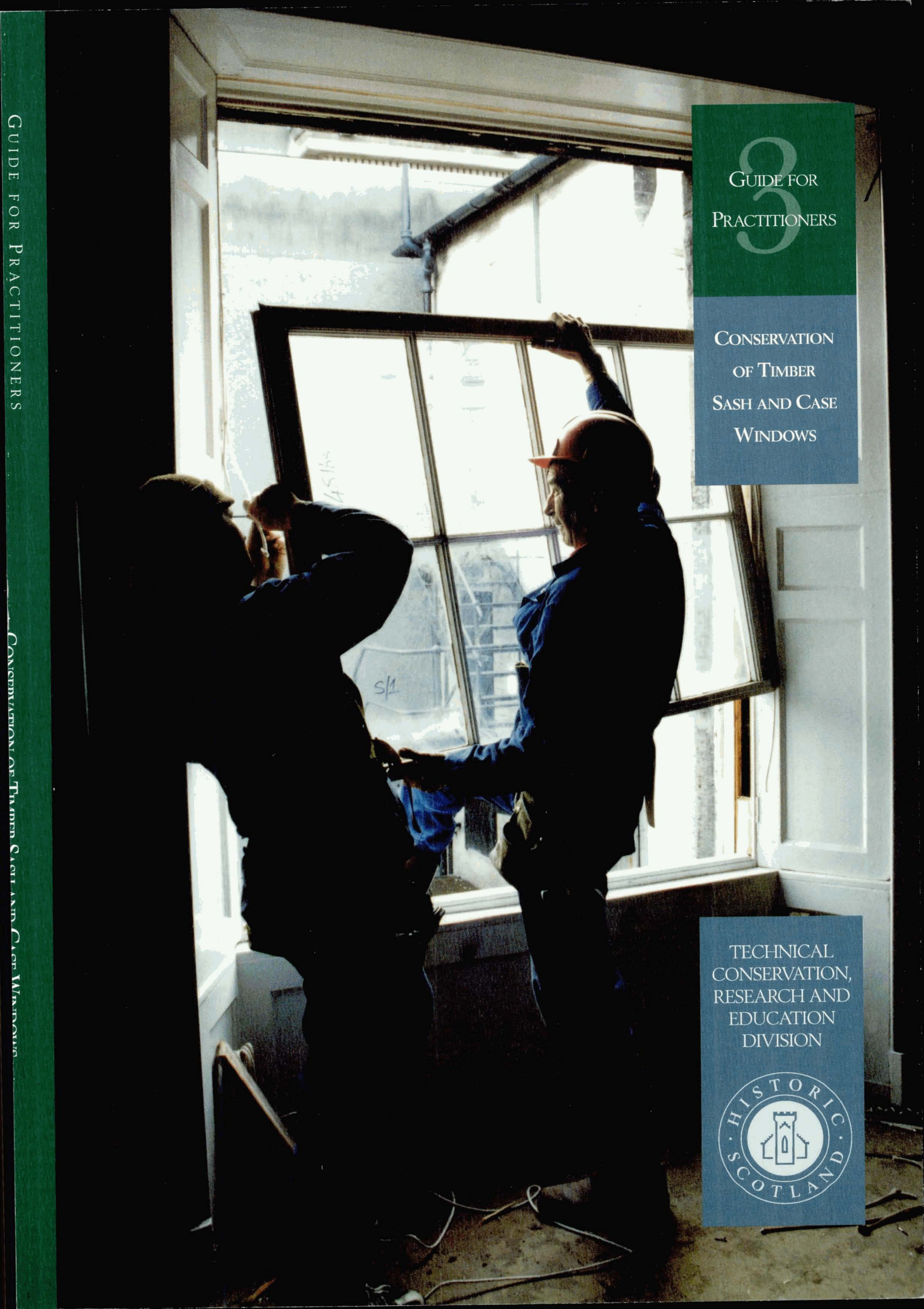

GUIDE FOR PRACTITIONERS

3

GUIDE FOR PRACTITIONERS

CONSERVATION OF TIMBER SASH AND CASE WINDOWS

TECHNICAL CONSERVATION, RESEARCH AND EDUCATION DIVISION

HISTORIC SCOTLAND

CONSERVATION OF TIMBER SASH AND CASE WINDOWS

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1 Preparation and Use of Lime Mortars (revised 1995)
2 Conservation of Plasterwork (revised 2002)
3 Performance Standards for Timber Sash and Case Windows (1994) (withdrawn)
4 Thatch & Thatching Techniques (1996)
5 The Hebridean Blackhouse (1996)
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GUIDE FOR PRACTITIONERS

CONSERVATION OF TIMBER SASH AND CASE WINDOWS

Maintaining, repairing and improving the performance of traditional windows

Stephen Newsom

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Author

This document has been researched and written by

Stephen Newsom, Architect
63 Main Street, Aberdour
Fife KY3 0UH

Telephone: 01383 86116

Fax: 01383 860825

email: info@stephennewsom.co.uk

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CONTENTS

LIST OF ILLUSTRATIONS

ABBREVIATIONS USED:

SN	Stephen Newsom, Crown copyright
NLS	National Library of Scotland
NR	Nessa Roche, Crown copyright
RCAHMS	Royal Commission for the Ancient and Historical Monuments of Scotland, Crown copyright
S&B	Simpson and Brown, Architects

FOREWORD

Earlier this year, Historic Scotland published a Research Report entitled the *Historical and Technical Development of the Sash and Case Window in Scotland.* The Report is a comprehensive guide to help 'read' Scottish sash and case windows. It can be viewed as a companion volume to this Guide – understanding the history of the windows and the full significance of their detailing is vital in order to determine the importance of the windows and hence to decide on the most appropriate conservation techniques.

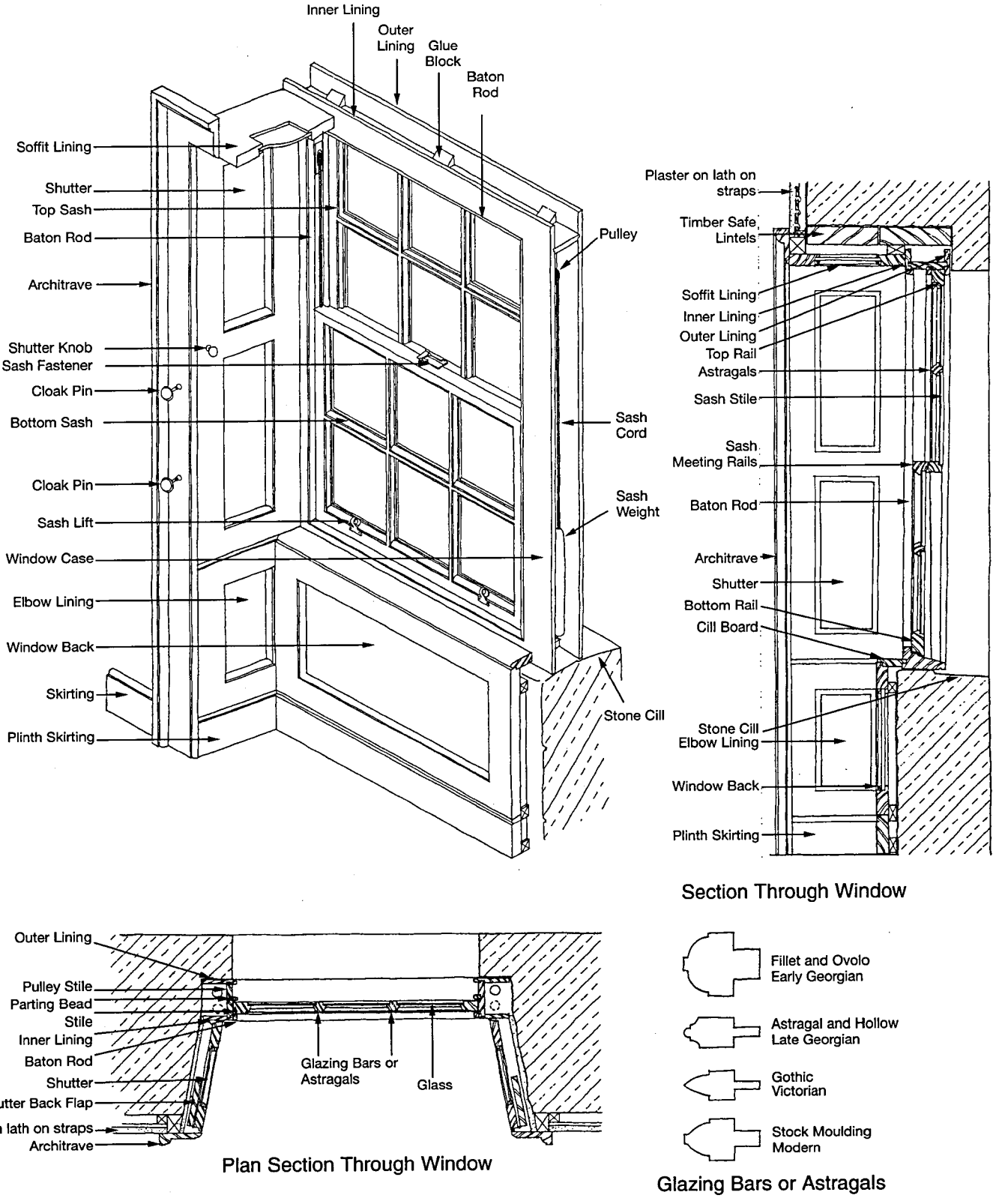
But windows are not just historic fittings; they must also function safely and efficiently. Timber sash and case windows have been the dominant window type from the end of the seventeenth century until the mid-twentieth century in Scotland. The reason for this is simple: they are extremely practical. They are well suited to the Scottish climate as their opening area can be adjusted from the merest crack to fully half the glazed area of the window. They are also extremely durable. Examples of windows that have been in service for 250 years are known. They do require some care and attention, but this is generally simple to do.

The conservation techniques that are applicable to timber sash and case windows are described in this Guide for Practitioners. Thus maintenance, repair and upgrading to improve performance are all covered.

This Guide for Practitioners updates and in some instances supersedes Technical Advice Note 3 *Performance Standards for Timber Sash and Case Windows* (1994) which is now withdrawn.

Ingval Maxwell
Director
Technical Conservation,
Research and Education Division
Historic Scotland

September 2002



2 *A typical sash and case window*

SUMMARY

The appearance of a façade, and consequently of the building of which it forms a part, is greatly affected by the number, size and disposition of openings contained within it, and by the manner in which these openings are detailed. Windows are therefore an important element in the design of any building and contribute substantially to a building's character. In order to protect the appearance of such buildings, methods of repair and any proposals to carry out work that will alter the style, detailing, materials or method of operation of the windows require very careful consideration.

Evidence from surviving examples indicates that well-made and maintained timber sash and case windows are easily capable of providing well over one hundred years of serviceable life. This durability can be extended by often quite straightforward repairs. By contrast modern window replacements are often made from substitute or inferior materials and are usually incapable of being repaired.

Where sash and case windows are damaged or decayed, or where building owners wish to improve the performance of windows to meet modern standards, there is often pressure for their replacement with new windows. This frequently results in the new work having a different design or altered details, with resultant changes in the appearance and character of the windows, and with a consequent reduction in the historic value of the building of which they are a part. Often these decisions are taken on the misunderstanding that traditional sash and case windows are not capable of being repaired, or of meeting current performance standards.

This Guide for Practitioners sets out to demonstrate that it is possible to carry out successful repairs to windows that maintain and improve their performance, using traditional techniques and craft skills. The guide summarises current performance standards for windows, and demonstrates possible methods of achieving these standards in sash and case windows, while retaining the original materials, detailing and design.

By careful and thorough repair, correctly specified and carried out by suitably skilled contractors, existing windows can be made to meet acceptable performance standards, either alone or by additional upgrading, without significant loss of original material. Where this is not feasible, more extensive alteration or additions can be considered. Exceptionally, new sash and case windows can be manufactured that match the original design but with improved performance.

Correct diagnosis of problems is an essential first step before any action is taken. Before carrying out any repairs, or agreeing to the alteration or replacement of historic windows, it is important to have fully understood the significance of the window. It is also necessary to establish and agree, in detail, exactly what is technically required. Many well-made original sash and case windows will perform satisfactorily, with the correct degree of maintenance, repair and modification.

The performance of windows can be evaluated by the following criteria:

- weather resistance (air leakage, water penetration and strength)
- thermal performance
- sound insulation
- safety, security and convenience
- costs (lifetime cost-in-use)

Proposals to undertake any work which, in the opinion of the planning authority, may change the appearance of windows in listed buildings, or unlisted buildings in a conservation area with an appropriate Article 4 Direction, will be subject to listed building control and planning permission. Works likely to require consent or planning permission include changes of material, section profiles, configuration or operating method of windows and the provision of double-glazing, secondary glazing and the provision of permanent ventilation.

This Guide for Practitioners updates and in some instances supersedes Technical Advice Note 3, *'Performance Standards for Timber Sash and Case Windows'* (1994) which is now withdrawn.

3 The variety in proportions of window openings and their effect on a classical facade. Heriot Row, Edinburgh.

1 INTRODUCTION

1.1 The origins of traditional sash and case windows

Sash windows were developed by the Office of Works in London in the early 1670s, and were adopted in Scotland soon after. An example of an early Scottish sash window can be found in the Low Parks Museum in Hamilton (illus 8). Other old sash windows are located in the stair at Drum Castle, Aberdeenshire and a ground floor window in Kelburne Castle, Largs.

From the start there were variations in construction practice between Scotland and England. In Scotland windows were fitted by wrights, and were always set into a pre-formed opening, often rebated in a check away from the face of the masonry. English builders often used windows as load-bearing elements in brick buildings, and set the window at the outer face of the wall.

Those concerned with specifying repairs or alterations to traditional sash and case windows should be aware of the potential for variations and anomalies in style, materials and construction that are possible. A more detailed overview of the development of the sash and case window in Scotland is given in Chapter 2.

The term 'sash' is thought to derive from the French word *chassis*, meaning 'frame'. The timber sash and case window offered considerable advantages over the earlier fixed light and shutter board windows which, because of the limited strength of their lead kames, allowed only the use of relatively small panes of glass, therefore restricting the amount of light that was transmitted to the interior.

The introduction of sash windows coincided with improvements in glass-making, so larger panes of clearer glass were available. Equally important as a reason for the growth in popularity of sash and case windows by the early 1690s was that they suited the fashionable, classically derived architectural styles of the period.

Other advantages were the strength of the timber frames, the increased control over ventilation, and improved weather-tightness provided by the puttied seal between glass and timber.

The appearance of the sash and case window gradually changed during the following two centuries of its development (1670-1870), with the early thick, closely spaced glazing bars giving way to larger panes of glass and thinner glazing bars, commonly called *astragals* in Scotland. Many eighteenth and early nineteenth century windows are three panes wide, and six or nine panes tall. As methods of glass production advanced, sashes with four or two panes could be achieved. It was common for larger panes to be employed in the windows of rooms on the principal floors, with smaller panes used in attic and basement storeys (illus 3). In Scotland 'lying' or 'long' panes are also found (illus 4). By the mid-nineteenth century single panes were possible, but were very expensive, and required stronger sash frames and joints formed with complete mortice and tenon joints, and sometimes with 'horns' to give strength to the joints (illus 5).

1.2 Design and detail

Sash and case windows are constructed with two glazed frames – the sashes – fitted into but not fixed to the case (frame). At least one sash (and usually both) slides vertically, counter-balanced by an independent system of weights and pulleys. The sashes slide in grooves formed by the framework on each side, with a central vertical parting bead separating the two sashes from each other.

In Scotland the tradition has always been to set the frame of the window within a deep check or rebate in the masonry, to more efficiently withstand the effects of the weather. The frame is therefore almost completely hidden from view (see illus 2).

The design of windows developed over time and early examples may be found that vary from this 'standard' design (see chapter 2). Such windows require special care to ensure no inappropriate alterations are made which could obscure their early origins.

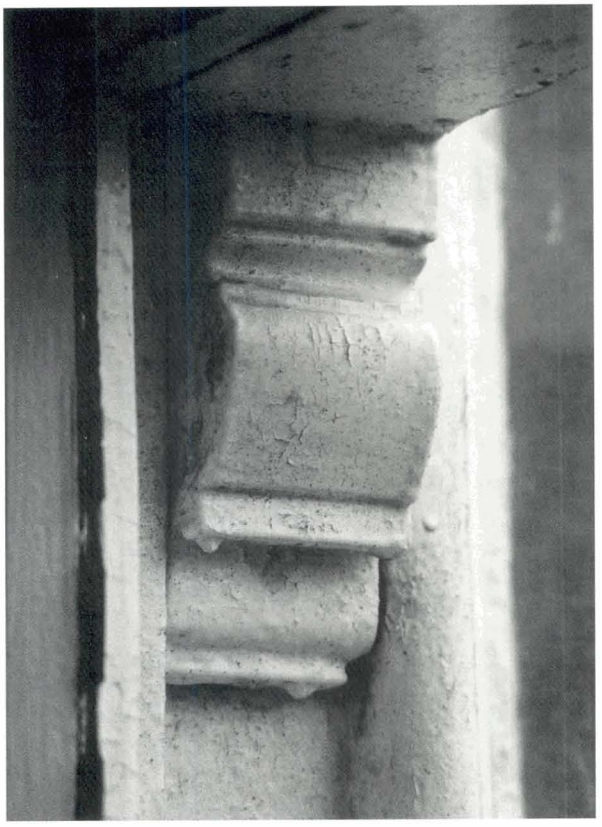
Window proportions can vary considerably. The dimensions of each pane are not dependent on any fixed formula, but the general arrangement was always intended to be in harmony with the rest of the facade.

1.3 Materials and methods of construction

1.3.1 Frame materials

Early sash and case windows were made of native oak. Later windows used locally available Scots pine. When

4 Lying panes, Saline, Fife.



5 *Sash with horns.*

native timber became unavailable in sufficient quality, pine and oak were imported from the Baltic. Very occasionally windows were made from Mahogany or from a combination of Mahogany with oak or cast or wrought iron, to achieve a very slim profile. In the late twentieth century timber quality has declined, and the practice of using poor quality sapwood for many common joinery tasks is commonplace.

1.3.2 Glass

Early glass was termed broad cylinder glass. It was made by blowing a cylindrical shape in glass, and then cutting and flattening sheets from the cylinder while it was still hot (illus 6). Broad glass is usually imperfect in surface and colour, with bubbles or streaks in the glass, and a greenish colour (illus 12 and 13).

In the eighteenth century crown glass was used, produced by spinning a disc of molten glass to allow it to spread out into a flat plate that was (when cold) cut up into rectangular panes (illus 14). This glass is usually of a very high quality, with discernible curved ripples in the pane (illus 15). Some panes have a greenish or purplish tint.

Plate glass, blown into a cylinder or disc, or cast onto a bed of sand, allowed very large sizes, but its expense meant that it was most often used for mirrors, not window-panes (illus 16). It had to be ground and polished on both sides, a skilled operation.

Improved cylinder glass, in wide use from the 1850s, was an industrialised reworking of the broad glass method to allow large panes. This glass, when polished like plate glass, was known as patent plate glass.

Modern float glass is floated on a bed of molten tin, which ensures that both surfaces are exactly flat, with no flaws in the body of the glass.

1.3.3 Frame construction

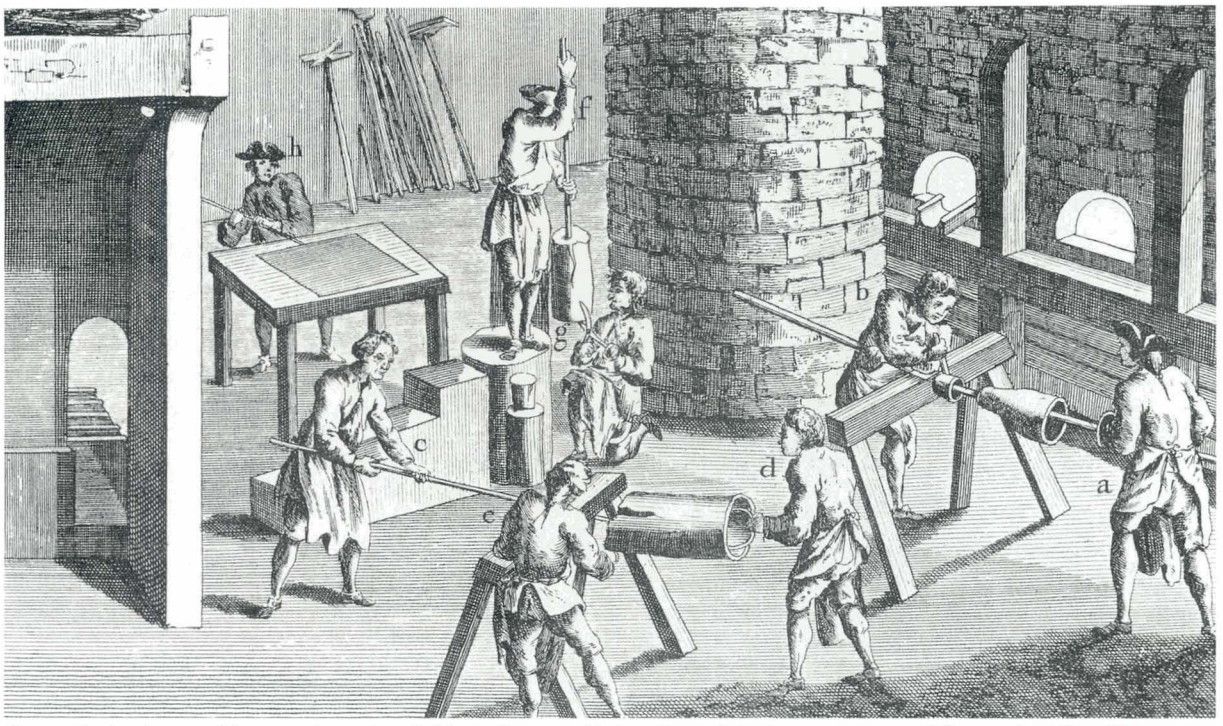
The essential method of construction is based on the mortice and tenon joint, although early windows may have more simple, doweled mortice joints (using oak pegs). Sashes are made by assembling the glazing bars (astragals) into the required pattern, and fitting them into a frame that is tenoned and pegged together under compression. Glass is set and sealed with putty into a check or rebate made on the weather or outer side of the glazing bars and sash frames. Later nineteenth-century sashes sometimes have horns on the lower corners of the top sash to help support the joints against the large panes of plate glass then fashionable (illus 5). Window cases are assembled from the various stiles, heads, facings and linings on a cill member. They were always made to fit the particular opening, rather than being made to a standard size. Most windows have panelled shutters, window back and elbow linings with similar mouldings to those of the door joinery in the room or whole house.

1.3.4 Paint

The application of paint to the exposed timber parts of the window ensures they are protected against decay. Traditional paints were based on the combination of natural or chemical pigments, a catalyst such as lead acetate, and linseed oil that acted as a drying agent. Modern paints have been completely reformulated and are no longer able to contain lead-based materials, due to health and safety requirements. To obtain a high quality finish zinc-based paint may be used or exceptionally, where a building is listed Category A and the work is to match the original in appearance and durability, a licence can be obtained to use lead paint.

1.4 Fittings for sash and case windows

The fittings developed for sash and case windows are essential for their efficient operation. Surviving early windows may not have been counterbalanced. Instead they relied on timber pegs pushed into the frame to support the open sashes, or a timber quadrant or shaped metal stay. These were fixed to the sash and designed to be rotated into position, either under the lower sash rail or into one of a series of holes in the frame or baton rod, to hold the sash at pre-determined positions (illus 7).



6 Early glass making – molten glass is blown into a cylinder shape, it is then cut open and flattened while still hot. (Engraving from Diderot's 'Encyclopaedia')

The majority of sash windows, up to the present day, are double-hung, requiring ironmongery, which includes pulleys, sash cords and weights, hinges, locks, screws, catches, shutter knobs and sash rings or pulls. All are indispensable to the use of the counter-balanced sash and case window. In Scotland a common, but not universal, hinge and stop mechanism is colloquially known as a Simplex hinge. These allow the lower sash to be removed, rotating it into the room to aid cleaning (see illus 56).

1.5 The performance of sash and case windows

The predominance of the sash and case window in Scotland's buildings, for at least two hundred and fifty years since its development, is testimony to its suitability for our climate and in providing adequate levels of convenience and comfort for building owners and occupants. Sash windows have developed to accommodate changes in taste and other technical requirements placed on their performance. Their relatively simple construction has proved to be durable, allowing them to be maintained and repaired throughout the period, and many early examples survive in working order.

The trend for other forms of window to be installed began in the twentieth century and continues into the twenty-first. Pressure for change is generated by fashion and the desire to improve technical performance in equal measure. This Guide for Practitioners sets out to demonstrate that by careful and

7 Example of early quadrant sash stays, Traquair House.

thorough repair (sometimes augmented by upgrading works) correctly specified and carried out by suitably skilled contractors, existing windows can be made to meet acceptable performance standards without significant loss of original material.

1.6 The case for maintenance and repair

There are no inherent defects in the design of the sash and case window. The basic construction has remained the same for over 300 years. That some of the earliest sash windows remain in use today (see Chapter 2) is evidence of their potential durability given appropriate maintenance. The historic value and constructional details of original windows often form an important part of the surviving fabric of a building. Therefore whenever possible they should be repaired rather than replaced.

Given sensible maintenance at regular intervals, sash and case windows of good quality timber should remain in good repair and will be capable of efficient use in their original positions. The relatively straightforward removal of sashes, the only moving part, should allow them to be repaired on the joiner's bench. The fixed case or frame may also be removed, once any shutters or elbow linings have been set aside, by taking out the timber wedges which secure it in place, but it is more common for the frame to be repaired in-situ (see also 4.2).

1.7 Common defects

A detailed survey and analysis will be necessary to determine the extent of any defects in each of the windows of a building. It should not be assumed that because one defect exists in some windows, that they are all affected. Particular localised conditions may apply that have caused the defect to occur. Key points to look for are:

- Cracked, missing or loose pointing between the frame and the wall opening.
- Stuck sashes, or those which can not be easily operated.
- Evidence of wood decay (wet or dry rot).
- Poor condition of paintwork, either inside or out.
- Opening up of joints in timbers.
- Cracked, loose or missing putty.
- Cracked glass.
- Faulty or missing ironmongery.
- Damaged sash cords.
- Standing water on any part of the window frame.

The diagnosis of signs of structural movement, which may be affecting the window, are beyond the scope of this guide.

1.8 Inspection

It is best to record the defects for each window as it is inspected. This will allow appraisal of the scope of repair works required. An example of a survey pro-forma sheet is provided in Appendix B.

The inspection should be not only visual, as often what appears to be a major fault may turn out to be simply the failure of a protective paint finish. Conversely a recent paint coating may conceal underlying timber decay. A sharp knife can be used to probe through surface finishes, and a damp meter can help to determine the moisture content of vulnerable timbers. (A damp meter must be calibrated before use in order to obtain accurate readings of moisture content, and care should be taken to ensure its sensors are not recording the surface condition of the timber).

The thorough inspection of windows will help avoid the costly and disruptive wholesale renewal of basically sound windows, as well as ensuring that a cosmetic "cover-up" with putty and paint is not used to disguise decayed timber or other fundamental defects.

Detailed advice on techniques for the repair of sash and case windows is given in Chapter 4.

1.9 Other traditional windows

It is not the intention of this Guide to discuss in detail the conservation and repair of other types of window. However it should be noted that similar principles would apply to many different windows, ranging from medieval shutter-board windows, to fixed and hinged casements, leaded or zinc lights, and early or twentieth-century metal windows.

8 One of the oldest surviving complete windows is now on display at the Low Parks Museum, Hamilton, Lanarkshire. The window came from the house originally built for the Duke of Hamilton's factor in 1696.

2 SUMMARY OF THE HISTORIC AND TECHNICAL DEVELOPMENT OF THE SASH AND CASE WINDOW IN SCOTLAND

2.1 The Seventeenth century

2.1.1 Introduction of the sash and case window

From the Renaissance onwards the drive towards achieving more daylight to illustrate grand interiors was a strong impulse in shaping architectural fashions. The early sash and case window let in more light than a half-glazed shutter-board window, despite having small panes and, at first, a high proportion of wood. Each sash could be made to larger sizes than a leaded-light due to its stronger construction. Façades of regularly spaced timber sash windows were complementary to Scottish baroque, and later Palladian, architecture. The introduction of the sash and case window into Scotland took place at the end of the 1660s, as a result of the innovation of applying pulleys and weights to timber sashes, which was developed by the Office of Works in London. The earliest windows were dogged by constructional problems and most were replaced in subsequent decades. Despite this the new window type quickly gained popularity. Sash and case windows were installed throughout the country in the 1680s and 1690s. Some older buildings were refenestrated with sashes to bring them up to date.

2.1.2 Seventeenth century sash and case styles

The earliest sash and case windows were reinforced by the use of a mullion (some types also have a transom) but these supporting elements faded from use in the 1680s. Early windows had small panes with thick glazing bars (known as 'astragals' only in Scotland). From its inception, the sash window was generally divided into panes proportionate to the overall size of the window, and to its importance, although glass was available in somewhat larger sizes. Early sashes were divided into four or five panes across. Panes were upright rectangles, though often tending towards the square. The lower sash could open, either counterbalanced or held up with catches.

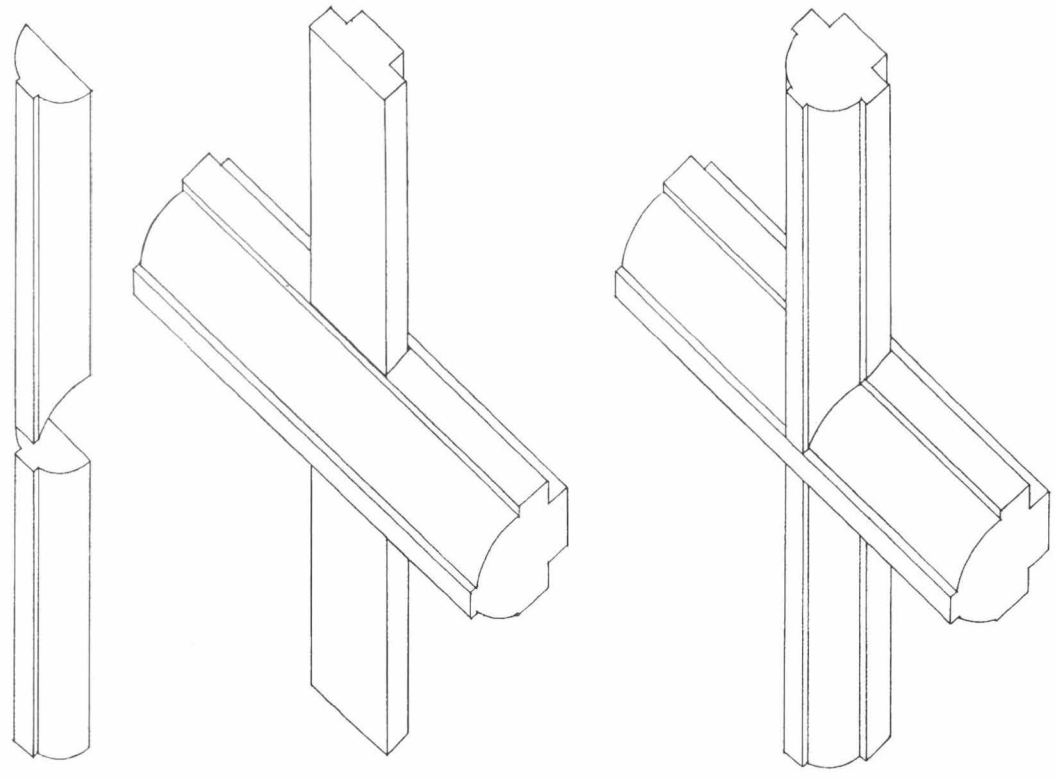
Shutters were always used on the windows of principal rooms, reflecting the style of their oak panelling mouldings (illus 9). Shutters were either fitted when open into a cavity formed by panelling the internal reveal, or simply opened against the reveal.

From the start some stylistic differences existed between Scottish and English sash and case windows, which arose from construction practices. In Scotland windows were fitted by wrights, and were always set into an ingo away from the exposed face of the wall in masonry buildings, and the frames were partly or fully rebated in a check. English builders often used the window lintels as load bearers in brick buildings and set the fully visible sash frames at the face of the wall.

2.1.3 Construction and material details in the seventeenth century

The earliest sashes were constructed using frame elements held together with mortice joints, usually dowelled with oak pegs for strength. Early glazing bars were 1¼ to 1½ inches (32-38mm) wide. In most sashes either the vertical or horizontal glazing bars were made in two parts, with the internal moulding separate from

9 Shutter panel mouldings: bolection in conjunction with raised and fielded, on a shutter of the 1690s.



10 Two-part glazing bars with lap joints.

the 'T-shaped' section that formed the glass check on the exterior (illus 10). All early Scottish sashes have ovolo and fillet glazing bars jointed with mitred mouldings.

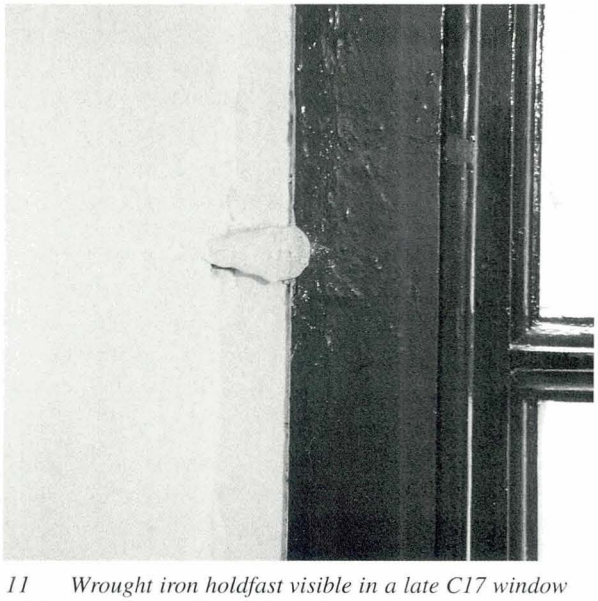
The operable lower sash was usually counterbalanced by cast lead weights, suspended on sash cord from timber or brass pulleys. The cased frame was not used in all early windows; solid-framed sashes were held open with a catch attached to the sash stile. The timber of choice was oak, preferably imported from Baltic countries, although native oak was widely used. The less important parts of the cased frame, the backs, internal linings and facings, were sometimes made in deal (fir or pine). Early sash windows, unlike their predecessors, the half-shuttered windows, were not built into the masonry but were fitted from the interior into the rebate and fixed with wrought iron tapered pins (illus 11).

Early sashes required frequent repairs, as the timber used was relatively thin and constructed with basic joints. However, ongoing experimentation and direct influence from London led to improvements in framing methods, and more lasting sashes became common from the 1680s onwards.

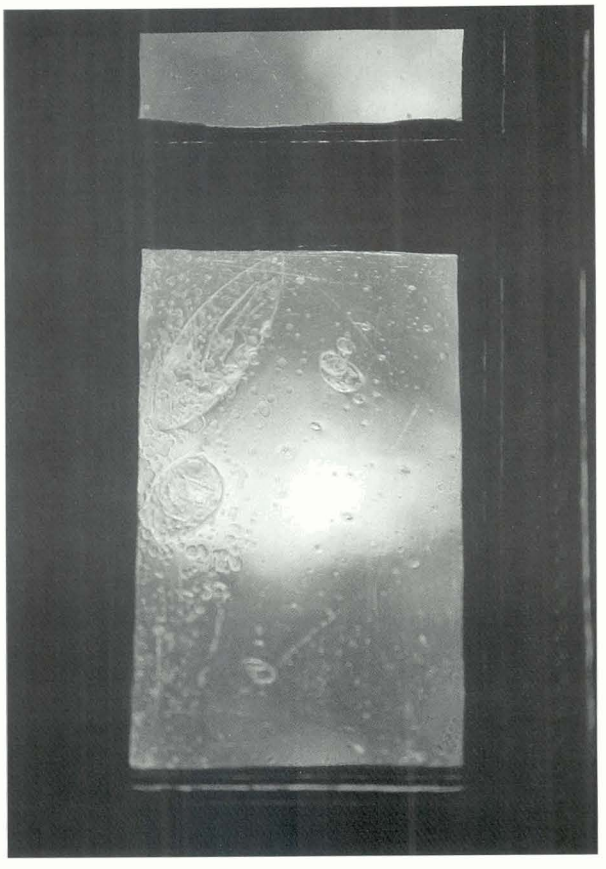
Window-glass was either broad or crown glass. Broad glass was blown into a cylinder and cut while hot into sheets (illus 6). It is often greenish in tint and characterised by seeds and speckles (illus 12 and 13).

