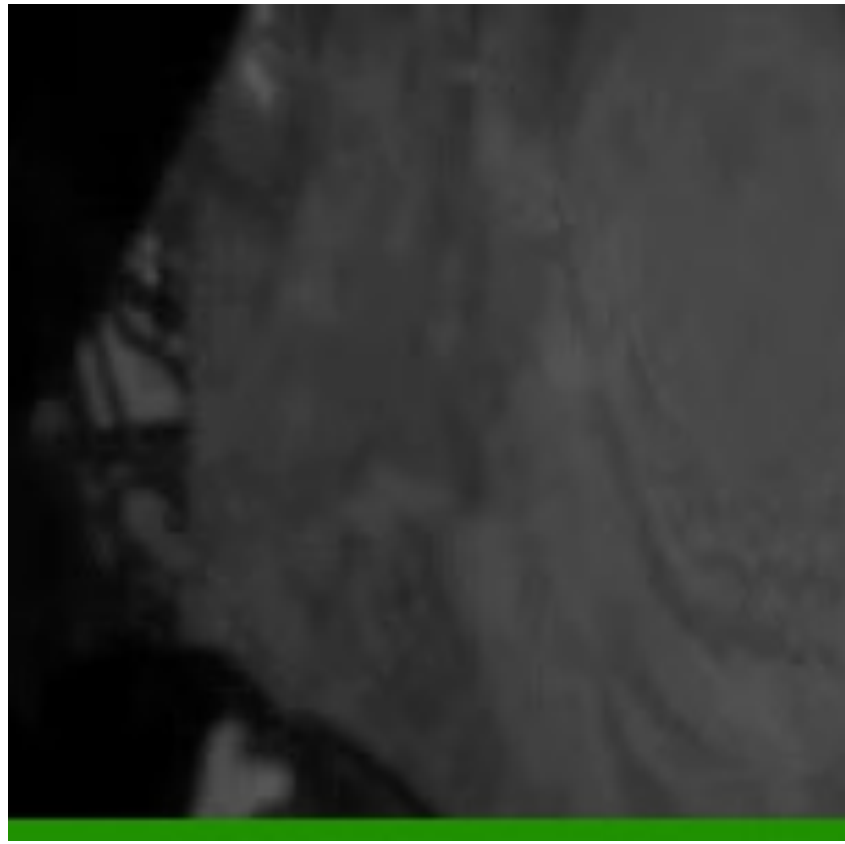




Strike Face

Energy absorption (intermediate layers)

Spall shield (backing)

