National Association of Rooflight Manufacturers

NARM Technical Document NTD03
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Application of ACR[M]001 'Test For Non-Fragility of Large Element Roofing Assemblies' to GRP Profiled Rooflight Sheeting

Contents

1. Introduction

Natural light improves the environment within a building, reduces running costs and helps the building's functionality. Invariably people will concentrate better, feel more comfortable and will tend to spend longer in a naturally lit building than if it were completely dependent on artificial light. Rooflights are the most practical way of getting natural light into many buildings.

The contribution of natural light and rooflights has been recognised in the latest Building Regulations (Approved Documents L2A and L2B). The inclusion of rooflights will reduce a building's CO_2 emissions helping to achieve the required targets, and will result in a net saving in energy consumption in most applications, as well as bringing the well documented advantages of a naturally lit interior. Full details are given in the NARM Guidance Note **"Designing with Rooflights: supporting the Guidance in ADL-2A and ADL-2B (2010)"** as referenced from the Building Regulations.

Inclusion of GRP rooflight products, available from National Association of Rooflight Manufacturers (NARM) members, makes a major contribution to the requirements of new Part L regulations, and allows the building Designer the comfort of being able to provide natural light to improve the ambience inside the building and aid comfort and productivity of people working there. They also ensure that the requirements for weatherability, safety, thermal performance, fire and all other regulatory requirements can be simply achieved: correctly specified GRP rooflights will retain this performance for over 25 years.

The issue of the provision of Natural Daylight is fully covered within the guide entitled **"Natural Daylight Design Through Rooflighting"** published by NARM and available for download from the NARM website www.narm.org.uk.

The Health and Safety Executive clearly states that those persons responsible for the design of a roof structure should consider carefully the potential to eliminate or reduce the hazard of using materials which are of a fragile nature. GRP rooflights have been used successfully to achieve desirable levels of day lighting for over 40 years. GRP rooflights by their very nature are highly durable and can safely be specified as non-fragile, providing that they have been manufactured to industry standards, fixed to manufacturers specifications, and used in conjunction with structurally compatible roofing components.

There is a wide range of GRP rooflights available, providing a selection of options to the designer. **This document is designed to provide a straightforward guide for the designer to simplify the specification of GRP rooflights to achieve non-fragility and retain it for 25 years.**

2. Scope

The ACR[M]001 "Test for Fragility of Roofing Assemblies", developed by the Health and Safety Executive in conjunction with various roofing trade associations including the National Association of Rooflight Manufacturers, applies to all roofs, including pitched roofs constructed from profiled metal and fibre cement sheeting. All roof assemblies should be tested to this standard to demonstrate non-fragility classification. It sets a minimum standard for non-fragility and all professionals involved with roofing should be familiar with it.

This Guidance Note sets out guidelines on the application of ACR[M]001 "Test for Fragility of Roofing Assemblies" to GRP Profiled Rooflight Sheeting, together with recommendations for GRP sheet classifications in order to achieve desired levels of performance in various applications.

ACR[M]001is a test of an assembly rather than a product. Rooflights are not tested alone, but as part of a representative roof assembly, and it is the whole assembly which achieves non-fragility. **The term "non-fragile" cannot be applied to an unfixed roofing sheet or rooflight, but only applies to a fully fixed assembly.**

Where profiled metal or fibre cement roofs have been separately demonstrated to be non-fragile without rooflights, this Guidance Note explains how to ensure that the inclusion of in-plane GRP (Glass Reinforced Polyester) rooflights, profiled to match the surrounding roofing sheets, can be achieved, without affecting the non-fragile classification of the roof assembly.

Members of the National Association of Rooflight Manufacturers have combined their experience of testing GRP rooflights to produce this Guidance Note, based on the extensive test programmes necessary in developing ACR[M]001. These results, based on large amounts of testing data for each particular rooflight assembly, are statistically significant: a single test of any one assembly may give an uncharacteristic result and is not a valid basis for assessing non-fragility.

This Guidance Note provides the relevant industry guidance referred to in paragraphs 2.3.1 and 2.3.8 of the test, and includes:

- minimum requirements for achieving consistent non-fragile performance under worst case test conditions
- durability and the likely effect of ageing on GRP sheeting
- safety factors and minimum requirements to ensure non-fragile performance can be expected to be maintained for 25 years
- conducting tests on GRP rooflights installed in fully representative assemblies of roof systems
- how the performance of similar profiles can be grouped

All recommendations are based on traditional weights and using traditional methods of manufacture.

Recommendations are made using the classifications defined in the UK National Annex to European Product Standard BS EN 1013:2012 for profiled rooflight sheets, ranging from CE18 to CE36, and CE18E to CE36E. Note that the European Standard specifies that these classifications will only apply to sheets which have a minimum glass content of 33%. The suffix E relates to additional weathering requirements for external performance, and is required for all external applications with expected long term performance, but can also be used in all other applications.

There are much stronger and safer rooflights options using heavier weights and advanced technology, offering further increases in margin of safety, which are not covered by this document. Further information regarding these safer rooflights is available from members of NARM.

This document includes:

• **recommendations for minimum classifications for GRP rooflights to consistently achieve non-fragility when new (see section 4).** Any rooflights below these minimum classification recommendations should always be regarded as fragile.