Crown glass was made from a globe of glass spun by a series of manoeuvres into a flat disc. The characteristic 'bullseye' cut from the centre of the crown was rarely used in windows of any importance (illus 14).

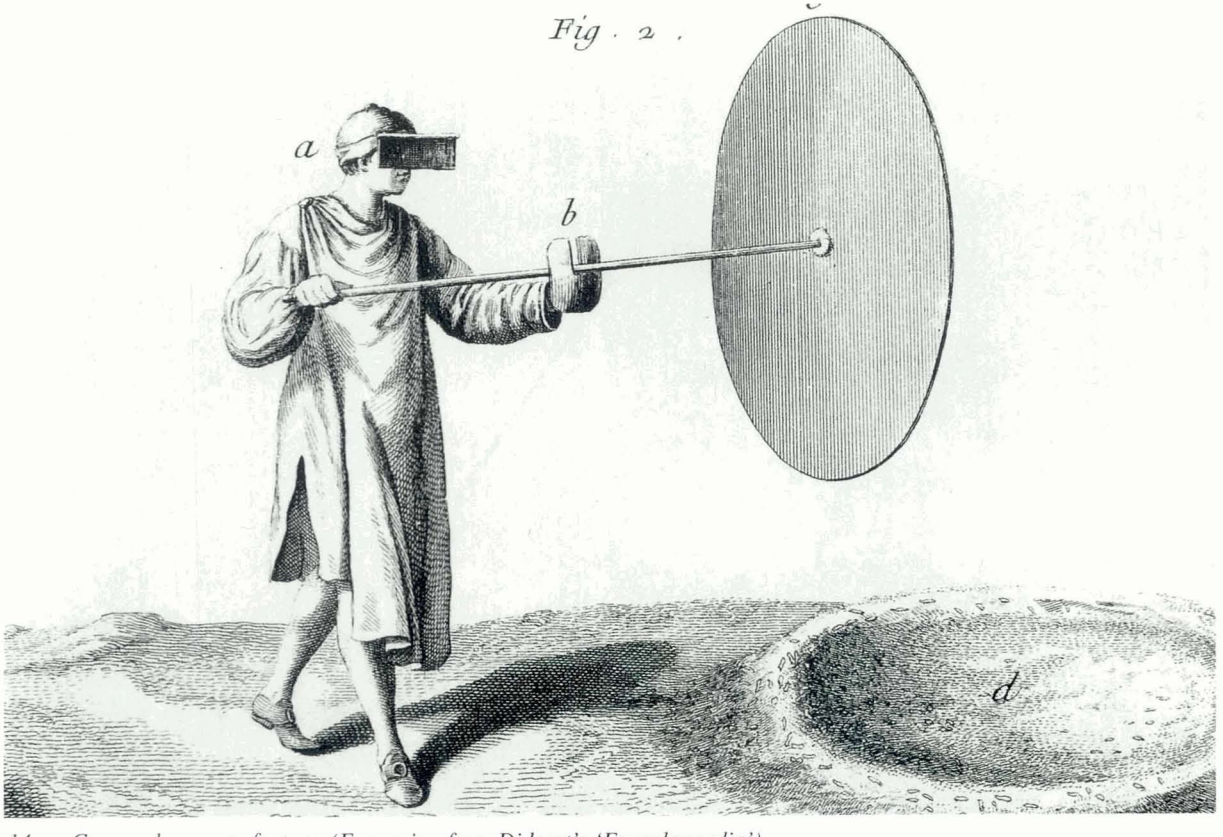
Polished plate glass, made by blowing thick crowns or casting a sheet, was available from the late seventeenth century but there is no evidence that it was much used in Scottish buildings (illus 16).



11 Wrought iron holdfast visible in a late C17 window without any internal covering joinery.



12 and 13 Broad glass panes; note the hammered surface and bubbles within the glass.



14 Crown glass manufacture. (Engraving from Diderot's 'Encyclopaedia')

15 *A mid C18 pane of Crown glass.*

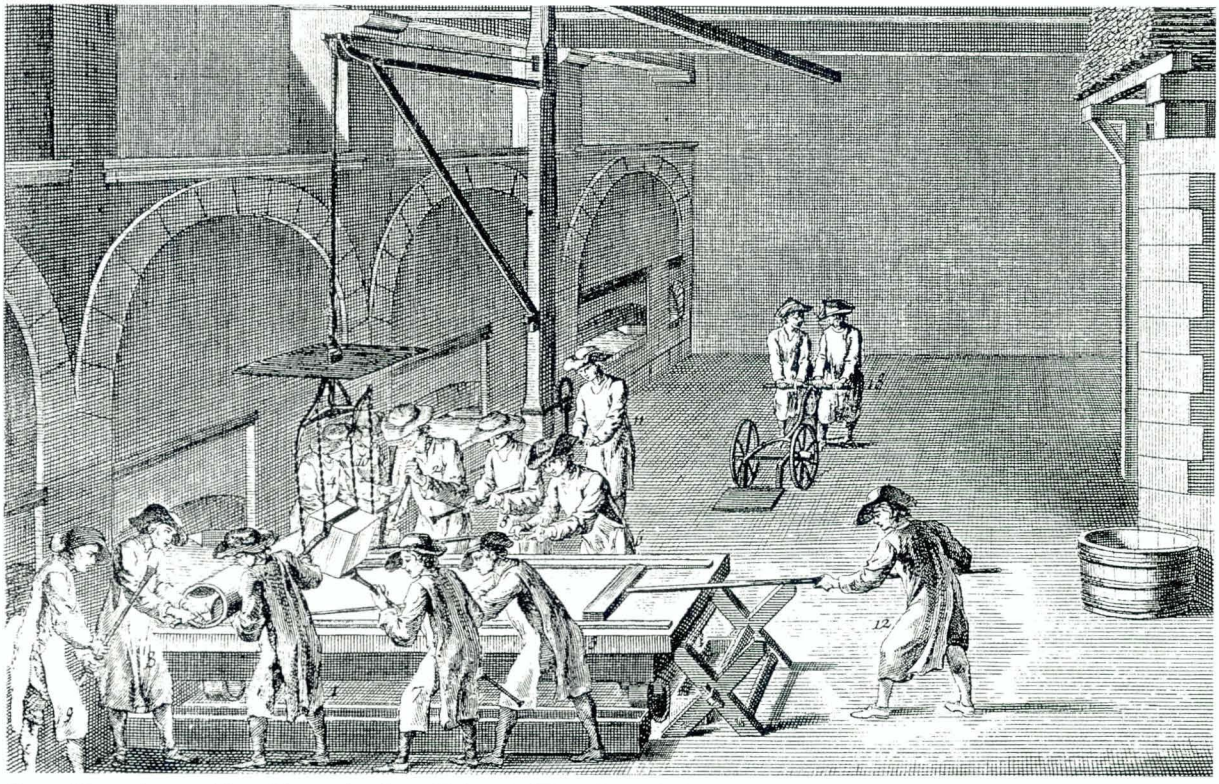
2.2 The eighteenth century

2.2.1 The place of the sash window in prevailing classical styles

All over Scotland new buildings were fitted with sash windows. Many older buildings had their early sashes or shuttered windows re-fenestrated with the latest style. Constructional requirements, and the Palladian fashion for a substantial grid of light-painted astragals ensured that heavy sashes remained standard until the 1750s (see illus 17).

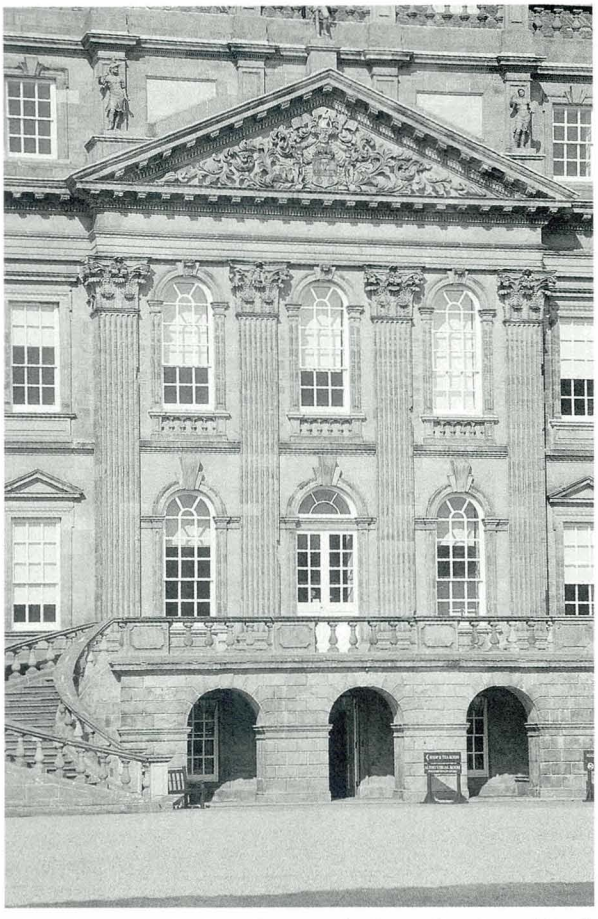
In building projects less influenced by Palladian principles, the sashes were usually made of somewhat slighter timber, more economically used. Therefore care is required before dating a sash based on its sash timber dimensions alone.

A growing interest in the 'natural' landscape as the century progressed, led to a change in styles, with larger windowpane sizes and slimmer sash members giving an elegant overall appearance. Architects such as Robert Adam led the field in promoting this style, in which the window was made to be unobtrusive while admitting as much light as possible (illus 26 and 27).



16 *Plate glass making. (Engraving from Diderot's 'Encyclopaedia')*

17 Ardmaddy Castle, Argyll, illustrates the character of the Palladian sash window framed by block-and-start dressed quoin stones.



18 Round arched windows on the front elevation of Duff House, Banffshire. (William Adam, 1735-40)

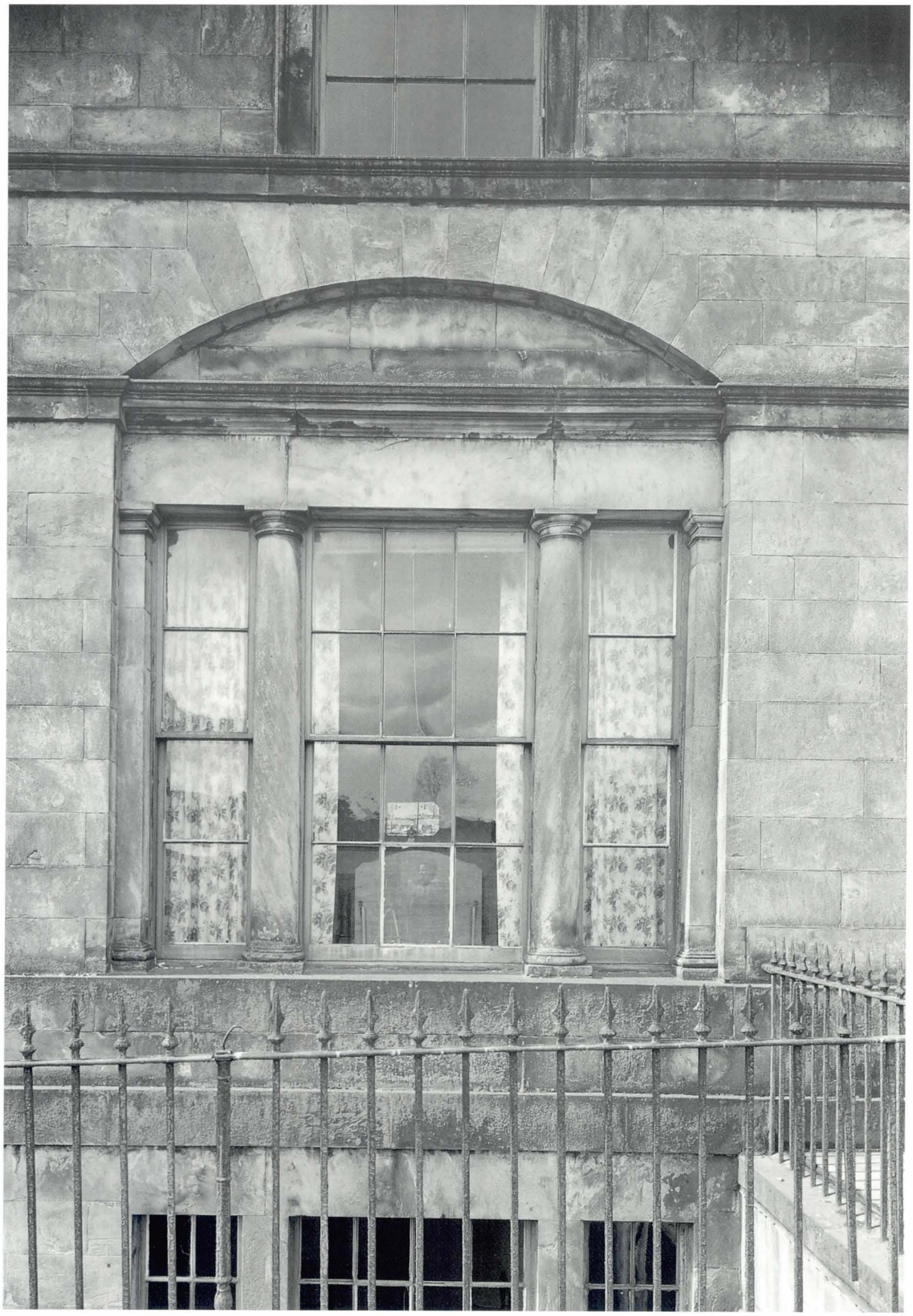
2.2.2 Eighteenth century sash and case window styles

Venetian, Diocletian, lunette and oculus and round- and basket-arched sash windows became popular in the early eighteenth century (illus 18 and 19).

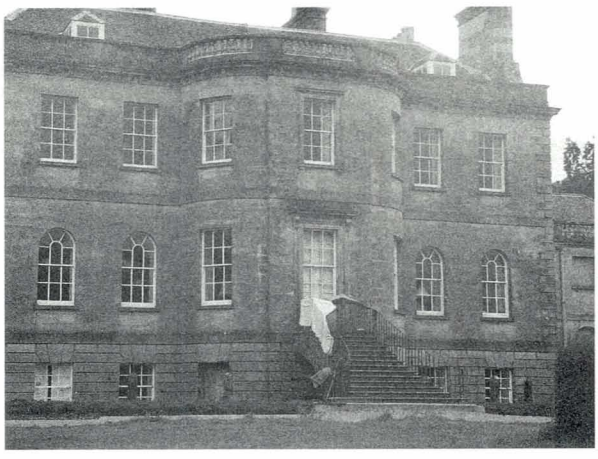
Round-arched windows and flat-headed tripartite windows (illus 20) retained their popularity in the neo-classical era and, late in the eighteenth century, bowed projections were a stylish way of inserting two or three curved windows where, according to the prevailing rules of proportion, only one or two would fit into a wall (illus 21). Sash and case windows proved popular also in Georgian Gothick architecture (illus 22).

Neo-classical designers started a fashion for lengthening the windows of reception rooms to the floor for maximum light and view. Sash-doors were in use in Scotland from the early eighteenth century (illus 23). However the side-hinged double doors of the French window provided more ready access out to the terrace or balcony of the late eighteenth century country house.

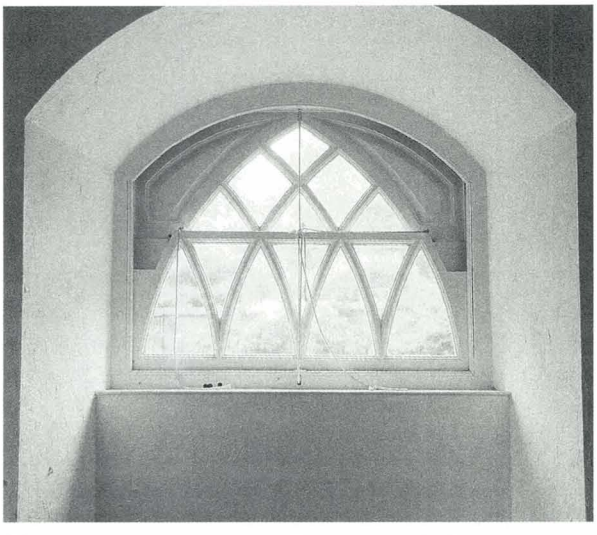
19 Basket arched window in the ground storey at Hopetoun, West Lothian. (Remodelled William Adam, 1721-48)



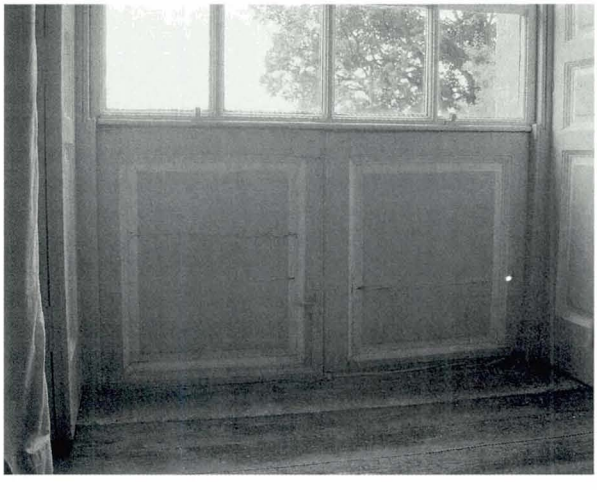
20 Tripartite window at Kennet House, Clackmannanshire.



21 Rear elevation bow at Cromarty, Ross and Cromarty.



22 Inveraray Castle, Argyll, started in 1745, retains some Gothick windows.



23 Sash door of the 1720s: sash windows with low double doors in timber below the cill, which open inwards when the lower sash is lifted.

A device used to obtain the desired plan into a classically fenestrated building was the introduction of blind or false windows. These were either outlined in stonework, with changes in plane to imitate the 'sashes', or were fully glazed timber windows with the interior of the glass blackened with paint or fabric (illus 24). Windows were also sometimes blinded to lessen the burden of the window tax (in force from 1695 until 1851) (illus 25).

From the 1750s the glazing bars, stiles and rails were slimmed down and the pane sizes increased. Where eighteen pane windows (nine pane sashes) were common in the first half of the century, thereafter the twelve pane window (six pane sashes) became usual. The popularity of the three-pane-wide window was almost universal, although in basement and dormer windows, due to their proportions, one might see four panes across. Where the proportions of the windows dictated unequally sized sashes (primarily on principal floor windows of more than two squares in height) it was common at this time for the upper sash to be larger.

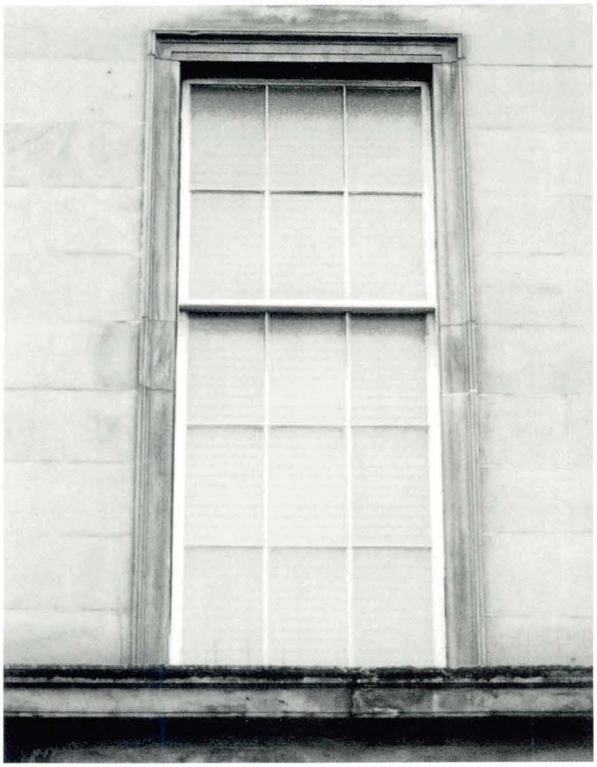
Shutters of the first half of the century usually had several 'raised and fielded' oblong panels. Later work favoured more elegant internal sash joinery with a simple bead bordering a flat panel and more widespread use of gilding, composition ornament and decorative painting (illus 28). The panels on the shutters did not always concur with the horizontal glazing bars, in some cases bearing no relation to each other. Many shutters were in two halves, even in relatively small windows, to allow the lower leaves to close for privacy while still admitting light.

Window dressing became more important as the century progressed, the drawn-up or ruched curtain gradually replaced by those hung from a rail and decorated with a pelmet. The splayed internal reveal, useful for admitting more light, also provided extra space into which the curtains could fit.

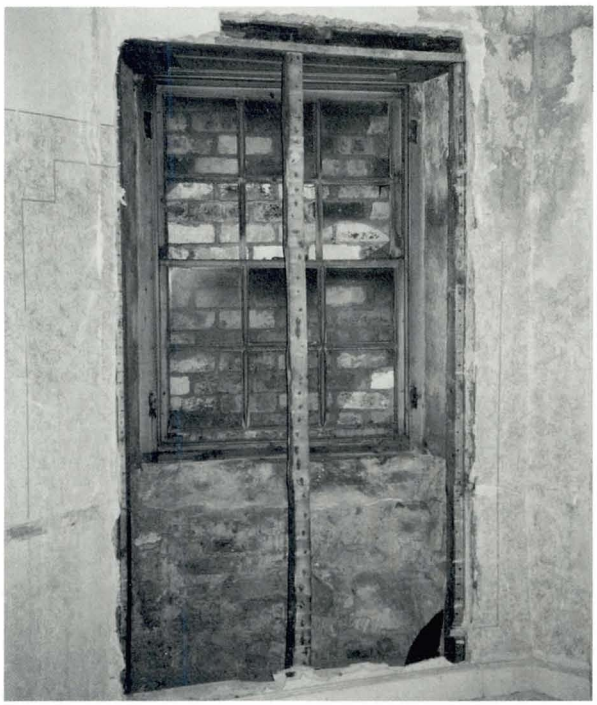
2.2.3 Construction and material details in the eighteenth century

Although the universal form of the two-sash window was rarely tinkered with, sometimes expediency led to changes (illus 29).

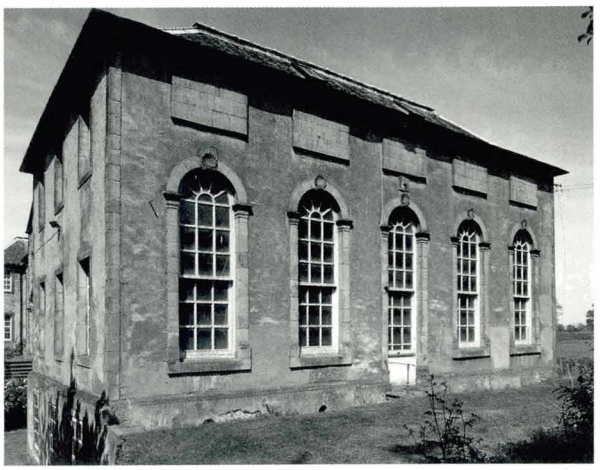
The sash windows in early William Adam buildings include some progressive detailing that was not seen elsewhere in Scotland at the time. The most obvious practical improvement was the use of a parting bead (of square section) to separate the sashes. Parting beads formed individual grooves in the pulley stile, providing a constrained path for movement for each sash when they were double-hung. In order to bridge the resultant gap, through which draughts and rainwater could pass, the meeting rails of each sash were widened and the



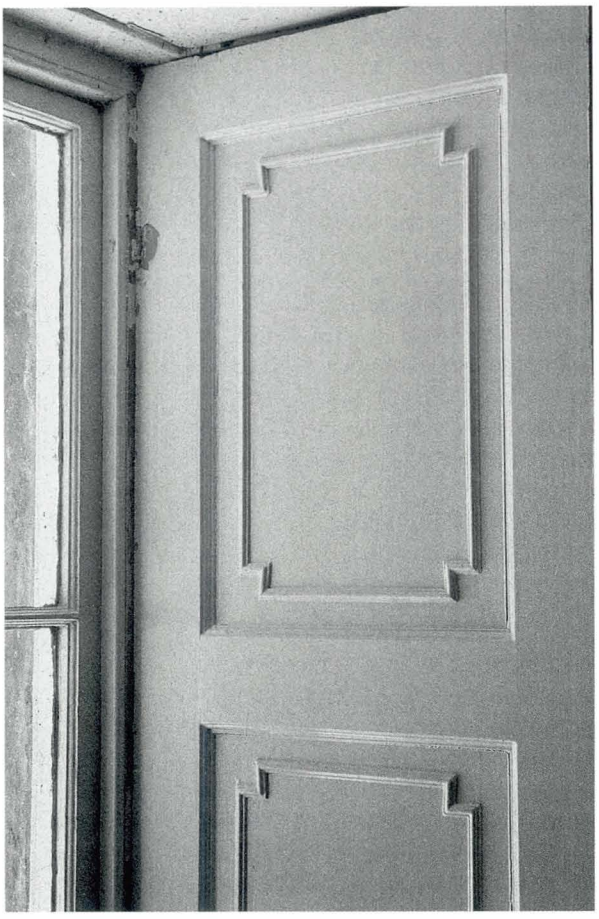
24 Annandale Street, Edinburgh: a blind, but glazed, sash window with the blank wall core screened using timber lath painted to produce the effect of a Venetian blind.



25 At Blackburn House, West Lothian, a complete but unpainted and unglazed sash window was recently uncovered. It had been fully blocked up within the masonry during construction - perhaps in response to the final insult of the glass tax, first levied in 1745 and in force with many increases until repeal in 1845.



26 and 27 Two phases of work at Newhailes near Musselburgh illustrate the difference between early and late eighteenth century work. The heavy Palladian glazing of the 1720s library contrasts with the State Bedroom (fitted out in the late eighteenth century) which has very fine metal glazing bars and bevelled Vauxhall plate glass.



28 Neo-classical period shutter panel with applied beading.

facing surfaces bevelled, stepped or hooked (illus 30 and 31). The bottom rail and cill faces were also bevelled and, usually, stepped.

From this date almost all sash windows designed to be double-hung had parting beads and, towards the middle of the eighteenth century, earlier sashes and frames were often altered to provide an operable top sash. From the late eighteenth century the parting beads were made slimmer, and had a more rounded moulding to lessen friction. However, in the north-east the square-sectioned parting bead remains universal to the present day.

The mouldings applied to the interior of the glazing bar did not vary until the middle of the eighteenth century. Then the 'ovolo and fillet' was replaced by more complex 'astragal and hollow' (the most popular), 'lamb's tongue', plain astragal or 'Gothick' moulding (illus 32). These bars became substantially slimmer towards the end of the century (at the thinnest about $^{1}/_{2}$ inch (13mm) wide). As sashes became more slender the meeting rail was also slimmed down as far as structurally possible, with the frame joints still dowelled or pegged for strength.

From the mid eighteenth century the increased use of hardwoods and more sophisticated tools made slimmer glazing bars and more intricate mouldings possible, facilitating the fashion for narrow sashes. Sashes were commonly made up in the workshop, allowing greater control than had been possible on site. Advances in metalworking also benefited sash-makers, as rolled wrought iron and brass became available and were employed to make strong but slender sash bars.

Timber pulleys were replaced by turned and cast brass and, eventually, by cast iron. Iron weights became common and were universal from the third quarter of the century. Meeting rail catches were unusual until the second half of the eighteenth century, when a number of styles were patented. Turned wood sash buttons and brass finger lifts set on the bottom rail survive from the earliest windows onward. Spring bolts were often fixed to the stiles of the lower sash to bolt into the baton rod or frame.

In Scotland a preference for oak sashes and frames continued much later than in the rest of the British Isles, where pine or fir was more usual. Mahogany was also used for window sashes after the middle of the eighteenth century. Use of softwoods increased for shutters and other internal work. Up to the middle of the eighteenth century there was a preference to paint windows a light colour on the exterior ('stone colour' is a term occasionally found), while the interior of hardwood windows was clear varnished.

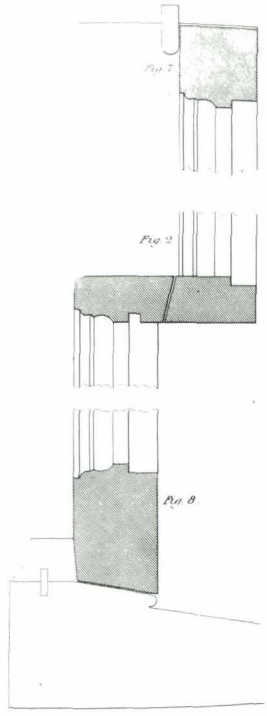
Crown glass was preferred for almost all building work, sometimes made by Scottish glasshouses, but also bought from London. Whereas before very large panes of glass had to be of expensive Vauxhall or French polished plate, now crowns of glass could provide panes of up to thirty inches (762mm) tall. The British Plate Glass Company was set up in 1773 and thereafter plate glass, although subject to punitive glass tax, was more readily available. In addition to the glass tax most foreign glass was loaded with an excise levy.

2.3 The nineteenth century

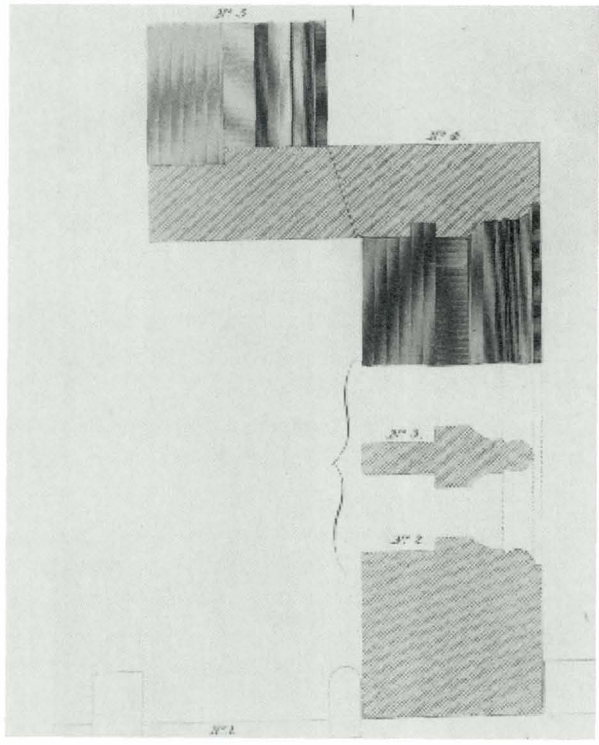
2.3.1 Architectural styles - revivals and new advances

The nineteenth century was an era of architectural revivals combined with technological advances and industrialisation. The window was no longer simply a unit of fenestration, but more a symbol of the romantic past, albeit constructed in a modern manner. In Scotland innovative sash and case window designs and details were adapted and spread throughout the country, giving nineteenth century Scottish architecture a distinct appearance.

29 Small windows of just one sash (made to slide upwards into a cavity in the masonry above the opening) are found in the attic storey of Gunsgreen, Eyemouth, c.1754, attributed to John Adam.



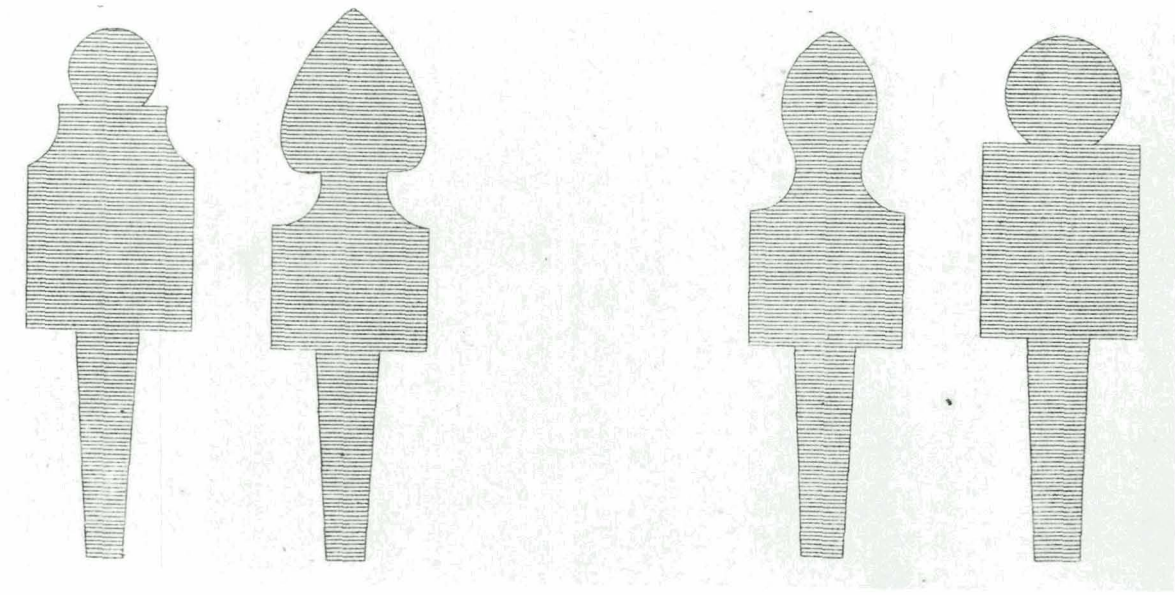
30 *Meeting rail joint. (Engraving from Nicholson's 'Practical Carpentry and Joinery', 1826.)*



31 *Meeting rail joint. (Engraving from Nicholson's 'Builder's Directory', 1862.)*

French influences from the end of the eighteenth century extended to adopting the French casement window (two full-height side-hung casements). Most owners were content to fit French doors in their principal rooms only, leaving an aesthetic dilemma of reconciling the three-pane wide sash with the strong central vertical stiles of the door, soon solved in a way unique to Scotland (see 2.3.2).

Many houses of the 1820s and later have 'lying' or 'long' pane sashes. Another popular variation on traditional sash patterns that emerged during the Regency Greek Revival was the use of margin sashes (with narrow borders), seen in houses from the second decade of the nineteenth century, and popular until the end of the century (illus 33). With dramatically reworked classical fenestration proportions and a tolerance for a mixed assortment of window types, the



32 *Glazing bars prevalent in the late C18 and early C19. (Engraving from Nicholson's 'Builder's Directory', 1862.)*

33 No. 23, Melville Street, Edinburgh (designed in 1814 by Robert Brown, but not built until the mid-1820s) is a showcase of all these fashionable variations of sash pattern.

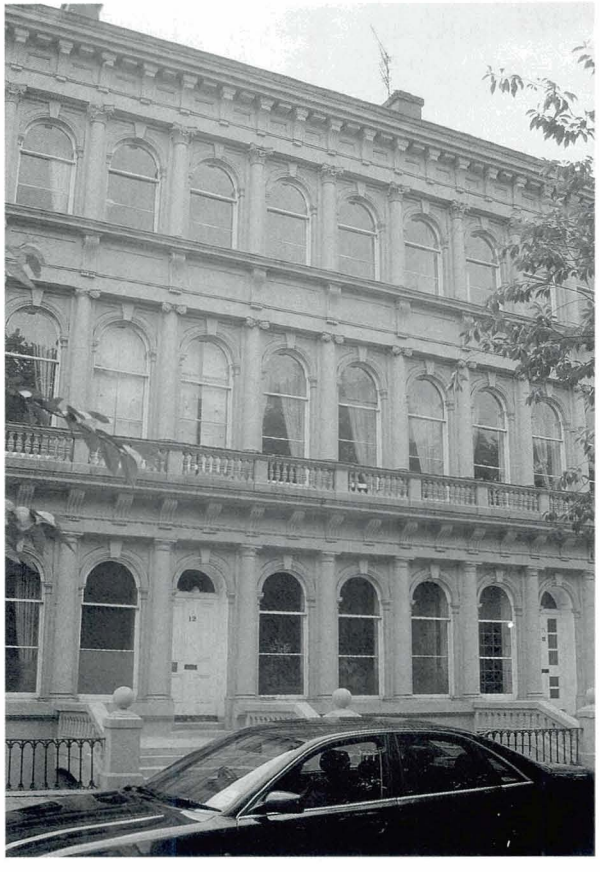
late Georgian terraces of Scottish towns and cities differ from those of other classical urban centres such as London, Dublin or Bath, where the individual house was subordinate to the group aesthetic.

Developments in glassmaking eventually gave the freedom to design windows with no glazing bars at all. The use of plate glass was a statement of wealth and fashion, most especially while the glass tax was still in force. Houses fitted with plate glass windows often look skeletal but where buildings were designed with plate glass in mind such as the palazzo terraces of mid-century Glasgow the result is more successful (illus 34).