Challenges with Bullet-Resistant Glass

Challenges - Durability

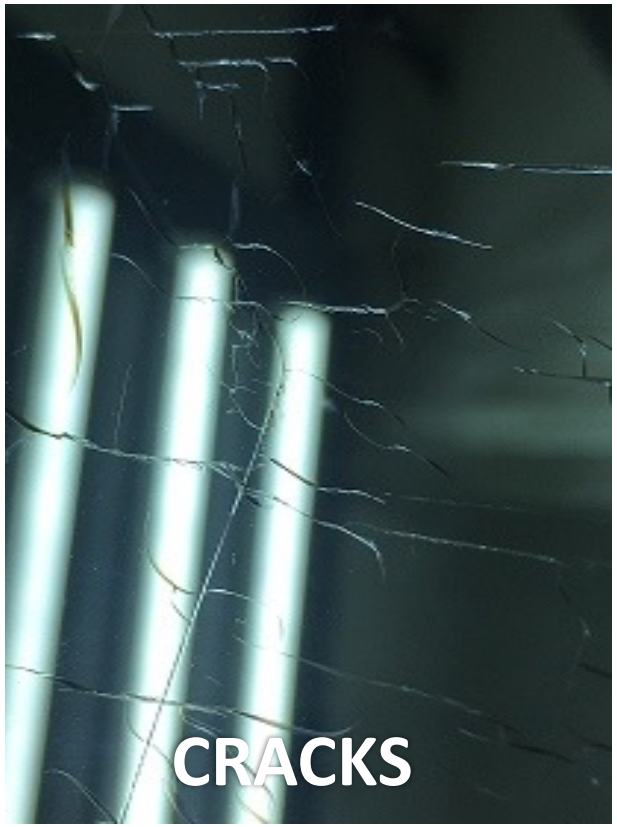
DURABILITY – INTERNAL FACTORS

Vacuum control
Autoclave cycles

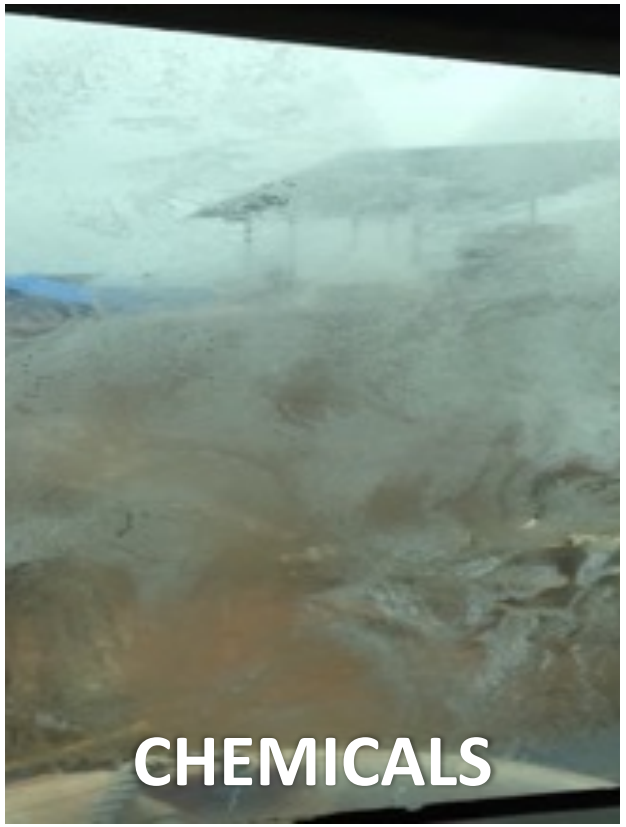
Autoclave cycles
Quality of organic materials
Edge sealing

Challenges - Durability

DURABILITY – EXTERNAL FACTORS



Handling
Treatment



Handling
Treatment

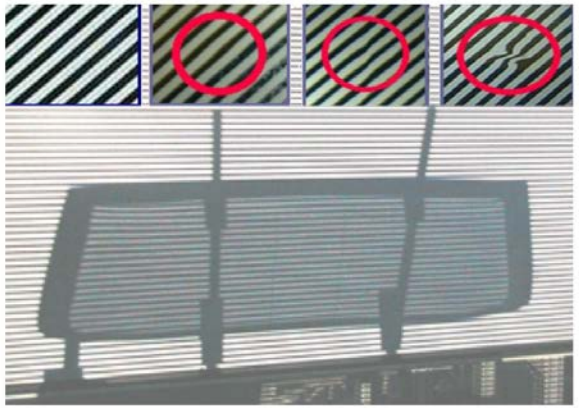
Design
Environmental Influences
(UV, IR, Temperature exposure, humidity, saline environment)

External factors vary between climatic areas in the world

Challenges - Optics

In addition to the protection armored glass provides, the **clear transmittance of reality** is vital. For this reason, **AGP** has implemented unique compositions and a **strict optical quality control** to ensure transparency and optical compliance, without jeopardizing **ballistic performance.**

Challenges - Optics



Optical distortion

Double image

What is important from an End-User perspective

Bullet resistant vs. bullet proof

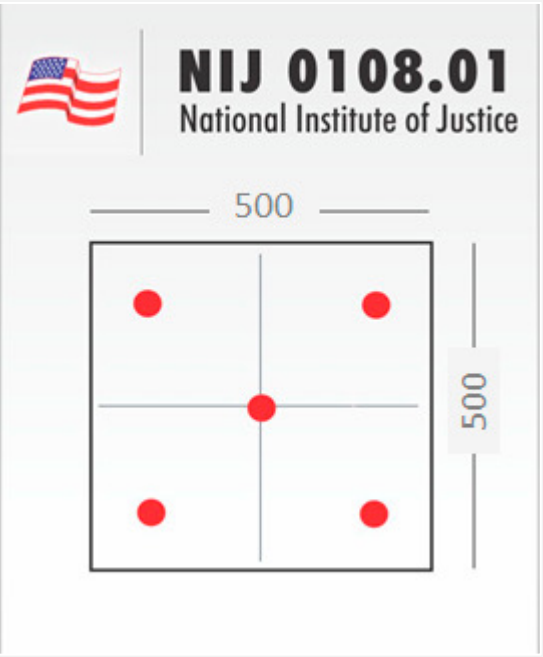
There is no bullet proof material and no bullet proof vehicles

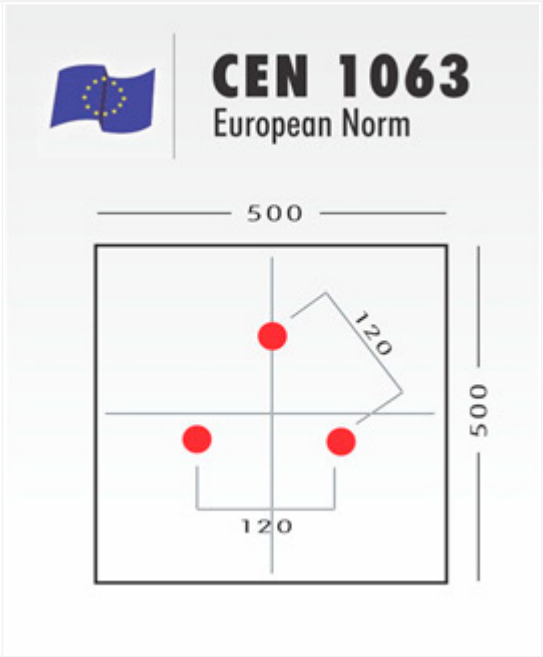
But: there is bullet resistant material and bullet resistant vehicles according to a well selected ballistic standard

