SKYLIGHTS AND DOME ROOFLIGHTS

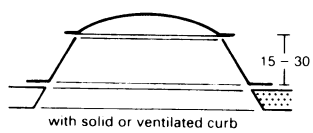
Domes, skylights, coffers, smoke vents and louvres, as fixed or moving units, can be used for lighting and ventilation, and for clearing smoke from rooms, halls, stair wells etc. All these can be supplied in heat-reflecting Plexiglas if required.

By directing the dome towards the north (in the northern hemisphere), sunshine and glare are avoided → ④. The use of high curb skylights → ① will reduce glare because of the sharp angles of incidence of the sunlight. Dome rooflights used for ventilation should face into the prevailing wind in order to utilise the extraction capacity of the wind. The inlet aperture should be 20% smaller than the outlet aperture. Forced ventilation, with an air flow of 150–1000 m^3/h, can be achieved by fitting a fan into the curb of a skylight → ②. Dome rooflights can also be used for access to the roof.

Attention should be given to the aerodynamic extraction surfaces of smoke exhaust systems. Orientating each extraction unit at an angle of 90° from the adjacent one will allow for wind coming from all directions. Position to leeward/windward if pairs of extraction fans are to be mounted in line with or against the direction of the prevailing wind.

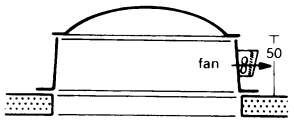
Smoke extraction vents are required for stair wells more than four complete storeys high. Variable skylight aperture widths up to 5.50 m are available, as is a special version up to 7.50 m wide which does not need extra support.

Skylight systems offer diffuse room lighting which is free from glare → ⑭. North-facing skylights with spun glass fibre inlays guarantee all the technically important advantages of a workshop illuminated by a north light → ⑬. Traditional flat roofs can be modified to admit a north light by inserting skylights with curbs.



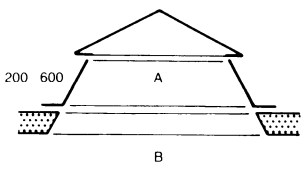
60 × 60	1.20 × 2.40	1.80 × 2.40
80 × 80	1.25 × 2.50	1.80 × 2.70
90 × 90	1.50 × 1.50	1.80 × 3.00
1.00 × 1.00	1.50 × 1.80	2.20 × 2.20
1.00 × 2.00	1.50 × 2.40	2.50 × 2.50
1.20 × 1.20	1.80 × 1.80	
1.20 × 1.80		
round domes: 60, 90, 100, 120, 150, 180, 220, 250 cm dia.		

① **'Normal' dome rooflight**



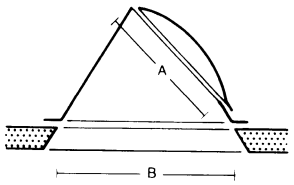
50 × 1.00	1.00 × 1.00	1.20 × 1.50
50 × 1.50	1.00 × 1.50	1.20 × 2.40
60 × 60	1.00 × 2.00	1.50 × 1.50
60 × 90	1.00 × 2.50	1.50 × 3.00
90 × 90	1.00 × 3.00	1.80 × 2.70

② **Dome rooflight with high curb**



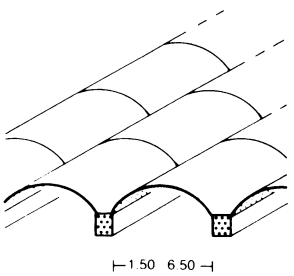
A	B	C	D
40	60 × 60	1.6	1.80 × 1.80
70	90 × 90	1.7	2.00 × 2.00
80	1.00 × 1.00	2.20	2.00 × 2.20
1.00	1.20 × 1.20	2.30	2.50 × 2.50
1.30	1.50 × 1.50	2.40	2.70 × 2.70

③ **Pyramid rooflight**

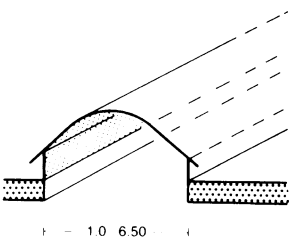


A = rooflight area	B = roof opening
72 × 1.20 × 1.08	1.25 × 1.25
72 × 2.45 × 2.30	1.25 × 2.50
75 × 1.16 × 76	1.50 × 1.50

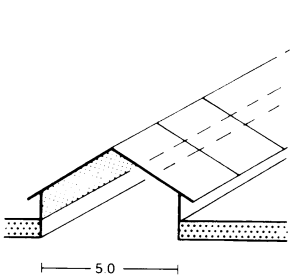
④ **North light dome**



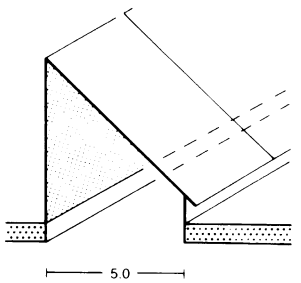
⑤ **Continuous multiple barrel skylights**



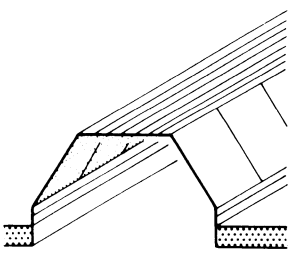
⑥ **Continuous barrel skylight**



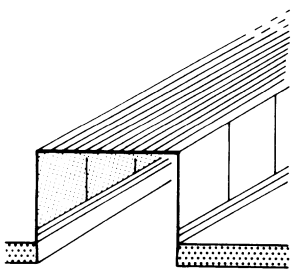
⑦ **Continuous double-pitched skylight**



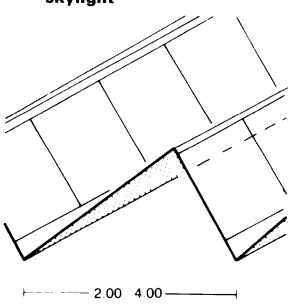
⑧ **Continuous mono-pitched skylight**



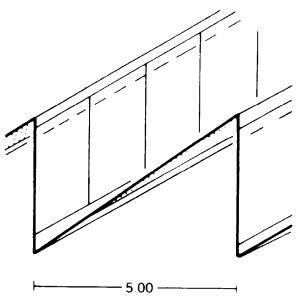
⑨ **Monitor rooflight with inclined panes**



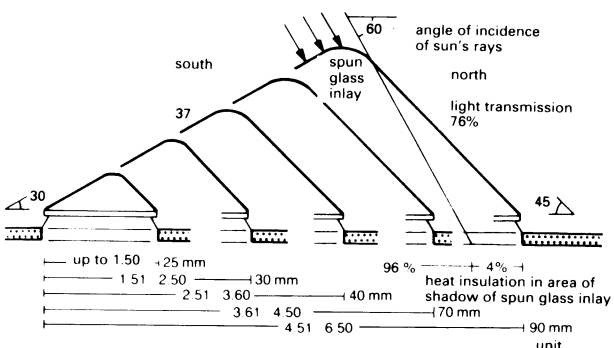
⑩ **Monitor rooflight with vertical panes**



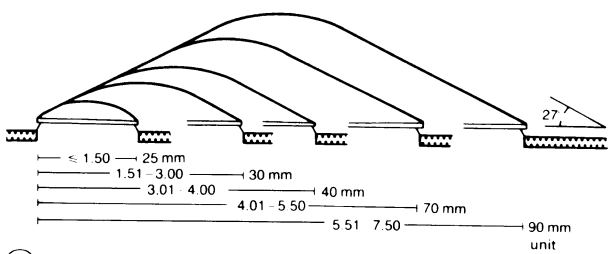
⑪ **60° saw-tooth north light**



⑫ **90° vertical saw-tooth north light**

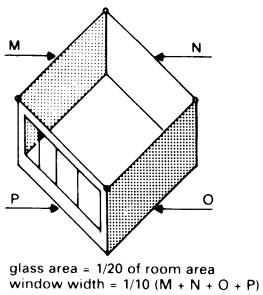


⑬ **Saw-tooth glass fibre-reinforced polyester skylight**

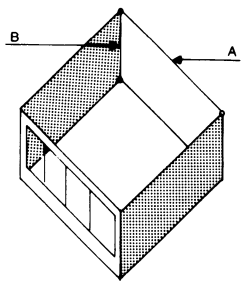


⑭ **Double-skinned rooflight units**

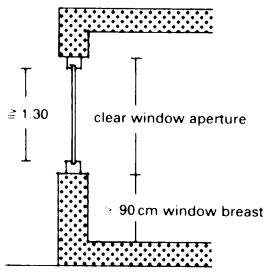
WINDOWS: SIZES



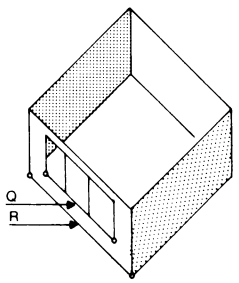
① **Window sizes for industrial buildings**



② **Window size ≥ 0.3 A × B**



③ **Section of façade**



④ **Width of the window aperture Q ≥ 0.5 R**

If daylight is considered to be essential for the use to which a room will be put, then windows are an unavoidable necessity. Simple apertures for daylight have developed into significant stylistic features, from Romanesque semi-circular arched windows to Baroque windows surrounded by rich, elaborate decoration. In the European cultural region lying north of the Alps, window forms reveal particularly strong features. In contrast to the climatically favoured cultural region of the Mediterranean, daily life here mainly had to be spent indoors. The people were thus dependent upon daylight because artificial light was expensive and good illumination of a room during the hours of darkness was beyond the means of most of the local population.

Every work area needs a window leading to the outside world. The window area which transmits light must be at least 1/20 of the surface area of the floor in the work space. The total width of all the windows must amount to at least 1/10 of the total width of all the walls, i.e. 1/10 (M + N + O + P) → ①.

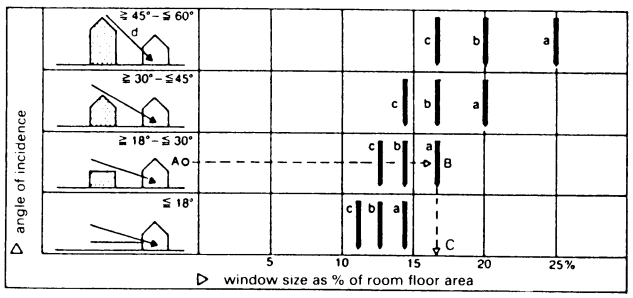
For workrooms which are 3.5 m or more high, the light transmission surface of the window must be at least 30% of the outside wall surface, i.e. ≥ 0.3 A × B → ②.

For workrooms with dimensions similar to those of a living room, the following rules should be applied.

Minimum height of the glass surface, 1.3 m → ③.

Height of the window breast from the ground, ≥ 0.9 m.

The total height of all windows must be 50% of the width of the workroom, i.e. Q = 0.5R → ④.



⑤ **Window sizes in domestic buildings**

Example → ⑤

A For a flat, angle of incidence of light 18°–30°

B Necessary window size for the living room

C 17% of the room floor surface area is sufficient for the size of the windows.

The slope of the roof surface is known. A skylight with a slope of 0° needs to be only 20% of the size of a vertical window to make the room equally bright – however, there is no view. Windows are generally the poorest point in terms of heat insulation. For this reason, it is convenient to fit the room with smaller windows, as long as the solar heat gain through the windows is discounted.

As well as the window size and the slope of the window surface, the siting of the house plays an important role. A free-standing house admits more light with the same surface area of windows than a house in the city centre.

Example → ⑥–⑦

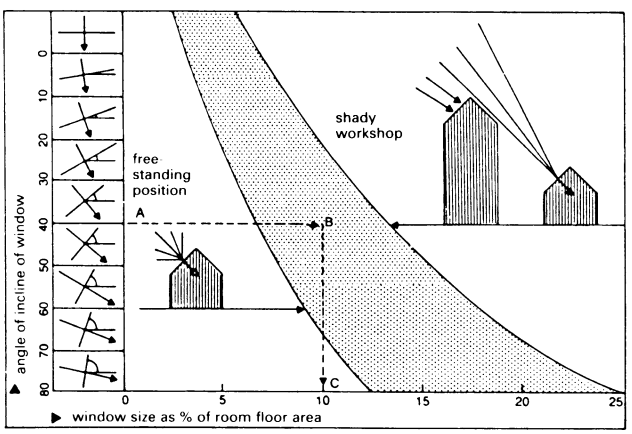
A Slope of a roof window of 40°

B The house is not free standing, but is also not in heavy shadow

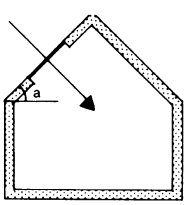
C 10% of the room floor surface area is sufficient for the size of the windows.

When calculating the window size for a living room, both the floor area of the room and the angle of incidence of the light must be taken into account → ⑤. Here, 'a' is the minimum window size for a living room as a percentage of the floor area of the room, 'b' is the minimum size for a kitchen window and 'c' is the minimum size for all other rooms. The angle of incidence of the light is 'd'. The larger the angle of incidence, the larger the windows need to be. This is because the closer the neighbouring houses are, and the higher they are, the greater the angle of incidence and the smaller the amount of light penetrating into the house. Larger windows will compensate for this smaller quantity of light.

