

Scope

This section deals with proprietary (standard or nonstandard) nonloadbearing walls of glass and other sheet and panel materials supported on framing, fixed to a supporting structure, designed and fixed as an integrated assembly complete with opening lights, doors, ventilators, etc.

For definitions of associated walling and roofing systems and their relevant NBS sections see general guidance 1 in this section.

This section does not include:

- General glazing – see section L40.
- Permanent access and safety equipment – see section N25.

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Reference documents

For a list of documents cited in NBS, refer to the Reference documents listing on the subscriber website.

For a list of documents cited in this section, refer to All reference documents for a work section on the subscriber website.

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Publishers of documents cited in this section include:

- American Architectural Manufacturers Association (AAMA)
- American Society of Civil Engineers (ASCE)
- American Society for Testing and Materials (ASTM)
- British Board of Agrément (BBA)
- British Constructional Steelwork Association Ltd (BCSA)
- British Standards Institution (BSI)
- Building Research Establishment (BRE)
- Building Services Research And Information Association (BSRIA)
- Butterworth Heinemann
- Centre for Window and Cladding Technology (CWCT)/ University of Bath
- Chartered Institution Of Building Services Engineers (CIBSE)
- Construction Confederation (CC) formerly Building Employers Confederation (BEC)
- Construction Industry Training Board (CITB)
- Council for Aluminium in Building (CAB)
- Fire Protection Association (FPA)
- Health and Safety Executive (HSE)
- Institution of Structural Engineers (ISE)
- Loss Prevention Certification (LPCB)
- The Stationery Office (TSO)

General guidance

1 Definitions

Developments in facade technology have resulted in a blurring of the boundaries between the many different methods and functions of cladding. It may be helpful, therefore, to define, not only curtain walling as covered by this section, but also the other categories – most of which are already covered in NBS.

Regardless of the differences, all of the following have one characteristic in common – they are all nonloadbearing, dead and live loads acting on them being transferred via connections to the building structure.

- **Curtain walling:** Glazing and panels/ facings set into or attached to framing members fixed back to the building structure – see also general guidance 3. External curtain walling should be specified in this section; internal curtain walling can also be specified here subject to adjustment of Design/ Performance Requirement clauses.
- **Patent glazing:** Glazing supported on two or four edges by metal glazing bars fixed back to the building structure to form walls or sloping roofs. Specify in section H10.
- **Structural glass assemblies:** Frameless glazing with sealant joints, attached by assembly fixings to glass fins or a secondary support structure and thereby back to the building structure. Specify in section H13. Do not confuse with structural sealant glazing as a method of curtain walling assembly – see general guidance 3.1.
- **Overhead glazing:** Glazing with a slope of less than 75° to the horizontal usually assembled from one of the three systems previously defined. Overhead glazing has inherent technical differences to curtain walling in providing for, e.g. rainwater and condensation drainage, snow and maintenance loadings. Where it is integral with curtain walling it may be specified in this section, provided the technical differences are accommodated.
- **Rainscreen cladding:** An external cladding or overcladding assembly fixed back to and providing weather protection to an inner structural leaf; the cavity between being drained and ventilated or pressure equalized. Specify in section H92.
- **Precast concrete cladding:** Large unit precast concrete panels (also known as integral panels) that may be faced with other materials. The panels are fixed back to the building structure but are able to support their own weight and resist design loads without additional framing. Specify in section H42.

2 Standards

The gap in UK curtain walling standards was closed in 1993 by the issue of the 'Standard and guide to good practice for curtain walling' by the Centre for Window and Cladding Technology (CWCT) at the University of Bath. In 1996 the document was revised and republished as a second edition in three volumes:

- 'Standard for curtain walling'.
- 'Guide to good practice for facades'.
- 'Test methods for curtain walling'.

These documents have been superseded by a single publication 'Standard for systemised building envelopes', which in nine volumes takes account of the European (CEN) standards dealing with envelope technologies. The nine (10 with 'Standard test methods for building envelopes') volumes are:

- Part 1 Scope, terminology, testing and classification
- Part 2 Loads, fixings and movement
- Part 3 Air, water and wind resistance
- Part 4 Operable components, additional elements and means of access
- Part 5 Thermal, moisture and acoustic performance
- Part 6 Fire performance (Not included in the first issue of the standard. To be released after publication of revised building regulations covering aspects of fire.)
- Part 7 Robustness, durability, tolerances and workmanship
- Part 8 Testing*
- Part 0 Specifiers' checklist and certification.
- Standard test methods for building envelopes.

*CWCT issued an erratum sheet dated 26 May 2006 revising the discretionary test sequence clause 8.13.5.

The CWCT Standard covers both curtain walling and rainscreen cladding (section H92).

BS EN 13830 is the curtain walling product standard and is supported by the following performance and test/ calculation standards:

- Air permeability: BS EN 12152 and BS EN 12153.
- Watertightness: BS EN 12154, BS EN 12155, BS EN 13051 and DD ENV 13050.
- Resistance to wind load: BS EN 13116 and BS EN 12179.
- Impact resistance: BS EN 14019.

The CWCT 'Standard for systemised building envelopes' takes account of the British standards and sets appropriate levels of performance for use in specific environments.

- Sets conditions when existing test results may be extrapolated to new projects.
- Provides additional information not included within European standards.

3 Types of curtain walling

The parts of the CWCT 'Standard for systemised building envelopes' do not deal with the design of curtain walling; their forewords state '*The documents are not a design guide and are intended for use by Designers and Specifiers with experience of building envelopes*'. It is also not the purpose of this NBS section to offer detailed advice on design, but an understanding of the technical language of curtain walling is essential for specifiers, even where design input is limited to preliminary design drawings and evaluation of proprietary systems. A brief introduction to the assembly and weathering methods of common types of curtain walling is given below and design items are noted where relevant in clause guidance.

3.1 Methods of assembly

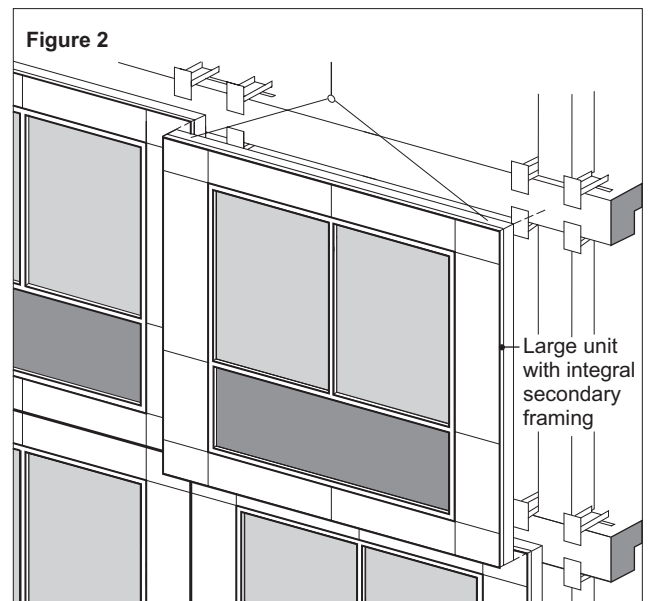
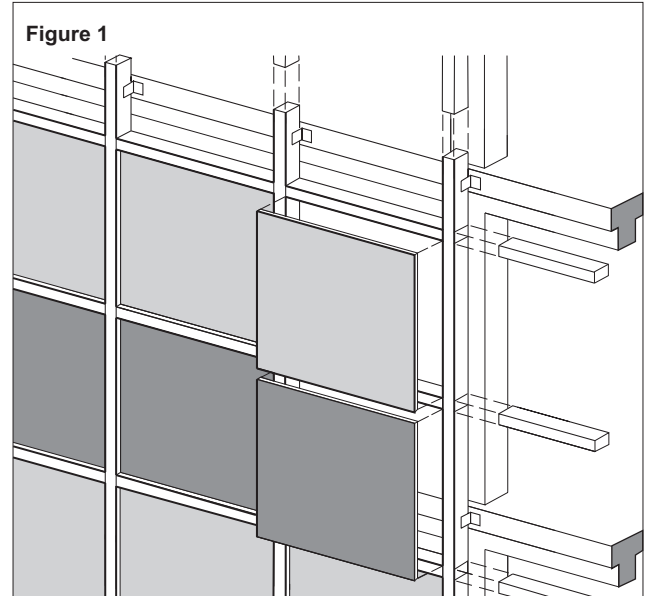
There are three basic methods of assembling curtain walling:

- **Stick systems:** (See figure 1). Site assembled, linear, light carrier frameworks (usually continuous mullions interspaced with discontinuous transoms) with infill glazing and panels. Manufacturers offer proprietary systems capable of versatile solutions to design requirements. All components should be delivered cut or formed to size to limit sitework to assembly and installation.
- **Unitized systems:** (See figure 2). Workshop prefabricated units of framework, glazing and panels/ facings. Units usually span vertically between storeys in module widths but may span horizontally between columns as spandrels. Large units (often referred to as panelized systems) will have steel or aluminium secondary framing integral with the units or site erected as a support structure. Manufacturers offer standard or bespoke systems dependent upon the custom design requirements and complexities of the project. Completed units are delivered to site and craned or hoisted into place on the facade. Sitework is usually limited to fixing units in place and fitting perimeter gaskets and cover strips.
- **Structural sealant glazing systems:** (See figure 3). Workshop or site bonding of glazing to prefabricated frames with silicone adhesive sealant. Workshop bonding is considered essential for UK systems and is the only method specified in this section. Hence the assembled units may be considered as variants of unitized systems and will usually be site fixed to a secondary support structure. Areas dedicated to structural sealant glazing fabrication should be provided in the workshop where temperature, humidity and dust contamination can be controlled. Structural bonding of panels/ facings should only be specified with project specific approval of the sealant manufacturer (clause 240) to all products in contact with the bonding sealant. Structural sealant glazing units can be bonded on two or four sides. Two sided bonding uses sealant for two opposite sides and conventional curtain wall framing for the other two. Four sided bonding uses sealant for all four sides, usually with secondary support setting blocks underneath and possibly with

secondary retention devices. Unsupported units require a significantly wider sealant joint bite dimension, increasing silicone use and thereby cost. Insulating glass units should not be specified as four sided bonded without secondary support or retention of the outer pane.

For further guidance see the following publications:

- AAMA, 'Structural sealant glazing systems'.
- ASTM, 'Science and technology of glazing systems'.
- ISE, 'Structural use of glass in buildings'.



3.2 Methods of weathersealing

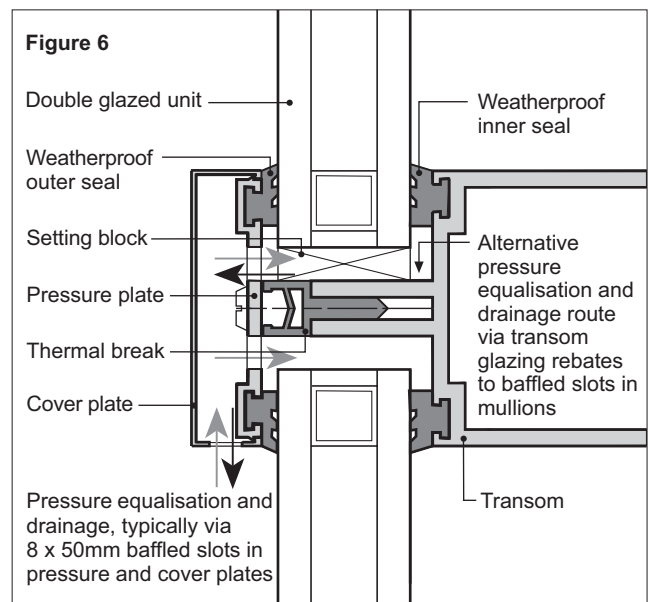
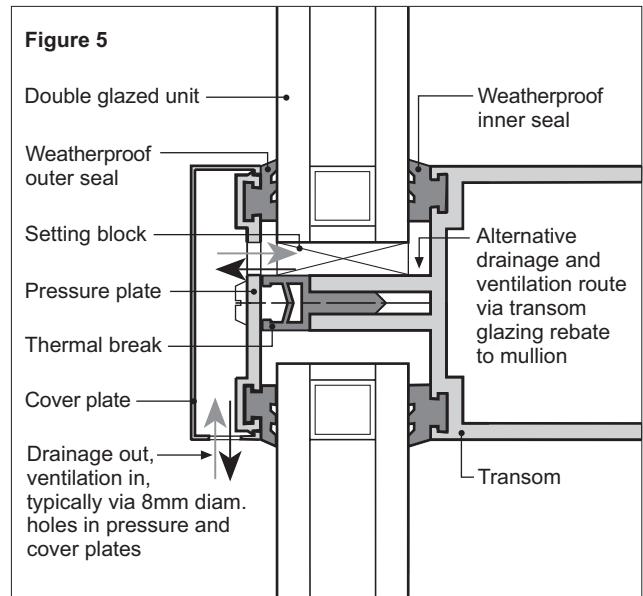
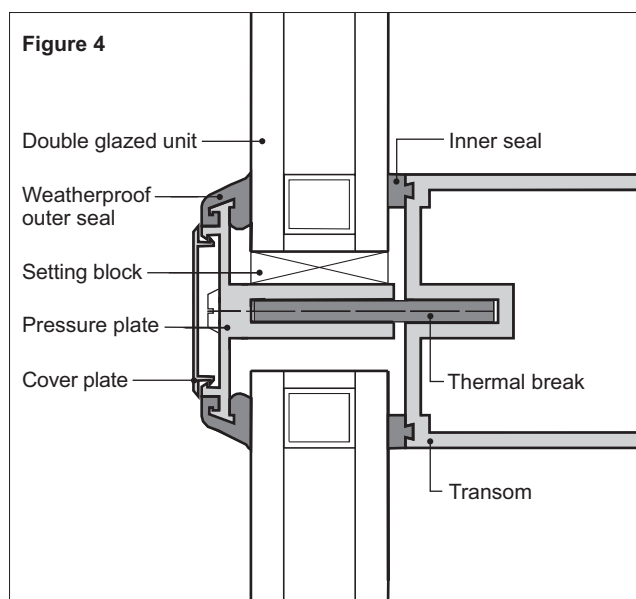
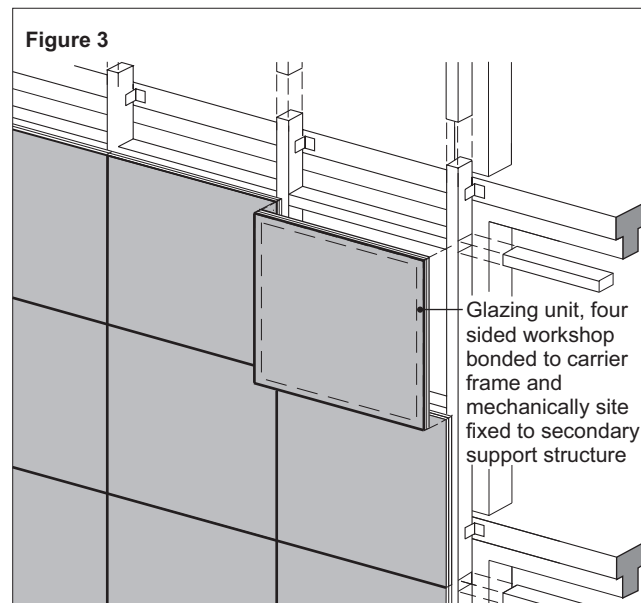
There are three basic methods of weathersealing curtain walling:

- **Single front sealed systems:** (See figure 4). These rely on weatherproof outer seals to glazing/ infill panel rebates and cavities to stop water penetration to the interior. Any water that bypasses the outer seals can drain away only within the framing system and may penetrate to the interior; it may also degrade mullion/ transom seals and double glazing edge seals. Single front seal curtain walling varies from simple systems for low rise, low exposure risk applications, to patented framed gasket systems for high exposure risk applications.
- **Drained and ventilated systems:** (See figure 5). These have weatherproof outer and inner seals to glazing/ infill panel rebates and cavities to stop water penetration to the interior. The rebates and cavities are also drained and ventilated to the exterior to prevent accumulation of any water that bypasses

the outer seals. Drainage of stick and exposed frame unitized systems is usually via small holes in the underside of transoms or via transom channels into and down mullions (the latter should drain to the outside of not more than three storey intervals).

