

Specification for

Rack and pinion lifts

Committees responsible for this Draft for Development

The preparation of this Draft for Development was entrusted to Technical Committee MHE/4, upon which the following bodies were represented:

- Associated Offices Technical Committee
- Association of District Councils
- British Broadcasting Corporation
- British Lift Association
- British Retail Consortium
- British Telecommunications Plc
- Chartered Institution of Building Services Engineers
- Chartered Institution of Environmental Health
- Department of the Environment (Building Research Establishment)
- Department of Trade and Industry (Standards Policy Unit)
- Electrical, Electronic, Telecommunications and Plumbing Union
- Engineering Surveyors Section of the MSF
- Health and Safety Executive
- Independent Engineering Insurers' Committee
- Institution of Electrical Engineers
- Institution of Incorporated Executive Engineers
- Institution of Mechanical Engineers
- Institution of Plant Engineers
- Lloyds Register of Shipping
- London Underground Ltd.
- National Association of Lift Makers
- Post Office
- Royal Association for Disability and Rehabilitation
- Coopted members

This Draft for Development, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on 15 May 1996

© BSI 03-2000

The following BSI reference relates to the work on this Draft for Development:
Committee reference MHE/4

ISBN 0 580 24510 1

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 References	1
3 Definitions	1
4 Units and symbols	2
5 Lift well	2
6 Location and requirements for machinery and control equipment	5
7 Landing doors	6
8 Car and counterweight	11
9 Rack and pinion system, counterweight suspension, safety gear and overspeed governor	15
10 Guides, buffers and final limit switches	22
11 Clearance between car and lift well wall, and between car and counterweight	23
12 Lift machine	24
13 Electrical installation and appliances	26
14 Protection against electrical faults; controls; priorities	28
15 Notices and operating instructions	31
16 Test, examination and technical data	32
17 Servicing	32
Annex A (normative) Test procedures for type examination	33
Annex B (informative) Operations (and subclauses where they are specified) which require the use of an electrical safety device	41
Annex C (normative) Test and examination of rack and pinion lifts	41
Figure 1 — Types of landing door	7
Figure 2 — Unlocking triangle	11
Figure 3 — Rack/pinion radial engagement	17
Figure A.1 — Examples of the engagement of the locking elements	36
Table 1 — Car floor area related to rated load	12
Table 2 — Car floor area related to number of passengers	12
Table 3 — Governor tripping speeds	21
Table A.1 — Model type-examination certificate	34
Table C.1 — Certificate of test and examination for rack and pinion lifts	43
Table C.2 — Certificate for periodic examination of rack and pinion lifts	60
List of references	Inside back cover

Foreword

This Draft for Development has been prepared under the direction of the Engineering Sector Board to meet the needs of the lift industry for a publication to cover the safety requirements for rack and pinion lifts and their testing and examination at the time of commissioning.

It was originally intended to publish the body of this draft as Part 4 of BS 5655 and its Annex C as a sub-section of Part 10 of BS 5655, but due to the emergence of such work within European standardization and the standstill agreement between members of CEN not to publish standards on subjects within the work programmes of CEN Technical Committees, this course of action was invalidated.

However, the recognition that some guidance was required by the lift industry on, particularly, the testing and examination of rack and pinion lifts at the time of commissioning, has resulted in the information contained within the draft being made available in the form of a Draft for Development.

It is being issued in the Draft for Development series of publications and is of a provisional nature because the preparation of a European Standard on the subject is anticipated, which, on its publication, will be implemented as a British Standard. A copy of this draft has been offered to the responsible CEN committee and will form the basis of the UK input to this work. This Draft for Development should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

This publication is not to be regarded as a British Standard

A review of this Draft for Development will be carried out not later than 2 years after its publication. Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development, will be made in an announcement in the appropriate issue of *BSI News*.

Observations which it is felt should receive attention before the official call for comments will be welcomed.

These should be sent to the Secretary of BSI Technical Committee MHE/4, 389, Chiswick High Road, London W4 4AL.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 64, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Draft for Development specifies safety requirements for rack and pinion driven passenger/goods lifts permanently installed in buildings.

2 References

2.1 Normative references

This Draft for Development incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Draft for Development only when incorporated in it by updating or revision.

2.2 Informative references

This Draft for Development refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Draft for Development the definitions given in BS 5655-5 apply together with the following:

3.1

available car area

area of the car measured at a height of 1.0 m above floor level, disregarding handrails, which is available for passengers or goods during use of the lift

3.2

buffer

a resilient stop at the end of travel, and comprising a means of braking using fluids or springs (or other similar means)

3.3

car apron

an apron having a smooth vertical part extending downwards from the sill of the car entrance

3.4

goods passenger lift

a lift mainly intended for the transport of goods, which are generally accompanied by persons

3.5

guides

the components which provide guiding for the car sling or the counterweight, if there is one

3.6

instantaneous safety gear

a safety gear in which the full arresting action is immediate

3.7

instantaneous safety gear with buffered effect

a safety gear in which the full arresting action is almost immediate, but the reaction on the car or counterweight is limited by presence of an intermediate buffering system

3.8

levelling

an operation which improves the accuracy of stopping at landings

3.9

lift

permanent lifting equipment serving defined landing levels, comprising a car, whose dimensions and means of construction clearly permit the access of persons; running on rigid vertical guides or guides whose inclination to the vertical is less than 15°

3.10

lift car

a part of the lift which carries the passengers and/or other loads

3.11

lift machine

the unit including the motor which drives and stops the lift

3.12

minimum breaking load of a rope

this load is the product of the square of the nominal diameter of the rope (in square millimetres) and the nominal tensile strength of the wires (in newtons per square millimetre) and a coefficient appropriate to the type of rope construction as given in BS 302-4

3.13

overspeed governor

a device which, when the lift car attains a predetermined speed, initiates a stoppage of the lift car

3.14

passenger

any person transported by a lift

3.15

pit

the part of the well situated below the lowest landing level served by the car

3.16**progressive safety gear**

a safety gear in which deceleration is effected by a progressive arresting action and for which special provisions are made so as to limit the forces on the car or counterweight to a safe value

3.17**pulley room**

a room in which pulleys are located and in which the overspeed governors and the electrical equipment may also be housed

3.18**rack and pinion lift**

a lift in which the movement of the car is achieved by meshing of the pinion, moving by rotation, on a fixed rack

3.19**rated load**

the load for which the equipment has been built and for which normal operation is guaranteed by the vendor

3.20**rated speed**

the speed of the car for which the equipment has been built and for which normal operation is guaranteed by the vendor

3.21**re-levelling**

an operation after the lift has stopped, to permit the stopping position to be corrected during loading and unloading, if necessary by successive movements (automatic or inching)

3.22**safety factor**

the ratio, for a particular material under stated conditions, of the yield load to the highest load that may be imposed upon a member

3.23**safety gear**

a mechanical device for stopping and maintaining stationary the lift car with its rated load or counterweight, in case of overspeeding in the downward direction

3.24**sling**

the metal framework carrying the car or counterweight, connected to the means of suspension

NOTE This sling may be integral with the car enclosure.

3.25**unlocking zone**

a zone, extending above and below the stopping level, in which the car floor shall be to enable the corresponding landing door to be unlocked

3.26**user**

a person making use of the services of a lift installation

3.27**well**

the space in which the car and the counterweight, if there is one, travels and which is bounded by the bottom of the pit, the walls and the roof of the well

4 Units and symbols**4.1 Units**

The units used are chosen from the International (SI) system of units.

4.2 Symbols

Measurement	Symbol	Unit
Standard acceleration of free fall	g_n	m/s ²
Rated speed	v	m/s
Sum of the mass of the empty car and the masses of the portion of the travelling cables and any compensation devices suspended from the car	P	kg
Rated load	Q	kg
Total permissible mass	$(P + Q)$	kg

5 Lift well

NOTE The requirements of this clause relate to wells containing one or more lift cars.