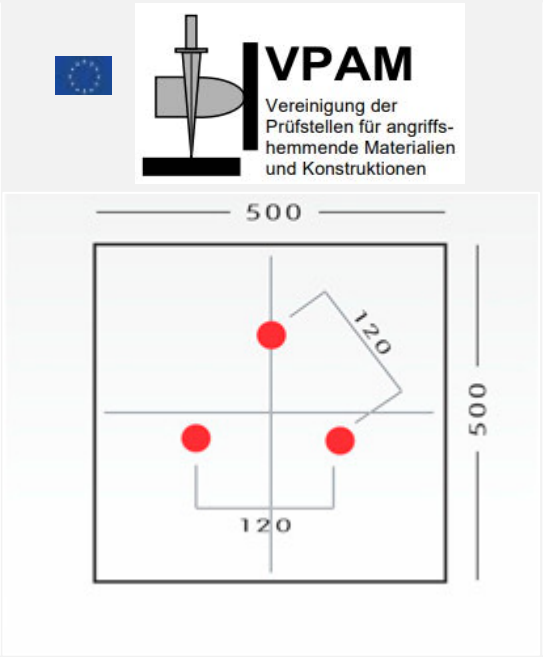
Protection is always relative, and you can always penetrate a material or vehicle by facing a higher threat
e.g. using a 7.62x51 Nato Ball ammo (VPAM Level 7) or a 7.62x51 Armored Piercing ammo (VPAM Level 9)

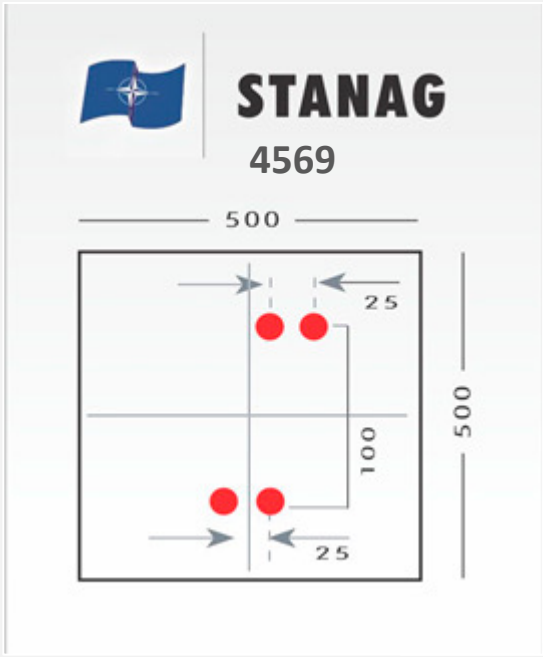
- VPAM Level 7: typical thickness of bullet resistant glass is 40mm / 91 kg/m²
- VPAM Level 9: typical thickness of bullet resistant glass is 70mm / 161 kg/m²

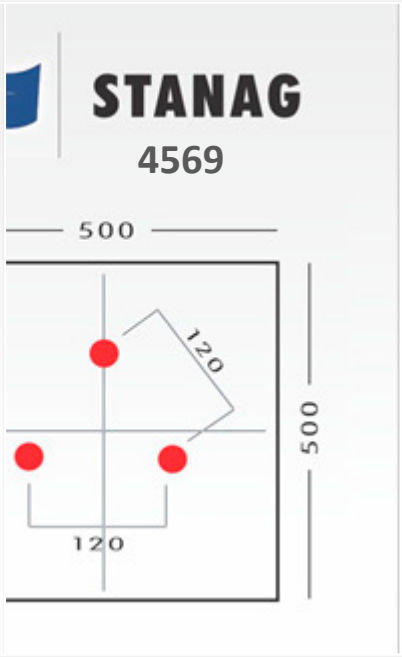
Threat definition: Material

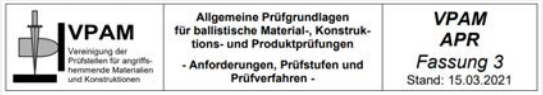


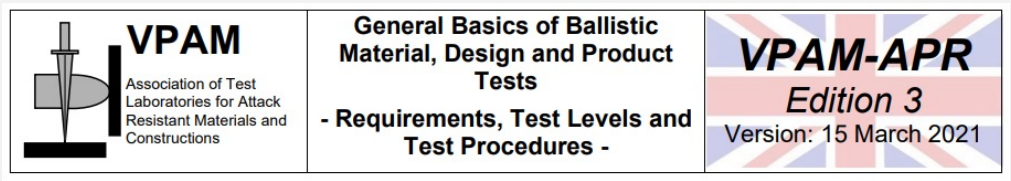












STANAG alternative multihit shooting pattern for transparent armor.
STANAG partial L1 to L3

Threat definition: Armored vehicles

VPAM
Vereinigung der Prüfstellen für angriffshemmende Materialien und Konstruktionen

Test guidline “Specially protected vehicles” according to VPAM BRV Edition 3:

This test guideline for specially protected vehicles regulates the procedure which, on the one hand, ensures reproducible results by standardizing the test and test effort and, on the other hand, provides customers and users of these vehicles with more market transparency by allowing them to objectively compare products from different providers that have been tested according to the same guidelines.

