

GGF Recommendations for Blast Mitigation: Adhesive Backed Polymeric Film Applied to Glass

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Introduction

This standard has been developed by the GGF **Window** Film Group, in association with all major film manufacturers, to clarify recommendations concerning the use of safety film applied to glass for blast mitigation purposes.

1. Scope

This standard gives recommendations for the use of adhesive backed polymeric safety film ("safety film") applied to glass for reducing the risk of injury from glass shattered in an explosion. It does not give guidance concerning peel testing of aged safety film (see GGF Datasheet 5.18.7 "GGF Standard for On-Site Peel Adhesion Testing of Aged Adhesive Backed Polymeric Film Applied to Vertical Flat Glass").

2. Definitions and Description

2.1 See GGF Datasheet 5.18.3 "GGF Recommendations for Adhesive Backed Polymeric Film Applied to Glass: Definitions, Descriptions and Components".

2.2 Blast Mitigation

Reduction of injuries, property damage and business disruption resulting from glass breakage under explosive pressure.

3. Hazard Rating / Threat Levels

3.1 Systems of Hazard Rating of the risks from shattered glass in an explosion have been developed by the UK Government and other organisations based upon decades of explosion testing, and are being incorporated into international standards such as ISO 16933.

3.2 Figure 1 shows the Hazard Rating system from standard ISO 16933. ISO 16933 uses a range test with 3 m deep test cubicles. Areas defined within the cubicle classify different hazard levels.

3.3 Explosion Properties

It can be difficult if not impossible to define exactly the specific properties and effects an explosion may have on particular buildings and structures around them. However, extensive research has developed substantial practical and theoretical understanding of explosions, allowing protective measures to be taken in order to reduce the effects of explosions to be made with confidence.

3.4 Threat Levels

Two levels of the potential threat of an explosion have been established: Low Threat and High Threat.

Low Threat is for buildings where there is a significant risk of a nearby explosion of approximately a satchel bomb size.

High Threat is for buildings where there is a significant risk of a nearby explosion of approximately a van bomb size.

Although these definitions are given in terms of improvised explosive devices, corresponding definitions can be extrapolated for explosion threats from other sources, e.g. oil refinery plant.

3.5 Recommendations for the use of safety film at these threat levels are given in section 5

4. Risk Reduction with Safety Film

4.1 Safety films on annealed glass are intended to reduce High Hazard to Low Hazard or Very Low Hazard. Safety film on annealed glass with specifically designed containment systems can further improve the performance to Minimal Hazard or No Hazard. (Figure 1 and section 6).

4.2 Risk Assessment

4.2.1 A professional Risk Assessment is required to establish the risks from an explosion for a particular building. This will be dependent upon criteria including the glazing and glass types, size and thickness, the assessed threat, the building location, the building environment, and the usage of the building. The Risk Assessment will also identify the measures required for reducing the risks from an explosion. Installation of safety film is only a part of the overall strategy for protecting people and property in an explosion.



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4.2.2 For specification of safety film, building owners and managers very often select the appropriate safety films based upon a High Threat (see section 3.4), principally because many at risk buildings are in major cities and are close to potential 'targets'. In addition, the cost penalty for the increased protection of higher performing is relatively small.

5. Recommended Safety Films for Blast Mitigation

5.1 The recommendations given below are the minimum levels of protection to be employed against both threat levels (section 3.4). They are based upon the current Home Office Scientific Development Branch (HOSDB) recommendations and publications and the current understanding of the effects of an explosion on glass.

5.2 Safety films for blast mitigation are recommended based upon their performance. This generally means that as film thickness increases, so does film performance, although the expectation is that technology improvements may result in higher performing products without always an increase in thickness.

5.3 These recommendations are not intended to substitute for a professional Risk Assessment but can be used to quickly decide the minimum specification of safety film required for the threat level (section 3.4).

5.4 Recommendations for buildings at Low Threat

The recommendations for use of safety film for a Low Threat from an explosion are given in Table 1.

Table 1: *Low Threat: Safety film recommendations for all pane sizes and thicknesses*

Floor level	Recommendation
All floors	Safety film ≥ 100 microns and meeting BSEN 12600 Class 2B2

5.5 Recommendations for buildings at High Threat

5.5.1 The recommendations for use of safety film for a High Threat from an explosion and where pane size $\leq 3\text{m}^2$ and pane thickness ≤ 6 mm are given in Table 2.

Table 2: *High Threat: Safety film recommendations for panes $\leq 3\text{m}^2$ & ≤ 6 mm*

Floor level	Recommendation
Ground – 11th	Safety film ≥ 150 microns and meeting BS EN 12600 Class 1B1
12th and over	Safety film ≥ 100 microns and meeting BS EN 12600 Class 2B2

5.5.2 The recommendations for use of safety film for a High Threat from an explosion and where pane size $> 3\text{m}^2$ and/or pane thickness > 6 mm are given in Table 3.