5.1 General provisions

The counterweight of a lift shall be in the same well as the car.

5.2 Well enclosure**5.2.1 General**

Each well shall be totally enclosed by imperforate walls, floor and ceiling, as specified in 5.3.

The only permissible openings in the enclosure are:

- a) openings for landing doors;
- b) openings for inspection and emergency doors to the well and inspection traps;
- c) vent openings for escape of gases and smoke in the event of fire;
- d) ventilation openings;

e) permanent openings between the well and any pulley room.

NOTE When the well is not required to contribute to the protection of the building against the spread of fire, the following is acceptable:

- 1) to limit the height of the walls on faces other than the entrance faces, to a height of 2.5 m above any points normally accessible to persons;
- 2) at the entrance faces of the well to use mesh or perforated panels upwards from a height of 2.5 m above landing level. [These means of protection are not necessary if the car door is locked mechanically (see note 3 of 5.4.4).] The dimensions of the mesh or perforations shall not exceed 75 mm measured horizontally or vertically.

5.2.2 Inspection and emergency doors (inspection traps)

5.2.2.1 Inspection and emergency doors, and inspection traps to the well, shall not be provided except on grounds of safety to users or to provide access for servicing.

Inspection doors shall have a minimum height of 1.4 m and a minimum width of 0.60 m.

Emergency doors shall have a minimum height of 1.8 m and a minimum width of 0.35 m.

Inspection traps shall have a maximum height of 0.50 m and a maximum width of 0.50 m.

5.2.2.2 When the distance between consecutive landing doorsills exceeds 11 m, intermediate emergency doors shall be provided, such that the distance between sills is not more than 11 m. This provision is not necessary in the case of adjacent cars, in which case the cars shall each be fitted with an emergency door conforming to 8.10.3.

5.2.2.3 Inspection and emergency doors and inspection traps shall not open towards the interior of the well.

5.2.2.4 The doors and traps shall be provided with a key-operated lock, capable of being reclosed and relocked without a key.

Inspection and emergency doors shall be capable of being opened from inside the well without a key even when locked.

5.2.2.5 Operation of the lift shall depend on the maintenance of these doors and traps in the closed position. For this purpose electrical safety devices conforming to 14.1.2 shall be provided.

The operation of the lift with an open inspection trap shall only be possible during inspection operations. This operation shall require continuous actuation of a device (only accessible when the trap is open) allowing the electrical safety device normally proving the closure of the trap to be shunted.

5.2.2.6 Inspection and emergency doors shall be imperforate and shall satisfy the same requirements for mechanical strength and fire resistance as the landing doors.

5.2.3 Ventilation of the well

Provision shall be made, at the top of the well, for ventilation openings, with a minimum area of 1 % of the horizontal cross-section of the well to the outside either directly or through trunking to pulley rooms.

The well shall not be used to provide ventilation of rooms other than those for the service of lifts.

5.3 Walls, floors and ceiling of the well

The structure of the well shall be designed to withstand all dead and live loads, with due allowance for moving masses or inertia forces, including the normal braking action and the application of the safety gear, the action of the buffers and any wind load.

The walls, floors and ceiling of the well shall:

- a) be made of incombustible durable materials which do not assist the creation of dust;
- b) have sufficient mechanical strength.

5.4 Construction of the walls of lift wells and landing doors facing a car entrance

5.4.1 The requirements of 5.4.2, 5.4.3 and 5.4.4, relating to landing doors and walls, or parts of walls, facing a car entrance, shall apply over the full height of the well.

NOTE For clearances between car and wall of the lift well facing the car entrance, see clause 11.

5.4.2 The assembly comprising the landing doors and any wall or part of a wall facing a car entrance shall form an imperforate surface over the full entrance width of the car, excluding the operational clearances of doors.

5.4.3 Below each landing sill over a vertical distance of not less than half the unlocking zone plus 50 mm, the wall of the lift well described in 5.4.2 shall:

- a) form a continuous vertical surface composed of smooth and hard elements, such as metal sheets, hard facings or materials equivalent with regard to friction. Plaster faced and glass walls shall not be used. Additionally, this assembly shall extend at least 25 mm on both sides beyond the full car entrance width.

Any projections shall be less than 5 mm.

Projections exceeding 2 mm shall be chamfered at least 75° to the horizontal.

b) be connected either to the lintel of the next door, or extended downwards using a hard smooth chamfer whose angle to the horizontal plane shall be at least 60°. The projection of this chamfer to the horizontal plane shall be not less than 20 mm.

5.4.4 Except for lift well walls referred to in **5.4.3**, the horizontal distance between the wall of the well and the sill or entrance frame of the car or door (or extreme edge of the doors in the case of sliding doors) shall not exceed 0.15 m.

NOTE 1 The object of this requirement is to prevent the following:

- a) a person falling down the well;
- b) a person getting into the gap between the car door and well during normal operation of the lift (it is with this in mind that the measurement of 0.15 m should be checked, particularly in the case of interlinked telescopic doors).

NOTE 2 The horizontal distance of 0.15 m may be increased to 0.20 m:

- 1) over a maximum vertical distance of 0.50 m; or
- 2) in the case of goods passenger lifts fitted with vertically sliding doors.

NOTE 3 These requirements need not be observed if the car is provided with a mechanically locked door which can only be opened in the unlocking zone of a landing door.

The operation of the lift shall automatically depend on the locking of the corresponding car door. This locking shall be proved by an electrical safety device conforming to **14.1.2**.

5.5 Protection of any spaces located below the car or the counterweight

NOTE Lift wells should preferably not be situated above a space accessible to persons.

If accessible spaces exist underneath the car or counterweight, the base of the pit shall be designed for an imposed load of at least 5 000 N/m² and, either:

- a) there shall be installed below the counterweight buffer a solid pier extending down to solid ground;
- or
- b) the counterweight shall be equipped with safety gear.

5.6 Protection of spaces around the car or counterweight

5.6.1 In the lower part of the well, there shall be a protective screen around the counterweight.

5.6.2 In the lower part of the well, there shall be a protective screen between the moving parts (car or counterweight) of different lifts.

5.6.3 The protective screens referred to in **5.6.1** and **5.6.2** shall extend from not greater than 0.3 m above the pit floor, to a height of not less than 2.5 m above the lowest landing served.

5.6.4 Further, if the horizontal distance between the edge of the car roof and a moving part (car or counterweight) of an adjacent lift is less than 0.3 m, the protective screen specified in **5.6.3** shall be extended through the full height of the well and over its effective width.

The width of the protective screen shall be at least equal to that of the moving part (or part of this) which is to be guarded, plus 0.1 m on each side.

5.7 Headroom and pit

5.7.1 Top clearances

5.7.1.1 The available travel of the car above the top floor, from the floor until it strikes the upper buffers, shall be at least 0.15 m. The car shall be guided to the limit of its buffer stroke.

5.7.1.2 The following conditions shall be met when the upper buffers are fully compressed by the car.

- a) The free vertical distance between the level of the highest area on the car roof whose dimensions conform to **8.11.1 b)** [areas on parts according to **5.7.1.2 b)** excluded] and the level of the lowest part of the roof of the well (including beams and components located under the roof) situated in the projection of the roof of the car, shall be at least 1.0 m.
- b) The free distance between the lowest part of the roof of the well and:
 - 1) the highest pieces of equipment fixed on the car roof, except for those covered by 2) as follows, shall be at least 0.3 m;
 - 2) the highest part of the guide shoes or rollers, of the rope attachments, or of the header, or the parts of the vertically sliding doors, if any, shall be at least 0.1 m.
- c) There shall be sufficient space above the car to accommodate a rectangular block not less than 0.5 m × 0.6 m × 0.8 m resting on one of its faces.

NOTE For lifts with counterweights, the suspension ropes or chains and their attachments may be included in this space, provided that no rope or chain centre-line is at a distance exceeding 0.15 m from at least one vertical surface of the block.