Not all early nineteenth century architects or clients favoured these new stylistic details, and not all buildings were designed with ever-increasing pane sizes. Opinion was divided as the century progressed on the suitability of 'plate glass windows' (as sashes with one or no glazing bar are called). Many conservative householders retained their older windows and, when extending their properties, small-pane sashes were used. Throughout the latter half of the nineteenth century the large-paned sash was used in estate cottages and factories as well as prestigious buildings. In domestic architecture the single or two-paned sash window usually lit the main rooms and the small-pane sash was relegated to the rear and basement. The range of timbers available was unsurpassed, as was the range and competitive price of glass. The sash remained popular despite the more widespread use of casements, hopper lights and pivoting lights.

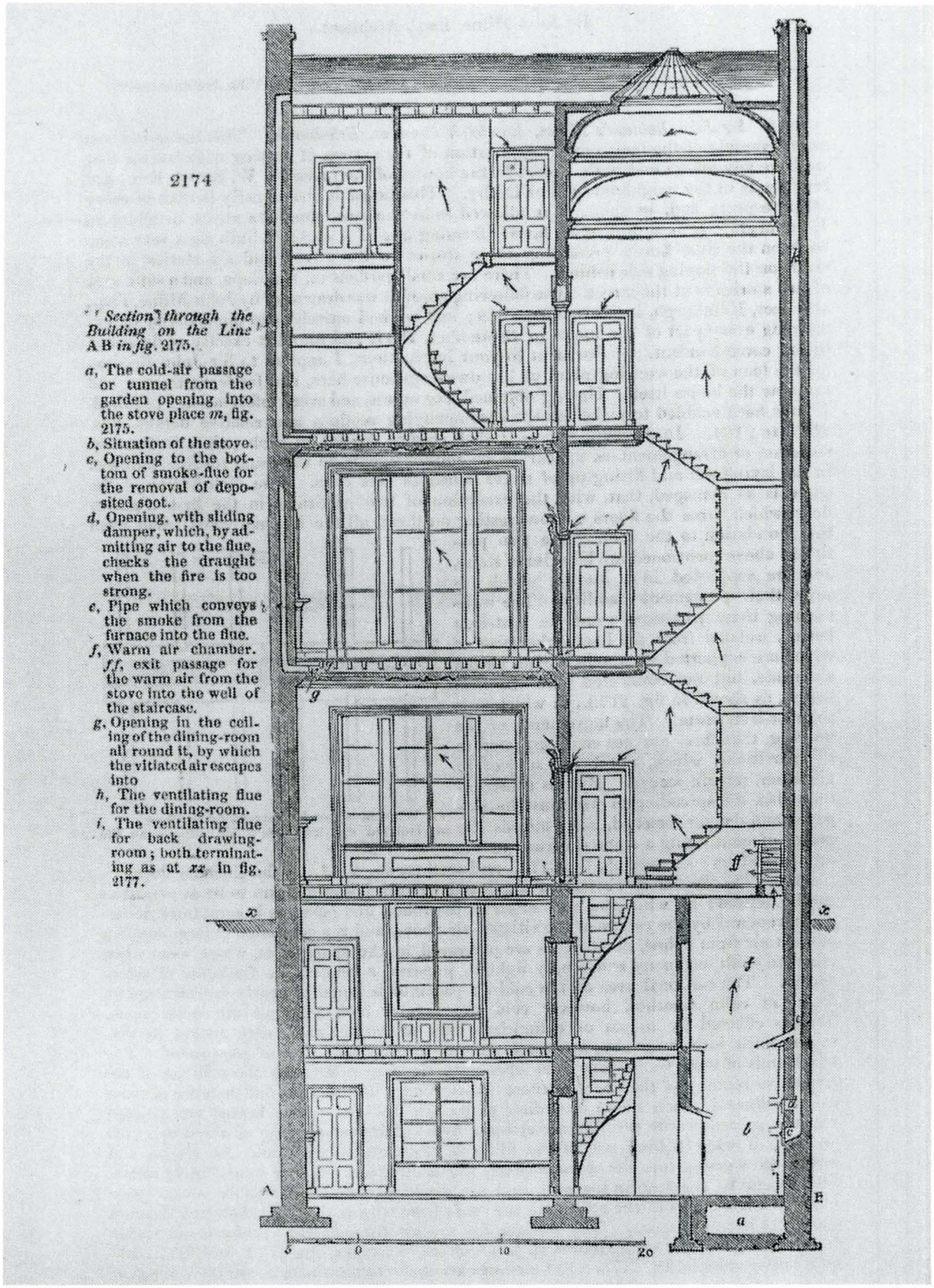
Towards the end of the nineteenth century, designers started to take liberties with the glazing pattern, to divert the eye. Sashes of different sizes and numbers of panes were popular, and patterned stained glass was also increasingly fitted into top sashes as it gained a following in the Arts and Crafts and Art Nouveau periods (illus 35).

The sash and case window ended the nineteenth century on a conservative note, with architects such as Rowand Anderson preferring small-paned sash and casement windows. The increasingly dominant Arts and Crafts style was also characterised by use of the sash window.

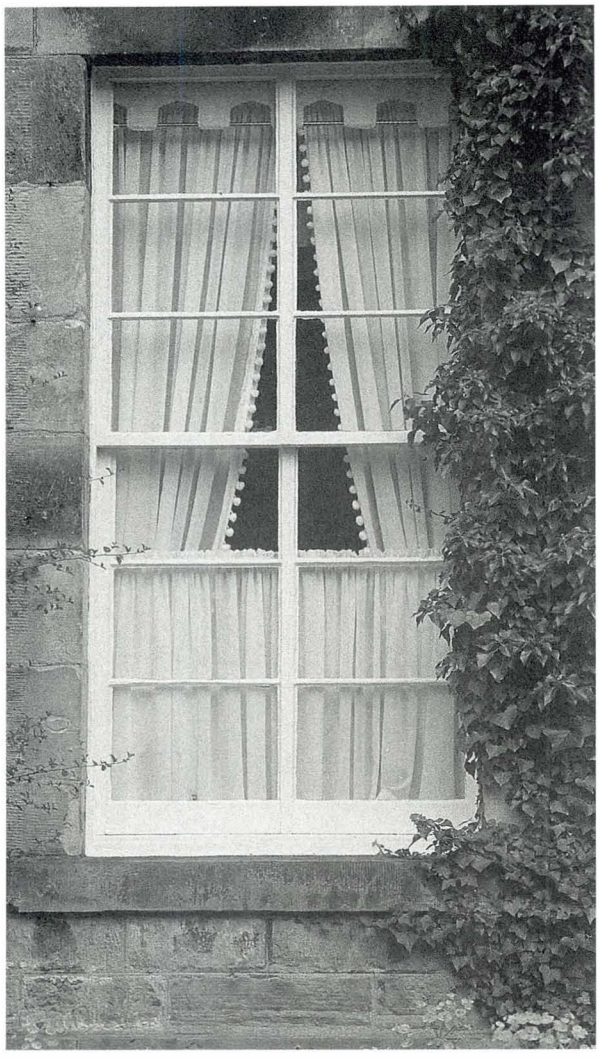


34 Fenestration using plate glass. Grosvenor Terrace, Glasgow.

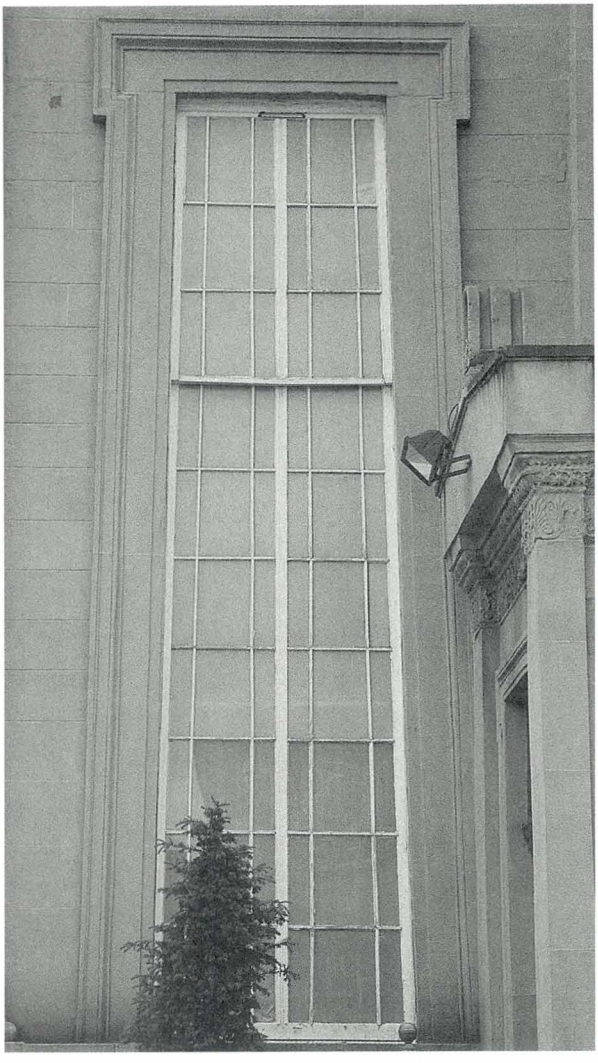
35 Mixed pane sizes in a building of 1899, Aberdeen.



36 Houses designed with both casements and sashes disguise the mix by giving every window a thicker vertical bar. No. 13, Randolph Crescent, Edinburgh was fenestrated in the early 1820s with French windows to the principal apartments, and sashes elsewhere conforming to the same centrally-divided pattern. (Engraving from J.C.Loudon's 'Cottage, Farm and Villa Architecture', 1853.)



37 The 'french window style' illustrated at 36 was further developed by the introduction of lying or long panes with a thick 'meeting stile' bar.



38 The former St. Jude's in Glasgow (John Stephen, 1838-9) has monumental sashes with margin panes in trabeated openings.

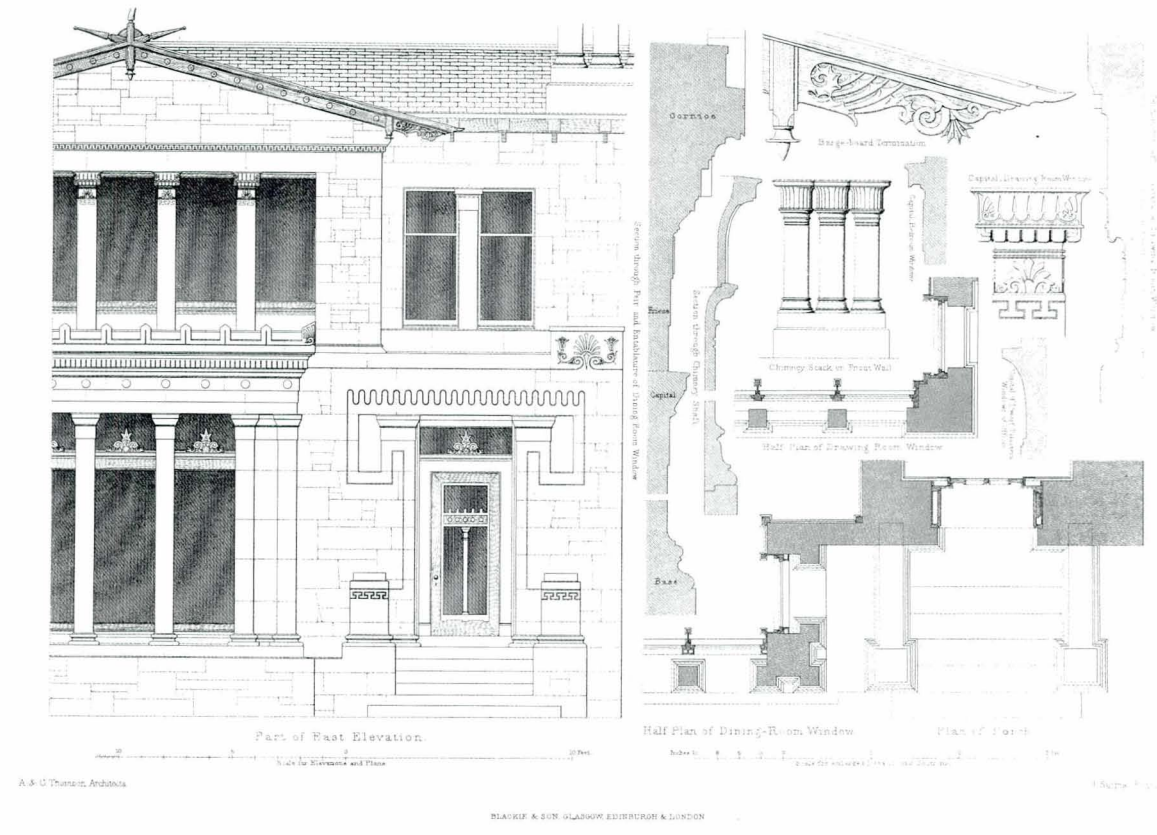
2.3.2 Nineteenth century sash and case styles

An early nineteenth-century Scottish fashion was for the adaptation of the sash glazing pattern to imitate that of the French window. In order to lessen the visual disparity between French casements and sash windows the vertical meeting stiles of the French window were imitated in a single piece of timber, complete with thicker profile and flush bullnose mouldings. This resulted in a sash of two larger (and usually squarer) panes of glass wide, characterised by this thick central line (illus 36).

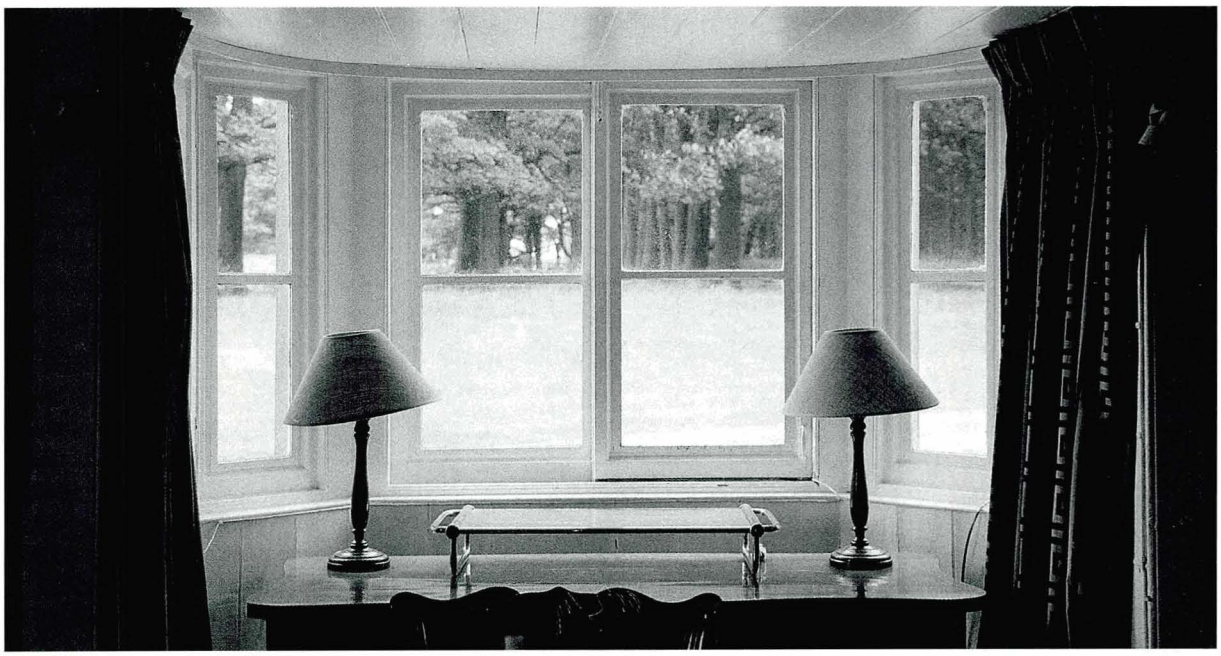
The development of margin sashes in the second decade of the nineteenth century may have related to restrictions in available glass sizes; crown glass made of insufficient size for single panes to be cut from it. While margin sashes with large horizontally-set panes are found in some English Regency buildings, the lying-pane sash with an accentuated vertical 'meeting stile' is a Scottish innovation (illus 37).

In the eighteenth century when the sashes were unequal in size the top sash was normally taller, but from the early nineteenth century pattern this was reversed (illus 38). When plate glass became more affordable in the middle of the nineteenth century it was sensible to have a lighter top sash, to lessen stress on the joints of the meeting rail. The plate glass window often has one vertical or horizontal glazing bar, which gave the impression of light and air while lessening the overall expense of the window.

Lodges and buildings of small dimensions unsuited to ordinary sash windows were sometimes fitted with horizontal sliding sashes in the middle decades of the nineteenth century (in England termed Yorkshire sashes) (illus 40). The horizontal sash window was a

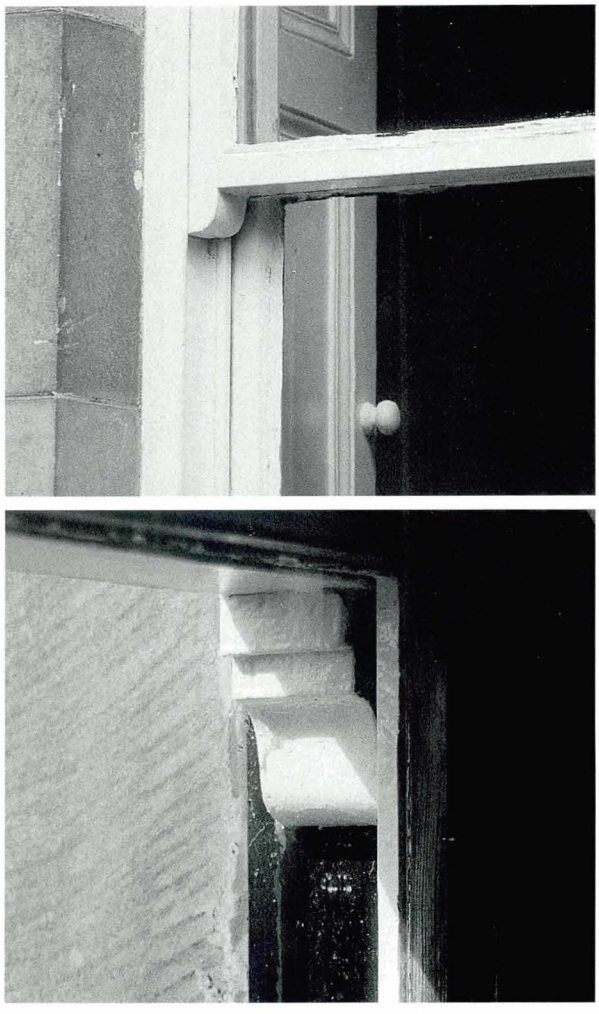


39 Double Villa, Glasgow. Alexander 'Greek' Thomson was one of the first architects to use plate glass on a wide scale, and he had windows made to his own designs. In this example the sash slides downwards into a cavity in the cill to allow good ventilation at the meeting rail and upwards into a cavity in the masonry or inner linings above the window head. ('Villa and Cottage Architecture', 1868.)



40 Horizontal sash window.

41 Very slender segmental metal glazing bar, tongued into vertical oak bar of normal early C19 proportions, at Abbotsford, Borders.



42 Moulded sash horns of the late C19.

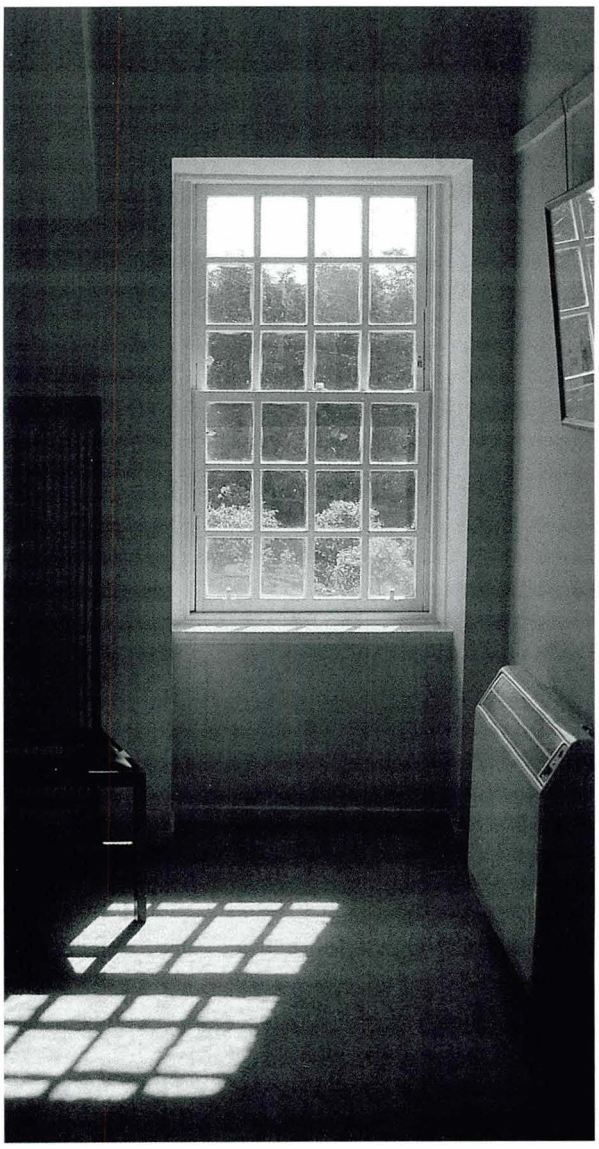
convenient form for a window that was wider than tall and of modest overall dimensions. Strictly speaking the horizontal sliding window is not sash and case, as the frame is solid and the operable sash is pushed manually, not counterbalanced.

2.3.3 Construction and material details in the nineteenth-century

The industrial revolution changed the nature of making windows in the nineteenth century, by slowly transforming the range of available materials and also the workshop environment in which windows were made. Until the middle of the century, windows were made in joiners' shops and were then glazed in a separate contract by glaziers. Printed exemplars on timberwork and the minor building trades (such as glazing) came into circulation in the early nineteenth century (the best known are those of the Scottish architect Peter Nicholson). These enabled joiners to enhance their competence and offer a complete manufacturing and installation service.

The nature of window making altered around the middle of the century as cutting, carving and moulding machinery (like Joseph Paxton's steam powered sash-bar machine of the 1840s, or the tools made by firms like John McDowell & Son of Johnstone, established 1838) came into use. Large firms began to specialise in producing door and window joinery and gained access, through nation-wide advertising, to the house-building mass market. Timber was bought in bulk at lower cost, and larger orders carried out more economically. The construction of windows changed to accommodate mechanically-cut components and the new types of glass becoming available.

Small stylistic differences and regional variations began to die out as mechanisation took over and



43 Hill House, Dunbartonshire. The work of Charles Rennie Mackintosh, innovative in many respects, displays a fondness for the small-paned sash window, which was positioned alongside typical Arts and Crafts lead-glazed iron casements. Mackintosh deliberately used small panes set into heavy, unmoulded glazing bars, glazed with wavy sheet glass.

windows were produced in quantity. With few exceptions glazing bar mouldings did not change substantially. The ovolo or ogee panel of the Regency shutter gave way to mechanically-run bolection mouldings. By the end of the century the choice was unlimited, as machines could be calibrated to produce any profile required. While it was still usual to make cills in oak, the materials for both sashes and cases consisted of North American pine or fir, or imported oak, mahogany or teak (illus 41).

Two related types of window-glass challenged crown glass, the staple glass of Scottish building projects: improved cylinder sheet and its more refined relation, patent plate glass. Both types were made from blown cylinders, of a much clearer quality and larger size than previously imported (in earlier years manufactured in England as broad glass). The introduction of cylinder sheet glass resulted in the possibility of producing single-pane sashes for all categories of building (illus 39). A price war followed upon the repeal of the glass tax in 1845, dramatically reducing prices over the next decade. By the end of the nineteenth century window-glass was almost unlimited in size, although the widest use of large panes was generally confined to shopfronts.

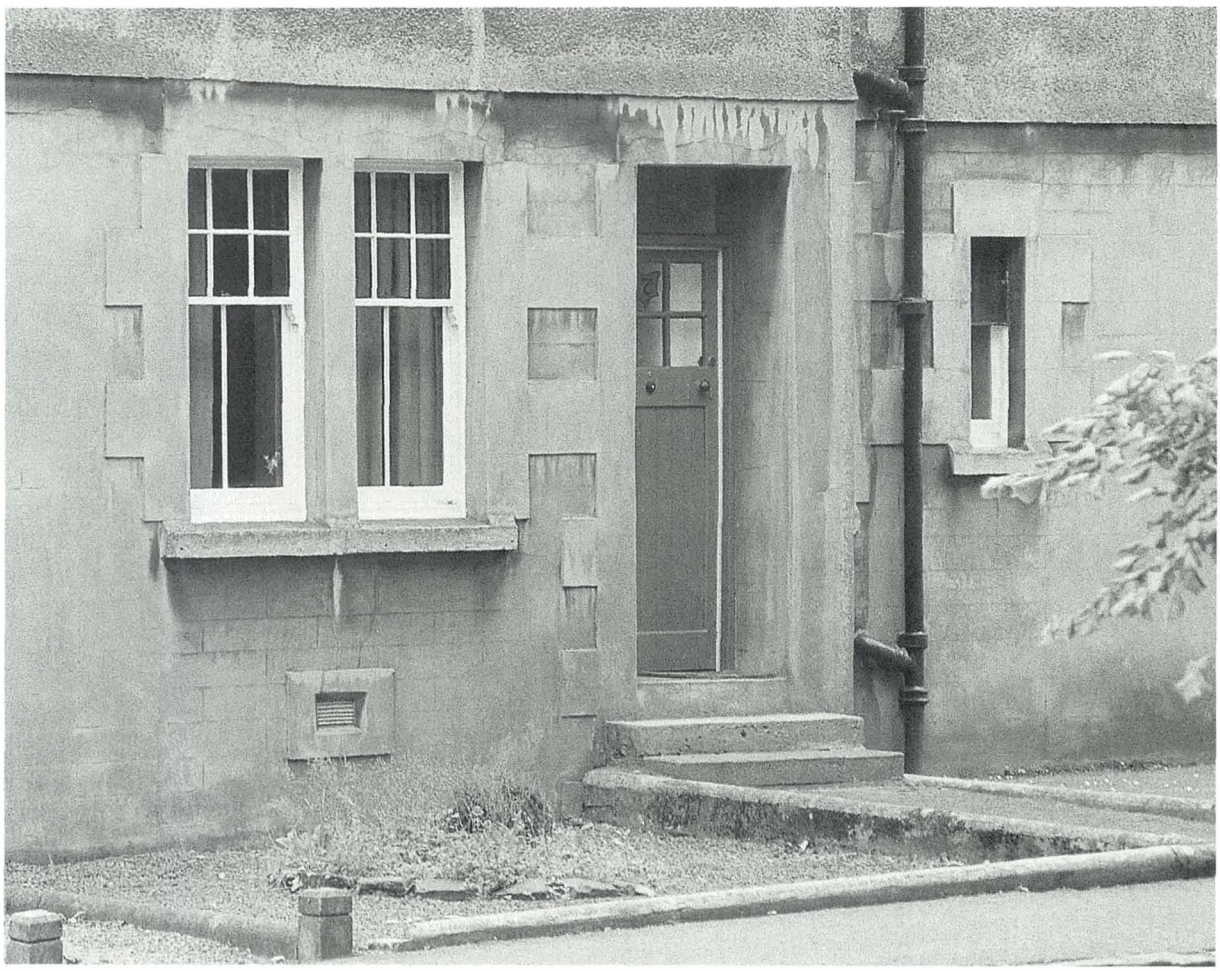
On the introduction of plate glass sashes, the heaviness of the glazed sash-frame, un-supported by glazing bars, may have led to failures. In England and Ireland at this time (or earlier) 'horns' were used to strengthen the crucial corner joints of the top sash. However, in Scotland horns were rarely used until the 1870s and even thereafter they are seldom found (illus 42).

The sash stiles and rails for plate glass were almost always more substantial, to cope with the greater weight and lack of reinforcement. Where a glazing bar was employed it was often wider than earlier in the century to provide sufficient support for the sash-frame, although the mouldings did not change substantially. Stock mouldings were produced, of which the 'astragal and hollow' and 'ovolo and fillet' retained their popularity.

Many windows were hung using chains instead of sash cord, even in sashes of modest dimensions, as the extra weight of plate glass caused many cord breakages. Mechanical ingenuity was employed to streamline the operation of sash and case windows: secondary pulleys were fitted onto the meeting rail ledges or window heads for running subsidiary cords, and multitudes of patents were taken out for catches, locks, stops, sliding mechanisms and other paraphernalia (illus 7).

Around the end of the century - probably in response to by-laws governing safety - it became mandatory in new sash windows in Scotland to provide a method of removing the lower sash, and the 'simplex' hinge was born. Many earlier sashes were fitted retrospectively with these hinges.

Internal and external blinds of various types proved popular. Shutters, while still popular, were seldom fitted on small houses. Window-dressing was a fine art in the nineteenth century, integral to the decoration of the room as a whole. Hung curtains could be sumptuous, covering the widely-splayed reveal found in many houses, and surmounted by elaborate cornices, often gilded.



44 Early C20 council flat with original fenestration.

2.4 The twentieth century

2.4.1 The eclipse of the sash and case window

The Arts and Crafts movement, which bridged the turn of the nineteenth and twentieth centuries, rebelled against the age of machine production. One of the most visible demonstrations of this was the use of old-fashioned types of windows (illus 43 and 45).

Domestic houses tended to mix the two main window types, sash and case and casement. Watered-down Arts and Crafts garden village schemes such as at Rosyth, Fife (essentially an English import, started 1914) were fenestrated with small-paned sash windows, as were many inter-war housing projects both public and private of no particular stylistic allegiance (illus 44). Until the 1930s it was common to fit patterned leaded glass into sashes or fixed lights.

Perceptions of what constituted fashionable architecture were changing dramatically by the 1920s. Modernism held sway and experimentation was encouraged. Even so, it took the radical upheaval of the Second World War to eliminate sashes from the architectural vocabulary of new buildings in Scotland.

2.4.2 Construction and material details in the twentieth century

At the start of the twentieth century, the sash and case window was considered capable of use in almost any style of architecture. They were produced by the thousand in all types of timber, for the vast new housing estates. Parts and accessories were available from catalogues, again of standard types. The spiral spring balance, an innovation from America of the inter-war period, was not popular in Scotland.

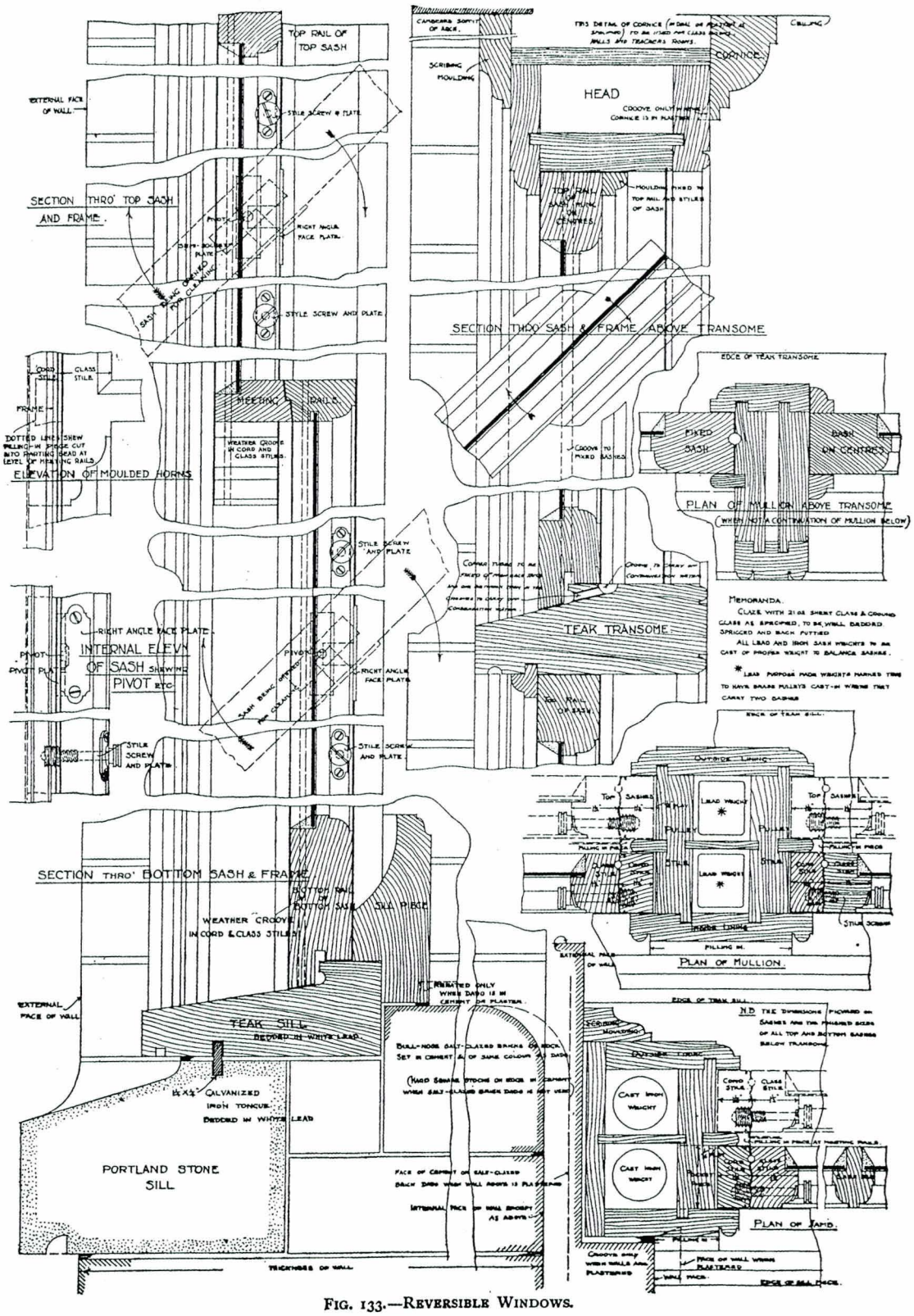


FIG. 133.—REVERSIBLE WINDOWS.

127

45 At Hill House, Mackintosh used an innovative method for opening sashes similar to a type designed by the National Accident Prevention Window Company. Both sashes may pivot about the horizontal axis for ventilation as well as hang on cord, a feature made possible by the stile being of two sections, the external one counterbalanced, the inner glazed frame fixed to it. When the inner pivoting sash is fixed closed the whole slides as normal. (Middleton's 'Modern Buildings'. 1911)

3 PLANNING PERMISSION AND LISTED BUILDING CONSENT REQUIREMENTS

3.1 Statutory Protection

The Scottish Ministers have responsibility for compiling or approving lists of buildings of special architectural or historic interest. Such buildings are afforded statutory protection.

3.2 Definitions

'Listed building'

The term 'building' is defined as including any structure or erection, and any part of a building. Thus any window in a listed building is protected against any alteration that would affect its character.

'Curtilage'

This protection is extended to cover buildings that are not necessarily described within the listing description, but can be deemed to be included with it by association. Any object or structure that is fixed to a listed building, or falls within the curtilage of such a building shall be treated as part of the building.

'Extent of listing.'

Listing covers the interior as well as the exterior of the building: the fact that the list contains no detailed interior description does not alter this rule.

'Conservation Area'

Although additional powers conferred by designation as a Conservation Area extend only to demolition of unlisted buildings, many planning authorities have sought to extend planning controls in conservation areas through an Article 4 Direction. Where so amended, additional controls will be in place covering otherwise permitted development, such as the insertion of replacement windows.

3.3 The need for listed building consent

Listed building consent is required for the demolition of a listed building, or its alteration or extension in any manner which would affect its character as a building of special architectural or historic interest.

Detailed proposals

When proposals to alter windows are submitted, the drawings and specifications must be at a scale and provided in a manner which makes the form and detailing of the new fenestration absolutely clear.

3.4 The presumption for repair

In considering any proposal to carry out work on windows, repair is always preferable to replacement. The nature of the traditional sash and case window is such that it is almost always capable of repair. It is recognised that the nature and extent of repairs will vary, and that economic repair will not always be possible in extreme cases. All repairs must be carried out with matching materials, and to the original details. All repairs must be sympathetic to the character and quality of the surviving original window.