• **recommendations for GRP rooflight classifications to provide sufficient safety margin to consistently maintain non-fragility for 25 years (see section 7) with typical maintenance regimes.** The period of non-fragility of rooflights of lower classifications may vary between 5-20 years, depending on the possible effect of external factors, unless fully documented maintenance procedures are sufficiently comprehensive to ensure prevention of any factors which could render the rooflight assembly fragile. Most typical maintenance regimes are not usually sufficient to achieve this even though GRP sheeting is extremely durable and the strength of UK manufactured minimum classification rooflight sheets will be retained in the long term.

The recommended minimum classifications only apply to rooflights as manufactured by NARM members. Rooflights (even of the same weight or classification) not included in the original test programme may not perform as well, and performance of any such rooflights must be demonstrated separately.

3. Non-fragility testing of GRP rooflight assemblies

Reference should be made to ACR[M]001 for full details of the test rig, drop test procedure and classification of the roofing assembly.

Appendix 1 provides a brief summary of the test procedure and classification, detail of rooflight arrangement and drop test positions. It is the experience of NARM members, after hundreds of impact tests on various forms and specifications of rooflights - including the metal profiles that there will always be some significant damage after two drops. It is unlikely that any profiled roof assembly will ever achieve a Class A non-fragile rating.

Experience in testing GRP shows different factors may affect performance, in comparison to metal or fibre cement sheets. Unlike many other materials, GRP sheets tend to perform better as flexible profiles with

few or shallow corrugations rather than more rigid profiles as they have greater ability to flex and absorb the energy of the drop test. Variations in fixings, and in location of impact point have more effect on results than the actual profile of GRP rooflights. Tests on every profile of rooflight are therefore unnecessary, provided that the rooflights are being incorporated into roof systems which have been individually demonstrated to be non-fragile, without rooflights. Profiles with similar performance can be grouped; a method of achieving this is shown in Appendix 2.

Increase in rigidity due to profile should not be confused with an increase in rigidity due to sheet weight (thickness); heavier sheets of a given profile perform significantly better and in these cases the increased rigidity is a positive advantage.

ACR[M]001 is a test of an assembly rather than of individual components. GRP sheeting should therefore be lapped with surrounding metal (or GRP) panels and fitted in accordance with manufacturers recommendations. The roof assembly into which the rooflight panel is fitted should be demonstrated to be non-fragile (without rooflights) separately.

The normal minimum fixing specification is shown in Appendix 3.

Test results achieved will not necessarily apply to any exceptional cases, such as:

- purlin spans outside the range 1.35-2.0 metres
- rooflights fitted to anything other than cold rolled steel purlins
- rooflights fitted to curved roofs
- rooflights fitted in continuous runs along a roof
- rooflights fitted as spaced sheeting in an agricultural building
- rooflights fitted at top of slope in hip roof applications

In such cases the rooflight manufacturer should always be consulted: separate testing and/or use of heavier weight rooflights may be necessary to assist the designer in specifying the correct grade of rooflight.

4. Minimum classifications for non-fragility when new

Results of testing by NARM members has established the minimum classifications necessary to ensure reliable non-fragility ratings for properly installed GRP rooflights manufactured by NARM members on purlin spans between 1.35 and 2.0 metres when new. These minimum classifications are shown in Table 1.

Notes to Table 1:

Table 1 - Minimum classifications for non-fragility when new

Application (rooflight type)	Non-fragile Classification to ACR[M]001	Minimum classification to NA to BS EN1013: 2012 for non-fragility when new
Single skin *(see section 9)*		
Rigid trapezoidal profiles for use with single skin metal sheeting	Class B	CE30(5)
Rigid sinusoidal profiles for use with fibre cement sheeting(4)	Class C	CE24(5)
Double or triple skin site assembled with flexible profile steel liners (typically 0.4mm) *(see section 10)* **for triple skin refer to section 12*		
Liner panel assembly only	Class C	Outer: N/A Liner: CE24
Double skin assembly (where Class C non-fragile liner is required e.g. when lining out)	Class B	Outer: CE18(5) Liner: CE24
Double skin assembly (where there is no requirement for non-fragility of liner alone	Class B	Outer: CE24(5) Liner: CE18
Double or triple skin site assembled with rigid profile steel liners (typically 0.7mm) *(see section 10)* **for triple skin refer to section 12*		
Liner panel assembly only	Class B	Outer: N/A Liner: CE30
Double skin assembly	Class B	Outer: CE18(5) Liner: CE30
Factory assembled double or triple skin *(see sections 11 & 12)*		
Medium/low flexibility outer profile for use with composite panels, continuous box (see diagram 1)	Class B	Outer: CE24(5) Liner: CE18(6)
Medium/low flexibility outer profile, separate boxes between purlins (see diagram 2)	Class B	Outer: CE30(5) Liner: CE18(6)

(1) An assembly of a roof system incorporating rooflights of the minimum classification shown will achieve the relevant classification when new, provided it has already been demonstrated that the roof system (without rooflights) has an equal or better non-fragility classification.