5.7.1.3 When the car rests on the fully compressed lower buffers the guide lengths of the counterweight, if there is one, shall permit further guided travel of at least 0.3 m.

5.7.2 Pit

5.7.2.1 The lowest part of the well shall consist of a pit, the bottom of which shall be smooth and approximately level, except for any buffer and guide bases and water drainage devices.

After the building-in of guide fixings, buffers, any grids etc., the pit shall be impervious to infiltration of water.

5.7.2.2 If there is an access door to the pit, other than the landing door, it shall conform to **5.2.2**.

Such a door shall be provided if the pit depth exceeds 2.5 m and if the layout of the building so permits.

If there is no other access, a permanent means shall be provided inside the well, easily accessible from the landing door, to permit competent persons to descend safely to the floor of the pit. This shall not project into the clear running space of the lift equipment.

5.7.2.3 When the car rests on its fully compressed buffers, the following conditions shall be simultaneously fulfilled.

- a) There shall be sufficient space in the pit to accommodate a rectangular block not less than 0.5 m × 0.6 m × 1.0 m resting on one of its faces.
- b) The clear distance between the bottom of the pit and:
 - 1) the lowest portions of the car, except for items detailed in 2) below, shall be at least 0.5 m;
 - 2) the lowest parts of the guide shoes or rollers of safety gear blocks, toe guards or parts of vertical sliding doors, shall be at least 0.1 m.

5.7.2.4 The following equipment shall be provided in the pit:

- a) a switch, accessible on opening the door to the pit, to stop the lift and keep it stopped, such that there is no risk of mistaking the stop position) (see **15.7**).
- This switch shall comply with the requirements specified in **14.2.2.4**;
- b) an electrical socket outlet (see **13.6.2**).

5.8 Exclusive use of the lift well

The well shall be used exclusively for the lift. It shall not contain cables or devices, etc., other than for the lift.

NOTE The well may, however, contain heating equipment for the lift well excluding hot water or steam heating; however, any control and adjustment devices are to be located outside the well.

5.9 Lighting of the well

The well shall be provided with permanent electrical lighting, allowing it to be lit during repairs or servicing, even when all doors are closed.

This lighting shall comprise lamps at a maximum of 0.5 m from the highest and from the lowest points in the well with intermediate lamps at 7 m maximum spacing.

NOTE If use is made of the exception referred to in **5.2.1**, this lighting may not be necessary if the electrical lighting existing in the neighbourhood of the well is sufficient

6 Location and requirements for machinery and control equipment

6.1 General provisions

NOTE Machinery, associated equipment and pulleys should be such that they will be accessible only to authorized persons, i.e. maintenance, inspection and rescue.

6.1.1 Motors and their contactors shall be mounted on the car.

The control equipment shall be located in a secure location.

NOTE The location should be such that it will be accessible only to authorized persons.

6.1.2 Diverter pulleys shall be installed such that:

- a) inspections and tests and maintenance operations can be carried out in complete safety from the car roof or from outside the well;
- b) they are provided with devices which prevent:
 - 1) injury to persons;
 - 2) the ropes or chains leaving their grooves if slack;
 - 3) the introduction of foreign objects between ropes or chains and grooves.

6.1.3 The devices in **6.1.2 b)** shall be such that they do not hinder inspection and test or any maintenance operation. The dismantling of these devices shall be necessary only in the following cases:

- a) replacement of a rope;
- b) replacement of a pulley.

6.1.4 If a separate room is used to locate the diverter pulleys for the counterweights, it shall conform to clause **7** of BS 5655-1:1986.

6.2 Access

6.2.1 Safe access shall be provided to the rack and pinion machinery, electrical control equipment and diverter pulleys for maintenance.

6.2.2 Electrical contactors shall be contained in a cabinet. The door of the cabinet shall be electrically and mechanically interlocked to prevent operation of the rack and pinion machine when the cabinet is open.

6.2.3 Access shall be provided for the hoisting of heavy equipment during erection and, if need be, its replacement, so that this can be done safely, especially avoiding handling on stairs.

6.3 Machinery maintenance area

6.3.1 Dimensions

The dimensions of the machinery maintenance area shall be sufficient to permit easy and safe access for maintenance personnel to all components, especially the electrical equipment. In particular the following shall be provided:

- a) a clear space in front of the panels or cabinets of at least 0.9 m depth over the full width of the panel or cabinet, by 2.14 m high;
- b) a clear horizontal area of at least 0.5 m × 0.6 m for maintenance and inspection of moving parts at places where this is necessary and, if need be, for manual emergency operation (see 12.4);
- c) access ways to these clear spaces shall have a width of at least 0.5 m.

NOTE This width may be reduced to 0.4 m in areas where there are no moving parts.

6.3.2 Lighting and socket outlets

The machinery maintenance area shall be provided with lighting on the basis of at least 200 lux at the working area. This lighting shall be provided by, either:

- a) the well lighting specified in 5.9; or
- b) permanent electrical lighting, the supply for which shall conform to 13.6.1.

A switch placed within the maintenance area, close to the access point or points, at an appropriate height, shall control lighting of the working areas on entry.

NOTE Alternatively this lighting may be achieved by means of the well lighting specified in 5.9.

One or more electrical socket outlets (see 13.6.2) shall be provided.

7 Landing doors

7.1 General provisions

The openings in the well giving access to the lift car shall be provided with imperforate landing doors. The choice of type of door shall be according to the building structural arrangements and examples given in Figure 1.

When measured from the back of a recess, the clearance between closed panels or between panels and uprights, lintels or sills, shall not exceed 6 mm. To avoid the risk of shearing during operation, the exterior face of automatically operated sliding doors shall not have recesses or projections exceeding 3 mm. Edges of these shall be chamfered in both directions of movement.

NOTE These requirements do not apply to access for the unlocking triangle specified in 7.7.4.

7.2 Strength of doors and their frames

7.2.1 Construction

Doors and their frames shall be constructed in such a way that they will not become deformed in the course of time (see 7.2.2.1, 7.2.2.2 and 6.2.1).

7.2.2 Mechanical strength

7.2.2.1 Doors, with their locks, shall possess mechanical strength such that in the locked position and when a force of 300 N is applied at right angles to the panel at any point on either face, being evenly distributed over an area of $5 \times 10^{-4} \text{ m}^2$ in round or square section, they shall:

- a) resist without permanent deformation;
- b) resist without elastic deformation greater than 15 mm;
- c) operate satisfactorily after such a test.

7.2.2.2 When a manual force of 150 N is applied, without a tool, at the most unfavourable point of the sliding doors, the clearances specified in 7.1 may exceed 6 mm but shall not exceed 30 mm.

7.3 Height and width of doors

7.3.1 Height

Landing doors shall have a minimum clear height of 2 m.

7.3.2 Width

The clear entrance of the landing doors shall not extend more than 0.05 m in width beyond the clear car entrance on either side unless appropriate precautions are taken.

7.4 Sills, guides and door suspension

7.4.1 Sills

Every landing entrance shall incorporate a sill of sufficient strength to withstand the passage of loads being introduced into the car.

A slight counter slope shall be provided in front of each landing sill to avoid water from washing, sprinkling, etc., draining into the well.

7.4.2 Guides

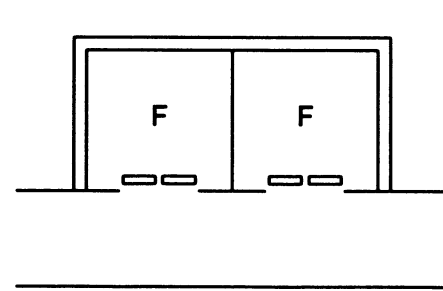
7.4.2.1 Landing doors shall be designed to avoid, during normal operation, derailment, jamming, or displacement at the extremities of their travel.