3.5 Memorandum of Guidance on Listed Buildings and Conservation Areas

Historic Scotland publishes the *Memorandum of Guidance on Listed Buildings and Conservation Areas*, which sets out Government policy and advice. The Memorandum is the document to which all planning authorities are directed, by Scottish Office Development Department Circular No.13/1998, in their consideration of conservation and listed building consent matters. It is a document that deserves careful consideration by all those concerned with the well being of the historic built environment.

The *Memorandum* contains several specific references to proposals that should not receive listed building consent. There is also advice relating directly to specific aspects of window alteration and repair. This is summarised in Appendix A.

46 Overhauling a window.

4 REPAIR AND MAINTENANCE OF TIMBER SASH AND CASE WINDOWS

4.1 Establishing the value of existing windows

The aim of action to conserve a building is to maintain its cultural significance. All material within the fabric, fixtures and fittings of sash windows of any period may contribute to this significance and is of potential value. Therefore the aim should be to minimise any physical intervention. Any work carried out should avoid distortion of the evidence provided by the existing fabric. Further information on conservation philosophy is available in TAN 8, *'The Historic Scotland Guide to International Conservation Charters'*, 1997, and in the Historic Scotland *Stirling Charter*, 2000.

As stated in BS 7913, *'Guide to the Principles of the conservation of historic buildings'*, those conservation values that are associated with cultural (including historic or aesthetic) significance need to be balanced against economic and environmental factors before making any decisions on repair or alteration work to windows.

Such factors will include the following:

- The frequency and scope of any work to maintain it in operating condition.
- The period over which, by wear and tear, and despite maintenance, it is rendered no longer capable of its function.
- The efficiency of the window in its contribution to the overall environmental energy balance.
- The overall environmental (life cycle) impact of all repair and replacement options that are being considered.

4.2 General principles for repair or replacement

Those involved in specifying or carrying out work on sash and case windows should adhere to the conservation principle of minimal intervention. Thus only work that is necessary should be undertaken. Reversibility is also a key principle. The repairs undertaken today are not likely to be the last in the long useful life of the window and it is important therefore that the construction system is not significantly altered by current work so as to render the window less straightforward to maintain in the future.

As stated in BS 7913, the principles should be as follows:

(a) Much work is of a specialist nature and requires skills attained by special training and experience.

(b) Before any work is specified or carried out a thorough assessment of value must be made.

(c) As far as practicable, existing material should be retained.

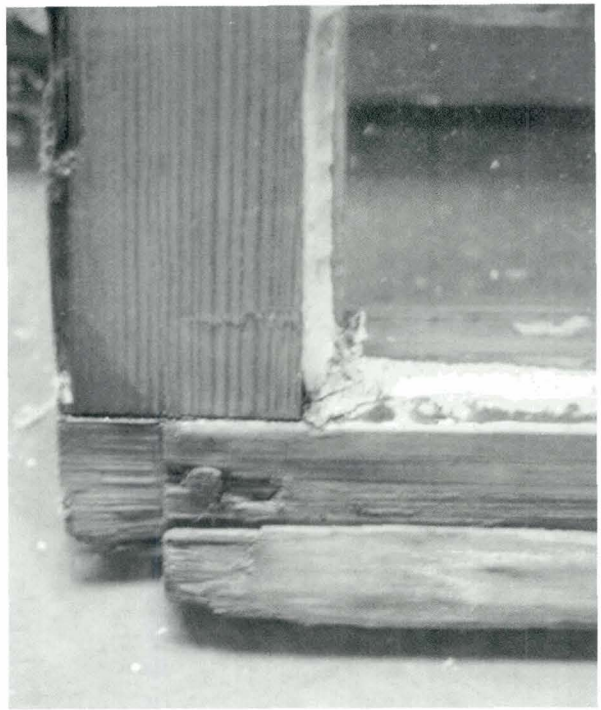
(d) Material that must be removed should be recorded.

(e) Any new work must be distinguishable from the original.

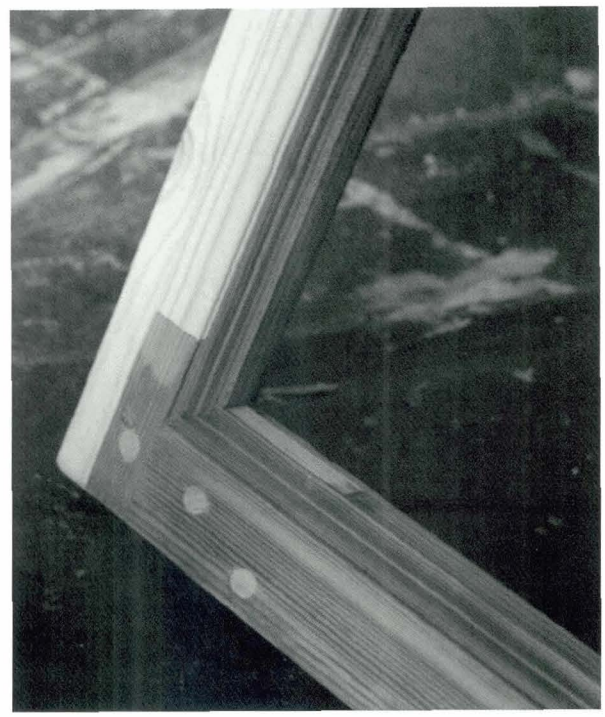
Thus, and as set out in 3.4, the first aim will be to repair the window in a way that allows it to continue in use, with improvements in performance achieved through appropriate adjustment or minor modification. If this approach is unable to satisfy the established performance criteria (see 5.1) then it may be possible to compromise on one or more of the criteria to ensure the retention of the window. The replacement of part, or all, of the window to allow it to fulfil an imposed function must only be a last resort, and will frequently be unacceptable in conservation terms.

Building owners and conservation practitioners will be familiar with the range of alternative non-traditional window materials currently available. It should be noted that recent research has highlighted the desirability of retaining timber windows over, for example, replacement with uPVC. There is clear evidence of the benefits of timber windows in terms of avoiding depletion of non-renewable resources, achieving lower life-cycle primary energy consumption and minimising toxic waste production (in particular of elements such as phthalates and heavy meals that are associated with plastic windows) *(Entec, nd).*

One example of the pressures for replacement of traditionally made sash windows is revealed by a recent survey, which shows that of all windows being replaced, only 5% were actually affected by decay. *(English Heritage, Framing Options leaflet 4).* However in another survey, 46% of owners who were interviewed stated that they replaced their windows due to 'rotten timber' and 20% blamed 'draughts'. *(Gallup Poll, 1991)*



47 The careful repair of decayed timber (before)



48 New timber is glued into place; tenons are re-made and made secure with timber dowels (after)

There is often an ill-founded perception that old sash and case windows are inevitably of poor quality and need to be replaced, whilst the reality is that with suitable repair (and appropriate upgrading if necessary) they can continue to operate successfully.

4.3 Repair and maintenance of timber components

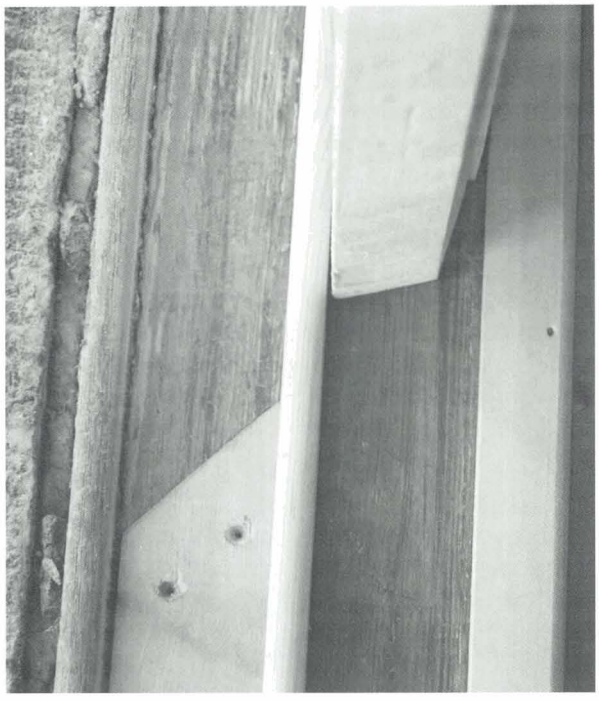
A traditional sash and case window is capable of almost infinite repair; it has no inherent defects that prevent its recurrent maintenance. Before repairing timber components, it is important to first identify and deal with any treatable general building defects, such as faulty rhones or defective masonry and pointing, which may be the underlying cause of the damage to the timber.

Maintenance, as distinct from repair, will frequently involve the stripping of excess paint from timbers so that they may slide freely, adjustment of the loose components such as parting beads or baton rods, and the overall easing and balancing that will make the sashes open and close smoothly and effectively.

Joinery components of the earliest historic windows were normally made from slow grown native hardwood or, if pine or deal, from good quality heartwood, which is more resistant to decay. The quality of timbers used in the manufacture of windows has declined from those found even 50 years ago. The replacement of all, or part, of the high quality original material with the commonly available softwoods of today must be carefully considered. It may be less economic in the long term to renew windows with relatively minor timber defects, despite the apparent present-day cost/benefit equation (see Section 6.5, illus 81 and 82). Decay in older windows is likely to be quite localised, and a skilled and experienced joiner should be able to cut out the affected parts and insert new timber of suitable quality (illus 47 and 48).

Other defects that may require repair include the excessive wearing of sash stiles in contact with the pulley stile of the outer frame, causing the windows to jam when sliding. In this case further material should be removed and new full-length sections planted on.

In most instances it will be necessary to remove the sashes to a workbench, and glass may also need to be carefully removed and later refitted (see 4.4). The repair of frame timbers is best done in-situ to avoid disturbing their relatively weak joints; replacement of complete cills will mean having to remake joints using a routing tool (see 6.1.3). Smaller separate components such as parting beads or baton rods can be easily prised out and re-fixed or, if necessary, renewed. Care should be taken to ensure any new material exactly matches that which is being replaced.



49 Renewing defective parting beads and baton rods.

4.4 Repair and maintenance of glass and glazing

Glass is a brittle material, and is liable to crack or break; both through physical impact and, often, due to movements of the timber frame in which it is contained. In addition, damage to glass is commonly due to external forces being brought to bear on the window from changes in its enclosing structure or environment. Some glass is also extremely thin, adding to its historic value and quality, but increasing its vulnerability. Early glass is an irreplaceable resource as many types of early glass are no longer manufactured (see Chapter 2). Any repairs should respect the need to carefully protect against any damage or loss. If renewal of windows which are otherwise beyond repair is being considered, then every effort should be made to salvage the historic glass for re-use, either in-situ or elsewhere. Arguments to the effect that glass is impossible to save or 'not worth' saving should be refuted, and suitably skilled alternative tradesmen should be located.

Plate glass is of value in itself, although it is not readily distinguishable from later float glass. Sashes now containing plate glass but that were formerly divided with glazing bars should not be restored to their original form without considering the implications of the loss of plate glass and its replacement with modern flat glass. This is especially the case where the historical replacement of small-paned sashes with plate glass formed part of a wider scheme of alterations that can be recognised.

Small corner cracks in panes are best left in-situ; there is no potential for further damage to occur and the reduction in thermal efficiency or draught control is minimal. Larger cracks in very valuable glass can be repaired by a specialist glazier using modern transparent resins, or sealed with flexible sealants. In this case, the glass will have to be removed, to allow the broken edges to be abutted using the new material.

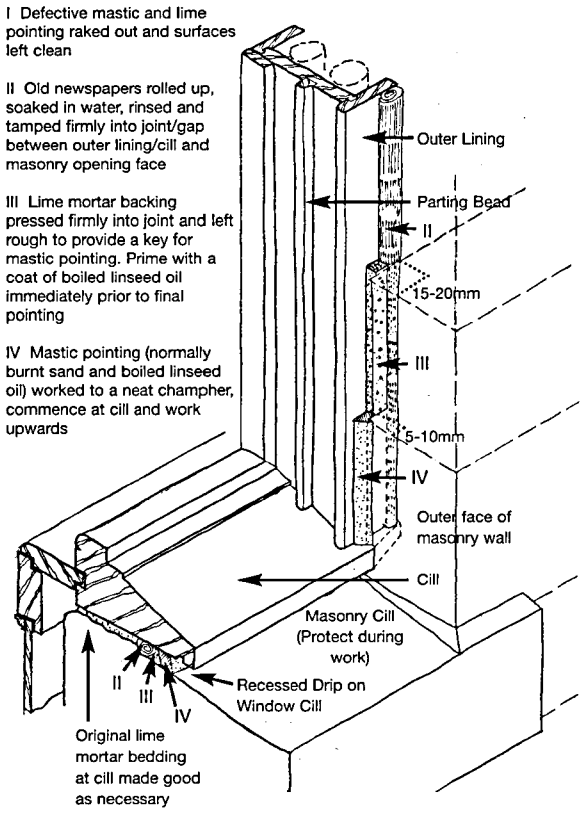
Where more serious damage has occurred to glass, there may be no alternative but to replace it. Any replacement glass should be selected to provide a close match with the original in pane size, thickness, colour and surface characteristics. It may be possible to use salvaged glass, either from the same building, or a matching type from elsewhere. Crown glass is no longer manufactured, but cylinder glass and modern replica crown glass can be obtained from specialist suppliers, if no sources of salvaged glass are available.

Often poor previous repairs may need to be corrected, such as where over-glazing has been carried out on top of the remaining edges of former panes, which remain embedded in the glazing putty. This will restore the correct planar relationship between the glass and the frame, and remove the need for an unsightly build up of putty.

If significant work is required to repair timber components of a window containing undamaged glass, then consideration should be given to its protection (using carefully cut templates of card or thin ply), or temporary removal during the work. Great care should be taken when loosening glazing putty, and all sprig, nail or other fixings should be removed before attempting to take panes of glass from their frame (see 6.1). If sashes have to be dismantled for re-making of joints or to insert large new timber sections then the glass will have to be removed, clearly labelled and laid aside.

With the exception of cleaning, the maintenance of surviving glass in sashes will be limited to the need for missing glazing putty to be replaced as necessary. Loose or decayed fore-putty should be carefully cut back with a sharp knife. Stubborn sections may need to be first softened using a paste paint stripper. Bedding putty will almost never need to be renewed, but if this is necessary the glass will first have to be taken out, allowing a full length to be renewed at a time. Any replacement material should match the original, which will normally be a putty formed from linseed oil and whiting. New putty needs to be left unpainted until it has thoroughly hardened, (approximately 28 days), but should receive a protective coating immediately thereafter.

Traditional linseed oil putty has not changed in character or composition, and defective original



50 Diagram showing the replacement of defective mastic pointing.

material can be replaced with new putty. There may be exceptions in the case of very old windows where the putty is original.

4.5 Repair and maintenance of pointing materials

In traditional construction the sash and case window frame is set against the projecting outer leaf or lip of the (normally masonry) wall construction (see also 6.1.8). The frame is wedged and there should be a gap of no more than 12mm between it and the masonry at the head and both jambs. This gap is frequently found to be wider, and may have been packed with rolled up newspaper before receiving a coat of lime mortar, which is primed with a coat of linseed oil and then finished with a fillet of mastic, making a watertight seal. The cill often sits at a level above, and projects clear of the cill of the wall, and is bedded onto a layer of mortar which is scraped back behind the outer face of the cill to form a drip for water to run off more effectively.

The mastic pointing is traditionally made from a combination of burnt fine sand and boiled linseed oil. Bedding for cills is normally a strong lime mortar or sometimes un-gauged lime putty, and is commonly finished with mastic, set back from the face of the cill to provide a weather drip. Provided they are correctly applied, and so long as the gap being filled is no greater than that stated above, then these materials should always be used in repair work (illus 50). Modern replacement materials such as polysulphide mastic are unsuitable for pointing around windows due to their inability to maintain vapour permeability, and their visual impact.

Old newspapers, or other packing material, have their own historic value, linked to that of the building, and they should not be removed and replaced unless they cannot provide adequate closure of the gap. Lime mortar fillers can easily be repaired. Traditional burnt sand and boiled linseed oil mastic would only need to be conserved if it is of particular historic interest.

4.6 Paint and other finishes

It is recognised that paint treatments will require occasional renewal to ensure the timbers are adequately protected. The aim should be to avoid building up excessive layers of paint that might affect the operation of the window. There is a wide range of products available; including traditional lead-based paints for use only on Category A listed buildings, frequently used oil- or acrylic-based paints, and more recently, micro-porous paints. The use of translucent stains and varnishes for replacement window joinery is only appropriate where there is evidence to show that this was the original method of finishing.

4.7 Internal shutters and ingo linings

Fixed boarded panels or ingo linings will seldom be defective, although in damp conditions, where they are at or below external ground levels, or where adjacent external masonry is subject to wetting, the woodwork may be found to be decayed; often on the concealed face.

Hinged shutters can become damaged in use, causing hinges to break or twist, and causing woodwork to be split or worn where the shutters cannot be easily opened or closed (illus 51). Woodwork that becomes damp will swell, and may close the fine tolerances between moving parts. Telephone or television aerial cables at window cills should be routed to avoid rendering shutters unusable.

Shutters may fall into disuse, from lack of demand or due to the defects noted above. Layers of paint can then build up, preventing them from being opened.

51 Shutter repair, replacing damaged timber at hinge fixing positions.

Plastered surfaces on the enclosed spaces behind shutters may deteriorate due to increased moisture levels associated with a lack of ventilation.

The repair of working shutters will involve removing them from their position, taking off and repairing or replacing defective ironmongery, piecing-in replacement sections where damaged or decayed, and adjusting tolerances to allow them to operate smoothly. Existing stays and security bars, shutter knobs and any other fittings should always be retained and re-used.

4.8 Hanging and re-cording sashes

Cotton cords and braids have a limited life, and they will require renewal many times in the life of a sash and case window (illus 85). Accidental over-painting of sash cords can prevent smooth operation of the window. In the largest windows, and where heavy plate glass has been used, sashes may have been suspended on chains. Where glazing bars have been removed and sheets of heavier plate glass substituted, additional lead collars will have been fitted above the original weights to counter-balance the sashes.

Sashes should be weighed, and counter-balance weights adjusted accordingly, whenever repairs or alterations are made to sashes or glazing (see 7.3). Replacement cast iron weights are readily available, and lead weights can be specially cast to fit into restricted weight boxes if required.

Generally windows should be repaired using the method of hanging sashes that was originally used. Some windows were never roped for hanging, relying instead on being lifted manually or wedged open. These windows can be hazardous in operation but may not be capable of conversion to being counter-balanced, as they have no space for weights. The use of modern spring balances is discouraged, as they are damaging to the original fabric and can be unreliable in use.

4.9 Repair and replacement of ironmongery

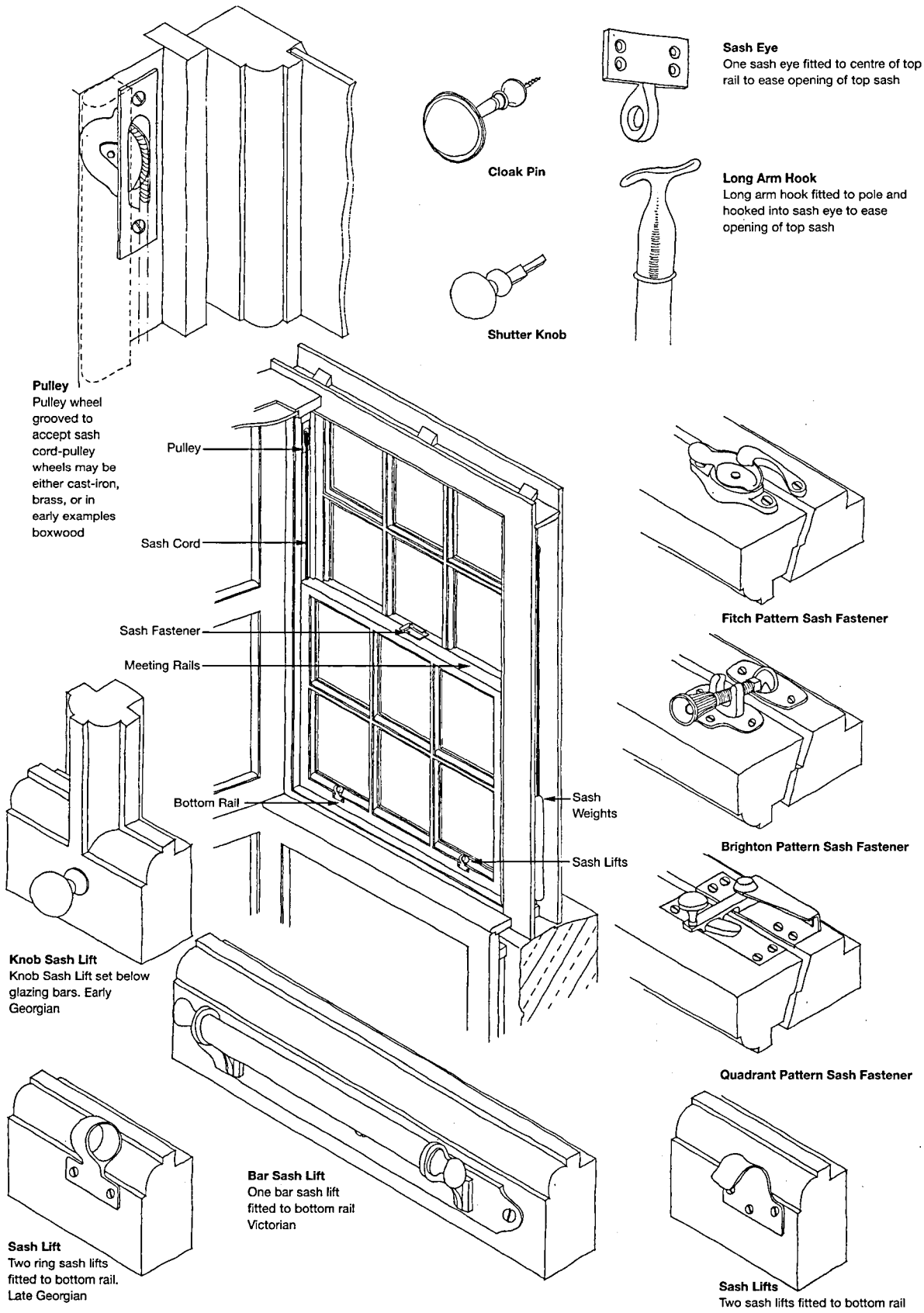
Early or original sash and case windows often have unique examples of hand-made ironmongery (illus 52). All ironmongery should be retained for re-use wherever possible. Replacement of fittings to achieve uniformity within a property is not encouraged, as this may result in loss of original character, as well as the potential destruction of historic components. It should be possible to repair and overhaul almost all fittings to achieve their continuing use.

4.10 Salvage and re-use of components

The salvage of valuable glass has been described above. The re-use of sashes or whole windows in other openings or buildings for which they were not originally intended is preferable to their disposal or being placed in storage, provided they are technically and visually suitable.

If windows cannot be re-used in their assembled state, then any defective sashes may be a source of high quality material for use in repairs to other window components.

Ironmongery from irreparable windows can be carefully removed and kept as spares against future damage, or ideally be re-used within the replacement window or sash. It should not be assumed that window weights can be directly applied to the replacement window, due to changes in the density of timber or changes in glass, but they can be modified by adding pieces of lead, or set aside for use elsewhere.



52 Ironmongery for sash and case windows.

5 UPGRADING THE PERFORMANCE OF TIMBER SASH AND CASE WINDOWS

5.1 Upgrading performance

The performance of windows is usually evaluated under one or more of the following criteria:

- weather resistance (air leakage, water penetration and strength)
- thermal performance
- sound insulation
- safety, security and convenience
- cost (lifetime cost-in-use)

Each of these criteria carries with it a genuine concern on behalf of the building, owner, occupier, manager and building professional, as well as to the casual visitor. It can be demonstrated that, with appropriate knowledge and skills, surviving windows or matching replacements can be made to meet accepted standards without compromising their significance.

5.2 Complying with Building Standards

There may be a requirement to comply with current Building Standards Regulations or other legislation. Owners and their advisors should be aware that in many cases existing arrangements are in place to negotiate relaxations of the standards where a listed building would have difficulty in meeting the standard without losing its character or damaging its historic fabric. Detailed advice on the specific case, or on procedures, can be obtained from the relevant Local Authority building control department.

5.2.1 The Building Standards (Scotland) Regulations 1990

These regulations set standards for building and demolition work. The detailed standards to be achieved are set out in a separate document, the *'Technical Standards for compliance with the Building Standards (Scotland) Regulations'*. The definition of construct includes 'Alter, Erect, Extend and Fit'. Therefore if a window is being repaired or renewed to match the original, the Regulations do not apply. However if the window is being replaced and changed in some way then the Regulations will usually have to be complied with, and more onerous conditions will apply.

5.2.2 Application of the Building Standards

Regulation 4, Schedule 2 lists items not requiring a warrant. Provided the regulations are complied with, a renewed window need not require a warrant. The schedule allows windows of the same general type (Class 7) to be renewed without the features that might otherwise be needed to meet current regulations. Windows not of the same general type (Class 8) may also be installed without a warrant but must 'in all respects and in the manner of their fitting' meet the current requirements. It would be a matter for legal debate whether the material a renewed window is made of is thereby controlled, but the pattern of opening definitely would be.

"Change of use" in building control can refer to the use of the building or to the use of an element of the building. (For example: if a building is split into separate occupancies, a part of an existing wall might then become a separating wall; such a change would attract the requirements relating to a separating wall, and a warrant for the work will be required). If a building changes use, moving it from one purpose group to another, any more onerous requirements that apply must be met.

5.2.3 Relaxation of the Building Standards

Where an existing building would have difficulty in meeting the Regulations without damaging its character or historic fabric, it will be necessary to apply to the Local Authority for relaxation of the current standards. In an effort to establish common interpretation of the Regulations in such situations, the Scottish Executive meets local authorities in the Building Control Forum, and papers are issued either from the forum or from the Scottish Association of Chief Building Control Officers setting out agreed practice. These are not however binding on any Authority, who are empowered to interpret the building regulations as they consider appropriate.

If a relaxation is refused, then the applicant can appeal to the Scottish Executive. If the disagreement is on a matter of interpretation however, appeal must be made to the Sheriff Court.

5.3 Relevant Building Standards

The following Technical Standards contain information relevant to the design and installation of sash and case windows. In each case a brief summary of the standard is given, prior to giving advice on how to meet the standard or resolve any potential conflict. While the information is correct at the time of going to press, reference should always be made to the current edition of the published Technical Standards.

5.3.1 Emergency escape windows

(Technical Standard E3.2): *A suitably designed and located emergency escape window must be provided in every apartment (in a house) in an upper storey at a height of not more than 4.5 m (subject to certain exceptions).*

Emergency escape windows (required at first floor and above of houses only) must be situated in an external wall or roof; have an unobstructed opening openable area of 0.33m² (minumum 450mm wide x 450mm high) and with the bottom of the openable area not more than 1100mm above the floor.

5.3.2 Conservation of fuel and power

(Technical Standards, Part J): *Reasonable provision shall be made for the conservation of fuel and power in a building to which this regulation applies.*

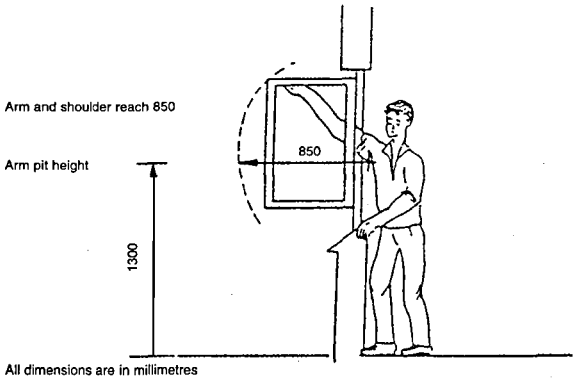
Part J will only apply if a change of use is required. The regulation as written is complex. In general terms, the regulations control the relative proportions of glazing (either single or double glazing) and solid wall to achieve the required overall thermal performance of a building. In many traditional buildings, where the proportion of window area is low relative to the wall area, the difference in potential heat loss from single-glazing through radiation alone, when compared to double-glazing, is unlikely to be significant.

Where a dwelling is created by virtue of a change of use, upgrading the thermal performance of the windows can be avoided by selection of an appropriate energy efficient central heating boiler.

Relaxation of the regulation is unlikely to be received favourably due to the current drive for energy conservation. Draught stripping will always be required, and assuming this is carried out, one could argue that overall, energy is saved by retaining existing fabric (see also 5.9).

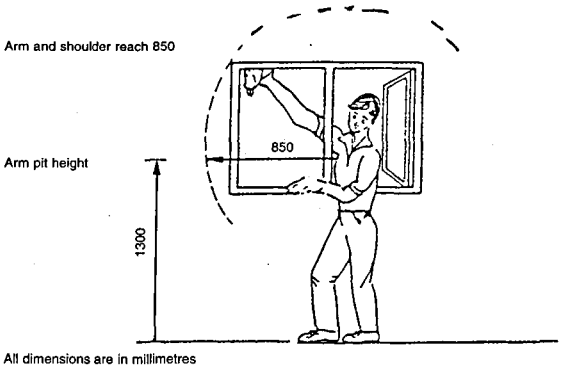
5.3.3 Ventilation

(Technical Standard K2.1): *A building other than a garage must have adequate provision for ventilation by natural means, mechanical means, or a combination of natural and mechanical means (subject to certain exemptions).*



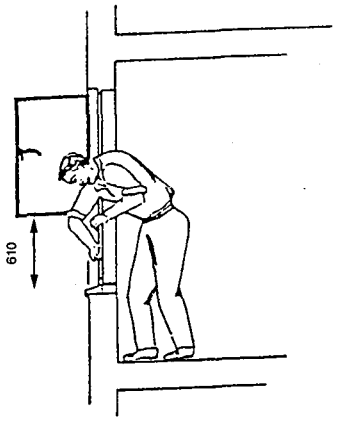
NOTE: Where people are smaller than average it may be necessary for them to use some form of cleaning aid to increase their reach. Cleaning from stepladders is considered unsafe.

Typical safe reach for cleaning an open casement



NOTE: Where people are smaller than average it may be necessary for them to use some form of cleaning aid to increase their reach. Cleaning from stepladders is considered unsafe.

Typical safe reach for cleaning from an adjacent opening light



Safe downwards reach for cleaning fixed lights through an opening light above the ground floor on a sheer wall face

53 Window cleaning access diagram from BS 8213, showing safe cleaning of casement windows. Cleaning sash and case windows should also comply with these safe reach dimensions

(Technical Standard K4.2): *Some part of the opening part of a ventilator, including a trickle ventilator, must be at least 1.75m above floor level.*

Ventilation as stated in these regulations will almost always be required. Methods of achieving adequate ventilation are described in 5.11.

5.3.4 Miscellaneous hazards

(Technical Standard P2.3): *In dwellings, any part of a window more than 4m above the ground must be constructed to allow safe cleaning of internal and external surfaces.*

(Technical Standard P2.4): *In other building types, there is the same requirement, but it is accepted that portable ladders may be used up to 9m above the ground.*

The requirement to have windows that may be safely cleaned can be satisfied by the provision of safety anchorage points. However in single occupancy dwellings this is unlikely to be accepted. Methods of cleaning windows are described in 5.7.1 and illus 53 and 57.

(Technical Standard P2.2): *Glazing in a building where accidental collision with it is likely, must be constructed and installed, or protected, to minimise the danger of collision and injury to people.*

This requirement is covered by BS6262: Part 4: 1994. The regulation will only apply to new buildings or those affected by a change of use. Small panes of existing glass (minimum 6mm thick, less than 250mm wide and with an area less than $0.5m^2$) are not considered to be at risk from accidental collision. Where panes are larger, or if the opening is less than 800mm above the floor, then glass may have to be replaced with toughened or laminated glass, or by float glass of greater thickness. Thin transparent films are available which, applied to a pane of glass, act to retain it in place after accidental breakage. These may be suitable in some cases, although not on historic glass due to the difficulty of subsequent removal. The installation of an internal barrier or rail may be a workable solution, but care is required to avoid possible visual intrusion. The fixings of any handrail should cause the minimum possible damage to the existing fabric.

5.3.5 Facilities for dwellings

(Technical Standard Q3.5): *Every apartment must have an aggregate glazed area equal to at least one-fifteenth of the floor area.*

This may limit those rooms that can be used as living, working or sleeping spaces within a building being considered for conversion to a dwelling.

5.3.6 Stairs

(Technical Standard S4.1 to S4.3): *A protective barrier must be provided at the edge of a floor, or on a flight of stairs, in front of fixed glazing and opening windows which are less than 800mm above floor level.*

In some cases the provision of such a barrier will not be possible without affecting the appearance of a window in a historic building (see 5.3.4 and illus 54).

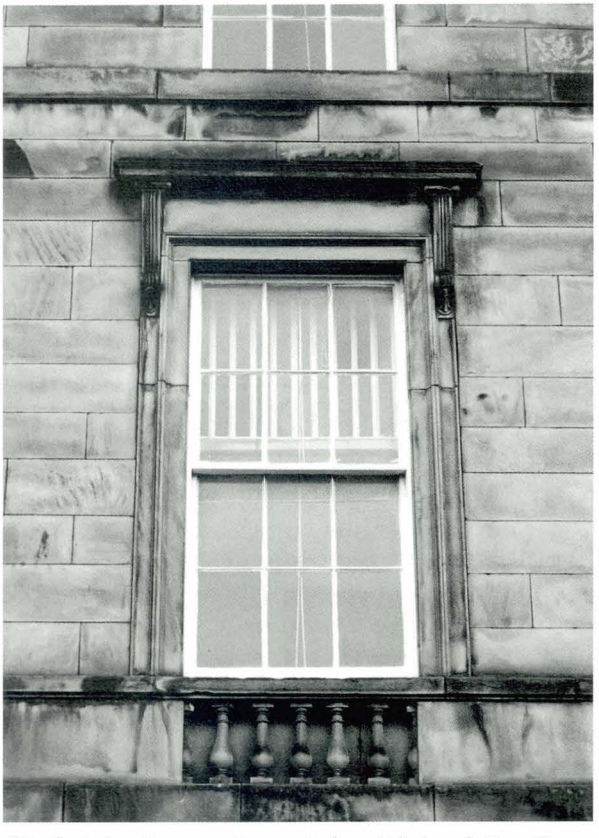
Suitably designed fixed glazing, incorporating laminated glass, for example, can perform the function of a protective barrier.

5.4 Complying with other legislation

Frequently local authority officials will take on the role of arbiter on other aspects of legislation (for example the Construction (Design and Management) Regulations and Health and Safety legislation generally, and for disabled access requirements).

There is often an informal arrangement whereby Local Authority building control officers consult the Fire Officer at Building Warrant stage of a project to avoid any unnecessary problems when Completion and Fire Certificates are being applied for.

The Fire Officer is also consulted formally if a Relaxation affecting escape from fire is being sought.

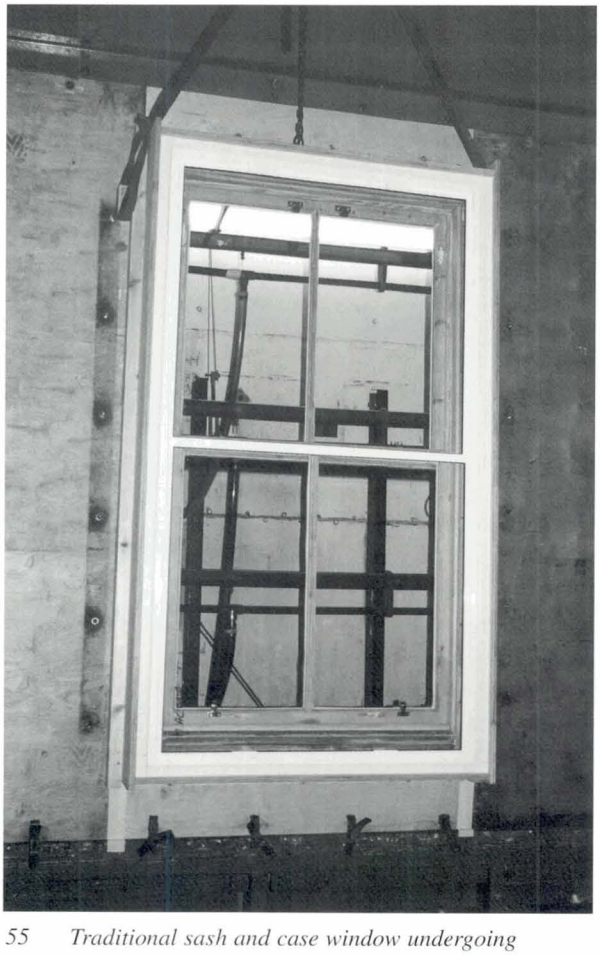


54 Stair landing crossing a window, Edinburgh New Town.

5.5 Performance of traditional windows in relation to recognised standards

The principal UK performance standard for new windows is BS 6375, which specifies performance requirements that are applicable to all types of windows. Part 1 defines exposure categories and specifies associated requirements for weather-tightness (defined as water-tightness, air permeability and wind resistance) to be achieved in British and European assessment tests (BS EN 1027, 1026 and 12211 respectively). The requirements are related to the building type and use, and those specified have to be achieved under the climatic conditions of wind pressure and wind-driven rain to which the window will be exposed.