Test guidline “Armored vehicles – explosive resistance” according to VPAM ERV 2010 Edition 2 and VPAM-ERV Edition 3 (new evaluation criteria with biofidelic dummy)

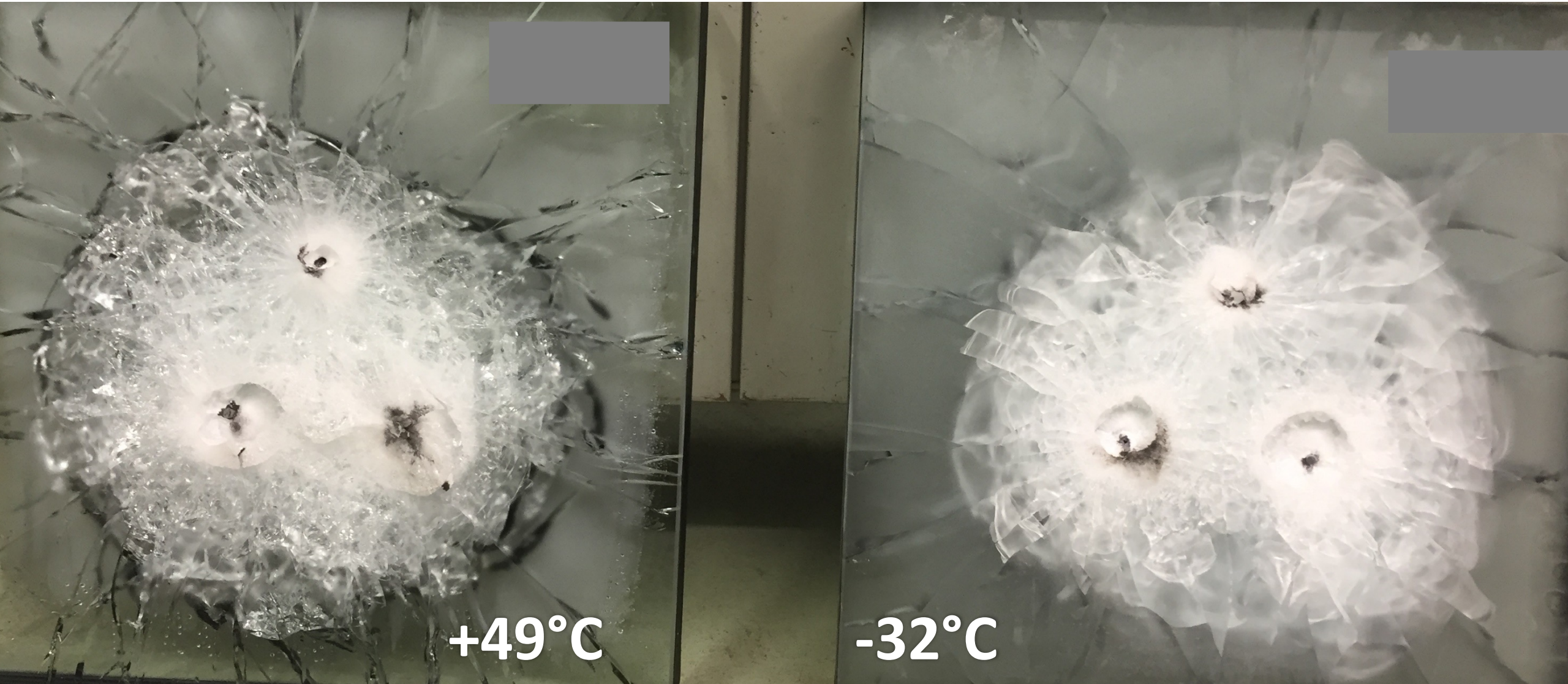
Ideal outcome: Armored vehicle certified in accordance with VPAM BRV Edition 3 and VPAM ERV Edition 3

