Vetrotech Saint-Gobain

Blast resistant systems

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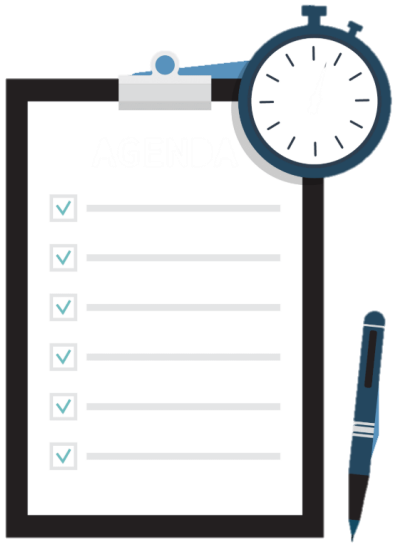
Agenda

1. Standards you need to know
2. EN 13541 – Glass testing
3. EN 13123-2 and EN 13124-2 – System testing by Range test
4. EN 13123-1 and EN 13124-1 – System testing by Shock tube
5. Common Applications




High Security Range

Need for high security solutions

Each scenario is different, and the potential risks must be evaluated for each situation and location.

Physical attack
(planned attacks & opportunistic damage like intrusion and theft)

Ballistic impact
(firearms of various calibres, including handguns, rifles & shotguns)

Explosive impact
(satchel, car bombs, chemical or gas accidents)

High-Security Glass and Framing Systems Testing & Classification Standards

BLAST RESISTANCE

Keep people safe from explosions.

Glass	Tested as per EN 13541	EN 13541 – Glass in Building – Security Glazing. Testing and Classification of resistance against explosion pressure
Systems	Tested as per EN 13121-1, -2, 13123-1,-2, 13124-1, -2	EN 13123-1,– Windows, Doors and Shutters, Explosion resistance – Requirements and Classification by Shock Tube EN 13124-1 - Windows, Doors and Shutters, Explosion resistance – Test Method by Shock Tube EN 13123-2 - Windows, Doors and Shutters, Explosion resistance – Requirements and Classification by Range Test EN 13124-2 - Windows, Doors and Shutters, Explosion resistance – Test Method by Range test

Blast resistant standards

Definitions

Maximum Overpressure

- Pressure which is measure near the specimen when blast wave hits and reflects back

Positive Specific Impulse

- Total energy / Force which is delivered by the shock tube.
- Higher value and Higher damaging energy

Duration of overpressure phase

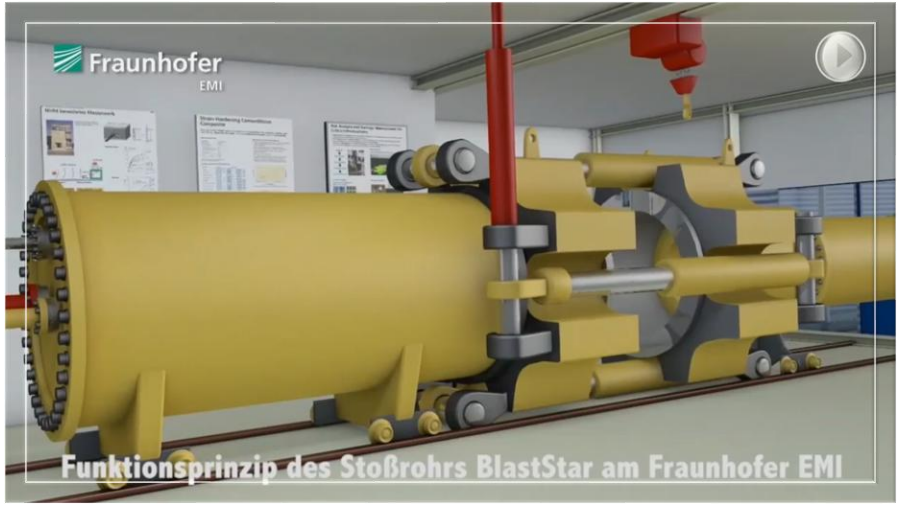
- How long the specimen stays in positive pressure phase.

The Shock Tube Test for Blast Resistant Glass

EN 13541

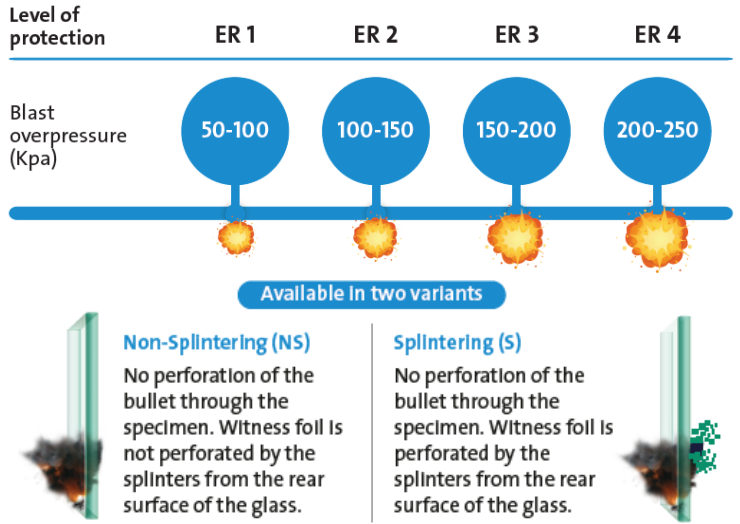
Requirements for the shock tube test

- ✓ The glass is subjected to blast overpressure in this test
- ✓ The blast should not create any 'see-through' opening on the glass