Table 3: *High Threat: Safety film recommendations: panes $> 3\text{m}^2$ and/or > 6 mm*

Floor level	Recommendation
Ground – 1st	Safety film ≥ 275 microns and meeting BS EN 12600 Class 1B1
2nd – 11th	Safety film ≥ 150 microns and meeting BS EN 12600 Class 1B1
12th and over	Safety film ≥ 100 microns and meeting BS EN 12600 Class 2B2

5.6 Recommendations for internal glass partitions

The recommendations for use of safety film for internal glass partitions are given in Table 4. For internal insulating glass units, it may be necessary to treat both sides with safety film.

Table 4: *Internal glass partitions: Safety film recommendations for all pane sizes and thicknesses*

Floor level	Recommendation
All floors	Safety film ≥ 100 microns and meeting BSEN 12600 Class 2B2

5.7 Recommendations for secondary glazing

The recommendations for use of safety films where the window consists of two separate frames and where both frames can be accessed independently (e.g. as in secondary glazing) are given in Table 5.

Table 5: *Secondary and similar glazing: Safety film recommendations for all pane sizes and thicknesses*

Glazing	Recommendation
Primary	As in sections 5.4 to 5.5
Secondary	Safety film 100microns and meeting BSEN 12600 Class 2B2

5.8 It is possible to obtain a different classification for a safety film on one thickness of float glass than for the same film on a different thickness of float glass. Therefore, classification to BS EN 12600 for safety film means that:

-The specific safety film has been independently tested as a safety film and float glass composite and meets the stated BS EN 12600 classification,

-Glass thickness is the same as that to be treated,

-The exception to the above is that occasionally glass > 6 mm may require protection, but independent testing to BS EN 12600 may not have been carried out for the specified film on the thicker glass. In these cases, it is normal to accept that testing on thinner glasses is sufficient evidence to demonstrate adequate performance. A film of at least 150 microns thickness is recommended. However, the client must decide whether further testing is needed to demonstrate BS EN 12600 performance for the particular film and glass thickness composite.

5.9 These recommendations are generally for monolithic glass. Laminated glass may be treated with safety film for blast mitigation and to reduce spalling.

5.10 It is important to check whether there are any other requirements when installing safety film, e.g. marking of safety glazing required in BS 6262-4.

6. Containment Systems

A containment system is designed to attach the safety film to the glazing bar, glazing system or frame. The use of a containment system with safety film can further reduce the risks from glass shattered in an explosion. See GGF Datasheets 5.18.4 "GGF Recommendations for Adhesive Backed Polymeric Film Applied to Glass in the Overhead Position for Containment of Glass in the Event of Failure: Types of Systems and Precautions in Use" and 5.18.5 "GGF Recommendations for Adhesive Backed Polymeric Film Applied to Glass in the Overhead Position for Containment of Glass in the Event of Failure: Test Method"

7. Additional Notes

7.1 Independent testing has shown the efficacy of safety films for protection in an explosion. As with all safety products, correct installation is essential. It is therefore very important to use a professional installation company with an appropriately trained and experienced workforce.

7.2 The cure time should not be confused with time to achieve a level of performance. For example, with good installation,

performance against impact to BS EN 12600 may be achieved within one or two days of installation for many safety films.

7.3 Peel adhesion testing is recommended for aged safety film. See GGF Datasheet 5.18.7 "GGF Standard for On-Site Peel Adhesion Testing of Adhesive Backed Polymeric Film Applied to Vertical Flat Glass"

8. References

8.1 Standards

ISO/DIS 16933 "Glass in building - Explosion-resistant security glazing - Test and classification by arena air-blast loading"

BS EN 12600 "Glass in building - Pendulum test - Impact method test and classification for flat glass"

8.2 GGF Datasheets

Current GGF Datasheets for adhesive backed polymeric film are:

5.18.1 "GGF Visual Quality for Adhesive Backed Polymeric Filmed Glass"

5.18.2 "GGF Installation Quality Standard for Applying Adhesive Backed Polymeric Film to Glass"

5.18.3 "GGF Recommendations for Adhesive Backed Polymeric Film Applied to Glass: Definitions, Descriptions and Components"

5.18.4 "GGF Recommendations for Adhesive Backed Polymeric Film Applied to Glass in the Overhead Position for Containment of Glass in the Event of Failure: Types of Systems and Precautions in Use"

5.18.5 "GGF Recommendations for Adhesive Backed Polymeric Film Applied to Glass in the Overhead Position for Containment of Glass in the Event of Failure: Test Method"

5.18.6 "GGF Recommendations for Blast Mitigation: Adhesive Backed Polymeric Film Applied to Glass"

5.18.7 "GGF Standard for On-Site Peel Adhesion Testing of Aged Adhesive Backed Polymeric Film Applied to Vertical Flat Glass"

5.18.8 "GGF Adhesive backed Polymeric Film-Guidelines for installation on existing Glazing"

9. Acknowledgement

The Home Office Scientific Development Branch (HOSDB) has provided valuable assistance and advice in preparation of these recommendations.

Figure 1:

Hazard Ratings in relation to a typical test cubicle; refer to the standard ISO 16933 for a fuller description.