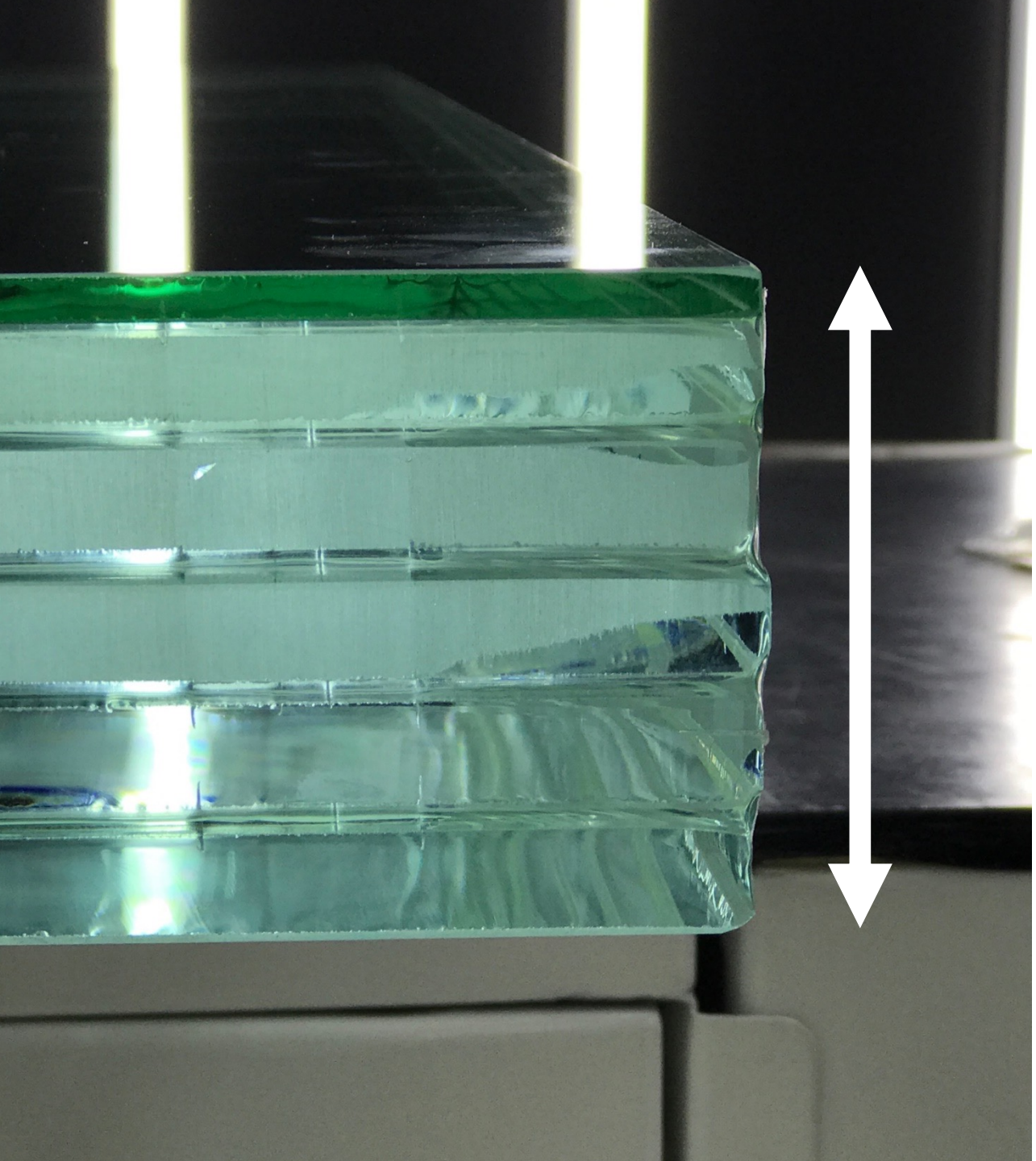
Environmental qualification testing

- ARMED FORCES increasingly demand for environmental qualification (according to TL2350-0006, US ATPD 2352; MIL STD 810)
- Longer durability of materials (from 2-5 years)
- Exposure to extreme environmental conditions