When tested as per EN 13541

Resistance-class EN 13541	Reflection-pressure	Positive specific impulse	Duration of positive pressure
	PR (Kpa)	Kpa ms	ms
ER 1 (S/NS)	>50 <100	370 - 900	>20
ER 2 (S/NS)	>100 <150	900 - 1500	>20
ER 3 (S)	>150 <200	1500 - 2200	>20
ER 4 (S/NS)	>200 <250	2200 - 3200	>20



The Shock Tube Test for Blast Resistant Glass

EN 13541

Test Specimen

- ✓ 900mm X 1100mm
- ✓ 3 Test pieces
- ✓ The glass should not have any see through holes
- ✓ No holes are permitted within the clamping frames and the edges of the test specimen.

Test Setup

- ✓ Rigid Structure to hold the specimen steady
- ✓ Uniform clamping along the edges over a width of (50 ± 10) mm applied with pressure of (14 ± 3) N/cm²
- ✓ A peripheral shield at least 1000mm wide or positioned to meet the blast wall surrounding the specimen edges.
- ✓ Plane to the specimen - parallelly placed

Device for generating the explosive blast

- ✓ A shock tube or a similar device, which hits the specimen directly and consistently.
- ✓ The overpressure phase should be of a form which can be related to that from a spherical charge of a known weight of trinitrotoluene (TNT) detonating at a known distance.

Measuring Device

- ✓ Capable to measure the magnitude and time of development of the overpressure of the shock wave reflected from specimen

Testing Condition

- ✓ (18 ± 10) °C.

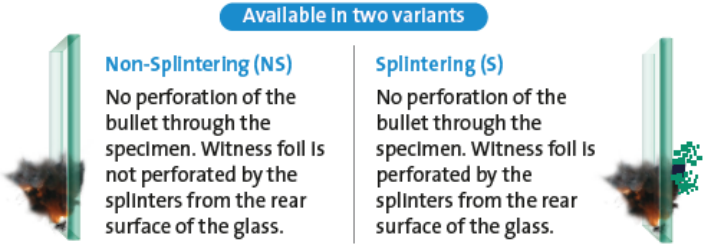
Range test for Blast resistant systems

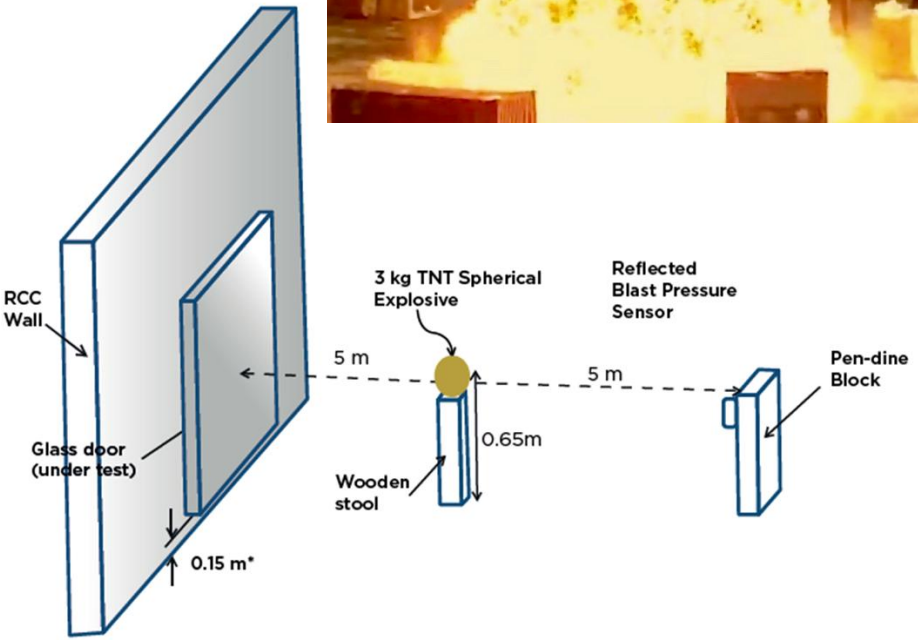
EN 13123-2, EN 13124-2

Requirements for the range test

- This test method against blast waves in open air resulting from high explosives that can be carried by hand is placed a few meters from a target (windows, doors, or shutters).
- It covers the behavior of the complete unit including infill, frame and fixings.

When tested with respect to load conditions as per EN 13123-2 and EN 13124-2





*Lowest edge of the Glass door at height of 0.15m from ground

Range test for Blast resistant systems

EN 13123-2, EN 13124-2

Test Specimen

- Actual door, window, or shutter.