Dutch regulations stipulate the sizes of windows in relation to the angle of incidence of the light.



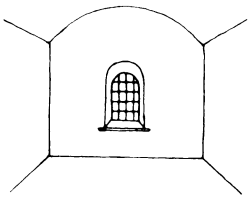
⑥ **Window sizes**



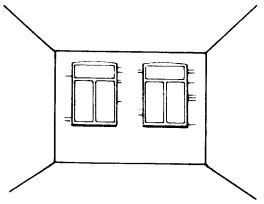
⑦ **Roof window**

WINDOWS: ARRANGEMENT

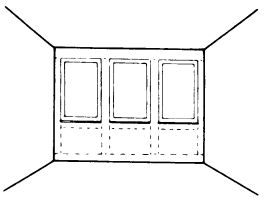
EFFECT ON WIDTH



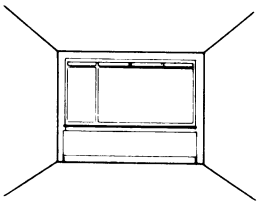
(1) With stone walls



(2) With brickwork

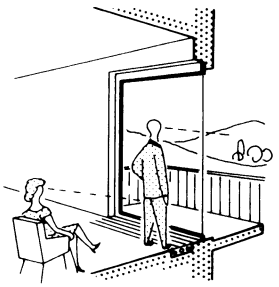


(3) With half-timbered construction

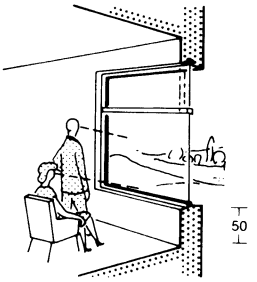


(4) With steel-frame structure
With reinforced concrete

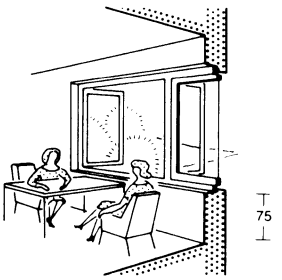
EFFECT ON HEIGHT



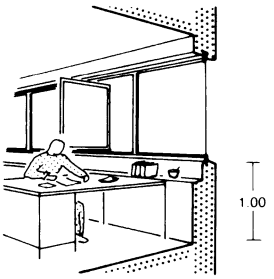
(5) With scenic view and balcony



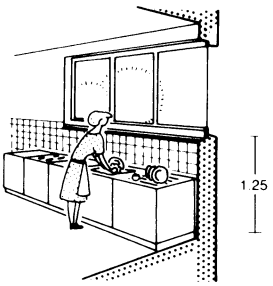
(6) Rooms with a view



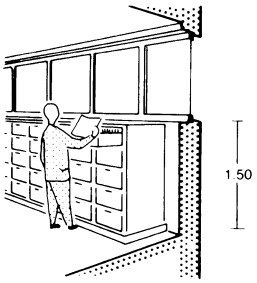
(7) Normal window height



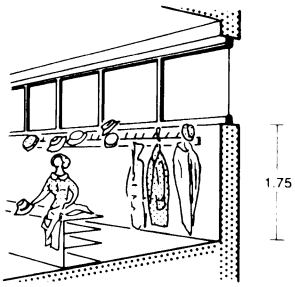
(8) Office



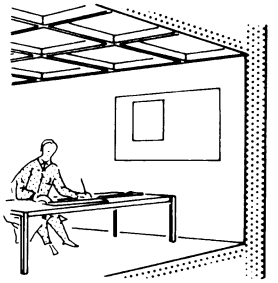
(9) Kitchen



(10) Office (filing room)

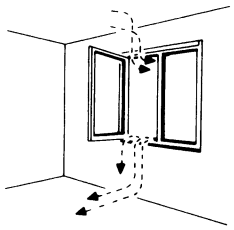


(11) Cloakroom

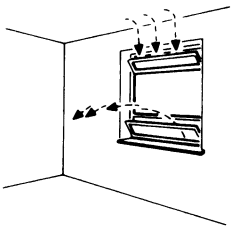


(12) Skylight e.g. drawing office

VENTILATION

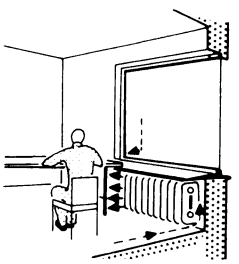


(13) Cool air drawn into room, warm air extracted

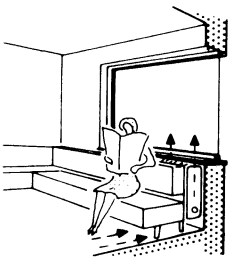


(14) Flap control: ventilation better

HEATING

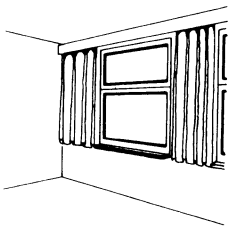


(15) Cold and warm air hitting the seated person (unhealthy)

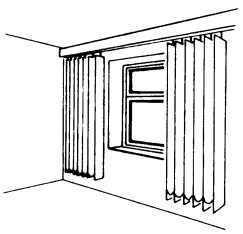


(16) Built-in radiators (convectors) require entry/exit for air

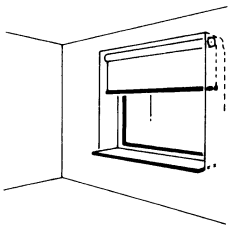
BLINDS AND CURTAINS



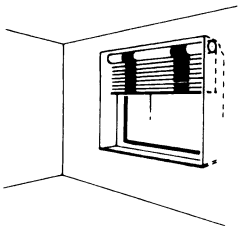
(17) Allow sufficient wall space in corners for curtains



(18) Vertical blinds, slatted curtains



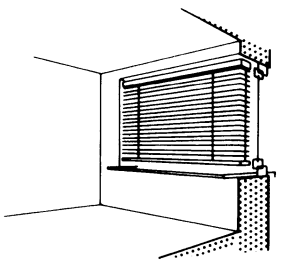
(19) Roller blinds of cloth or plastic



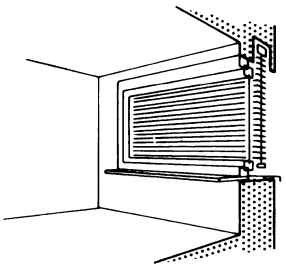
(20) Venetian blind

WINDOWS: SHADING

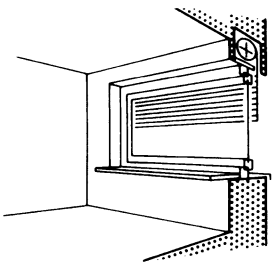
PROTECTION FROM THE SUN



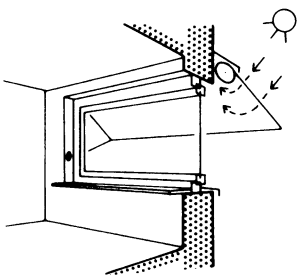
① **Internal venetian blind: sun comes through window (not good)**



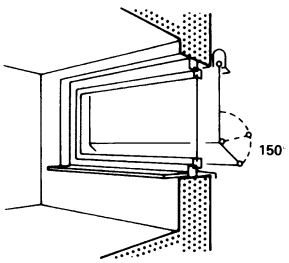
② **External louvred blind**



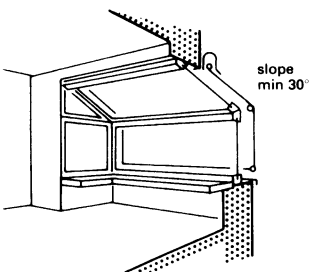
③ **Roller shutter**



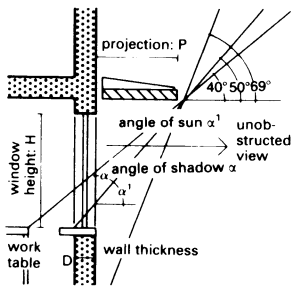
④ **Awning keeps sun's rays and heat at bay**



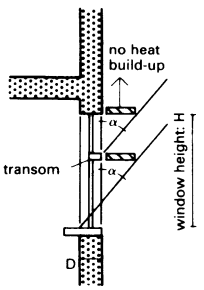
⑤ **Partly angled sun blind**



⑥ **Sloping awning with vertical fringe**



⑦ **Arrangement of single sun shades**



⑧ **Double sun shades**

angles of sun α^1 and angle of shadow α are given for a south wall at latitude 50° north → ⑦ - ⑧

21 June (summer solstice), midday
$\alpha^1 = 63°$; $a = 27°$

1 May and 31 July, midday
$\alpha^1 = 50°$; $a = 40°$

21 March and 23 Sept (equinox), midday
$\alpha^1 = 40°$; $a = 50°$

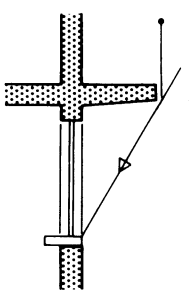
In general, projection P = tg angle of shadow α × height of window H; at the very smallest projection, P = (tg angle of shadow α × height of window H) – wall thickness D.

Protection measures must prevent glare and regulate the inflow of heat from sunlight. In temperate climates, large window apertures with a high but diffuse incidence of light are preferred, whereas in hot climates, small window apertures still allow sufficient light to enter.

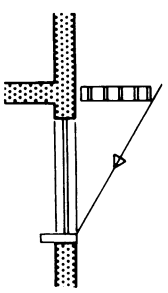
Venetian blinds → ⑬ (with flat slats of wood, aluminium or plastic), roller shutters, roller blinds and partially angled sun blinds are all useful and can be adjusted as required. Fixed external devices are clearly less flexible than retractable or adjustable ones. Vertical panel blinds → ⑮ (either fixed or pivoting around the axis of the slat) are also suitable for tall or angled window surfaces.

Heat rising up the face of a building should be able to escape, and not be blocked by external sun screens or allowed to enter the building via open skylights.

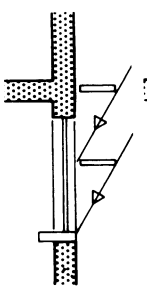
Internal shades are less effective than external ones for reducing solar heat gain because the heat they absorb is released into the room.



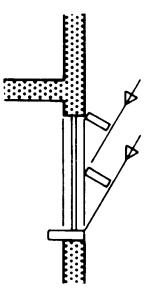
⑨ **Balcony or window ledge**



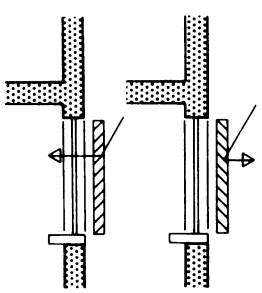
⑩ **Wooden, Al or sheet steel sun shades**