Structural sealant glazing systems with enclosed glazing rebate cavities should be drained and ventilated, particularly where insulating glass units are specified.

- **Pressure equalized systems:** (See figure 6). These also have weatherproof outer and inner seals and are drained and ventilated. The ventilation openings are of an increased size to permit rapid equalization of pressure in the curtain walling cavities with the external pressure, thereby preventing water penetration of the outer skin. It is important that the inner seals to the cavities are airtight and continuous to resist pressure fluctuations. Compartmentation within cavities is necessary to prevent pressure loss across an elevation to zones exposed to lower wind pressures. The confines of stick system cavities usually provide adequate discontinuities, but large cavities within unitized systems will require further measures.



4 Selection of curtain walling

4.1 Choice of system

There are three approaches when deciding upon a curtain walling system:

- **Proprietary systems:** Standardised systems designed, manufactured and tested by curtain walling manufacturers, usually for predetermined market areas. The manufacturer's performance and test data should be sufficient to determine if the system will meet the project requirements.
- **Modified proprietary systems:** Proprietary systems as described above, with a limited number of components modified to suit particular project details. Project testing may be necessary to ensure that the modifications have not impaired the systems ability to meet the project requirements.
- **Bespoke systems:** Custom designed, manufactured and tested systems, specified where proposals for curtain walling depart significantly from proprietary system concepts. Standard components will be used where possible but often not in the way conceived by the manufacturer.

The choice of system will depend upon the type, complexity and budget of the project. It is important to select from manufacturers of similar capabilities, with fabricators/ installers of similar experience, all appropriate to the demands of the project. Manufacturers are prepared to offer early advice on the design/ performance capabilities of their systems and arrange visits to workshops and sites of approved fabricators/ installers. This may

result in elimination of one or more manufacturers from consideration, but equally may highlight impracticable design criteria.

4.2 Design

Curtain walling contributes significantly to the aesthetic of a building. Consequently, it is an area where the Architect will normally seek to keep firm design control but not compromise good practice. Design intent should be communicated in contract documentation by preliminary design drawings and a concise specification.

The drawings will usually show three levels of detail:

- General arrangement:
 - Structural frame and floor levels with preferred locations and types of fixings and movement joints.
 - Critical overall or opening dimensions.
 - Setting out centres, e.g. for mullions and transoms or for units.
 - Cladding zones.
- Panel:
 - Sketch panel/ unit details.
 - Positions of incorporated components, e.g. doors, opening lights, sun screens.
- Components:
 - Sketch extrusion/ frame section details.
 - Sketch perimeter details, e.g. sills, copings, abutments.

Preparing detailed design drawings at pre-tender stage is likely to be unproductive. With proprietary systems they may limit competition and with bespoke systems they may pre-empt solutions for which the manufacturer will not accept liability. Experienced curtain walling companies can usually prepare tender submissions without first producing detailed drawings, because they can confidently anticipate how their system will meet the project requirements.

Specification clauses 210, 230 and 235 in this section assign the preparation of detailed drawings to the appointed curtain walling manufacturer or the approved fabricator/ installer. It is important that the contract documentation clearly defines responsibilities for detailed design to ensure that the Employer has a redress in the event of failure due to design.

4.3 Specification

The content of a specification must be appropriate to the method of choosing a curtain walling system. Whatever the approach, there should be a performance bias, since the product, fabrication and installation capabilities will be better understood and interpreted by the curtain walling companies. They must prove that their proposed solutions can meet the performance criteria.

Writing a performance biased specification for curtain walling is a way for the specifier to share, not shed, design responsibility. Curtain walling manufacturers should be allowed to advise the design team before tendering and the appointed contractor should become a part of the design team.

This NBS section, therefore, contains comprehensive subsections for design/ performance requirements and testing. Specifications for bespoke and modified proprietary systems will require inclusion of most clauses from these subsections. Specifications for proprietary systems will also require comprehensive inclusion of clauses from these subsections even when comparison (type) testing (clause 510) is acceptable.

Architects, unless specialists in curtain walling, may feel out of their depth with the specification of more complex curtain walling systems. The expertise of other design disciplines (structural engineers, service engineers and/ or cladding consultants) should be enlisted where required.

4.4 Tender submission

A disciplined approach to contract documentation can reduce the cost of curtain walling tender preparation and thereby tender prices. It is usually desirable to restrict the number of tender submissions to three or four, whichever method of procurement is followed. This may mean starting from a list of five or six companies and eliminating those that are not competing on an

equivalent basis. Two stage tenders may be favoured for more complex projects, the preliminary stage leading to qualifying interviews for the submission stage. Meetings during the tender period can resolve any difficulties of interpretation and should ensure the preparation of comparable bids.

Submissions must provide sufficient information to enable the design team to verify that all requirements have been correctly and adequately interpreted – see clause 10.

On acceptance of a submission, the successful curtain walling contractors detailed design process should start as soon as possible, with priority given to fixings and feature/ interface details. All members of the design team should be involved in this stage of detail development.

5 Dimensional coordination

5.1 Fixings

The design of curtain walling attachments involves the architect, structural or cladding consultant, and curtain walling contractor. Fixing design responsibilities should be clearly defined at tender stage and agreed in principle before acceptance of a tender. Detailed fixing design should then be agreed before commencement of building structure works on site.

The building structure will normally dictate the type and positioning of fixings to be used. All fixings should be capable of not less than ± 25 mm adjustment in three directions. Shims should only be used where adjustment beyond these tolerances is required; they should be of equal size to the area of fixing attachment, not more than 10 mm thick, and be locked by serrations, bonded or welded to the fixing.

Lining and levelling is carried out on site as preparatory work before erection of curtain walling. Only fine adjustment and locking of fixings should then be necessary during curtain walling installation. Good access to all fixing positions will facilitate the speed and accuracy of installation.

Comprehensive guidance on the type and location of fixings most suitable for different curtain walling systems is given in the SCI publication, 'Curtain wall connections to steel frames'.

5.2 Accuracy of structure

The design of the curtain walling system and its method of fixing must take account of the degree of accuracy that can be achieved in the construction of the supporting structure. Conversely, the degree of accuracy required of the supporting structure will depend to some extent on the amount of adjustability that will be provided by the fixing system. Generally, curtain walling tolerances are of the order of 1/4 to 1/3 of those associated with the supporting structure. The method of achieving these finer tolerances rests with adjustment of connections, or the inclusion of buffer zones.

Recommended permissible deviations for structural steel frames are given in BS 5950-2, section 7.3 and in the 'National Structural Steelwork Specification for Building Construction' (NSSS), section 9. Recommended permissible deviations for in situ concrete frames and walls are given in BS 5606.

Levels of accuracy for steelwork specified in the NSSS are invoked by NBS in clause G10/125, higher levels being specified in clause G10/420. Levels of accuracy for in situ concrete work given in BS 5606 (or higher levels) are specified in Preliminaries section A33. Increased accuracy should be specified only after consideration of increased cost.

5.3 Avoiding critical relationships

Problems of dimensional coordination are better avoided rather than solved. Structure and curtain walling should be detailed so that there is the minimum possible requirement for their parts and features to coincide. Curtain walling usually runs past columns and beams and is not directly related to the space between them. The only critical dimensions are the overall length and height of the facade, thus allowing minor inaccuracies between the curtain walling and the structure to be taken up over many joints rather than a few.

Consider also the coordination of tolerances of other building components at abutments, e.g. ceiling, wall and floor finishes.

5.4 Live load deflection

In addition to permissible deviations in the structure, the curtain walling will also have to cope with live load deflections. The structural consultant should provide drawings and schedules of anticipated loadings to curtain walling contractors at tender stage. Where deflections are high and curtain walling contractors are involved in design development (see general guidance 4.4) it may be considered more economical for the primary structure to be stiffened than allowances made to accommodate movement in the curtain walling.

6 Testing (verification of performance)

Testing of curtain walling can expose design, fabrication and installation weaknesses at an appropriate time for corrective action to be applied, but it does not guarantee satisfactory performance in use. Testing is intended to subject a specimen to performance criteria that will match or exceed the extremes of environmental conditions likely to be experienced during the life of the curtain walling. However, the exact combination or cyclical changes of conditions that may occur, cannot be reproduced and the specifier's evaluation of test results should make appropriate allowances where necessary.

The CWCT 'Standard for systemised building envelopes' states in clause 1.5 'It is fundamental to the use of this standard that a representative sample of the envelope system shall be tested as appropriate for air tightness, water penetration resistance, and resistance to wind and other loads, prior to installation'.

Specification clauses for testing these and a range of other criteria are provided in this section, but this does not imply that project testing is mandatory. The options for satisfying a specification for testing are:

- **Previous results** (for proprietary systems only): The CWCT 'Standard for systemised building envelopes' allows testing to be deemed unnecessary if one of two conditions are satisfied:
 - The system has been successfully tested to the CWCT standard to pressures not less than those applicable to the proposed location and the system is to be used with spans, support conditions and supporting structural frames similar to those originally tested or used.
 - The supplier/ manufacturer can demonstrate and/or produce evidence of satisfactory, prolonged and extensive use of their product in a similar manner and location to the intended project for not less than ten years.
- **Classification** (for proprietary systems only): The CWCT have adopted the performance classification system established in BS EN 13830. Proprietary systems are tested and performance classes shown in CWCT table 1.2 reproduced in table 1.

Table 1 CWCT Classification and appropriate usage

Maximum calculated wind pressure [pressure (p)]	Design wind pressure (p)	Air test pressure	Water test pressure	Wind serviceability test pressure	Wind safety test pressure
Up to 1200 Pa	Maximum calculated	300 Pa (A2)	300 Pa (R5)*	1.0 p	1.50p
1201 to 1600 Pa	wind pressure	450 Pa (A3)	450 Pa (R6)*		
1601 to 2400 Pa	but not less than	600 Pa (R7)	600 Pa (R7)*		
Over 2400 Pa	800 Pa	0.25p (RE)	0.25p (RE)		

* The selection of the test pressure is based on the degree of exposure to the weather. Where justifiable, the Specifier may wish to test the envelope to higher pressures than indicated.

The CWCT Standard defines the parameters for a standard test panel and details a suitable panel for proprietary systems. Test results are expressed in terms of pressures achieved for air permeability, water penetration and wind resistance g – Air permeability A2, A3, A4 or AE.xxx, Water penetration R5, R6, R7 or RE.xxxx and Wind resistance as the actual pressure achieved. Manufacturers have the opportunity to test standard systems and make results available for comparison. Again, any

variations in the proposed project details, e.g. spacing of Mullions/ transoms, will require evaluation.

- **Project testing** (for proprietary, modified proprietary and bespoke systems): A full scale specimen is laboratory tested in accordance with specified criteria and procedures. Panels can be tested using the facilities of an independent laboratory or the curtain walling manufacturer, in the latter case the results and report must be certified by an independent consultancy. Project testing is always time consuming and costly.

7 Health and safety

Health and safety risks should be listed in the pre-tender health and safety plan (Preliminaries section A34) and method statements obtained from the contractor in the outline construction phase health and safety plan (Preliminaries section A30).

7.1 Materials

The usual components of curtain walling are not considered a health risk, but care is required in handling cut edges of glass, panels/ facings and framing members. Unitized systems will require mechanical lifting into position and restraint during attachment of fixing anchors. Normal precautions should be taken with sealant application.

7.2 Design

The main hazards are associated with installing and maintaining curtain walling at high levels – people falling off the structure and materials or equipment falling onto others below. Consideration should be given to safe access systems for cleaning and inspection, e.g. gantries, cradles and anchorage points.

7.3 Reference documents

For guidance on working at heights see:

CC Construction health and safety manual, section 8D 'Work on roofs'.

CITB Construction site safety, section C6 'Safe working on roofs and at heights'.

HSE Publications INDG 401 'The work at height regulations 2005. A brief guide', 'Designing for Health and Safety in Construction: A guide for designers on the Construction (Design and Management) Regulations' and HSE Guidance booklets HSG 33 'Health and safety in roof work' and HSG 150 'Health and safety in construction'.

8 Contractual arrangements

The performance of curtain walling is dependent upon careful fabrication and installation in accordance with detailed design. Complications may arise where the curtain walling system includes components designed and/ or manufactured by other specialists, e.g. glazing and infill/ facing panels. Where such components are an integral part of the curtain wall assembly, the scope of this section enables their inclusion within the curtain walling specification and thereby achieves single contractor responsibility. This approach is recommended since the performance of the curtain walling is reliant upon the integrity of all components.

Where curtain walling is one cladding component of a complex building envelope, this section can be part of a stand alone contract package or it can be incorporated with other sections (e.g. L10 Windows, L20 Doors, H92 Rainscreen cladding) into an inclusive work package.

8.1 Subcontracting

The specifier may choose a subcontractor or influence the choice of subcontractor in several different ways. See Preliminaries section A30.

8.2 Requirements for submission of information

The specifier may require the Contractor or a subcontractor to submit drawings or other technical information. Clause 10 specifies submissions at tender stage. Clauses 230, 235 and 240 specify submissions during the course of the contract. See also Preliminaries section A31.

Guidance notes

10

The listed particulars are intended to provide adequate information for technical evaluation of tender submissions.

Second item: Insert, e.g. *Full size head and sill sections at positions indicated on drawing L(2)04.*

Third item: List products and finishes specified by performance or to approval for which submission of proposals are required at tender stage. Insert, e.g.

*insulating glass units.
structural sealant glazing.*

Sixth item: Amendments and additions to supporting structure may improve accuracy and/ or loading deflections – see general guidance 5.2 and 5.4.

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Use this clause for performance or proprietary reference specification of all types of curtain walling.

Some abbreviation of the clause may be possible for proprietary systems. However, most curtain walling manufacturers obtain glazing and infill/ facing panels from other manufacturers, hence a full specification is still required here.

This clause can be repeated as necessary for each variation in type of glazing, external materials, etc. For complex systems it may be necessary to significantly expand the clause to convey a full description of the curtain walling components and assembly requirements.

The example inserts assume that the curtain walling contractor will be providing information and detailed drawings – see general guidance 4.2, 4.3 and 4.4.

Clause heading: Insert location or identification, e.g.

*TO EAST ELEVATION BLOCK B
TYPE A*

Supporting structure: Insert details of building frame construction. Describe or refer to any prerequisites for positioning of fixing anchors. Clause 10 requires proposals from the curtain walling contractor for any additional secondary supporting structure.

Curtain walling system:

– **Manufacturer/ Product reference:** See general guidance 8.1. Insert two or more proprietary references where selection from comparable systems is acceptable. It is common practice when specifying standard curtain walling systems to select a manufacturer and obtain competitive tenders from approved fabricators/ installers. If choice of system is left to the contractor, insert, e.g. *Contractor's choice.*

– **Type:** Describe design principles – see general guidance 3.1 and 3.2. Insert, e.g.

*Stick system, pressure equalized.
Unitized structural sealant glazing system, drained and ventilated via mullions. →*

Specification clauses

H11 CURTAIN WALLING

To be read with Preliminaries/ General conditions.