7.4.2.2 Horizontally sliding landing doors shall be guided top and bottom.

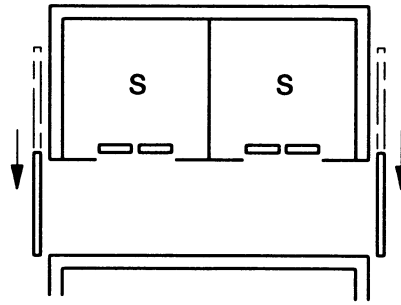
7.4.2.3 Vertically sliding landing doors shall be guided at both sides.

7.4.3 Suspension of vertically sliding doors

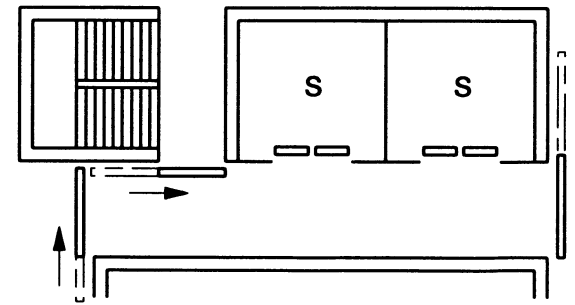
7.4.3.1 Panels of vertically sliding landing doors shall be fixed to two independent suspension elements.



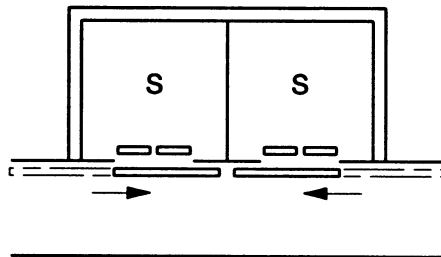
a) The lift landings are not isolated



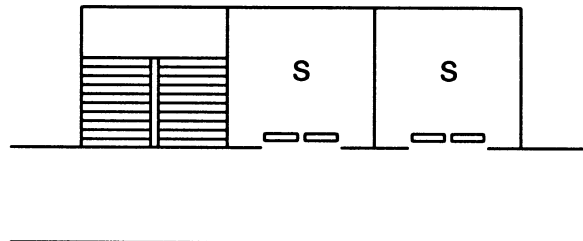
b) The lift landings are isolated



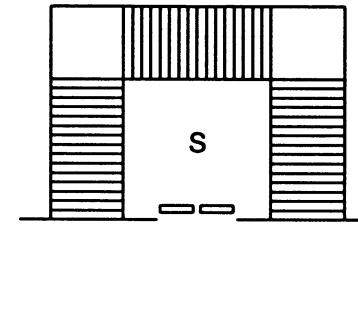
c) The lift landings and the stairwell are isolated



d) The lift doors are backed up by separate fire resisting doors

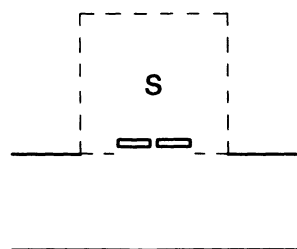


e) The lift landings common to stair landings are not isolated

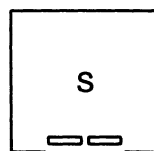


f) Lift completely surrounded by a stairwell

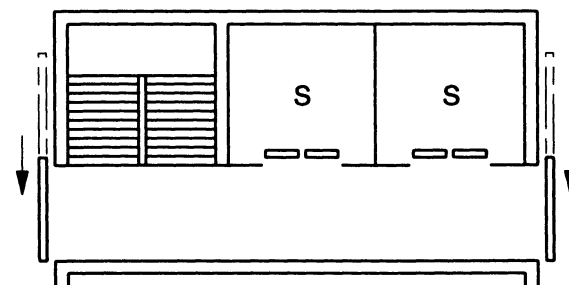
Figure 1 — Types of landing door



g) Lift adjoining a building



h) Lift installed in a hall or open space within a building



i) The lift landings common to stair landings are isolated

NOTE 1 Doors satisfying all the criteria are designated by the letter F.

NOTE 2 Doors satisfying only the criteria for integrity are here designated by the letter S.

NOTE 3 The walls of the well and the doors (apart from the lift doors) are shown with a double line when they are fire resistant, without pre-judging their degree of resistance.

NOTE 4 Fire resistant doors are presumed to close automatically either always or in case of fire.

NOTE 5 In the case of a structural arrangement not shown above, the device of the type of door should be made by comparison.

Figure 1 — Types of landing door (concluded)

7.4.3.2 Suspension elements shall be designed to have a safety factor of at least 8.

7.4.3.3 The diameter of suspension rope pulleys shall be at least 25 times that of the rope diameter.

7.4.3.4 Safeguards shall be provided to prevent ropes and chains leaving the pulley grooves or sprockets.

7.5 Protection in relation to door operation

7.5.1 General

The doors and their surrounds shall be designed in such a way as to minimize risk of damage or injury due to jamming of a part of the person, clothing or other object.

7.5.2 Doors with power operation

7.5.2.1 General

Doors with power operation shall be designed to reduce to a minimum the harmful consequences of a person being struck by a door panel.

7.5.2.2 Horizontally sliding doors

7.5.2.2.1 Automatic power operated doors

The effort needed to prevent the door closing shall not exceed 150 N. This measurement shall be made after the first third of travel of the door.

The kinetic energy of the landing door and the mechanical elements to which it is rigidly connected, calculated or measured¹⁾ at the average closing speed²⁾ shall not exceed 10 J.

A sensitive protective device shall automatically initiate re-opening of the door in the event of a person being struck (or about to be struck) by the door when crossing the entrance during the closing movement.

NOTE 1 This protective device may be that of the car door.

NOTE 2 The effect of this device may be neutralized during the last 50 mm of travel of each door panel.

In the case of a system which makes the sensitive protective device inoperative after a fixed period of time, to counteract persistent obstructions when closing the door, the kinetic energy defined above shall not exceed 4 J during movement of the door with the protective device inoperative.

7.5.2.2.2 Doors where closing is carried out under the continuous control of users (e.g. by continuous pressure on a button)

When the kinetic energy calculated or measured as laid down in **7.5.2.2.1** exceeds 10 J the average closing speed of the fastest panel shall be limited to 0.3 m/s.

7.5.2.3 Vertically sliding doors

NOTE Vertically sliding doors should only be used on goods passenger lifts.

Power closing of vertically closing doors shall only be used if all the following conditions are fulfilled:

- a) closing is carried out under the continuous control of the users;
- b) the average closing speed of the panels is limited to 0.3 m/s;
- c) the car door is of perforated or mesh panel construction as provided for in the note to **8.5.1**;
- d) the car door is at least two-thirds closed before the landing door begins to close.

7.5.2.4 Other types of doors

When using other types of doors (e.g. hinged) with power operation, where there is a risk when opening or closing, or of striking persons, precautions similar to those laid down for power operated sliding doors shall be taken.

7.6 Local lighting and “car here” signal lights

7.6.1 Local lighting

Natural or artificial lighting of the landings in the vicinity of landing doors shall be at least 50 lux at floor levels.

NOTE This is to ensure that a user can see what is ahead when opening the landing door to enter the lift, even if the car light has failed.

7.6.2 “Car here” indication

In the case of landing doors with manual opening, to enable the user to know, before opening the doors, whether the car is at a landing there shall be installed, either:

- a) one or more transparent vision panels complying with the following requirements:
 - 1) mechanical strength as specified in **7.2.2**;
 - 2) minimum thickness of 6 mm;
 - 3) minimum glazed area per landing door of 0.015 m² with a minimum of 0.015 m² per vision panel;

¹⁾ Measured using, for example, a device consisting of a graduated piston acting on a spring with a spring constant of 25 N/mm, and fitted with an easy sliding ring allowing the extreme point of movement at the moment of impact to be measured. An easy calculation allows the graduation corresponding to the limits fixed to be determined.