Ballistic integrity at extreme temperatures

Definition of temperature range



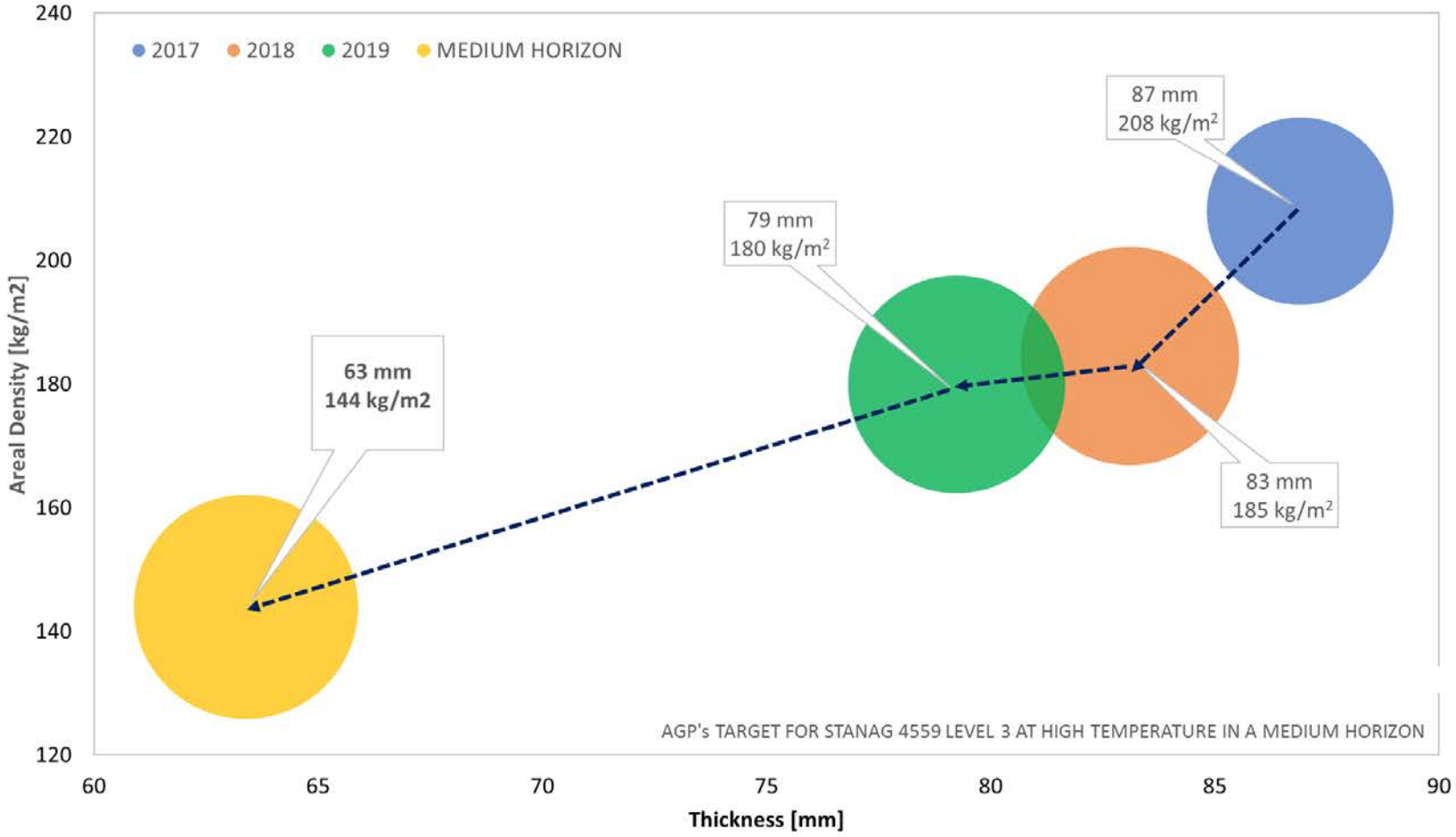


Reduction of weight (areal density)

- HIGHER PROTECTION WITH LESS WEIGHT
- UTILIZATION OF NEW MATERIALS AND PROCESSES TO REINFORCE THE TRANSPARENT ARMOR

Development of transparent armor solutions

7.62 mm x 51 WC: STANAG L3 at +49/-32 °C



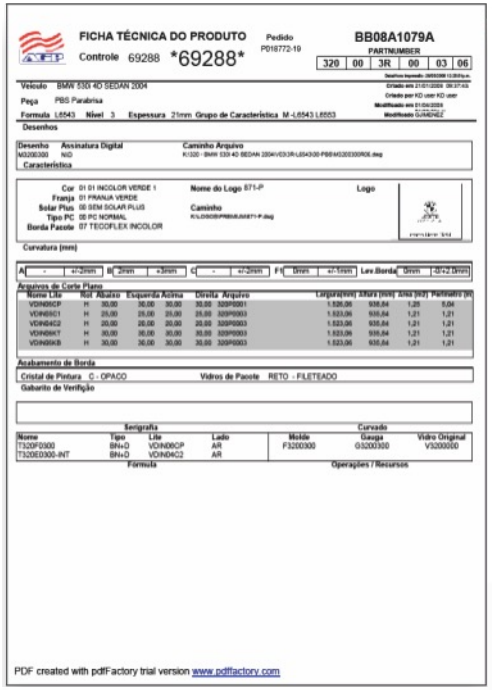
Bullet Resistant Glass with **very high light transmission values** for compatibility with **night vision goggles and cameras.**

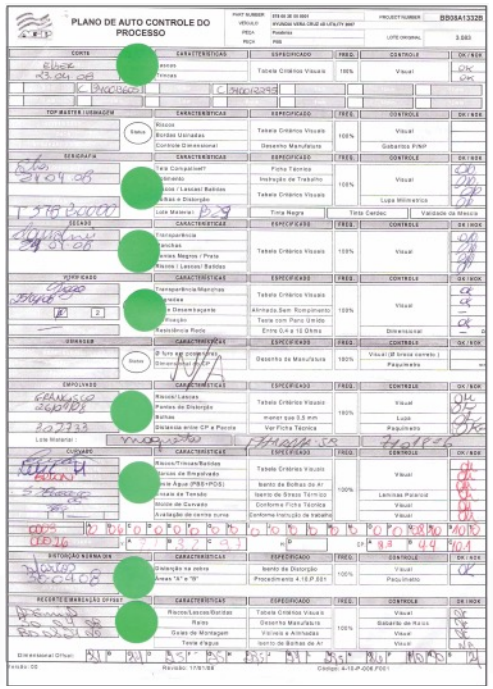

Luminous transmittance
(e.g. +75% in 100mm glass)

