

## **SAFETY AT GLASS LIFTS - UK EXPERIENCE**

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### ABSTRACT

The increasing use of glass in the fabrication of lift cars and lift well enclosures has been very evident in the past decade or so.

'Exposed vertical transportation' was a common feature within prestige buildings, grand hotels, etc, of the Victorian era, and modern architects have not been slow in developing the incorporation of 'glass lifts' in new building projects within the UK and the European continent. The UK safety advice and experience is described, as well as new guidance emanating from the European Standards organisation.

### 1. HEALTH AND SAFETY ADVICE - UK

Advice was issued in 1986 (Part 1) and 1990 (Part 2), and edited versions of the two Parts now follow.

#### 1.1 Part 1 (1986)

##### 1.1.1 Introduction

This advice is intended to assist persons assessing the safety of glass lift installations. It relates some of the historical background of such lifts and describes the two basic types which are now being installed. Whilst the advent of glass lifts should not dilute the safety standards for passengers travelling in the lift car, other features of the lift installation may introduce particular hazards for other people, eg intending passengers, maintenance personnel etc. Such hazards would also exist if lift cars of conventional 'non-glass' lifts were exposed in similar fashion to glass lifts.

For many years it has been UK practice for the cars of passenger lifts to travel within a liftway enclosure which is complete and usually opaque, whether or not fire-safety precautions demanded a solid, fire-resistant enclosure. The moving car could not generally be seen from outside the enclosure, and lift passengers could see nothing beyond the confines of the car.

Recent years have witnessed the re-emergence of 'exposed vertical transportation' which was common within prestige buildings, grand hotels etc of the Victorian age, and lifts providing 'exposed vertical transportation' are often now referred to as 'glass', 'observation', 'panoramic' or 'scenic' lifts. The use of glass, coloured plastics, aluminium, stainless steel and electric lamps in the construction of cars and liftway enclosures can make them aesthetically attractive and architects are thus very interested in making use of these lifts. Predictably there have already been many 'variations on a theme'.

The term 'wall-climber' is used within the lift industry to describe an exposed vertical transportation type of lift commonly installed on the outside of exterior walls of high-rise buildings, most notably within the USA. It is not anticipated that wall-climbers will be installed for general public use within the UK to any appreciable extent, and such lifts are not intended to be within the scope of this advice. However, although particular considerations will apply to this type of lift, eg. effects of solar radiation, icing-up of guides/ropes/safety gear, or emergency release or passengers, some of the ensuing advice may still be apposite.