Test Setup

- Rigid Structure to hold the specimen steady
- 200mm perimeter support all around the specimen
- 800mm set back of rear face of the test specimen
- Min. 2.4x2.4x0.8m

Table 1 — Classification, charge mass and range

Classification code	Charge mass (kg)	Stand-off (m)
EXR1	3	5,0
EXR2	3	3,0
EXR3	12	5,5
EXR4	12	4,0
EXR5	20	4,0

Evaluation

- No perforation or opening where a 10mm dia blunt rod can easily pass through.
- No opening between the test frame and the specimen by 10mm
- No opening by detachment of material from the test specimen
- No detachment of material from the rear side of test specimen.
- The locking mechanisms must be in lock and secure positions
- S / NS category shall be mentioned

Table A.1 — Peak pressure P_{so} and incident impulse (i_{so})

Class	kg at m	Pressure P_{so} bar	Impulse i_{so} bar/ms
EXR1	3 at 5	0,75	1,05
EXR2	3 at 3	2,30	1,65
EXR3	12 at 5,5	1,70	2,25
EXR4	12 at 4	3,60	3,00
EXR5	20 at 4	6,30	4,20

Shock tube test for Blast resistant systems

EN 13123-1, EN 13124-1

Requirements for the shock tube test

- The blast waves generated by using a shock tube facility to simulate a high explosive detonation on windows, doors and shutters with frames and infills, for use in both internal and external applications.
- Shock tube simulates the force of 100kg to 2500 TNT at a distance from 35m to 50m

Available in two variants

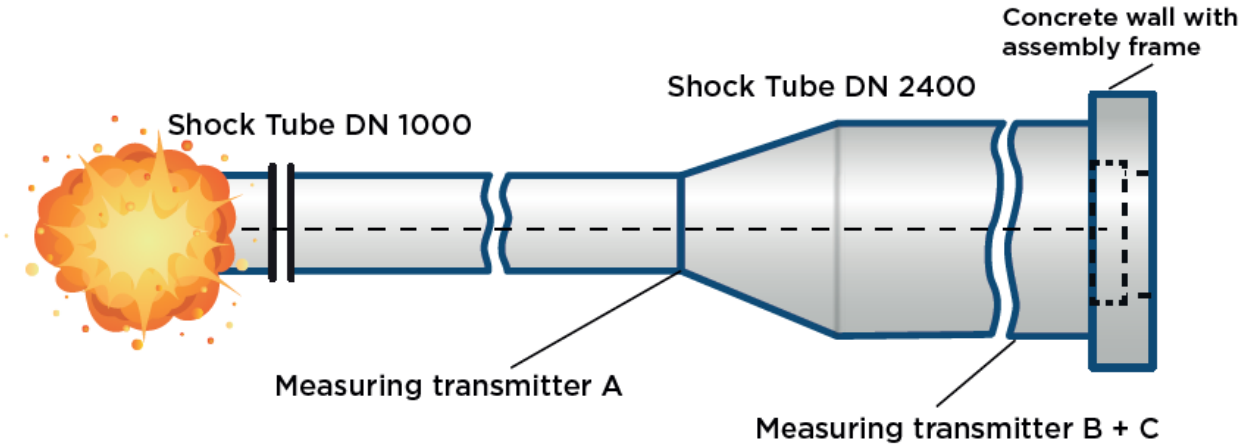
Non-Splintering (NS)

No perforation of the bullet through the specimen. Witness foil is not perforated by the splinters from the rear surface of the glass.

Splintering (S)

No perforation of the bullet through the specimen. Witness foil is perforated by the splinters from the rear surface of the glass.

When tested as per EN 13123-1 and EN 13124-1



Shock tube test for Blast resistant systems

EN 13123-1, EN 13124-1

Table 1 — Characteristics of the shock wave

Minimum values of:		
Classification code	**Peak pressure** P_{max} bar [a]	**Positive specific impulsion** i_+ bar-ms
EPR1	0,50	3,7
EPR2	1,00	9,0
EPR3	1,50	15,0
EPR4	2,00	22,0
[a] The duration of the positive phase (t_+) shall be not less than 20 ms		

Measuring Devices

- Thermometer for Ambient temperature measurement
- Barometer for Ambient pressure measurement
- Pressure gauges of measuring the pulse wave
- Witness panel at 3m distance from the rear end of the test specimen
- High Speed Camera

Evaluation

- No perforation or opening where a 10mm dia blunt rod can easily pass through.
- No opening between the test frame and the specimen by 10mm
- No opening by detachment of material from the test specimen
- No detachment of material from the rear side of test specimen.
- The locking mechanisms must be in lock and secure positions
- S / NS category shall be mentioned

Blast resistant systems

Common Applications

Government & Military

- ✓ Embassies and consulates
- ✓ Military bases and defense buildings
- ✓ Courthouses and government offices
- ✓ Research facilities
- ✓ Defense storage

Specialized Applications

VVIP Guest Houses

Secure control rooms

Applications: Hazardous Industrial Sites

- ✓ Oil refineries
- ✓ Gas plants
- ✓ Chemical processing facilities

Thank you

Any Question