BRE Digest 377: 1992 provides guidance on the selection of new windows by performance. Five exposure categories are defined, based on wind pressure levels. Design wind pressure can be established from tables in Appendix B to BS 6375, part 1. Factors such as the building height, building plan ratio, ground roughness and wind speed are combined. The highest exposure levels, those found in Scotland only on the north-west coast, in the Hebrides, Orkney and Shetland, involve testing to a design wind pressure of 2000 Pa, although tests can be carried out to higher pressures where unusual exposure conditions apply.



55 Traditional sash and case window undergoing performance tests at Paisley University.

5.5.1 Air permeability

The operation of vertical sliding sashes in a window frame requires that there be adequate dimensional tolerances between the moving parts. In a well-made window these gaps will be minimal, but there will always be some degree of natural air movement through traditional sash and case windows. In historic buildings this continual air movement is to the benefit of the fabric, as well as to the well-being of any occupants. For example, free air circulation within elements of construction helps to prevent timber decay.

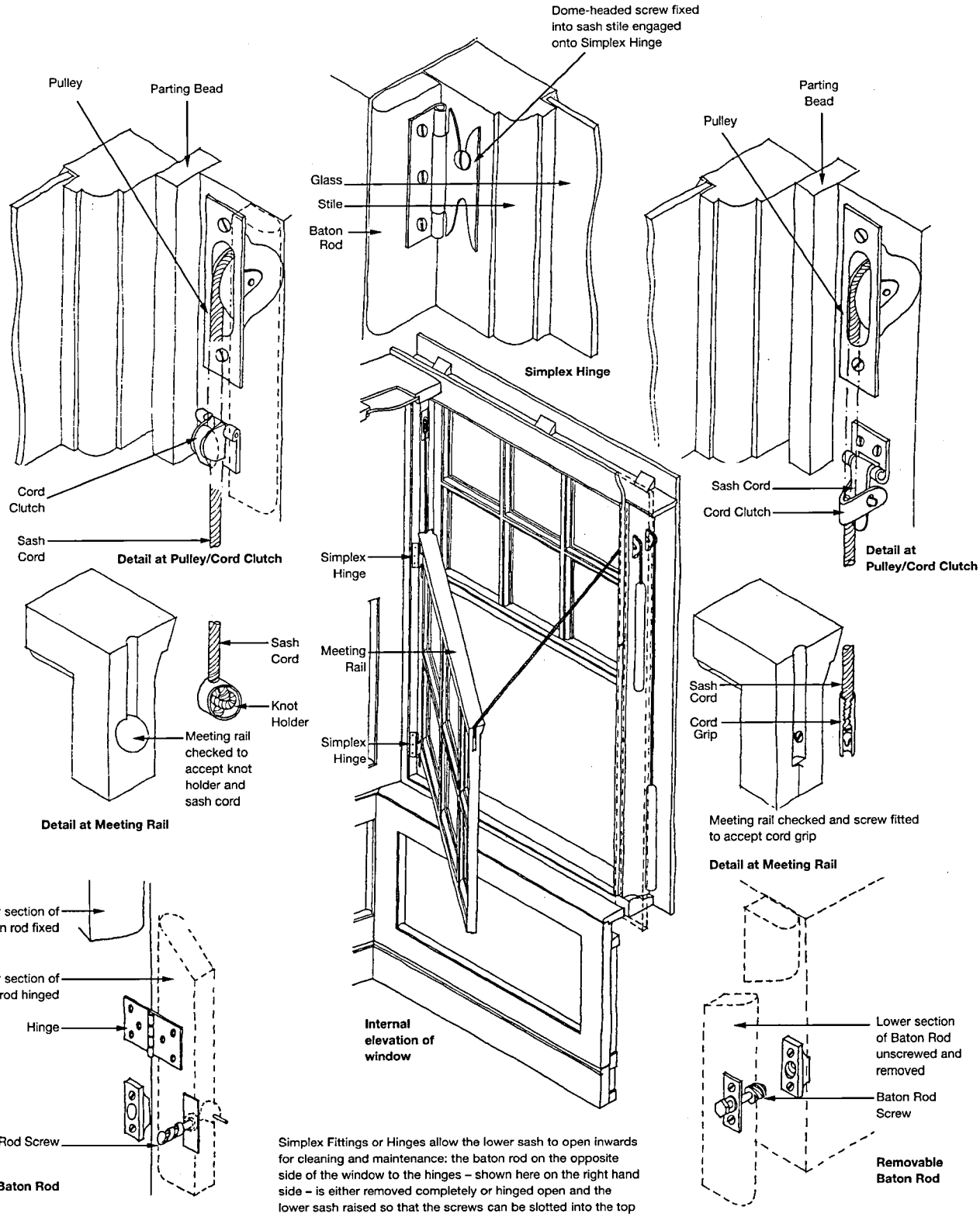
However draught-proofing the doors, windows and other sources of air leakage of a building can be an effective method of reducing heat loss and improving the perceived comfort of the occupants. In most situations, draught-proofing is unlikely to cause any deterioration in the quality of indoor air but, before carrying out such measures, consideration should be given to any lack of air being supplied to combustion appliances, and whether increased condensation may result. BRE Digests 306: 1986 and 319: 1987 contain further information. It may be possible, through the application of partial seals, to avoid the direct impact of draughts without loss of the benefit of air circulation.

5.5.2 Water-tightness

BS 6375 requires that there shall be no water penetration through a window at the range of test pressures for the anticipated exposure level. Many well-maintained and good quality sash windows are found to be watertight without the need for any upgrading or repair work.

5.5.3 Wind resistance

The measure of wind resistance is essentially that of the resistance of the window components to either inward pressure or outward suction. The severity of exposure will depend on the building's location, on local topographical features and on the position and height of the window within the building. Sash and case windows have an advantage over other window types, as they do not rely on the use of ironmongery to resist wind forces. The timber frame of a sound, original sash and case window, or a modern replacement that is made in accordance with BS 644: part 1: 1989, will achieve the required standard for wind resistance without modification. The selection of glass that is suitable for the design wind loading is determined by BS 6262.



Simplex Fittings or Hinges allow the lower sash to open inwards for cleaning and maintenance: the baton rod on the opposite side of the window to the hinges – shown here on the right hand side – is either removed completely or hinged open and the lower sash raised so that the screws can be slotted into the top of the Simplex Hinge: the sash cord on the right hand side is temporarily removed from the meeting rail and held in place by activating the cord clutch fitted below the pulley. The window can then be opened to 90°

56 Simplex fittings.

5.6 Improving standards of weather-tightness

Recent tests have shown that, given a good state of general repair and the addition of weather seals on meeting rails, and at the head, cill and stile members of both sashes, sash and case windows can meet the 300 Pa standard for air permeability to BS 6375 (illus 55) (*Macdata test reference EJ 061, 24.10.97, Department of Civil Engineering, University of Paisley*). Further significant improvements are likely to be achieved if, in addition, a suitable secondary glazing unit is fitted to the inside of the window. In the test case, an air-permeability rating of 600 Pa was achieved. Depending on the local conditions, this might provide an exposure category of 2000 Pa (i.e. the highest exposure levels as defined in BS 6375).

Where there is a need for precise data, or if doubts are expressed concerning the performance of a specific window or group of windows of a similar type, then tests (as described in 5.5) may be carried out to determine the performance of the existing window. This will involve the removal of a sample window to a recognised testing organisation (see Appendix F for addresses).

5.7 Operation of sash and case windows

Normal operation of a sash and case window involves the release of any security devices and sliding one or both sashes vertically to provide ventilation. The degree of ventilation control available is more precise than with other types of window. It can be achieved at both the foot of the lower sash, the top of the upper sash, and at the meeting rails, thus providing a degree of air circulation not achievable with other types of window.

Provided the window has been well maintained and the sashes are adequately counter-balanced, opening and closing is relatively simple and can be effectively adjusted. Problems will occur, however, if the window is in poor condition. Un-weighted sashes or those where the weights are incorrect for the sash will often prove difficult to open. Large ill-fitting sashes may not run smoothly in the grooves, and excess layers of paint may cause sashes to become stuck. Each of these faults can be readily overcome and do not constitute acceptable reasons for seeking to replace sash and case windows.

The design of a traditional sash and case window offers several benefits. The absence of any projection beyond the outer or inner face of the enclosing wall avoids the danger of collision for people walking close to the wall. This also allows blinds, curtains and shutters to be used even when the window is open. The provision of other fixed components such as secondary windows or internal or external security bars or grilles (although normally requiring listed building consent) is also possible without inhibiting the operation of the window.

5.7.1 Cleaning sash and case windows

The Technical Standards for compliance with the Building Standards (Scotland) Regulations, 1990 require that in new buildings in single domestic occupation, and in existing buildings of other types being converted for domestic occupation, all windows above 4 metres from the ground should be accessible for cleaning from the inside or from a safe platform. In buildings of other types, including communal parts of tenements, eg common stairs, cleaning from outside is permitted provided they are no more than 9 metres above the ground and there is suitable space for a ladder to be erected. Alternatively they must be capable of being cleaned safely from inside or from a safe platform. This is in accordance with BS 8213: Part 1: 1991 (illus 53 and 57).

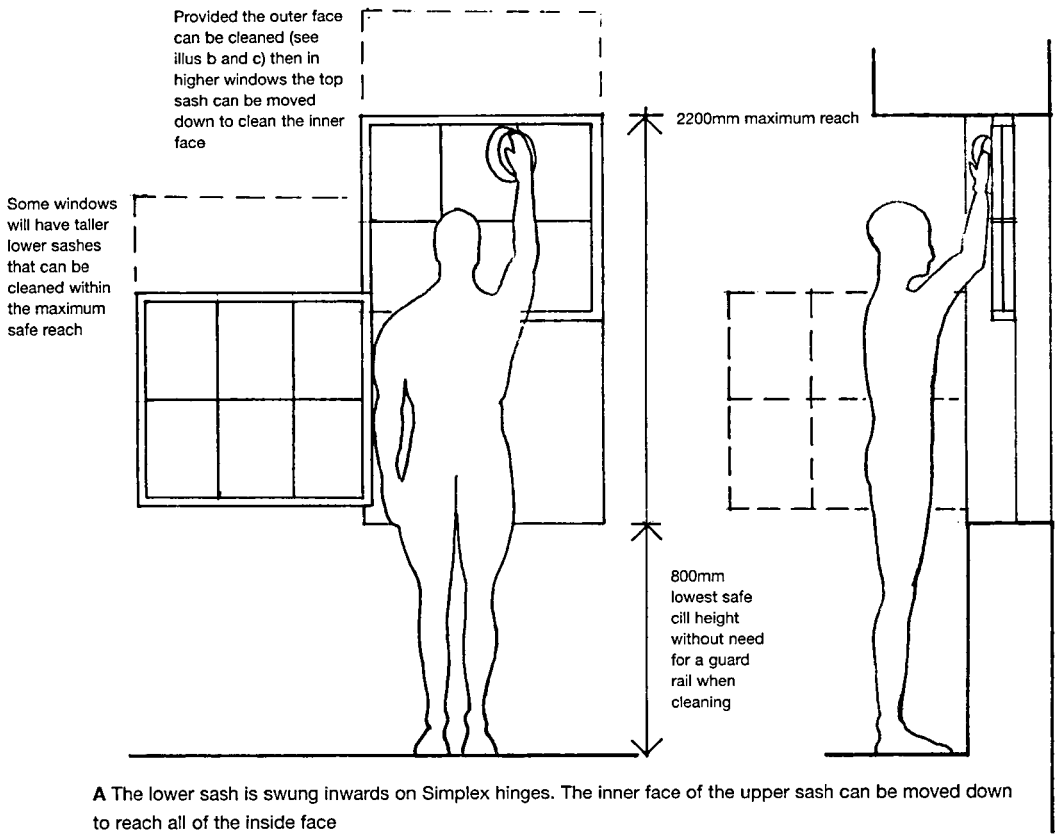
The application of the Management of Health & Safety at Work Regulations: 1992 requires building owners to consider the provision of adequate means of access to carry out cleaning and maintenance work. Those responsible for arranging maintenance and cleaning are required to use Risk Assessment techniques to consider how each task may be safely carried out, and to devise safe systems for managing hazardous work.

The introduction to BS 8213 notes that windows in historic buildings may be exempt from some of the recommendations that follow. It is recognised that the need to obtain listed building consent for any proposed alterations to the windows of a listed building may mean that modifications that would otherwise be required are not possible. This requires careful consideration when dealing with the risks associated with cleaning operations.

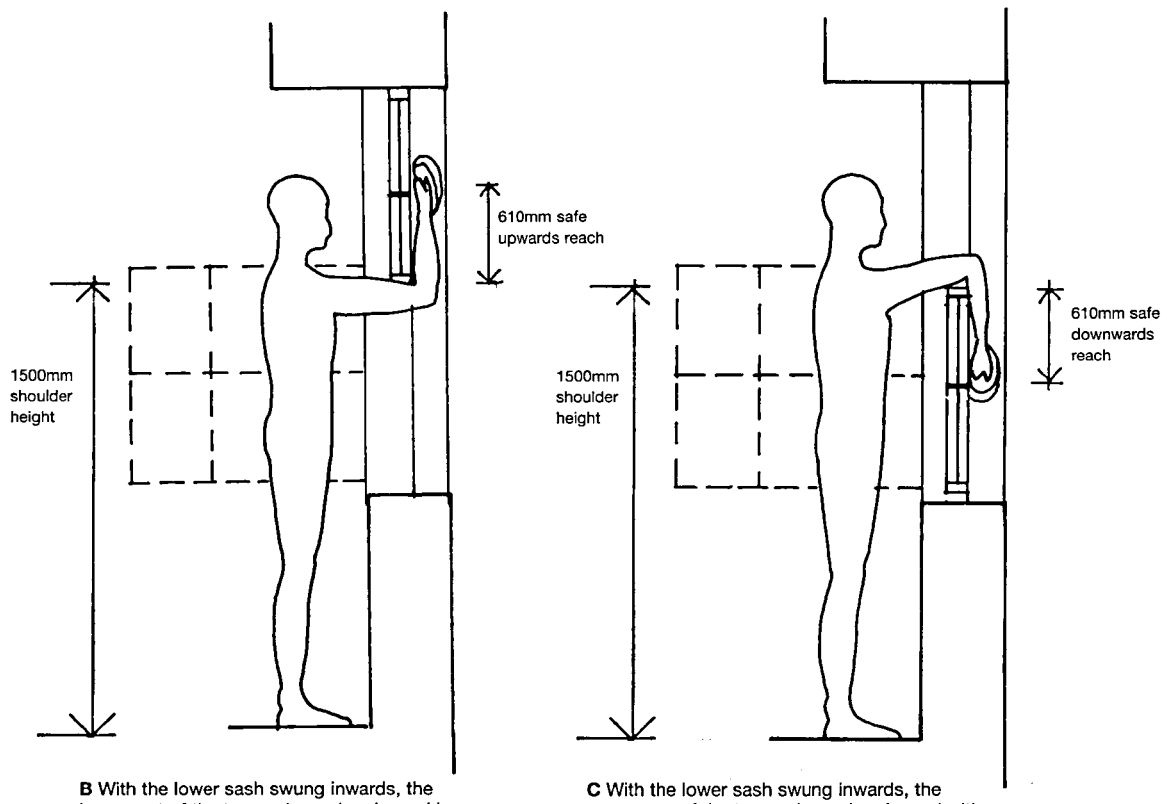
If the lower sashes of traditional sash and case windows are fitted with the 'Simplex' hinge system then both sides of the sash can be cleaned from inside, and the outer face of the upper sash can normally be reached within the guidelines given in BS 8213 (illus 53, 56 and 57).

The window manufacturing industry is constantly reviewing measures to comply with legislation. There are now systems available that can be fitted to sash and case windows allowing outer sashes to be hinged inwards for cleaning purposes (illus 58). Where new windows are being installed then this adaptation of traditional window practice may be acceptable. Retrospective fitting to historic windows will require careful consideration.

In some circumstances the window may not be capable



A The lower sash is swung inwards on Simplex hinges. The inner face of the upper sash can be moved down to reach all of the inside face

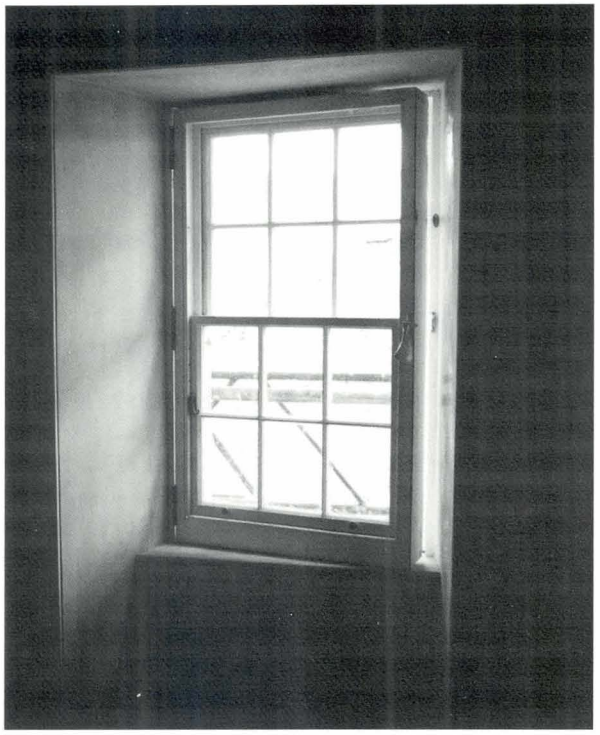


B With the lower sash swung inwards, the lower part of the top sash can be cleaned in the raised position

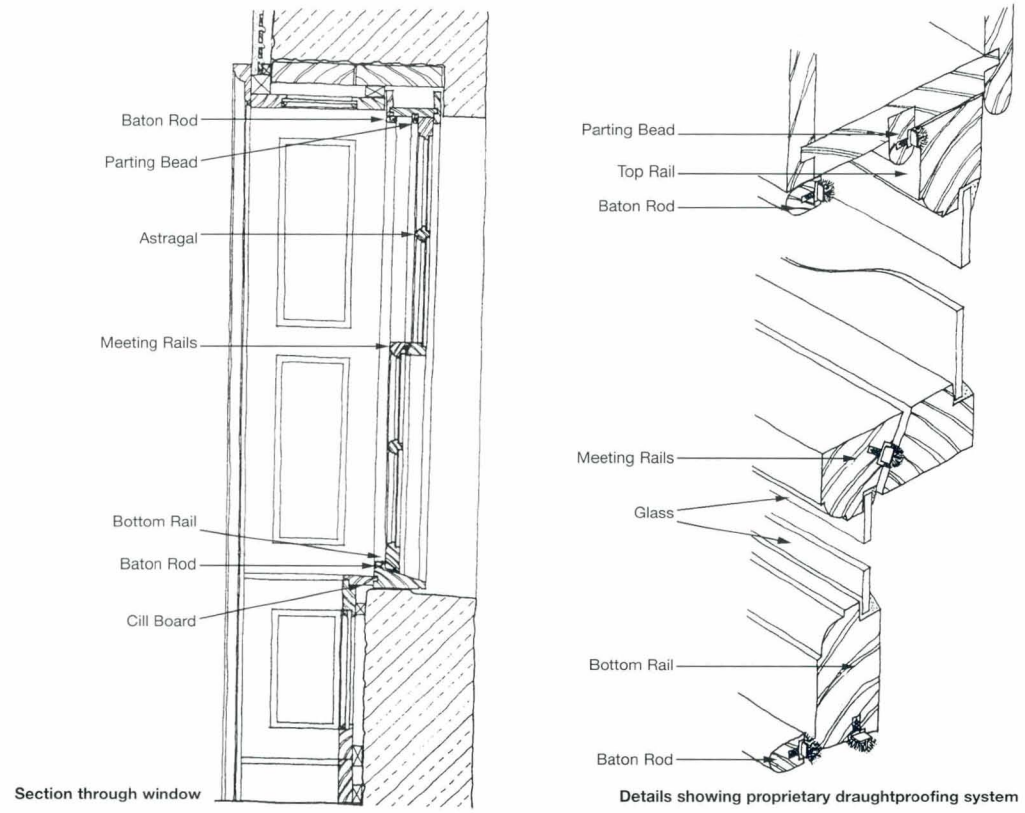
C With the lower sash swung inwards, the upper part of the top sash can be cleaned with it in the fully lowered position (see also diags 4 and 6 to BS 8213 (Illus 55))

57 Diagrams showing how sash and case window may be safely cleaned, following guidelines in BS 8213.

58 A demonstration of the provision of hinges that can allow an upper sash to open inwards for cleaning. The lower sash is rotated on a hinged baton rod. The upper sash is then located onto hinge pins folding out from the pulley stile. A section of the parting bead is made removable so that the sash can swing inwards.



59 Sash and case window adapted to operate as an emergency escape window. The window functions normally as a sliding sash, but in an emergency it can be hinged in as a single unit.



60 A method of draught stripping.

of being safely cleaned within the guidelines, in these situations additional safety measures, such as the provision of internal anchorage points for use with a harness, together with strict instructions for use, may satisfy the regulations. Any anchorage needs to be installed under license and tested on a regular basis. The location of anchor points needs to be carefully considered to avoid damage to interior finishes. Anchorages should not be fixed to the external facades of listed buildings, and would in any case be subject to Listed Building Consent. Fixing into the floor has been found to be successful, provided a suitable structural anchorage can be located.

Alternative methods are available for the satisfactory cleaning of windows including, at a commercial scale, the use of high-pressure hoses operating on extending lances, and mobile access platforms. These options should be fully explored prior to making alterations to the window in order to comply with the regulations.

5.8 Emergency escape

The lower sash of a window may be capable of providing an opening of suitable proportions to comply with the Building Standards without modification. Suitable ironmongery can be specified that allows the sash to open in the required manner, and indeed the common Simplex fitting may be adequate if correctly fitted. Smaller windows may have to be modified to allow the whole window to hinge in a frame, and this has been successfully achieved (see illus 59).

Before any major alterations to windows are proposed, alternative methods of compliance should be sought, including the provision of compensatory improvements in the other fire safety installations, such as improved fire detection, alarm or automatic fire fighting and smoke dispersal systems.

5.9 Improving thermal performance

Thermal insulation is commonly cited as the main reason why building owners propose to alter or replace traditional sash and case windows. However research indicates it is likely that less than 20% of heat loss from a traditional masonry building is directly through the windows; the majority of the remainder will be through the roof and walls. Of the heat losses attributable to windows a large proportion is due to air leakage, and only a relatively small proportion by thermal radiation through the glazing (*English Heritage, 'Framing Opinions', Leaflet 1*).

5.9.1 Draughts

Elimination of air leakage through draughts should therefore be the first consideration. This is discussed in detail in 5.5. The benefits obtained from improved weather-tightness will also significantly reduce heat losses. As discussed previously, increased condensation and inadequate supply of air to combustian appliances are possible side-effects of lack of air circulation, and care should be taken to ensure that neither occurs.

A number of companies now carry out draught-stripping as well as undertaking window repairs. A number of different methods are employed, involving the removal of some timber to allow the letting in of silicone rubber tubes, polypropylene and nylon-finned pile brushes or rubber, polyester or sprung metal fins (illus 60). These are all intended to act as seals when under compression between the timber surfaces of the sashes and window case. The better systems will not only reduce air leakage but will improve ease of opening due to reduction in the frictional resistance between the sashes and the frame.

It should not be assumed that all windows are suitable for the installation of draught-stripping. The historic importance and the method of construction of the window may mean it would be inappropriate and damaging to carry out such alterations, which often include the cutting of chases in sash frames to accommodate draught strips. Windows with particularly slender members, for example, might be weakened by any removal of material.

5.9.2 Double-glazing

Although the use of double-glazing may reduce condensation on the internal surface of windows, it will make only a marginal contribution to improving their overall thermal performance. Increased condensation elsewhere in the fabric of the building may derive from the lack of air circulation after double-glazing has been fitted and care should be taken to ensure this does not occur.

Whilst the replacement of single glazing with double-glazed panes may in certain cases be physically possible, there are significant difficulties to be overcome. In most situations where original sashes are concerned the necessary adjustments will result in unacceptable alterations and loss of original fabric. In the case of listed buildings, consent for the provision of double-glazing would be required.

Many slender glazing bars and sash frame members are unable to accommodate the thicker double-glazing unit, most of which require the use of a glazing bead to secure them into the frame. The overall weight of the sash will increase significantly and counter-balancing may no longer be possible. The presence of a sealed, double-glazed unit is likely to be visually intrusive: the edge-sealing material will be visible, and modern glass creates unacceptably flat reflections. New glass will frequently be highly polished and reflective, with none of the character of original historic glass.

61 Original nineteenth century casement secondary glazing to sash and case window. Library, Royal College of Physicians, Edinburgh.

Although some window manufacturers have attempted to produce acceptable replacement sash and case windows that incorporate double-glazing, none can satisfactorily match the appearance and detailing of an original sash and case window.

5.9.3 Secondary glazing

Internal secondary glazing units can make a contribution to the overall thermal performance of sash and case windows, both directly through reducing radiated heat losses and indirectly by reducing air-leakage. Secondary glazing has the advantage of being capable of removal on a seasonal basis when not required, and, if the glazing is carefully designed, any alterations made to accommodate it are reversible without significant loss of original fabric.

The installation of secondary glazing in a listed building will normally require listed building consent.

Occasionally internal secondary glazing was incorporated as part of the original design (illus 61). In some situations, where new shutters and window joinery are to be provided, it may be appropriate to provide secondary windows as part of the new window. This might take the form of timber sashes or casements, or a modern system as described below.

Although the optimum air space between panes is 20mm, wider air gaps, such as are achieved with secondary glazing, maintain but do not enhance thermal performance beyond that achieved by a 20mm space. This is due to the effects of convection currents within the enclosed air space.

To eliminate the possibility of condensation on the inner face of the outer glazing a small amount of ventilation should be maintained through it to the outer air, and the secondary unit should be well sealed.

To minimise the visual effect of secondary windows, glazing bars should not be used, and the meeting rail should align with that of the external window. Care should be taken to avoid ironmongery interrupting the glazing plane, and to minimise inner frame dimensions, which should be less than the corresponding existing window members to reduce visual intrusion.

Provided the original window has no internal shutters or window panels the fitting of internal secondary glazing should present no practical problems. The secondary window will comprise a sub-frame, commonly of timber, into which opening casements or sliding sashes, often with polyester powder-coated or anodised aluminium frames, are fixed.

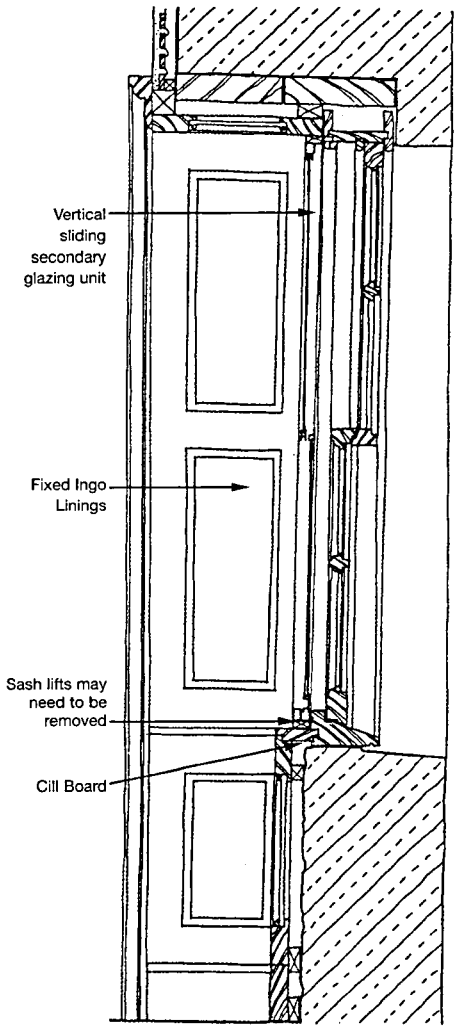
Secondary windows are usually located immediately inside the existing sashes or at a suitable position within the depth of the window reveal. They can be most easily located if there is an existing inner cill projection (illus 62).

In some windows the narrowness of the internal cill means that alterations will be required before secondary glazing can be installed. Systems are available that occupy the space taken up by the original baton rod, which is removed and replaced with a metal or plastic frame. This method may involve the removal of existing lifting bars or sash lifts.

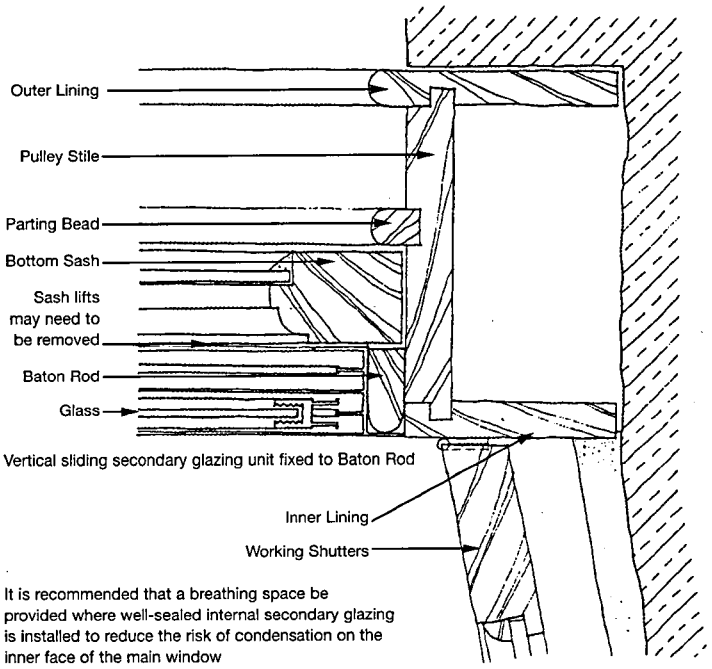
Where existing shutters or other joinery are present, the installation of secondary glazing will require careful thought to detailing and fixing.

Where necessary, to allow for cleaning, the detailing of secondary windows should take account of the need for 'Simplex' hinges on the sash and case outer window.

Secondary windows should never be fitted externally. Their presence in front of the original windows will not

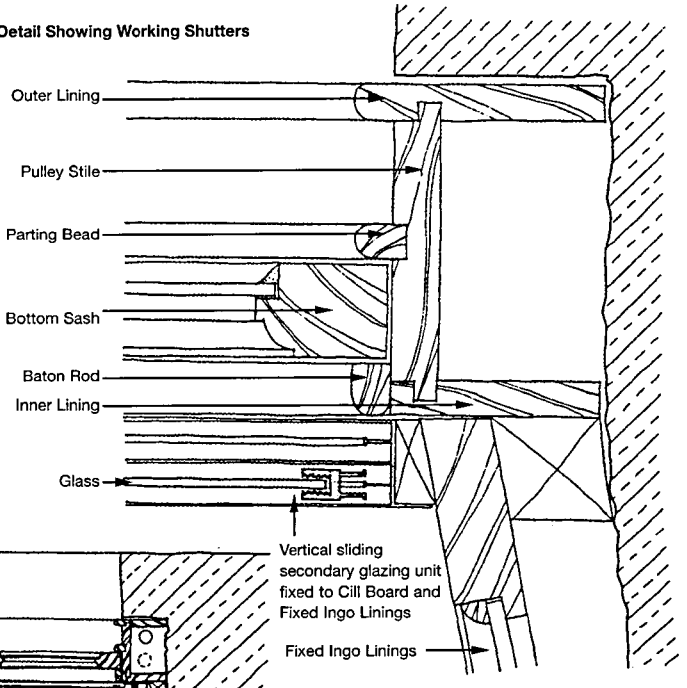


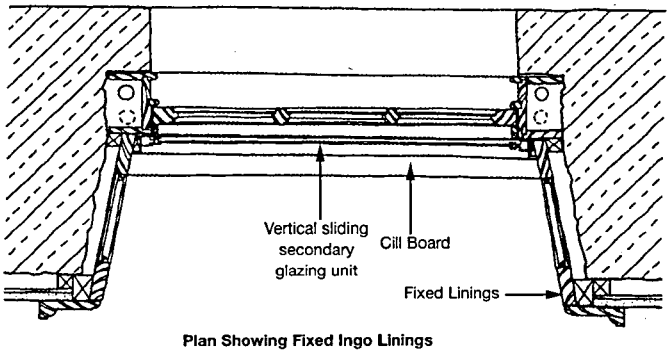
Section showing Fixed Ingo Linings



It is recommended that a breathing space be provided where well-sealed internal secondary glazing is installed to reduce the risk of condensation on the inner face of the main window

Detail Showing Working Shutters





Plan Showing Fixed Ingo Linings

Detail Showing Fixed Ingo Linings or Shutters fixed in Place

Secondary Glazing
May be provided by a made-to-measure system for the particular window. Where there are fixed ingo linings the unit may be fitted onto the cill board between them. Where there are working shutters, it may be possible to fit secondary glazing onto the baton rod if it is deep enough. Alternatively the shutters should not be altered, so that they can be brought back into use at a later date.

62 A method of internal secondary glazing.

only reduce the visual depth crucial to the correct relationship between window and wall, but also create unacceptable flat reflections from the large panes of modern glass.

5.9.4 Shutters, blinds and curtains

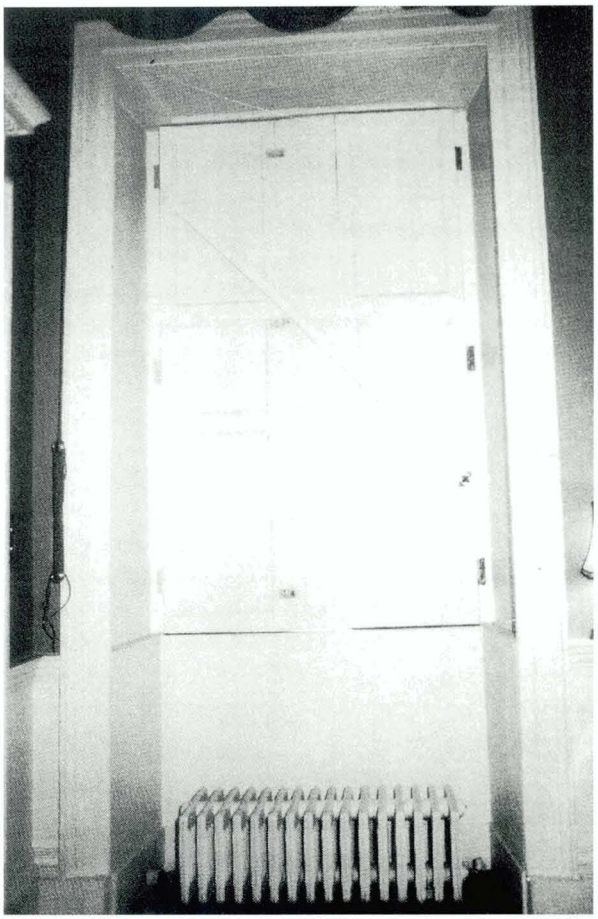
Original internal timber window shutters can provide effective night time thermal insulation, and where existing they should be repaired and retained for use, in preference to other options for reducing heat losses (illus 63). The maximum benefit of solar heating can be obtained from a combination of single glazed windows during daytime, supplemented by timber shutters at night.

In many cases, roller blinds, or heavy curtains can also provide significant reductions in heat loss.

5.9.5 Solar control

Where heat and glare are causing inconvenience to building occupants, solar reflective films, applied to the inner surface of glazing, are a potential solution. However these can be very difficult to remove, and therefore should not be applied to valuable historic glass. Poor application can cause air bubbles that are visually intrusive and diminish the transparency of the glazing. In addition, the most reflective films will cause significant changes in the appearance of a window when viewed from outside.

Where solar control is essential then consideration should be given to the use of the existing shutters during the day, or of internal blinds that can be fitted without damage to the window, to provide the necessary shade.