(2) The recommended weights shown are minimum values as determined by testing on rooflight sheets supplied by NARM members: it cannot be assumed that any rooflight of the same weight will achieve the same level of performance. Classifications shown only apply to rooflights with minimum glass content of at least 33%; see BS EN 1013:2012 for full details. **Performance of rooflights not included in the original test programme should be demonstrated separately.**

(3) Separate testing should normally be carried out for exceptional cases as shown in section 3 (e.g. purlin spans (see diagram 1)outside the range 1.35-2.0 metres, rooflights fitted to curved roofs, in continuous runs, at hips, as spaced sheeting or to anything other than cold rolled steel purlins), although a simple and safe alternative may be an incremental increase in classification..

(4) This recommendation only applies to rooflights for use with current reinforced fibre cement sheeting; obsolete asbestos and fibre cement profiles should always be regarded as fragile.

(5) This table shows minimum requirements for non-fragility when new, and therefore does not consider durability requirements. However, it is recommended that all sheets for external application should be classified with the suffix E (CE18E, CE24Eetc) in accordance with the National Annex to BS EN 1013, which does include durability requirements.

(6) Alternatively it is acceptable to use liner panels with an overall profiled weight of 1.5 kg/sq.m

The classifications in Table 1 ensure the non-fragility rating will always be achieved by these rooflights when new. The recommendations shown are statistically significant, based on large amounts of testing data. Individual test results can vary and are not a valid basis for assessing non-fragility; rooflights below the minimum classifications shown should always be regarded as **fragile.**

GRP rooflights of these classifications are extremely durable and their strength will be retained in the long term. However, the period of non-fragility of these rooflights may vary between 5-20 years, depending on the possible effect of external factors, unless fully documented maintenance procedures are sufficiently comprehensive to ensure prevention of any factors which could render the rooflight assembly fragile. Most typical maintenance regimes are not usually sufficient to achieve this; in the interests of safety it is prudent when accessing roofs incorporating these rooflights to take full precautions.

Rooflights are also available with increased margin of safety, sufficient to maintain non-fragility for 25 years under all normal conditions (see section 7).

Much stronger rooflights which retain their non-fragile classifications with further increases in margins of safety are also available.

5. Durability

GRP is a very durable material and some rooflights over 40 years old are still in service. Good quality GRP rooflights are a uniquely attractive rooflight product. They are highly resistant to degradation by the elements, do not rust or corrode, are unaffected by most aggressive chemicals and have a low coefficient of thermal expansion compared to other plastics, making them less subject to cracking problems at the fixing points.

Long term performance is dependant on the quality and thickness of the sheet and quality of the surface protection (there is a wide range of choice). Any rooflights intended for external use (as opposed to an internal liner) should meet the requirements defined in the National Annex of European Standard BS EN 1013 for classifications with the suffix E (eg CE24E).

The durability of GRP rooflights manufactured by NARM members ensures the strength of the sheet itself will be retained in the long term. However, impact resistance is also heavily dependant on other factors, for example method and condition of fixings, and any deterioration of the installation can jeopardise the non-fragility classification, even when there is no deterioration of the rooflight sheet itself.

The safety margin of minimum classification rooflights is sufficient to ensure they will achieve the non-fragility classification when new, but will not allow for any deterioration of other aspects of the installation. Non-fragility would only be maintained if comprehensive inspection and maintenance could ensure there was no deterioration to any aspect of the original installation in the long term (see section 13). In practice, with typical maintenance regimes, it is likely that many of these minimum classification rooflights will stay non-fragile for 5-20 years, depending on application; the exact time at which the assembly may become fragile cannot be determined.

6. Long term non-fragility

GRP rooflights manufactured by NARM members have a service life in excess of 25 years, but the resistance to impact also relies heavily on many other aspects of the installation. Even if there is little degradation of the rooflight sheet itself, long term non-fragility could be affected by many external factors such as:

- poor design and specification
- incorrect initial installation
- corrosion of the fasteners (or degradation of supporting material)
- fasteners which have worked loose
- seals which have hardened or perished
- corrosion of surrounding metal sheeting
- mechanical damage to the sheet
- chafing around the fixings (which can be accelerated by failure to install additional fixings around areas of high wind load)

Results of testing and experience of NARM members has established that where the non-fragile classification of an assembly incorporating GRP rooflights manufactured by NARM members is achieved solely at the liner level, protected by a separate weather sheet which does not contribute to the non-fragile classification, it can be expected that the non-fragile classification of the assembly should be maintained for at least 25 years, provided it has already been demonstrated that the roof liner system, without rooflights, will retain the same non-fragile classification for that same period.

Where the non-fragile performance of an assembly is partially or fully dependant on the performance of a rooflight outer sheet, the strength of GRP sheets (as manufactured by NARM members) will be maintained in the long term, but non-fragility will only be maintained if maintenance and inspection is sufficient to eliminate any possible effect from any of the factors listed above. NARM members have established that typical maintenance procedures (see section 13) are usually not sufficient to achieve this; non-fragility of a roof assembly containing minimum classification rooflights (as shown in section 4) may be maintained for 5-20 years but the period at which one or more of the factors listed above may render the assembly fragile cannot be determined exactly.

In such cases NARM has established that non-fragility can be maintained by use of rooflights that provide an increased safety margin, to reduce dependence on method and condition of fixing. An incremental increase in classification of the rooflight outer sheet (e.g. for factory assembled rooflights from CE24E to CE30E) will increase margin of safety and reduce dependence on method and condition of fixing, and will ensure long term non-fragility is preserved with typical maintenance regimes (see section 7).