²⁾ The average closing speed of a sliding door is calculated over its whole travel, less the following:

- 25 mm at each end of the travel in the case of centrally closing doors;
- 50 mm at each end of the travel in the case of side closing doors.

4) width of at least 60 mm, and at most 150 mm. The lower edge of vision panels which are wider than 80 mm shall be at least 1 m above floor level; or

b) an illuminated “car here” signal which only lights up when the car is about to stop or has stopped at the particular landing. The signal shall remain illuminated all the time the car is at the landing.

7.7 Locking and closed landing door check

7.7.1 Protection against the risk of falling

It shall not be possible in normal operation to open a landing door (or any of the panels in case of a multi-panel door) unless the car has stopped, or is on the point of stopping, in the unlocking zone of that door.

The unlocking zone shall not extend more than 0.2 m above and below the landing level.

NOTE In the case of mechanically operated car and landing doors which operate simultaneously, the unlocking zone may extend to a maximum of 0.35 m above and below the landing level.

7.7.2 Protection against shearing

It shall not be possible in normal operation to start the lift nor keep it in motion if a landing door (or any of the panels in the case of a multi-panel door) is open.

NOTE Preliminary operations preparing for the movement of any car may take place.

7.7.3 Locking

7.7.3.1 Each landing door shall be provided with a locking device conforming to **7.7.1**. This device shall be protected against deliberate misuse.

7.7.3.2 The effective locking of the landing door in the closed position shall precede the movement of the car.

NOTE Operations preparing for the movement of the car may however take place.

The locking shall be proved by an electrical safety device conforming to **14.1.2**.

7.7.3.3 The car shall not be able to start moving until the locking elements are engaged by at least 7 mm (see **A.2**).

7.7.3.4 The connection between one of the contact elements which breaks the circuit, and the device which locks mechanically, shall be direct and foolproof, but adjustable if necessary.

7.7.3.5 For hinged doors, locking shall be effected as near as possible to the vertical closing edge(s) of the doors, and maintained even in the case of panels sagging.

7.7.3.6 The locking elements and their fixings shall be resistant to shock, and shall be made of, or reinforced with metal.

7.7.3.7 The engagement of the locking elements shall be achieved in such a way that a force in the opening direction of the door does not diminish the effectiveness of locking.

7.7.3.8 The lock shall resist, without permanent deformation during the test specified in **A.2**, a minimum force at the level of the lock and in the direction of opening of the door of:

- a) 1 000 N in the case of sliding doors;
- b) 3 000 N on the locking pin, in the case of hinged doors.

7.7.3.9 The locking action shall be effected and maintained by the action of gravity, permanent magnets, or springs. The springs shall act by compression, be guided and be of such dimensions that, at the moment of unlocking, the coils are not compressed solid.

In the event of the permanent magnet (or spring) no longer fulfilling its function, gravity shall not cause unlocking.

If the locking element is maintained in position by the action of a permanent magnet, it shall not be possible to neutralize its effect by simple means (e.g. heat or shock).

7.7.3.10 The locking device shall be protected against the risk of an accumulation of dust which could hinder its proper functioning.

7.7.3.11 Inspection of the working parts shall be easy, as, for example, by use of a vision panel.

7.7.3.12 In the case where the lock contacts are in a box, the fixing screws for the cover shall be of the captive type, so that they remain in the holes in the cover or box when opening the cover.

7.7.4 Emergency unlocking

Each of the landing doors shall be capable of being unlocked from the outside with the aid of a key which will fit the unlocking triangle shown in Figure 2.

After an emergency unlocking, the locking device shall not remain in the unlocked position with the landing door closed.

All landing doors shall have a device (e.g. counter-weight or springs) which will ensure the closing of the landing door if this door becomes open, for whatever reason, when the car is outside the unlocking zone.

7.7.5 Electrical device for proving the landing door is closed

7.7.5.1 Each landing door shall be provided with an electrical safety device conforming to **14.1.2** for proving the closed position so that the conditions specified in **7.7.3** are complied with.

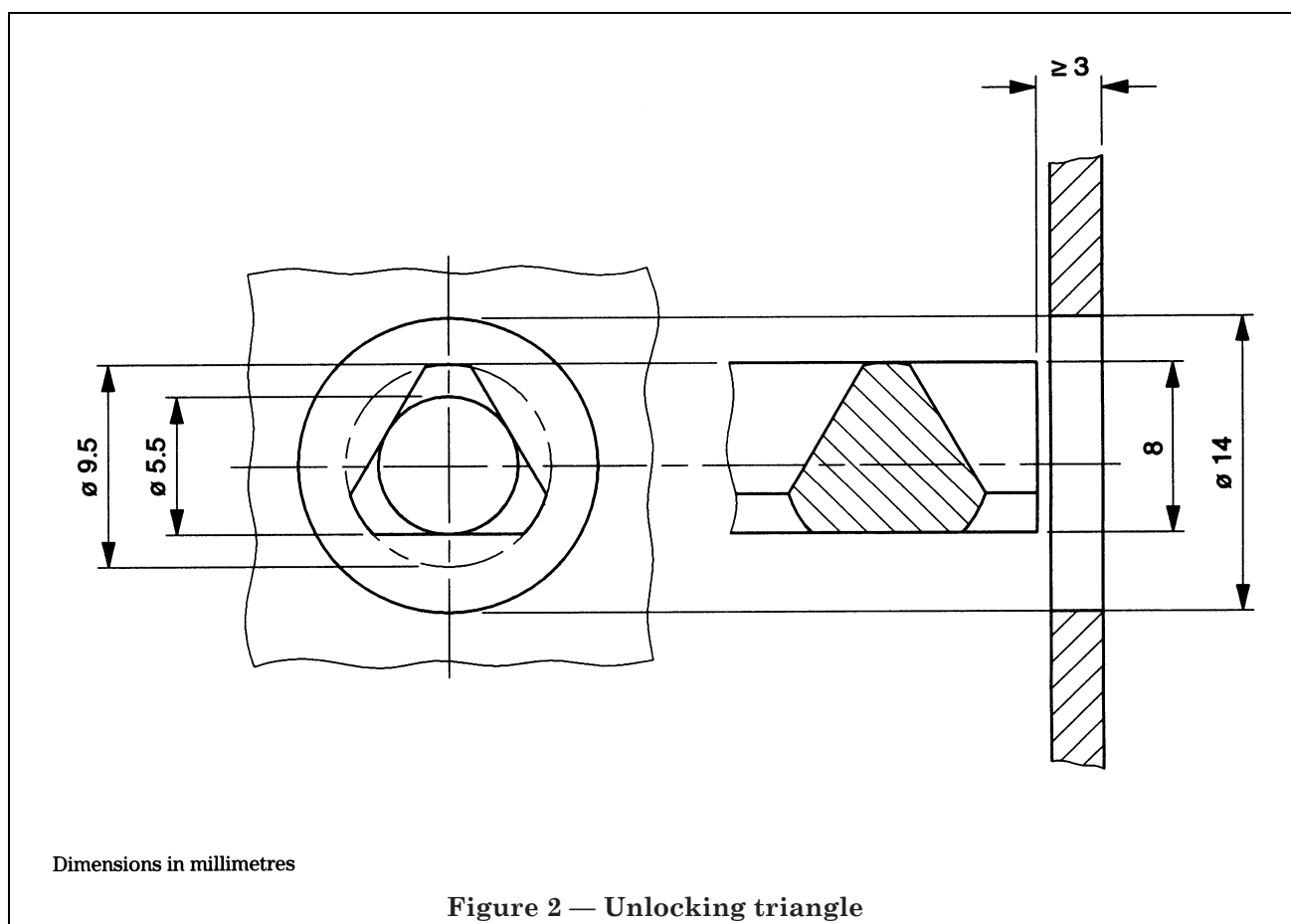


Figure 2 — Unlocking triangle

NOTE In the case of horizontally sliding landing doors, coupled with car doors, this device may be in common with the device for proving the locked condition, provided that it is dependent upon the closing of the landing door.