TENDERING

10 INFORMATION TO BE PROVIDED WITH TENDER

- Submit the following curtain walling particulars:
 - Typical plan, section and elevation drawings at suitable scales.
 - Typical detailed drawings at large scales, including
 - Technical information and certification demonstrating compliance with specification of proposed incorporated products and finishes, including
 - Certification, reports and calculations demonstrating compliance with specification of proposed curtain walling.
 - Proposals for connections to and support from the building structure and building components.
 - Proposals for amendments to primary supporting structure and for secondary supporting structure additional to that shown on preliminary design drawings.
 - Schedule of builder's work, special provisions and special attendance by others.
 - Examples of standard documentation from which project quality plan will be prepared.
 - Preliminary fabrication and installation method statements and programme.
 - Schedule of products and finishes with a design life expectancy less than that specified in clause 440, with proposals for frequencies and methods of replacement.
 - Proposals for replacing damaged or failed products.
 - Areas of non-compliance with the specification.

TYPES OF CURTAIN WALLING

110 CURTAIN WALLING

- Supporting structure:
- Curtain walling system:
 - Manufacturer:
 - Product reference:
 - Type:
- Internal framing member:
 - Material:
 - Finish:
 - Colour/ Texture:
 - Minimum film thickness:
- External cover cap:
 - Material:
 - Finish:
 - Colour/ Texture:
 - Minimum film thickness:
- Glazing:
 - Inner pane:
 - Outer pane:
- Glazing system:
- Panel/ facing type:
 - External material:
 - External finish:
 - Internal material:
 - Internal finish:
 - Core insulation:
- Accessories:
- Incorporated components:
- Other requirements:

Internal framing member: The subitems are for use with exposed mullion/ transom sections of stick or unitized systems. Adapt them for other framing member arrangements, e.g. unitized systems with secondary framing (see general guidance 3.1).

Where framing members are to provide support to internal fixtures, e.g. radiators, partition end posts, details of the fixtures should be provided on drawings or schedules.

– **Material:** See 'Products' clauses and insert, e.g.

Aluminium.

PVC-U.

– **Finish:** A decorative finish will normally be required for metal framing. Aluminium alloy can be anodized, powder coated or liquid coated. Steel must be galvanized and can be powder coated or liquid coated. Curtain walling manufacturers may offer standard factory applied finishes that can be specified if a single proprietary system is selected. To complete this and the following two subitems see 'Finishes' clauses and insert, e.g.

– Finish: *Powder coating.*

Colour/ texture: *RAL 9003/ matt (30 ±5 units).*

Minimum film thickness: *60 micrometres.*

External cover cap: The subitems are for use with cover caps to pressure plates of exposed mullion/ transom sections of stick or unitized systems. Adapt them for other restraint systems, e.g. compressed gasket glazing.

– **Material:** See 'Products' clauses and insert, e.g.

Aluminium.

PVC-U.

– **Finish:** A decorative finish will normally be required for metal. To complete this and the following two subitems insert, e.g.

– Finish: *Anodizing.*

Colour/ texture: *Dark bronze.*

Minimum film thickness: *25 micrometres.*

Glazing/ Inner pane/ Outer pane: Determination of glass thickness can be left to the contractor – see Integrity clauses 311, 312 and 313. However, if the contractor is not made responsible for integrity, the thickness should be specified. For general guidance on glass types see section L40.

For generic specification, see 'Products' clauses and insert, e.g.

Glazing: *Insulating glass units.*

– Inner pane: *Clear float glass.*

– Outer pane: *Laminated solar control glass.*

For special types of glazing, insert proprietary references.

Glazing system: See 'Products' clauses and insert, e.g.

Gaskets, cover plate fixed.

Structural sealant, four side bonded.

Panel/ facing type: This item assumes composite units or fabrications with external and internal linings. Insert, e.g.

Composite infill panels, external cover plate fixed.

Composite facings, mechanically fixed to secondary framing.

Edit or amend the subitems to suit other panel/ facing arrangements. Ventilation of cavities in panels/ facings may be an extension of the drained and ventilated or pressure equalized weathersealing system. If not, specify details here or require details in tender submissions (clause 10).

– **External material:** See 'Products' clauses and insert, e.g.

6 mm laminated, ceramic coated glass.

40 mm polished white granite.

Include description of any complexities that cannot be shown on drawings.

– **External finish:** Use where the panel/ facing has a decorative finish. For metals see guidance note to 'Internal framing member' above. Also see general guidance 2 to section Z11.

– **Internal material:** Insert, e.g.

9 mm fibre cement board.

12.5 mm plasterboard dry lining.

– **Internal finish:** Use where a workshop applied decorative finish is required. For metals see guidance note to Internal framing member above.

– **Core insulation:** Specify by prescription for proprietary or specifier designed constructions, see clause 780. Specify by performance where the curtain walling contractor is providing detailed design, e.g. *As clause 780, to comply with thermal performance requirements of clause 370.* →

Also specify associated weather or vapour barriers, see clause 785.

Accessories: Describe here minor components to be incorporated into the curtain walling, e.g. parapet pressings, flashings, nonstandard ironmongery.

Incorporated components: Describe here major standard components to be incorporated into the curtain walling. Insert, e.g. *Top hung opening lights as drawing ???*

See clause 130 to 145 for major nonstandard components to be incorporated into the curtain walling. Insert, e.g. *Sun screens*.

Other requirements: Use this item to draw attention to any unusual requirements, e.g. *Glazing installation to be from interior*.

130, 135, 140, 145

Use these clauses to specify major nonstandard components integrated into or attached to the curtain walling. Specify permanent access systems in section N25. Expand or amend the clauses where necessary to convey a full description of the components. Repeat and retitle the clauses for other components.

Clause heading: Insert, e.g.

SUN SCREENS TO SOUTH ELEVATION
DOORSTO MAIN ENTRANCE

Manufacturer/ Product reference: Insert proprietary details if appropriate.

Material: See 'Products' clauses and insert, e.g. *Aluminium*.

Finish: Use where the component has a workshop applied decorative finish. See 'Finishes' clauses and insert, e.g.

Finish: *Powder coating*.

– Colour/ Texture: *RAL 9003/matt (30 ±5 units)*.

– Minimum film thickness: *60 micrometres*.

Fixing: Describe method of attachment to curtain walling or through into building structure.

130 SUN SCREENS

- Manufacturer:
- Product reference:
- Material:
- Finish:
- PVDF coating
- Colour/ Texture:
- Minimum film thickness:
- Fixing:
- Other requirements:

135 DOORS

- Manufacturer:
- Product reference:
- Material:
- Finish:
- Colour/ Texture:
- Minimum film thickness:
- Fixing:
- Other requirements:

140 LOUVRES

- Manufacturer:
- Product reference:
- Material:
- Finish:
- Colour/ Texture:
- Minimum film thickness:
- Fixing:
- Other requirements:

145 INTEGRATED ACCESS EQUIPMENT

- Manufacturer:
- Product reference:
- Material:
- Finish:
- Colour/ Texture:
- Minimum film thickness:
- Fixing:
- Other requirements:

GENERAL REQUIREMENTS/ PREPARATORY WORK

210

This clause presumes that preliminary design drawings will be prepared by the specifier and detailed design drawings by the curtain walling contractor – see general guidance 4.2.

215

This clause is most appropriate for modified standard or bespoke curtain walling systems where alternatives can be considered.

210 DESIGN

- Curtain walling and associated features: Complete the detailed design. Submit before commencement of fabrication.
- Related works: Coordinate in the detailed design.

215 DESIGN PROPOSALS

- Submission of alternative proposals: Preliminary design drawings indicate intent. Other reasonable proposals will be considered.

220

The status of the CWCT Standard is outlined in general guidance 2.

230

Proposals for fixing anchors should be checked for compatibility with the building structure.

A testing programme may not be required for proprietary systems (see general guidance 6), in which case the fourth item will not be applicable.

232

At the time this guidance was written, the CWCT were preparing a technical note dealing with method statements for the construction of building envelopes, which is scheduled to contain guidance on quality plans.

235

Method statements should contain control procedures to ensure compliance with the project requirements including programme, sequence of erection and coordination with other trades.

The method statement for handling should state any special arrangements for transportation, lifting and storage.

The specifier should advise the Employer where there is a need to keep spare parts. The need is proportional to the risk of damage and the extent of use of bespoke products. Provisional sums should be allocated where appropriate.

220 SPECIFICATION

- Compliance standard: The Centre for Window and Cladding Technology (CWCT) 'Standard for systemised building envelopes'.
- Reference information: For the duration of the contract, keep available at the design office, workshop and on site copies of:
 - The CWCT 'Standard for systemised building envelopes'.
 - Publications invoked by the CWCT 'Standard for systemised building envelopes'.

230 INFORMATION TO BE PROVIDED DURING DETAILED DESIGN STAGE

- Submit the following curtain walling particulars:
 - A schedule of detailed drawings and dates for submission for comment.
 - A schedule of loads that will be transmitted from the curtain walling to the structure.
 - Proposed fixing anchor details relevant to structural design and construction.
 - A detailed testing programme in compliance with the Main Contract master programme.
 - A detailed fabrication and installation programme in compliance with the Main Contract master programme.
 - Proposals to support outstanding applications for Building Regulation consents or relaxations.

232 QUALITY PLAN

- Requirement: Submit during detailed design.
- Content: In accordance with BS 5750, BS EN ISO 9001 and including the following:
 - Name of the quality manager.
 - Quality assessment procedures.
 - Inspection procedures to be adopted in checking the work.
 - Stages at which check lists will be used and samples of the lists.
 - List of work procedures on the correct use of materials or components, both off site and on site.
 - List of product information with latest revisions.
 - Subcontractors involved in the work.
 - Subcontractors' quality plans.
 - Storage, handling, transport and protection procedures.
 - Procedure for registering and reporting non compliances.
 - Maintenance procedures and calibration records.
 - Certification that completed work complies with specification
 - Check list register to ensure all items have been inspected and non compliances discharged.

235 INFORMATION TO BE PROVIDED BEFORE COMMENCEMENT TESTING OR FABRICATION OF CURTAIN WALLING

- Submit the following curtain walling particulars:
 - Detailed drawings to fully describe fabrication and installation.
 - Detailed calculations to prove compliance with design/performance requirements.
 - Project specific fabrication, handling and installation method statements.
 - Certification for incorporated components manufactured by others confirming their suitability for proposed locations in the curtain walling.
 - Recommendations for spare parts for future repairs or replacements.
 - Recommendations for safe dismantling and recycling or disposal of products.

240

Use this clause only where structural sealant glazing techniques are specified – see general guidance 3.1. It is important that structural bonding sealant manufacturers provide approval on a project specific basis. They will require:

- Samples for testing (clause 660).
- Preliminary design and detailed drawings.
- Relevant specification sections.

250

It is usually important to obtain panel/ facing product samples – see guidance note to clause 750. Samples of powder coating finishes are required by clause Z31/230.

270

Use this clause where a full scale mock-up (clause 280) cannot be justified. Insert required sizes and details, e.g. *600 x 600 mm mullion and transom intersection with fitted glazing units.*

280

On large projects the construction of a full size mock-up, usually on site, may be justified to validate, e.g. detailed design, tolerances.

Extent: Insert size and details of mock-up, e.g. *Storey height bay of south elevation including sun screen.*

Purpose: Insert, e.g. *To validate gasket glazing system and serve as an installation reference panel.*

A test specimen (clause 540) or a preliminary area of curtain walling (clause 965) may serve the same purposes as a mock-up, in which case this clause can be deleted.

DESIGN/ PERFORMANCE REQUIREMENTS

The performance bias of curtain walling specifications is discussed in general guidance 4.3.

Note that the CWCT 'Standard for systemised building envelopes' advises the specifier to assess the performance criteria given in the Standard with the needs of the building and indicates that the assessment may lead to an upward adjustment of values. It is important that full site information is assimilated and conveyed as part of the contract documents.

305

Where the CWCT 'Standard for systemised building envelopes' performance criteria are to be modified to suit project requirements it will be necessary to add supplementary items and/ or clauses in this subsection.

240 INFORMATION TO BE PROVIDED BEFORE COMMENCEMENT OF STRUCTURAL SEALANT GLAZING

- Submit structural bonding sealant manufacturer's project specific approval for:
 - Compatibility and adhesion of products and finishes.
 - Full details of structural sealant glazing design.
 - Structural sealant dimensions.
 - Project specific sealant application method statement.

250 PRODUCT SAMPLES

- General: Before commencing detailed design, submit labelled samples of:

260 SAMPLES OF FIXINGS

- General: During detailed design, submit labelled samples of each type of fixing anchor, including casting-in restraints and shims, together with manufacturers' recommended torque figures.

270 FABRICATION SAMPLES

- General: During detailed design, submit samples of:
 - Obtain approval of appearance before proceeding.

280 MOCK-UP

- General: Construct during detailed design work in an approved location. Obtain approval of appearance before proceeding. Retain undisturbed until completion of curtain walling installation.
- Extent:
- Purpose:

DESIGN/ PERFORMANCE REQUIREMENTS

305 CWCT 'STANDARD FOR SYSTEMISED BUILDING ENVELOPES'

- General: Unless specified or agreed otherwise comply with:
 - Part 2 – Loads, fixings and movement.
 - Part 3 – Air, water and wind resistance.
 - Part 4 – Operable components, additional elements and means of access.
 - Part 5 – Thermal, moisture and acoustic performance.
 - Part 6 – Fire performance
 - Part 7 – Robustness, durability, tolerances and workmanship.
- Project performance requirements specified in this subsection: Read in conjunction with CWCT performance criteria.

311, 312, 313

Alternative clauses to specify integrity by performance where the curtain walling contractor is to be responsible for detailed design.

Use clause 311 to specify design wind pressure. Use clause 312 or clause 313 where the curtain walling contractor is to calculate design wind pressure (in clause 312 the basic wind load design parameters are to be specified). In all cases provide adequate site location and building configuration information on drawings to enable the contractor to propose an appropriate system. Any required coordination of joint spacing with other building elements should be indicated on general arrangement drawings.

Design wind pressure (clause 311): The maximum wind pressure should be calculated in accordance with BS 6399-2 and BS 6262. The design wind pressure for standard curtain wall systems is derived from the maximum calculated wind pressure as follows (CWCT 'Standard for systemised building envelopes' 2.2.4). Insert value from the following table.

CWCT 'Standard for systemised building envelopes'

Table 2.1 Design wind pressure

Maximum calculated wind pressure $q(C_{pe}-C_{pi})$ in Pascals (Pa)	Design wind pressure (Pa)	
	Proprietary system	Custom system
Up to 800	800	Maximum calculated wind pressure but not less than 800 Pa
801 – 1200	1200	
1201 – 1600	1600	
1601 – 2000	2000	
2001 – 2400	2400	
Over 2400	As calculated	

On complex projects where different design wind pressure values apply to different zones or types of curtain walling, extend this clause to suit. Insert, e.g. *800 Pascals to walling Type A, 1200 Pascals to walling Type B*.

Design wind pressure (clause 312): Complete inserts as follows (references are to clauses, figures and tables in BS 6399-2):

- Basic wind speed: Refer to figure 6.
- Altitude factor: Refer to clause 2.2.2.2 and figure 7.
- Direction factor: Refer to clause 2.2.2.3 and table 3. If a conservative approach is required, insert 1.
- Seasonal factor: The inserted value of 1 is valid for permanent buildings. Refer to clause 2.2.2.4.
- Probability factor: The inserted value of 1 is valid for normal design conditions. Refer to clause 2.2.2.5.
- Terrain and building factor: Refer to clause 2.2.3.3 and table 4.
- Size effect factor: The inserted value of 1 is conservative. Refer to clause 2.1.3.4 and table 4.
- External pressure coefficients: Refer to clauses 2.4 and 2.5 and subdivide curtain walling areas, where necessary, into pressure coefficient zones (shown on drawings).
- Internal pressure coefficients: Refer to clause 2.6.
- Dominant opening: Refer to clause 2.6 and determine whether any external opening can be considered dominant and if it will normally be left open. Insert, e.g. *Service bay doors to be considered as open*.