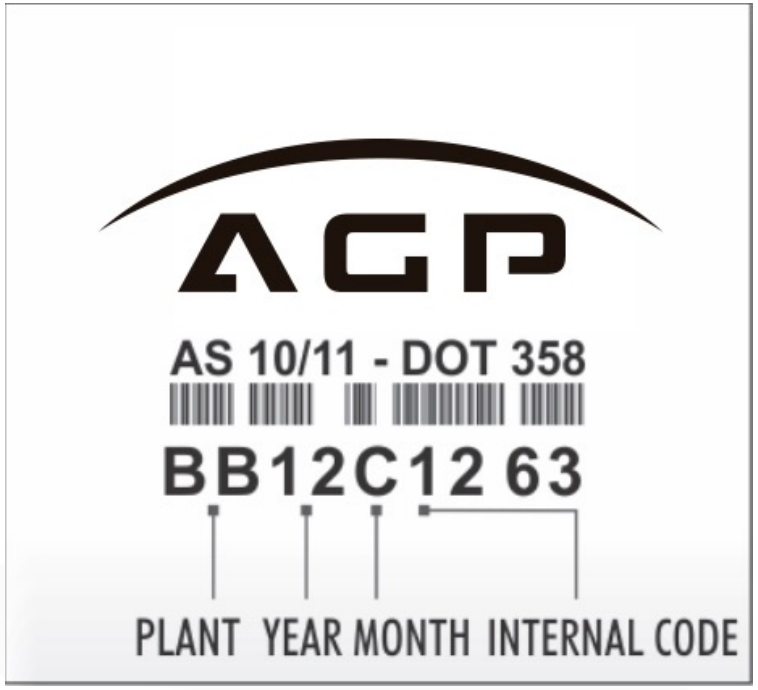
Traceability

ROAD MAP control process audited by OEMs and ARMED FORCES

Every piece of glass produced has its own specific process file to guarantee fulfillment of all technical specifications, as well as a unique serial number which allows for full traceability and after-sales tracking.







Enhanced Durability

AGP EDGE PLUS® performance has been verified by aging testing applied to the AGP BRG under the method PV12000 “Testing of resistance to environmental cycle test”

Edge Plus ® provides extended durability

Enhanced Durability

- Resistance against chemicals (DURA P, G, NPC)
- Scratch resistant (DURA G)
- Extended warranty periods from 3-5 years

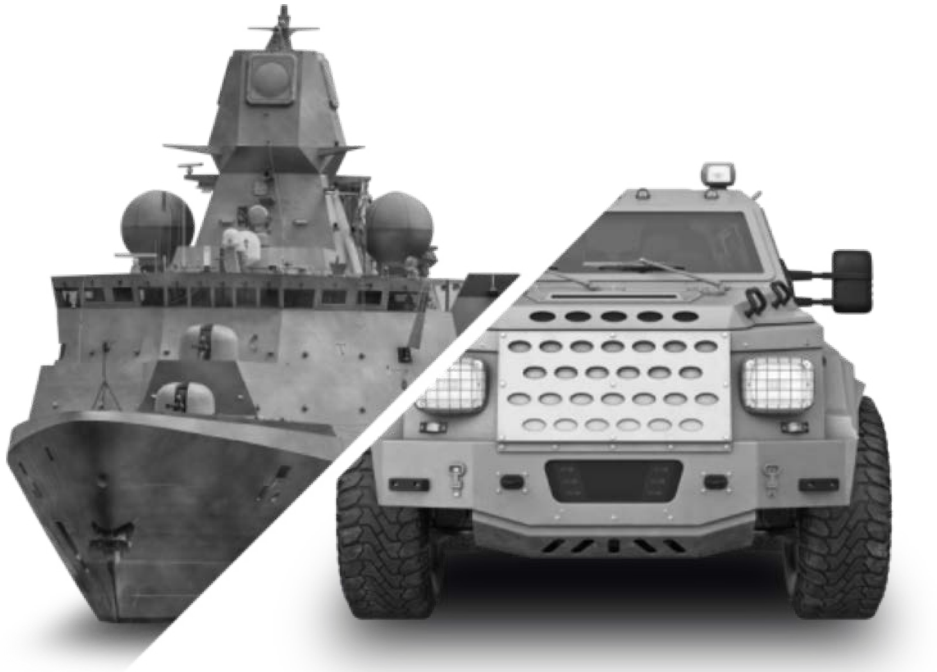
AGP Group

DEVELOPMENT AND PRODUCTION OF COMPLEX GLAZING SOLUTIONS SINCE 1965

It all started in Berlin, at the beginning of the last century, with the Mannheim family's first glass company. After 100 years and a clear vision of becoming leader in designing and manufacturing complex glazing, the company's core technologies respond to rising demands in performance, durability, optics and complex geometries.

AGP SGLASS

Bullet resistant glass for civilian armored vehicles



Transparent armor systems for land and naval platforms

AGP EGLASS

High-tech glazing solutions for the future of mobility, tailored for electric and autonomous vehicles

SIX PLANTS

Four in South America and two in Europe

2500+ EMPLOYEES

Over 15 nationalities in over 13 locations

ISO CERTIFIED

ISO 9001:2015, IATF 16949, ISO 14001:2015, ISO 45001:2018

80.000 m²

Production capacity of armoured transparencies per year

Key manufacturing points

- Press & gravity bending capacities for complex medium to large laminated geometries
- Flat processing and chemical toughening for small and large formats.
- Mechanical edge and laser surface edge deletion for metallic coating capacity for Solar Control and EMI shielding

Local Support
GLOBAL PRESENCE

- Tech Centers
- Current manufacturing plants: sGlass
- Current manufacturing plants: eGlass
- Future manufacturing plant
- Future AVO plant

- Commercial Units: Germany, USA, United Arab Emirates, Japan, Korea, Australia, South Africa, India, Egypt, Spain, Argentina, Mexico, Singapore.