7.7.5.2 In the case of hinged landing doors, this device shall be placed adjacent to the closing edge of the door or on the mechanical device proving the closed condition of the door.

7.7.6 Requirements common to devices for proving the locked condition and the closed condition of the door

7.7.6.1 It shall not be possible, from positions normally accessible to persons, to operate the lift with a landing door open or unlocked, after one single action not forming part of the normal operating sequence.

7.7.6.2 The means used to prove the position of a locking element shall have positive operation.

7.7.7 Horizontally or vertically sliding doors with multiple panels and mechanical linking

NOTE 1 When a horizontally or vertically sliding door comprises several panels which are directly mechanically linked, it is acceptable to lock only one panel, provided this single locking prevents the opening of the other panels and also locates the door closed proving device specified in 7.7.5.1 on a single panel.

When the panels are indirectly mechanically linked (e.g. by rope, belt or chain) such linkage shall be designed to resist normally anticipated forces, and be constructed with special care.

NOTE 2 Such linkages should be checked periodically.

It is acceptable to lock only one panel provided this single locking will prevent the opening of other panels, and these panels are not fitted with a handle. The closed position of the other panel(s), not locked by the locking device, shall be proved by an electrical safety device conforming to 14.1.2.

7.8 Closing of automatically operated doors

In normal service in the absence of a signal for the movement of the car, automatically operated landing doors shall close after a pre-selected period of time.

NOTE This period of time would be selected to represent the traffic expected to use the lift.

8 Car and counterweight

8.1 Height of car

8.1.1 The interior clear height of the car shall be at least 2 m.

8.1.2 The clear height of the car entrance(s) for the normal access of users shall be at least 2 m.

8.2 Available car floor area, rated load, number of passengers

8.2.1 General case

To prevent an overloading of the car by persons, the available floor area of the car shall be limited according to the relationship between rated load and maximum available floor area given in Table 1.

NOTE Recesses and extensions, even of height less than 1 m, whether protected or not by separating doors, are only acceptable if their area is taken into account in the calculation of maximum available car area.

Table 1 — Car floor area related to rated load

Rated load (mass) kg	Maximum available car floor area m ²	Rated load (mass) kg	Maximum available car floor area m ²
100 ^a	0.37	900	2.20
180 ^b	0.58	975	2.35
225	0.70	1 000	2.40
300	0.90	1 050	2.50
375	1.10	1 125	2.65
400	1.17	1 200	2.80
450	1.30	1 250	2.90
525	1.45	1 275	2.95
600	1.60	1 350	3.10
630	1.66	1 425	3.25
675	1.75	1 500	3.40
750	1.90	1 600	3.56
800	2.00	2 000	4.20
825	2.05	2 500 ^c	5.00

NOTE For intermediate loads determine the area by linear interpolation.

^a Minimum for 1 person lift.

^b Minimum for 2 person lift.

^c Beyond 2 500 kg add 0.16 m² for each extra 100 kg.

8.2.2 Goods/passenger lifts

In addition to the requirements specified in 8.2.1, design calculations for goods/passenger lifts shall take into account not only the rated load but also the effect of handling devices which may enter the car.

8.2.3 Number of passengers

The number of passengers shall be as follows:

- a) calculated from the formula,

$$\frac{\text{Rated load}}{75 \text{ kg}}$$

and the result rounded down to the nearest whole number; or

- b) determined from Table 2;

whichever gives the smaller value.

8.3 Walls, floor and roof of the car

8.3.1 The car shall be completely enclosed by walls, floor and roof, the only openings shall be as follows:

- entrances for the normal access of users;
- trap doors and doors for emergency use and maintenance access to machinery and equipment;
- ventilation apertures.

Table 2 — Car floor area related to number of passengers

Number of passengers	Minimum available car floor area m ²	Number of passengers	Minimum available car floor area m ²
1	0.28	11	1.87
2	0.49	12	2.01
3	0.60	13	2.15
4	0.79	14	2.29
5	0.98	15	2.43
6	1.17	16	2.57
7	1.31	17	2.71
8	1.45	18	2.85
9	1.59	19	2.99
10	1.73	20	3.13

NOTE Beyond 20 passengers add 0.115 m² for each extra passenger.

8.3.2 The assembly comprising the sling, guide rollers or shoes, walls, floor and roof of the car shall have sufficient mechanical strength to resist the forces which will be applied in normal lift operation, in safety gear operation or impact of the car on its buffers.

8.3.3 The car floor shall extend over the entire area within the car walls and shall have a slip resistant surface.

The design of the floor shall take into account the fact that loads in the car could be such that their distribution may not be uniform or symmetrical. The deflection at any point on the car floor, when the car is uniformly loaded to the rated capacity of the lift, shall not exceed $1/200$ of the span, relative to the car floor itself.

The deflection of any part of the car sling, when the car is uniformly loaded to the rated capacity of the lift, shall not exceed the following:

- $1/200$ of the span when the car is cantilevered from the guides;
- $1/400$ of the span when the car is centre slung between guides.

8.3.4 Each wall of the car shall resist the application of a force of 300 N, applied at right angles to the wall, at any point, from the inside of the car towards the outside, this force being evenly distributed over an area of $5 \times 10^{-4} \text{ m}^2$ in round or square section, such that the wall behaves as follows:

- a) resists without permanent deformation; and
- b) resists without elastic deformation greater than 15 mm;

8.3.5 The car roof shall also conform to 8.11.

8.3.6 The walls, floor and roof shall not be made of materials likely to become dangerous through flammability or through the nature and quantity of gas and fumes they may generate.

8.4 Car apron

8.4.1 The entrance sill of the car shall be fitted with an apron which extends to the full width of the clear landing entrance which it faces. The vertical section of the apron shall be extended downwards by a chamfer whose angle with the horizontal plane shall be greater than 60° . The projection of this chamfer on the horizontal plane shall be not less than 20 mm.

8.4.2 The height of the vertical portion of the apron shall be at least 0.75 m.

8.5 Car entrances

8.5.1 Car entrances shall be provided with doors which shall be imperforate.

NOTE On goods/passenger lifts fitted with vertically sliding doors, the doors may be in mesh or perforated panel form, provided the dimensions of the mesh or perforations conform to A.4 in BS 5304:1988.

8.5.2 The car doors when closed shall, apart from the necessary clearances, completely close the car entrances.

8.5.3 When closed, the clearance between panels, or between panels and uprights, lintels or sills, shall be as small as possible and shall not exceed 6 mm.

Except for vertically sliding doors, these clearances shall be measured at the back of recesses, if present.

8.5.4 Hinged doors, shall be prevented from swinging outside the car.

8.5.5 Any vision panels incorporated in car doors shall conform to 7.6.2 a). Their positions shall coincide with each other when the car is at the level of the landing.

NOTE A vision panel is not necessary in the car door when the latter is automatic and remains in the open position when the car is stationary at the level of the landing.

8.5.6 The sills, guides and door suspension shall conform to the relevant requirements specified in 7.4.

8.5.7 Car doors in the closed position shall resist a force of 300 N, applied at right angles to the door, at any point, from the inside of the car towards the outside, this force being evenly distributed over an area of 5 cm^2 in round or square section, such that the door performs as follows:

- a) resists without permanent deformation;
- b) resists without elastic deformation greater than 15 mm;
- c) operates satisfactorily after such a test.

8.6 Protection during operation of doors

8.6.1 General

The doors and their surrounds shall be designed in such a way as to minimize risk or damage or injury due to jamming of a part of a person, clothing or other object.

In order to avoid the risk of shearing during operation, the interior face of automatically operated sliding doors, shall not have any recesses or projections exceeding 3 mm.

Edges of such recesses or projections shall be chamfered in both directions of movement.

NOTE Exception to these requirements can be made for vertically sliding doors according to the note of 8.5.1.