All other components in the rooflight assembly must also be specified accordingly to retain non-fragility for 25 years: for example, stainless steel fixings will normally be required.

There are still exceptional factors which can jeopardise non-fragility under certain circumstances, which should not normally be guaranteed: for full details, refer to NARM technical document NTD08.

There are much stronger and safer rooflight options available using advanced technology which retain their non-fragile classifications with a further increase in margin of safety. The designer should determine the risks, the required life and period of non-fragility and the higher safety margins to consider in order to maintain long-term non-fragility and then has the responsibility to specify accordingly.

7. Minimum classifications for non-fragility for 25 years

NARM has been able to recommend the minimum classifications necessary to ensure that non-fragility ratings can be expected to be retained for 25 years, with typical maintenance regimes. These recommendations are based on results of testing, and experience of NARM members and the roofing industry, and apply to properly installed GRP rooflights manufactured by NARM members, on purlin spans between 1.35 and 2.0 metres. These recommended classifications are shown in Table 2.

Table 2 - Minimum classifications for non-fragility for 25 years

Application (rooflight type)	Non-fragile Classification to ACR[M]001	Minimum classification to NA to BS EN1013: 2012 for expected 25yr non-fragility
Single skin *(see section 9)*		
Rigid trapezoidal profiles for use with single skin metal sheeting	Class B	CE36E
Rigid sinusoidal profiles for use with fibre cement sheeting (see note 5)	Class C	CE30E
Double or triple skin site assembled with flexible profile steel liners (typically 0.4mm) *(see section 10)* **for triple skin refer to section 12*		
Liner panel assembly alone is Class C non-fragile	Class C	Outer: CE18E Liner: CE24
Double skin assembly (where Class C non-fragile liner is required e.g. when lining out)	Class B	Outer: CE24E Liner: CE24
Double skin assembly (where there is no requirement for non-fragility of liner alone	Class B	Outer: CE30E Liner: CE18
Double or triple skin site assembled with rigid profile steel liners (typically 0.7mm) *(see section 10)* **for triple skin refer to section 12*		
Liner panel assembly only	Class B	Outer: CE18E Liner: CE30
Double skin assembly	Class B	Outer: CE18E Liner: CE30
Factory assembled double or triple skin *(see sections 11 & 12)*		
Medium/low flexibility outer profile for use with composite panels, continuous box (see diagram 1)	Class B	Outer: CE30E Liner: CE18[7]
Medium/low flexibility outer profile, separate boxes between purlins (see diagram 2)	Class B	Outer: CE36E Liner: CE18[7]

Notes to Table 2:
(1) It can be expected that the non-fragile classification of a roof assembly incorporating these increased classification rooflights should be maintained for at least 25 years under all normal conditions, provided it has already been demonstrated that the roof system, without rooflights, will retain the same non-fragile classification for that period.
(2) The non-fragility classification will only be retained where all other components have been specified accordingly - for example fasteners will usually need to be stainless steel.
(3) The classifications shown are minimum values as determined by testing on rooflight sheets supplied by NARM members: it cannot be assumed that any rooflight of the same weight will achieve the same level of performance. Classifications shown only apply to rooflights with minimum glass content of at least 33%; see BS EN 1013:2012 for full details. **Performance of rooflights not included in the original test programme should be demonstrated separately.**
(4) To comply with these recommendations, rooflights used as outer sheets must be classified with the suffix E (eg CE30E, as shown above) in accordance with the National Annex to European Product Standard BS EN 1013:2012, which includes durability requirements. Such rooflights may also be used as inner sheets, even where the recommendation above does not include the suffix E. However, rooflights which are classified without the suffix E must never be used as outer sheets, where the requirement includes the suffix E (eg CE30 sheet must not be used where the requirement is CE30E)
(5) Separate testing should normally be carried out for exceptional cases as shown in section 3 (e.g. purlin spans outside the range 1.35-2.0 metres, rooflights fitted to curved roofs, in continuous runs, at hips, as spaced sheeting or to anything other than cold rolled steel purlins), although a simple and safe alternative may be an incremental increase in classification.
(6) This recommendation only applies to rooflights for use with current reinforced fibre cement sheeting; obsolete asbestos and fibre cement profiles should always be regarded as fragile.
(7) Alternatively it is acceptable to use liner panels with an overall profiled weight of 1.5 kg/sq.m

The increases in classification shown in Table 2 significantly increase the factor of safety and ensure that typical deterioration to an installation should not affect non-fragility under normal conditions, subject to normal maintenance requirements (see section 13).

The specification of all components in the roof assembly must be carefully considered, and manufacturer's advice followed to achieve long term performance. For example, where it is expected that non-fragility is to be retained for 25 years:

• all fasteners (for both main and sidelap fixings) must be guaranteed for a 25 year lifespan. This will normally require use of stainless steel fasteners in all locations

• it is often not appropriate to specify or use expanding rubber grommet fasteners (designed for use where rooflights lap under adjacent metal sheets, or wherever rooflights lap with fibre cement sheets).
These require very precise installation techniques; any variation can affect performance and it may be preferable for:

- single skin or site assembled rooflights to lap over metal sheets on both sides

- factory assembled rooflights to incorporate galvanised steel angles where they lap under adjacent composite panels, to accept stainless steel stitching screws

- significantly more expensive specialist fasteners to be used

Long term non-fragility of the rooflight assembly is highly dependent on the long-term durability and performance of all associated components: if they degrade, the rooflight assembly may become fragile. Incorrect installation, serious deterioration or total failure of associated components, abuse and exceptional circumstances could all still jeopardise non-fragility within this period, and it therefore should not normally be guaranteed. For full details, refer to NARM technical document NTD08.