63 Working shutters. Drawing Room, Royal College of Physicians, Edinburgh.

5.10 Acoustic performance

Sash windows have an advantage over other window types that project at an angle to the face of the building when open: their vertical sliding arrangement does not reflect sound into or out of the building.

In locations where external noise sources adversely affect the occupants of a building, it may be desirable to control noise levels transmitted to the interior. Windows are one of the most vulnerable parts of a building to noise transmission; due to their relatively lightweight construction. However, the sound insulation of windows can be improved by a number of measures.

High frequency noise is likely to be conveyed through air infiltration routes, thus windows with high air leakage rates will be poor insultaors for this type of noise. Lower frequency noise is more likely to be transferred through materials of construction, the rate of transfer being inversely related to the density and thickness of the material. Thus any sound reduction measures should combine the sealing of air-leakage paths with increases in the thickness and density of materials in the path of the noise.

Draught-stripping measures will seal air gaps and therefore contribute significantly to sound reduction.

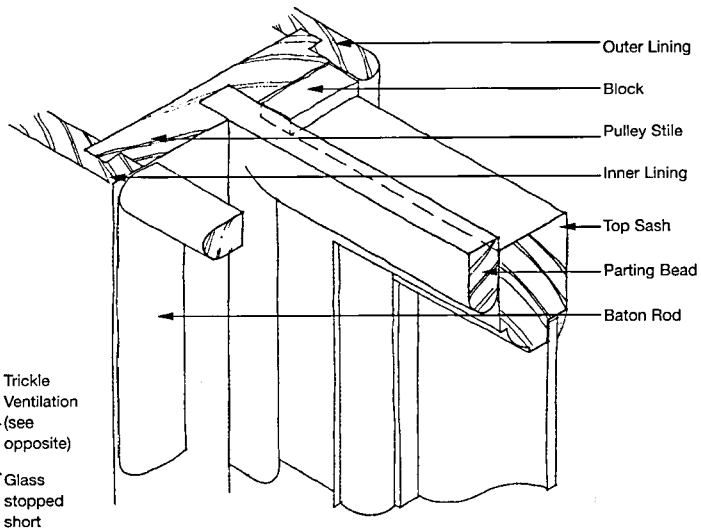
Fitting thicker glass into sash frames, or introducing additional layers of glass, including secondary glazing, will also improve acoustic performance. The most efficient method involves the creation of a wide air gap between the glass panes. Therefore 20mm double-glazed units will not be as effective an acoustic insulator as an air gap greater than 50mm, such as would be achieved by secondary glazing. In cases where noise pollution is very great the introduction of absorbent materials around the perimeter of the space between inner and outer glazing will provide additional reductions in transmission.

Depending on the source of noise, some glazing can attenuate noise of a particular frequency. Varying the thickness of glass can prevent this from occurring: it is recommended that secondary glazing should have a glass thickness differing by at least 30% from that of the outer glazing.

5.11 Ventilation and condensation

Increased standards of living have resulted in increased condensation for two reasons: the occupation of

Permanent Ventilation by Blocking Down Top Sash
The top sash may be blocked down on both sides to allow a continuous flow of air over the top rail and at the sash meeting rail. The depth of the block will depend upon the amount of permanent ventilation required. It is also necessary to insert an equal sized block beneath the sash fastener to allow it to engage properly

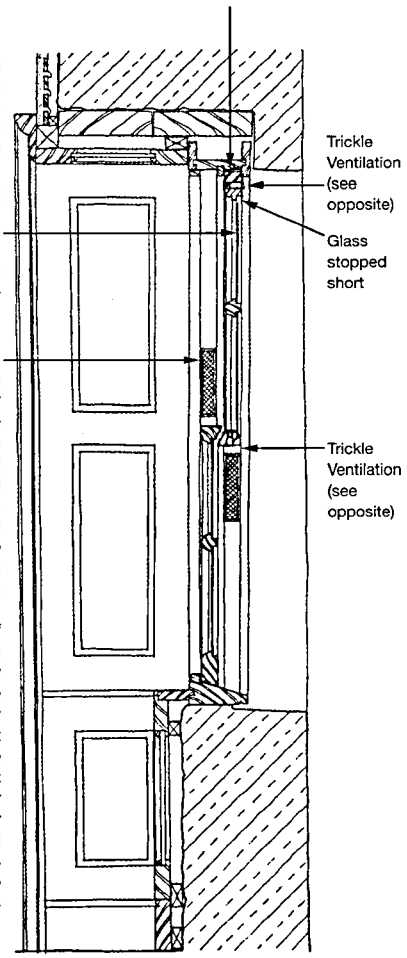


Permanent Ventilation
Top sash may be blocked down (see opposite) to provide permanent ventilation

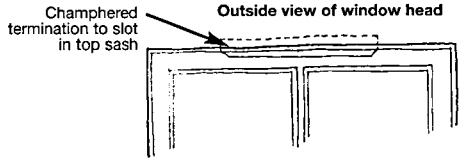
Permanent Ventilation
Glass may be stopped short to provide permanent ventilation. Extent of air gap should be calculated to comply with requirements.

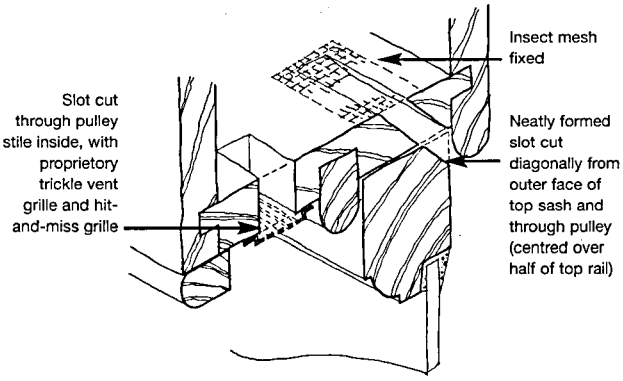
Permanent or Trickle Ventilation
May be provided by cutting holes in both the inner and outer section of the pulley stile and fitting fly screens and grilles as shown. The size of the opening should be calculated to comply with requirements.

The system of permanent ventilation using fly screens may be adapted to provide trickle ventilation by fitting a proprietary vent and hit-and-miss grille of appropriate length at the top of the inner section of pulley stile or two smaller vents fitted to each side. This allows the lower sash to slide upwards

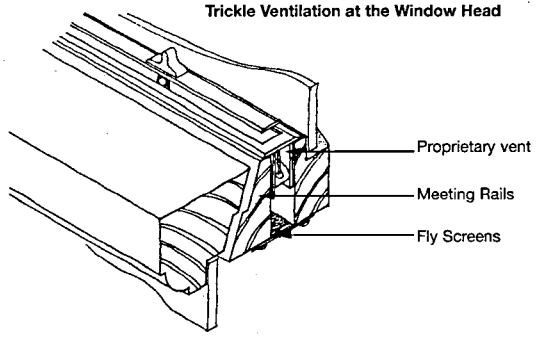


Section through Window





Trickle Ventilation at the Window Head



Trickle Ventilation at the Meeting Rails
A vertical channel of appropriate length to comply with the requirements may be cut in the meeting rail of the top sash. A flyscreen may then be fitted to the under-side of the rail and a proprietary vent and a hit-and-miss grille fitted into the channel.

64 Methods of providing permanent and trickle ventilation.

historic property today generates increased levels of water vapour, and this water is unable to disperse as a result of reductions in natural air circulation and ventilation. The absence of fuel-burning naturally-flued appliances, the closing up of fireplaces and flues, draught-stripping existing windows and the provision of replacement windows all increase the risk of condensation. Any condensation that does occur will first be exhibited on the coldest available surface, which is likely to be the inner face of glass in a single-glazed window.

Although the provision of double-glazing or secondary windows may appear to reduce the problem, this condensation will merely be transferred to some other (often hidden) part of the structure, with the potential of long-term harm to the fabric (see also 5.9.1). The provision of controlled ventilation is therefore essential to alleviate the occurrence of condensation.

The Technical Standards for compliance with the Building Standards (Scotland) Regulations 1990 as amended require the provision of 'trickle ventilation' to rooms in new buildings and, in the case of a change of use, to existing buildings.

Trickle ventilators can be 'stand-alone' components of a building. In recent years such ventilators have been incorporated into the heads of windows. However trickle ventilators can also be in the form of other types of air inlet sited in walls or ceilings, ducted to the external air and fitted with an adjustable vent cover.

There is only one case in the Technical Standards (K4.1b) where there is a mandatory requirement for a trickle ventilator. The reference to such ventilators is principally in the 'deemed to satisfy' section where they feature as a part of a package of measures which are capable of achieving compliance with the Standards. Applicants are however entitled to demonstrate adequate ventilation of a building to Building Control by way of an alternative method.

In view of the above, if a sash and case window is replaced with another of the same general type as that which it is replacing, it should not be necessary to fit a trickle vent unless the original window enjoyed that feature. In a 'change of use', the need to provide a 'deemed to satisfy' trickle vent is not as clear-cut and depends very much on the interpretation of the standards by the local authority building control officer.

It should be possible to develop an argument against the need to insert an additional trickle ventilator into an existing sash and case window, based on the fact that sash and case windows are capable of being manipulated to form two distinct ventilation openings at both high and low levels simultaneously, and that they are also capable of fine adjustment to achieve the minimal background ventilation that satisfies the true intention behind the requirement for a trickle ventilator.

Thus, it could be argued, having the top sash slid open a fraction and held in place by a 'Weeks' sash stop or similar provides the trickle ventilation mode; an openable window is achieved by sliding top and bottom sashes so as to create an opening which is one-thirtieth of the floor area of the room; while by combining the two by sliding the sashes further apart the aggregate area of one-thirtieth of floor area added to the minimum trickle vent area may be achieved.

The installation of a combustion appliance could also require a permanent vent to be provided in the affected room. As discussed above (in 5.2.2) the replacement of a window need not necessitate the provision of additional permanent ventilation.

Where ventilation is required, it is best practice that ventilators should not be inserted into historic window sashes. This is visually unacceptable and is destructive to the original fabric. Alternative locations should be considered for ventilators, perhaps using otherwise redundant flues.

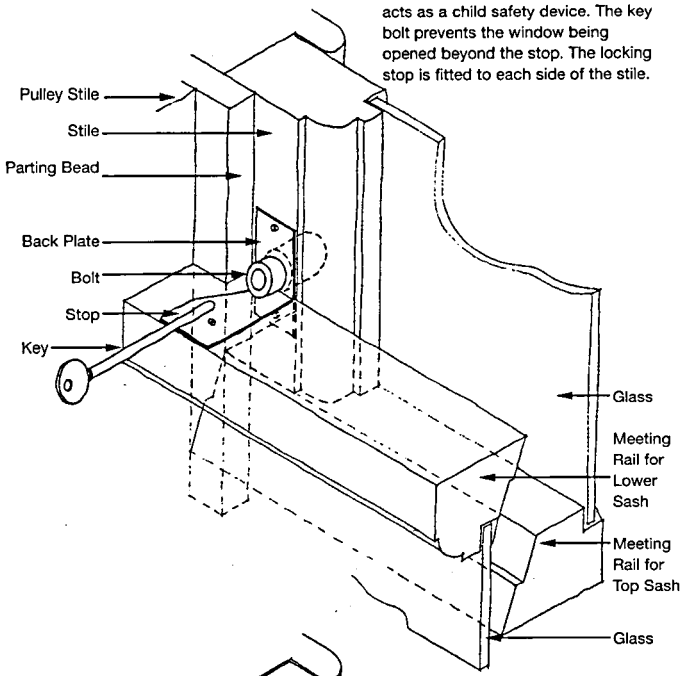
Where no other alternative is available, a range of possible measures involving alterations to windows may be considered (illus 64). In the first instance the simple application of blocks to prevent the complete closing of an upper sash is often adequate, although this will cause the misalignment of the meeting rails. The insertion of grilles to draw air through from outside, using the pulley stiles as an air transfer plenum has also been successfully applied. The installation of a vent into the mid-rail is visually unobtrusive, but will cause irreversible physical damage to the sash rail.

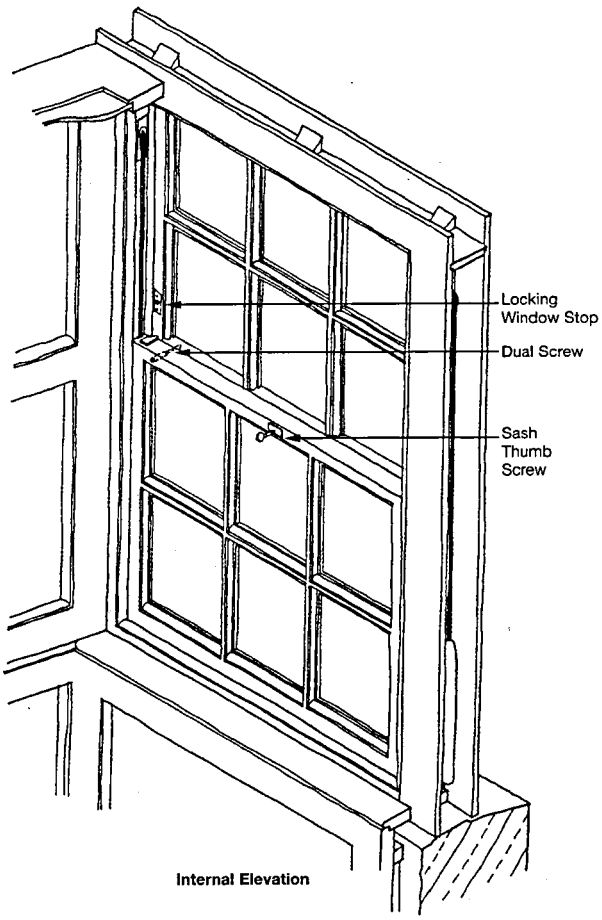
5.12 Security

Where possible original ironmongery should be retained in-situ, even if it has to be supplemented with new fittings offering a higher level of security. Some original fittings may already be able to provide adequate security (illus 65), and those elements that are damaged can be overhauled or replaced with matching fittings.

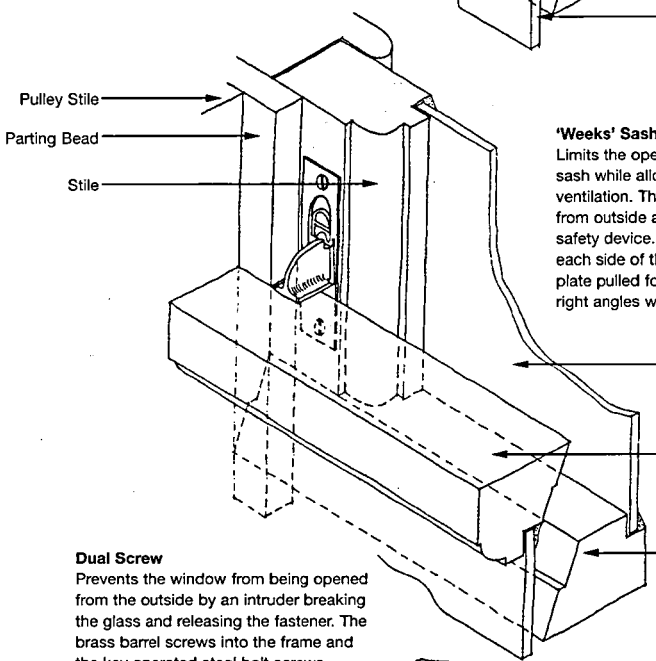
Many insurance companies require locks with separate keys to be fitted. Additional secure locking can be installed, with minimal alteration, through the sash meeting rails. Stops are available that prevent sashes from opening beyond the required point, thus giving ventilation whilst preventing illegal entry, and securing against accidental falls through the window from inside.

Locking Window Stop
Secures a sash window while allowing space for ventilation. This prevents easy access from the outside and also acts as a child safety device. The key bolt prevents the window being opened beyond the stop. The locking stop is fitted to each side of the stile.



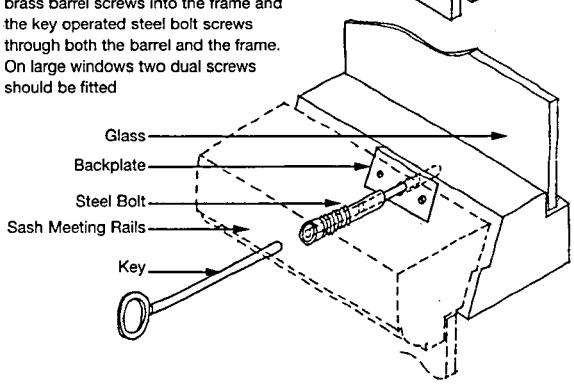


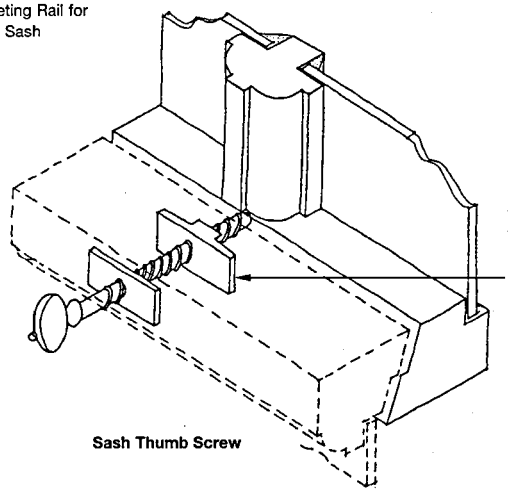
Internal Elevation



'Weeks' Sash Stop
Limits the opening of the lower sash while allowing space for ventilation. This prevents easy access from outside and also acts as a child safety device. A sash stop is fitted to each side of the stile with the stop plate pulled forward and secured at right angles when in use

Dual Screw
Prevents the window from being opened from the outside by an intruder breaking the glass and releasing the fastener. The brass barrel screws into the frame and the key operated steel bolt screws through both the barrel and the frame. On large windows two dual screws should be fitted





Sash Thumb Screw
Provides additional security by fastening the meeting rails together

Sash Thumb Screw

65 Security fittings.

66 *Replacement timbers to match those being replaced. Note the grain density and direction.*

6 WINDOW REPAIRS

6.1 Preparing a specification for sash and case window repairs

This chapter describes a range of repairs, one or more of which may be required to return a sash window to good working order. The aim should always be to retain as much as possible of the original fabric, and to ensure that any replacement materials are introduced in ways that would allow them to be distinguished from the original. The need for a careful survey of each window within a building undergoing repair has already been stressed. It should not be assumed that the nature or condition of a sample window is repeated throughout a building. In the same way the use of standard or generic specifications for repair should be avoided.

Those responsible for instructing window repairs should have an understanding of conservation issues. The recommendations made in good faith by a joiner or building contractor should not be adopted without exercising judgement. In addition, ongoing communication between the conservation professional and the tradesperson carrying out the work will be necessary to properly address any unforeseen problems encountered as the work progresses.

Before commencing repairs to sash windows, it will be necessary to consider the context in which the window is expected to operate. External factors, such as leaking rainwater goods or saturated masonry, which might contribute to the degradation of the fabric, need to be dealt with before window repairs are put in hand. This will ensure that repair work will not be abortive, and avoid any further damage.

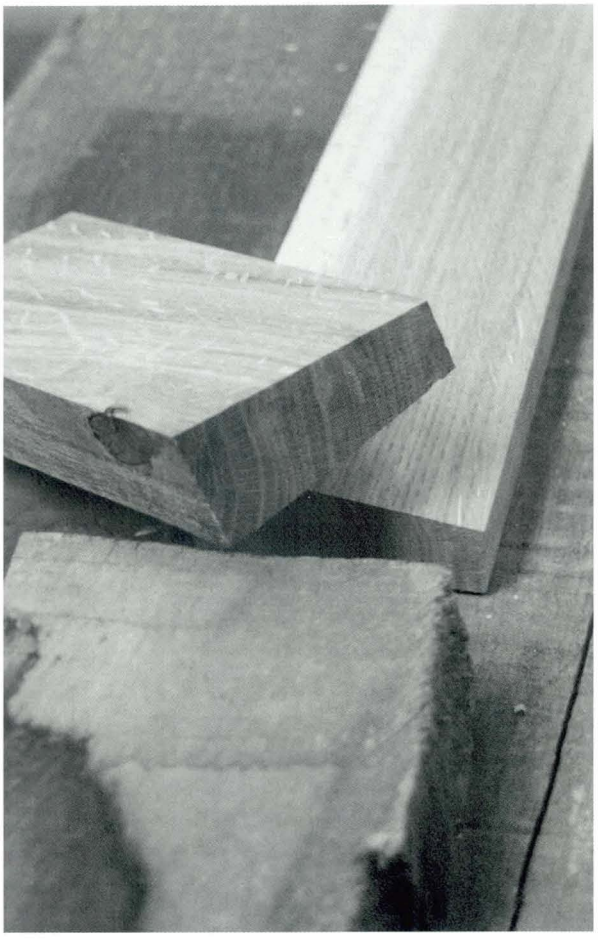
Window repairs should be scheduled to ensure that maximum benefit, through improvements in the operating efficiency and performance of the windows, are gained whilst minimising loss of original material.

Any risks to health or safety should be considered before carrying out repair work. There will be a need for proper access to the work area. It will also be necessary to take precautions against cuts from broken glass, and to follow manufacturers' guidance when using glues, toxic or corrosive chemicals.

The work required to 'overhaul' a sash window, including re-roping, balancing and easing the moving parts, as well as cleaning and painting is not considered here. This work of basic or routine maintenance is dealt with in Chapter 7.

6.1.1 Selection of replacement timber and suitable glass for repairs

As with all joinery repairs it is important to select any replacement timber to match the existing as closely as possible. Species, density and grain all affect the performance of timbers that are subject to wetting and drying, and incompatible timbers will shrink and expand at different rates, causing gaps to open up in otherwise sound repairs (see illus 66 and 67) . The use of timber salvaged from windows that are being replaced should be considered as a means of achieving a close match.



67 New oak for cills.

68 A loose sash joint.

Replacement timber should meet the following criteria:

- 100% heartwood
- close-grained (8 –10 grains per centimetre),
- radially cut, with the radial cut inserted parallel to the widest dimension of the repair object
- air-seasoned, NOT kiln-dried, for at least two years, and in the workshop for as long as possible prior to use.

In order to avoid excessive shrinkage and subsequent opening up of joints, moisture content of 14% is preferable in most new joinery work within dry existing buildings. A further reduction of 2% is desirable if the building is continuously heated. The new timber must always have a moisture content compatible with that of the component undergoing repair. This may involve storage of the component alongside the intended new timber within the same part of the workshop, where time permits.

New replacement timber may benefit from some form of preservative treatment, but if this is proposed the type of treatment should be selected to ensure it will be appropriate for the location, and will not affect later applied paint coatings.

A variety of suitable woodworking glues are available, but care should be taken to ensure they are waterproof. A specialist manufacturer or supplier should be able to give advice.

6.1.2 Repairs to defective joints

Mortice and tenon joints are commonly used in the manufacture of sash windows. These joints rely on accurate tolerances to provide a secure joint, and often used waterproof glue to ensure a tight fit. Thin timber dowels were frequently placed through the joint so that it would not be released. Over time and through misuse these joints may become loose, or timber decay may weaken them (see illus 68). It is usually possible to repair damaged joints. Often gluing, wedging and clamping the joint will suffice, but it may involve taking the damaged sash apart, and re-forming the joint with new timber pieced-in. Guidance on the dismantling of sashes is given in section 6.1.2 below. The cuts made in the old wood should, wherever possible, be angled so as to direct moisture away from the site of the repair.

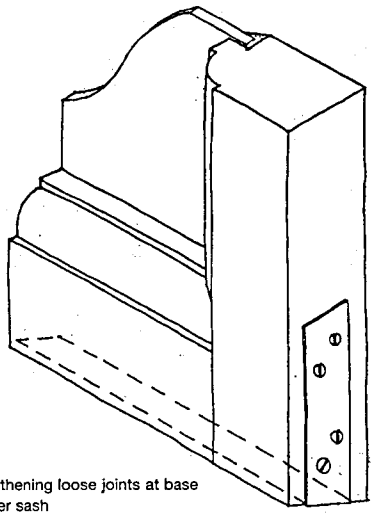
Where no damage has occurred it may be possible to improve the strength of a weakened sash. Old loose dowels can be carefully driven out (dowels were often tapered and the corresponding holes in the sash frame tenon joints were offset so as to use the driven dowel as a means of drawing the joint tight) and new dowels glued into place. Strengthening can also be achieved by the addition of galvanised, or stainless steel, plates recessed into the inside face of the timber, and secured with non-ferrous screws (see illus 69). Metal plates and brackets can become a focus for moisture through trapping rainwater in contact with the surface of the wood, and should therefore not normally be considered for repairs on the external face. Internally they may become a cold surface onto which condensation forms more readily.

6.1.3 Sash repair

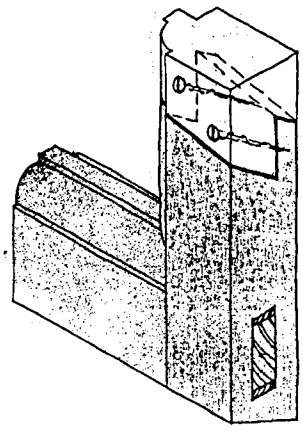
In addition to defective joints, sashes may also have suffered excessive wear, leaving wide gaps or making them difficult to operate. Damage may also have occurred to stile or rail arrises (illus 70). Judgement will be required to determine the extent to which new timber should be inserted to make good such defects. Severely warped or damaged sashes may need to be completely renewed. Many sash repairs can be carried out without dismantling the sash, and subject to the need for matching timber and suitable glues in any repair, can be readily achieved.

Should the need arise, then a sash can easily be taken apart. Carefully remove the glass as described in 6.1.7. Then identify any wedges or dowels and remove these, before carefully easing apart the sash rails and stiles by gentle tapping with a hammer (against a wood block placed inside the frame) near to the joints. Any glued joints can be released by the application of steam.

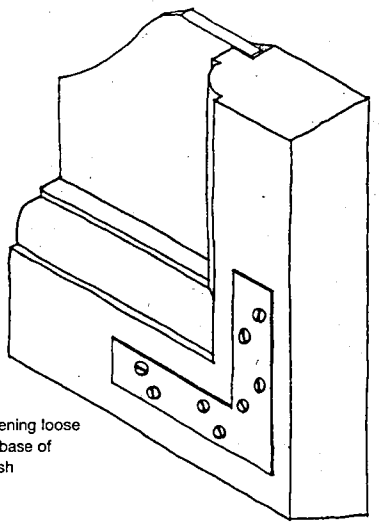
Care will be needed to ensure any new timbers have



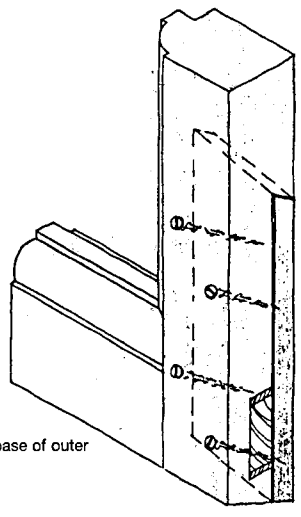
Strengthening loose joints at base of lower sash



Replacement of bottom rail at base of sash stile



Strengthening loose joints at base of lower sash



Replacement of base of outer face of sash stile

69 Strengthening joints

70 Rail and stile repairs

profiles that exactly match the existing. Samples may have to be run using the proposed metal profile cutters before approval for use (illus 71).

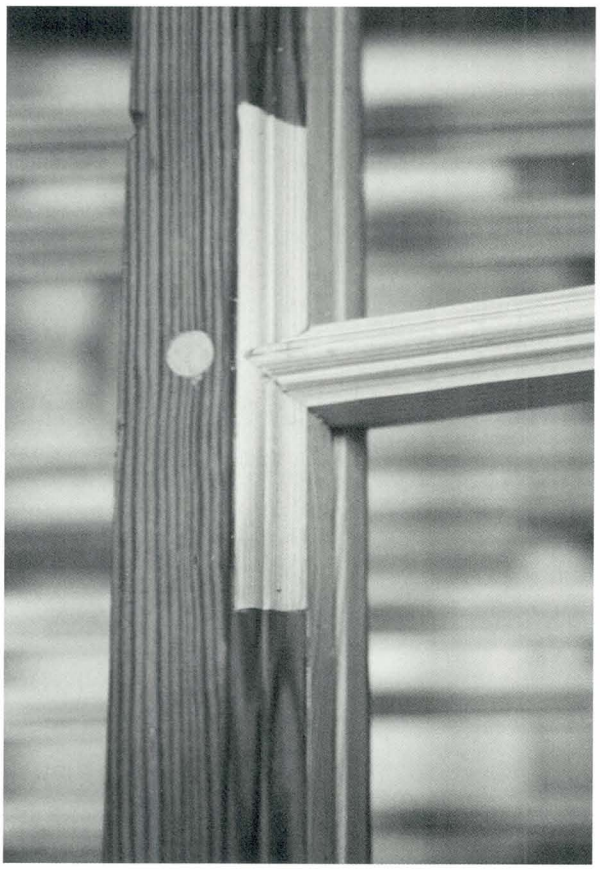
6.1.4 Frame repair

Repairs may be made to frame members using the same techniques as used for sash repairs. It is usually possible to repair frames *in-situ* and this is preferable as, where timber decay is present, frames can become distorted during their removal and may become unsuitable for re-use. Special tools are required to rout out decayed or defective timber to allow new wood to be spliced into place, replicating the necessary jointing. Always ensure that decayed timber is completely removed, as any remaining rot will continue to decay behind the newly indented timber.

Sections of parting beads or baton rods that are damaged or decayed can be pieced-in, or commonly they may be replaced by a piece of matching cross-section. This is best done in complete lengths to ensure they are securely fixed.

Where weight boxes are provided with removable covers these may be defective or missing, and replacement should be carried out to the original profile (illus 72 and 73). This work is often done while accumulations of debris are being cleared from the base of weight boxes (see 7.3).

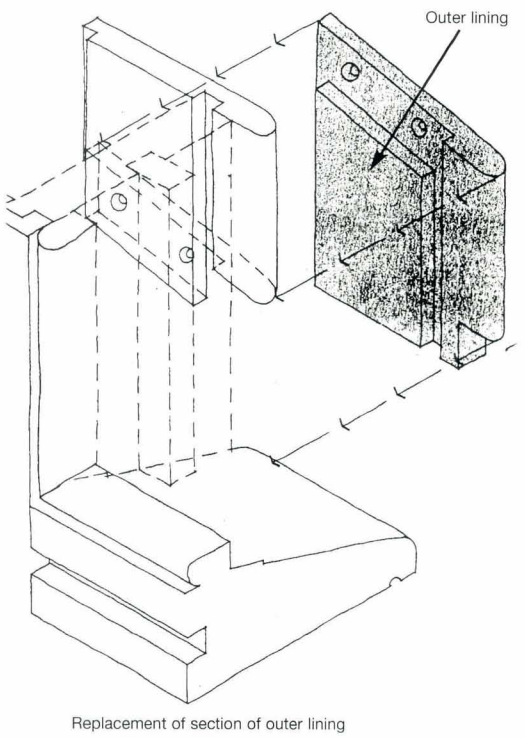
The decay of cills is one of the most commonly occurring defects in sash windows, as they are subject to constant wetting. The complete cill can be replaced *in-situ*, together with the lower parts of the outer lining and pulley stile (illus 74 and 75). Where decay is more limited, and to avoid unnecessary disruption of an otherwise sound frame, the outer half of the cill only can be replaced (illus 76). Full cill repair is complex but if correctly carried out will ensure adequate protection of the sash window. Half-cill repairs tend to



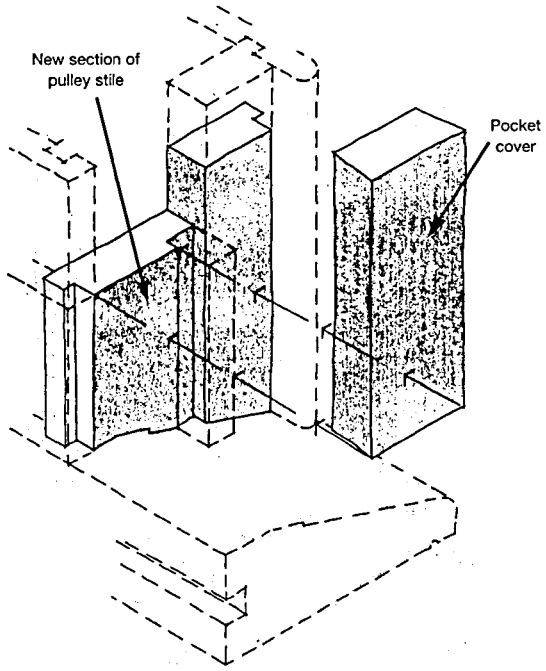
71 Sash repair, showing a dowelled mortice and tenon joint.

72 Weight pocket before repair.

73 New weight cover fitted.



74 Lining repair

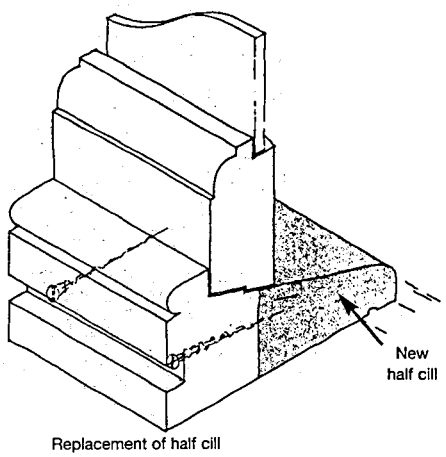


75 Pulley stile and pocket cover repair

be more easily achieved but are likely to be successful only as a stopgap measure. Judgement will be required to assess the type of repair most appropriate in each particular case.

The use of proprietary plastic fillers, including modified epoxy resins or acrylics is not recommended, as they are unsuitable for anything other than the smallest patch repairs. This form of repair will serve to trap moisture within the remaining wood, and will accelerate, rather than reduce, decay. Careful preparation, following the manufacturer's instructions, is essential to the success of any plastic repairs.

In exceptional cases it may be necessary to remove the entire window frame from the masonry opening to allow for more extensive repairs or, for example, if work to the surrounding wall is to be carried out. Removal of a window frame is a major undertaking and should only be undertaken once all other options have been considered. Internal finishes around the window will have to be carefully removed, shutters and window sashes set aside, and any internal plaster removed from the ingoes. Mastic pointing should also be removed from the external face. The frame is normally secured into the masonry with hardwood wedges, but iron wedges or fastenings may also be found on older examples and these should be carefully retained for re-use. After removing any wedges the window can be gently manhandled (inwards) and set down gently onto a cleared level surface. If the frame is in poor condition then the installation of temporary timber bracing will help prevent torsional stress from damaging sound



76 Cill repair

joints. On completion of the repairs the window should be lifted into position and wedged in its original manner. The provision of additional fixings should be considered to ensure long-term stability. Care should be taken during the installation of driven wedges, to ensure the frame does not distort. Window frames should always be set plumb and level, despite any discrepancies in the dimensions of the masonry opening, and this may require careful thought to ensure a water-tight external seal is achieved. The sashes should then be re-hung and tested to ensure they are working before the reinstatement of internal finishes and mastic pointing.

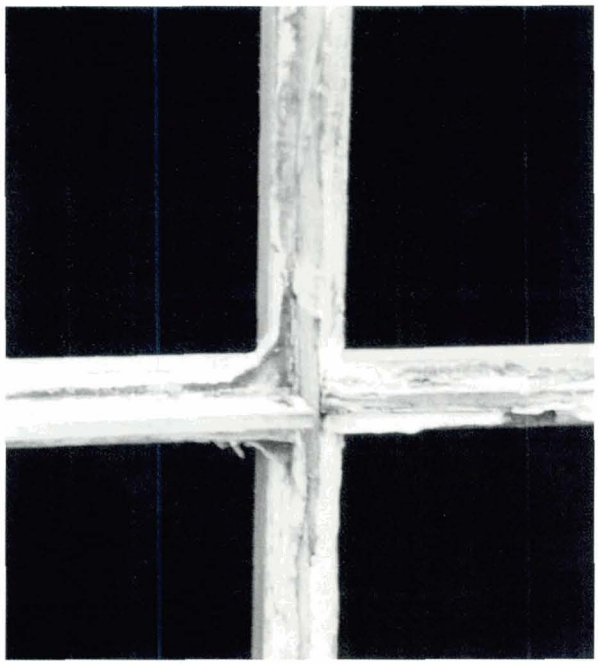
6.1.5 Glazing bars

Glazing bars of relatively thin sections frequently suffer accidental damage due to impact, or due to decay where dampness has collected at one or more joints in poorly maintained timber. They may also have been weakened by unsympathetic treatment during previous glass replacement (illus 77).