Hard body impact loads to BS 8200: CWCT TN 52 offers guidance on impact specification. At the time this guidance was written, CWCT TN 52 had not been published. Check with CWCT for availability.

Soft body impact loads – curtain walling to BS EN 14019:

BS EN 14019 covers areas of curtain walling other than glass. CWCT 'Standard for systemised building envelopes' requires the use of this standard for curtain wall systems other than glass areas. CWCT TN 52 offers guidance on impact specification. At the time this guidance was written, CWCT TN 52 had not been published. Check with CWCT for availability.

Soft body impact loads – glass to BS EN 12600: BS EN 12600 covers glass areas of curtain walling. CWCT Standard requires the use of this standard for glass areas. For classifications see BS EN 12600 clause 6 and refer to manufacturer. CWCT TN 52 offers guidance on impact specification. At the time this guidance was written, CWCT TN 52 had not been published. Check with

311 INTEGRITY

- Requirement: The curtain walling must resist wind loads, dead loads and design live loads, and accommodate deflections and movements without damage.
- Design wind pressure:
- Hard body impact loads: To BS 8200:
 - Location and category:
- Soft body impact loads – curtain walling to BS EN 14019:
 - Location and classification:
- Soft body impact loads – glass to BS EN 12600:
 - Location and classification:
- Permanent imposed loads:
- Temporary imposed loads:

312 INTEGRITY

- Requirement: The curtain walling must resist wind loads, dead loads and design live loads, and accommodate deflections and movements without damage.
- Design wind pressure: Calculate in accordance with BS 6399-2, Standard Method:
 - Basic wind speed (V_b):
 - Altitude factor (S_a):
 - Direction factor (S_d):
 - Seasonal factor (S_s): 1.
 - Probability factor (S_p): 1.
 - Terrain and building factor (S_b):
 - Size effect factor (C_s): 1.
 - External pressure coefficients (C_{pe}):
 - Internal pressure coefficients (C_{pi}):
 - Dominant opening:
- Hard body impact loads: To BS 8200:
 - Location and category:
- Soft body impact loads – curtain walling to BS EN 14019:
 - Location and classification:
- Soft body impact loads – glass to BS EN 12600:
 - Location and classification:
- Permanent imposed loads:
- Temporary imposed loads:

313 INTEGRITY

- Requirement: The curtain walling must resist wind loads, dead loads and design live loads, and accommodate deflections and movements without damage.
- Design wind pressure: Calculate in accordance with BS 6399-2.
- Hard body impact loads: To BS 8200:
 - Location and category:
- Soft body impact loads – curtain walling to BS EN 14019:
 - Location and classification:
- Soft body impact loads – glass to BS EN 12600:
 - Location and classification:
- Permanent imposed loads:
- Temporary imposed loads:

CWCT for availability.

Imposed loads: Permanent imposed loads include, e.g. sun screens. Temporary imposed loads include, e.g. maintenance access, occupant impact. State types, giving values where possible, and/ or refer to drawings/ schedules.

320

Use with framed curtain walling. This clause specifies supplementary requirements to the CWCT 'Standard for systemised building envelopes' clause 2.3.2 criteria and is derived from the AAMA 'Metal curtain wall manual'.

325

CWCT 'Standard for systemised building envelopes' establishes performance requirements for the deflection under wind load of curtain wall elements, but recognizes that greater limitations may be required to maintain the efficacy and visual acceptance of fixtures, finishes and interfaces.

Requirement: Refer to CWCT Standard clause 3.5.2 and insert deflection requirements for elements and components that exceed those included in the clause. Insert, e.g. *Normal to plane deflection not to exceed 10 mm for framing members between 2500 mm and 3000 mm long.*

Additional stiffness: CWCT Standard clause 3.5.4.1 requires that when calculating deflections and stresses no account is taken of additional stiffness imparted by other components. Clause 3.5.4.2 allows the requirement of this clause to be waived by agreement between the Specifier and the Contractor/ Building Envelope Contractor. Insert, either *Allowed* or *Not allowed*.

330

Building movements may be due to design loads, settlement, creep, racking (drift) or movement joints. They are calculated usually by the structural engineer. Insert locations, durations, sizes and directions of movements relevant to curtain walling, and whether they are once only or recurring. Refer to structural drawings/ schedules where necessary – see general guidance 5.4. Movements can be simulated in a building movement regime (clause 560).

Specify permissible deviations in the supporting structure in other sections – see general guidance 5.2.

The CWCT 'Standard for systemised building envelopes' does not state performance standards for earthquake (seismic) loads, and there are no relevant British Standards. Where the project location demands, earthquake load resistance should be specified for curtain walling by addition of a clause invoking an appropriate national standard, e.g. ASCE 7-05 for the USA.

332

Primary support structure:

– **Design tolerances:** CWCT 'Standard for systemised building envelopes' requires the design tolerances of the primary support structure to be stated by the specifier. See Preliminaries section A33 and insert appropriate section references, e.g.

As sections G10 and F10.

Curtain wall envelope zone tolerances: CWCT Standard clause 7.4.3 requires the specifier to state the toleranced dimensions of the zone within which the envelope is to be constructed and in guidance gives a reminder of the cumulative nature of tolerance dimensions. Refer to CWCT clauses 7.4.3 and 7.4.4 for further guidance.

Maximum permitted component and installation tolerances: Refer to clause guidance in Preliminaries section A33. Complete A33 clauses with requirements for the curtain wall system that affect other work sections. Use this item to list other critical dimensions. CWCT Standard clause 7.4.2 guidance states that critical dimensions relating to interfaces with adjacent envelope construction, penetrations through the envelope and Internal fit out should be shown on drawings. Insert, e.g.

Panel length ±2 mm.

Panel width ±1 mm.

Panel tolerance ±2 mm, installation tolerance ±2 mm, overall = ±4 mm.

320 DEFLECTION UNDER DEAD LOADS

- Requirement: Framing members parallel to the curtain walling plane must not:
 - Reduce glass bite to less than 75% of design dimension.
 - Reduce edge clearance to less than 3 mm between members and immediately adjacent glazing units, panel/ facing units or other fixed units.
 - Reduce clearance to less than 2 mm between members and movable components such as doors and windows.

325 DEFLECTION UNDER WIND LOAD

- Requirement: To CWCT 'Standard for systemised building envelopes' clause 3.5.2 and the following additional requirements:
- Additional stiffness to CWCT 'Standard for systemised building envelopes' clause 3.5.4.2:

330 GENERAL MOVEMENT

- Requirement: Curtain walling must accommodate anticipated building movements as follows:

332 APPEARANCE AND FIT

- Requirement: Design curtain walling system:
 - To ensure position and alignment of all parts and features as shown on preliminary design drawings.
 - To accommodate deviations in the primary support structure.
- Primary support structure: Before commencing installation of curtain walling system, carry out survey sufficient to verify that required accuracy of erection can be achieved.
 - Give notice: If the structure will not allow the required accuracy or security of erection.
 - Design tolerances:
- Curtain wall envelope zone tolerances:
 - Width:
 - Critical reference location:
- Maximum permitted component and installation tolerances:

335

CWCT 'Standard for systemised building envelopes' clause 2.7.2 in table 2.2 and 2.3 list the temperature ranges for materials used in normal circumstances in the UK which are required to be considered when designing the curtain wall system. Where project requirements exceed these values use this clause to amend or add to the tabulated values. The tables are reproduced below.

CWCT 'Standard for systemised building envelopes'

Table 2.2 External surface temperatures

Cladding walling and roofing	
Heavyweight, light colour	-20°C to +50°C
Heavyweight, dark colour	-20°C to +65°C
Lightweight (insulated), light colour	-25°C to +60°C
Lightweight (insulated), dark colour	-20°C to +80°C
Glass	
Clear	-25°C to +40°C
Coloured or solar control	-25°C to +90°C

CWCT 'Standard for systemised building envelopes'

Table 2.3 Internal room temperatures

Building empty or out of use	-5°C to +35°C
Building in normal use	+10°C to +30°C

Note: Internal surface temperatures may be influenced by solar gain or the presence of heating panels

340

BS EN 12152 is used by the CWCT 'Standard for systemised building envelopes' to define the required air permeability at a peak test pressure. CWCT guidance states that the selection of a suitable peak test pressure is dependent on the environmental conditions required within the building. CWCT Standard clause 3.3.2.2 indicates that the recommended minimum peak test pressure is as in table 2.

TABLE 2: Peak test pressures – Part of CWCT Table 1.1

Maximum calculated wind pressure (Pa)	Air test pressure (Pa)
Up to 800	300/450/600
801 to 1200	300/450/600
1201 to 1600	300/450/600
1601 to 2000	300/450/600
2001 to 2400	300/450/600
Over 2400	0.25 of calculated design wind pressure

However, for each design wind pressure/ maximum calculated wind pressure, a range of values is given for the air test pressure. It has been suggested that 300 Pascal may be appropriate for lower quality commercial buildings rising to 600 Pascal for high quality commercial buildings.

BS EN 12152 links peak test pressure and permeability class as in table 3.

TABLE 3: Permeability class

Permeability class	Peak (maximum) test pressure (Pa)
A2	300
A3	450
A4	600
AE	>600

Permeability class to BS EN 12152: Insert appropriate class selected from table 3. AE indicates exceptional performance, i.e. achieving less than the required leakage for A4 at a test pressure greater than 600 Pa.

– **Peak test pressure:** Insert the value linked with the permeability class from table 3. For AE class insert required pressure.

335 THERMAL MOVEMENT – SERVICE TEMPERATURE RANGES

- Requirement: To CWCT 'Standard for systemised building envelopes' clause 2.7.2 amended and/or with the addition of the following:

340 AIR PERMEABILITY

- Requirement: Permissible air leakage rates of 1.5m³/hr/m² for fixed lights and 2.0 m³/hr/lin.m for opening lights must not be exceeded when the curtain walling is subjected to the peak test pressure.
- Permeability class to BS EN 12152:
 - Peak test pressure:

345

CWCT 'Standard for systemised building envelopes' clause 3.3.2.3, requires air exfiltration rates through the building envelope system to be specified. BSRIA publication 'Specification 10/98' and CIBSE TM23 'Testing buildings for air leakage'. Give recommended levels for various building types. Whole building pressure testing is covered in Preliminaries section A33. Insert, e.g.

Computer suite: 4 m³/(h.m²) at a test pressure of 100 Pa.

All external walls: 4 m³/(h.m²) at a test pressure of 50 Pa.

350

BS EN 12154 is used by the CWCT 'Standard for systemised building envelopes' to define the required watertightness at a peak test pressure. The minimum recommended peak test pressure is given in Table 1.1 of Part 1 to the CWCT Standard – see table 4.

TABLE 4: Peak test pressures – Part of CWCT Table 1.1

Maximum calculated wind pressure (Pa)	Water test pressure (Pa)
Up to 800	300
801 to 1200	300
1201 to 1600	450
1601 to 2000	600
2001 to 2400	600
Over 2400	0.25 of calculated design wind pressure

CWCT guidance states that selection of the test pressure should be based on the degree of exposure to the weather and if justified higher test pressures than indicated in Table 1.1 may be used.

BS EN 12154 links peak test pressure and watertightness class as in table 5.

TABLE 5: Watertightness class

Watertightness class	Peak (maximum) test pressure (Pa)
R5	300
R6	450
R7	600
RE xxx	>600

Watertightness class to BS EN 12152: Insert appropriate class selected from table 5. RE xxx indicates exceptional performance, i.e. achieving no water leakage at a test pressure greater than 600 Pa.

– Peak test pressure: Insert the value linked with the watertightness class from table 5. For RE xxx class insert required pressure.

Additional requirements: CWCT Standard clause 3.4.2.1 requires that 'There shall be no leakage onto the internal face of the building envelope system at any time during the test'. Under the same clause the Specifiers' Checklist (Part 0) requires the declaration of any components of the building envelope that are not to be wetted.

Clause 1.5 of CWCT 'Standard test methods for building envelopes', which forms part of the 'Standard for systemised building envelopes' requires determination before testing of the following:

- Which, if any, materials may be permitted to be wetted
- Any zones of the wall where water should not enter.
- Any other criteria that may determine a water penetration failure.

Insert, e.g. *Underside of any transom not to be wetted at peak test pressure.*

370

Heat loss through external walls should be limited to comply with Building Regulations:

- **E&W** Approved Documents

L1A

L1B

L2A

L2B

- **IRL** Technical Guidance Document L.
- **NI** Technical Booklet F.
- **Scot** Technical Handbook 6.

CWCT 'Standard for systemised building envelopes' clause 5.2.3.1 requires the U-value of a zone of a building envelope to be

345 AIR PERMEABILITY EXFILTRATION

- Requirement: The maximum permissible air exfiltration rate through the curtain walling system must not exceed:

350 WATER PENETRATION

- Watertightness class to BS EN 12154:
- Peak test pressure:
- Additional requirements:

370 THERMAL PROPERTIES

- Method of calculating the thermal transmittance (U-value) of curtain walling/ each zone of curtain walling: Weighted U-value.
- Average U-value of curtain walling:
- Curtain wall zone interfaces: Co-ordinate to achieve required average U-value.
- Method for assessing thermal transmittance (U-value) of assemblies:

calculated using the weighted U-value method. Building Regulations (E & W) Approved Documents L2A and L2B require U-values to be calculated in accordance with BRE BR 443 and refer to the CAB/CWCT publication 'The thermal assessment of window assemblies, curtain walling and non-traditional building envelopes' for guidance concerning curtain walling. The CAB/CWCT publication covers stick and unitized curtain walling. BRE BR 443 is similarly cited in Building Regulations (E & W) Approved Documents L1A and L1B.

Average U-value of curtain walling: On complex projects where different U-values apply to different areas or types of curtain walling, or the components within it, extend this clause to suit. Insert, e.g. *1.6W/mK to walling Type A and 2.5W/mK to walling Type B.*

Method for assessing thermal transmittance (U-value) of assemblies: CWCT Standard clause 5.2.3.2 indicates two methods. Insert, *Hot box in accordance with BS 874-3, By calculation or Not applicable.*

380

CWCT 'Standard for systemised building envelopes' clauses 5.4.2 and 5.4.3 deal respectively with total solar energy transmission and visible light transmission. For both properties the CWCT Standard requires the inclusion of either a value relating solely to the glazing or a value that includes the effect of any shading devices. Where there are no shading devices or they are designed by the Architect/ Building Services Engineer, the Standard indicates the use of glazing only values. Where the Contractor is to design or select the shading devices the effective values inclusive of shading devices should be used.

Total solar energy transmission:

BRE Trust report FB9 'Summertime solar performance of windows with shading devices'. Defines the 'Total solar transmittance (g-value)' as *'the fraction of incoming solar radiation that passes through a window and/or shading system'*. It is usual to measure the total solar transmittance at the normal incidence, i.e. with the sun directly opposite the glazing. Sun hitting the glazing at an oblique angle will produce less transmitted radiation. The 'effective g-value' allows for this effect.

– **Maximum g-value/ Maximum effective g-value:** BRE Trust report FB9 shows how to calculate g-values. The report tabulates 'effective g-values' when used with generic shading devices and various glass types and configurations. The tables provide information for the following window orientations N, NE-NW, E-W, SE/SW, S and horizontal. Insert a value in the appropriate sub item and *Not applicable* in the remaining the sub item.