8. Design

The designer and building owner have a responsibility to design the roof to suit the expected life, and the

ongoing need for maintenance and roof access. Guidance on designers' responsibilities is included in ACR[CP]001 "Recommended Practice for Work on Profiled Sheeted Roofs" (paras 59 - 72, and Appendix C). Paragraphs 71-73 state:

- low maintenance roofs are those which require very infrequent access (requiring only maintenance that can be done from ladders, or requiring only infrequent access for maintenance only, by experienced roofworkers). For these roofs the minimum non-fragility classification is Class C.

- medium maintenance roofs are those which require regular access for maintenance of the roof only by experienced roofworkers. For these roofs the minimum non-fragility classification is Class B.

- high maintenance roofs are those which require frequent access for maintenance, e.g. for plant exhausts etc. For these roofs the minimum non-fragility classification is Class B, with dedicated walkways to reach the plant to be maintained.

Designers should adopt the principle of matching the non-fragile classification of the roof and rooflight assemblies, whilst following these guidelines, thereby eliminating areas of unequal performance from the roof covering.

In addition, on high maintenance roofs and in other places where risks may be greater than usual, use of rooflights with higher safety margins should be considered: there are much stronger and safer rooflight options available which retain their non-fragile classifications with a further increase in margin of safety. It is the responsibility of the designer to determine the risks, the required period of non-fragility and the safety margins required, and then to specify accordingly.

In all cases the Health and Safety File for the building must give clear guidelines on the roofing system used and an indication of when the roof is likely to become fragile.

9. Single skin rooflights

CE30 single skin trapezoidal profiles can be regarded as Class B non-fragile when new(1); classification should be increased to a minimum of CE36E where non-fragility for 25 years is required(2). These classifications are the recommended standard for GRP sheets to be used in conjunction with single skin profiled metal sheeting.

Sinusoidal profiles are more flexible and less prone to tearing. When assembled with reinforced fibre cement sheeting (which usually achieves Class C non-fragility) CE24 single skin sinusoidal profiles can be regarded as Class C non-fragile when new(1), whilst CE30E single skin sinusoidal sheets can be expected to remain Class C non-fragile for 25 years(2). Note that these recommendations only apply to rooflights for use with current reinforced fibre cement sheeting; obsolete asbestos/fibre cement profiles should always be regarded as fragile. Performance of sinusoidal roof systems in other materials (eg metal) may vary; rooflight manufacturers should be consulted once the performance of the system (without rooflights) has been demonstrated.

(1) provided it has already been demonstrated that the roof system, without rooflights, will achieve the same classification of non-fragility to ACR[M]001
(2) provided it has already been demonstrated that the roof system, without rooflights, will retain the same non-fragile classification to ACR[M]001 for 25 years, which requires all other components to have been specified accordingly (for example, fasteners will usually be stainless steel)

Non-fragile classification can often be achieved with CE24 trapezoidal sheet, but all NARM members have experienced occasional failures; performance of these sheets is not sufficiently consistent and single skin sheeting less than the stated classifications should therefore always be treated as fragile.

10. Double skin site assembled rooflights

Double Skin Site-Assembled rooflights will achieve Class B non-fragility when new(1) provided at least one of the sheets is classified at least CE24.

If the building is to be lined out, liner panels of minimum classification CE24 should be used. Being flexible, when tested in an assembly these will normally be at least Class C non-fragile when new(1). Once covered with the separate outer sheet (of at least CE18E), CE24 liner panels can be expected to retain Class C non-fragile classification for at least 25 years(2).

An assembly of CE18E outer sheet over a CE24 liner will achieve Class B non-fragility when new(1). The strength of GRP sheets (as manufactured by NARM members) will be maintained in the long term, but non-fragility of this assembly will only be maintained if maintenance and inspection is sufficient to eliminate any possible effect from any external factors (see section 6). NARM members have established that typical maintenance procedures (see section 13) are usually not sufficient to achieve this; non-fragility of this roof assembly may be maintained for 5-20 years but the period at which one or more external factors may render the assembly fragile cannot be determined exactly. Where Class B non-fragility for 25 years is required, NARM members therefore recommend that the classification of the outer sheet should be increased, to give an assembly of CE24E outer sheet over a CE24 liner(2).

Liner panels classified CE18 should be regarded as fragile and represent a hazard during the construction phase due to flexible sidelaps, even if they pass the test. If the roof is not to be lined out, an assembly of CE24E weather sheet over a CE18 liner will achieve Class B non-fragility when new(1), but should be regarded as fragile once the construction phase is complete. If the classification of the outer sheet is increased, an assembly of CE30E outer sheet over a CE18 liner can be expected to remain Class B non-fragile for at least 25 years(2). This results in a tougher completed roof with less likelihood of accidental damage and need for replacement.

The choice between CE30E over a CE18 liner, or CE24E over a CE24 liner, which can both be expected to remain Class B non-fragile for 25 years, depends on circumstances such as preferred construction sequence.