VIEW OF GLASS LIFT SHOWING TYPES OF LIFTWAY ENCLOSURES AT VARIOUS LANDINGS

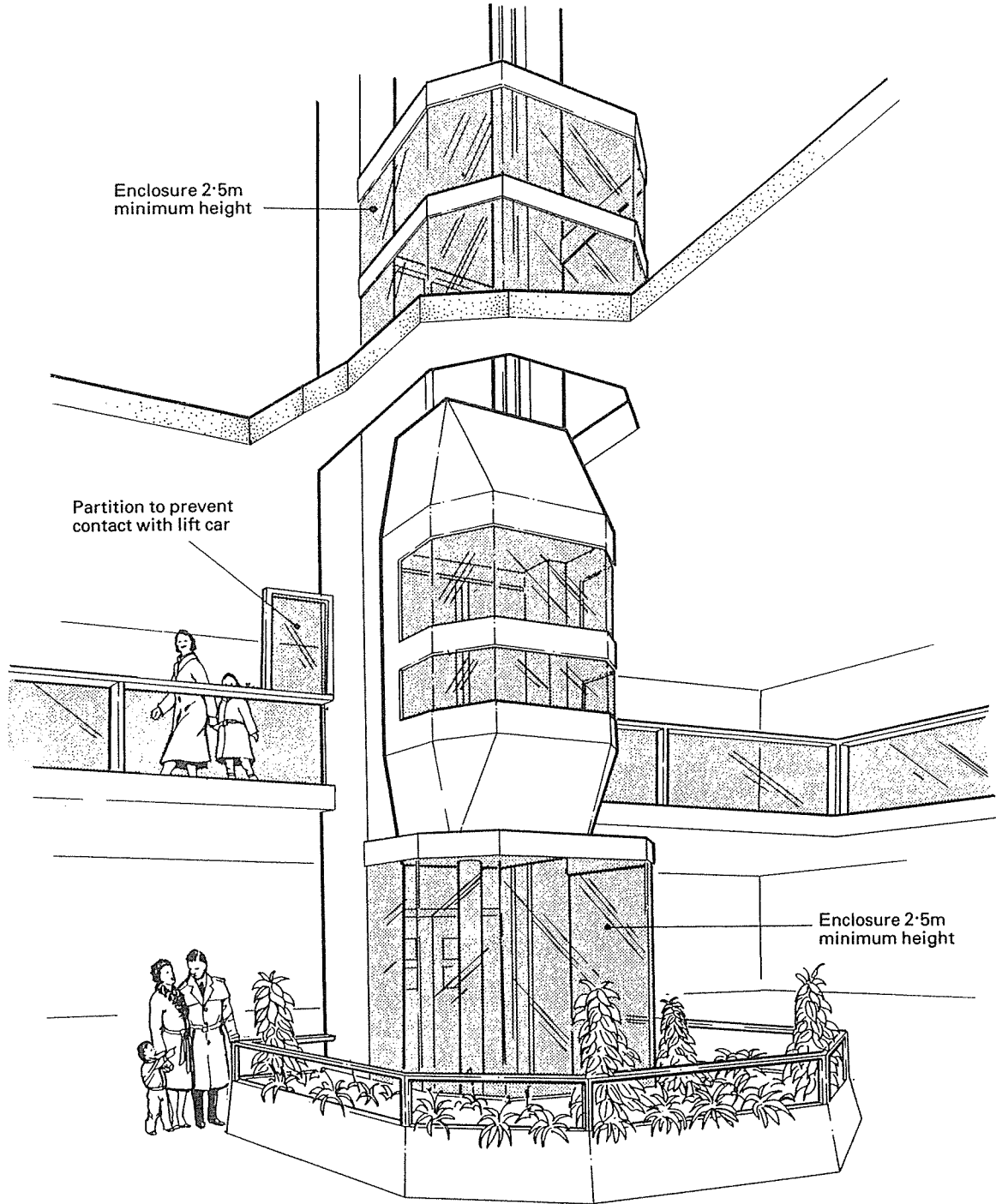


Figure 1

**Note:** Readers of the magazine 'Elevator World' in October 1956 or in August 1989 would be aware of the claim that the 'world's first exterior glass elevator' was erected against an outside wall of the El Cortez Hotel, San Diego, USA in 1956.

In the UK the vast majority of glass lifts installed, or likely to be installed, are sited inside buildings. Such lifts are readily distinguishable from their conventional counterparts because their liftways are seldom completely enclosed and the enclosures which are provided are usually transparent.

Incomplete enclosure of the liftway of a glass lift is taken to mean that the 'enclosure' does not completely surround the liftway, or its height does not fully span the distance between floor and ceiling or between floor and top of liftway (see Figure 1).

INCOMPLETE ENCLOSURE MAY ADVERSELY AFFECT THE SAFETY OF ALL THOSE PERSONS IDENTIFIED IN PARA 1.1.2, AND THE POSSIBLE DANGERS CREATED BY INCOMPLETE ENCLOSURE SHOULD BE CONSIDERED VERY CAREFULLY BY ALL CONCERNED BEFORE SUCH A POLICY IS ADOPTED.

Some glass lifts will be installed in atriums or main entrance areas of buildings when it may normally only be possible for the liftways to be approached from one direction (or 'side') at each floor or perhaps from an adjacent stairway. Such lifts are similar in principle to 'wallclimbers', and enclosure will not usually completely surround the liftway.

At many glass lift installations it may be possible for persons to approach a liftway from all directions because a floor(s) extends right up to the liftway, eg at the lowermost floor of an atrium-type lift or at floors in a conventional building. At such lifts it is common practice for the height of the enclosure surrounding the liftway to be less than the distance between floor and ceiling or between floor and top of liftway (see Figure 1).

### 1.1.2 Safety

The ensuing advice relates to safety precautions to be taken in respect of the following:

- (1) passengers (including intending passengers);
- (2) other persons who may be in the vicinity of the lift(s), eg persons working in, or visiting the building where the lift is installed; and
- (3) persons working on the lift(s), eg those engaged in maintenance, repair, examinations, cleaning, etc.