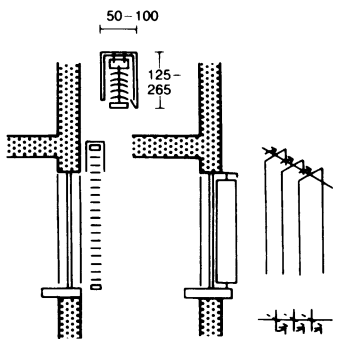
⑪ **Double sun shade**



⑫ **Angled shades**

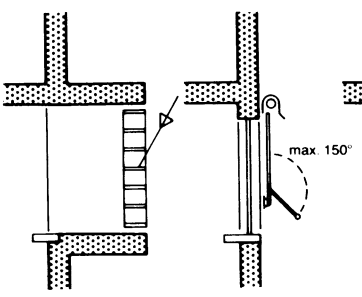


⑬ **Blind alignment gives diffused light or shadow effect**



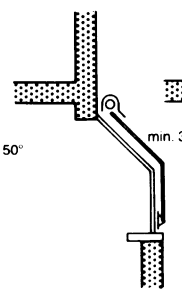
⑭ **Sun-blocking slats**

⑮ **Vertical slats**

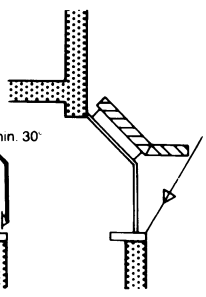


⑯ **Sun screen**

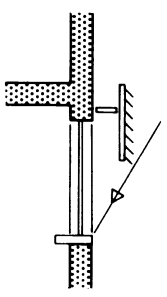
⑰ **Partially angled blind**



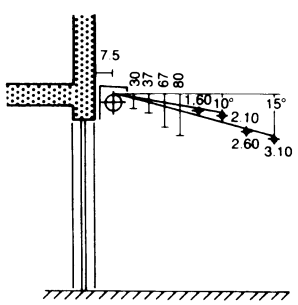
⑱ **Sloping and vertical blind**



⑲ **Cantilevered screen**



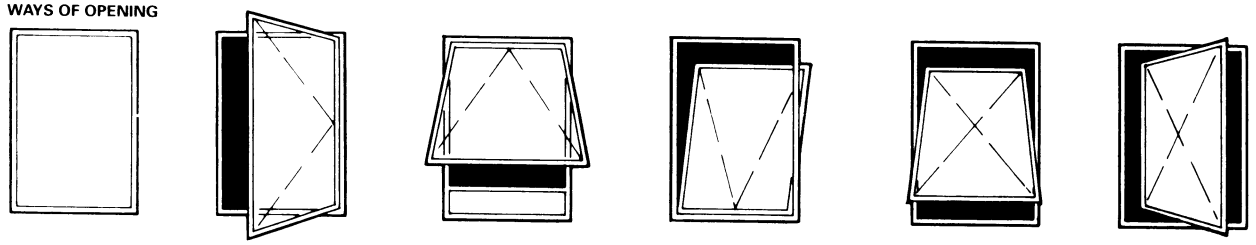
⑳ **Projecting screen**



⑲ **Adjustable awning**

WINDOWS: TYPES AND DIMENSIONS

WAYS OF OPENING



(1) **Fixed light**

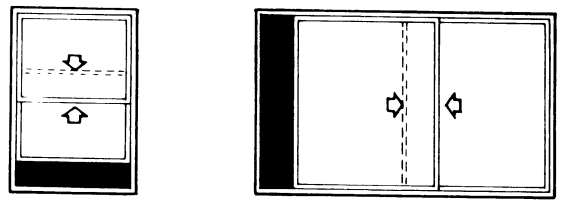
(2) **Casement, side hung**

(3) **Casement, top hung**

(4) **Casement, bottom hung**

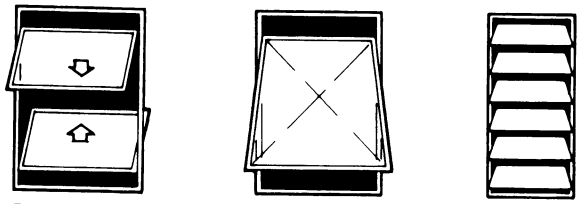
(5) **Horizontally pivoted**

(6) **Vertically pivoted**



(7) **Vertically sliding**

(8) **Horizontally sliding**

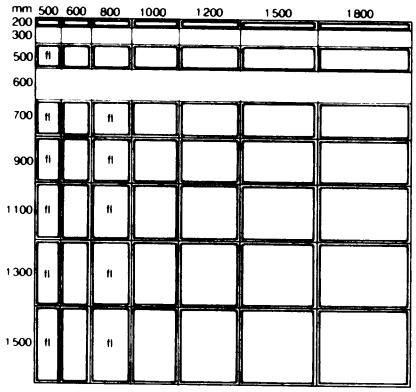


(9) **Linked hopper**

(10) **Projected, top hung**

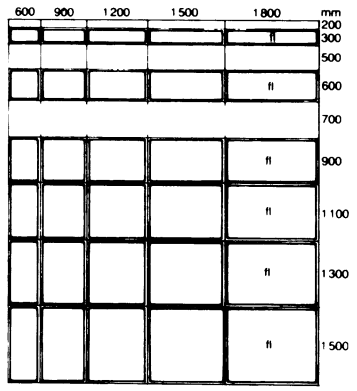
(11) **Louvred**

COORDINATING SIZES



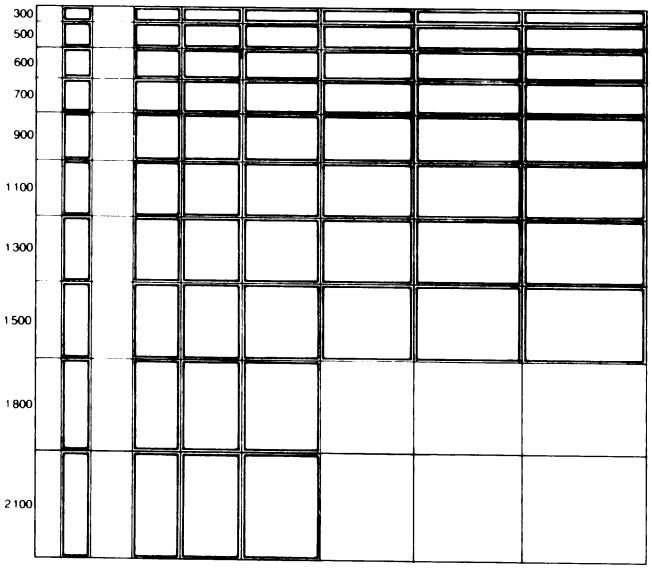
Note: BS and module 100 metric range includes doors & associated mixed lights (not shown); fl = fixed lights

(12) **Ranges of steel windows to BS 990: Part 2 and to 'Module 100 Metric Range' as given by Steel Window Association**

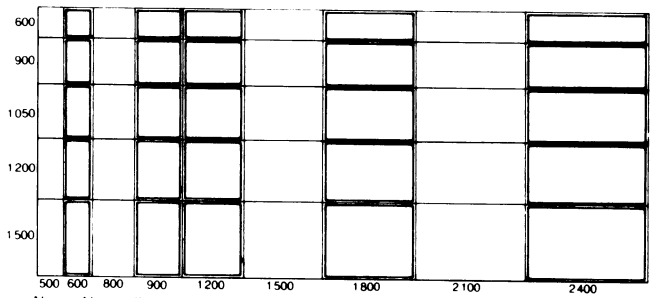


Note: This range also includes 1800 & 2100 h with fixed lights only: 2100 h include doors

(13) **Metric preferred range of W20 steel windows as specified by Steel Window Association**



(14) **Ranges of aluminium windows to BS 4873 – wide range of windows including vertically and horizontally sliding types**



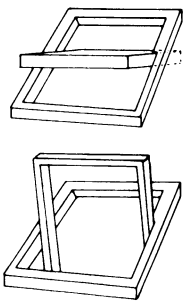
Note: Above diagrams intended for general guidance on overall sizes only; no distinction made between types of opening light; some sizes, fixed lights only (designated fl) obtainable in standard ranges

(15) **Dimensionally coordinated metric sizes for wood windows as recommended by British Wood-working Federation**

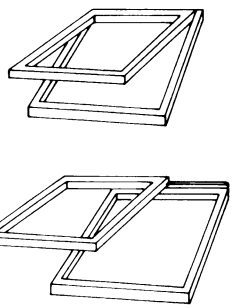
LOFT WINDOWS

In planning the size of windows, the optimum daylight level relative to the purpose of the room must be the deciding factor. For instance, building regulations require a minimum window area of 1/8 of the floor surface area for living rooms → ⑪.

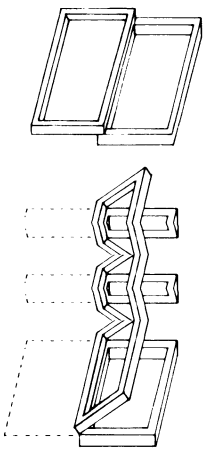
Large windows make living rooms more comfortable. The window width in secondary rooms can be chosen according to the distance between the rafters. Generously wide windows in living rooms can be achieved by the inclusion of rafter trimmers. Steeper roofs need shorter windows, while flatter roofs require longer windows. Roof windows can be joined using purpose-made prefabricated flashing, and can be arranged in rows or in combinations next to or above one another → ⑫ + ⑬



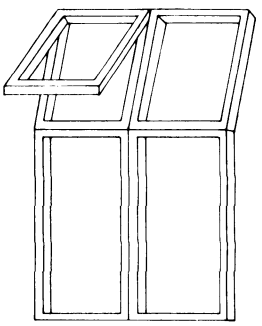
① **Pivoting windows**



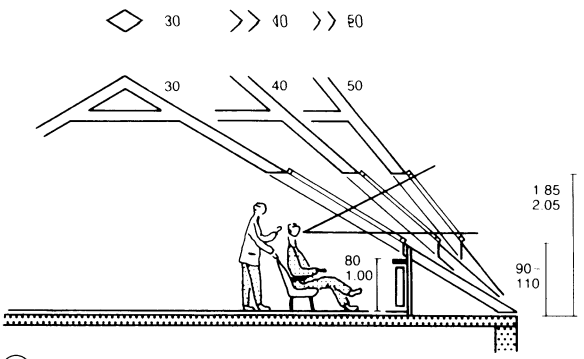
② **Top-hung windows; sliding**



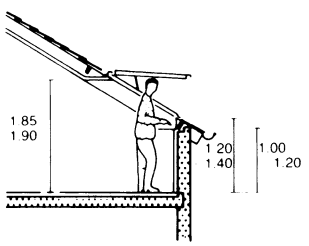
③ **Sliding windows; escape**



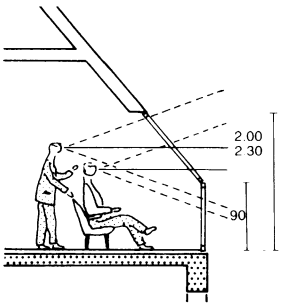
④ **Top-hung window with vertical unit** → ⑫



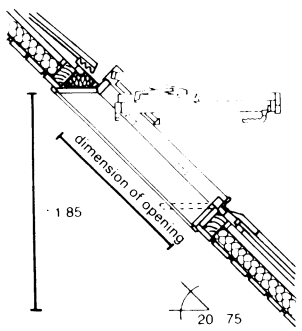
⑤ **Layout of roof windows**



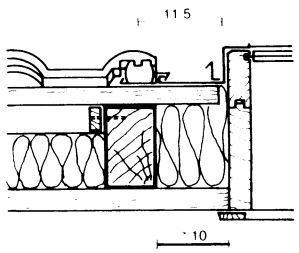
⑥ **At the eaves**



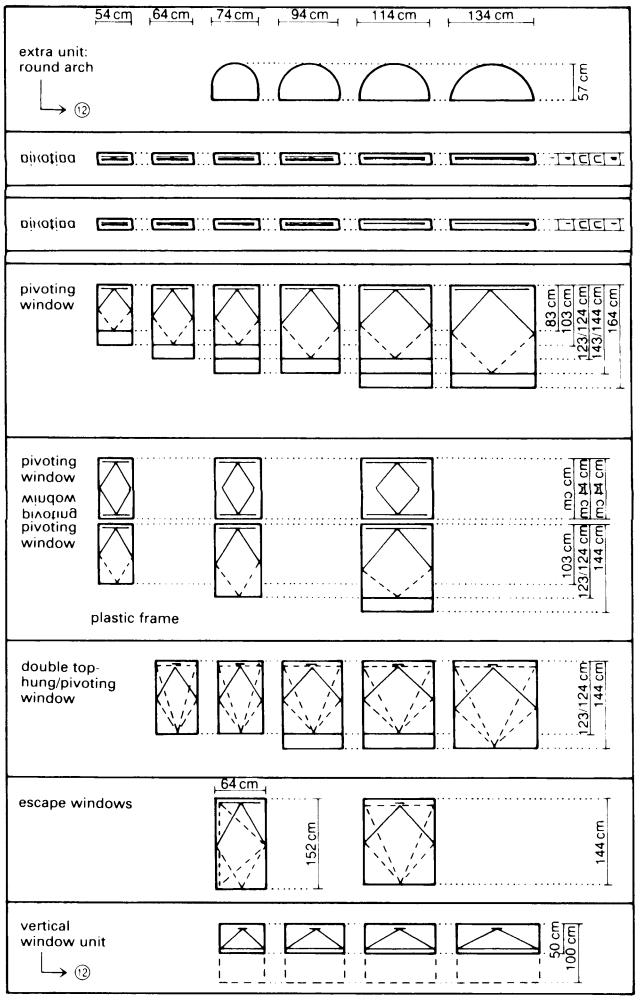
⑦ **With vertical unit**



⑧ **Section of built-in options**



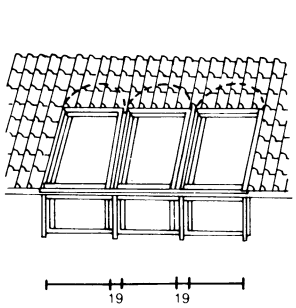
⑨ **Horizontal section**



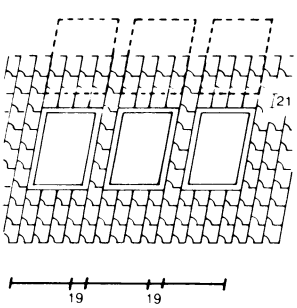
⑩ **Window sizes**

window size	54/83	54/103	64/103	74/103	74/123	74/144	114/123	114/144	134/144
surface area of light admission (m^2)	0.21	0.28	0.36	0.44	0.55	0.66	0.93	1.12	1.36
room size (m^2)	2	2–3	3–4	4–5	6–7	9	11	13	