Where liner panels are rigid profile 0.7mm steel liner panels, then rooflight liner panels of minimum CE30 should be used.These will achieve Class B non-fragility when new(1), and once covered with a separate outer sheet (of at least CE18E) can be expected to retain Class B non-fragile classification for at least 25 years(2). NARM recommend that the outer sheet should be a minimum of CE18E wherever there is a requirement for 25 year durability.

(1) provided it has already been demonstrated that the roof system, without rooflights, will achieve the same classification of non-fragility to ACR[M]001
(2) provided it has already been demonstrated that the roof system, without rooflights, will retain the same non-fragile classification to ACR[M]001 for 25 years, which requires all other components to have been specified accordingly (for example, fasteners will usually be stainless steel)

11. Factory assembled rooflights

Factory Assembled units should be made to the same material standard as site-assembled, with a minimum requirement of CE24 weather sheet over CE18 liner tray (or liner tray with an overall profiled weight of at least 1.5 kg/sq.m.), to achieve Class B non-fragility when new(1). The liner tray of factory assembled rooflights has a very small bearing on the purlin, and the use of purlin extension plates at factory assembled rooflight endlaps is recommended.

Good quality GRP rooflights have a service life in excess of 25 years, but resistance to impact of factory assembled rooflights is particularly prone to external factors as detailed in section 6. There is a significant risk that the non-fragile classification of factory assembled rooflights with a CE24E outer sheet would not be maintained for 25 years, due to the effect of these external factors. NARM members have established that in order to ensure long term non-fragility of these rooflights is preserved, the classification of the rooflight outer sheet must be increased to CE30E.

These rooflights can then be expected to remain non-fragile for at least 25 years(2).

Some factory assembled units have discontinuous 'boxes' between purlins, and are effectively not much stronger than single skin - these rooflights should have a minimum of CE30 weather sheet for class B non-fragility when new, or CE36E weather sheet for class B non-fragility for 25 years.

Factory assembled units can vary in design. The use of dissimilar materials for outer sheet and liner can potentially have a detrimental effect on long term durability and impact resistance due to different expansion rates. In any case, outer sheet classification should never be less than CE24 for non-fragility when new, and CE30E for expected 25 year non-fragility, regardless of method of construction.

Diagram 1. Factory assembled rooflights
CONTINUOUS BOXES – COMPOSITE PANEL ROOFS

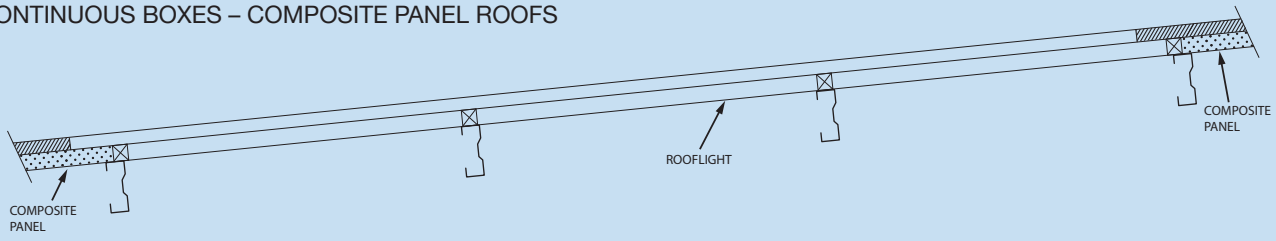
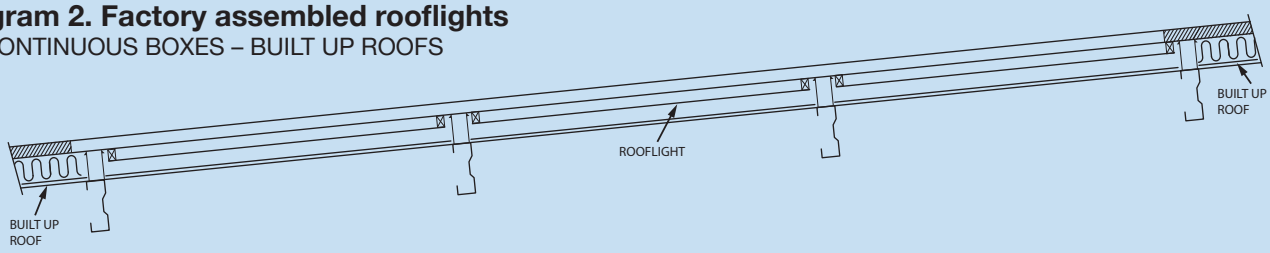


Diagram 2. Factory assembled rooflights
DISCONTINUOUS BOXES – BUILT UP ROOFS



(1) provided it has already been demonstrated that the roof system, without rooflights, will achieve the same classification of non-fragility to ACR[M]001
(2) provided it has already been demonstrated that the roof system, without rooflights, will retain the same non-fragile classification to ACR[M]001 for 25 years, which requires all other components to have been specified accordingly (for example, fasteners will usually be stainless steel)

12. Multi-skin rooflights and rooflights containing insulation materials

In response to the requirement to improve insulation values to comply with the requirements of Approved Document L of the Building Regulations, site and factory assembled rooflights of triple (or multiple) skin construction, or containing insulating materials, have been introduced. In factory assembled rooflights, the inclusion of an intermediate layer or insulating material will not usually make any significant contribution to impact performance and the minimum classification requirements shown in Tables 1 and 2 and detailed in section 11 apply to triple as well as double skin rooflights.

In most site assembled rooflights, an intermediate skin or insulating material is laid into place underneath a standard spacer bar system, and simply retained with tape; it will usually not make a significant contribution to impact performance.

The minimum classification requirements shown in Tables 1 and 2 and detailed in section 10 will apply to triple as well as double skin rooflights in most cases.

In some triple skin site assembled systems, the intermediate sheet may be secured more firmly, and may contribute to impact resistance. In certain circumstances this may allow a reduction in classifications from those shown in Tables 1 and 2, but it would be the responsibility of the system supplier to establish the performance of any such system. Any reduction in classification can only be justified if fully supported by satisfactory evidence from a sufficiently rigorous and extensive test programme. For example, if it could be demonstrated that the liner panel and the intermediate sheet of a system when fixed to specification reliably achieve Class B non-fragility when new, then once covered with a separate outer sheet such a system could then be expected to retain this non-fragility for 25 years (even though the liner panel classification is slightly less than that shown in Tables 1 and 2).

13. Maintenance of rooflights

Rooflights should be cleaned and inspected on a regular basis.

All rooflights should be cleaned approximately every 2-3 years with a stiff brush or cloth, using mild detergent and water (avoiding use of abrasive cleaners or tools) to preserve light transmission.

Inspection of rooflights which are expected to maintain non-fragility for 25 years (see section 7) should be carried out at the same time as routine cleaning (every 2-3 years), and must ensure there has been no significant damage to the rooflight sheet itself, and that all fasteners remain tight and in good condition.

Non-fragility of minimum classification rooflights (see section 4) can only be maintained if inspection and maintenance are sufficiently frequent and comprehensive to ensure there is no deterioration to any aspect of the original installation. They should be inspected annually and after any period of severe winds, following a documented inspection and maintenance plan; inspection would have to ensure there was no damage to the rooflight sheet itself (including penetration of the surface film or rooflight sheet itself, severe

bruising or cracks), no deterioration of the sealants, fasteners (including washers) or supporting structure, no chafing, cracking or deterioration of the rooflight sheet underneath any fastener washers, and that all fasteners remain correctly tightened.

14. Health and safety file

On completion of the building, designers should provide an up-to-date Health and Safety File to the Planning Supervisor and Client. The following should be included in respect of the roof and rooflights.

• No person should have access to the roof unless under the direct supervision of an experienced roofer who should be sufficiently competent to assess and take action to minimise any risks.

• Access to the roof should be avoided when it is wet or in slippery conditions

• The rooflight specification, including the weight of the rooflights, the non-fragile classification when new and the expected non-fragile life of the roof and rooflights

• Rooflights should be cleaned periodically to maintain light levels within the building and minimise their deterioration.

• NEVER walk on rooflights, irrespective of their fragility class. Even rooflights that are designed to be non-fragile for the life of the roof could be damaged by foot traffic, which may affect the light transmitting quality and weatherability in the long term.

• Minimise the need for access to roofs at any time.

The onus for safety until building completion lies with the construction professionals – designer, planner, contractors – as well as the client. On completion however the onus is with the client/occupier.

15. Bibliography

For further guidance on rooflights, access and safe working at any time when persons must be on the roof, the following are recommended for consultation:

1. HSG 33 Health & Safety in Roof Work - HSE Books

2. ACR[M]001 “Test for Non-Fragility of Profiled Sheeted Roofing Assemblies”

3. Profiled Sheet Roofing & Cladding - A Guide to Good Practice - NFRC

4. Technical Guides - MCRMA

5. BS 5427: Part 1:1996 Code of Practice for the use of profiled sheet for roof and wall cladding on buildings

6. Building Regulations & Approved Documents

7. Rooflight Manufacturers’ Literature

8. ACR[CP]001 “Recommended Practice for Work on Profiled Sheeted Roofs”

9. BS4154: Part 1: 1985 (withdrawn) “Corrugated plastics translucent sheets made from thermo-setting polyester resin (glass fibre reinforced)”

10. BS EN 1013: 2012 “Light transmitting single skin profiled plastic sheets for internal and external roofs, walls and ceilings — Requirements and test Methods”

11. NARM Technical Document NTD03 “Guidance on non-fragility for specifiers of in-plane rooflights”

Appendix 1. Worst cases and failure modes

The ACR[M]001 test is very demanding, simulating the impact of a falling person with a significant safety margin. It is applicable to any roof covering. There is a significant risk that any roof covering may fail this test if incorrectly specified or fitted.

In summary, a sample rooflight sheet is installed as an assembly with appropriate surrounding roof sheets, fixed to a specified test rig, and a 45kg bag of dry sand is dropped once or twice from a height of 1.2m onto a point which can be demonstrated to be worst load case for the sample (paragraph 2.3).

Classifications can be summarised as follows:

1. If the bag passes through the assembly it is classified as fragile.

2. If the bag is retained on the assembly after one drop, the assembly is classified as Class C non-fragile.

3. If the bag is retained after two drops, the assembly is classified as Class B non-fragile.

4. If there is no significant damage to the assembly which would affect long term strength or weatherability after two drops, it is classified as Class A non-fragile.