TRUSTED BY OVER 1.000 COMPANIES AROUND THE WORLD

LAND SYSTEMS

RHEINMETALL DEFENCE
GENERAL DYNAMICS European Land Systems
THALES
KOMATSU
NIMR
Kovico
TATA
Patria
ST Engineering Land Systems
URO
ASHOK LEYLAND
EXCALIBUR ARMY
TATRA DEFENCE VEHICLE
Soframe
SISU

NAVAL PLATFORMS

Navantia
thyssenkrupp
CANTIERE NAVALE VITTORIA
COTECMAR
MARINE ALUTECH OY AB
DOCKSTA VARVET
ST Engineering Marine
MITSUBISHI HEAVY INDUSTRIES
OCEA
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CIVILIAN PLATFORMS

STOOF International
BMW
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VOLVO
THE ARMORED GROUP
REPETTI SPA

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TESLA
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VOLVO
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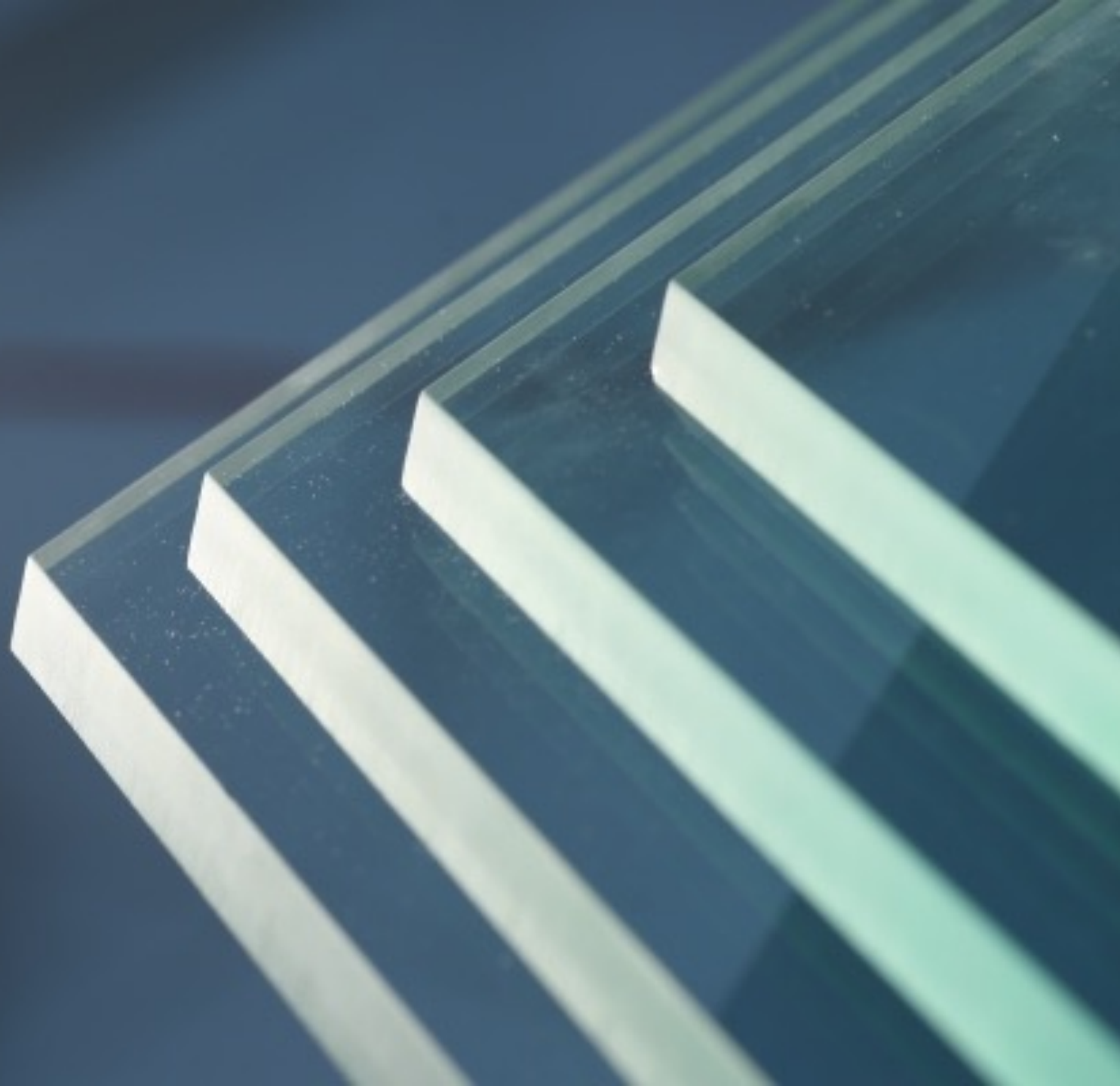
McLaren

Contact:
Christoph A. Schulz
Director sGlass Europe
+49 151 525 766 71
cschulz@agpglass.com



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