8.6.2 Power operated doors

Power operated car doors shall conform to 7.5.2.

8.7 Electrical device for proving the car doors closed

8.7.1 It shall not be possible in normal operation to start the lift nor keep it in motion if a door (or one panel of a multi panel door) is open.

NOTE Preliminary operations preparing for the movement of the car may take place.

8.7.2 Each car door shall be provided with an electrical safety device conforming to 14.1.2 for proving the closed position so that the conditions specified in 8.7.1 are satisfied.

8.8 Horizontally or vertically sliding doors comprising several mechanically interlinked panels

8.8.1 If a horizontally or vertically sliding door comprises several directly mechanically linked panels, the following options may be considered any one of:

- a) to place the device (8.7.2) on a single panel (the rapid panel in the case of telescopic doors);
- b) to place the device (8.7.2) on the door driving element if the mechanical connection between this element and the panels is direct;

c) in order to ensure locking, in the case and conditions laid down in 5.4.4 note 3 to lock only one panel, provided that this single locking prevents the opening of the other panels (by hooking the panels in the closed position in the case of telescopic doors).

8.8.2 If the panels are indirectly mechanically linked (e.g. by rope, belt or chain) such means of linkage shall be designed to resist normal anticipated forces, shall be constructed with special care and shall be examined periodically.

It is acceptable to place the device (8.7.2) on a single panel, provided that:

- a) this is not the driven panel; and
- b) the driven panel is mechanically linked directly to the door driving element.

8.9 Opening the car door

8.9.1 In order to permit passengers to leave the lift car, if the lift stops close to a landing for any reason, it shall be possible with the car stopped and the power/electricity supply to the door operator (if any) disconnected:

- a) to open or partly open the car door manually from the landing;
- b) to open, or partly open, the car door together with the landing door linked to it if they are coupled, manually from within the car.

8.9.2 The opening of the car door under the conditions provided for in 8.9.1 shall be able to be carried out at least in the unlocking zone.

The force necessary to open the door shall not exceed 300 N.

In the case of lifts covered by note 3 of 5.4.4 the opening of the car door from inside the car shall be possible only when the car is in the unlocking zone.

8.9.3 The opening of the car door with the lift in motion, the rated speed of which exceeds 1 m/s, shall require a force greater than 50 N.

NOTE This requirement is not necessary in the unlocking zone.

8.10 Trap doors and emergency doors

8.10.1 Assistance to the passengers in the car shall always come from outside, being provided in particular by the emergency operation mentioned in 12.4.

8.10.2 If there is an emergency trapdoor in the car roof to permit the rescue and evacuation of passengers, it shall measure at least 0.35 m × 0.50 m.

NOTE This trap door may be used as a means of access to machinery or equipment.

8.10.3 If emergency doors are to be provided for emergency transfer of passengers between adjacent cars the horizontal distance between cars shall not exceed 0.75 m (see especially 5.2.2.2).

These emergency doors shall be at least 1.8 m high and 0.35 m wide.

8.10.4 If trapdoors or emergency doors are installed they shall conform to 8.3.2 to 8.3.6, and also the following.

- a) Trap doors and emergency doors shall be provided with a means for manual locking.
- b) Trap doors shall be capable of being opened from outside the car without a key and from inside the car with a key suited to the triangle specified in 7.7.4.
- c) Trap doors in the roof shall not open towards the inside of the car.
- d) Trap doors in the floor shall not open towards the outside of the car.
- e) Trap doors in the open position shall not project beyond the edge of the lift car.
- f) Emergency doors shall be operable from outside the car without a key and from inside the car using a key suited to the triangle specified in 7.7.4.
- g) Emergency doors shall not open towards the outside of the car.
- h) Emergency doors shall not be located in the path of a counterweight or in front of a fixed obstacle (except for beams separating the cars) preventing passage from one car to another.

8.10.5 The locking specified in 8.10.4 a) shall be proved by means of an electrical safety device conforming to 14.1.2.

This device shall cause the lift to stop if the locking ceases to be effective.

Restoring the lift to service shall only be possible after deliberate relocking.

8.11 Car roof

8.11.1 In addition to the requirements specified in 8.3 the car roof shall:

- a) be capable of supporting two persons i.e. able to support a vertical force of 2 000 N at any position without permanent distortion;
- b) provide at one point a clear area, for standing, of at least 0.12 m², in which the lesser dimension shall be at least 0.25 m;
- c) be so designed as to permit the installation of a balustrade (see BS 7255);
- d) have a surface which is slip resistant.

8.11.2 If there are pulleys fixed to the car sling or machinery they shall be provided with effective devices to prevent the following:

- a) injury to persons;
- b) the suspension ropes or chains, leaving their grooves, if slack;
- c) the introduction of objects between ropes or chains and grooves.

These devices shall be so constructed as not to hinder inspection or maintenance of the pulleys.

8.12 Car header

If an empty space can exist between the car roof and the header of a landing door when this door is opened, the upper part of the car entrance shall be extended upwards, over the whole width of the landing door, by a rigid vertical panel to fill the empty gap.

8.13 Equipment on the roof of the car

The following shall be installed on top of the car:

- a) a control device conforming to **14.2.1.3** (inspection operation);
- b) a stopping device conforming to **14.2.2.4** and **15.3**;
- c) a socket outlet conforming to **13.6.2**.

8.14 Ventilation

8.14.1 Cars with imperforate doors shall be provided with ventilation apertures in the upper and lower parts of the car.

8.14.2 The effective area of ventilation apertures situated in the upper part of the car shall each be at least 1 % of the available car area and the same also applies for the apertures in the lower part of the car.

NOTE The gaps around the car doors may be taken into account in the calculation of the area of ventilation holes, up to maximum of 50 % of the required effective area.

8.14.3 Ventilation apertures shall be built or arranged in such a way that it is not possible to pass a straight rigid rod 10 mm in diameter through the car walls from the inside.

8.15 Lighting

8.15.1 The car shall be provided with permanent electrical illumination ensuring a light intensity of at least 50 lux at floor level and on the control devices.

8.15.2 If lighting is of the incandescent type there shall be at least two lamps connected in parallel.

8.15.3 There shall be an automatically rechargeable emergency supply capable of feeding at least a 1 W lamp for 1 h. This lighting shall come on automatically upon failure of the normal lighting supply.

8.15.4 If the supply specified in **8.15.3** is also used to feed the emergency alarm signal specified in **14.2.3**, its capacity shall be rated accordingly.

8.16 Counterweight

8.16.1 Where a counterweight is provided and incorporates filler weights, measures shall be taken to prevent their displacement. To this effect the following shall be used:

- a) either a frame in which the fillers are secured; or
- b) if the fillers are made of metal, and if the rated speed of the lift does not exceed 1 m/s, fillers should be secured to a minimum of two tie-rods.

8.16.2 If pulleys are fixed to the counterweight they shall be provided with devices to avoid the following:

- a) the suspension ropes or chains, if slack, leaving the grooves;
- b) the introduction of objects between ropes or chains and grooves.

The device shall be constructed so as not to hinder inspection or maintenance of the pulleys.

8.16.3 The lift car shall not be used to counterbalance another car.

9 Rack and pinion system, counterweight suspension, safety gear and overspeed governor

9.1 Rack and pinion system

9.1.1 General

All rack and pinions shall be manufactured in accordance with the dimensional requirements of BS 436-2 and shall be designed in accordance with BS 436-3; the metric module shall be not less than 7.

The car shall be supported, raised and lowered, by means of one or more pinions, driven by one or more motors, mounted on the car and meshing with the rack fixed and parallel to the guides for the lift.

9.1.2 Driving pinion(s)

The driving pinion(s) shall be machined from a material that will resist wear and provide a safety factor of not less than 6. Undercutting of the teeth shall be avoided. The pinion(s) shall be securely fixed to the output shaft(s) by one of the following methods:

- a) key and keyway;
- b) splines or serrations;
- c) machined fitted bolts to a flange forming an integral part of the shaft or driving unit;
- d) forging the pinion integral with the shaft.