Visible light transmission: This decreases relative to solar energy transmission. See BS 6262-2, section 5 and 'Glass in building' chapter 9 for detailed guidance. Where applied, ceramic fritting will reduce light transmission according to its density and pattern.

On complex projects where different solar and light control values apply to different areas or types of curtain walling extend the items to suit.

385

The risk of thermal breakage of glass can be calculated by the glass manufacturer when provided with adequate building configuration information. Request submission of technical information and certification using clause 10. See the documents listed in guidance to clause 380.

380 SOLAR AND LIGHT CONTROL

- Total solar energy transmission:
 - Maximum g-value – glazing only:
 - Maximum effective g-value – glazing with shading devices:
- Visible light transmission:
 - Minimum light transmission – glazing only:
 - Minimum effective light transmission – glazing with shading devices:

385 THERMAL STRESS IN GLAZING

- Glass panes/ units: Must have adequate resistance to thermal stress generated by orientation, shading, solar control and construction.

390

Requirement:

- **Notional outdoor psychrometric conditions:** For locations outside of the UK, revise clause to exclude reference to BS 6229 and insert appropriate values for winter and summer conditions.
- **Notional indoor psychrometric conditions:** Data is given in CWCT 'Standard for systemised building envelopes' table 5.2b with added vapour pressure values from BS 6229 as follows:

CWCT 'Standard for systemised building envelopes' Table 5.2 with added values for vapour pressure (source BS 6229).

	Temp °C	RHh %	Dew Point C	VPp kPa
Houses, flats	20	55	10.7	1.28
Offices	20	40	6.0	0.93
Schools	20	50	9.3	1.17
Factories and heated warehouses	15	35	-0.3	0.6

410

CWCT 'Standard for systemised building envelopes, clause 5.5 requires sound reduction requirements to be declared. Use this clause where special sound reduction measures are required. On complex projects where different sound reduction levels apply to different areas or types of curtain walling, extend the items to suit.

Minimum weighted sound reduction index (Rw) to

BS EN ISO 717-1: BS EN ISO 717-1 defines this as a 'single number quantity'. The CWCT Standard indicates that spectrum adaptation terms may be used, for instance $R_w + C_{tr}$.

Guidance on external sound reduction can be found in CWCT Technical Notes (TN) 38 and 39.

Minimum weighted standardized level difference (DnTw) to

BS EN ISO 717-1: BS EN ISO 717-1 defines this as a 'single number quantity'. The CWCT Standard indicates that spectrum adaptation terms may be used, for instance $D_{nT,w} + C_{tr}$.

Reductions between adjacent floors and rooms will vary with the treatment of internal abutments.

420

Aluminium curtain walling has negligible fire resistance. Curtain walls are classed as unprotected areas for Building Regulation purposes. Modification of curtain walling to provide any meaningful period of resistance will be necessary. Insert periods and criteria, e.g. *30 min. integrity, 15 min. insulation*.

Fire resistance should comply with Building Regulations:

- **E&W** Approved Document B
- **IRL** Technical Guidance Document B.
- **NI** Technical Booklet E.
- **Scot** Technical Handbook 2.

Where requirements are variable or localized extend the clause to suit, or refer to location drawings.

425

Class 0 is a Building Regulation addition to BS 476-7 classification – see section Z12, general guidance 2.2. Insert the class required for internal surfaces.

Surface spread of flame should comply with Building Regulations:

- **E&W** Approved Document B
- **IRL** Technical Guidance Document B.
- **NI** Technical Booklet E.
- **Scot** Technical Handbook 2.

Where requirements are variable or localized extend the clause to suit, or refer to location drawings.

430

Fire stopping should comply with Building Regulations:

- **E&W** Approved Document B
- **IRL** Technical Guidance Document B.
- **NI** Technical Booklet E.
- **Scot** Technical Handbook 2.

390 AVOIDANCE OF CONDENSATION

- Requirement: Notional psychrometric conditions under which condensation must not form on building interior surfaces of framing members or any part of infill panels/ facings are:
 - Notional outdoor psychrometric conditions as BS 6229, table A1.
 - Notional indoor psychrometric conditions:
 - Temperature:
 - Relative humidity:
 - Vapour pressure:

410 SOUND TRANSMITTANCE

- Minimum weighted sound reduction index (R_w) to BS EN ISO 717-1:
 - Between internal and external surfaces of curtain walling:
- Minimum weighted standardized level difference ($D_{nT,w}$) to BS EN ISO 717-1
 - Between adjacent floors abutting curtain walling:
 - Between adjacent rooms on same floor abutting curtain walling:

420 FIRE RESISTANCE OF CURTAIN WALLING

- Standard: To BS 476-22.
 - Minimum periods and criteria:

425 INTERNAL SURFACE SPREAD OF FLAME OF CURTAIN WALLING

- Standard: To BS 476-7.
 - Class

430 FIRE STOPPING

- Locations: At junctions of curtain walling with compartment walls and floors.
- Materials and methods of fixing: To ensure fire resistance not less than that specified for compartment walls and floors.

435

Performance criteria: CWCT 'Standard for systemised building envelopes' clause 4.2.1 recommends that opening lights integrated into curtain walling comply with Part 3 of the CWCT Standard, and advises that BS 6375-1 does not test the interface between the component and surrounding envelope.

Security:

– **Applicable opening lights:** CWCT Standard clause 4.2.4 requires the listing of those opening lights to which the security rating is applicable.

– **Security rating:** LPS 1175 lists six classifications, 1 to 6, with 1 being the least secure and 6 the most secure. BS 7950 applies to domestic windows and excludes resistance to breakage of the glazing. DD ENV 1627 like LPS 1175 lists six classes, 1 to 6 with 1 being the least secure and 6 the most secure.

Restrictive catches: To avoid the risk of falling from an opening light, restrictive catches should be provided to appropriately located lights. Where the opening light is to be used as a means of escape in case of fire, the restrictor should not be key lockable.

Ventilation requirement: CWCT Standard clause 4.2.6 requires the extent of ventilation to be provided by opening lights to be declared by the specifier and indicates that the requirement is determined by the Building Regulations:

- **E & W** Approved Document F.
- **IRL** Technical Guidance Document F.
- **NI** Technical Booklet K.
- **Scot** Technical Handbook 3.

Windows to be cleaned from inside of the building: CWCT Standard clause 4.2.7 requires the specifier to determine which, if any of the windows are to be cleaned from inside of the building and reminds that they should comply with the Building Regulations:

- **E & W** Approved Document N.
- **NI** Technical Booklet V.
- **Scot** Technical Handbook 4.

Fasteners/ Integral locks: This item is supplementary to the requirements of the CWCT Standard. For locks insert, e.g.

Suited to pass same key.

Suited to differ.

Not required.

436

Performance criteria: CWCT 'Standard for systemised building envelopes' clause 4.3.1 requires that doors shall meet the requirements of clause 4.2.1 which recommends for opening lights (doors) integrated into curtain walling usage of the standards set by Part 3 of the CWCT Standard and advises that BS 6375-1 does not test the interface between the component and surrounding envelope. If deemed appropriate the CWCT Standard allows other criteria to be used.

Access facilities designated for use by disabled persons:

CWCT Standard clause 4.3.2 requires all designated doors and associated ramps, stairs and thresholds to comply with the Building Regulations and not to provide a barrier to access in accordance with Disability Discrimination Act. Insert details of all entrance facilities designated for use by disabled persons. The respective Building Regulations are:

- **E & W** Approved Document M.
- **IRL** Technical Guidance Document M.
- **NI** Technical Booklet R.
- **Scot** Technical Handbook 4.

Additional guidance on the design of entrance doors for use by disabled persons can be found in BS 8300.

Door strength and durability:

– **Forces and tests:** CWCT Standard clause 4.3.3 requires doors to have adequate strength to resist forces imposed by normal operation and to withstand any specified forces. Use this sub item to specify additional forces and durability requirements with appropriate tests. Refer to MOAT 7 for forces and BS EN 12400 for durability. BS EN 12400 assigns to tested doors classes 0 to 8, with 0 being the least durable and 8 the most durable. Annex A to the standard gives guidance on the classes by indicating class duty equivalents with class 1 equating to occasional, class 2 light, class 3 infrequent, class 4 moderate, class 5 normal, class 6 frequent, class 7 heavy and class 8 severe. If there are no special requirements

435 OPENING LIGHTS (WINDOWS)

- Performance criteria:
- Security:
 - Applicable opening lights:
 - Security rating:
- Opening lights restrictive catches to CWCT 'Standard for systemised building envelopes' clause 4.2.5:
- Ventilation requirement:
- Windows to be cleaned from inside of the building:
- Fasteners: Concealed multipoint, operated by an internal handle.
- Integral locks:

436 DOORS AND OTHER ACCESS FACILITIES

- Performance criteria:
- Access facilities designated for use by disabled persons:
- Strength and durability: To CWCT 'Standard for systemised building envelopes' clause 4.3.3.
 - Forces and tests:
- Security:
 - Applicable doors:
 - Security rating:

then insert *No additional requirements*.

Door security:

- **Applicable doors:** CWCT Standard clause 4.3.5 requires the listing of those doors to which the security rating is applicable.
- **Security rating:** LPS 1175 lists six classifications, 1 to 6, with 1 being the least secure and 6 the most secure. PAS 24-1 applies to domestic doors and excludes resistance to breakage of the glazing. DD ENV 1627 like LPS 1175 lists six classes, 1 to 6, with 1 being the least secure and 6 the most secure.

437

CWCT 'Standard for systemised building envelopes' clause 4.5.1 requires the declaration of performance class. Clause 4.5.2 determines that louvres should be tested and classified in accordance with BS EN 13030.

Discharge operation: Indicate the designed direction of flow over the louvres. Insert *Inlet* or *Outlet*.

Water penetration class: BS EN 13030 table 3 lists classes A to D, with class A being the least effective class and D the most effective class. Insert *A*, *B*, *C* or *D*.

Discharge/ entry loss coefficient class: BS EN 13030 table 4 lists classes 1 to 4, with class 1 having a coefficient value of 0.4 to 1.0, class 2 a value of 0.3 to 0.399, class 3 a value of 0.2 to 0.299 and class 4 a value of 0.199 and below. Insert *1*, *2*, *3* or *4*.

440

For definitions of terms associated with durability, CWCT 'Standard for systemised building envelopes' uses BS ISO 15686-1 which also gives guidance on service life planning and service life forecasting.

Relevant agents or degradation mechanisms: BS 7543 Annex A gives information on agents that cause deterioration, e.g. weathering agents such as temperature, solar radiation, precipitation, air contaminants, freeze-thaw and wind; biological agents such as plants or micro-organisms; intermittent or sustained stress agents; chemical and physical agents such as incompatibility of materials and use agents such as abuse. Guidance can also be found in BS ISO 15686-2. Insert, e.g. *Marine environment with annual driving rain index 4 m²sec⁻¹*.

Design life of curtain walling system: CWCT Standard indicates that the design life of the building envelope should be agreed with the client/ building owner at an early design stage and before the award of the contract for the envelope system works. The design life of the cladding system may be less than that for the building. Insert, e.g.

Not less than 30 years.

Not less than 50 years.

Secondary components: Defined as those having a forecast service life less than that of the envelope system, assuming the maintenance requirements of the supplier have been carried out. Probable secondary components are, e.g. sealants, gaskets, insulating glass units.

445

BS 6651 allows metal components of the building envelope to be used as part of the lightning protection system. Insert details of the components used or *None*

450

These requirements are supplementary to the CWCT 'Standard for curtain walling' criteria.

460

Use this clause where structural sealant glazing techniques are specified – see general guidance 3.1.

Structural sealant glazing units: Compliance with the removal and replacement requirement is dependent upon building and curtain walling construction details.

Structural sealant glazing design: The structural glazing industry set a 138 kPa limit on design tensile stress early in the development of this glazing method. This figure provides a usual safety factor of not less than 5:1, which is conservative but proved and accepted in practice.

437 LOUVRES

- Performance classification to BS EN 13030.
 - Discharge operation:
 - Water penetration class:
 - Discharge/ entry loss coefficient class:

440 DURABILITY

- Relevant agents or degradation mechanisms:
- Design life of the curtain walling system:
- Secondary components: Submit details together with required maintenance regime, replacement periods and methods of replacement.

445 LIGHTNING PROTECTION SYSTEM

- Curtain wall components used as part of lightning protection system:

450 SAFETY

- Finished surfaces of curtain walling: Accessible internal and external areas must not:
 - Have irregularities capable of inflicting personal injury.
 - Release irritant or staining substances.

460 STRUCTURAL SEALANT GLAZING REQUIREMENTS

- Structural sealant glazing units: Installable, removable and replaceable without site application of structural bonding sealant.
- Structural sealant glazing design: Must limit design tensile stress of sealants to 138 kPa.

TESTING

See general guidance 6 for optional methods of verification of performance of curtain walling. The test clauses in this NBS subsection invoke CWCT 'Standard for systemised building envelopes' Part 8, and are appropriate to previous results, classification or project testing. Amend the clause test references where previous results submissions based on, e.g. British Standard window testing methods, will be considered.

510, 515

Usually alternative clauses.

Use clause 510 where previous results or classification submissions will be considered. Include laboratory test clauses from this subsection for which submissions are to be made.

520

Site water tests (clauses 630/635) are recommended for all curtain walling as a check on fabrication and installation workmanship.

530, 535

Alternative clauses.

Amend clause 530 if the name of a specific testing laboratory is required – search on the UKAS website. UKAS approval should be extended to international bodies participating in their Mutual recognition agreements where testing is to be outside the UK. Testing authorities in countries not participating in the above should be evaluated.

Confirmation of UKAS accreditation is available by e-mail or through the UKAS website.

Use clause 535 where the testing authority is to be an appropriately qualified independent consultant or the Architect who will witness and certify tests undertaken by a non accredited organization. Insert *the Architect* or the name of an independent consultant.

540

Use this clause for project testing. Laboratory specimens must be secured to a support structure to simulate site fixing conditions. Locations for measuring devices are to be agreed.

Where other cladding components form an integral part of the curtain walling they should be included in the test specimen.

TESTING

510 COMPARISON (TYPE) TESTING

- Requirement: To CWCT 'Standard for systemised building envelopes', Part 8.
- Test results and reports: Before commencement of curtain walling fabrication and installation, submit proof of compliance with this specification.

515 PROJECT TESTING (LABORATORY)

- Test results and reports: Before commencement of curtain walling fabrication and installation, submit proof of compliance with this specification.

520 PROJECT TESTING (SITE)

- Test results and reports: Before installation of general areas of curtain walling, submit proof of compliance with this specification.

530 TESTING AUTHORITY

- Requirement: Project testing must be carried out by a United Kingdom Accreditation Service (UKAS) approved independent laboratory.

535 TESTING AUTHORITY

- Requirement: Project testing must be carried out by the curtain walling manufacturer/ contractor and is to be witnessed and certified by

540 TEST SPECIMEN

- Arrangement and overall dimensions:
- Features:

550

550, 555 and 560 are alternative clauses for project testing.

Use clause 550 for testing curtain wall systems to CWCT 'Standard for systemised building envelopes' 'Standard sequence A' (clause 8.12.1) where the peak test pressure for the static water penetration test is less than 600 Pascals and the curtain wall contains no ventilated cavities.

Test Sequence A is reproduced below to help complete the clause.

Standard sequence A:

- Air permeability (infiltration).
- Air permeability (exfiltration).
- Water penetration resistance – static.
- Wind resistance – serviceability.
- Air permeability (infiltration).
- Air permeability (exfiltration).
- Water penetration resistance – static.
- Hose test.
- Wind resistance – safety.
- Impact – safety (Optional, Note 1).
- Dismantle, inspect and record.

Note:

1: This test is recommended for proprietary envelope tests.