**Note:** The use of glass in the construction of this type of lift means that lift cars and enclosures need to be cleaned carefully and frequently. Care must be taken for the safety of persons engaged in cleaning operations, particularly if such persons are not experienced lift-servicing personnel.

#### 1.1.2.1 General

Glass lifts should generally be installed in accordance with current UK safety legislation and with due regard to current British Standards which closely reflect European (EN) Standards. Whilst BS 5655: Part 1 and 2 do not recommend the use of glass for lift cars and liftway enclosures, the practice is likely to be covered by future revisions of the European Standards.

### Glass used in construction of lifts

Glass is used extensively for lift cars and liftway enclosures of this type of lift and a 11.5 mm thick "sandwich" of glass - clear resin - glass is frequently used. If single-sheet glass is used then its thickness should not be less than 10 mm and it should be fitted with a shatter-resisting plastic film on at least one side. The type of glass used should conform to BS 6206: 1981 "Impact performance requirements for flat safety glass and safety plastics for use in buildings". Care is needed to ensure that glass panels are suitably mounted, properly secured, and are not designed to be load-bearing, structural elements. It is recommended that guard/hand rails and toe-plates (kick-plates) should be provided within cars, fixed adjacent to the walls.

### Incomplete liftway enclosures

Enclosure of the liftway at any floor (or part of floor) is not deemed to be necessary if the minimum horizontal distance between liftway and floor-edge or stairway is 2 metres.

**Note:** The enclosure at the landing side of such lifts is normally continuous from floor to ceiling at each floor and such enclosures should extend sideways sufficiently to prevent persons from reaching around the enclosure to gain access to the liftway (see Figure 1).

To prevent persons falling, where necessary, 1.1 metre high balustrades/guard-rails should be provided at edges of floors/stairways. It is recommended that no ledge shall be created between the liftway side of a balustrade/guard-rail and the floor-edge. If a ledge is created it should be limited in width to 120mm and should preferably slope downwards in the direction of the liftway at a minimum angle of 25° from the horizontal.

At glass lifts, where the above-mentioned 2 metres minimum horizontal separation is not achieved, the perimeter of the liftway should be suitably enclosed on all 'sides' to a height of at least 2.5 m.

The height of any enclosure which does not fully span the distance between floor and ceiling or between floor and top of the liftway should be at least 2.5 metres; additional safety may be achieved by providing a horizontal/inclined projection of the enclosure parapet towards from the liftway, and/or maximising the horizontal clearance between enclosure and lift car, where practicable.

**Note:** A horizontal clearance of at least 450 mm is sometimes provided at or below the lowest level served by the lift to provide safe access to the car etc for maintenance/servicing personnel.

The enclosure should be vertical, and its exterior surface should be smooth and free of projections (except for parapet) and indentations which would permit persons to scale it.

At any lift where 'full-height' enclosure is not provided opposite the car entrance it should not be possible for passengers to open a car door(s) if the car is outside the unlocking zone of any landing door, or in the event of power failure, (BS 5655 requirement).

The height of enclosure(s) should not be effectively reduced by items such as display stands, furniture, etc being sited outside and immediately adjacent to the enclosure.

Safe arrangements for releasing passengers trapped because of lift breakdown etc must be carefully organised and strictly followed by authorised personnel. Whilst a transparent incomplete enclosure and car may aid communication, it should not become a convenient reason for releasing passengers with the car away from a landing.

Safe systems of work must be carefully prepared and provided for all persons engaged to work on the lifts and a suitably trained and authorised person should be in control whenever such work is carried out. The adoption and use of a permit-to-work system should be considered, particularly when cleaning of the lift installation is being undertaken and/or when scaffolding or other types of working platforms are erected near the liftway.

Cleaning of the exterior of the car(s) and of the liftway enclosure(s), should be done with car(s) stationary and power locked off at the mains supply. The entry of persons into the liftways of glass lifts, other than by experienced lift-servicing personnel, should be avoided, even if the horizontal clearance of 450mm provided for maintenance/servicing personnel (see 'Note' above) exists.

If it is considered necessary for a car(s) to be moved intermittently during cleaning operations then the car(s) should preferably be moved via the normal car/landing controls, with all persons either inside the car(s) or outside the liftway enclosure. If a car-top control station is to be used to move the car(s) then the car(s) should only be moved in the 'downward' direction and under the individual control of an authorized and trained operator, with landing and normal car controls isolated and machine-room locked to prevent unauthorised access.