9.1.3 Rack(s)

Each length of rack shall be made of material having properties compatible with those of the pinion in terms of wear and impact strength, and shall possess an equivalent safety factor. The racks shall be securely attached to the guides or their supporting structure and shall be designed to withstand all dead and live loads, for which the lift is designed and rated with due allowance for moving masses and inertia forces, including the normal braking action and the application of the safety gear and any wind load. Any deflections shall be limited to values that will not affect the normal operation of the lift. Joints in the rack shall be accurately aligned to avoid faulty meshing or damage to the teeth.

9.1.4 Rack/pinion(s) engagement

9.1.4.1 Means shall be provided to maintain the rack and all the driving and safety device pinions in correct mesh under every load condition. Such means shall not rely solely upon the car guide rollers or shoes.

The correct mesh shall be when the pitch circle diameter of the pinion is coincident with, or not more than $\frac{1}{3}$ of the module out beyond, the pitch line of the rack [see Figure 3 a)].

9.1.4.2 Further means shall be provided to ensure that in the event of failure of the means provided in **9.1.4.1**, the pitch circle diameter of the pinion shall never be more than $\frac{2}{3}$ of the module out beyond the pitch line of the rack [see Figure 3 b)].

9.1.4.3 Means shall be provided to ensure that the width of the rack is always in full lateral engagement with pinion teeth of full form [see Figure 3 c)].

9.1.4.4 Further means shall be provided to ensure that in the event of failure of the means specified in **9.1.4.3**, not less than 90 % of the width of the rack shall in lateral engagement with pinion teeth of full form [see Figure 3 d)].

9.1.4.5 The pinion teeth and the rack teeth shall be square to each other in all planes, within a tolerance of $\pm 0.5^\circ$ [see Figure 3 e)].

9.2 Counterweight suspension

9.2.1 Suspension

If the car is counterbalanced, the counterweight shall be suspended from steel wire ropes, or steel plate link chains, or roller chains.

9.2.2 Ropes

The ropes shall conform to the following:

- a) the nominal diameter of the ropes shall be at least 9 mm;
- b) the tensile strength of the wires shall be as follows:
 - 1) 1 570 N/mm² or 1 770 N/mm² for ropes of single tensile;

2) 1 370 N/mm² for the outer wires and 1 770 N/mm² for the inner wires of ropes of dual tensile;

3) the other characteristics shall conform to those specified in BS 302-4.

9.2.3 Number of ropes or chains

There shall be at least two independent ropes or chains.

Where reeving is used the number to take into account is that of the ropes or chains and not the falls.

9.2.4 Ratio between diameter of sheaves or pulleys and diameter of ropes, safety factors of ropes and chains

9.2.4.1 The ratio between the pitch diameter of sheaves or pulleys and the nominal diameter of the suspension ropes shall be at least 25 regardless of the number of strands.

9.2.4.2 The minimum breaking load of each rope or chain shall be at least 10 times the maximum force in the rope or chain when the car is stationary at the top of its travel. For the calculation of this maximum force the following shall be taken into consideration:

- a) the number of ropes (or chains);
- b) the reeving factor (in case of reeving);
- c) the mass of the rope (or chain); and
- d) the mass of any travelling cables suspended from the counterweight.

9.2.5 Rope termination

9.2.5.1 The junction between the rope and the rope terminations according to **9.2.5.2** shall be able to resist at least 80 % of the minimum breaking load of the rope.

9.2.5.2 The ends of the ropes shall be fixed to the car, counterweight or suspension points by means of metal or resin filled sockets, self tightening wedge type sockets, heart shaped thimbles with at least three suitable rope grips, hand spliced eyes, ferrule secured eyes, or any other system with equivalent safety.

9.2.6 Reverse bends

Arrangements entailing reverse bends of wire shall be avoided.

9.2.7 Chain termination

The ends of each chain shall be fixed to the car, counterweight or suspension points by suitable terminations. The junction between the chain and chain termination shall be able to resist at least 80 % of the minimum breaking load of the chain.

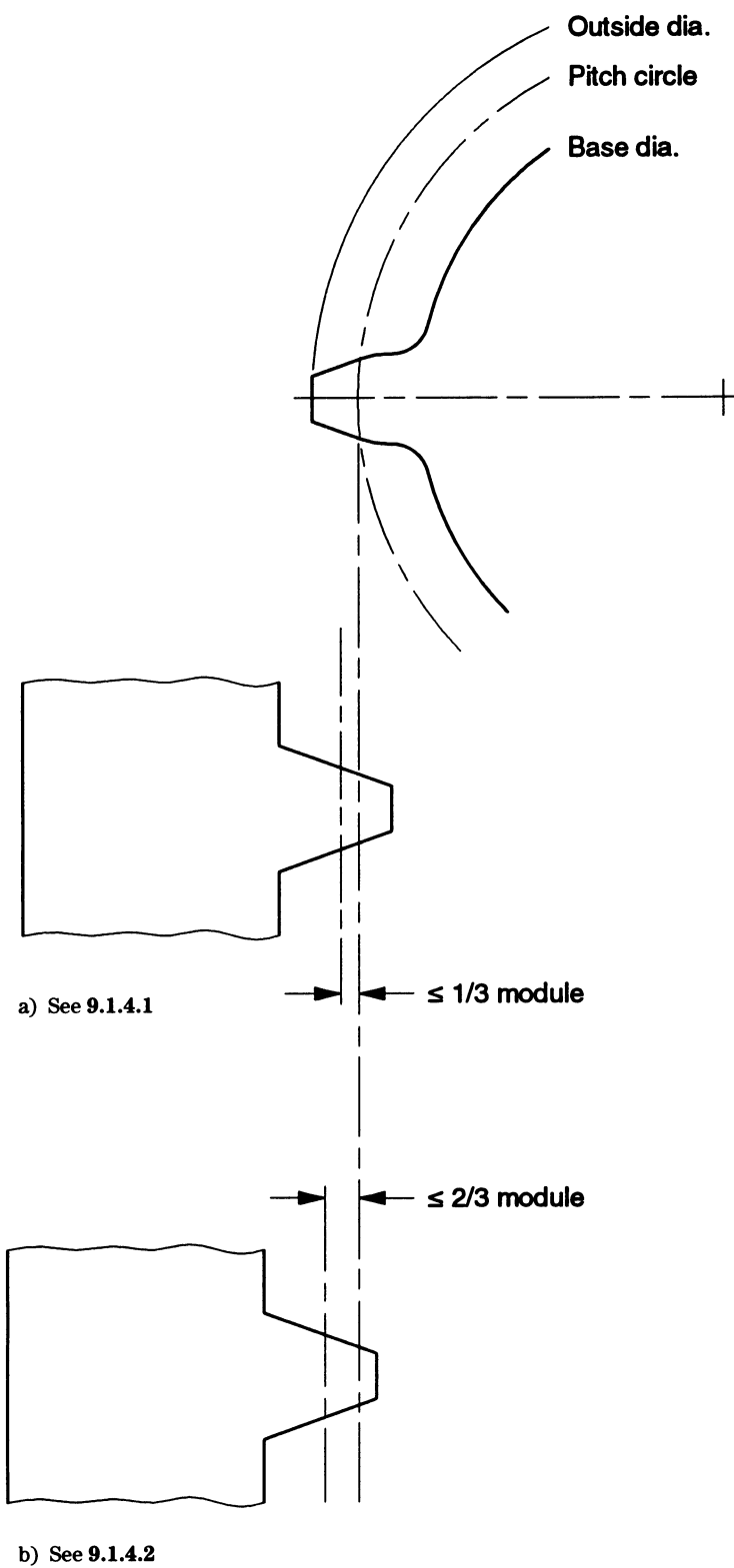


Figure 3 — Rack/pinion radial engagement