Air permeability (infiltration/ exfiltration):

– Method for identifying areas of concentrated air leakage:

CWCT Standard guidance lists the following qualitative methods:

- Not applicable
- Hot wire anemometers
- Smoke
- Back of hand.

Wind resistance – serviceability:

– **Peak test pressure:** Insert reference to clause 311, 312 or 313.

– **Position of displacement measuring devices:** CWCT 'Standard test methods for building envelopes' Section 11 requires the specifier to agree the position of the measuring devices. Insert, e.g. *As shown on drawing.*

– **Allowable elastic and residual deformation:** CWCT Standard clause 3.5.2 establishes maximum allowable deflection criteria and the allowable residual deformation requirements.

Hose test: This test is carried out in the laboratory to establish comparative values for site tests which are used to help detect construction and workmanship defects. Insert, *To CWCT clause 8.16.2 or Not required.*

– **Joints to be tested:** Insert locations or refer to drawings.

Wind resistance – safety:

– **Peak test pressure:** Insert reference to clause 311, 312 or 313.

– **Position of displacement measuring devices:** CWCT 'Standard test methods for building envelopes' Section 12 requires the specifier to agree the position of the measuring devices. Insert, e.g. *As shown on drawing.*

– **Allowable residual deformation:** CWCT Standard clause 3.6.2.2 establishes maximum allowable residual deformation of framing members as 1/500 of the span, measured between points of attachment to the building, one hour after the loading has been removed.

Impact – safety: The impact safety test is included by the CWCT Standard as a recommended test for proprietary systems. Impact testing is only required for custom curtain wall systems if suggested by the in use conditions.

CWCT TN 52 gives guidance on impact specification and testing. At the time this guidance was written CWCT TN 52 had not been published. Check with CWCT for availability.

Insert, *To CWCT clause 8.10 or Not required.*

– **Type of soft body impactor:** Insert either *Double tyre to BS EN 12600, Loaded canvas spherical/conical bag as described in CWCT 'Standard test methods for building envelopes' clause 15.4.1 or Not applicable.*

– **Required hard body impact load category:** Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

– **Required soft body impact classification:** Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

550 TEST SEQUENCE – STANDARD LABORATORY TESTS

- Requirement: To CWCT 'Standard for systemised building envelopes', Standard sequence A, clause 8.12.1, and as follows:
 - Air permeability (infiltration): To CWCT clause 8.6.
 - Peak test pressure: As clause 340
 - Method of identifying areas of concentrated air leakage:
 - Air permeability (exfiltration): To CWCT clause 8.6.
 - Peak test pressure: As clause 340.
 - Allowable exfiltration rates: As clause 345.
 - Method of identifying areas of concentrated air leakage:
 - Water penetration resistance – static: To CWCT clause 8.7.1.
 - Peak test pressure: As clause 350.
 - Wind resistance – serviceability: To CWCT clause 8.8.
 - Peak test pressure: Equal to design wind pressure specified in clause
 - Position of displacement measuring devices:
 - Allowable elastic and residual deformation:
 - Air permeability (infiltration): Repeat as above.
 - Air permeability (exfiltration): Repeat as above.
 - Water penetration resistance – static: Repeat as above.
 - Hose test: To CWCT clause 8.16.2.
 - Joints to be tested:
 - Wind resistance – safety: To CWCT clause 8.8.
 - Peak test pressure: Equal to 1.5 times design wind pressure specified in clause
 - Position of displacement measuring devices:
 - Allowable residual deformation:
 - Impact – safety:
 - Location, sequence and number of impacts to be applied:
 - Type of soft body impactor:
 - Energy of soft body impactor (E):
 - Required hard body impact load category:
 - Required soft body impact classification:
- Dismantle inspect and record.

555

550, 555 and 560 are alternative clauses for project testing. Use clause 555 for testing curtain wall systems to CWCT 'Standard for systemised building envelopes' 'Standard sequence B' (clause 8.12.2) where the peak test for the static water penetration test pressure is equal to or more than 600 Pascals or the curtain wall contains ventilated cavities.

Notes are appended to CWCT 'Standard sequence B' that determine whether, dependent on the type of curtain wall a particular test is appropriate. The test sequence and notes are reproduced below to help complete the clause.

Standard sequence B:

- Air permeability (infiltration) (Note 1).
- Air permeability (exfiltration) (Note 1).
- Water penetration resistance – static (Note 2).
- Wind resistance – serviceability.
- Air permeability (infiltration) (Note 1).
- Air permeability (exfiltration) (Note 1).
- Water penetration resistance – static (Note 2).
- Water penetration resistance – dynamic.
- Hose test (Note 2).
- Wind resistance – safety.
- Impact – safety (Optional, Note 3).
- Additional rainscreen tests (Note 4).
- Dismantle, inspect and record.

Notes:

- 1: This test is not applicable to rainscreens with a separate backing wall.
- 2: Not applicable to open jointed systems.
- 3: This test is recommended for proprietary envelope tests.
- 4: Testing of wind loading on rainscreen panels.

Air permeability (infiltration/ exfiltration):

– Method for identifying areas of concentrated air leakage:

CWCT Standard guidance lists the following qualitative methods:

- Not applicable
- Hot wire anemometers
- Smoke
- Back of hand.

Wind resistance – serviceability:

– **Peak test pressure:** Insert reference to clause 311, 312 or 313.
 – **Position of displacement measuring devices:** CWCT 'Standard test methods for building envelopes' Section 11 requires the specifier to agree the position of the measuring devices. Insert, e.g. *As shown on drawing.*

– **Allowable elastic and residual deformation:** CWCT Standard clause 3.5.2 establishes maximum allowable deflection criteria and the allowable residual deformation requirements.

Water penetration resistance – dynamic:

– **Test method:** CWCT Standard clause 8.7.2 provides alternative test methods, the dynamic aero engine test or the dynamic fan test. CWCT guidance indicates the fan test is not applicable to building envelopes containing ventilated cavities and not suitable for walls with additional components such as sun shades or locally faceted walls. Insert either *Dynamic aero engine* or *Dynamic fan*.

Hose test: This test is carried out in the laboratory to establish comparative values for site tests which are used to help detect construction and workmanship defects. Insert, *To CWCT clause 8.16.2 or Not required.*

– **Joints to be tested:** Insert locations or refer to drawings.

Wind resistance – safety:

– **Peak test pressure:** Insert reference to clause 311, 312 or 313.
 – **Position of displacement measuring devices:** CWCT 'Standard test methods for building envelopes' Section 12 requires the specifier to agree the position of the measuring devices. Insert, e.g. *As shown on drawing.*

– **Allowable residual deformation:** CWCT Standard clause 3.6.2.2 establishes maximum allowable residual deformation of framing members as 1/500 of the span, measured between points of attachment to the building, one hour after the loading has been removed.

Impact – safety: The impact safety test is included in the CWCT Standard as a recommended test for proprietary systems. Impact

555 TEST SEQUENCE – STANDARD LABORATORY TESTS

- Requirement: To CWCT 'Standard for systemised building envelopes', Standard sequence B, clause 8.12.2, and as follows:
 - Air permeability (infiltration): To CWCT clause 8.6.
 - Peak test pressure: As clause 340
 - Method of identifying areas of concentrated air leakage:
 - Air permeability (exfiltration): To CWCT clause 8.6.
 - Peak test pressure: As clause 340.
 - Allowable exfiltration rates: As clause 345.
 - Method of identifying areas of concentrated air leakage:
 - Water penetration resistance – static: To CWCT clause 8.7.1.
 - Peak test pressure: As clause 350.
 - Wind resistance – serviceability: To CWCT clause 8.8.
 - Peak test pressure: Equal to design wind pressure specified in clause
 - Position of displacement measuring devices:
 - Allowable elastic and residual deformation:
 - Air permeability (infiltration): Repeat as above.
 - Air permeability (exfiltration): Repeat as above.
 - Water penetration resistance – static: Repeat as above.
 - Water penetration resistance – dynamic: To CWCT clause 8.7.2.
 - Test method:
 - Test pressure: As clause 350.
 - Hose test: To CWCT clause 8.16.2.
 - Joints to be tested:
 - Wind resistance – safety: To CWCT clause 8.8.
 - Peak test pressure: Equal to 1.5 times design wind pressure specified in clause
 - Position of displacement measuring devices:
 - Allowable residual deformation:
 - Impact – safety:
 - Location, sequence and number of impacts to be applied:
 - Type of soft body impactor:
 - Energy of soft body impactor (E):
 - Required hard body impact load category:
 - Required soft body impact classification:
- Dismantle inspect and record.

testing is only required for custom curtain wall systems if suggested by the in use conditions.

CWCT TN 52 gives guidance on impact specification and testing. At the time this guidance was written CWCT TN 52 had not been published. Check with CWCT for availability.

Insert, *To CWCT clause 8.10 or Not required.*

–**Type of soft body impactor:** Insert either *Double tyre to BS EN 12600, Loaded canvas spherical/conical bag as described in CWCT ‘Standard test methods for building envelopes’ clause 15.4.1 or Not applicable.*

– **Required hard body impact load category:** Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

– **Required soft body impact classification:** Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

560

550, 555 and 560 are alternative clauses for project testing.

Use clause 560 only where there is a need to specify further discretionary tests in accordance with CWCT ‘Standard for systemised building envelopes’ clause 8.13.5. CWCT issued an erratum sheet dated 26 May 2006 which corrected parts of clause 8.13.5. The corrected test sequence and notes are reproduced below to help complete the clause.

Sequence for discretionary tests:

- Air permeability – (infiltration) (Notes 1, 2 and 5).
- Air permeability – (exfiltration) (Notes 1, 2 and 5).
- Water penetration resistance – static (Notes 1 and 3).
- Wind resistance – serviceability.
- Air permeability – (infiltration) (Notes 1, 2 and 5).
- Air permeability – (exfiltration) (Notes 1, 2 and 5).
- Water penetration resistance – static (Notes 1 and 3).
- *Water penetration resistance – dynamic.
- *Impact serviceability.
- *Air permeability – (infiltration) (Notes 1, 2 and 5).
- *Air permeability – (exfiltration) (Notes 1, 2 and 5).
- *Water penetration resistance – static (Notes 1 and 3).
- *Building movement regime.
- *Air permeability – (infiltration) (Notes 1, 2 and 5).
- *Air permeability – (exfiltration) (Notes 1, 2 and 5).
- *Water penetration resistance – static (Notes 1 and 3).
- *Thermal cycling regime.
- *Air permeability – (infiltration) (Notes 1, 2 and 5).
- *Air permeability – (exfiltration) (Notes 1, 2 and 5).
- *Water penetration resistance – static (Notes 1 and 3).
- Hose test (Note 3).
- Wind resistance – safety.
- Impact – safety.
- *Load tests (other than wind load).
- *Additional rainscreen tests (Note 4)
- Dismantle, inspect and record.

Tests marked * are discretionary, all other tests are mandatory.

Notes:

1: An air permeability and water penetration resistance test – static shall be carried out between each discretionary loading regime in order to assess any reduction in performance caused by loading.

2: To save time and costs, air permeability tests, other than the first and last tests, may be simplified by reducing the number of pressure increments but not the peak test pressure. However, if there is a marked change in air leakage rate the air permeability test should be repeated with measurements taken at all the pressure increments. Similarly, checking for draughts is not required other than on the first and last tests.

3: Not applicable to open jointed systems.

4: Testing of wind loading on rainscreen panels.

5: This test is not applicable to rainscreens with a separate backing wall.

Air permeability (infiltration/ exfiltration): Air permeability tests are required following discretionary tests for impact – serviceability, building movement regime and thermal cycling. Refer to Sequence for discretionary tests above, the accompanying notes and determine whether air permeability tests are required. Insert either *To CWCT clause 8.6 or Not required.* →

560 TEST SEQUENCE – STANDARD LABORATORY AND DISCRETIONARY TESTS

- Requirement: To CWCT ‘Standard for systemised building envelopes’ Sequence for discretionary tests, clause 8.13.5 and as follows:
- Air permeability (infiltration): To CWCT clause 8.6.
 - Peak test pressure: As clause 340.
 - Method for identifying areas of concentrated air leakage:
- Air permeability (exfiltration): To CWCT clause 8.6.
 - Peak test pressure: As clause 340.
 - Allowable exfiltration rates: As clause 345.
 - Method of identifying areas of concentrated air leakage:
- Water penetration resistance – static: To CWCT clause 8.7.1.
 - Peak test pressure: As clause 350.
- Wind resistance – serviceability: To CWCT clause 8.8
 - Peak test pressure: Equal to design wind pressure specified in clause
 - Position of displacement measuring devices:
 - Allowable elastic and residual deformation:
- Air permeability (infiltration): Repeat as above.
- Air permeability (exfiltration): Repeat as above.
- Water penetration resistance – static: Repeat as above.
- Water penetration resistance –dynamic:
 - Test method:
 - Test pressure:
- Impact serviceability:
 - Location, sequence and number of impacts to be applied:
 - Type of soft body impactor:
 - Energy of soft body impactor (E):
 - Required hard body impact load category:
 - Required soft body impact classification:
- Air permeability (infiltration):
 - Peak test pressure: As clause 340.
 - Method for identifying areas of concentrated air leakage:
- Air permeability (exfiltration):
 - Allowable exfiltration rates: As clause 345
 - Method of identifying areas of concentrated air leakage:
- Water Penetration resistance – static:
 - Peak test pressure: As clause 350.
- Building movement regime:
 - Displacements to test specimen supports:
 - Condition of specimen for follow on air permeability and water penetration resistance tests:
- Air permeability (infiltration):
 - Test pressure: As clause 340.
 - Method for identifying areas of concentrated air leakage:
- Air permeability (exfiltration):
 - Allowable exfiltration rates: As clause 345
 - Method of identifying areas of concentrated air leakage:
- Water Penetration resistance – static:
 - Peak test pressure: As clause 350. →

– Method for identifying areas of concentrated air leakage:

CWCT Standard guidance lists the following qualitative methods:

- Not applicable
- Hot wire anemometers
- Smoke
- Back of hand.

Water penetration resistance– static: A water penetration – static test is required following discretionary tests for impact – serviceability, building movement regime and thermal cycling. Refer to Sequence for discretionary tests above, the accompanying notes and determine whether a water penetration – static test is required. Insert, *To CWCT clause 8.7.1 or Not required.*

Wind resistance – serviceability:

– Peak test pressure: Insert reference to clause 311, 312 or 313.
– Position of displacement measuring devices: CWCT 'Standard test methods for building envelopes' Section 11 requires the specifier to agree the position of the measuring devices. Insert, e.g. *As shown on drawing.*

– Allowable elastic and residual deformation: CWCT Standard clause 3.5.2 establishes maximum allowable deflection criteria and the allowable residual deformation requirements.

Water penetration resistance – dynamic:

– Test method: CWCT Standard clause 8.7.2 provides alternative test methods, the dynamic aero engine test or the dynamic fan test. CWCT guidance indicates the fan test is not applicable to building envelopes containing ventilated cavities and not suitable for walls with additional components such as sun shades or locally faceted walls. Insert either *Dynamic aero engine* or *Dynamic fan.*

Hose test: This test is carried out in the laboratory to establish comparative values for site tests which are used to help detect construction and workmanship defects. Insert, *To CWCT clause 8.16.2 or Not required.*

– Joints to be tested: Insert locations or refer to drawings.

Impact – serviceability: Impact testing is only required for custom curtain wall systems if suggested by the in use conditions.