The Test states that an assembly should be impact tested in the worst case position(s).
The worst case test position may vary for assemblies using different materials and/or designs. Test results from NARM members clearly demonstrate that when testing normal profiled GRP sheet on common spans (1.35 to 2.0 metres), the following are the worst case test positions:

Multi-span sheets (see diagram 3 overleaf):
- At a corner of an end span, where incorrectly specified rooflights may tear or pull over at the fixings
- Close to a mid purlin and underlap, where incorrectly specified rooflights may rupture under tension

Single span sheets (see diagram 4 overleaf):
- At the side, centre-span, where the impact weight may penetrate the sidelap of incorrectly specified rooflights

These can be assumed to be the worst case test positions for normal applications and it is unnecessary to test at other positions if a sample passes all of these cases, in both overlap and underlap conditions.

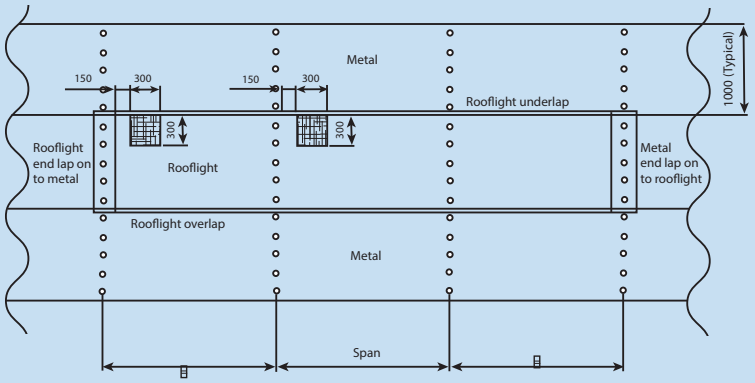


Diagram 3. Multi-span rooflight
WORST CASE IMPACT POSITIONS

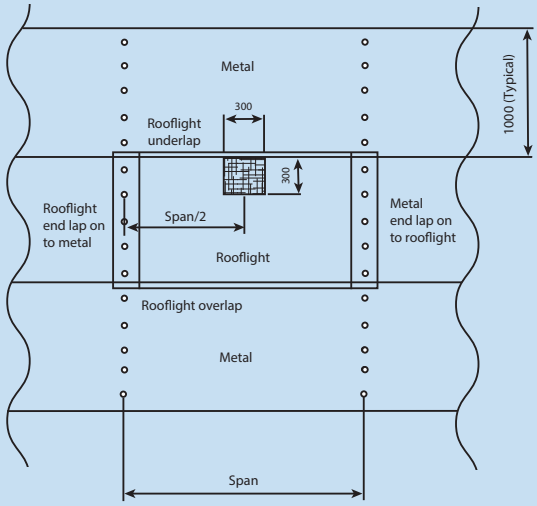


Diagram 4. Single-span rooflight
WORST CASE IMPACT POSITION

Appendix 2. Grouping of profiles

A reliable way of classifying GRP sheeting into groups with similar drop test performance is the non-destructive deflection test described in BS4154 (Corrugated plastics translucent sheets made from thermo-setting polyester resin).This measures the load at which the deflection of the test sheet reaches 15mm; lower loads on a sheet of a given weight/thickness correspond to a more flexible profile. Profile flexibility can be grouped into 3 categories based on this simple test when carried out on CE18 sheeting:

- high flexibility (which require a load less than 50kg)
- medium flexibility (which require a load of 50kg to 110kg)
- low flexibility (which require a load over 110kg)

Most flexible liner panels (e.g. 17-20mm deep, 1000mm cover width) are in the high flexibility group and GRP sheets in these profiles will perform better than in most typical weather sheet profiles (30-40mm deep, 1000mm cover width) which are in the low flexibility group. GRP sheets in certain profiles, with deep ribs, narrow crowns and steep sided corrugations are more prone to failure. These same characteristics result in stiffer sheet and lower deflection in the BS4154 deflection test.

Appendix 3. Typical minimum fixing specification

Flexible liner panel profiles: Minimum 5 primary fasteners at every purlin, minimum 5.5mm diameter, with minimum 29mm diameter washers, or passing through spacer bar brackets, with maximum spacing of 200mm and no less than 50mm from the end of any sheet, after allowing for any on-site tolerances. Rooflights should usually lap over metal on both sides, and side laps should be secured, typically with 40-50mm wide film backed butyl tape applied over the laps.

Rigid weather sheet profiles: Minimum 5 primary fasteners at every purlin, minimum 5.5mm diameter, with minimum 29mm diameter washers, with maximum spacing of 200mm and no less than 50mm from the end of any sheet, after allowing for any on-site tolerances. For trapezoidal profiles, the primary fasteners are normally through the troughs and for sinusoidal, through the crowns.

Rooflights should usually lap over metal on both sides, and side laps should be secured, typically with minimum 5.5mm diameter stitching screws, at maximum 450mm centres. If GRP laps under metal, suitable sidelap fasteners (e.g. expanding rubber grommet, or expanding metal bolt fasteners) must be used.

End laps and side laps should be sealed with cross-linked sealant or a sealing tape, positioned relative to the fixings as and where recommended by the rooflight/roofing system manufacturer. Adhere to the recommendations of the sealant tape manufacturer when preparing sheet surfaces to receive tape where these are included in the assembly. Dust and damp conditions may affect performance.

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