If any person is permitted to work at an elevated position adjacent to the liftway enclosure, then the car should be positioned, with normal controls isolated, at a height to prevent accidents being caused by falls into the liftway, unless other equally effective means of achieving safety are provided.

Effective means/systems should be provided to prevent persons falling from a car roof or from being trapped between moving and fixed parts whilst on the roof of a moving car. Guard-rails, safety harnesses or other suitable safeguards should be used where necessary.

Care should also be taken - and means provided - to prevent objects, eg tools, falling from a car roof. Incomplete enclosure clearly exposes persons near the lift to the hazards from falling objects.

For aesthetic reasons, the liftway at the lower-most floor served by an atrium-type lift is sometimes partially embellished by special visual arrangements, eg shrubbery, floral displays, fountains, moats, etc. It may be contended that such displays, etc create a suitable enclosure/barrier and that the provision of a 2.5 metre high glass enclosure is therefore unnecessary. Such arrangements are NOT considered to constitute suitable alternatives to the safeguards provided by a 2.5 m (minimum) high enclosure.

## 1.2 Part 2 (1990)

### 1.2.1 Introduction

During the four years since Health and Safety Executive (HSE) information and advice concerning glass lifts were promulgated, the growth of experience in the use of such lifts has predictably coincided with a rapid increase in the numbers of glass lifts being installed.

It has been estimated that they are being installed in the UK at a rate of 125 to 150 per year, compared with 10 per year in 1985. As a result of HSE monitoring of the 'national scenario' over the past few years, advice can be given upon:-

- (i) the general situation;
- (ii) a particular problem associated with the preponderant use of glass lifts by the general public, and their consequent attraction to young children;
- (iii) remedial measures which may be contemplated by those responsible for design, installation and safety of such lifts.

### 1.2.2 General Situation

Because glass lifts are more expensive than conventional lifts and are usually of intricate architectural design, adherence to well-established Standards and criteria for their basic design, manufacture and installation is normally achieved.

Consequently, functional, structural and component failures have not apparently been a problem.

Safeguards for persons working on top of lift cars appear to have been adequate, despite the fact that complete enclosure of liftwell is not usually provided.

The only relevant known accident occurred when a glass panel forming part of a continuous liftwell enclosure became dislodged, resulting in the fall of a lift fitter from the car top. (An occurrence which might also have happened if the enclosure had been fabricated from panels of other materials).

Cleaning of glass lift cars, glass lift enclosures and pits does not seem to have caused problems concerning safety, which may indicate that effective safe working procedures are being suitably organised and are being followed by those concerned.

### 1.2.3 Particular Problem

In the UK these lifts are often provided with car doors and landing doors made largely or wholly of transparent glass which, together with the remainder of the glass enclosures of the car and liftwell act as windows for persons within a car or at a landing area.

Young children are particularly prone to press themselves against glass landing doors in order to watch a car(s) moving within the lift well, and in so doing they often press the palms of their hands tightly against the surface of the landing door(s). Although it is less likely, children may also press themselves against glass car doors.

Consequently, accidents have occurred when automatic powered opening of the door(s) has caused children's fingers to be moved sideways into the horizontal gap between door(s) and architrave/jamb. [6 mm (0.236 ins) maximum at a new lift] (See Figure 2).

Doors with fully-flush surfaces will probably cause squeezing/pinching injuries, but more severe injuries, eg. lacerations, may occur if an accident is caused by a door in which a glass panel(s) is recessed within a metal frame. The gap between such a door and its architrave may thus vary between approximately 3 mm and 6 mm as the door opens fully.

#### 1.2.4 Comment

Glass lifts will continue to be installed.

They are very popular with architects, developers etc, for shopping precincts, hotels and atriums of prestige office buildings.

Predictably, risks are greater at lifts in shopping precincts which are frequented by many children and the feedback on relevant accidents confirms this prediction.

#### 1.2.5 Remedial Measures (General)

Efforts to develop intrinsic safeguards against finger-trapping at glass doors have usually been induced by pressures from lift-owners, site managers, inspectors, etc, and response from lift companies has therefore been spasmodic rather than concerted.

The most effective measure would be to cease manufacture/installation of glass doors and some lift makers have never espoused such doors.

#### 1.2.6 Remedial Measures (Particular)

##### 1.2.6.1 Provision of metal doors at glass lifts not yet installed

This is worthy of serious consideration by the owners/managers of the particular premises, and the problems associated with inquisitive young children deserves to be carefully considered before any decision to provide glass doors is finalised.

##### 1.2.6.2 Retrospective provision of metal doors on existing glass lifts

Even at premises frequented by many young children, consideration of the situation might still not convince an owner/occupier that existing glass doors need to be replaced by metal doors, if the customary view of 'reasonable practicability' is taken.

##### 1.2.6.3 Safety improvements at lifts with glass doors

Note: The following list exemplifies measures which - either individually or in combination - have been applied at/are being considered for existing and new glass lifts:

(1) Doors made fully-flush on their exposed surfaces.

(2) Clearances between doors and their architraves reduced to a minimum, as far as practicable below 6 mm.

(3) Provision of bristle-type deflector devices over full height of architraves to prevent access to the gaps between doors and architraves. (see (2) above).

(4) Doors rendered opaque or sufficiently translucent over the whole of their surface areas, or over an area sufficient to preclude their effective use as 'windows' by young children. (Methods used to achieve opaqueness or translucency may also reduce the likelihood of 'stiction' between childrens' hands and door surfaces).

- (5) Automatic door-opening speeds reduced to a practicable minimum.
- (6) Automatic door-opening forces reduced to a practicable minimum.
- (7) Automatic door-opening delayed until a lift-car has arrived and stopped level with a landing.
- (8) The use of audio or visual warnings, eg to advise children to stand clear of doors.

#### 1.2.6.3 Safety measures at premises containing glass lifts.

Adequate supervision, eg specialised security staff, should be provided to help in preventing young children being endangered by glass doors of lifts, and such staff should be properly trained in relevant emergency procedures, etc.

## 2. EXISTING EUROPEAN (CEN) STANDARDS

### 2.1 EN81: Part 1:1985 (Electric Lifts) and EN81:Part 2:1987 (Hydraulic Lifts)

#### 2.1.1. Use of glass in cars and lift well enclosures

The use of glass, 'even armoured, or of plastic materials' is effectively only permitted for specific vision panels in manually-operated landing doors or car doors.

## 3. REVISION OF EUROPEAN (CEN) STANDARDS

### 3.1 Aims of Revision

To remove national variations, obvious errors, and to draft requirements for the use of glass in lifts.

#### 3.1.1 Use of glass in lifts

Drafting of the requirements is being undertaken by Working Group 1 of Technical Committee 10 of the European Committee for Standardisation (CEN/TC 10/WG1).

It is not intended to produce a complete and separate package of requirements for the type of lift categorised variously as a glass lift, scenic lift, panoramic lift, observation lift, etc.

Instead, amendments are being made to the existing requirements of the European Standards which will enable glass to be used in lifts with safety. Naturally, the use of glass in lifts is not acceptable if dilution of safety standards results.

Two prime areas of concern are the degree of protection provided by incomplete enclosure of the lift well, and, the strength of the glass used in the fabrication of lift cars and lift well enclosures (including doors).

#### 3.1.2 Incomplete enclosure of lift well

In the existing EN81 standards, incomplete enclosure is specifically and conditionally permitted 'when the well is not required to contribute to the protection of the building against the spread of fire'.



It is proposed that the revised standards will similarly tolerate incomplete enclosure providing:

i) the height of the enclosure at points normally accessible to persons is sufficient to prevent such persons being endangered by moving parts of the lift and from interfering with the safe operation of the lift by reaching lift equipment within the well, either directly or with hand-held objects;

(The height is assumed to be sufficient if it is in conformity with Figures 3 and 4, and it should be noted that the minimum horizontal distance between car and enclosure will be 0.5 m).

ii) the enclosure is imperforate;

iii) the enclosure is located within 0.15 m maximum of the edges of floors, stairs or platforms;

iv) provisions are made to prevent other equipment, eg nearby cleaning machinery, from interfering with the safe operation of the lift(s);

v) special precautions are taken to protect lifts exposed to the weather, eg wall-climbing lifts installed against the exterior walls of a building.

[NOTE: Installation of a lift with incomplete enclosure of its well should only occur after full consideration of the types of person to whom it will be accessible, eg unsupervised children, vandals, cleaning staff, etc and of the environment in which it will operate]

### 3.1.3 Strength of glass used for well enclosures and for lift cars

#### 3.1.3.1 Walls, floor and ceiling of the well

Existing requirements for the load-resistance properties of the structure of the well will still be included, and it is intended to make use of informative annexes which will exemplify glass types, dimensions and fixing arrangements, which may be used to satisfy the structural strength requirements.

#### 3.1.3.2 Walls, floor and roof of the car

Existing requirements for the 'enclosure' of the car and the mechanical strength of the walls, floor and roof will be unchanged. Again, the use of informative annexes is proposed to give advice on how glass can be used to meet the stated requirements.

Additionally, it is proposed that a hand-rail be provided within the car against any wall which includes glass below a height of 1.1 m from the floor.

#### 3.1.3.3 Landing doors and car doors

Existing requirements for the mechanical strength of these doors will remain and it is again the intention to provide informative annexes to assist in achieving conformity when glass is to be used.

Some additional textual additions are proposed regarding the proper fixing of glass for landing doors.

To help to protect children against the finger-trapping hazard described and depicted earlier in this paper, it is proposed to include the following requirements, for glass doors fitted at landings and to cars: 'Power-operated horizontal sliding doors shall be opaque up to a height of 1.1 m'.

4. COMMENTS

4.1 Revision of European Standards

The revisions being proposed are subject to further consideration within the working group and eventually their ratification by CEN/TC10 will be required, within the formal CEN regulatory procedures.

Ultimately, it will be necessary for detailed comparisons to be made between the requirements of the revised European (EN) Standards and the essential safety requirements of relevant EEC Directives.

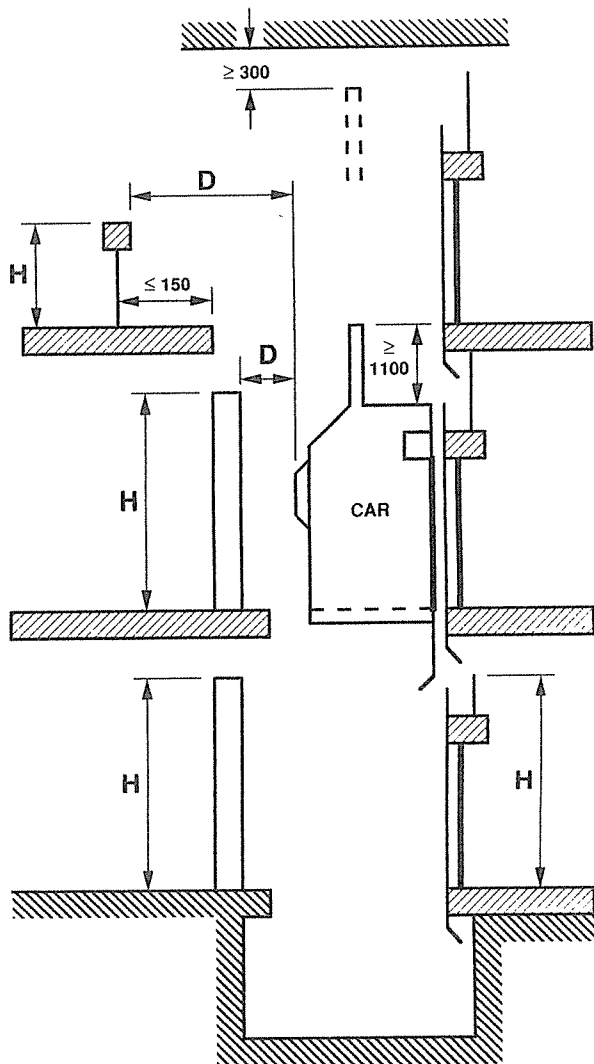


Figure 3

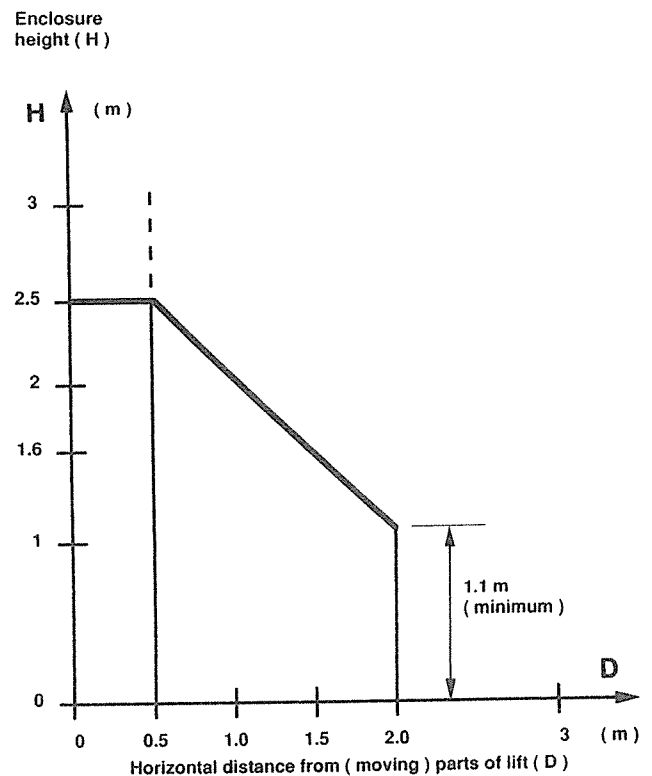


Figure 4

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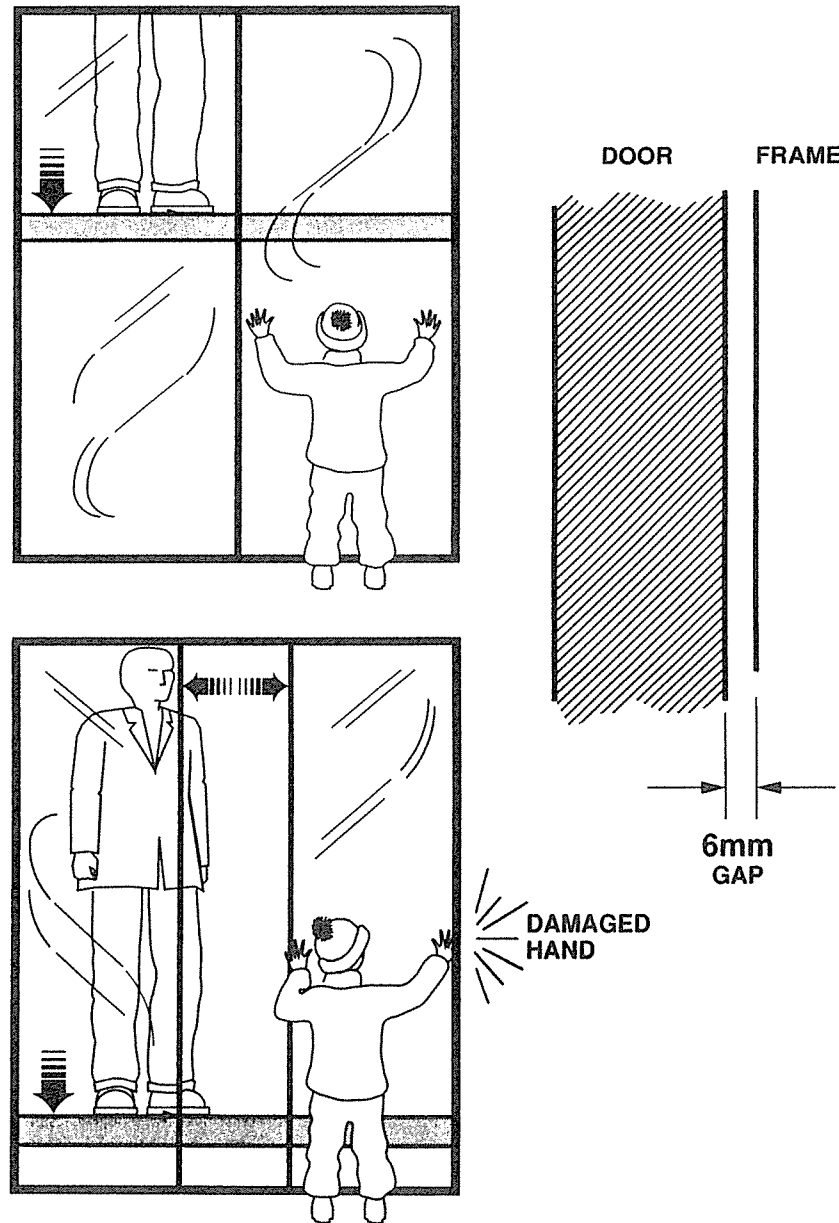


Figure 2

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