CWCT TN 52 gives guidance on impact specification and testing. At the time this guidance was written CWCT TN 52 had not been published. Check with CWCT for availability. Insert either *To CWCT 8.13.1 or Not required.*

–Type of soft body impactor: Insert either *Double tyre to BS EN 12600, Loaded canvas spherical/conical bag as described in CWCT 'Standard test methods for building envelopes' clause 15.4.1 or Not applicable.*

– Required hard body impact load category: Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

– Required soft body impact classification: Insert, *As clause 311, As clause 312, As clause 313. or Not applicable.*

Building movement regime/ racking procedure: Racking regimes are compulsory when specifying earthquake load resistance – see guidance note to clause 380. Insert *To CWCT 8.13.3 or Not required.*

– Displacements to test specimen supports: Insert location, direction, magnitude and cycle of displacements, e.g. *Move upper fixings 50 mm in the two directions horizontal to the plane of the specimen. Repeat this cycle three times within a ten minute period.*

– Condition of specimen for follow on air permeability and/ or water penetration tests: CWCT 'Standard test methods for building envelopes' Section 17 indicates that on completion of the racking regime the required state of the specimen should be determined ready for the follow on tests. Insert either *Retain deformed position, Return to normal or Not applicable.*

Thermal cycling regime: CWCT Standard requires the inclusion of thermal cycling testing to be discussed with the Client prior to the preparation of the specification. See guidance to CWCT Standard clause 8.13.4. Insert either *To CWCT clause 8.13.4 or Not required.*

– External air temperature limits: Insert in °C the maximum and minimum air temperatures.

Hose test: This test is carried out in the laboratory to establish comparative values for site tests which are used to help detect construction and workmanship defects. Insert, *To CWCT clause 8.16.2 or Not required.*

– Joints to be tested: Insert locations or refer to drawings.

Impact – safety: The impact safety test is included in the CWCT Standard as a recommended test for proprietary systems. Impact

- Thermal cycling regime:
 - External air temperature limits:
 - Maximum solar radiation intensity on a vertical surface:
 - Internal in use psychrometric conditions: As clause 390.
 - Post-test requirement: Retain specimen in its final condition for subsequent air permeability and water penetration resistance tests.
- Air permeability (infiltration):
 - Test pressure: As clause 340.
 - Method for identifying areas of concentrated air leakage:
- Air permeability (exfiltration):
 - Allowable exfiltration rates: As clause 345
 - Method of identifying areas of concentrated air leakage:
- Water Penetration resistance – static:
 - Peak test pressure: As clause 350.
- Hose test: To CWCT clause 8.16.2.
 - Joints to be tested:
- Wind resistance – safety: To CWCT clause 8.8
 - Peak test pressure: Equal to 1.5 times design wind pressure specified in clause
 - Position of displacement measuring devices:
 - Allowable residual deformation:
- Impact – safety: To CWCT clause 8.10.
 - Location, sequence and number of impacts to be applied:
 - Type of soft body impactor:
 - Energy of soft body impactor (E):
 - Required hard body impact load category:
 - Required soft body impact classification:
- Load tests (other than wind load):
- Dismantle inspect and record.

testing is only required for custom curtain wall systems if suggested by the in use conditions.

CWCT TN 52 gives guidance on impact specification and testing. At the time this guidance was written CWCT TN 52 had not been published. Check with CWCT for availability.

Insert, *To CWCT clause 8.10 or Not required.*

– **Type of soft body impactor:** Insert either *Double tyre to BS EN 12600, Loaded canvas spherical/conical bag as described in CWCT 'Standard test methods for building envelopes' clause 15.4.1 or Not applicable.*

– **Required hard body impact load category:** Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

– **Required soft body impact classification:** Insert, *As clause 311, As clause 312, As clause 313 or Not applicable.*

Load tests (other than wind load): Insert clause reference covering test or *Not required.*

Site water tests

Site water tests should only be used to confirm benchmark workmanship standards established by laboratory results for the same tests. Guidance on the tests can be found in CWCT TN 41.

630, 635

The spray bar test is carried out with a single bar with nozzles allowing water to cascade down the face of the curtain wall. The hose test is not applicable to open joint systems.

Requirement (clause 630):

– **Area to be tested:** This is a test for runoff, and the location of the spray nozzles in relation to joints should be considered. Preferably, the nozzle should be located above the joint(s) under consideration and match the area selected for the benchmark laboratory test.

– **Pressure difference across curtain wall:** It may be possible to form a temporary test chamber to apply a pressure difference. See CWCT TN 41 and insert *Not applicable* or *As clause 345.*

Requirement (clause 635):

– **Joints to be tested:** Insert joint locations or refer to drawings.

Additional Tests

Confirm the need for all additional tests with the Employer before inclusion. These tests will usually be carried out by specialist testing authorities and require separate test specimens – repeat and adapt clauses 530, 535 and 540 where necessary.

650

The CWCT 'Standard for systemised building envelopes' section 8.14 lists the following additional tests:

- 8.14.1 Anchor point test.
- 8.14.2 Sound attenuation test.
- 8.14.3 Thermal performance test.
- 8.14.4 Fire testing.
- 8.14.5 Equipotential test.
- 8.14.6 Cyclic wind loading.

For cyclic wind loading insert name of test and as *clause 655.*

For other listed and nonlisted tests insert title from above, references to British and other standards and particulars of procedures. Repeat clause as necessary.

655

Requirement:

– **Test sequence:** CWCT 'Standard for systemised building envelopes' clause 8.14.6 offers alternative sequences. A tabulated scheme using six different load pressures each with a defined number of cycles or a simple but more onerous regime of 10,000 cycles at 100% effective wind pressure. Insert, *As CWCT 'Standard for systemised building envelopes' Table 8.1 or 10,000 cycles of 100% effective wind pressure.*

630 SITE SPRAY BAR TEST

- Requirement: To CWCT 'Standard for systemised building envelopes', 'Standard test methods for building envelopes' Section 10.
 - Area to be tested:
 - Pressure difference across curtain wall:

635 SITE HOSE TEST

- Requirement: To CWCT 'Standard for systemised building envelopes', 'Standard test methods for building envelopes' Section 9.
 - Joints to be tested:

650 TEST:

Requirement: Carry out in accordance with

655 WIND LOAD FATIGUE TEST, SMALL SPECIMEN

- Requirement: To CWCT 'Standard for systemised building envelopes', 'Standard test methods for building envelopes' Section 14.
 - Test sequence:
 - Effective wind pressure: As clause 360.

660

See general guidance 3.1. It is important that product samples are laboratory tested for sealant compatibility and adhesion, even when also project (site) testing specimens. Sealant manufacturers will only provide project specific approval (clause 240) after carrying out successful laboratory tests. Allow a six week period for tests.

Samples must be of the products and finishes proposed for use, e.g. glass must have actual surface coats and/ or laminate interlayers. Mill finish aluminium is not a suitable surface for bonding. Where powder coating is specified ensure that it is extended to all bond surfaces. Some anodized surfaces may exhibit bond difficulties.

712

Aluminium alloy EN AW 5005 to BS EN 573 (or J57S, a proprietary modified version of it) is recommended for consistent anodizing results on sheets.

BS 8118-1, Table A.1 lists the nearest foreign equivalents of British Standard aluminium alloys.

715

This clause is intended for steel integrated into the curtain walling framing/ units, not for primary or secondary supporting structure.

717

BS 1449-1, referred to in CWCT 'Guide to good practice for facades', clause 4.3.1, has been superseded in parts by the listed standards.

725

Standard: BS EN 12608 specifies requirements for raw materials and properties of white or near-white PVC-U profiles.

– **Climatic zone classification:** The national annex to BS EN 12608 gives two classifications: Moderate (M) and Severe (S) and confirms that the UK is deemed a moderate climate. Check requirements for projects outside of the UK.

– **Impact classification:** The national annex to BS EN 12608 fails to give guidance or recommendations for the appropriate classification. Class I covers an impact object with a falling mass of 1000 g dropped from a height of 1000 mm. Class II covers an impact object of the same mass but dropped from a height of 1500 mm.

– **Main profile wall thickness classification:** BS EN 12608 defines three classes, Class A, Class B and Class C. The national annex to BS EN 12608 states that in the UK it is considered unnecessary to specify wall thicknesses and Class C is deemed the appropriate specification and advises that over specification of wall thickness can lead to excessive use of raw materials without any commensurate increase in performance.

660 STRUCTURAL SEALANT GLAZING TESTS

- Product samples: Provide the structural bonding sealant manufacturer with framing profiles, glass, gaskets, assembly/ weathering sealants and other curtain walling products that are proposed for contact with structural bonding sealant.
- Testing: By sealant manufacturer to determine compatibility and adhesion of structural bonding sealant under specified design loadings.
- Modification of product to enable compliance with test criteria: Details must be recorded in the sealant manufacturer's project specific approval.

PRODUCTS

710 ALUMINIUM ALLOY FRAMING SECTIONS

- Standard: To relevant parts of BS EN 515, BS EN 573, BS EN 755 and BS EN 12020.
- Alloy, temper and thickness: Suitable for the application and specified finish.
- Structural members: To BS 8118.

712 ALUMINIUM ALLOY SHEET

- Standards: To relevant parts of BS EN 485, BS EN 515 and BS EN 573.
- Alloy, temper and thickness: Suitable for the application and specified finish.

715 CARBON STEEL FRAMING SECTIONS/
REINFORCEMENT

- Standards: To relevant parts of BS 7668, BS EN 10029, and BS EN 10210.
- Thickness: Suitable for the application, and for galvanizing or other protective coating.

717 CARBON STEEL SHEET

- Standards: To relevant parts of BS 1449-1, BS EN 10048, BS EN 10051, BS EN 10111, BS EN 10131, BS EN 10132, BS EN 10139, BS EN 10140, BS EN 10149, BS EN 10209 and BS EN 10268.
- Grade and thickness: Suitable for the application, and for galvanizing or other protective coating.

720 STAINLESS STEEL SHEET

- Standards: To relevant parts of BS EN 10029, BS EN 10048, BS EN 10051, BS EN 10095, BS EN 10258, BS EN 10259.
- Grade: To BS EN 10088-2, austenitic 1.4301 (304) generally, 1.4401 (316) when used externally or in severely corrosive environments.
- Thickness: Suitable for the application.

725 PVC-U FRAMING SECTIONS

- Standard: To BS EN 12608.
 - Climatic zone classification:
 - Impact classification:
 - Main profile wall thickness classification:
- Manufacturer: A firm currently registered under a scheme operated by a certification and inspection body accredited by the United Kingdom Accreditation Service (UKAS).

730 MECHANICAL FIXINGS

- Stainless steel: To BS EN ISO 3506, grade A2 generally, grade A4 when used in severely corrosive environments.
- Carbon steel: To BS 4190 and suitable for galvanizing or other protective coating.
- Aluminium brackets, rivets and shear pins: To relevant parts of BS EN 755.

732

Adhesives may be used for, e.g. laminating of composite panels.

735

Fixing anchor proposals should be made by the curtain walling contractor. Details are required by clause 235 and samples by clause 260.

Dimensions: This is particularly appropriate to cast-in inserts.

Adjustment capability: This should not compromise the depth of embedment.

737

Specify types of glass in clause 110.

The edge condition of solar control glass is particularly critical. There must be no vents or severe feathering.

739

Use this clause for, e.g. unframed (structural sealant fixed) glass where tight glass dimensional tolerances will limit deviation in sealant joint width. For most framed glass, the more generous dimensional tolerances set in the product standards listed in clause 737 will be adequate.

Clause heading: Insert location or identification, e.g. *FIXED WITH STRUCTURAL SEALANT*

Pane dimensions: Values are based on BS EN 572-8 for cut sizes of float glass.

741

Use this clause for, e.g. reflective coated glass where distortional tolerances dictate the consistency of surface reflection.

Clause heading: Insert location or identification, e.g. *WITH REFLECTIVE COATING*

Maximum roller wave/ edge dip: Tolerances are specified as maximum rather than average values, based on the practicalities of measurement. They depend on quality of production and thickness of glass (thinner glasses are subject to more distortion).

742

See section L40, general guidance 4.8.2 'Nickel sulfide inclusions and heat soaking' and discuss with glass manufacturer.

Standard:

- **Holding period:** UK manufacturers normally heat soak for a period of 2 hours, but if required will soak for longer periods to remove more inclusions. Insert, e.g. *2 hours*.

Locations of heat soaked glass: Heat soaking is recommended for toughened glass that is to be installed in positions where the greater risk of failure and fall out of untreated panes would present significant threats to safety, e.g. *In inclined overhead curtain walling*.

732 ADHESIVES

- General: Not degradable by moisture or water vapour.

735 FIXING ANCHORS

- Type and use: Reviewed and approved by fixing manufacturers. Submit confirmatory information on request.
- Dimensions: Not less than recommended by their manufacturers.
- Adjustment capability: Sufficient in three dimensions to accommodate building structure and curtain walling fabrication/ installation tolerances.

737 GLASS GENERALLY

- Standards: To BS 952 and relevant parts of:
 - BS EN 572 for basic soda lime silicate glass.
 - BS EN 1096 for coated glass.
 - BS EN 1748 for borosilicate glass.
 - BS EN 1863 for heat strengthened soda lime silicate glass.
 - BS EN 12150 for thermally toughened soda lime silicate glass.
 - BS EN 13024 for thermally toughened borosilicate glass.
 - BS EN ISO 12543 for laminated glass.
- Glass quality: Clean and free from obvious scratches, bubbles, cracks, rippings, dimples and other defects.
- Glass edges: Generally undamaged. Shells and chips not more than 2 mm deep and extending not more than 5 mm across the surface are acceptable if ground out.

739 DIMENSIONAL TOLERANCES ON GLASS

- Measurement of tolerances: Before any thermal toughening/ heat strengthening.
- Pane dimensions less than 1500 mm:
 - For 3 to 6 mm thick glass: ± 1.0 mm.
 - For 8 to 12 mm thick glass: ± 1.5 mm.
 - For 15 mm thick glass: ± 2.0 mm.
 - For 19 mm and 25 mm thick glass: ± 2.5 mm.
- Pane dimensions more than 1500 mm:
 - For 3 to 6 mm thick glass: ± 1.5 mm.
 - For 8 to 12 mm thick glass: ± 2.0 mm.
 - For 15 mm thick glass: ± 2.5 mm.
 - For 19 mm and 25 mm thick glass: ± 3.0 mm.
- Pane squareness: Not more than 4 mm difference in diagonal measurements.

741 DISTORTIONAL TOLERANCES ON GLASS

- Measurement of tolerances: After any thermal toughening/ heat strengthening.
- Maximum bow: 0.2% of pane dimension.
- Maximum roller wave:
 - For 3 to 5 mm thick glass: 0.5 mm.
 - For 6 to 10 mm thick glass: 0.3 mm.
 - For 12 mm and thicker glass: 0.15 mm.
- Maximum edge dip:
 - For 3 to 5 mm thick glass: 0.8 mm.
 - For 6 to 10 mm thick glass: 0.5 mm.
 - For 12 mm and thicker glass: 0.25 mm.

742 HEAT SOAKED THERMALLY TOUGHENED GLASS

- Standard: To BS EN 14179.
 - Holding period:
- Locations of heat soaked glass:

745

Colour of aluminium perimeter spacers: Unit manufacturers may offer a colour choice, natural and black being the most common.

Perimeter seals: Failure of perimeter seals in insulating glass units may result from incompatibility with applied sealants.

747

See general guidance 3.1.

750

Use this clause for metal or manufactured board, single layer or composite panels/ facings. Manufacturing and finishing processes may impose limits on size.

Rigidity will depend upon the method of fixing single layer panels/ facings or the method of assembling composite panels/ facings. Where rigidity is critical, e.g. for reflective metal, samples should be required (clause 250).