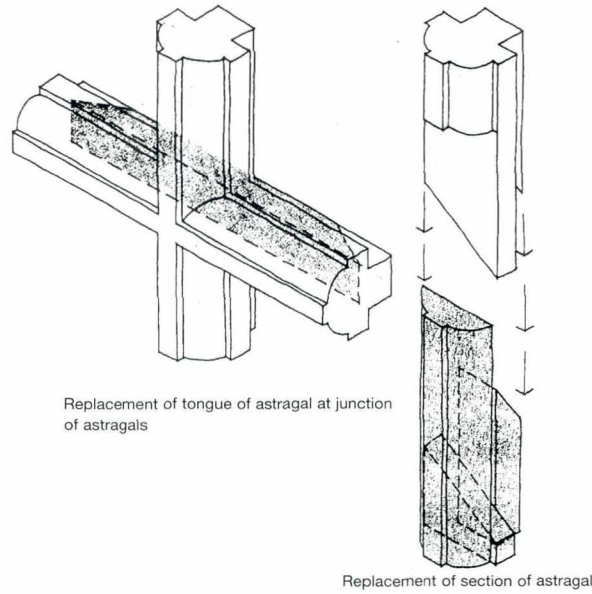
The oldest sashes may have glazing bars formed with the moulded profile separate from the glazing checks. Care will be needed to ensure any repairs take this into account.

Where consent has been granted for glazing bars to be inserted (to replace those previously removed to allow large single sheets of glass to be installed in a sash), evidence for the location and profile can usually be found at the filled tenon holes in surviving sash frames.

Sections of matching timber can be pinned and glued in situ to repair minor damage, but where significant material has to be replaced it will be necessary to remove the sash to the workbench (illus 78). Here the valuable early glass must be protected or temporarily removed (see 6.1.7) before timber repairs are carried out.



77 Glazing bars damaged when hacking out glass and old putty. This might have been avoided if the putty was softened beforehand (See 6.1.6).



78 Glazing bar repairs

6.1.6 Ironmongery

Specialised ironmongery is essential to ensure the proper working of sash and case windows. Harm can be caused to the window assembly as a result of the failure of a single item of ironmongery. The maintenance and repair of these components is therefore vital. Any original fittings should be retained, repairing where necessary.

Although replica ironmongery is now more commonly available it should not be assumed that existing items should be replaced. The quality and durability of much replacement ironmongery cannot match that of the originals, which may have been in use for many years. Weights, pulleys and sash lifts can all be re-used following minor maintenance (see 7.3), and catches and hinges, which have vulnerable moving parts, can be repaired by specialists, often using spare parts taken from previously salvaged fittings.

Layers of paint should be removed from ironmongery using appropriate solvents, before assessing the full extent of damage. Paint removal will itself improve the efficiency of their operation.

Often the ironmongery of a sash window will have been replaced or re-fixed several times before, and this can lead to weakening of the timber at fixing positions. It may be necessary to insert new timber into sash rails to allow the ironmongery to be properly secured.

6.1.7 Putty and glazing repair

Over time putty based on linseed oil may dry out, losing its ability to accommodate the frequent dimensional changes associated with timber windows. When this occurs the putty will tend to crack and allow water in to attack the vulnerable timber. Replacement with matching material is relatively straightforward. Any defective putty can be carefully chipped out, or may first have to be softened to avoid damaging the surrounding timber or the glass. Putty can be softened using an alkali paint stripper or, with careful use to avoid cracking the glass, a hot-air gun.

Other methods of softening putty have been recently developed, using infra-red and microwave heat sources. These methods involve expensive equipment, which is not yet readily available in Scotland, and are therefore only likely to be employed in large repair projects.

The practice of using alkali immersion as a means of removing paint and softening putty is recognised but there is no data available on the effects of such treatment on the long-term durability of timbers (see 6.1.9).

Any metal nails or sprigs used to secure the glass should be carefully retained and re-fixed as necessary. It is often worthwhile to apply a coat of linseed oil thinned with turpentine to the exposed timber before applying new putty, as this will reduce the possibility of the wood drawing the oil binder out of the putty.

Where sashes had previously been glazed with crown glass, timber profiles may have been adjusted to accommodate the distortions found in the glass. Difficulty may occur when using glazing nails where glass has to be inserted into frames that are not true, particularly if the replacement glass is also distorted. Experience has shown that siliconised latex (painter's caulk) as an adhesive can be successfully substituted for the back putty, obviating the need for glazing sprigs. Once set, the caulk may be neatly trimmed with a sharp knife, before traditional fore putty is applied. Glazing can be released from the caulk by careful prising with a knife.

New putty should not be painted until at least 28 days after installation, as this will allow the correct degree of hardening to take place. Painting should occur as soon as possible after this time, so that the putty does not become too brittle.

Glass that has been broken should be replaced as soon as practically possible. This will avoid the risk of decay to window and other interior timbers and finishes. Otherwise sound original panes with only small corner cracks may not need to be replaced, as the crack will not affect performance unduly and because historic glass is a limited resource.

Where a sash must be replaced, any sound historic glass should be salvaged and stored for future use in repairs. Many architectural salvage yards will receive such glass and can provide a source of replacement material when breakages occur.

Sources of new replacement glass should be carefully considered. Of the available alternatives, the following are not recommended for use in historic windows:

- Modern float glass is perfectly flat and its appearance is totally alien to the subtle variations of reflection and surface that are such a feature of historic glass. Float glass that has been distorted by heating in a kiln is available, but it still lacks surface brilliance.
- Drawn sheet or horticultural glass has been used to replicate the patina of historic glass, but it cannot be generally recommended, as poor colour matches may occur and its surface will usually be excessively distorted.
- Cathedral glass, which is machine made, is unlikely to be appropriate for use in sash and case windows due to its heavily obscured textured finish.
- Effects placed on drawn sheet glass by pressing into a mould or by stroking with wire when still hot are only suitable for the art glass market.

The only modern hand-made glass that is readily available is cylinder glass (although confusingly, it is now described commercially as Crown Glass). This glass is blown into a tube in the traditional manner, but not spun as for genuine historic crown glass. No glass of this type is currently manufactured in the UK, but reliable supplies are available from Poland or Germany, where the glass-blowing tradition has continued to this day.

Care must be taken to select the appropriate glass, based on samples of sufficiently large pane size, to assess the visual effect. Exaggerated surface patterns should be avoided.

6.1.8 Repair of pointing materials

As with glazing putty, the pointing used to seal the gap between a window frame and the masonry opening can deteriorate due to excessive drying out or as a result of differential movement. Missing or defective pointing can lead to water ingress and subsequent timber decay.

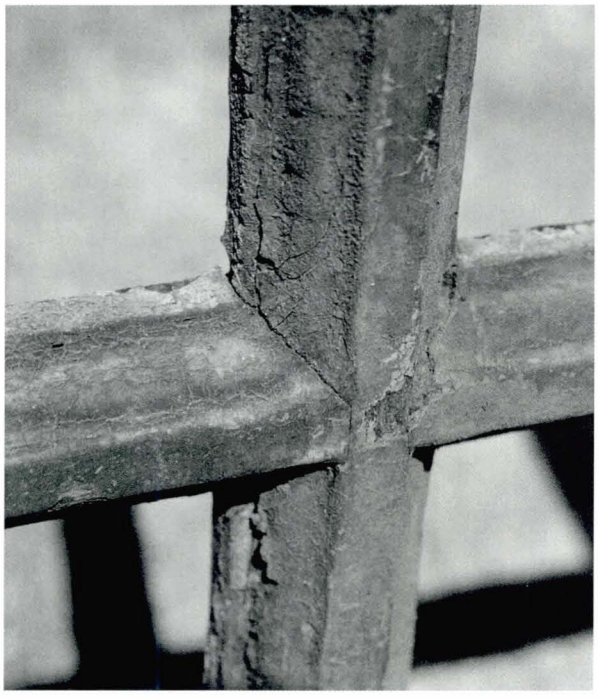
Loose or otherwise defective pointing materials should be cut out, and the backing material (if any) should then be examined. Traditionally, lime mortars were used to seal these gaps over a gap filler of rolled, wetted newspaper, with a fillet of more flexible burnt sand and boiled linseed oil mastic in front to waterproof the joint. Where a deep masonry check is found it is likely that the mortar will have deteriorated and alternative packing materials may have been substituted during later repairs (see also section 4.5 and illus 50).

Repairs may be carried out using the traditional materials. Some experimentation may be required to gauge the thickness and degree of soaking of the rolled newspaper required to correctly fill the gap. The lime mortar backing should be applied in a relatively dry form, and may be reinforced using added animal hair to give more cohesion to the mix. Alternatively compressible foam strips can be used, or modern aerosol-propelled foam fillers, provided precautions are taken to avoid the risk of the filler being foamed within the weight box. For both these modern substitutes, periodic replacement may be required as they do not have proven durability.

Burnt sand and boiled linseed oil mastic is available through specialist merchants, and is usually preferable to modern one- or two-part polysulphide mastics. Before the application of the mastic the dry mortar and adjacent timber should be primed with boiled linseed oil to maximise the bonding action. The mastic is trowelled on and finished at a neat chamfered angle. The material will take about 28 days to become sufficiently hard, and may have to be protected until then.

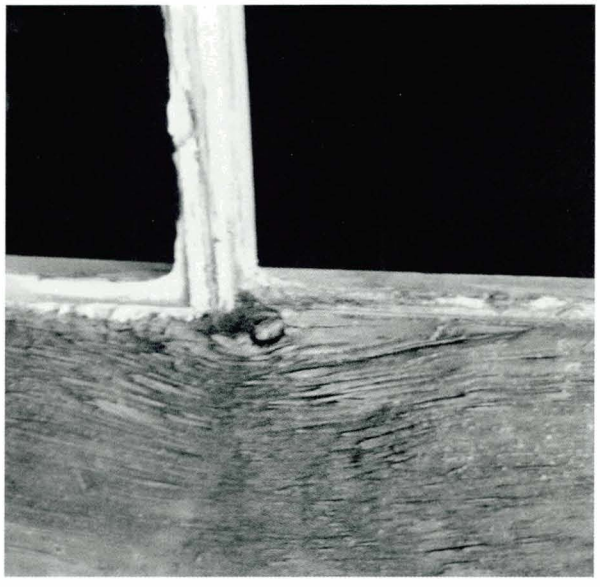
There is some debate whether the finished pointing should be painted along with the window timbers. Once painted there will be less flexibility in the mastic, but it may be more durable. It has been known for

certain birds to be attracted to mastic containing linseed oil (as well as to glazing putty) and painting may help to deter them from pecking it. Painted mastic can be visually detrimental by enlarging the apparent size of the frame members and, on balance, should be avoided.



79 Layers of paint on an old window.

sandpaper and a thin-bladed scraper, taking care not to damage the underlying timber. For some windows this may be all that is required. If it is necessary to remove further paint, or to return the timber to its natural state prior to repairs and re-painting, then an alkali paint stripper or gentle heat from a hot-air gun, taking care to avoid heating any glass that may be in place, may be successful. The use of a gas-fuelled blow-torch is not recommended.



80 The affects of caustic dipping on timber. The grain on the rail member has opened up and splintered.

6.1.9 Paint removal techniques

Methods of painting are described in detail in 7.2, the intention here is to provide information on removal of existing paint. This may be in preparation for re-painting, but may also be a necessary preparatory step for many of the timber and glazing repairs described above.

Excessive build-up of layers of paint over time will tend to interfere with the smooth running of sliding sashes and if painting has been incorrectly carried out working parts can become stuck (illus 79). Paint build-up on parting beads may wear a groove into the sash stiles over time. However the regular painting of the exposed timbers against water penetration is essential to ensure the longevity of the window. There is therefore a need to ensure painting is done regularly and well.

Paint failure may occur on internal surfaces due to the effects of condensation, and more frequently on external surfaces where they are exposed to the sun and rain. Paint may blister, peel or flake, and discoloration will occur. Defective paints may craze or crack to allow moisture to attack underlying timber, causing decay.

Loose paint can easily be removed by rubbing with

Elsewhere in Europe, large-scale projects have successfully employed microwave equipment to loosen paint, so that it may be easily scraped off. This technique has not yet been tried in Scotland but may have advantages over alkali immersion as a quick and efficient method of paint removal.

Caustic stripping, most commonly by alkali immersion, is widely used for paint removal. There are concerns that some timber, putty and old glass may undergo irreversible damage during this process and it cannot therefore be recommended (illus 80). There is evidence that an adverse reaction can develop between caustic solutions and certain timber species, notably oak. Recent experience with oak windows has shown that timbers can be irreversibly stained black and, if inadequately rinsed after treatment, they may sustain the development of mould and other microbial growths.

6.2 Trade skills and training

It is essential to the successful completion of sash window repairs that those concerned have an understanding of the value of the original window,

appreciation of the scope of the proposed work and have the necessary skills and experience to carry out the work to a high standard.

The specifier of the work, either the building owner or guardian, or the professional person engaged on their behalf, must first have clearly stated what is required and specified the quality of materials and skills that are to be employed.

6.2.1 Selection of tradespeople

The tradespeople involved: joiner, glazier and painter, should be carefully selected to ensure they are capable of undertaking the specified work. It may be necessary to request information on previous projects, and inspect these projects to check on the quality of the work carried out.

In situations where contractors are tendering for work of a more general nature which includes a specialist window repair element, and for work requiring the highest levels of skill, then selected approved contractors should be named within the tender documents

6.2.2 Availability of skills

Construction industry trends of the past twenty years have encouraged the provision of a labour force with relatively low skill levels. However the re-emergence of conservation-based projects as a major part of the construction market is likely to change the balance, with small specialist contractors and self-employed tradespeople who can provide the necessary skills and knowledge to satisfy the increasing demand from building owners and professional specifiers.

A specialised market has recently developed where contractors offer to upgrade performance through the introduction of technically innovative weather-resistant products allied to traditional repairs.

6.2.3 Training

An examination of courses currently available from further education establishments indicates that sash and case window repair is not seen as a necessary core skill for graduating trainees. Colleges that were approached confirmed that their trainees may elect to work on sash and case windows when taking courses in general and traditional joinery repairs, but the manufacture of a sash and case window is no longer an essential part of the training of a joiner.

It is more likely therefore that the necessary skills will be learnt by apprentices working in a specialist manufacturing joinery workshop, or in the small group of firms who have established themselves in the sash window repair market. The protection and development of these skills will rely on the continuing demand for such specialist services.

6.3 Selection of contractors

It has been noted above that, with the exception of the smallest traditional joinery-based building contractors and those with specialist window repair skills, the majority of contractors do not possess the range of skills to carry out window repair projects. Instead such firms sub-contract these activities on the basis of competitive tender to a range of joiner contractors. While this approach may be suitable for relatively simple work, it is not appropriate for the majority of sash window repair work.

It may be necessary to specify the particular specialist contractor who is required to carry out the work within the tender documents for the main contractor, or to provide a list of suitable approved contractors from whom the main contractor can select his preferred sub-contractor.

The contractor's site foreman, supervisors and project managers should all be fully briefed on the work required. This is essential to the successful outcome of any repair project.

The Scottish Conservation Bureau maintains lists of suitably qualified and experienced contractors and specialist sub-contractors (see Appendix F). Wherever possible, references should be sought to confirm that contractors have performed adequately on recent similar work.

6.4 Selection of specialist suppliers

The following specialist suppliers may all be involved in sash and case window repair works:

- timber merchants
- manufacturing joiners
- glass suppliers
- ironmongery and sash cord suppliers
- putty and mastic manufacturers
- paint suppliers

It may be necessary for those proposing window repairs to establish sources of materials in advance of preparing specifications. The Scottish Conservation Bureau may be able to provide guidance, as should the respective trade organisations. Useful addresses are provided in Appendix F.

	SOFTWOOD	HARDWOOD	ALUMINIUM	uPVC
Installation cost	**21**	**27**	**25**	**23**
Occupancy cost	**49**	**39**	**50**	**37**
Total cost in use	**70**	**66**	**75**	**60**
Life expectancy (based on current standards)	**35 years**	**40 years**	**50 years**	**40 years**
Replacement cost per year of life expectancy	**30**	**34**	**25**	**29**
Total cost in use and replacement cost	**100**	**119**	**100**	**89**

81 Table A: Comparison of total costs over 50 years, adapted from English Heritage data. (Values are % relative to softwood).

6.5 Costs and grants

6.5.1 Assessing overall costs

There is a widely held perception of traditional timber windows that they are costly to maintain, whereas uPVC and aluminium double-glazed windows are virtually maintenance-free. However, when all the factors listed at 4.1 are taken into account, the true position is by no means so clear cut. Unfortunately the replacement window salesperson is unlikely to provide potential customers with a balanced assessment of the repair options for their existing sash and case windows.

English Heritage *'Framing Opinions'* leaflet 5 (October 1994), compares repair, upgrading and replacement costs, and leaflet 7 (September 1994), describes methods for evaluating energy savings and gives comparative costs for a range of window materials (illus 81 and 82). The following tables convert this information into proportional data based on repaired original or matching replacement timber sash and case windows.

Although the data is based on specific examples, it is clear that repaired and upgraded existing timber sash and case windows achieved lower overall costs than the available alternative replacement windows. New timber windows presently cost more than the equivalent uPVC window. But if full renewal of the uPVC windows is necessary within a 50-year cycle, then they will not be cheaper in overall cost terms.

In considering costs on a more holistic level, it will be necessary to consider factors such as natural resource depletion, pollution through waste disposal and life cycle energy consumption (see also 4.2).

6.5.2 Cost of repairs

Information on costs has been obtained from projects completed in 1999 involving repairs to sash and case windows (illus 83). Three different projects have been used. In each project, a different range of repair and maintenance tasks was undertaken, and a different level of specification applied, depending on the aims of the project. A window 1100mm wide and 2100m high is assumed in each case.

Case reference	**1**	**2**	**3**	**4**	**5**	**6**
Window type	**Existing softwood sash windows**				**Replacement uPVC windows and occupancy/ cyclical maintenance**	
	Occupancy/ cyclical maintenance	**1 + Additional draught proofing**	**1 + 2 + Overhauling, repairs**	**1 + 2 + Major repairs**	**industry supplied data**	**data from a case study**
Initial cost of repairs /installation	**0**	**9.5**	**16.25**	**39**	**62.5**	**124.5**
Occupancy costs	**60.75**	**60.75**	**60.75**	**60.75**	**44.5**	**44.5**
Cost in use totals	**60.75**	**70.25**	**77**	**100**	**107**	**169**

82 Table B: Repair versus replacement. Comparison of total costs over 30 years, adapted from English Heritage data. (Values are % relative to column 4).

DESCRIPTION OF REPAIR	WINDOW 1	WINDOW 2	WINDOW 3
Generally overhaul window. Checking, easing and adjusting to run smoothly.	£29.98	£25.50	
Renew 35x15mm baton rod, 2000mm long.	£19.98	£10.50	£15.00
Renew 30x15mm parting bead, 2000mm long.	£19.98	£10.50	£15.00
Remove & re-fix weight pocket covers.	£4.00	£3.00	
Renew weight pocket covers.	£35.98	£17.50	
Renew full cill.	£19.99	£22.50	£140.00
Renew half cill.	£15.00	£17.50	
Renew sash cords (pair).	£19.99	£20.00	£40.00
Renew outer facing, 2000mm.	£30.00	£17.50	£25.00
Patch repair to worn sash rail, 1000mm. (Re-hanging sash taken elsewhere).	£15.00	£12.50	£30.00
Remove existing glass from one sash, (assumes 6 panes).	£27.74	£15.00	
Re-make one sash frame mortice and tenon joint.		£150.00	
Re-glaze one 6-pane sash with float glass.	£18.00	£39.00	£30.00
Ditto, using reproduction Crown glass.	£157.00	£144.00	
Replace cast iron weights to balance sashes, (re-hanging taken above).		£27.50	
Renew 2 no. pulleys.		£12.00	
Install new Simplex system.		£15.00	£30.00
Strip paint from one sash. (Glass removed and re-fitted elsewhere).	£319.80	£50.00	£30.00
Paint one window inside and out. (3 full coats).		£40.00	£50.00
Remove and re-fix one pair internal shutters.		£45.00	
Replace mastic and backing pointing on 4 sides.	£42.00	£75.00	

NOTE: Window 1 is from a major refurbishment project to a Category A listed building. Window 2 is for a large project of tenement repairs. Window 3 is taken from a small-scale house repair where few windows were involved. The above costs are for guidance only. Each case will be different and may vary according to the extent of deterioration, available skills, timber specification, and the scale and complexity of work required.

83 Table C: Comparison of costs for various repairs

The specification and subsequent cost estimating for complex joinery or glazing repairs may involve the need for detailed discussions on site between the specifier and those estimating the cost of the work. The modern practice of issuing general documents for pricing without schedules prepared on a window-by-window basis, will create difficulties for estimators in anticipating the intentions of the specifier. There may be a tendency for either party to generalise and make assumptions, resulting in significant under- or over-pricing. Either will be detrimental to the successful completion of a window repair project.

An example of a suitable schedule, which should be prepared following the initial window inspection (see Appendix B), is shown below (illus 84). This could be issued by the specifier, or prepared by the contractor as part of the tendering requirements. This would allow tenders to be compared before any decision is taken to proceed.

6.5.3 Grants

Under the powers vested in them by section 51 of the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997, Local Authorities can make grants available towards the repair and maintenance of historic buildings. These are discretionary and funds available are usually limited.

Improvements and repairs grants can also be awarded by Local Authorities under the Housing (Scotland) Act 1987.

The Scottish Ministers may, through Historic Scotland, make grants available towards the repair of buildings of outstanding historic or architectural interest. They can also make grants available towards the preservation or enhancement of an outstanding conservation area.

Grants may also be made available through town schemes established in partnership between Historic Scotland and Local Authorities. Trial schemes relating to the repair or reinstatement of sash and case windows have recently been carried out in conservation areas in Moffat, Dumfries & Galloway, and in Inverness, Highland. In Edinburgh, a similar scheme is operated by Edinburgh World Heritage Trust.

Guidance on grants can be obtained from the relevant Local Authority and from Historic Scotland.

The approval of a scheme of repair for grant purposes does not remove the obligation on owners to comply with the normal requirements of the planning acts, or any other legislation. In cases where listed building consent is required, the granting of consent does not imply that the works will be eligible for grant assistance.

WINDOW NO. W28 / [redacted] E2

SASH/CASE WORK	REMARKS	ACTION	QTY	COST
CASE WORK				
1 Bill Item 35 x 15mm baton roods	2NO @ 2600mm			
2 Bill Item extra baton rods curved				
3 Bill Item 30 x 15mm parting beads	2NO @ 2600mm			
4 Bill Item extra parting beads curved				
5 Remove refix pockets covers				
6 Extra new cover	2NO FLUSH FIT POCKETS			
7 Bill Item replace full sill ex 185 x 1107 labs				
8 Replace half sill				
9 Bill Item remove/replace sash ropes	REMOVE / REPLACE 2NO SETS			
10 Bill Item/use existing sash/new Item weights size x				
11 Bill Item/extra new x new Item				
12 Refix window head	REMOVE / REFIX WINDOW HEAD			
13 Patch at pulley wheels				
14 PULLEY WHEELS	REMOVE & REFIX			
15 PULLEY STILE	PATCH TOP & BOTTOM BOTH SIDES TO TAKE FLUSH FIT POCKETS			
16				
17	PATCH TOP LH @ BLIND BRACKET			
18	PATCH REPAIR LH & RH @ 1500mm			
19 PARTING BEAD CHECK	PATCH LHS OUTSIDE 700mm → 2300mm			
20	PATCH LHS INSIDE 0mm → 2400mm			
21	PATCH RHS OUTSIDE 700mm → 2300mm			
22	PATCH RHS INSIDE 0mm → 1400mm		4	
23 OUTSIDE FACING	REPLACE @ WINDOW HEAD 1400mm			
24 BOTTOM BATON ROD	REPLACE			
25 VARIOUS HOLES	FILL WITH PUTTY			
26				
27				

Authorisation One Richard 6.1.98

main and return

18

84 A contractor's worksheet for the repair of a sash and case window, for authorisation by the contract administrator.

7 MAINTENANCE OF WINDOWS

7.1 Cleaning

Regular cleaning of timber surfaces and glass, both inside and outside, will improve the appearance of sash windows and ensure they function correctly. Paintwork can deteriorate if surface deposits are not removed, allowing decay of putty and timbers. Access for cleaning of all but the tallest windows, provided they are well maintained, is relatively easy due to the operation of simplex fittings. Methods of arranging safe access and cleaning are described in 5.7.1

7.2 Painting

Paint defects, problems associated with excess accumulations of paint layers on moving parts and the removal of old paint are described in 6.1.9

7.2.1 Preparation for painting

It is never desirable to remove all previous paint coatings; sound earlier layers will usually be of high quality lead-based paint and, if properly adhered, will provide a good base for finishing coats. It is also desirable to leave evidence of previous painting to allow interpretation of the history of the paint layers to be undertaken. Investigation of the original and subsequent paint finishes should be considered for any repair project. Such an investigation will assist in evaluating the benefits to be obtained from removal of any or all of the previous coats, as well as providing information on original and later colour schemes.

Special precautions are required for the removal of lead-based and other paint, to ensure that dust and toxic pollutants are collected and disposed of, and that operatives are adequately protected against risk of inhaling dangerous substances.

Before painting is carried out, ironmongery should be removed, clearly labelled and set aside for re-use. It may not be desirable to remove the sash fastener if it is in good condition, as later realignment is often difficult.

Preparation for painting will include timber repairs and paint removal as required, as described in 6.1. Neutralise any paint strippers thoroughly before rinsing down all timber surfaces, rub down with an abrasive paper until the surfaces are smooth, prime areas of bare wood and apply the paint finish.

7.2.2 The painting sequence

A clear description of the sequence of painting, including a description of those areas of timber that should never be painted, is given in *Traditional Homes leaflet No.4 'Sash Windows'* and is summarised here:

Preparation:

- remove sashes from frame before painting.
- remove sash lifts and other fittings but not sash fastener.
- clean painted wood with non-alkali soap and water.
- rub down smooth.
- remove only loose, excess layers and otherwise defective paint.
- prime any bare wood.

Painting:

- pull the outer sash right down, push inner sash up past it.
- paint three sides of the top and bottom meeting rails, the lower half of the stiles and glazing bars, and the parts of the lower sash you can reach.
- paint the inner cill and the lowest 75mm of the inner runners, (the sides of the frame between the parting bead and the baton rod).
- let the paint dry for a while.
- swap the position of the sashes, i.e. lower sash right down and upper half way up.
- paint the remaining parts of both sashes.
- paint the top half of the inner runners.
- DO NOT paint the parts of the runners that are hidden by the sashes when they are closed.
- let the paint dry.
- paint the surrounding woodwork.

7.2.3 Specification for painting

The selection of a suitable paint specification will vary according to local conditions, and compatibility with any existing paint finishes. The principles of thorough preparation, priming of bare and new wood, and the subsequent application of a number of thin layers, finishing with a gloss top coat capable of being waterproof, will hold true for all possible systems. Ensure each layer is applied onto a perfectly dry, clean and sound previous layer. Avoid spreading paint onto adjacent glass surfaces, but ensure the putty is completely covered and the glass to putty joint is sealed, and that sight lines are straight.

The selection of an appropriate colour scheme may be informed by previous site investigation, but any proposal to alter the existing scheme should also be discussed with the local conservation officer. Paint colours based on historic precedent are available from a number of manufacturers, or colours may be specially mixed to match surviving colours. It should be borne in mind that paint colours fade over time.

7.3 Overhauling and roping

The term overhauling requires precise definition, as it has frequently been the practice for a specifier to request a window be overhauled when actually intending the tradesman to appraise the window and repair all defects to put it into working order.

It is suggested that the term should be limited to mean only the carrying out of such work that is necessary so as to allow a window, which is generally already in a good state of repair, to function efficiently in operation.

Thus the work might involve the replacement of worn or broken sash cords, the clearing out of weight pockets, counter-balancing sash weights, and making minor adjustments to ease parting beads and baton rods so as to allow the sashes to slide and catches to operate properly.

In many cases this work need not be carried out by a tradesman but, with guidance, could be done by an owner possessing a little skill. The scope of the tasks would need to be assessed to ensure they could be done safely and without risk of damage to the window. (The lifting down and re-hanging of a large sash would require at least two people, and where the cill is low, some form of protective barrier may be required while the window is being worked on.)

7.3.1 Replacing a sash cord

To replace worn or broken sash cords, the sashes should first be removed from the frame (illus 85). All of the work can be done from inside the building. If only the cord on one side is damaged, then the weights on that side can be immobilised by tying a knot in the cord close to the pulley or by carefully wedging the pulley wheel. Remove the inner baton rods, which will be secured by secret nailing or with Simplex screws if these are fitted. Cords still secured to the stiles of each sash can be cut if they are redundant, removed by withdrawing any tacks or nails, or detached if cord clips are found.

Once the sash is detached from the cord, the counter-balance weight will drop to the foot of the weight pocket if not temporarily supported. Heavy weights could damage the frame if allowed to fall. If the cord for the top sash is being replaced, the parting bead on the same side as the removed baton rod should be carefully prised out to allow the sash to be withdrawn. Remove any nails securing the old cord to the sashes. Once the sashes are set aside, the weights and remaining old cord can be retrieved by prising off the weight box cover (a rectangular trap door in the side of the frame). Clear out the accumulated debris inside the weight pocket. Check that the weights adequately balance the sashes by weighing with a scale or spring balance; the weights for the upper sash should normally be 2lb (0.9kg) heavier than the sash, and lighter than the lower sash by the same amount. Extra weight can be added as described in 4.8 and 4.10.

New sash cord must be of the same diameter as the old to avoid snagging on the pulley. Cotton cord is normally supplied pre-stretched and impregnated with wax to reduce the risk of rot, and to allow it to run smoothly.

The new cord is threaded over the pulley and into the weight box from the top, often using a thin string with a weight on its leading end as a guide, and the weight is then firmly attached. Manoeuvre the sashes back into position. The system should be adjusted to allow the weights to hang 75 to 100mm clear of the bottom or top of the weight box when the sashes are in the fully open position, to reduce knocking noises in the frame.

7.3.2 Making windows work

The most common source of dissatisfaction with sash windows occurs when they are resistant to being opened or closed. Stuck sashes are likely to be caused by excess paint, wrongly painted parts or distortion of rotten or damaged timbers causing undue friction between the moving parts. Provided there is no rot, it should be a fairly simple matter to get stuck sashes working again. Clearing weight pockets and adjusting baton rods, as described above, will remove most sources of difficulty, but it may be necessary to remove the sashes and take off paint layers (see 6.1.9) before re-hanging them on new cords. The application of wax (by rubbing with a candle) to the sash stiles before re-hanging may improve their ability to slide against the frames.

7.4 Mastic pointing

Sand and burnt linseed oil mastic pointing dries out over time and may exhibit the following symptoms: bleaching (especially those facing the sun or prevailing westerly and south-westerly wind), minor longitudinal cracking, slightly crumbly and dry surface.

In these circumstances, repainting the mastic with burnt linseed oil will lubricate and soften the material, which can then be manipulated with a wooden spatula or the end of a paint brush to close the hairline cracking

and smooth out any undulations in the surface. Much of the original colour is reinstated and the mastic regains its malleable characteristics and will be able to respond to temperature changes and weathering satisfactorily for many more years. Care must be taken to apply sufficient linseed oil (preferably in two coats to ensure deep absorption) but not to saturate the adjacent stone surfaces, which can take on a dark stain, although this evaporates with time.

85 Re-cording a sash and case window.

APPENDIX A

GOVERNMENT POLICY AND ADVICE ON REPAIRING, ALTERING AND REPLACING SASH AND CASE WINDOWS

The following section analyses the *Memorandum of Guidance on Listed Buildings and Conservation Areas* and presents an interpretation of how this reflects Government policy on sash and case windows. The *Memorandum* contains several specific references to proposals that should not receive listed building consent. Appendix I of the *Memorandum* contains advice relating directly to specific aspects of window alteration and repair.

The text in *italics* quotes directly from the *Memorandum* (with its heading references in brackets). The subsequent text expands and interprets the statements where necessary. This text can be seen as a summary of this Guide for Practitioners.

1.0 Introduction

1.1 Statutory Protection

(1.1) Scottish Ministers have the responsibility for compiling or approving lists of buildings of special architectural or historic interest. Such buildings are afforded statutory protection.

1.2 Definitions

Listed building:

(1.2) The term 'building' is defined as including any structure or erection, and any part of a building.

Thus any window in a listed building is protected against any alteration that would affect its character.

Curtilage:

(1.2) Any object or structure which is fixed to a listed building, or which falls within the curtilage of such building and, although not fixed to the building, has formed part of the land since before 1 July 1948, shall be treated as part of the building.

This protection is extended to cover items that are not necessarily described within the listing description, but can be deemed to be included with it by association.

Extent of listing:

(1.3) *Listing covers the interior as well as the exterior of the building: the fact that the list contains no detailed interior description does not alter this rule.*

Conservation Areas:
(4)

Although additional powers conferred by designation as a Conservation Area extend only to demolition of unlisted buildings, many planning authorities have sought to extend planning controls in conservation areas through an Article 4 Direction. Where so amended, additional controls will be in place to prevent unauthorised alterations, such as the insertion of unsuitable replacement windows.

1.3 The need for listed building consent

(2.1) Listed building consent is required for the demolition of a listed building, or its alteration or extension in any manner which would affect its character as a building of special architectural or historic interest.

Detailed proposals.

(A 1.2.1) When proposals to reinstate the original window pattern or insert additional windows are submitted, the drawings and specifications must make the form and detailing of the new fenestration absolutely clear.

Proposals likely to be refused:

(A 1.2.1) External secondary glazing should always be refused.

2.0 Presumption for repair

2.1 The appropriate approach to repairs

(A 1.2.1) As a general rule, original doors and windows should be retained. Where these are in poor order, this may well involve considerable repair work, but repair is almost always cheaper than replacement and is certainly the historically correct solution. Only where repair is clearly out of the question should replacement be accepted, and then only on condition that the replacements match the originals in every respect. Any application to carry out such work must be accompanied by detailed drawings which clearly indicate that this will be the case.

In considering any proposal to carry out work on windows, the presumption will always be that the

existing windows should be repaired. The nature of the traditional sash and case window is that it is almost always capable of repair. It is recognised that the nature and extent of repairs will vary, and that economic repair will not always be possible in extreme cases. All repairs must be appropriate to the character and quality of the existing window.

2.2 Materials to be assessed for repair

Timber:

(A 1.2.4) Timber sash windows have a very long life if they are well made using good quality material, correctly installed and properly maintained.

The quality of timbers used in the manufacture of windows has declined from those found even 50 years ago. The replacement of parts or all of the high quality original material with the commonly available softwoods of today must be carefully considered. It may be less economic in the long term to renew windows with relatively minor timber defects, despite the apparent present-day cost/benefit equation.

Glass:

(A 1.2.4) Original sashes, especially those where the crown, cylinder or early polished plate glass survives, should be retained if at all possible. Those which are defective are often capable of repair, and this is always preferable to replacement (and frequently much less expensive).

Early glass is an irreplaceable resource. Any repairs should respect the need to carefully protect against damage or loss. If replacement of windows which are otherwise beyond repair is being considered, then every effort should be made to salvage the historic glass for re-use, either in-situ or elsewhere.

Putty:

Traditional linseed oil putty has not changed in character or composition, and therefore would not normally need to be conserved. There may be exceptions in the case of very old windows in original condition.

Paint:

(A 1.2.1) It is also important to achieve a correct surface finish to the timber. Paint is appropriate. Stain or varnish in most cases is not.

It is recognised that paint treatments will require occasional renewal to ensure the timbers are adequately protected. The aim should be to avoid building up excessive layers of paint that might affect the operation of the window. There is a wide range of products available; including traditional lead-based paints for use only on Category A listed buildings, frequently used oil- or acrylic-based paints, and more recently developed micro-porous paints. The use of translucent stains and varnishes is not appropriate in most cases.

Mastic pointing:

As for putty, traditional burnt sand and boiled linseed oil mastic would only need to be conserved if of particular historic interest.

2.3 Window fittings and methods of operation (including cleaning)

Ironmongery:

(A 1.2.4) Original sash fittings should also be retained.

Early or original sash and case windows may have unique examples of, often, hand-made ironmongery. All ironmongery should be retained for re-use wherever possible. Replacement of fittings to achieve uniformity within a property is not encouraged, as this may result in loss of original character, as well as the potential destruction of historic components. It should be possible to repair and overhaul almost all fittings to achieve their continuing use.

Sash cords:

Cotton cords and braids will normally have a limited life, and they will be replaced many times in the life of a sash and case window. Where heavy plate glass has been used, then often sashes are suspended on chains. Generally windows should be repaired using the method of hanging sashes that was originally used. Some windows were never roped for hanging, relying instead on being lifted manually or wedged open. These windows may not be capable of conversion to being counter-balanced, as they have no space for weights. The use of modern spring balances is to be discouraged, as they are damaging to the original fabric and of dubious quality in use.

2.4 Salvage

(A 1.2.4) Where the original glazing, whether it be crown, cylinder or early polished plate glass, survives, every effort should be made to retain this or to salvage as much as possible of it for re-use. Crown and cylinder glass manufactured in the original way are no longer available and modern float glass is incapable of reproducing the sparkle created by irregularities in the surface of these earlier materials.

This passage makes a clear case for the salvage of valuable glass. The re-use of sashes or whole windows

in other openings or buildings for which they were not originally intended is preferable to their disposal or being placed in storage.

2.5 Repairs Generally

(A 1.2.1) The original proportions of door and window openings must always be retained. If they are changed the architectural integrity of the building will be severely compromised.

All repairs must be carried out with matching materials, and to the original details.

3.0 Alternatives to repair

3.1 Upgrading existing windows

In considering any alterations to existing windows that will improve their performance, the aim must be to achieve maximum benefit with the least visible or physical and visual intrusion.

Draught proofing:

(A 1.2.4) Modern draught-stripping systems are available which now make it possible to deal quickly and effectively with windows that rattle or are draughty.

Perhaps the least destructive method of upgrading sash and case windows. A number of proprietary methods are available that use flexible seals or brushes to reduce the air gaps around the sashes. The loss or alteration of parting beads and baton rods as part of the work may be an acceptable compromise, provided the overall integrity of the windows is retained.

Secondary glazing:

If draught proofing is not likely to be successful, the preferable alternative may be the provision of a second internal window, separate from the outer window, providing a wide air gap between them. This can give useful thermal and sound insulation, as well as reducing air leakage.

Double-glazing:

(A 1.2.4) Double-glazing in itself does not eliminate draughts and is not cost-effective in terms of heat conservation.

The installation of double-glazed sealed units into existing astragalled timber sash frames is not acceptable in aesthetic or functional terms. The additional thickness of glass can not be made to fit within most sash profiles, and the added weight makes operation of the sashes difficult. Double-glazing in itself does not eliminate draughts and has been found not to be cost-effective in energy saving as a method of thermal insulation.

Ventilation:

(A 1.2.11) Proposals to use wired glass, obscured glass, louvred glass or extract fans in windows on main elevations should be refused consent. Every effort should be made to provide permanent ventilation, where this is required, without the need for ventilators cut through the glass or slots cut in top or bottom sash rails.

The unaltered sash and case window provides ventilation in an uncontrolled way. If draught proofing is subsequently installed, ostensibly to improve comfort for building occupants, then there may be a corresponding need to provide for controlled ventilation. This may be a requirement of the Building Standards. The use of proprietary ventilator cowls or grilles, fixed over a slot made in the top rail of the upper sash, is not normally acceptable. Other less intrusive methods of achieving ventilation can usually be contrived.

3.2 Matching replacement windows

There will be circumstances where repair of an original window is not possible; this may be due to technical or economic reasons. If upgrading of the existing windows has been considered and rejected, possibly for the same reasons, then there is no alternative but to replace the window.

Materials:

(A 1.2.4) Where replacement is unavoidable, modern substitutes for timber sash windows should be very firmly discouraged.

(A 1.2.11) The damage which may be caused by the replacement of any window which is historically and architecturally correct with a modern unit made from a different material, to a different design or with a different method of opening is potentially immense. Any proposal which would result in a diminution of architectural quality, no matter how small, should be refused.

Where replacement is unavoidable, modern substitutes for timber sash windows should be very firmly discouraged. It is unlikely that a replacement window made from other materials, such as plastic, steel, aluminium or any composite of these with timber, could be detailed to replicate the appearance of its traditional timber sash and case predecessor without some change in and hence loss of detail.

Matching existing details:

(A 1.2.4) Great care should be taken to ensure that replacement sash and case windows match the originals in every respect. They should be fitted in the same plane, be made up from timber sections of the same profile and dimensions, and have the meeting rails in the same position.

(A 1.2.4) The proportions of the sashes are always carefully thought out and relate both to the size of the window opening and to the glazing pattern within each sash. The original proportions and glazing pattern should always be respected, even if these differ from adjoining buildings of similar style and date. A composite building may exhibit a variety of window sizes and glazing patterns. In such instances, no attempt should be made to standardise the fenestration as the differing pane sizes and astragal profiles are important evidence of the building's history and contribute to its character and interest.

(A 1.2.11) Where a traditional timber sash and case window has to be replaced, it is not sufficient that the new unit opens in the same way. The replacement must match the original unit exactly in all respects (see also 1.2.4). This is particularly important where the window is in a principal elevation.

Great care should be taken to ensure that replacement sash and case windows match the originals in every respect. They should be fitted in the same plane, be made up from timber sections of precisely the same profile and dimensions, and have the meeting rails in the same position.

Methods of opening windows:

The method of opening of any replacement for sash and case windows in normal use should be by sliding the sashes vertically in the frame. It may be possible to devise alternative additional opening modes, for example to permit fire escape and safe cleaning, provided these do not involve alteration of the appearance of the window.

3.3 Non-matching replacement windows:

The need to install non-matching replacement windows may be due to the absence of an existing window, or replacement of one that is non-original.

Reinstatement of missing details:

(A 1.2.4) Where there is either photographic or physical evidence that astragals have been removed it will often be desirable to encourage their reinstatement. Where such work is to be carried out great care must always be taken to identify and ensure the replication of the profile and dimensions of the original astragal.

Care must always be taken to identify and ensure the replication of the profiles and dimensions of the original window.

Unacceptable details:

(A 1.2.11) Most replacement units, whether manufactured from timber or from other materials such as uPVC, are built up from heavy unmoulded sections. Where astragals are present, they are usually too thick and the wrong profile. Such units inevitably lack the refinement and elegance of the traditional sash and case. They are consequently not convincing substitutes and should be avoided. Replacement windows which open in a different manner are never visually satisfactory and should also be avoided.

(A 1.2.4) Consent for replacement windows which reproduce the astragal pattern but open in a different manner should always be refused, as should consent for those where the astragals are merely applied to the surface of or sandwiched between the panes of double-glazing. When a window must be replaced, it is important that the astragals in the new unit replicate the originals in all respects. The upper sashes of original Georgian and early Victorian windows never have horns (the short downward projections of the stiles at either end of the bottom rail which help to stiffen the frame) and neither should replacements of these. Horns do however appear on the upper sashes of some late Victorian and Edwardian astragalled windows. Where this is so and the sashes must be replaced, the horns should be replicated.

As stated above, replacement with windows of other materials, or to details or opening methods that do not match the original window will not be acceptable.

It is accepted that in modern manufacturing processes there will be some methods of jointing etc. that do not exactly replicate the making of traditional windows, for example, the use of metal dowels to secure sash rails where tenons were traditionally employed.

4.0 Meeting modern standards.

(A 1.2.11) One of the commonest problems is that created by the misconception that traditional timber sash and case windows are incapable of meeting modern performance standards. This gives rise to frequent requests to replace such windows with other forms of unit. However recent research shows that it is possible to meet the required standards, at considerably less cost, by upgrading the existing windows or, at reasonable cost, by providing new sash and case units to the original design with an upgraded specification.

The pressure on building owners to upgrade the performance of sash and case windows to meet modern

standards may arise from one of two sources. Firstly, there may be a perceived need to achieve modern standards of comfort or convenience. It is a misconception that traditional timber sash and case windows are incapable of meeting modern performance standards.

Secondly there may be external pressures to comply with building control or other legislation. ***Practitioners and owners should be aware that in many cases existing arrangements are in place to negotiate relaxations of the standards where listed buildings are concerned. Detailed advice on particular cases can be obtained from the relevant Local Authority building control department.***

4.1 Privacy

(A 1.2.11) Proposals to use wired glass, obscured glass, louvred glass or extract fans in windows on main elevations should be refused consent.

APPENDIX B

GUIDE TO THE ASSESSMENT OF SASH AND CASE WINDOWS

This section provides advice on how to carry out an inspection of a sash and case window. A blank pro-forma and a worked example of a survey record sheet follow. In order to carry out a proper inspection it will be necessary to closely examine and operate the window. Viewing from a distance, e.g. through binoculars, does not constitute an inspection.

Preparation:

Allow adequate time.

Assess any risks involved. (e.g. Difficulty of access, loose, damaged or broken glass, hinges or sash cords).

Ensure area around window is clear, to allow full operation of the parts.

Prepare a pro-forma checklist of all components and go through it systematically for each window. (A suggested format is shown on the following page).

Obtain local knowledge from owners or occupiers.

Tools required:

Ladders or other special access arrangements.

Penknife, for testing timber for decay and to loosen seized sashes.

Wood chisel, for loosening seized sashes. (Use with care to avoid damage).

Craft knife, for cutting through paint layers if window has been painted shut.

Damp meter, to observe moisture content of vulnerable or suspect timbers.

Screwdriver, to free sash locks, screw-fixed baton rods and open weight box covers.

Pliers, to turn stiff batten rod devices.

Camera, may be used to record condition.

Visual inspection:

Make a detailed sketch of the window to locate any defects, and measure and record timber profiles.

Describe type and metal of all ironmongery,

Describe type and appearance of glass (there may be more than one).

Check if window opens in for cleaning and record any "Simplex" fittings.

Note type of sash cord.

Investigate whether glazing bars have been removed or altered. (This can normally be seen through any overlying paint coatings).

Operate window, opening and closing:

Open sash fasteners and any other locking device and operate both sashes, sliding for full length of travel in each case. Note any stiffness or resistance, as well as any tendency to fall out of control of the counterbalancing weights.

If unable to move either upper or lower sash, check for signs that paint is sticking sashes together or to frame.

Undo and remove or rotate clear batten rod if easy-clean turnbuckles or screws provided.

Hinge in lower sash on easy-clean hinges or other devices.

Open weight box covers to examine type and condition of weights, and ensure box is clear of debris that might accumulate. A musty smell and spores resembling reddish dust may indicate the presence of dry rot.

Check operation of shutters (if any). Look behind shutters for signs of dampness in plaster or wood-rot in the window frame or in timber safe lintels.

Common defects:

Consider the defects in turn and determine the underlying cause in each case (see Appendix C). Most will be recognised on close visual inspection, but this may not be sufficient in the case of timber decay. If decay is suspected, test the timber with the blade of a penknife – sound timber will resist penetration.

Consider other factors affecting the window:

In addition to the window components themselves, it will be necessary to consider the condition of the immediately adjacent building fabric. Many sash and case windows are provided with internal shutters, and frequently are placed within timber-lined ingoes. There may be other external forces affecting the use of the window, such as structural deflection of the opening in the masonry wall or decayed plaster due to rising damp or other building defects.

SURVEY OF SASH AND CASE WINDOW PRO-FORMA CHECKLIST (1 of 2)

Window No.	Date.	Surveyor

SKETCH OF WINDOW (show dimensions, and key to notes on condition)	TIMBER PROFILES (show dimensions)
	SASH RAIL/ASTRAGAL
	MEETING RAILS
	CILL

Blank survey record sheet

SURVEY OF SASH AND CASE WINDOW PRO-FORMA CHECKLIST (2 of 2)

Window No.	Date.	Surveyor

DESCRIPTION OF WINDOW: note where elements are original (O) or new (N)

FRAME MATERIAL	HARDWOOD	SOFTWOOD	OTHER
PAINT SYSTEM	OIL PAINT	STAIN/VARNISH	OTHER
GLAZING SYSTEM	PUTTY	TIMBER BEADS	OTHER
IRONMONGERY	SASH LIFTS	SASH LOCK	SASH STOPS
	BATON ROD FIXING	OTHERS	
OPERATION	SASH CORD	PULLEYS	CORD CLUTCH
CLEANING FACILITY	SIMPLEX FITTING	OTHER	
GLAZING	GLASS TYPES		
OTHER FEATURES	WEIGHTS	VENTS	SEALS
	DRAUGHTSTRIPPING (Full? / Partial?)	MASTIC POINTING (Linseed oil & sand? / Silicone?)	
SHUTTERS/INGOES	ELBOW	SOFFIT	BACK

CONDITION OF WINDOW: (tick list of common defects, or additional notes as required)

Gaps leading to draughts	Timber decay in cill
Visible gap at cill	Timber decay in sash frame (specify)
Meeting rails not level	Timber decay or defects in parting beads
Broken sash cords	Timber decay or defects in baton rods
Broken or cracked glass (specify)	Incorrect weights
Timber missing or damaged (specify)	Debris in weight pockets
Previous repairs	Shutter defects (specify)
Missing or defective putty	Ingo lining defects (specify)
Missing or defective mastic (state if pointing was part of grant repair)	Structural opening defects or distortion
Missing or defective cill bedding	Paint defects (specify)

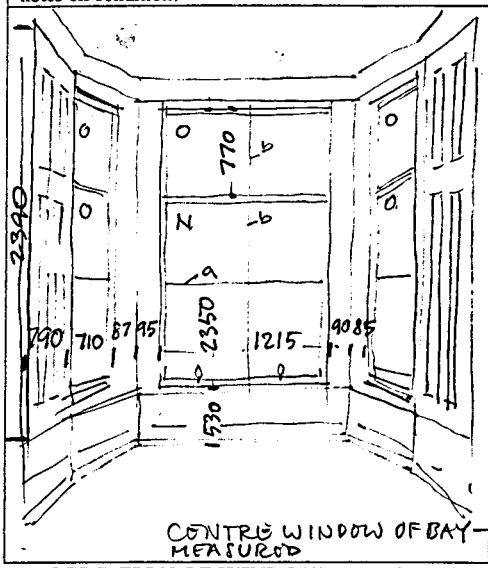
GENERAL COMMENTS

PROPERTY ADDRESS ..... ********,*********
SURVEY REFERENCE no. .....

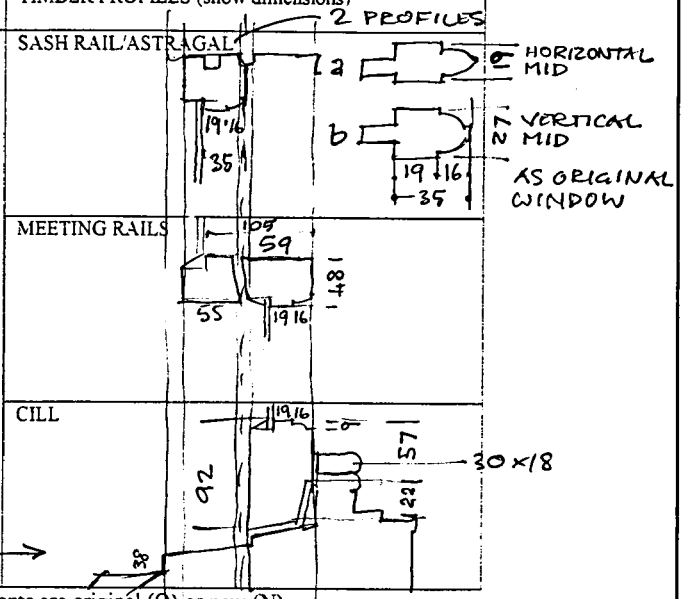
Window No. A
(see Property survey key elevations)

SURVEY OF SASH AND CASE WINDOW

SKETCH OF WINDOW (show dimensions, and key to notes on condition)



TIMBER PROFILES (show dimensions)



DESCRIPTION OF WINDOW: note where elements are original (O) or new (N)

FRAME MATERIAL	HARDWOOD	SOFTWOOD O N UPPER LOWER	OTHER
PAINT SYSTEM	OIL PAINT N	STAIN VARNISH	OTHER
GLAZING SYSTEM	PUTTY N	TIMBER BEADS	OTHER
IRONMONGERY	SASH LIFTS O	SASH LOCK N brass screw	SASH STOPS
	BATON ROD FIXING none	OTHERS	
OPERATION	SASH CORD N	PULLEYS O	CORD CLUTCH
CLEANING FACILITY	SIMPLEX FITTING none	OTHER	
GLAZING	GLASS TYPES O in orig sashes New in new		
OTHER FEATURES	WEIGHTS O	VENTS none	SEALS
	DRAUGHTSTRIPPING (Full? Partial?) full	MASTIC POINTING (Linseed oil & sand? Silicone?) painted over	
SHUTTERS/INGOES	ELBOW shutter bolection moulding	SOFFIT decorative cornice	BACK plain but orig.

CONDITION OF WINDOW: (tick list of common defects, or additional notes as required)

Gaps leading to draughts	X	Timber decay in cill	X
Visible gap at cill	X	Timber decay in sash frame (specify)	X
Meeting rails not level ✓ 5mm makes sash screws difficult to use		Timber decay or defects in parting beads	X lining of ventrolla draughtseal already torn
Broken sash cords	X	Timber decay or defects in baton rods	X
Broken or cracked glass (specify)	X	Incorrect weights	X
Timber missing or damaged (specify)	X	Debris in weight pockets	X
Previous repairs cill has been renewed		Shutter defects (specify) slightly out of plumb ✓	
Missing or defective putty messy in side sashes - good in New	X	Ingo lining defects (specify) over painted	
Missing or defective mastic (state if pointing was part of grant repair)		Structural opening defects or distortion	X
Missing or defective cill bedding can't see but paint appears adequate		Paint defects (specify) fair condition but thick	

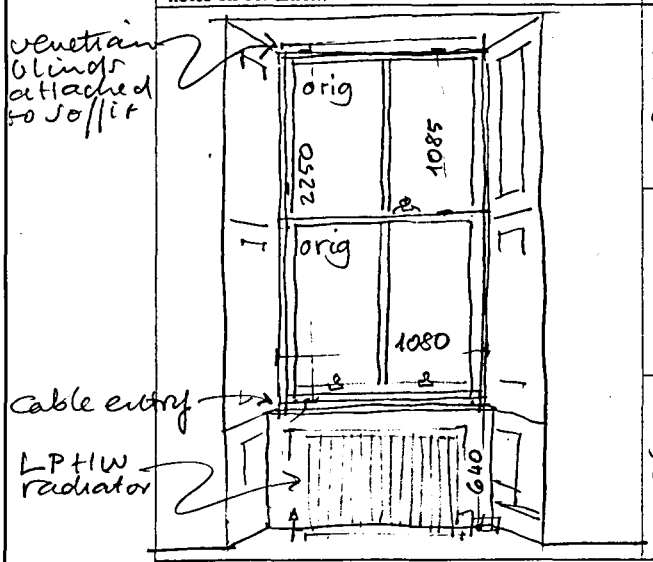
Worked example of survey record sheet

PROPERTY ADDRESS ..... ********** .....
SURVEY REFERENCE no. 49

Window No. A
(see Property survey key elevations)

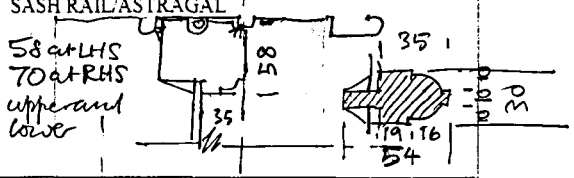
SURVEY OF SASH AND CASE WINDOW

SKETCH OF WINDOW (show dimensions, and key to notes on condition)

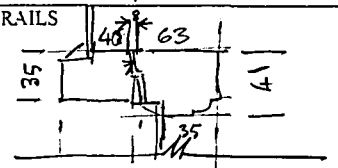


TIMBER PROFILES (show dimensions)

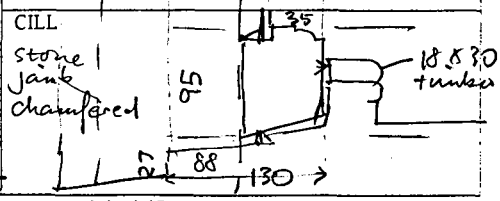
SASH RAIL/ASTRAGAL



MEETING RAILS



CILL



DESCRIPTION OF WINDOW: note where elements are original (O) or new (N)

FRAME MATERIAL	HARDWOOD	SOFTWOOD O ✓	OTHER
PAINT SYSTEM	OIL PAINT O	STAIN VARNISH	OTHER
GLAZING SYSTEM	PUTTY O	TIMBER BEADS O + N outer inner	OTHER pvc PARTING BEAD
IRONMONGERY	SASH LIFTS O brass	SASH LOCK N brass screw	SASH STOPS O brass painted over
	BATON ROD FIXING sprigs	OTHERS	
OPERATION	SASH CORD N (waxy)	PULLEYS O	CORD CLUTCH none
CLEANING FACILITY	SIMPLEX FITTING none	OTHER	
GLAZING	GLASS TYPES O all 4 panes	clear polished plate	
OTHER FEATURES	WEIGHTS O	VENTS none	SEALS
	DRAUGHTSTRIPPING (Full? Partial?) full	MASTIC POINTING (Linseed oil & sand? Silicone?) L O & S	
SHUTTERS/INGOES	ELBOW shutters painted fixed shut	SOFFIT	BACK sainsbetas shutters

CONDITION OF WINDOW: (tick list of common defects, or additional notes as required)

Gaps leading to draughts ? RHS		Timber decay in cill	✗ appears to have been renewed within 20yrs
Visible gap at cill	✗	Timber decay in sash frame (specify)	✗
Meeting rails not level 6 mm higher at LHS		Timber decay or defects in parting beads	✗
Broken sash cords	✗	Timber decay or defects in baton rods	✗
Broken or cracked glass (specify)	✗	Incorrect weights	✗
Timber missing or damaged (specify)	✗	Debris in weight pockets	✗
Previous repairs see also cill RHS sash appears thicker than LHS		Shutter defects (specify) jammed shut	
Missing or defective putty	✗	Ingo lining defects (specify) paint splashes	
Missing or defective mastic (state if pointing was part of grant repair)	✗	Structural opening defects or distortion	✗ slight efflorescence and spalling at top of jamb
Missing or defective cill bedding	✗	Paint defects (specify)	

APPENDIX C

GUIDE TO SPECIFYING REPAIRS

The extent to which repair is necessary or desirable will depend on a number of factors, including the overall condition of the window, its historical significance and the budget set for the repairs. Often simple remedial work can stall continuing deterioration of a window. However there may well be a point where repair cannot be justified. Then the decision will have to be made whether to renew the window or a significant part of it.

Sash and case windows are constructed in a way that permits continual repair of their major parts. However the overall degree of intervention that is acceptable will need to be decided at the outset, to avoid unnecessary and potentially damaging disturbance of original or historic fabric and finishes.

Guidance is provided in the following section on the specification of appropriate repairs. Crafts people with suitable skills are essential to ensure the repair is carried out satisfactorily.

DEFECT AND (PROBABLE) CAUSE.	SUGGESTED REPAIR (GUIDE REFERENCE IN BRACKETS)
1.0 Visible Defects	
1.1 Visible gap at cill. (Twisted casement frames or weights being prevented from performing full travel in weight box.)	Check and free snagged weights. (7.3.2) Remove lower sash and piece in additional timber to bottom rail.(4.3, 6.1.3)
1.2 Meeting rails not level. (Twisted, warped or excessively worn sashes.)	Check and replace sash cords. Remove both sashes and piece in new timbers to each side to square up sashes. (4.8, 6.1.3, 7.3.1)
1.3 Opening up of mortice joints in sashes, showing through paint finish. (Mortices snapped or being eased apart, due to excessive force in use.)	Strengthen sash by adding metal angle plates across corners. (4.3) Take out glass from sash; take apart the sash frame members and piece in new timbers at ends with new mortices and/or tenons. (6.1.3)
1.4 Broken sash cords. (Wear and tear in old cords. If new cords are broken this may be due to under-sizing of cord for heavy sashes, or cord snagging on pulley wheel.)	Take out sashes and weigh them to ensure correct weights. Replace weights or amend as necessary. Renew sash cord. Check sash pulleys free from defects. (4.8, 7.3.1)
1.5 Broken or cracked glass. (External accidental damage or vandalism. Small diagonal cracks in corners often indicate distortion in sash frame.)	Small corner cracks in valuable glass will probably be acceptable. Remove broken glass without damaging timbers and re-glaze as necessary. (4.4, 6.1.7)
1.6 Flaking or missing paint. (Deterioration of old paint system, or may indicate excess moisture levels in under-lying timber.)	Check moisture levels in timber and correct associated defects. Remove loose paint layers back to a sound base. Prepare and re-paint windows using an appropriate paint system. (4.3, 4.6, 6.1.9, 7.2)
1.7 Timber missing or damaged.	Consider requirement for piecing in new timber. This will

	(May be due to localised decay (e.g. in cills), but elsewhere is likely to be as a result of physical impact damage.)	depend on chosen criteria. Decayed timber should be cut out (first removing glass if necessary), and replaced with matching sections. (4.3, 6.1.3, 6.1.4)
1.8	Previous repairs. Evidence may include metal strengthening angles. (Often metal angles are used to secure broken mortice joints in sashes.)	No work may be necessary. Metal angles may continue to perform their function. If necessary replace by re-making mortices as described above. (4.3, 6.1.3)
1.9	Missing or defective putty. (Deterioration due to ageing process or where, following repairs, putty has not been re-painted correctly.)	Cut out defective putty, repair the missing section using appropriate and compatible material. New putty should not be painted until 28 days after it has been installed. (4.5, 6.1.7)
1.10	Missing or defective mastic or other sealant at joints with masonry wall /frame. (Deterioration due to ageing process or where actual movement in either casement frame or masonry has caused mastic to fail. Applying paint to mastic can accelerate loss of its flexing properties.)	Cut out defective mastic. Ensure adequate packing of any excessive gap between frame and masonry wall, using suitable packing material. (Rolled newspaper has traditionally served well, but modern expanding foams have been successfully used). Replace mastic using appropriate and compatible material. (4.5, 6.1.7)
1.11	Missing or defective cill bedding. (Deterioration of (lime) mortar bedding from external sources such as driven rain or other concentrations of water (e.g. from overflowing rhones).)	Rake out defective material, place replacement bedding mortar, thoroughly packing it to the full depth of the cill. Rake back to form a recessed drip below the edge of the frame. (4.5, 6.1.7)
2.0	**Hidden Defects**	
2.1	Window closes by gravity. (Sash weights may be inadequate, or new, heavier glass may have been fitted.)	Take out sashes and weigh them to ensure correct weights. Replace weights or amend as necessary. Renew sash cord. Check sash pulleys free from defects. (4.8, 7.3.1)
2.2	Timber decay in cill. (External weathering accelerated if lack of paint finish, or where timber comes in direct contact with masonry.)	Replacement of either the front part or whole cill using new matching timber can be done with the window in situ. Routing tools will be needed to form proper joints in the frame. (4.3, 6.1.4)
2.3	Timber decay or defects in parting beads. (External weathering. Water running down face of window glazing is often concentrated here by being driven by the wind.)	Parting beads are often best replaced in their entire length. The lower sash will have to be removed while this is done. (4.3)
2.4	Timber decay or defects in sash frame, commonly at lower railsand mortice joints of upper or lower sashes.(External weathering, as above, or frequently due to excess internal condensation gathering on horizontal frame members.)	Replace missing tenons or mortices as described above. (4.3, 6.1.3)
2.5	Timber decay within hidden parts of frame. (External weathering, as above, or due to more distant outbreak finding an environment, within the weight pocket, which encourages the development of the rot.)	Remedy sources of moisture ingress. Ventilate the affected area as much as possible, by opening shutters and weight pockets, carefully setting aside ingo linings. Chemical treatments are rarely necessary on dense pine or oak window joinery.
2.6	Split external part of glazing bars. (Frequently occurs due to repair of broken glass, in removing old putty from the glazing bar check.)	Piecing in missing part is unlikely to be successful over anything other than a short length. In which case full astragal should be replaced, first carefully removing the adjacent glass. (4.3, 6.1.5)

2.7	Incorrect weights. (Due to gradual replacement of thinner crown glass with modern float glass, causing sashes to increase in weight.)	Weigh sashes and weights, replace or create additional weight as necessary, ensuring the new weights can run freely. Consider need to upgrade sash cord capacity. (7.3.1)
2.8	Debris in weight pockets. (Commonly due to gradual erosion of mortar or soft sandstones within the core of the wall.)	Remove weight pocket covers, usually found by removing paint locally in outer face of window frame, and clear debris, before replacing cover. (7.3.2)
3.0	**External Factors**	
3.1	Shutters will not open. (Shutters may simply be stuck with layers of paint, or nailed shut.)	Carefully prise open shutters, removing any fixings. Remove excess paint. (4.7)
3.2	Shutters open with difficulty. (Hinges on shutters may be damaged or require overhauling. Frequently shutters with back flaps suffer from distortion, causing parts to catch on the surrounding frame during operation. This could also be caused by distortion of the structural opening, depressing the soffit linings and causing the shutter to snag. (See below).	Take off and set aside shutters, check dimensions. Rectify external causes of deflection where possible. Reinstate shutters, 'easing' as required. (4.7)
3.3	Split panels in shutters or ingo linings. (May be due to changes in moisture levels in timber.)	No work is required. Fill cracks and redecorate.
3.4	Damp plaster in ingo linings or behind shutters. (Lack of ventilation can cause minor efflorescence on plaster, but more significant moisture is likely to be the result of some external building defect, or of a change of internal environmental conditions.)	Remedy external sources of moisture. Remove defective plaster. Ensure adjacent timbers are dry, and fixings securing window are sound before replacing plaster.
3.5	Structural opening defects or distortion. (There may be evidence of historic movement, due to settlement or changes in ground or support conditions, but recent movement may be due to ongoing problems, such as decaying timber safe lintels.)	Investigate causes of deflection, using non-destructive techniques where possible. Note that window frames should be set plumb, level and square in openings to ensure that sashes can operate correctly.
3.6	Decayed timber ingo linings or panelling. (Likely to be the result of some external building defect, or of a change of internal environmental conditions.)	Remedy external sources of moisture. Carefully dismantle and set aside decayed components. Check window frame is sound before repairing and reinstating linings.

APPENDIX D
GLOSSARY

Architrave
A moulded frame surrounding a door or window.

Arris
A sharp edge produced by the meeting of two surfaces. (Plural: arrises).

Astragal
Originally from a specific entablature moulding of circular section, now commonly used in Scotland to describe a glazing bar.

Baton rod
A timber bead fitted on the inner edge of the frame in a sash and case window.

Bottom rail
The lowest rail on a sash frame.

Case
A built up frame for the sashes of a sash and case window; the hollow vertical side section of the frame to contain the counterweights.

Casement
A window frame to which sashes are hinged, as opposed to a case within which sashes are hung.

Cill (Sill)
The lower horizontal frame of a window case.

Cord clutch
A device through which a sash cord passes, below the counterweight pulley, allowing the cord to be gripped firmly when operating Simplex hinges.

Cord grip
A small metal cylinder that can be 'crimped' onto the cut end of a sash cord, and hooked onto the upper end of the sash stile. It allows the cord to be quickly removed from the sash during maintenance or cleaning. See also knot-holder.

Crown glass
Historic glass, made by cutting panes from a disc of spun molten glass.

Cylinder glass
Historic glass, made by opening out and flattening a cylinder formed by blowing molten glass.

Elbow lining
A timber panel, lining the window ingo beneath the jamb or shutter panel.

Float glass
Modern glass made flat by extrusion and polishing.

Glazing bar
Moulded timbers sub-dividing a sash into small panes, often known as astragals.

Heart wood
Timber converted from the heart of a tree, providing a dense and more resinous material.

Horns
A projection. In a sash window the sash stiles project beyond the rails, allowing a full tenon joint to be formed.

Ingo
The face of a door or window opening, where the wall turns at right angles to the main external face.

Inner lining
The inside facing on a window case, forming the enclosure for the counterweights.

Kames
Grooved lengths of lead soldered together to make a frame for glass.

Knot holder
A device for securing a sash cord onto a sash. See also cord-grip.

Maintenance
Routine work necessary to keep a window in good order.

Margin panes
Narrow panes of glass at the edge of a sash, originally a device to provide the widest possible central panes, but later used as a stylistic feature.

Mastic
A gum or resin, a combination of burnt sand and boiled linseed oil used to seal the outer face of a window frame to the enclosing wall.

Meeting rail
The top rail of the lower, or bottom rail of the upper sash, which close closely together to form a weather-tight joint.

Mortice
A housing cut into a rail or frame, into which a tight-fitting tenon can be inserted.

Outer lining
The outside facing on a window case, forming the enclosure for the counterweights, and sealing the case against water penetration.

Ovolo and fillet
A type of decorative moulding applied to sash frames and glazing bars.

Parting bead
A thin timber section, fixed onto the case, and used to separate two vertical sliding sashes.

Plate glass
Made by casting glass on a bed and then polishing it to produce an even surface.

Pulley
A grooved wheel on an axle, fixed to a window case, over which the sash is hung.

Pulley stile
The side member of a window case.

Putty
(Glazier's putty). A malleable raw material, which hardens in air, used for bedding glass into frames and to make a weatherproof fillet of face putty outside the glass. Made from whiting mixed with linseed oil. Historically white lead may have been added.

Repair
(Of a window). Carrying out work beyond the scope of regular maintenance, to remedy defects, the object of which is to return the window to good order without alteration or restoration.

Replacement
(Of a window). The removal of an original or later sash and case window and the installation of a modern substitute, not exactly matching the original. The 'replacement window industry' is now a widely recognised term.

Renewal
(Of a window). The removal of an original or later sash and case window and the installation of a new window, exactly matching the original.

Sap wood
The outer wood in a tree. Lighter in colour, it decays more easily than heartwood, but is not necessarily weaker.

Sash
Any framed light of a casement or sliding sash window.

Sash cord
A cord secured to the side of a sash frame, passing over a pulley and tied to a sash counter-balance weight. In heavier windows with plate glass, sash chains may have been used.

Sash eye
A form of sash lift. It can also be fitted to the upper rails of top sashes, allowing them to be drawn down, often using a hook mounted on a hand-held pole.

Sash fastener
A fastening on the meeting rail of one sash which, when swung across, engages with that of the other.

Sash lift
A metal pull or hook on a sash, with which to lift and open it.

Sash pull
A form of sash lift.

Sash stile
The side member of a sash frame.

Sash weight
The counter balance fixed onto a sash cord, assisting in the movement of the sash when it is opening or closing.

Shutter
A wooden cover that fastens over a window. In a sash window the shutter is placed on the inside, and is hinged from its frame. In the open position it forms the upper part of the elbow lining.

Shutter back flap
An extension to the shutter that is not visible when closed against the window ingo, but is required to fully cover the opening when in the open position. It is hinged off the first part of the shutter.

Shutter knob
A small knob, in metal or wood, used to pull the shutter from its ingo housing.

Simplex fittings
A combination of ironmongery fitted to sash windows specifically where the lower sash is to open inwards for cleaning. See illustration in chapter 5.

Soffit lining
The board or panel lining the internal window opening at its head.

Sprig
A small wire nail with no head, used to hold glass in place.

Tenon
The end of a rail or frame member, reduced in area to allow it to enter a mortice cut into another rail.

Top rail
The upper (normally) horizontal frame of a sash.

Upgrading
(Of a window). The improvement of the technical performance of a window through physical alteration, usually to provide better resistance to external climatic conditions, under the headings of water-tightness, air permeability and wind resistance.

Window back
The panelling or other internal joinery between the floor and a window cill.

Window case
The outer window frame, within which the sashes slide.

Yorkshire sash
Type of window, traditionally common in parts of Yorkshire, where the sashes slide horizontally within frames that are grooved at the cill and head.

APPENDIX E
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APPENDIX F
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(as at September 2002)

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  hs.conservation.bureau@scotland.gsi.gov.uk

- EDINBURGH WORLD HERITAGE TRUST
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  www.ehwt.org.uk
  info@ewht.org.uk

- SCOTTISH EXECUTIVE
  DEVELOPMENT DEPARTMENT
  Building Standards Division
  Area 2-H
  Victoria Quay
  Edinburgh, EH6 6QQ.
  T – 0131 244 7449 F – 0131 244 7454
  alan.murchison@scotland.gsi.gov.uk

- ENGLISH HERITAGE
  23 Savile Row
  London, W1X 1AB.
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  www.english-heritage.org.uk
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Performance testing facilities

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  University of Paisley
  High Street
  Paisley, PA1 2BE.
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  martin.arthur@paisley.ac.uk

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  bwf@bwf.org.uk

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