⑪ **Calculation of window size, in relation to floor area**



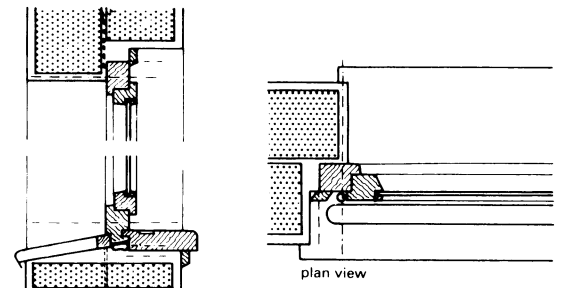
⑫ **Row of windows with vertical window units** → ⑩



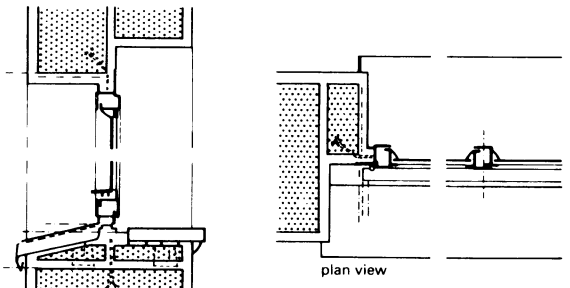
⑬ **Adjacent to/above one another**

WINDOWS: CONSTRUCTION

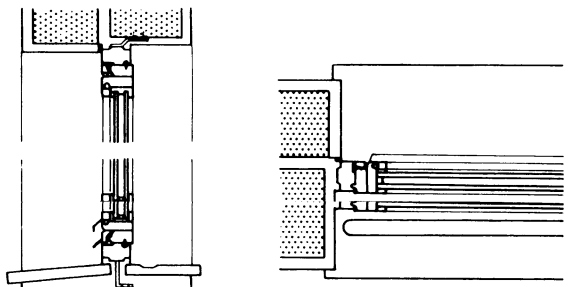
Wooden sections for turning, turn and tilt, and tilting windows have been standardised. Windows are classified according to the type of casement → Ⓐ – Ⓓ or the type of frame → Ⓔ – Ⓗ. The many demands made on windows (e.g. protection against heat and noise) have resulted in a vast range of window shapes and designs → ① – ⑤. Externally mounted windows and French windows must at the very least be fitted with insulation or double glazing. The coefficient of heat transfer of a window must not exceed 3.1 W/m²K.



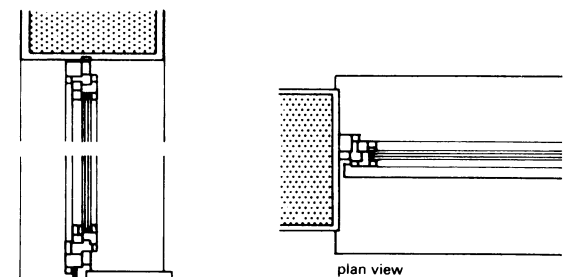
① **Timber windows**



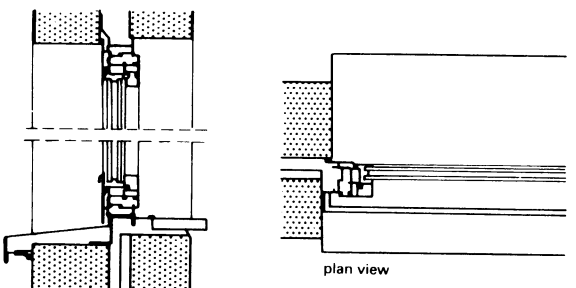
② **Steel windows**



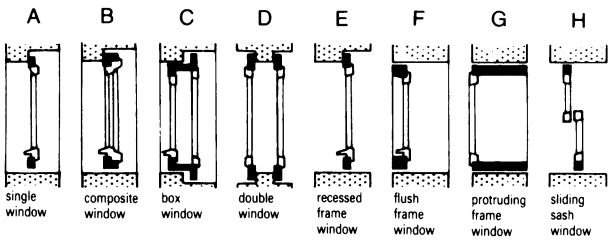
③ **Profiled steel tube windows**



④ **Plastic windows**



⑤ **Aluminium windows**



⑥ **Window types**

	1	2	3	4	5	6	7
	description of glazing	g-glazing[1] $C_G = C_G$ W m^{-2}K^{-1}	C_W for windows and French doors, including frames of material group[2] W m^{-2}K^{-1}				
			1	2.1	2.2	2.3	3
	with use of normal glass						
1	single glazing	5.8	5.2				
2	double glazing: 6 mm ≤ gap < 8 mm	3.4	2.9	3.2	3.3	3.6	4.1
3	double glazing: 8 mm ≤ gap < 10 mm	3.2	2.8	3.0	3.2	3.4	4.0
4	double glazing: 10 mm ≤ gap < 8 mm	3.0	2.6	2.9	3.1	3.3	3.8
5	triple glazing: 6 mm ≤ gap < 8 mm (×2)	2.4	2.2	2.5	2.6	2.8	3.4
6	triple glazing: 8 mm ≤ gap < 10 mm (×2)	2.2	2.1	2.3	2.5	2.7	3.2
7	triple glazing: 10 mm ≤ gap < 16 mm (×2)	2.1	2.0	2.3	2.4	2.7	3.2
8	double glazing with 20 to 100 mm between panes	2.8	2.6	2.7	2.9	3.2	3.7
9	double glazing with single glazing unit (normal glass; air gap 10 to 16 mm) with 20 to 100 mm between panes	2.0	1.9	2.2	2.4	2.6	3.1
10	double glazing with two double glazing units (air gap 10 to 15 mm) with 20 to 100 mm between the panes	1.4	1.5	1.8	1.9	2.2	2.7
11	glass brick wall with hollow glass bricks						3.5

[1] for windows in which the proportion of frame makes up no more than 5% of the total area (e.g. shop window installations) the coefficient of thermal conductance C_G can be substituted for the coefficient of thermal conductance C_W

[2] the classification of window frames into frame material groups 1 to 3 is to be done as outlined below

Group 1: Windows with frames of timber, plastic and timber combinations (e.g. timber frame with aluminium cladding) without any particular identification or if the coefficient of thermal conductance of the frame is proved with test certificates to be $C_W < 2.0$ W m^{-2}K^{-1}
N.B. Sections for plastic windows are only to be classified under Group 1 when the plastic design profile is clearly defined and any possible metal inserts serve only decorative purposes

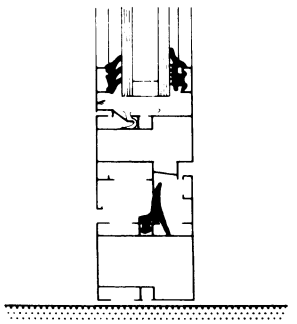
Group 2.1: Windows in frames of thermally insulated metal or concrete sections, if the coefficient of thermal conductance is proved with test certificates to be $C_F < 2.8$ W m^{-2}K^{-1}

Group 2.2: Windows in frames of thermally insulated metal or concrete sections, if the coefficient of thermal conductance is proved with test certificates to be $2.8 < C_F < 3.6$ W m^{-2}K^{-1}

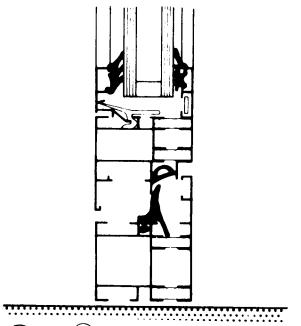
⑦ **Values of thermal conductance for glazing and for windows and French doors including the frames**

WINDOWS: CONSTRUCTION

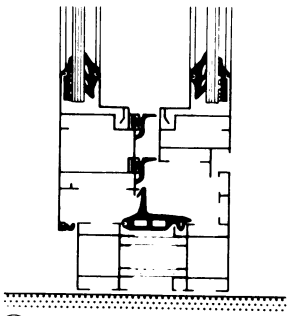
Any window design must satisfy the technical requirements of the relevant parts of the building. The main considerations are the size, format, divisions, way of opening, frame material and surface treatment. Ventilation, thermal and sound insulation, fire resistance and general safety issues, including the use of security glazing, must also be taken into account. The design of the sections and the location and type of sealing are of great importance in guaranteeing a long-lasting water- and draught-proof seal. Built-in components such as roller shutter boxes, window sills and vents must match the noise insulation of the windows → ⑩ – ⑫ as well as other technical specifications.



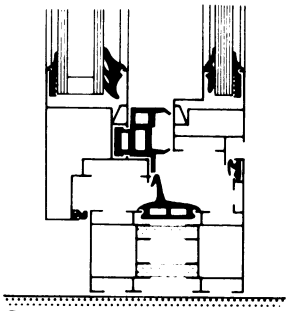
① **Aluminium windows with flush mounted casements**



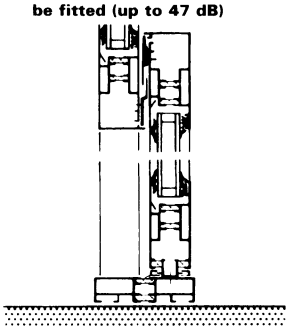
② **As ① but with thermally separated profile sections (up to 37 dB)**



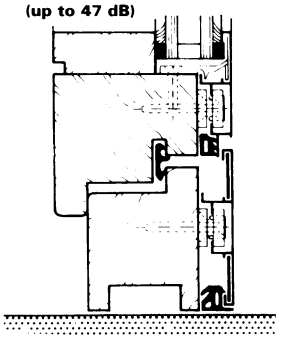
③ **Universal aluminium window into which a sun screen can be fitted (up to 47 dB)**



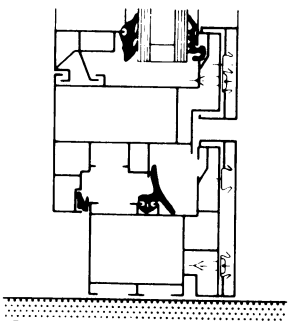
④ **Aluminium thermally separated composite casement window (up to 47 dB)**



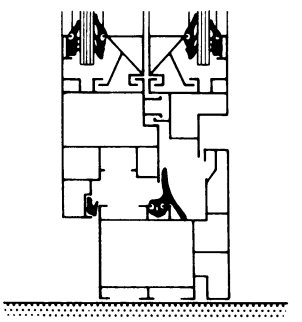
⑤ **Aluminium thermally separated sliding window (up to 35 dB)**



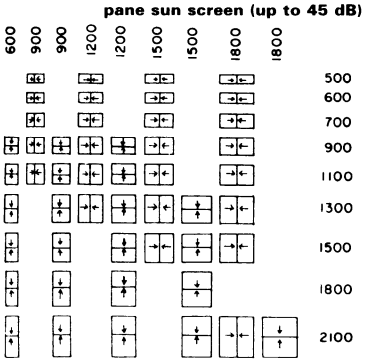
⑥ **Aluminium/timber combination casement window (up to 40 dB)**



⑦ **Plastic window with aluminium facing frame (up to 42 dB)**



⑧ **Plastic double glazed window, composite casement, intra-pane sun screen (up to 45 dB)**



⑨ **Coordinating sizes of (horizontally and vertically) aluminium sliding windows to BS 4873**

type of street	distance: window to middle of road (m)	daytime traffic density: vehicles per hour	noise band
residential street		< 10	0
two-lane residential street	< 35		0
	26–35	10–50	I
	11–25		II
	⩽ 10		III
residential main road (2 lane)	> 100		0
	36–100		I
	26–35	50–200	II
	11–25		III
	⩽ 10		IV
country road, built-up area[1] (2 lane)	101–300		I
	101–300		II
	36–100		III
residential main road (2 lane)	11–35	200–1000	IV
	⩽ 10		III
urban main roads, industrial areas	101–300		IV
	36–100	1000–3000	V
	> 35		IV
main roads 4 to 6 lanes	101–300		V
motorway feeder roads and motorways	⩽ 100	3000–5000	

[1] apply the next highest noise level band for surburban built-up areas and roads in commercial areas

⑩ **How loud is it?**

applicable noise level band	average external noise level (dB)	necessary window sound insulation R_W (dB) in residential habitable rooms of housing [2]
0	⩽ 50	25 (30)
I	51–55	25 (30)
II	56–60	30 (35)
III	61–65	35 (40)
IV	66–70	40 (45)
V	> 70	40 (45)

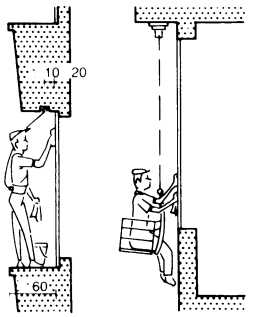
[2] values in brackets apply to outside walls and must also be used for windows if these form more than 60% of the outside wall surface

⑪ **Selecting sound insulation**

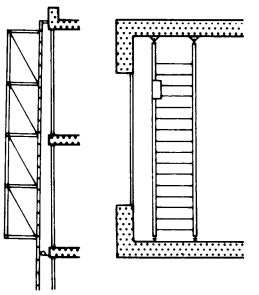
noise insulation class	noise insulation value (dB)	guiding remarks for design characteristics of windows and ventilation equipment
6	50	box windows with separate recessed frames specially sealed and very large gap between the panes; glazed with thick glass
5	45–49	box windows with special sealing, large gap between frames and glazed with thick glass; double glazed composite casement windows with isolated casement frames, special sealing, more than 100 mm between panes and glazed with thick glass
4	40–44	box windows with extra sealing and average density glazing; double glazed composite casement windows with special sealing, over 60 mm between panes and glazed with thick glass
3	35–39	box windows without extra sealing and with average density glass; double glazed composite casement windows with extra sealing, normal distance between panes and glazed with thick glass; sturdy double/triple glazing units; 12 mm glass in fixed or well-sealed opening windows
2	30–34	composite casement windows with extra sealing and average density glazing; thick double glazing units, in fixed or well-sealed opening windows; 6 mm glass, in fixed or well sealed opening windows
1	25–29	double glazed composite casement windows with extra sealing and average density glazing; thin double glazing units in windows without extra sealing
0	20–24	unsealed windows with single glazing or double glazing unit

⑫ **Noise insulation classification for windows**

WINDOWS: CLEANING



① **Mobile safety cradle and safety belt**

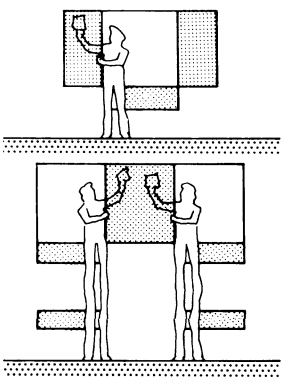


② **Parallel travel safety ladders (for 3 or 4 storeys)**

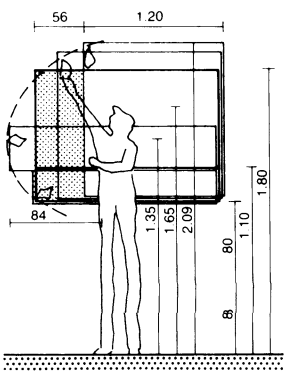
Safety belts with straps, safety cables or safety apparatus for working at heights should be used as a protection against falls → ①.

Façade hoists and mobile equipment (allowing access to fixed glazing) for cleaning windows and façades → ⑧ - ⑪ are available to carry out maintenance and repair work (thus saving the cost of scaffolding). If fitted at the right time, they can be used to carry out minor building work (such as fixing blinds, installing windows etc.). With slight modifications, façade hoists and access equipment can be used as rescue apparatus in the event of a fire. The options available include mobile suspended ladders mounted on rails, trackless roof gantry equipment with a cradle, and a rail-mounted roof gantry with a cradle and attached to the roof deck or the balustrade.

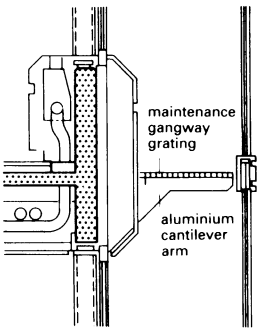
Suspended aluminium ladder equipment (for façade access) → ② consists of a suspended mobile ladder on rails. The width of the ladder is 724 mm or 840 mm, and the total overall length is 25 m maximum, depending on the shape of the building. The maximum safe working load (S.W.L.) is 200 kg (i.e. two men and the apparatus itself). Alternatives are available, such as maintenance gangways → ⑤ and cleaning balconies → ⑥.



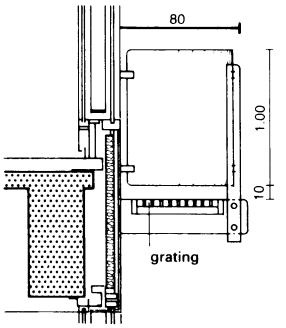
③ **Adjacent window cleaning**



④ **Shading shows acceptable cleaning surface area**



⑤ **Maintenance gangway**

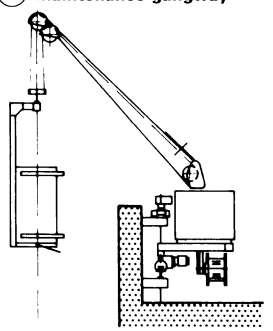


⑥ **Cleaning platform**

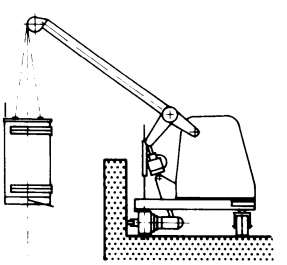
type of building	outside window	roof window
offices	every 3 months*	every 12 months
public offices	every 2 weeks	3 months
shops	every week (inside, 2 weeks)	6 months
shops (high street)	daily	3 months
hospitals	3 months	6 months
schools	3–4 months	12 months
hotels (first class)	2 weeks	3 months
factories (precision work)	4 weeks	3 months
factories (heavy industry)	2 months	6 months
private house	4–6 weeks	–

* ground floor windows must be cleaned more frequently

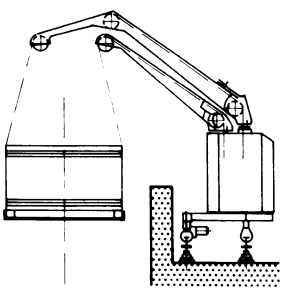
⑦ **Intervals of time for window cleaning**



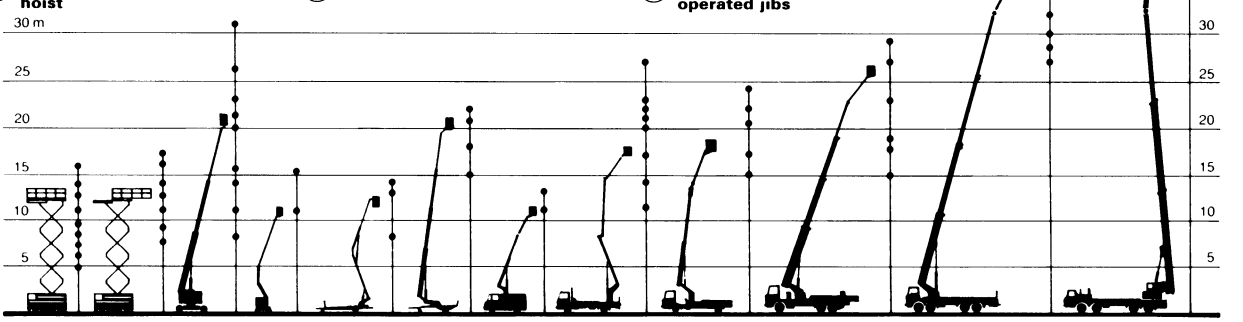
⑧ **One person façade cradle hoist**



⑨ **Parallelogram jib action**



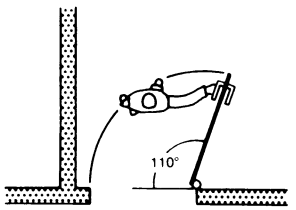
⑩ **With two independently operated jibs**



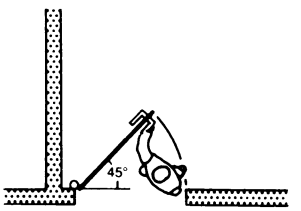
⑪ **Work platform hoists**

Gardemann system

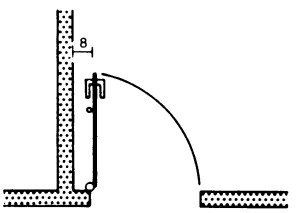
DOORS: INTERNAL



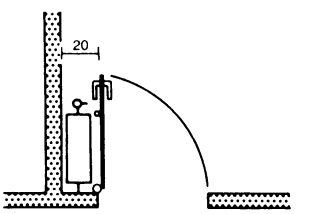
① Generally, wrongly hung



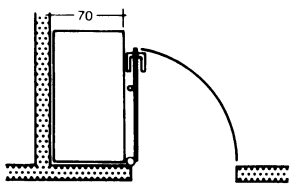
② Generally, correctly hung



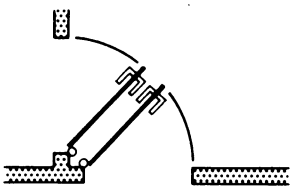
③ Min distance from wall



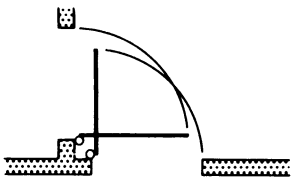
④ With radiator



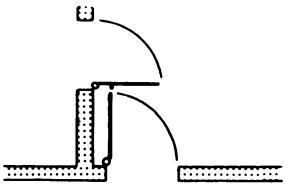
⑤ With cupboard (good arrangement)



⑥ Arrangement of two corner doors, opening into the same room

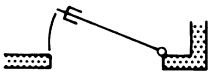


⑦ Two doors wrongly fitted

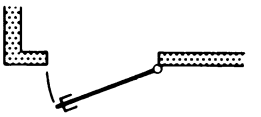


⑧ Two doors correctly fitted

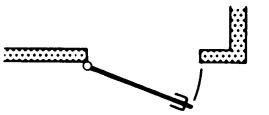
⑨ Hung right



⑩ Hung left



⑪ Hung right



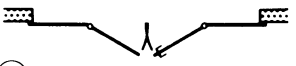
⑫ Hung left

⑬ Paired doors; right-hand lock

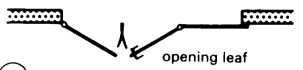
⑭ Swinging double doors; pass through on right

⑮ Pivoting door, eccentrically mounted

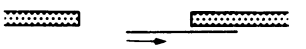
⑯ Pivoting centrally; pass through on the right



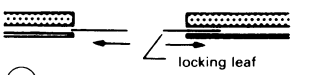
⑰ Four-leaf door



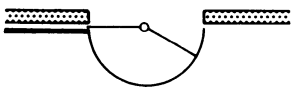
⑱ Three-leaf door



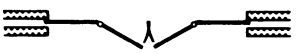
⑲ Sliding door, wall mounted



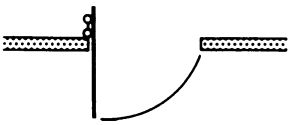
⑳ Sliding door, recessed



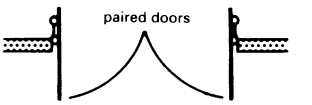
㉑ Sliding door, with hinged leaf



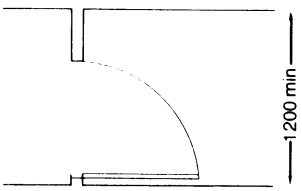
㉒ Four-leaf sliding door, with two hinged pairs



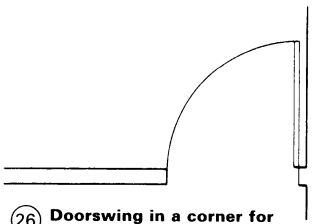
㉓ American 'balanced door'



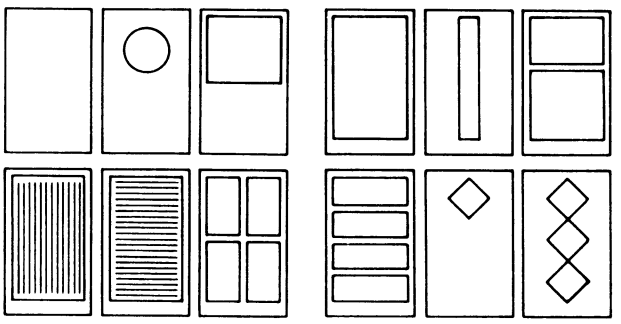
㉔ American 'balanced door'



㉕ Corridor door for wheelchair users



㉖ Doorswing in a corner for wheelchair users



㉗ Door panel shapes

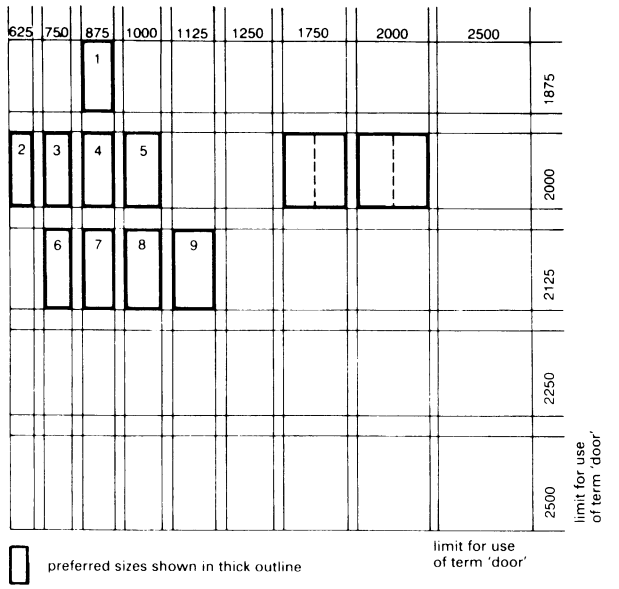
Internal doors must be positioned in order to maximise the usable room space → ① – ⑧. It is necessary to decide whether a door should open inwards or outwards. Normally doors open into the room → ㉕. Door types are named according to their construction, position and purpose. A balanced door › ㉓ + ㉔ requires little strength to open it, and is well suited for corridors.

The width of a door is determined by its use and the room into which it leads. The minimum inside width of a door opening is 55cm. In residential buildings the standard door opening widths are as follows. Single-panel doors: main rooms approx. 80cm; auxiliary rooms approx. 70cm; front doors to flats approx. 90cm; front doors to houses up to 115cm. Double doors: main rooms approx. 170cm; front doors 140–225cm. Door opening height at least 185cm, but normally 195–200cm. Sliding and revolving doors are not permitted for escape or exit doors, as they could block the route in an emergency.

Disabled persons have special requirements. The minimum convenient door width for the ambulant disabled is 80cm. This is too narrow for wheelchair users, but 90cm is usually adequate. There should be adequate space to position a wheelchair beside the door. Corridors should be not less than 120cm wide so that wheelchair users can position themselves to open a door in the end wall of a corridor or at the side. An end door should be offset to give maximum space beside the handle. Similarly, when a door is located in the corner of a room, it should be hinged at the side nearer the corner → ㉕, ㉕

DOORS: SIZES AND FRAMES

The sizes of wall apertures for doors → ① are nominal standard building sizes. If, in exceptional cases, other sizes are necessary, the building standard size for them must be whole number multiples of 125mm (100mm according to British Standards). Steel frames can be used as left- as well as right-hand frames → ⑩.



preferred sizes shown in thick outline

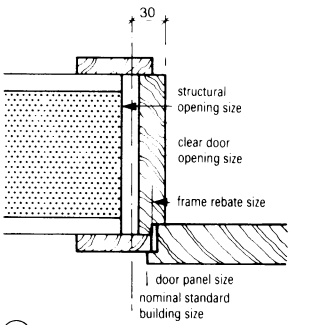
7 the standards give the exact measurements concerning frames and door panels for those sizes which are indicated with a number → ⑧

structural openings for these preferred sizes are, as a rule, for double doors

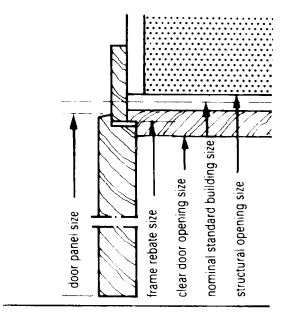
① Typical structural opening sizes to DIN 4172 → ⑧

	nominal standard building size		size of door panel				size of door frame	
	standard structural opening sizes for doors		standard overall door dimensions		door rebate size, nominal dimensions tolerance ± 1	+ 2;– 0	door opening width at the rebate tol. ± 1	door opening height at the rebate tol. + 0; –2
1	875	1875	860	1880	834	1847	841	1858
2	625	2000	610	1985	584	1972	591	1983
3	750	2000	735	1985	709	1972	716	1983
4	875	2000	860	1985	834	1972	841	1983
5	1000	2000	985	1985	959	1972	966	1983
6	750	2125	735	2110	709	2097	716	2108
7	875	2125	860	2110	834	2097	841	2108
8	1000	2125	985	2110	959	2097	966	2108
9	1125	2125	1110	2110	1084	2097	1091	2108

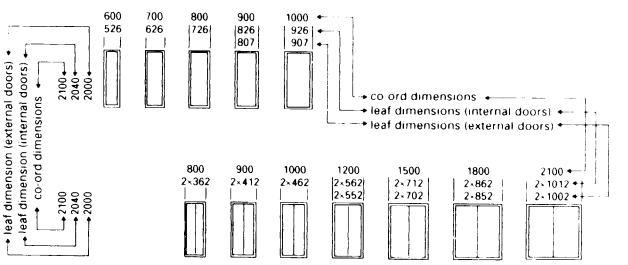
⑧ Standard rebated door panels and door frames



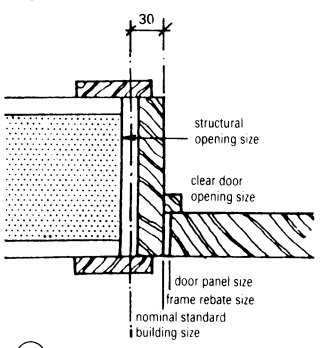
② Width of the door



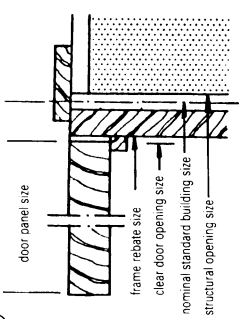
③ Height of the door



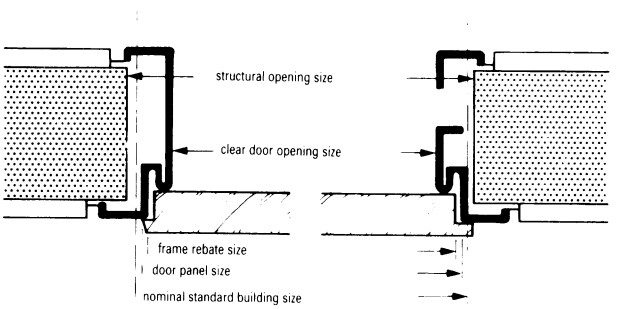
⑨ Sizes of internal and external doors to BS 4787: Part 1



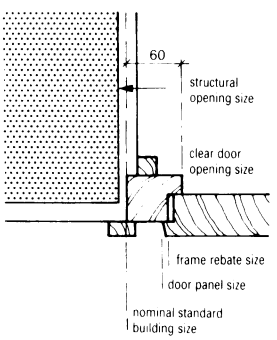
④ Width of the door (UK)



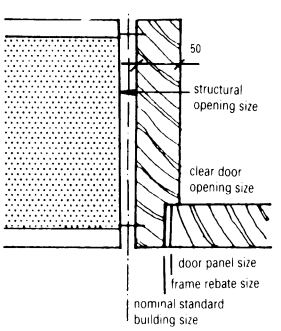
⑤ Height of the door (UK)



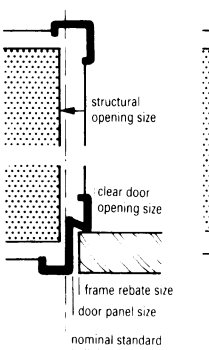
⑩ Standard steel frame types



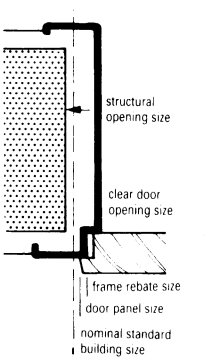
⑥ Recessed door frame



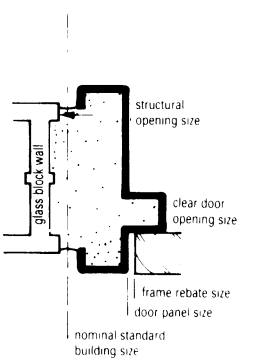
⑦ Full lining door frame (UK)



⑪ Architrave frame

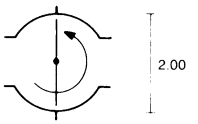


⑫ Combined lining and architrave frame

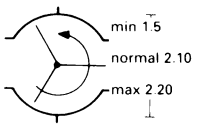


⑬ Full lining frame

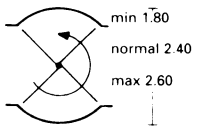
REVOLVING AND SLIDING DOORS



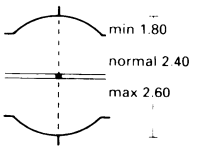
① **Revolving door, two panels**



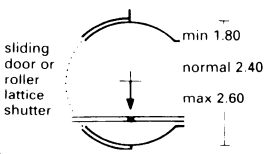
② **With three panels**



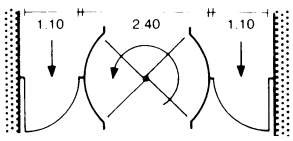
③ **With four panels**



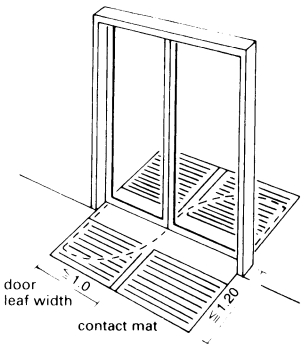
④ **Four panels, folded back**



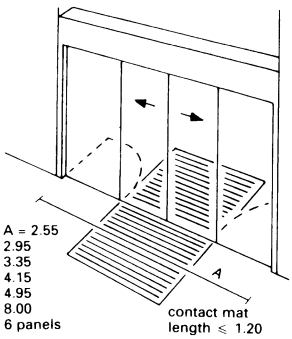
⑤ **Door assembly pushed to side**



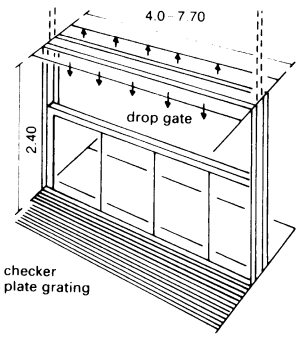
⑥ **Revolving door with extra emergency exits**



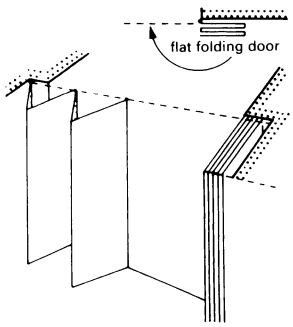
⑦ **Automatic hinged doors**



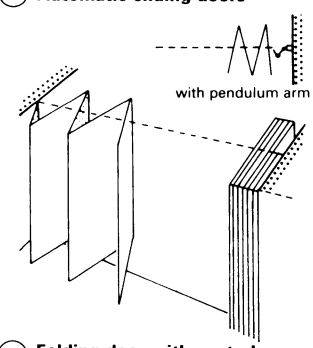
⑧ **Automatic sliding doors**



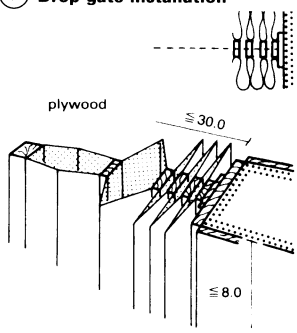
⑨ **Drop gate installation**



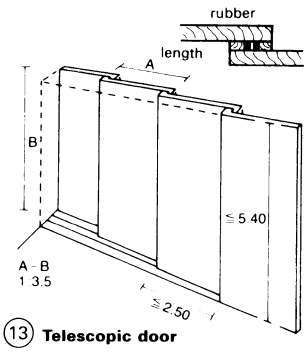
⑩ **Folding door with side guides**



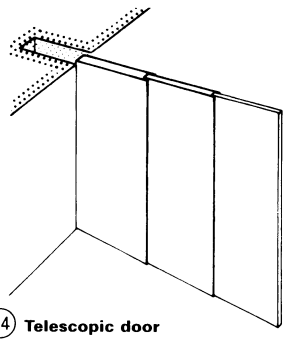
⑪ **Folding door with central guides (concertina door)**



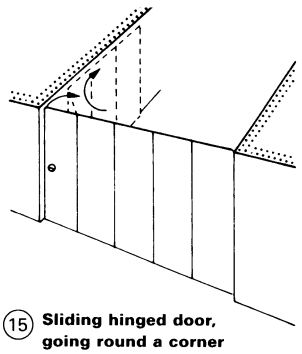
⑫ **Accordion door; wood panels or flexible material**



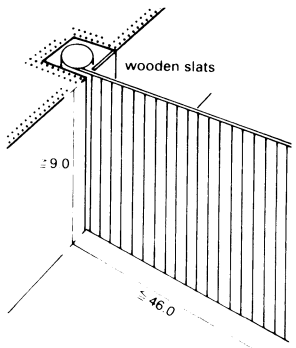
⑬ **Telescopic door**



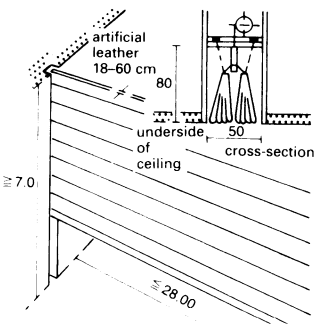
⑭ **Telescopic door**



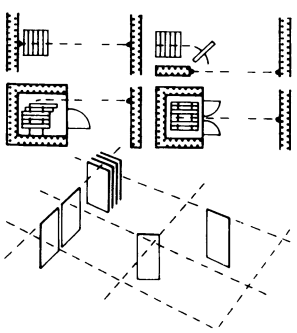
⑮ **Sliding hinged door, going round a corner**



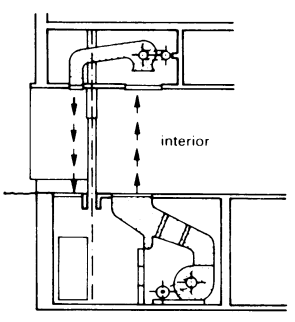
⑯ **Roller wall**



⑰ **Partition curtain**



⑱ **Variable sliding doors**



⑲ **Air curtain installation** → ⑨

Revolving doors are made in several different designs → ① - ⑥. Some are adjustable, e.g. when the number of users is large, particularly in the summer, the panels can be folded into the middle to allow people to go in on one side and out on the other at the same time. Some designs have panels which can be pushed to the side if traffic is only in one direction (e.g. when business closes for the day).

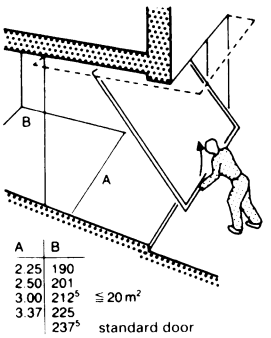
Actuating devices for *automatic doors* can be controlled by radar, electric contact mats → ⑦ - ⑧ or pneumatic floor contacts. Unidirectional or reflecting light barriers controlling automatic sliding doors with six panels up to 8 m wide are ideal for installation on emergency escape routes in office blocks, public buildings and supermarkets. Air curtain doors → ⑲ can be shut off at night by a raised door → ⑨.

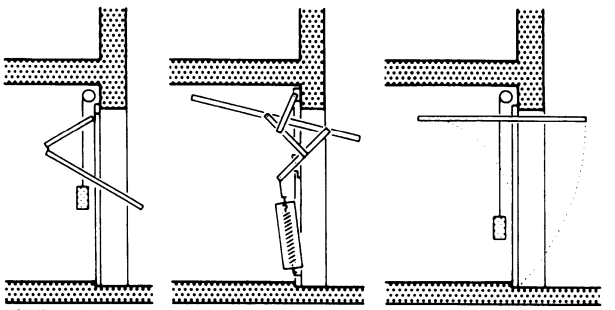
Room dividers can be provided by the use of folding doors, guided from the side → ⑩. Concertina doors are centrally hung → ⑪ for closing off wide openings. A revolving movement can be combined with a sliding movement. Accordion doors can be made of plywood, artificial leather or cloth → ⑫.

Telescopic doors have several panels joined by engagers. Externally guided telescopic doors are single-skinned → ⑬; those with internal guides are double-skinned → ⑭. These doors can move alongside each other → ⑬ or retract inside each other → ⑭. Sliding wall doors, suspended from above, can be guided round corners → ⑮ or can be used as flexible enclosures → ⑱.

Curtain partitions can be folded down from above → ⑰, or can move horizontally with guides above → ⑯. They allow large rooms to be divided up into sections.

GARAGE/WAREHOUSE DOORS





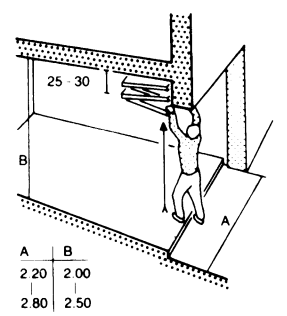
① **Up and over doors**

Up and over doors can be used for garages and similar installations → ①. They can be folding doors, or doors with a spring counterbalance or a counterbalance weight. They can have a single or a double skin, and be solid, partially glazed or fully glazed. They can have wooden panels, or be made of plastic, aluminium or galvanised sheet steel. The largest available dimensions for access purposes are 4.82 m × 1.96 m, and the maximum panel area is approx. 10 m². Up and over doors are also available in arched segments. They are easy to operate since the door drive is mounted on the ceiling and controlled by radio.

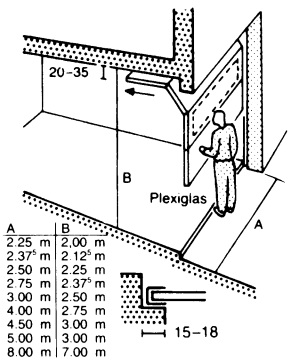
Also available are lifting folding doors → ②, sectional doors → ③, telescopic lifting doors → ④ and roller shutter doors made of aluminium → ⑤ which are completely out of the way when open. Single- or multiple-skin doors can be used for industrial, transport and workshop buildings. The maximum available size is 18 m wide and 6 m high. These doors can be activated by a ceiling pull switch, a light barrier, an induction loop or remote control (either electric or pneumatic), or contact pads.

Drive-through doors should be power-operated for speed → ⑧. Rubber swing doors → ⑨ and single-layer clear PVC are resistant to abrasion and impact, and PVC strip curtains are also available → ⑩. Rubber sections which serve as door seals and rubber cushion seals are available for loading and unloading from docks and in and out of heated storage depots. They give protection from the effects of the weather during these operations → ⑪, ⑫.

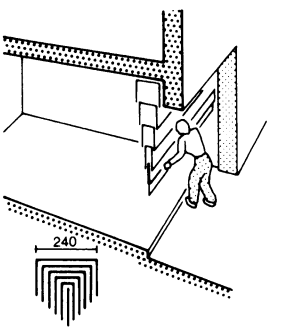
Fire protection doors T30–T90 can be single- or double-leaf → ⑬. Sliding fire protection doors are also available → ⑭. Any movable fire-resistant barrier, such as sliding, lifting or swing doors, must be able to operate independently of the mains electricity supply. In the event of fire, they must close automatically. (See also p. 130.)



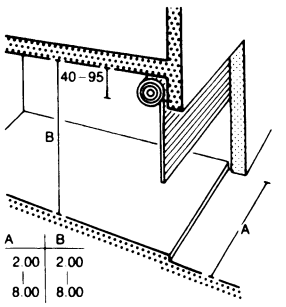
② **Folding, lift door**



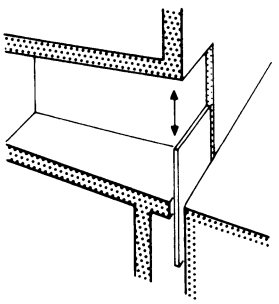
③ **Linked up and over door (sectional)**



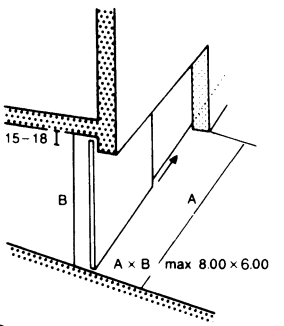
④ **Telescopic lifting door**



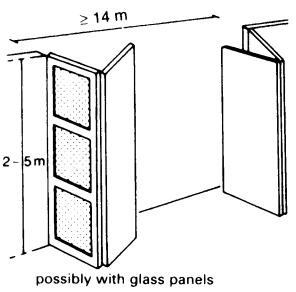
⑤ **Roller shutter door (in steel or aluminium)**



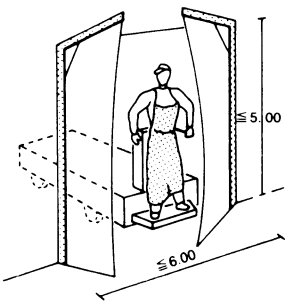
⑥ **Drop door**



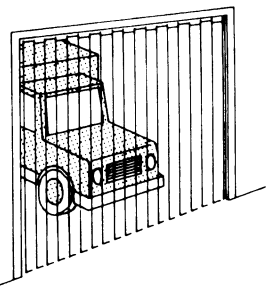
⑦ **Sliding door (steel T30–T90)**



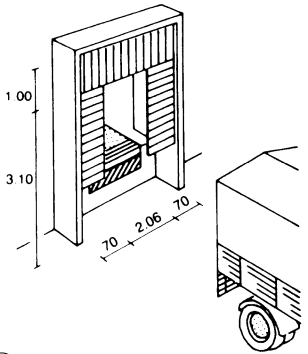
⑧ **Power operated folding door (quick operation)**



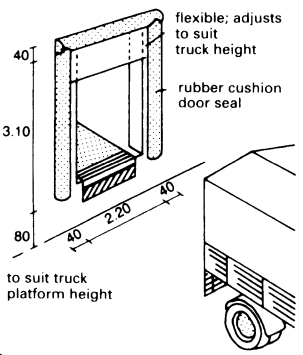
⑨ **Rubber swing door**



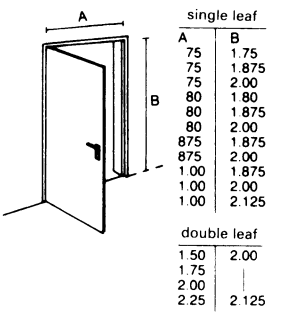
⑩ **PVC strip curtains for large drive-through passages**



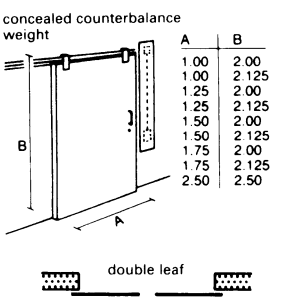
⑪ **Rubber segment door seal**



⑫ **Rubber cushion door seal**

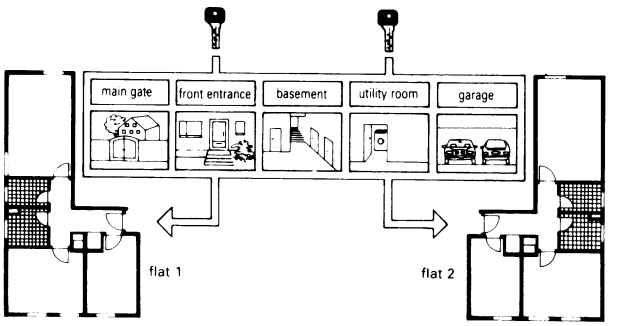


⑬ **Fire doors T30–T90**

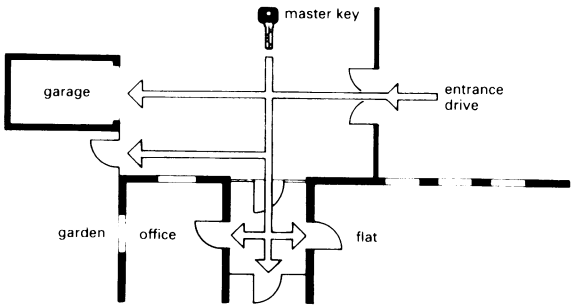


⑭ **Sliding fire doors T30–T90**

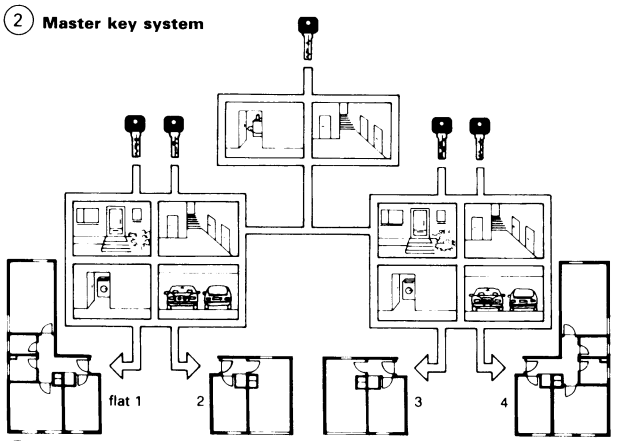
LOCKING SYSTEMS



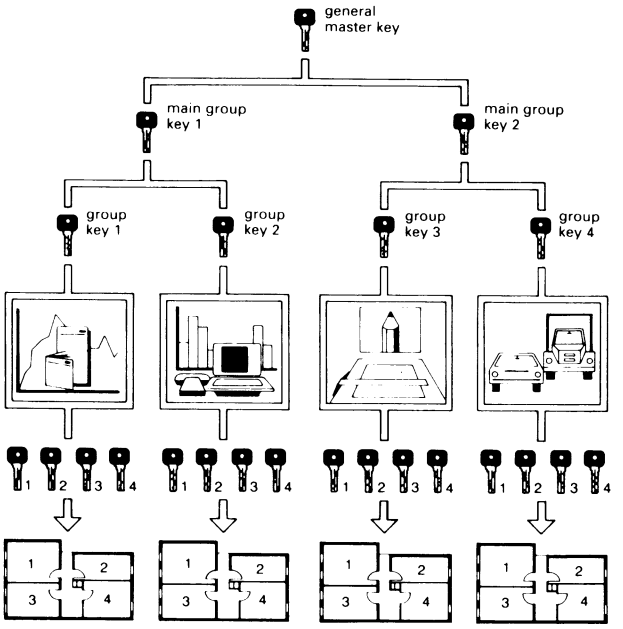
① **Combination key system**



② **Master key system**



③ **Combined combination key and master key system**



④ **General master key system**

Cylinder locks offer the greatest security, for it is virtually impossible to open them with tools. The cylinder lock developed by Linus Yale is very different from other locking systems. There are profile, oval, round and half cylinder locks. Cylinder locks are supplied with extensions as necessary on one or both sides, increasing in increments of 5 mm, to suit the thickness of the door → ⑥.

During the planning and ordering phase for a locking system, a locking plan is drawn up which includes a unique security certificate. Replacement keys are only supplied after production of this document.

Combination key systems

With a combination key system, the key of the entrance door to each flat also opens all doors to shared facilities as well as shared access doors, e.g. courtyard, basement or main front door. This is suitable for houses with multiple family occupancy or estate houses → ①.

Master key systems

In a master key system, a principal pass key opens all locks throughout the complete system. This is suitable for single family occupancy houses, schools and restaurants.

Central key systems

With a central key system, several combination key systems are combined. This is suitable for blocks of flats → ③. Separate keys unlock the front door to each flat and to all shared facilities. In addition, there is a master key which unlocks all the shared doors in the blocks.

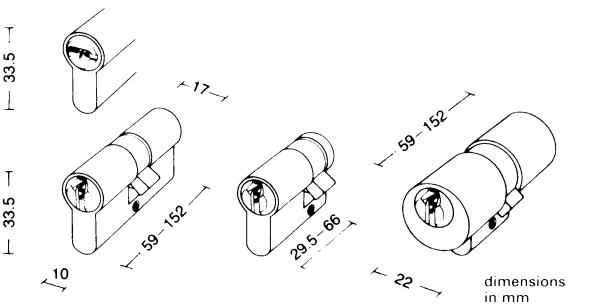
General master key systems

A general master key system consists of multiple master key systems. The general master key allows one person access to all rooms. It is possible to subdivide areas by using main and group keys. Each cylinder has its own individual lock and, with the exception of the correct master (or pass) key, can only be opened with its own key.

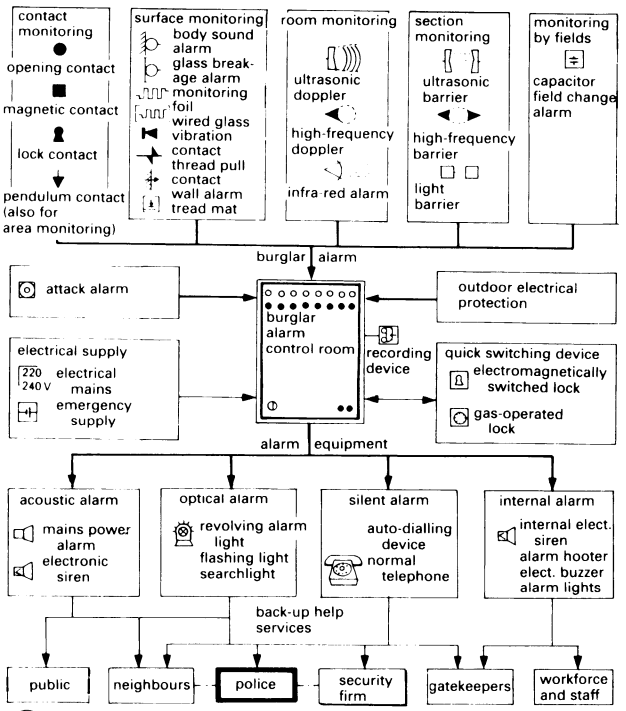
This system is suitable for factories, commercial premises, airports and hotels → ④. Vulnerable points which should be taken into account during the planning stage are set out in → ⑤.

filing cabinets, bath cubicles, letter boxes, access doors, emergency exit doors, cloakrooms, locks for boxes, cold stores, furniture doors, tubular framed doors, roller shutter doors, cupboard doors, writing desks, sliding bolts, changing cubicles	at risk
lift machinery room, lift switch box, electricity rooms, garage access doors, garage up and over doors, lattice gates, boiler room doors, basement doors, oil filler pipes, distribution boxes	strongly at risk
main office doors, skylights, tilt and turn windows, computer rooms, main entrance doors, gratings, front entrance doors to blocks of flats, trap doors, basement windows, fan lights, switch boxes	very strongly at risk

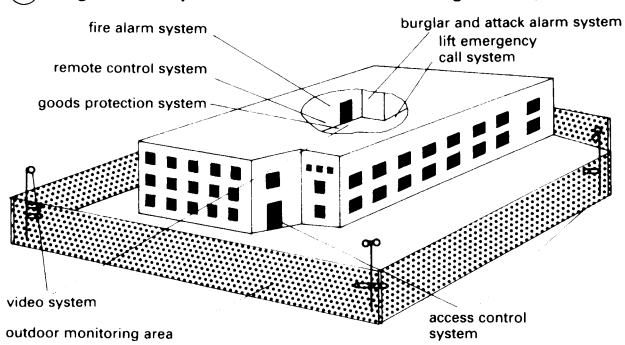
⑤ **Check list**



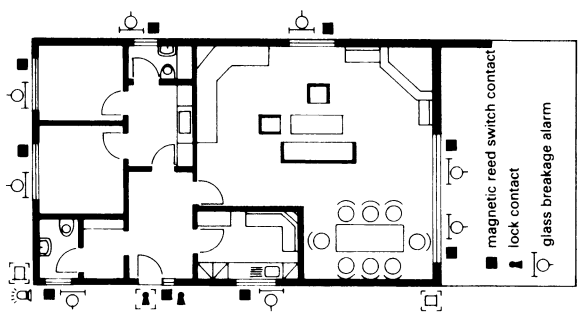
⑥ **Cylinder lock: profile, half, round**



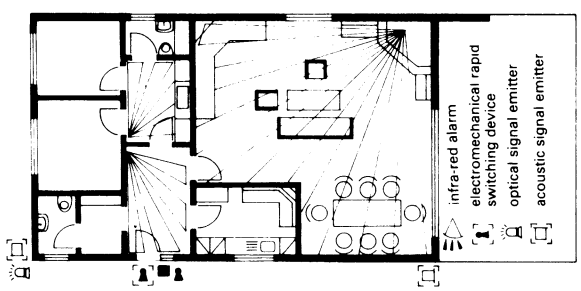
(1) **Burglar alarm systems (installation and working method)**



(2) **Security systems**



(3) **Outer perimeter security on private premises**



(4) **Security in the industrial and community sectors**

The term 'security technology' is to be understood as covering all devices used for defence against criminal danger to the body, life or valuables. In reality, all parts of a building can be penetrated, even those made of steel and reinforced concrete. The need for security should be established by an in-depth study of vulnerable areas, with an estimate of costs and benefits. The police will advise on the choice of security and monitoring system equipment.

Mechanical protection devices are constructional measures which provide mechanical resistance to an intruder. These can only be overcome by the use of force, which will leave physical traces behind. An important consideration is the effectiveness of this resistance. Such measures are necessary for the main entrance doors, windows and basement entrances in blocks of flats, and display windows, entrances, other windows, skylights and fences in business premises. Mechanical protection devices include steel grilles, either fixed or as roller shutters, safety roller shutters, secure locks and chains. Wire-reinforced glass also has a deterrent effect, and acrylic or polycarbonate window panes offer enhanced protection.

Electrical security devices will automatically set off an alarm if any unauthorised entry to the protected premises is attempted. An important consideration is the time taken from when the alarm is triggered until the arrival of security staff or the police.

(1) Burglar and attack alarm systems help to monitor and protect people, property and goods. They cannot prevent intruders entering premises, but they should give the earliest possible warning of such an attempt. Optimum security can only be achieved by mechanical protection and the sensible installation of burglar alarm systems. Supervisory measures include monitoring the outside of the building, as well as each room and individual objects of value, security traps and emergency alarm calls.

Fire alarm systems give an early warning of smoke or fire, and may also alert the emergency services. Fire alarm systems are there to protect people and property.

(2) Outdoor supervision systems are used to monitor areas around the building. They increase security by recording all nearby activity, usually up to and including the property boundary. They consist of mechanical or constructional measures, electronic or other detection devices, and/or organisational or personnel action. Their objective is legal fencing, to deter or delay intruders, or to detect and give early warning about unauthorised people or vehicles. This also includes the detection and identification of possible sabotage attempts or espionage. Mechanical measures include construction work, fences, ditches, walls, barriers, gates, access control and lighting. Electrical measures can involve control centres, detectors, video/television sensors, an access control system, an alarm connected to higher communication systems, an automatic telephone dialling device and/or radio. Organisational actions include the briefing of personnel, observation, surveillance, security, task forces, technical staff, watchdogs and an emergency action plan.

(3) Goods protection systems, also called shoplifting protection systems, are electronic systems which serve to protect against theft and the illegal removal of goods from a controlled area during normal business hours.

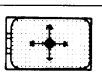
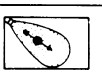
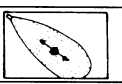
SECURITY OF BUILDINGS AND GROUNDS

parts of building and equipment to be protected	lock contact	magnetic contact	surveillance contact	transitional contact	glass breakage alarm	monitoring foil	glass wired for alarm	body noise alarm	vibration contact	wallpaper alarm and wiring	tread mat	trip wire contact	pendulum alarm	special types
front doors, external doors	●[2]	●	○											
internal security doors	●[3]	●	●							○				●[4]
room doors [12]	●[3]	●	●							○	○[5]			
internal sliding doors [12]	○[3]	○	●	●						○	○[5]			
garage up and over doors		●	○											●[6]
windows with casements		●	○		●	○	●		○[7]					
glass doors, lifting doors		●	○	○	●	○	●		○[7]		○[5]			
external glass sliding doors		○		●	●	○	●		○[7]		○[5]			
dome lights		○										●	○	●[8]
roof windows		●			●		○[9]		○[7]					
glass block walls								○	●					
display windows, large fixed glazing					●	●	●		○[7]					
heavy walls and ceilings								●	●	○				
light walls and ceilings										●				
loft ladder – retractable		○	○							●	○[5]	●	○	
individual objects [12] – sculptures paintings		●												●[10]
internal floor surfaces [12]											●			
safes [12]								●			○[5]			●[11]
cupboards for apparatus [12]		●	●								○[5]			
conduits, ventilation shafts, service installations												●	●	

burglar alarm ● very suitable ○ still suitable

1) various alarms only to be used with reservations (e.g. not on wired, laminated or toughened glass)
2) principally as a security device
3) if there is rapid switching on this door
4) if only the internal security door is to be protected (cf. also door interlock with alarm)
5) designed for security traps
6) magnetic contact – special type for floor mounting
7) not to be used where it can be touched by hand, if panels are unstable or there are vibration sources near by
8) there are dome lights with built-in alarm protection
9) note reservations concerning the weight of glass
10) individual protection is recommended for very valuable furnishings or those with very valuable contents
11) capacitative field alarms are the recommended protection
12) and/or included in the room surveillance

(1) **Contact and surface monitoring – appropriate use of burglar alarms**

comparative criteria	ultrasonic room protection	ultrasonic doppler	high-frequency doppler	infra-red alarm
monitoring features preferred, direction of movement registered				
monitoring range per unit – recommended values and range	when mounted on ceiling 90–110 m^2, wall mounted ≈ 40 m^2 up to 9 m	depending upon unit 30–50 m^2 up to 14 m	depending upon unit 150–200 m^2 up to 25 m	depending on unit 60–80 m^2 rooms up to 12 m, corridors up to 60 m
surveillance of complete room (over 80% of the room monitored)	guaranteed	not guaranteed	not guaranteed	guaranteed
typical application	– small to large rooms – corridors – complete and part room monitoring	– small to large rooms – monitoring part of rooms – security traps	– long, large rooms – monitoring part of room – security traps in large spaces	– small to large rooms – complete and part room monitoring – security traps – at same time fire alarm
permissible ambient temperature: under 0°C from 0°C to 50°C over 50°C	conditionally permissible permissible not permissible	conditionally permissible permissible not permissible	permissible permissible permissible	permissible permissible not permissible
are several alarms possible in the same room?	no problem	with care	with care	no problem
influences from adjacent rooms or nearby road traffic	no problem	no problem	not recommended	no problem
possible cause of false alarms	– loud noises in ultrasonic frequency band – air heating near the alarm – strong air turbulence – unstable walls	– loud noises in ultrasonic frequency band – air heating – air turbulence – unstable walls – moving objects (e.g. small animals, fans) – disturbing influences near the alarm (sensitivity too great)	– deflection of beam by reflection from metal objects – beam penetrates walls and windows – unstable walls – moving objects (e.g. small animals, fans) – electromagnetic influences	– heat sources with rapid temperature changes (e.g. incandescent lamps, electric heating, open fire) – direct, strong and changing light effect on the alarm – moving objects (e.g. small animals, fans)

(2) **Room monitoring – the most important comparative criteria**

(4) Access control systems are devices which, in combination with a mechanical barrier, only allow free access to any area by means of an identity check. Access is only granted after electronic or personal authorisation. A combination of access control and a time-recording device is technically feasible.

(5) Remote control systems or data transfer/exchange over the public telephone network facilitate monitoring at a distance. Such systems can be used for measurement, control, diagnosis, adjustments, remote questioning, controlling the type of information, and assessing the position of one object in relation to another.

(6) Monitoring systems observe or control the sequence of events by means of a camera and a monitor which are operated either manually and/or automatically. They can be installed either inside or outside, and can operate both day and night throughout the year.

(7) Lift emergency systems are used in personnel lifts and goods lifts. Lift emergency call systems ensure the safety of the users. They are designed first and foremost to free people who are trapped inside. Anyone who is trapped can talk directly to someone in a control centre which is constantly manned, and who will alert the rescue services.