755

Use this clause where natural stone panels/ facings and accessories are integrated into the curtain walling. Stone can be framed into stick and small unitized systems, or can be fixed to secondary framing in larger unitized and spandrel systems. The application of natural stone in curtain walling is covered in the CWCT 'Guide to the selection and testing of stone panels for external use'. See also general guidance to section H51.

BS EN 12440 formalizes the description of natural stones to include traditional name, petrological family, typical colour and place of origin (geographical names not related to the actual place of origin should be avoided). Annex A to the standard includes details for stones from UK and European quarries. Insert from Annex A or as appropriate. Complete items, e.g.

Name (traditional): *Ashdown Fell*.

Petrological family: *Limestone*.

Colour: *Buff*.

Origin: *Ashdown Fell Quarry, Stoneshire, England*.

Finish: *Fine rubbed*. (See H51 general guidance 2.2).

Supplier: *XYZ Stone Ltd*.

Reference should be made to any approved samples, and where they are held. For advice on selection of stone see H51 general guidance 2.

Minimum thickness: Stone cladding held in position by perimeter metal frames is excluded from the scope of BS 8298, but the clause and table referred to are an appropriate basis for determining stone thickness. The use of thin stone veneers bonded to metal honeycombs or fibre reinforced resins are precluded by this thickness requirement. Proprietary cladding fabrications of this type are produced in America and Europe, but do not come within the scope of national standards. If thin stone faced composite panels are to be used, amend this item and add appropriate clauses to cover their specification. For more guidance on this type of panel See H92 general guidance 5.1.

Dimensional tolerances: BS EN 1469 covers natural stone slabs for cladding.

Thickness tolerances are as follows:

- Slabs 12 mm to 30 mm thick: $\pm 10\%$.
- Slabs 30 to 80 mm thick: $\pm 3\text{mm}$.
- Slabs > 80 mm thick: ± 5 mm.

These tolerances are not applicable to slabs with natural cleft faces for which thickness tolerance values shall be those declared by the manufacturer.

Length and width tolerances are related to slab size and thickness as follows:

- Slab dimensions < 600 mm and ≤ 50 mm thick: ± 1 mm.
- Slab dimensions < 600 mm and > 50 mm thick: ± 2 mm.
- Slab dimensions ≥ 600 mm and ≤ 50 mm thick: ± 1.5 mm.
- Slab dimensions ≥ 600 mm and > 50 mm thick: ± 3 mm.

745 INSULATING GLASS UNITS

- Standard and labels for hermetically sealed units: To BS EN 1279.
- Label: Each pane.
- Colour of aluminium perimeter spacers:
- Perimeter taping: Not to be used.
- Perimeter seals:
 - Resistant to UV light degradation on exposed edges.
 - Compatible with structural, assembly and weather sealants.

747 GLASS EDGE CONDITION FOR STRUCTURAL SEALANT GLAZING

- Bonded, unframed outer edges: Flat ground with a small arris suitable for open jointing or for weatherseal jointing.

750 INFILL PANELS/ FACINGS

- Tolerances:
 - Deviation in size (maximum): ± 1 mm.
 - Deviation in flatness from plane per 2 m length (maximum): ± 1 mm.
- Rigidity: Adequate to comply with design/ performance requirements.

755 NATURAL STONE INFILL PANELS/ FACINGS

- Name (traditional):
- Petrological family:
- Colour:
- Origin:
- Finish:
- Supplier:
- Quality: Free from vents, cracks, fissures, discolouration, or other defects deleterious to strength, durability or appearance. Before delivery to site, season thoroughly, dress and work in accordance with shop drawings prepared by supplier.
- Minimum thickness: To BS 8298, clause 3.9 and table 4, unless proved otherwise by calculation or testing in accordance with design/ performance requirements.
- Dimensional tolerances: To BS EN 1469

760

Continuity: Adhesive bonded joints in gaskets may be acceptable in smaller or lower quality curtain walling installations – in which case amend this item.

Durability: Black EPDM gaskets are commonly used. They have good resistance to UV degradation.

770

Where doubt exists about sealant compatibility, e.g. migration of plasticizers from perimeter sealants in contact with natural stone, the manufacturer should be required to test – use clause 650.

772

Material: Neutral curing silicones are specified to avoid incompatibility problems that can be caused by acetoxy curing silicones, e.g. bond failures in insulating glass units.

Manufacturer/ Product reference: Insert silicone sealant proprietary name and reference or, e.g. *Contractor's choice*. Also insert colour choice where visible.

775

See general guidance 3.1.

Material: Neutral curing silicones are specified to avoid incompatibility problems that can be caused by acetoxy curing silicones, e.g. bond failures in insulating glass units. Testing for compatibility and adhesion is specified in clause 660.

Manufacturer/ Product reference: Insert proprietary name and reference. Also insert colour choice, if available.

777

The weathersealing of some structural glazing systems is accomplished by rebate framing sections and gaskets or the bonding sealant – in which case weathersealing is not required.

Material: It is recommended that the same manufacturer is specified/ approved for structural bonding sealants and weathersealing. Neutral curing silicones are specified to avoid incompatibility problems that can be caused by acetoxy curing silicones, e.g. bond failures in insulating glass units. Testing for compatibility with the structural bonding sealant is specified in clause 660.

Manufacturer/ Product reference: Insert proprietary name and reference. Also insert colour choice.

780

Material: Insert a proprietary reference or, e.g. *Mineral wool boards*. Thickness will be determined by the curtain walling contractor when thermal properties are specified by performance (clause 730).

Combustible insulation must only be used with a suitable fire barrier, e.g. expanded/ extruded foam enclosed by an aluminium tray in a spandrel panel.

760 GASKETS

- Material:
 - Noncellular rubber to BS 4255-1.
 - Cellular rubber to ASTM-C509.
- Continuity: Outer gaskets of single front sealed curtain walling systems and inner gaskets of drained and ventilated or pressure equalized curtain walling systems must be formed in a complete frame with sealed joints. Vulcanized rubber gaskets must have factory moulded corner joints.
- Durability: Resistant to oxidation, ozone and UV degradation.

765 WEATHERSTRIPPING OF OPENING UNITS

- Material:
 - Noncellular rubber to BS 4255-1.
 - Cellular rubber to ASTM-C509.
 - Polypropylene woven pile, silicone treated.
- Attachment: Fixed in undercut grooves in framing sections using preformed corners, with any joints in the length.

770 GENERAL SEALANTS

- Selection: In accordance with BS 6213 from:
 - Silicone to BS 5889.
 - One part polysulfide to BS 5215.
 - Two part polysulfide to BS 4254.
 - One or two part polyurethane.
- Classification and requirements: To BS EN ISO 11600.
- Reaction to contact products and finishes: Stable and compatible.

772 CURTAIN WALLING JOINT ASSEMBLY SEALANTS

- Material: Silicone to BS 5889, type A or B, neutral curing where in contact with or close proximity to other products that may be adversely affected by acetoxy curing.
- Manufacturer:
 - Product reference:

775 BONDING SEALANTS FOR STRUCTURAL SEALANT GLAZING

- Material: Silicone, neutral curing, designed and manufactured for bonding of structural sealant glazing. Compatible with contact and close proximity products and finishes.
- Manufacturer:
 - Product reference:

777 WEATHERSEALING FOR STRUCTURAL SEALANT GLAZING

- Material: Silicone, one or two part, neutral curing. Designed and manufactured for weathersealing of structural sealant glazing. Compatible with contact and close proximity products and finishes.
- Manufacturer:
 - Product reference:
- Colour:

780 THERMAL INSULATION

- Material:
 - Properties: Durable, rot and vermin proof and not degradable by moisture or water vapour.
- Fixing: Attached to or supported within the curtain walling so as not to bulge, sag, delaminate or detach during installation or in situ during the life of the curtain walling.

785

The internal lining of composite infill panels/ facings will often serve as a vapour control layer.

785 VAPOUR CONTROL LAYER

- Acceptable materials:
 - Aluminium alloy.
 - Carbon steel, galvanized or protective coated.
 - Stainless steel.
 - Reinforced membranes: Foil, plastics or rubbers, protected both sides by rigid facings/ linings.
- Location: Warm side of thermal insulation.
- Integrity: Continuous, free from gaps and sealed at joints.

FINISHES

810 PROTECTIVE COATING OF CARBON STEEL FRAMING SECTIONS/ REINFORCEMENT

- Treatment: One of the following to all surfaces:
 - Hot dip galvanized to BS EN ISO 1461.
 - An appropriate equivalent coating to BS 5493, BS EN ISO 12944 or BS EN ISO 14713.

820 PROTECTIVE COATING OF CARBON STEEL MECHANICAL FIXINGS

- Treatment: One of the following to all surfaces:
 - Hot dip galvanized to BS EN ISO 1461.
 - Sherardized to BS 4921, class 1 coating thickness and passivated.
 - Zinc plated to BS EN 12329, coating designation Fe//Zn//C for an iridescent (yellow passivate) chromate conversion coating or Fe//Zn//D for an opaque (olive green) chromate conversion coating.

830

Powder coating provides a protective, decorative coating on aluminium alloy or galvanized steel.

830 POWDER COATING

- Requirement: As section Z31.

840

Anodizing provides a protective, decorative oxide layer on aluminium alloy. BS 3987 requires an average coating of not less than 25 micrometres and a local coating of not less than 20 micrometres. Higher minimum values have been recommended by the CWCT. Proposed products with lower values will require evaluation.

840 ANODIZING

- Requirement: As section Z33.

850

PVDF coating provides a protective, decorative coating on aluminium alloy or galvanized steel. BS 4842, AAMA 2604-05 and AAMA 2605-05 are specifications for application to aluminium alloy only. It is applied over a primer usually in a single coat, but with an additional clear lacquer coat over metallic or light sensitive colours.

A definition of significant surface can be found in BS EN ISO 2064.

850 POLYVINYLIDENE FLUORIDE (PVDF) COATING OF ALUMINIUM ALLOY

- Standard: To BS 4842, AAMA 2604-05 or AAMA 2605-05, subject to minimum coating thicknesses recommended by the manufacturer on significant surfaces.
 - Applicator:
 - Product reference:
- PVDF resin content of coatings: Not less than 70%.
- Process: Prepare base metals, prime, PVDF coat, test samples, protect components and repair damage in accordance with manufacturer's recommendations.
- Sequence: Wherever possible, apply coatings after fabrication is complete.
 - Fabrication of prefinished lengths: Submit proposals beforehand.
 - Uncoated edges: Invisible in completed assemblies.

FABRICATION AND INSTALLATION

Obtain fabrication, handling and installation method statements from the curtain walling contractor before commencement of any of these work stages – see clause 235.

910

Clause 235 requires the curtain walling contractor to submit detailed drawings of junctions, etc. Accuracy of fabrication and erection is specified in CWCT 'Standard for curtain walling', clause 2.20.

Alignment, fit and uniformity of appearance are covered by clauses in Preliminaries section A33.

Preliminaries section A33 requires the employment of competent operatives. A training scheme for curtain walling installers is operated by the CWCT. The scheme is recognized by the Construction Skills Certification Scheme (CSCS). Registration cards are issued to operatives who successfully complete system specific courses. If appropriate, add competency requirements in this clause.

915

Tolerances on patterned and wired glass do not allow for exact alignment of adjacent panes.

925

Specification of structural sealant glazing in this section is limited to workshop prefabricated units – see general guidance 3.1. Obtain project specific approval (clause 240) from the structural bonding sealant manufacturer before commencement of fabrication.

955

Clause 230 requires submission of proposals for fixing anchors.

Lining and levelling of fixing anchors is usually carried out as preparatory work even for anchors with drilled-in fixings – see general guidance 5.1.

Concrete supporting structure: Cast-in inserts should be held in place by formwork, not attached to reinforcement. Drilled-in fixings to slab edges should only be used for light stick systems.

965

Insert location and size of preliminary installation. Where site testing (clause 520) is specified it may be appropriate to use this area of curtain walling.

FABRICATION AND INSTALLATION

910

- Electrolytic corrosion: Prevent. Submit proposed methods.
- Fixings: Concealed unless indicated on detailed drawings. Where exposed they must match material and finish of the products fixed.
- Fabrication: Machine cut and drill products in the workshop wherever possible.
- Identification of products: Mark or tag to facilitate identification during assembly, handling, storage and installation. Do not mark surfaces visible in the completed installation.

912

- Requirement: As section Z11, unless specified otherwise in this section.

915

- Requirement: As section L40, unless specified otherwise in this section.
- Directional patterned/ wired glass: Generally fix parallel to surround and align adjacent panes where seen together at close quarters.

917

- Requirement: As section Z20, unless specified otherwise in this section.

920

- Requirement: As section Z22, unless specified otherwise in this section.

925

- Curing: Do not transport units until structural bonding sealant has adequately cured for the period stated in the project specific approval.

930

- General: Carry out as much assembly as possible in the workshop.
- Joints (other than movement joints): Rigidly secured, reinforced where necessary and fixed with hairline abutments.
- Displacement of components in assembled units: Submit proposals for reassembly on site.

955

- Site drilling or cutting into structure: Submit proposals for positions other than shown on detailed drawings.
- Concrete supporting structure:
 - Cast-in inserts: Provide detailed locational information. Protect cavities in inserts from entry of concrete.
 - Edge fixing distances: Not less than recommended by fixing anchor manufacturers.
- Corrective fabrication: Minimize. Where necessary, submit proposals.

965

- Requirement: Complete an area for inspection and approval of appearance as follows:

970

- Securing to fixing anchors: Through holes formed during fabrication only.
- Tightening mechanical fasteners: To manufacturer's recommended torque figures. Do not overtighten fasteners intended to permit differential movement.
- Protective coverings: Remove only where necessary to facilitate installation and from surfaces that will be inaccessible on completion.

975

When welding in situ there is a risk of fire where flame or sparks contact combustible materials. Wherever possible metalwork should be formed and welded on the bench.

Insert, e.g.

Not permitted.

Permitted, subject to completion of and compliance with a hot work permit form.

Prohibiting in situ welding will preclude welding of shims and lock nuts on fixing anchors.

The hot work permit should be a printed form supplied by the Contractors Safety Officer. A suitable form and checklist of precautions is appended to the Fire Protection Associations leaflet RC7, 'Recommendations for hot work'.

Check that the Employer will consent to in situ hot work.

985

CWCT 'Standard for systemised building envelopes' clause 7.6.1 lists more appropriate contents for a curtain walling system maintenance manual than do the clauses in NBS Preliminaries section A37. Contents listed are:

- Contact details for subcontractors and suppliers.
 - Design criteria for the curtain wall system.
 - Product information for components and materials including manufacturers' literature, COSHH data sheets and recommendations for cleaning maintenance and repair.
 - Copies of material, components and finishes certification and test report
 - A full set of construction drawings, updated to include any changes made up to the time of completion.
 - The terms and conditions of any guarantee.
 - Method statement for means of access for maintenance and for use of any permanent equipment.
 - Method statement covering the procedures for replacement of parts that have a design life less than the design life of the curtain wall system.
 - Recommendations for routine maintenance and cleaning, including suitable cleaning agents and lubrication/ adjustments to working parts.
 - Record book for listing defects, maintenance and repairs.
- List any supplementary contents in the clause.

The maintenance manual should schedule inspection requirements. Submission requirements need to be included in section A37.

975 WELDING

- In situ welding:

980 INTERFACES

- Flashings, closers, etc: Locate and form correctly to provide weathertight junctions with the curtain walling.

982 IRONMONGERY

- Assembly and fixing: Accurately, using fasteners with matching finish supplied by ironmongery manufacturer.
- Completion: Check, adjust and lubricate as necessary to ensure correct functioning.

985 MAINTENANCE

- Maintenance manual: Incorporate details within the Building Manual in accordance with CWCT 'Standard for systemised building envelopes' clause 7.6.1.
 - Materials certification and test reports to be included: