Scottish Health Technical Memorandum 2024

(Part 2 of 4)

Design responsibilities

Lifts

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1. Scope

General

1.1 Healthcare premises are dependent upon lifts to provide an efficient, fast and comfortable vertical transportation service for the movement of patients, staff, visitors, medical equipment and ancillary services items.

NOTE: Throughout this document, healthcare premises have also been referred to as hospitals.

1.2 All lifts are subject to strict statutory regulations which cover operational safety to ensure that passengers can be fully confident that the lift service is safe to use.

NOTE: Lifts in healthcare premises provide an essential service that may not always be fully appreciated by the users.

1.3 The scope of this Scottish Health Technical Memorandum does not cover manual lifts, hoists, escalators and paternosters. Paternosters are considered too hazardous in a healthcare environment.

User considerations

1.4 The psychological aspects of lift design in terms of being user-friendly need to be addressed to allay anxieties and fears of users.

1.5 Travelling in a lift can be perceived as dangerous by persons of a nervous disposition, in several different ways, but mainly from the notion of being isolated in a sealed box inside a vertical well which extends from the lowest ground floor level to the top floor of the building.

1.6 A common claustrophobic fear is that of being trapped between floors without the means to communicate with persons outside to give warning of the predicament or to receive reassurance that assistance is at hand.

1.7 Physiological constraints affect the rates of acceleration and deceleration which the human body can comfortably withstand and in healthcare premises, the selection of operational lift speed is important to minimise any adverse effects on patients.

1.8 Psychological appreciations are more subtle and can be influenced by the lift finishes, decor, apparent reliability, frequency and transit time of the service.

2. Management responsibilities

2.1 It is incumbent on management to ensure that their lift installations comply with all the statutory regulations applicable to lifts on their premises. Other functional guidance in terms of standards and codes of practice should also be noted.

Statutory requirements

2.2 Safety regulations are as laid down in the:

f. Offices, Shops and Railway Premises (Hoists and Lifts) Regulations 1968;

g. Health and Safety at Work etc Act 1974;

h. Electricity at Work Regulations 1989;

i. Fire Precautions Act 1971 (as amended by the Fire Safety and Safety of Places of Sport Act 1987);

j. Factories Act 1961 (as amended);

k. The Building Standards (Scotland) Regulations 1990 (as amended).

l. Lifting Operations and Lifting Equipment Regulations 1998;

m. Management of Health and Safety at Work Regulations 1999;

n. Workplace (Health, Safety and Welfare) Regulations 1992;

o. Construction (Design and Management) Regulations 1994;

p. Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR);

q. Electromagnetic Compatibility Regulations 1992, (as amended);

r. Supply of Machinery (Safety) Regulations 1992.

Functional guidance

2.3 Guidance is as laid down in:

a. British Standards and Codes of Practice;

b. Health and Safety Executive Guidance;

c. NHS Model Engineering Specifications;

d. Health Building Notes;

e. Scottish Hospital Technical Notes;

f. Scottish Health Technical Memoranda and NHS in Scotland Firecode - NHS Estates;

g. Scottish Hospital Planning Notes

h. The Technical Standards For compliance with the Building Standards (Scotland) Regulation 1998.

For further details please refer to the references section.

2.4 The Offices, Shops and Railway Premises (Hoists and Lifts) Regulations 1968 require that a lift will function without injury or danger to the general public and passengers.

Safety applications

2.5 The Factories Act 1961 and the Offices, Shops and Railway Premises (Hoists and Lifts) Regulations 1968 require that every power-driven lift should be of good mechanical construction, sound material, adequate strength, properly maintained and thoroughly examined by a competent person (lifts) at least once in a period of six months, and that a report of the result of every such examination should be prepared on the prescribed form F2530, (previously F54) (see Part 4 'Operational management' of this SHTM), signed and dated by the person carrying out the examination.

> **NOTE:** Competent person (lifts) - refer to Chapter 12 'Designated staff functions'.

2.6 The report should be retained and kept readily available for inspection for at least two years after the date of the lift examination.

2.7 The legal responsibility for ensuring that lifts are properly maintained rests with the management of the healthcare premises in which the lifts are installed.

2.8 At present, while there is no legal requirement for new lifts to be tested before being taken into service, it is strongly recommended that all lifts should be examined and tested in accordance with BS 5655 Part 1: 1986, by a competent person (lifts). (Reference should also be made to BS EN 81-1)

2.9 Fire regulations require that certain lift controls can be operated by the fire brigade so that firemen can take immediate control of the lift for safety and fire-fighting purposes.

2.10 At least one bed-lift in an acute hospital should be connected to the emergency electrical supply system in line with the guidance contained in SHTM 2011; *Emergency electrical services*.

2.11 All passenger and bed/passenger lifts should be fitted with an emergency intercommunication point.

3. Functional overview

This chapter presents a summary of lift types and categories. More detailed design advice is contained in subsequent chapters.

Types of lift

3.1 There are two main types of lift installed in healthcare premises, these are

a. traction lifts;

b. hydraulic lifts.

Consideration should be given to the running (maintenance) costs incurred over the life span of the lift installation when comparisons are made between traction and hydraulic lifts.

Traction lifts

3.2 Traction lifts are most commonly used in high-rise buildings. They are rope-driven where the drive is by an electric variable speed motor, through a gearbox. This type has a lift car which travels vertically up and down a lift well between the lowest ground floor and the top floor. The lift car's weight is counterweight balanced throughout its full travel in the lift well.

3.3 Magnetic brake systems control the lift car movements between landing levels. In the event of an overtravel, the bottom of the lift well is cushioned by a buffer recoil mechanism The top is protected for the safety of maintenance personnel, by first and second overtravel limit switches to give adequate top of car clearance.

3.4 The traction lift is versatile and can be designed to operate at very fast speeds, such as is required in high-rise buildings. Passenger lifts can routinely carry up to 21 passengers (1.6 tonnes) at speeds of 0.5 to 3.5 metres per second (100 to 700 ft/min), depending on travel and duty.

Hydraulic lifts

3.5 Hydraulic lifts are suitable for applications in low-rise buildings, usually up to a maximum of four floors. They utilise less plantroom space and, in general, the overall capital cost is lower than the traction lift.

3.6 The hydraulic lift is powered by oil-operated ram(s). For the direct acting type, the rams are located below or to the side of the lift car and for the indirect action type it is usual to have a driving mechanism with a side jack arrangement. The extended vertical length of the ram is physically limited and this in turn limits its suitability to low-rise buildings.

3.7 Hydraulic lifts generally operate at a slower speed in the raise direction than for lowering. Lowering is by gravity, and is speed controlled by restrictors in the hydraulic oil return path from the ram(s) to the hydraulic pump reservoir tank.

Categories of lift

3.8 Lifts are categorised according to their use. In healthcare premises they fall into one of the following categories:

a. **passenger lifts**: intended to carry standing and wheelchair-seated passengers. Typical carrying capacity varies from 600 to 1000 kg;

b. **bed/passenger lifts**: generally constructed to similar standards as passenger lifts but have a car of larger dimensions. This permits the carrying of a passenger (patient) on bed or trolley together with the necessary staff and equipment. Typical carrying capacity varies from 1660 to 2500 kg;

c. **goods lifts**: typically carry up to 5 tonnes. Goods lifts that are also used to carry passengers should conform in all respects to the regulations governing the use of passenger lifts;

d. **service lifts**: service lifts are not designed to carry passengers. They are arranged to be called and despatched externally, normally by a call point adjacent to each level hatch or access door, and are generally used for small loads.

4. Lift planning

General

4.1 A lift service is defined by the "interval" and "handling capacity". Interval is the time between lift arrivals at a particular floor. Handling capacity is the number of passengers that can be moved by a lift (or lifts) in a five minute period when "loading factor" is taken into consideration (see Figure 1).

4.2 "Loading factor" is the number of passengers the lift may comfortably accommodate whilst providing a personal comfort zone for each occupant. A comfort zone or pedestrian area is approximately $0.65m^2$ (7 sq. ft). The number of people that a lift may "comfortably" accommodate is therefore less than the rated load of the lift. For small lifts, a loading factor of 80% is typical and for large bed lifts, a loading factor of 50% is typical.

4.3 Many new hospitals are of a low-rise nature which reduces the traffic demand upon the lifts. New hospital departmental layouts should be planned to ensure that the traffic flow is horizontal wherever possible.

4.4 There are many software programs available to simulate the lift passenger traffic in office blocks which have defined directional peaks. However, these can not be easily applied to hospitals where traffic is one- and two-way and peak periods are longer than in offices.

4.5 For effective operation of a hospital, lift systems should be designed to provide adequate lift service during periods of two-way peak passenger traffic and for all other types of traffic that are encountered during the normal operational day. Whilst it would be desirable to segregate all patient traffic from visiting traffic, economics do not permit this.

4.6 Where the same lifts are used for the transportation of patient trolleys and visiting traffic, a compromise lift car design is recommended. A patient trolley requires a narrow, deep car, however, this reduces passenger efficiency and slows transfer times. The compromise lift car design should be of a size able to accommodate patient trolleys and wide enough to expedite passenger transfer.

> **NOTE:** Refer to HBN 40 - 'Common activity spaces', Volume 4, 'Circulation areas'.

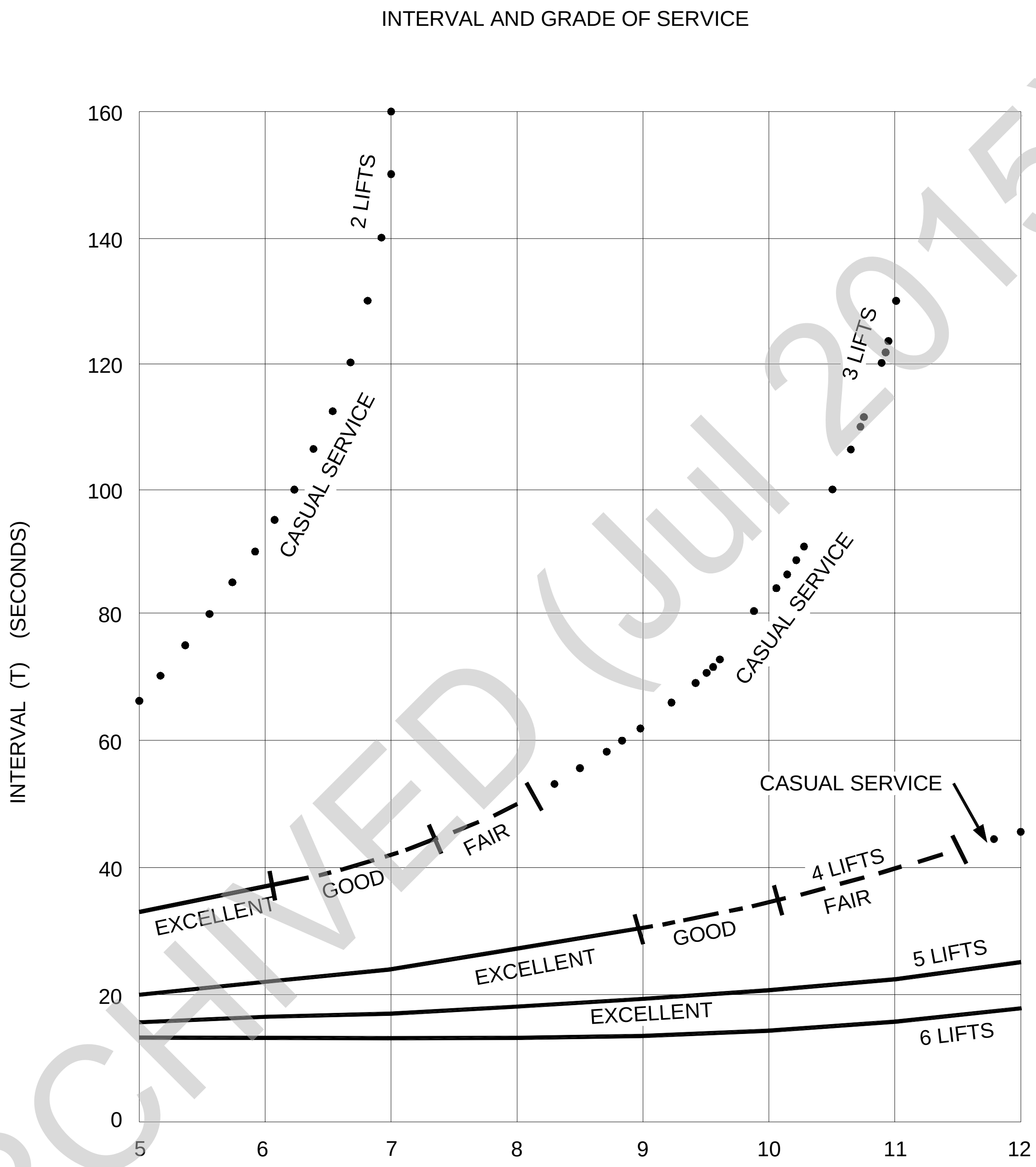
4.7 The expected passenger traffic will peak during visiting hours. Demand on the lifts is reduced to some extent by "open" visiting hours thereby having a constant two-way traffic pattern. The highest demands upon the lifts tend to be at the end of the visiting time. The other peak demands are when two-way visiting traffic coincides with meal trolley retrieval.

Circulation principles

4.8 Planning the circulation of people and goods within any building is a complicated activity and more so in a hospital. Hospitals incorporate regular movements of pedestrians (staff, visitors and ambulant patients) between departments and the regular movement of goods.

4.9 Regardless of similarities in building template, the circulation of any two hospitals will differ if the departmental layouts are different.

Figure 1: Typical representation of preliminary lift planning



Stops per minute/on system (F)

1. Lift speed = $\frac{\text{No. of floors}}{6}$
2. Average floor pitch = 3.5m
3. Average stopping time = 14 secs.

4.10 The design of circulation is basically an architectural function and is not an exact science. It may be based largely upon the designer's experience of similar developments, taking into consideration fire and safety regulations and the advice of the healthcare establishment planning staff.

4.11 Interior circulation would include hospital streets, stairs, corridors and lifts (this list is not exhaustive). The main principles that should be adopted are:

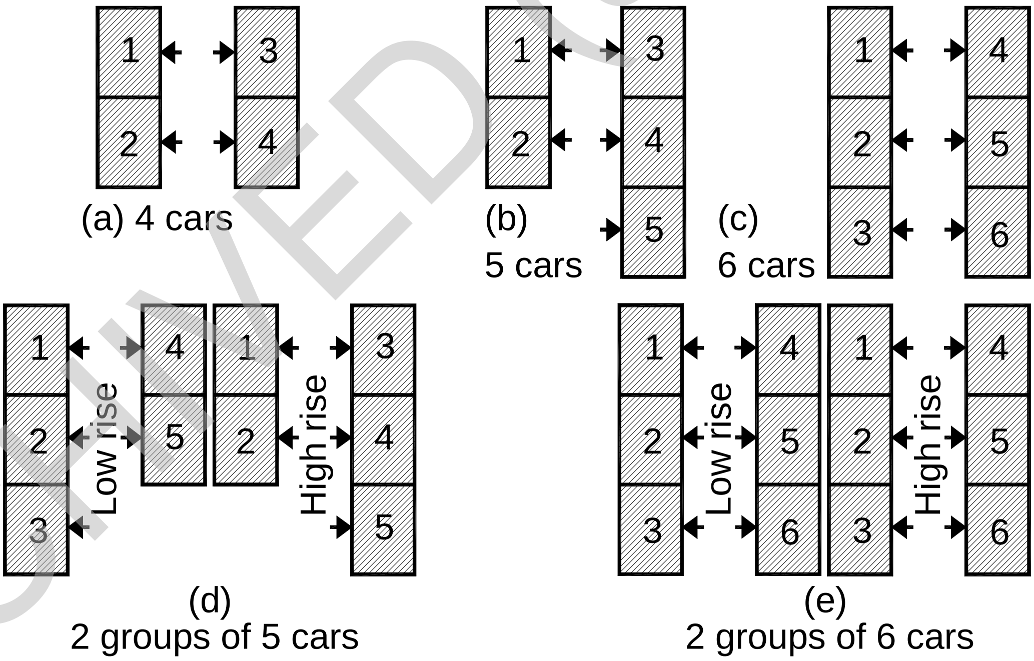
a. location of lifts for passengers as near to the point of entry to the building as possible;

b. placement of lifts so that they can be accessible during the day for normal operational traffic;

c. location of lifts in groups rather than distributed around the hospital as single units. This allows improved handling by a group of lifts and does not disable an area when a single lift fails (see Figure 2);

d. wherever possible, lifts should be located adjacent to a core containing a stairwell so that ambulant passengers can use the stairs for journeys of one floor in preference to the lifts.

Figure 2: Typical grouping of lifts (courtesy of the BSI)



Location of lifts

4.12 Lifts should be located at strategic positions with respect to the anticipated flow of traffic. For incoming traffic, lifts ideally should be positioned near entrances so that the incoming traffic goes vertically to the required floor and then horizontally to the final destination.

4.13 Lifts should not open directly onto streets or corridors but should ideally open onto lobbies recessed from the corridors. Lobbies should be at least 1.5 times the depth of the car and twice as wide.

NOTE: Refer to HBN 40 - 'Common activity spaces', Volume 4, 'Circulation areas'.

Traffic types

Pedestrian

4.14 Pedestrian traffic is all of those ambulant people who require transportation between floor levels. The pedestrian traffic will therefore include staff, patients and visitors. The location of outpatient departments, day surgeries and similar departments generating large numbers of ambulant people should be identified to the lift designer.

Mobility impaired

4.15 It may be considered that the majority of wheelchair traffic in a hospital will be accompanied by an ambulant pedestrian, however the term "mobility impaired" could include:

a. mothers with baby buggies;

b. people on crutches;

c. sight impaired people.

4.16 Lifts serving some locations, for example paediatric or orthopaedic departments, may be expected to have a number of passengers requiring more space than the average.

Bed

4.17 The need to move high dependency patients in beds with equipment may arise and should be considered relative to the departmental structure. In hospital design where wards are on the same level as the theatres, there is often little vertical movement of patients between floors via lifts.

Trolley

4.18 Trolley traffic is probably the most significant traffic in a hospital as the constant flow of food, clean/soiled linen, drugs, sterile supplies, etc, is essential to the smooth operation of a hospital. The methods of distributing laundry, food, etc should be made known to the lift designer who will allow for the peak traffic generated.

4.19 Patient trolley traffic must also be considered in relation to proposed departmental structures as common facilities may be shared between various departments on different floors.

Assessment of traffic

General traffic

4.20 Unlike office lift traffic planning, hospitals have their own unique traffic patterns which vary according to the nature of departments being served, relative locations of the lifts entrances, links to other buildings, their location with respect to incoming and outgoing loading bays, etc.

4.21 Various factors dictate the traffic of a hospital, however vertical traffic can be separated into two distinct parts:

a. pedestrian traffic consisting of staff, visitors and ambulant patients;

b. trolley traffic consisting of beds, patient trolleys, catering trolleys, linen, etc.

4.22 In some locations, these traffic groups may be separated to optimise on efficiency and provide some degree of privacy to patients. All of these items should be considered when planning an effective and economical lift system.

Goods traffic

4.23 When assessing goods traffic, the method of transportation and its effect on other types of traffic requires to be addressed.

4.24 It can be impractical to mix goods trolleys with pedestrian traffic. Goods trolleys often take up the majority of the available lift car space. The tendency is to temporarily remove a lift from passenger service by means of a key switch or similar device. However, this can severely disrupt the passenger handling capabilities of the lifts.

4.25 Consideration should be given to the provision of either dedicated goods lifts or adequately sized passenger lifts, which can also transport goods.

4.26 When calculating goods traffic, the operation of the hospital needs to be considered The designer will need to know, for example, if the hospital uses hot food distribution as opposed to regeneration.

4.27 Where hot food distribution is used, there is a requirement to distribute a large number of trolleys in a short space of time. To determine the number of trolleys that need to be moved, a typical assessment is to divide the number of beds by ten.

NOTE: This has to be adapted to suit local requirements/trolley capacity, etc.

4.28 The total number of trolleys that are transported in a lift car will depend upon:

a. the size of the lift;

b. the number of trolleys that can be transported in a specific period of dedicated goods lift service.

Trolley traffic can be determined using an approach similar to the round trip time calculation described in paragraph 4.36.

Visitor traffic

4.29 Visiting traffic may be estimated in relation to the number of beds and the type of wards. The following table indicates the total number of visitors per bed at any given time:

Table 1: Total visitor numbers per bed at a given time

Maternity	2 visitors per bed
General	1 visitor per bed
Paediatric	1 visitor per bed
Geriatric	¼ visitor per bed

4.30 In an emergency situation, it should be possible to clear all visitors from the hospital in 15 minutes. The handling capacity of the lift system should meet this criterion.

Theatre traffic

4.31 In modern hospitals operating theatres are often located on the same floors as surgical wards. The transfer is horizontal rather than vertical, which does not involve lift movements.

4.32 In some existing or high-rise hospitals, this might not be the case and patient transfer to theatres requires a lift service.

4.33 It is generally uneconomical to provide lifts which are dedicated to operating theatres unless for some specific reason they are located in non-public areas. In practice, theatre patients are often transported in bed/passenger lifts that have been temporarily removed from ordinary passenger service on a key switch function.

4.34 Theatre traffic can be negligible with only occasional trips throughout the day, and is therefore unlikely to coincide with visitor traffic. If the lifts are designed to meet the demand of peak visitor traffic, they should cope with occasional theatre movements.

Determining interval and handling capacity

4.35 There are a number of theories regarding the calculation of passenger traffic; however, most of these relate to the calculation of traffic in office buildings and are generally based upon the incoming peak traffic pattern.

4.36 For hospitals of only two or three floors, such traffic analysis is difficult to apply. The recommended method of determining the quality of lift service is based on a round trip time (RTT) calculation.

Assumptions

a. 28 person bed/passenger lift;

b. Serving three floors;

c. Floor-to-floor height 3.3 m;

d. Speed 0.63 m/s;

e. Two-panel side opening;

f. 1300 mm wide doors;

> **NOTE:** If the entrance to the ward block is on the ground floor, the visiting traffic at this level can be ignored.

g. Serving a ward block with the following occupancy:

  (i) level 2 = maternity 60 beds;

  (ii) level 1 = general 60 beds;

  (iii) ground = geriatric 60 beds.

Calculation

- Using the table in paragraph 4.29, visitor traffic on each level can be calculated as follows:
  - (i) level 2 = 60 x 2 visitors per bed = 120;
  - (ii) level 1 = 60 x 1 visitor per bed = 60;
- If there is a staircase adjacent to or within the vicinity of the lift, and on the basis of clearing the visitors from the hospital in 15 minutes, it may be assumed that:
  - (i) 25 % of the visitors on level 2 will use the stairs;
  - (ii) 50 % of the visitors on level 1 will use the stairs.

- Thus the traffic in any five-minute period becomes:
  - (i) level 2 = (120 x 0.75)) 3 = 30 people in any five-minute period;
  - (ii) level 1 = (60 x 0.5)) 3 = 10 people in any five-minute period;
  - (iii) **Total** = 40 people in any five-minute period.
- The following tables are used in the performance calculations:

Table 2: Door operating times

Door type	Width (mm)	Open (seconds)	Close (seconds)
Two-speed	900	2.1	3.3
Centre-opening	900	1.5	2.1
Two-speed	1100	2.4	3.8
Centre-opening	1100	1.7	2.4
Two-speed	1300	3.3	5.0
Centre-opening	1300	2.3	3.3

Table 3: Single floor trip times in seconds

Floor heights	3.0 m	3.3 m	4.0 m	4.6 m
Lift speed	-	-	-	-
0.5 m/s	8.2	8.8	10.0	11.2
0.63 m/s	7.5	8.1	9.2	10.1
1.0 m/s	6.1	6.4	7.0	7.6
1.6 m/s	5.1	5.3	5.6	5.9

- Performance calculations (assuming the lift car is at ground level with the doors open):

Table 4: Performance calculations

Activity		Seconds
Door close		5.0
Lift run up to level 2	= [$^{3.3}/_{0.63}$] + [8.1]*	13.3
Door open		3.3
Passenger transfer (in)	= [10 x 1.2]†	12.0
Door close		5.0
Lift run down to level 1		8.1
Door open		3.3
Passenger transfer (in)	= [4 x 1.2]#	4.8
Door close		5.0
Lift run down to ground level		8.1
Door open		3.3
All passengers transfer (out)	= [14 x 1.2]	16.8
Total round trip time (RTT)		88.0

* The time taken by the lift car to travel one floor including acceleration and deceleration.
† Assuming 10 passengers [30/3] from level 2 taking 1.2 seconds each to enter the lift car.
# Assuming 4 passengers [10/3, rounded up to 4] from level 1 taking 1.2 seconds each to enter the lift car.

- The handling capacity, at this loading, in any five-minute period would be:

  $$\frac{(5x60)}{88} \text{ x 14 persons = 47 people in five minutes.}$$

- This indicates that one lift will provide an interval of 88 seconds and a handling capacity of 47 people in five minutes which will achieve the designed 40-person capacity.
- By separating the RTT calculation into fixed and passenger-dependent elements, the performance calculations above can be expressed as:

  RTT = fixed time + (transfer time in and out x number of passengers);

  RTT = 54.4 + (2.4 x 14) = 88 seconds.

  Thus once the fixed time element for any lift is known, the RTT for any passenger loading can be estimated.
- Using the above data, the maximum loading RTT can be calculated as follows:

  RTT (max) = 54.4 + (2.4 x rated capacity x % loading factor)

  = 54.4 + (2.4 x 28 x 0.6) = 94.7 seconds.

- The theoretical maximum handling capacity is:

$$\frac{(5 \times 60)}{94.7} \times 28 \times 0.6 = 53$$ people in any five minutes.

NOTE: For information on passenger handling times in relation to different sizes and speeds of lifts, refer to BS 5655 Part 6: 1990.

Ergonomics

4.37 Ergonomic considerations for hospital lifts are described in HBN 40 – ‘Common activity spaces’, Volume 4, Circulation areas.

5. Special lift designations

Fire-fighting lifts

General

5.1 The need for fire-fighting lifts in a new building needs to be determined by the design team, in conjunction with the health establishment fire officer and the local fire service.

NOTE: Refer to NHS in Scotland Firecode SHTM 81; *Fire precautions in new hospitals* and BS 5588: Part 5:1991 for further guidance.

Criteria to install

5.2 If the need to install a fire-fighting lift is established, it is recommended that the building is treated in a similar manner as a commercial building. If the height of the building exceeds 18 m, fire-fighting stairways, each incorporating a fire-fighting lift, should be provided so that the horizontal distance from any part of any storey to the nearest fire-fighting lift does not exceed 60 m, and so that there is one lift for each 900 m^2 of floor area (or part thereof) on any floor above the 18 m level. The recommendation also requires a fire-fighting lift to be installed where there is a basement(s) with a depth exceeding 9 m.

NOTE: Refer to BS 5588 Part 11: 1997.

Design applications

5.3 Design teams and planners should refer to BS 5588:Part 5: 1991 which provides comprehensive guidance on the design of fire-fighting lifts.

Evacuation lifts for the disabled

5.4 The Disabled Persons Act 1981 includes a requirement that provision for access to public buildings should comply with BS 5810:1979 which is implemented by the Building Standards (Scotland) Regulations. The regulations linked access to egress and from this, the suitability of normal lifts for evacuating the disable was questioned. In response to public concern, BS 5588: Part 8:1999 was generated.

Design applications

5.5 Guidance on evacuation lifts for the disabled is provided in BS 5588: Part 8: 1999. The requirements are similar to a fire-fighting lift and BS 5588: Part 8 makes an allowance for a fire-fighting lift to be used in place of a disabled evacuation lift.

Escape bed lifts

Provision

5.6 It is important that the design team of a new hospital is familiar with progressive horizontal evacuation or alternative means of escape for patients. It is normal in an emergency to proceed with horizontal evacuation of patients, but where this is not possible, alternative provisions are required.

5.7 NHS in Scotland Firecode SHTM 81; *Fire precautions in new hospitals* gives guidance on the provisions of escape stairways, lifts, bed lifts, and protected lobbies.

5.8 Where the recommendations of SHTM 81 necessitate the use of escape bed lifts, these should comply with the requirements of NHS in Scotland Firecode and SFPN 3 - 'Escape bed lifts'.

Machine room and well

5.9 Escape bed lifts should be located in protected shafts which may incorporate escape stairways, service ducts, etc.

5.10 The lift machine room should be contained within the same protected shaft as the lift well. Where the lift lobbies are pressurised, in the event of a fire the shaft should not be ventilated to the atmosphere. If the lobbies are naturally ventilated, due to being located on an outside wall, the lift wells should be ventilated directly to the atmosphere via a louvre grille of not less that 0.1 m^2 free area. This will prevent the build-up of smoke at the top of the well.

Cars

NOTE: Refer to BS 5655 Part 1: 1986, (BS EN 81-1: 1998) and (BS EN 81-2: 1998).

5.11 The internal dimension of the car should be not less than that required to accommodate an occupied bed and its ancillary equipment, attendant, and a lift warden. The sizes required should be adequate to accommodate a Kings Fund bed.

NOTE: Refer to Scottish Fire Practice Note 3 - 'Escape bed lifts'. Details of the dimensions of a Kings Fund bed are provided in the ergonomic data sheets for bed passenger lifts of HBN 40 - 'Common activity spaces', Volume 4, 'Circulation areas'.

5.12 In the event of an emergency, there will not be adequate time to carefully steer a bed into a minimum-sized lift car. Where bed lifts perform a dual role as bed/passenger lifts and escape bed lifts, a larger lift car should be selected.

5.13 The lift car should be provided with a clear and conspicuous notice stating **"ESCAPE BED LIFT: DO NOT USE FOR GOODS OR REFUSE"**.

Controls

5.14 Escape bed lift controls should be provided in accordance to the guidance of SFPN 3. The required operation of the switch is, in principle, the same as that for the fireman's control detailed in Chapter 7 of this document.

NOTE: Refer to SFPN 3, clause 6.14 'Evacuation control switch'.

NOTE: SFPN 3, chapter VI 'Technical recommendations' contains details of recommendations for escape bed lift services.

Services

5.15 The electrical supply to each escape bed lift should be from a circuit dedicated to the lift and separated from any other building services, except as permitted by paragraph 5.16.

5.16 Where more than one escape bed lift is in the same protected shaft, they may be fed from the same circuit, provided that it is adequate for this purpose and that a fault occurring in any one lift will not affect in any way the operation of any other.

5.17 To ensure availability of escape bed lifts and their associated controls in the event of failure on the normal supply, they should be connected to the emergency standby supply of the hospital.

NOTE: Refer to SHTM 2011; *Emergency electrical services*.

6. Lift equipment

Drive systems

General

6.1 All components used in the assembly of a hospital lift drive system should be designed for continuous heavy duty operation and operate with the minimum of noise under all loading conditions. A minimum life expectancy of 20 years is anticipated.

6.2 A drive system may be defined as the prime mover which makes the lift move in a controlled manner between floors so that it stops within an acceptable tolerance with respect to the landing floor levels. Lift drives can be classified in two main categories:

a. electric traction;

b. hydraulic.

6.3 The selection of the most suitable type of drive is determined by:

a. the length of travel;

b. number of starts per hour;

c. speed of lift;

d. number of lifts required;

e. ride quality.

6.4 Hydraulic lifts are particularly suited to low-rise buildings and are preferred by architects/planners due to the absence of a top machine space. The use of hydraulic lifts is not recommended where:

a. the travel distance exceeds 16 m;

b. the number of starts exceeds 45 electrical starts per hour;

c. the speed exceeds 0.8 m/s.

Electric traction lifts

NOTE: Refer to BS5655: Part 1:1986, (BS EN 81-1: 1998).

6.5 Electric traction lift drives can be grouped into several categories based on the motor type and the method of motor speed/torque control (see Figure 3). These are listed below.

Geared traction drives

6.6 Geared traction machines (see Figure 4) comprise a:

a. worm reduction gearbox;
b. traction sheave;
c. gearbox to motor split-coupling;
d. spring applied/electrically released d.c. brake, (mounted around the split-coupling);
e. hauling motor;
f. fly wheel.

Figure 3: Typical traction lift assembly (courtesy of NALM)

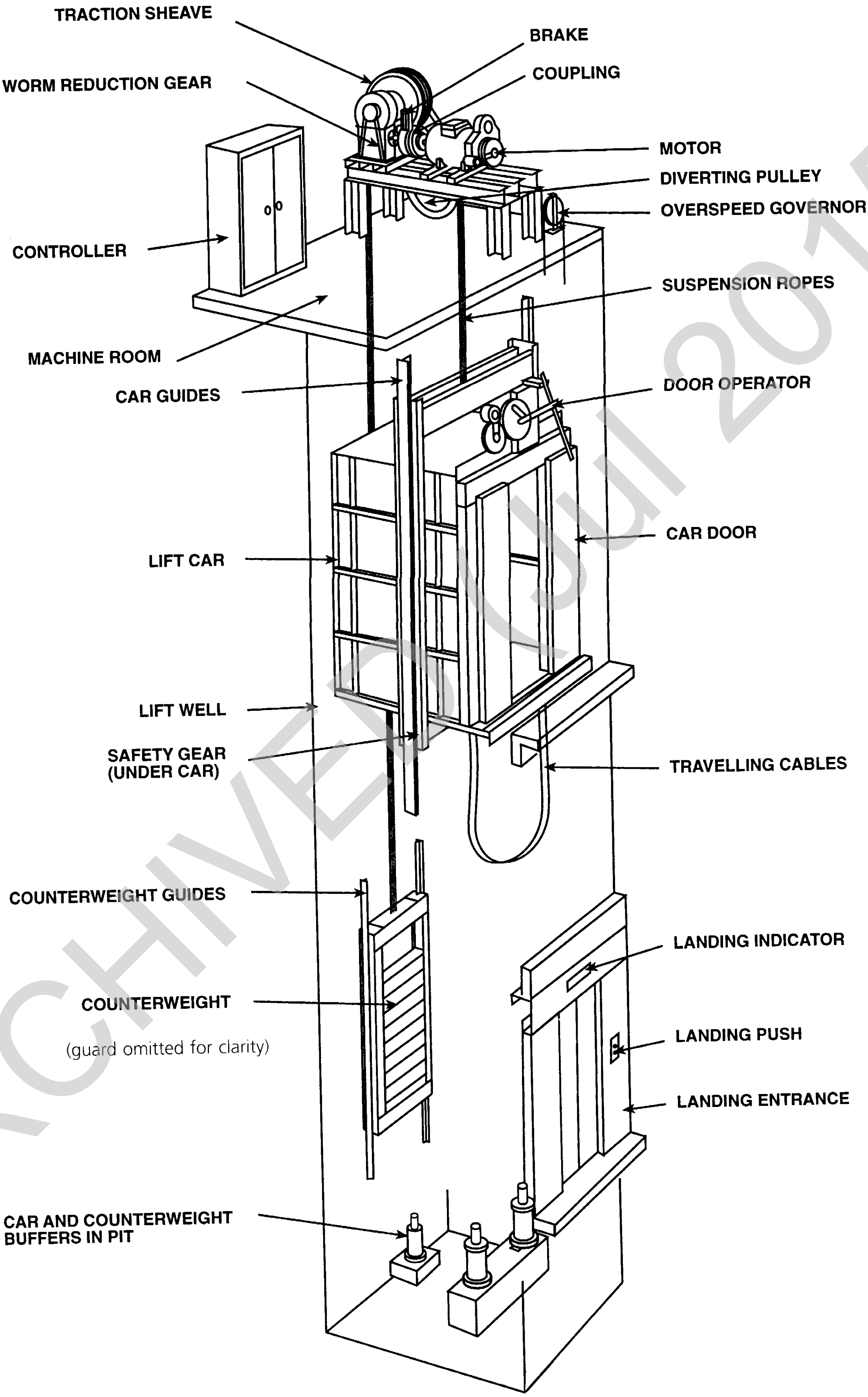
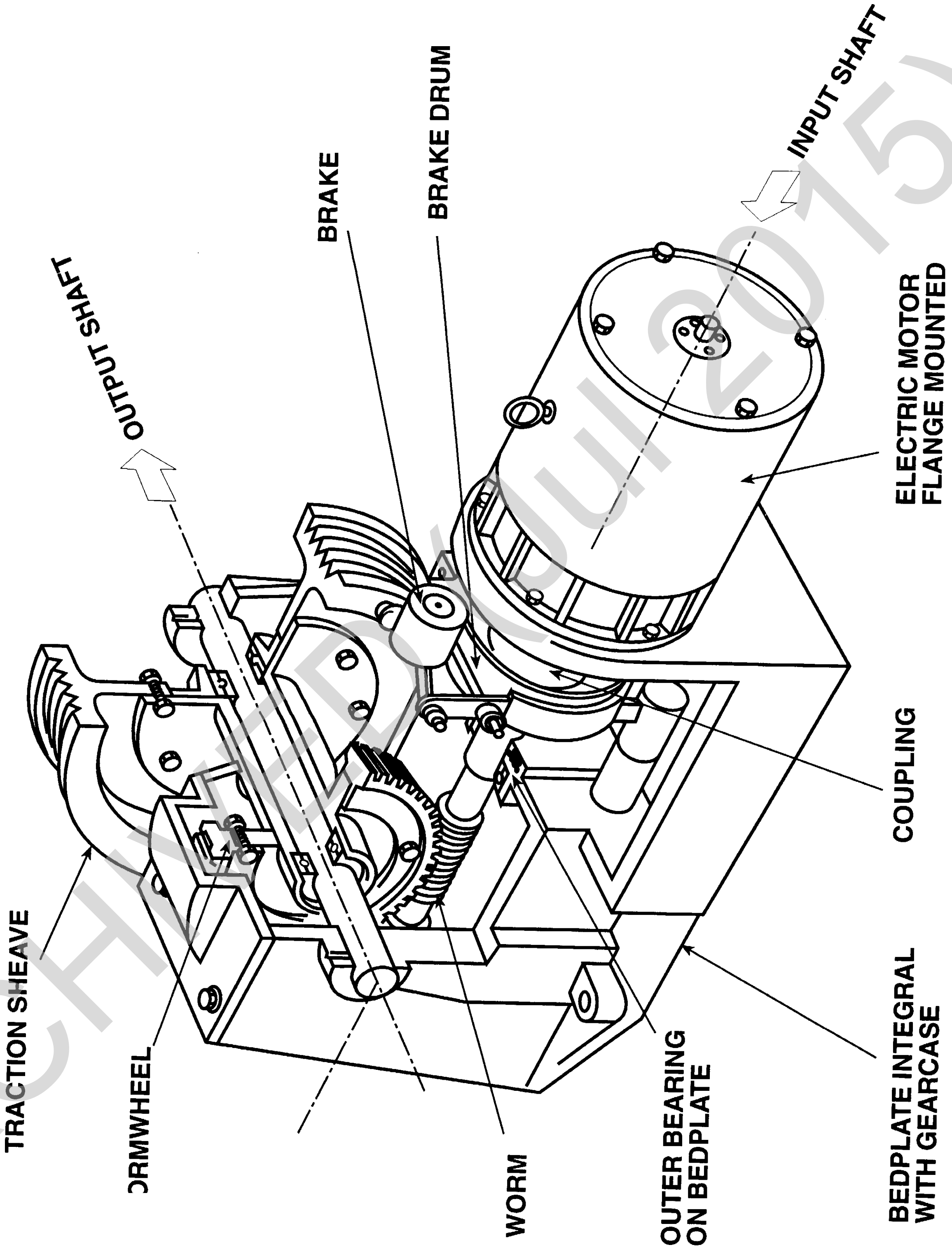


Figure 4: Typical arrangement of geared lift machine (courtesy of NALM)



6.7 The worm is integral with its shaft. The worm shaft is normally supported by journal bearings and is fitted with a double thrust ball-bearing to counteract the forward and backward thrusts. The thrust bearing is normally fitted with a detachable cover.

6.8 The worm wheel should be accurately hobbed and finished for ensuring quiet and smooth engagement with the worm gear.

6.9 Traction sheaves should have precisely machined grooves to maintain efficient traction of the suspension ropes and to minimise wear of the ropes and grooves.

6.10 Flanged rimmed sheaves are recommended. This will prevent the suspension ropes leaving the sheaves. If rimless sheaves are used, rope stops should be fitted.

6.11 Positive means are recommended to be fitted for retaining the suspension ropes on the hauling sheave.

6.12 Geared traction machines can be sub-grouped into:

a. single-speed a.c. motors;
b. two-speed a.c. motors;
c. variable voltage a.c. motor control (VVAC);
d. variable voltage variable frequency a.c. motor control (VVVF);
e. variable voltage d.c. motor control.

6.13 Geared traction drives can be used with controlled a.c. motors with worm reduction or helical gearboxes to attain speeds of up to 2.5 m/s and good ride quality.

6.14 In hospitals, it is likely that the most appropriate drives will be geared traction motors utilising single a.c., two speed a.c. and VVAC motor control. Costs and electromagnetic interference should be critically examined when other types are considered.

NOTE: Refer to SHTM 2014; *Abatement of electrical interference*.

6.15 **Single-speed a.c. motors**: should only be used in new installations for service lifts, that is, non-passenger carrying lifts. Many existing passenger lifts have single-speed a.c. motors and, in some circumstances, these may be retained as part of a refurbishment scheme but consideration should be given to using a method of a.c. motor speed control.

6.16 **Two-speed a.c. motors**: should only be considered for passenger lift and goods lift applications where slow speeds and short travel is intended. Two-speed a.c. motors have two separate windings of different numbers of pole pairs. For lift application, a ratio of 4:1 is typical. Preference should be given to comparable cost, controlled a.c. drives, even for goods lifts, to reduce the starting currents and improve levelling accuracy.

6.17 **Variable voltage drive (with single-speed motor)**: there are several types of variable voltage drives, varying according to manufacturer and application. In four-speed applications, the deceleration phase of the lift journey is controlled by star-delta switching. Semi-conductor switching, thyristors or power transistors are used to reduce the voltage to the motor and can be controlled to produce pulsed d.c. voltages to slow the rotating magnetic field (mf) with a greater braking torque. Semi-conductor switching can also be used to control the acceleration and deceleration of the lift by reversing the phase rotation of the supply. The electrical losses associated with the phase rotation method of braking are dissipated as heat in the motor. This may require forced cooling where the heat has to be removed from the machine room by natural or mechanical ventilation.

6.18 **Variable voltage drives (with two-speed a.c. motors)**: various types of variable voltage a.c. drives can be achieved with a two-speed a.c. motor. One type is where the main winding operates normally as an a.c. induction motor and the high pole, low speed winding is fed with a d.c. current. By this method, eddy current braking is achieved, the synchronous speed of the winding being zero. Another method is to use a semi-conductor bridge to constantly vary the voltage to the main winding according to the speed such that a quasi-constant acceleration torque is achieved. The deceleration is achieved by a d.c. injection as in the above example, thereby producing a comfortable ride characteristic from relatively simple components. The resistive losses in both, however, can be a disadvantage: they create inefficiencies which in turn necessitate an increase in the dimensions of motors and/or the use of forced ventilation to the motor.

6.19 **Variable voltage variable frequency drives (VVVF)**: a VVVF drive comprises a line filter and a diode bridge converter producing an intermediate direct current which charges the capacitor. The d.c. is smoothed and fed to a controlled invertor bridge which, by means of pulse modulation technique, converts the intermediate d.c. into a three-phase alternating current of variable voltage and variable frequency. The controlled a.c. is fed typically into a squirrel cage induction motor. By maintaining the voltage/frequency ratio as a virtual constant, the motor can operate with virtually zero slip and high power factor. These drives only require a single speed motor and offer high operating efficiencies. The disadvantage with this type of drive is that the rectifier at the front end is taking pulses of current from the supply which can cause harmonic distortion. On large kW drives, the harmonic currents can be significant and where groups of lifts, or large numbers of lifts, are connected to the same supply transformer, the resultant total harmonic distortion can be excessive.

6.20 The harmonic orders produced are in direct relation to the pulse number of the rectifier, that is:

harmonics = kp ± 1 where,

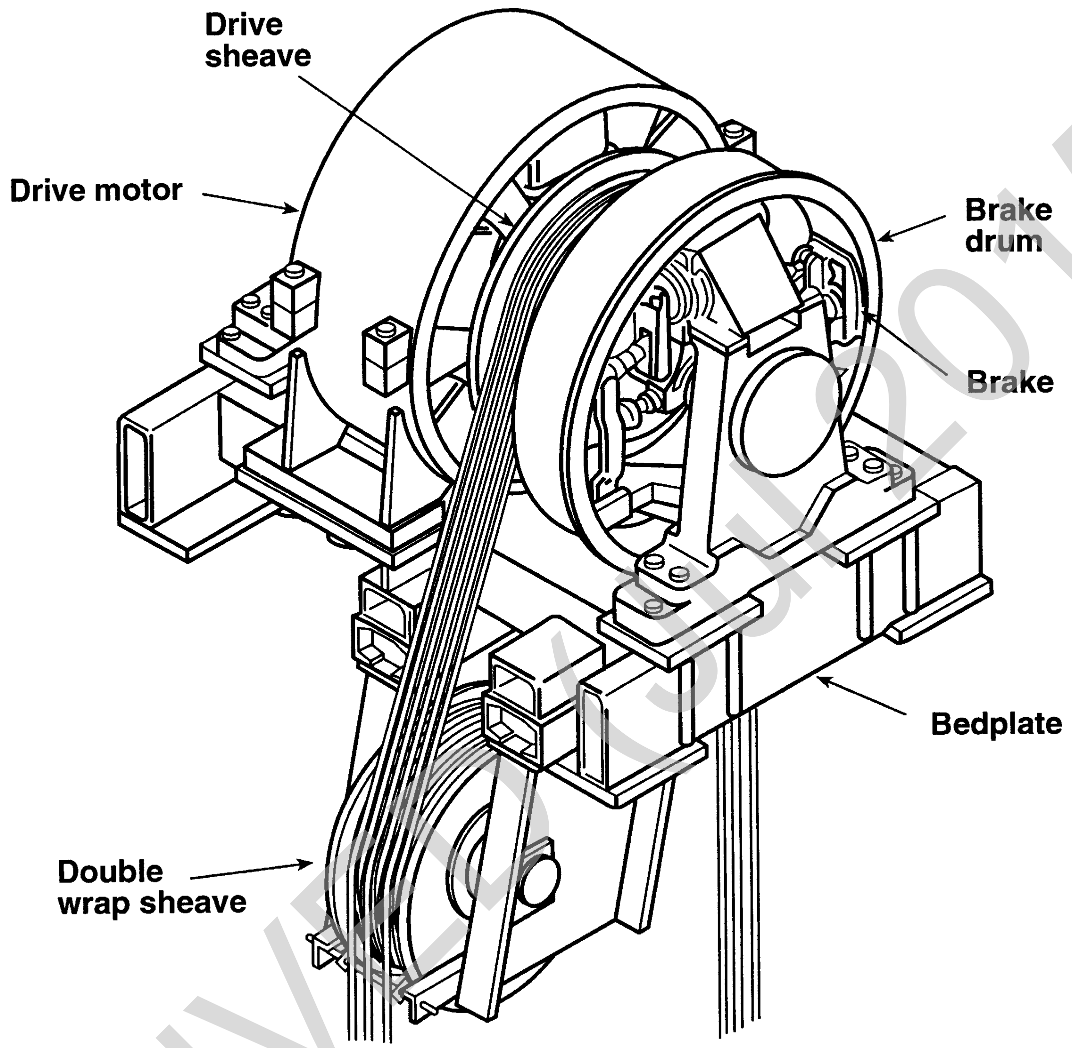
k = any integer;

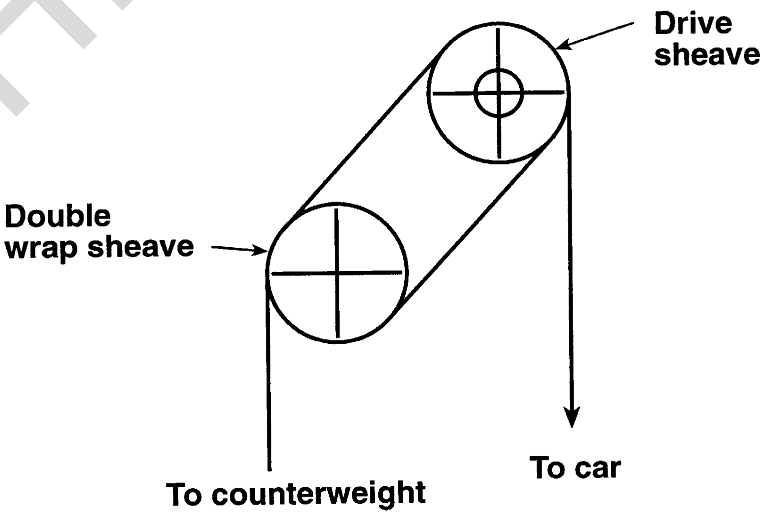
p = pulse number.

For example, a six-pulse system produces harmonics of the 5th, 7th, 11th, 13th, etc, orders and a 12-pulse system produces harmonics of the 11th, 13th, 23rd, etc order. As the lower harmonics are the more damaging ones, the advantage of a 12-pulse system is visible. A 12-pulse system, however, requires six phase input, therefore a transformer with a double wound delta-star secondary winding is required as well as a further bridge rectifier. This is an expensive arrangement to install and the losses of the transformer will reduce the overall efficiency of the drive. With geared lift applications, the regenerated power is generally dissipated in the d.c. circuit via a large braking resistance to provide a heating effect in the machine room. Depending upon the usage and size of the lift, the heat output could be significant.

NOTE: In gearless lift applications, there are no gears opposing the regenerated power therefore the regenerated power is normally fed to a further invertor bridge to reshape the d.c. to a 50 Hz sinusoidal waveform which is fed back to the supply in advanced VVVF drives, the diode bridge rectifier circuit is replaced by a convertor bridge using high speed semi-conductor switching devices to convert the a.c. to d.c. in a manner which does not cause phase shifting of the supply and thereby reduces the harmonic content to an insignificant value. The use of the convertor allows the inversion of the regenerated power, even on geared lift applications.

Figure 5: Typical arrangement of gearless lift machine (courtesy of CIBSE)





6.21 Due to their high operating efficiencies, VVVF drives offer a desirable solution. However, harmonic distortion in large kW or multiple lift drives can be a significant problem and should be addressed by specialists.

Gearless traction drives

6.22 A gearless lift machine is simply a lift machine in which there is no speed reduction unit between the motor and the traction sheave which are mounted on a common shaft (see Figure 5).

> **NOTE:** The general safety requirements for gearless lifts are the same as for geared lifts. There are very few clauses in BS 5655 Part 1: 1986 which refer specifically to gearless lifts. (Reference should also be made to BS EN 81-1)

6.23 As modern hospitals are predominantly low-rise, the application of gearless lift machines will not be a consideration. Gearless lifts may still be used in newly-built hospitals of high-rise design or on refurbishment, however cost implications should be considered.

6.24 They can be sub-grouped into:

a. variable voltage d.c. motors;

b. variable voltage variable frequency a.c. motors.

6.25 Gearless traction drives should be considered for all lifts having a contract speed of 2.5 m/s or greater using conventional high speed motors at 1000-1500 rpm. Due to their higher efficiencies, gearless machines may be adopted for lower contract speeds in special applications. Historically, d.c. gearless machines have always been of d.c. variable voltage type, however, variable voltage variable frequency a.c. control gearless machines became available in the early 1990s. They offer a more compact machine arrangement than d.c. types – d.c. gearless machines could be retained as part of a modernisation scheme dependent upon age and condition.

6.26 In a gearless machine, the motor armature, the traction sheave and the brake drum are mounted on a common shaft of tough, high-strength steel set in two substantial bearings which have to bear the entire suspended mass and the related accelerating forces. The motor frame, the bearings and the brake frame are normally carried on a common bedplate of cast iron, or fabricated steel construction.

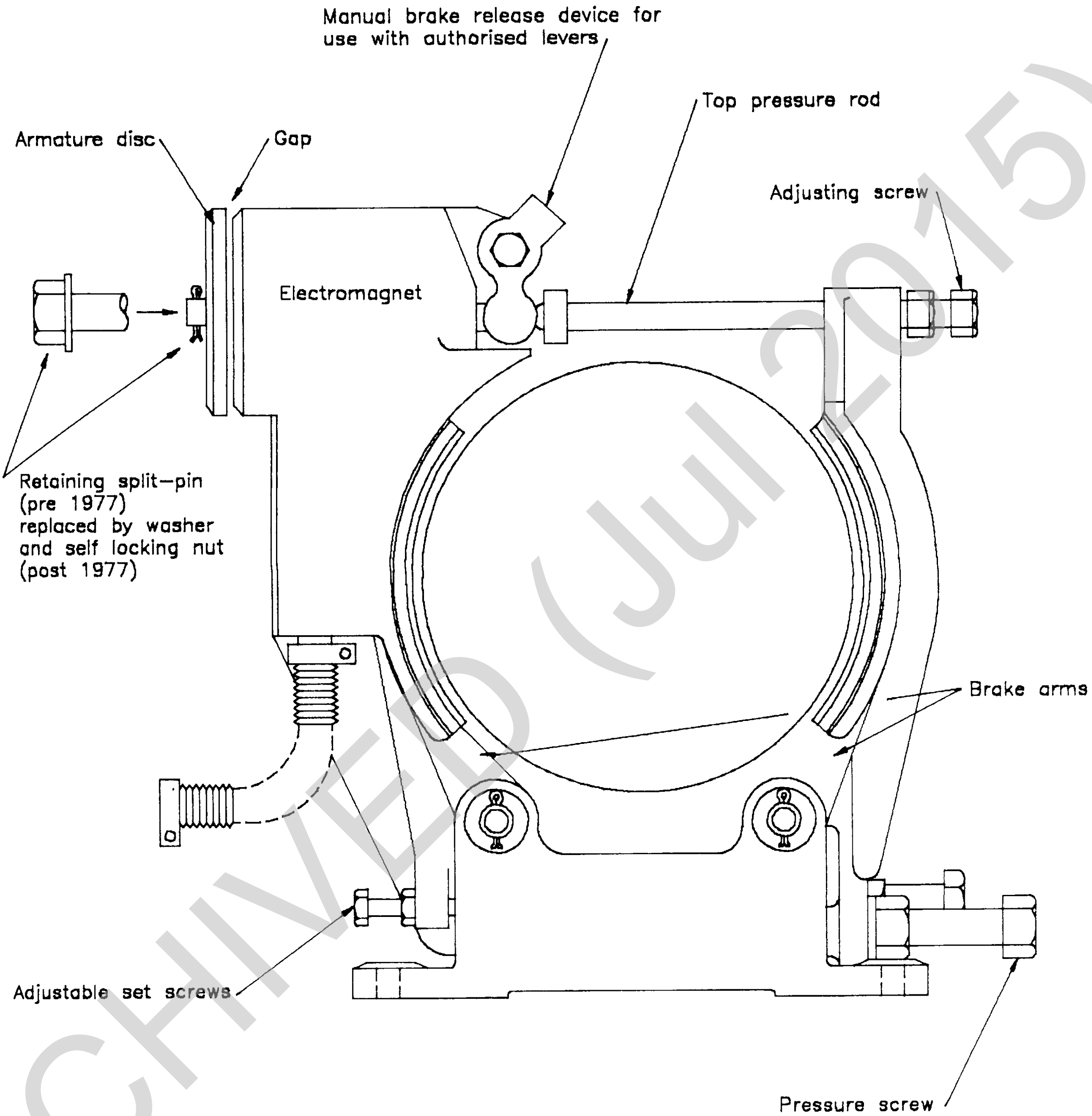
6.27 Traditionally, gearless machines have had very large frame sizes, worked at low magnetic flux density, and have had no assisted cooling. However, in recent times, more compact machine designs have been developed to reduce weight and cost. Compact machines operate at higher magnetic flux densities and often have forced ventilation of the type provided for geared motors, with ventilation fans fixed on the motor frames.

6.28 Good communication is a critical feature of gearless motor performance. There must be good access facilities to inspect and service the brushes and commutator. To ensure adequate traction, double-wrap pulleys are normally employed with gearless machines. These are usually mounted on the machine bedplate as a common load-bearing unit, frequently on an adjustable bracket. They also have substantial bearings as they carry a heavy load.

Hauling machine brakes

6.29 Hauling machine brakes are electro-mechanical (friction type) brakes operated by a d.c. solenoid on the hauling machine. The brakes are applied automatically and instantly in the event of failure or interruption of the power supply from any cause by large springs on the operating linkages (see Figure 6).

Figure 6: Typical arrangement of an electromagnetic brake



Note: Brake may be assembled ‘left hand’ or ‘right hand’ to suit individual machines.

6.30 Each brake should be capable of stopping the hauling machine when the lift car is travelling in either direction with 125% of its rated load. The retardation of the lift in this situation should not exceed that resulting from the operation of the safety gear; this ensures that the passengers are not subject to undue retardation forces.

6.31 Each brake should be specified to perform a number of stops equal to the specified number of electrical starts of the hauling machine, or 180 stops per hour, whichever is the greater. Where the specified drive has electronically controlled deceleration and stopping, the brake may be rated accordingly.

NOTE: It should be designed to accommodate not less than 180 stops per hour equivalent for short periods to allow for maintenance operation.

6.32 Each brake should be equipped with self-aligning shoes acting independently on a brake drum or split-coupling. Brakes should adjust automatically to compensate for the wearing of linings.

6.33 Each brake should be supplied complete with a fixed brake release hand lever and its design should ensure immediate re-application of the brake when hand pressure on the lever is removed.

Manual winding for geared hauling machines

NOTE: All manual winding operations should be conducted by a competent person (lifts).

6.34 Each hauling machine should be equipped with a device to enable the lift car to be raised or lowered safely by manual operation in an emergency, regardless of the car's load or position.

NOTE: This is normally a hand-winding wheel or a flywheel.

6.35 The effort required to hand-wind the hauling machine should not exceed 400 N. The manual device should ensure that the operator performing the winding can move the car gradually without any danger of the car moving out of control during any part of the travel.

6.36 Arrows should be fixed to the end of the hauling motor to indicate clearly in which direction the motor should be turned, to raise or lower the lift car.

6.37 Where the design of the hauling machine incorporates a flywheel, it may be used instead of a removable handwheel, provided that the competent person (lifts) who is carrying out the hand-winding operation has sufficient space to remove their hand in case of emergency. In this case, the flywheel guard should be secured with wing-nuts.

NOTE: The flywheel and its guard should be painted bright yellow to denote **"DANGER".**

Hydraulic drives

General

6.38 In hydraulic systems, the lift car is raised by pressurising the hydraulic system which causes the ram to extend, thereby raising the car.

6.39 The lifting power is derived from an electrically-driven pump transmitting hydraulic fluid to either a single or multiple jacks, acting directly or indirectly on the car.

> **NOTE:** Refer to BS 5655 Part 2: 1988 and BS EN 81-2: 1998.

6.40 The downward movement is activated by the opening of the down direction valve causing a downwards gravitational force made up of the weight of the car plus load and ram. This ensures that the oil in the system flows back to the power unit reservoir tank.

6.41 Contract speed should be achieved in both directions of travel under full load conditions. Furthermore, the speed of the empty car upwards shall not exceed the contract speed by more than 8% and the speed of the car with rated load downwards shall not exceed the contract speed by more than 8%.

6.42 The main components of a hydraulic lift system are:

a. hydraulic jacks;
b. oil reservoir tank;
c. pump (inclusive of motorised and hand pumps);
d. motor;
e. automatic control valves;
f. hydraulic pipework.

6.43 The reservoir tank should have sufficient capacity to allow a large “non-working” volume of oil to remain in the tank when the ram is fully extended.

6.44 A positive non-return or check valve should be incorporated in the valve block to hold the lift car at any point in the lift well with the valve in the closed position.

6.45 A manually-operated emergency hand-lowering valve should be incorporated in the valve block. The lowering of the lift should depend upon continual operation of the valve handle and should re-set to the closed position when pressure to the valve handle is released.

NOTE: The speed of the lift during manual lowering should not exceed 0.3 m/s.

6.46 All hydraulic lift applications of three floors or more should incorporate a manually-operated pump.

6.47 Operation of the manual pump should not require a force exceeding 400 N and should deliver sufficient volume to raise the car without an exhaustive number of pumping actions.

6.48 Where pipework or electrical trunking is routed through lift well or pump room walls acting as fire partitions, it should pass through fire sleeves.

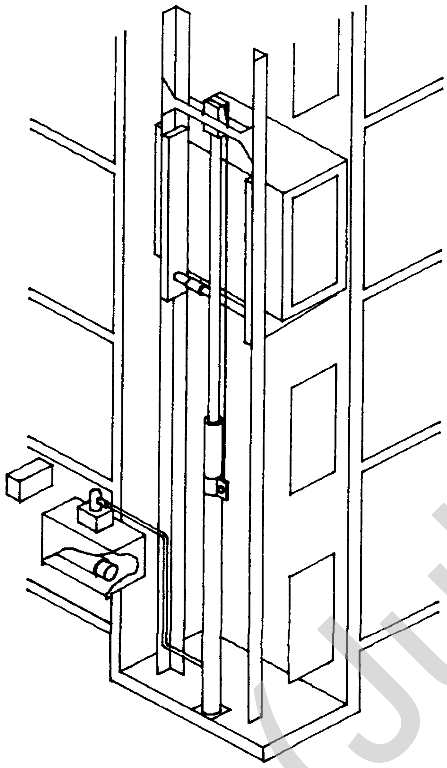
6.49 In a hydraulic lift application, the lift car travels between vertical guides fixed in the lift well but, instead of using a traction machine with ropes and counterweight, the lift is moved by the actions of a hydraulic jack or jacks. The lift may be either:

a. **a direct-acting lift**: where the lift car, or its sling, is directly attached to the ram which is placed either directly below or, alternatively, at the side or rear of the car. If the ram is directly below the lift car, the jack is normally placed in a borehole in the base of the pit. Boreholes can be expensive to produce and maintain, however, direct acting arrangements with the ram centred under the car provide a smooth ride (see Figure 7);

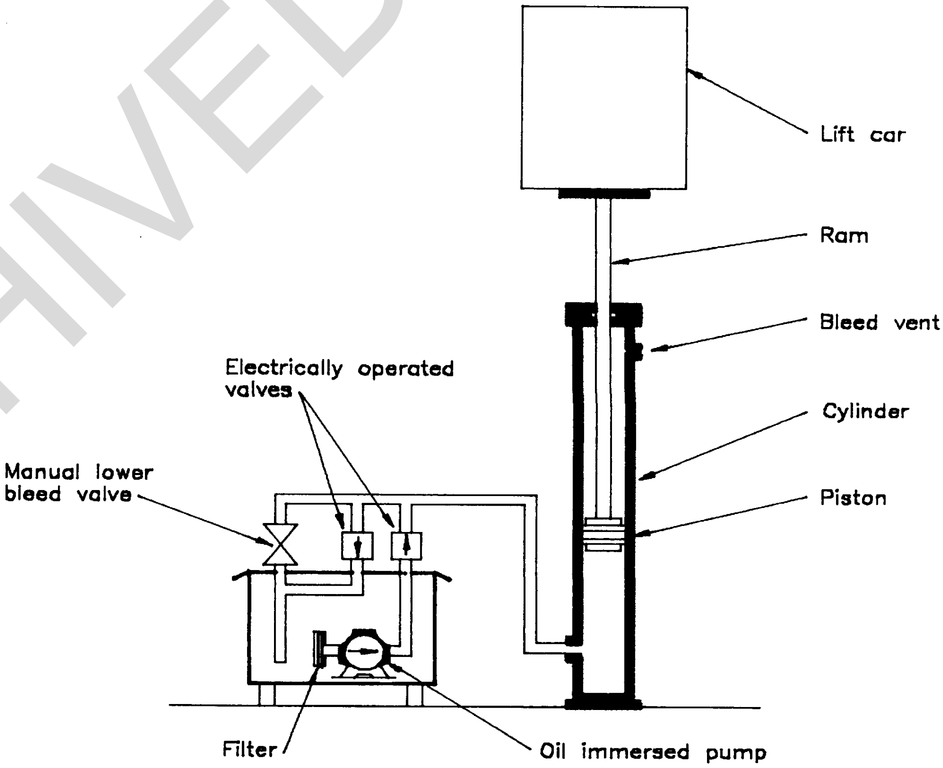
or

b. **an indirect-acting lift**: here the hydraulic principle remains unchanged, but the jack is located at the side or rear of the well without a borehole. The lift car is attached to a set of multiple steel wire suspension ropes or chains, which are laid directly over a multiplying pulley mounted on the top of the ram and then to a fixed anchorage point at the bottom of the well. Through this reeving arrangement the lift car travels twice the distance of the ram at twice the speed. For indirect-acting lifts, a safety gear is provided on the car. In the unlikely event of the car overspeeding downwards, the overspeed governor will operate to trip the car safety gear (see Figure 8).

Figure 7: Typical arrangement of direct-acting hydraulic lift



2:1 suspension – single or double cam



Block diagram of hydraulic lift

Figure 8: Typical arrangement of indirect-acting hydraulic lift (courtesy of NALM)

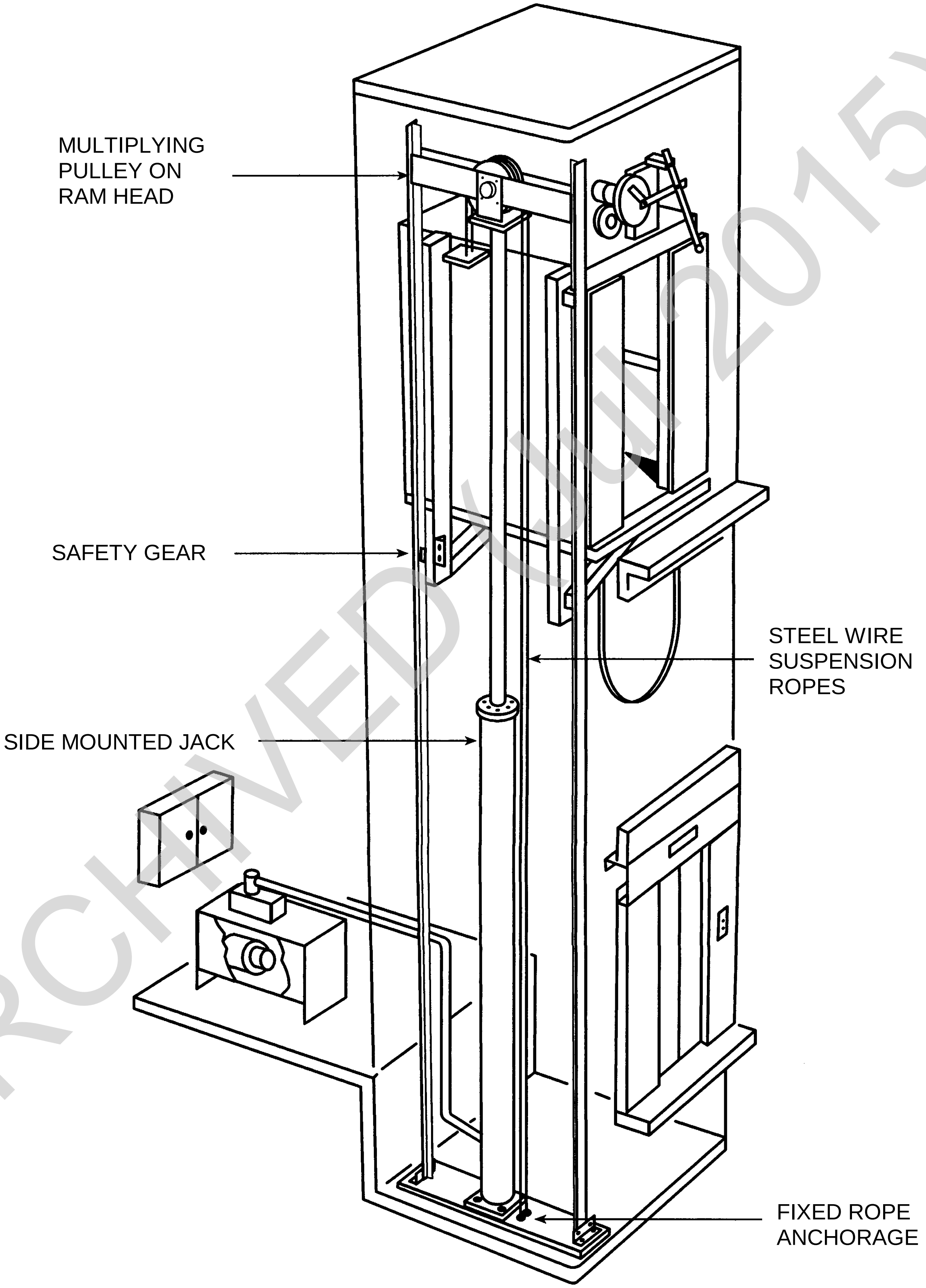
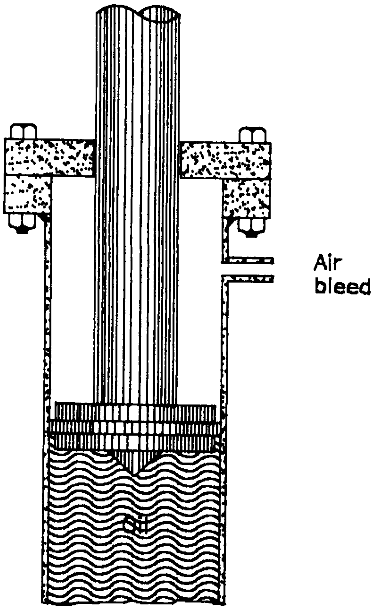
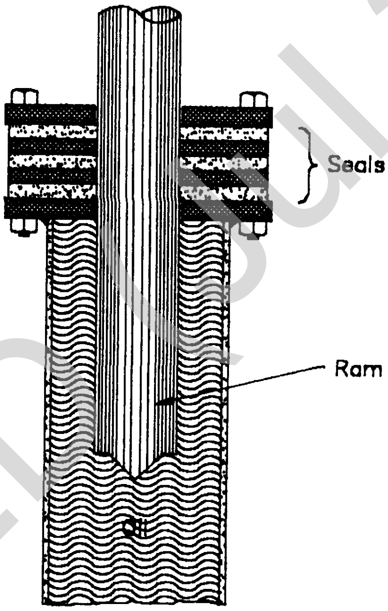


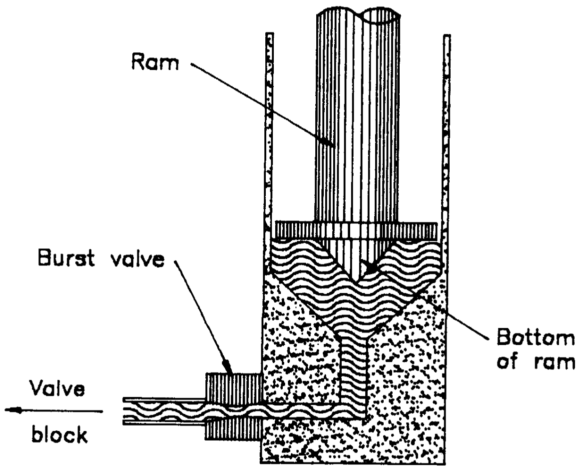
Figure 9: Typical arrangement of hydraulic list rams



Piston Ram



Displacement ram



Hydraulic jack operations

6.50 The ram and the cylinder combined comprise the jack, which is mounted vertically in the well. The car moves up or down as hydraulic fluid, oil under pressure, is pumped in or out of the cylinder. The fluid is fed into the jack from a storage tank by an electrically-driven pump (see Figure 9).

6.51 The movement of the hydraulic fluid is controlled through an electrically-operated valve block adjacent to the tank, driven from the lift control panel. This panel also controls the pump motor.

6.52 As hydraulic fluid is pumped into the cylinder, the ram is driven outwards causing the lift car to travel upwards, When the pump stops, a non-return valve in the hydraulic system prevents the fluid returning to the tank and thus holds the car stationary.

6.53 To activate downward travel, an electrically-operated down direction valve is opened in the pipe line, permitting the fluid to return to the tank at a controlled rate, and causing the ram to retract into the cylinder, under the gravity force of the car.

Jack mounting arrangements

NOTE: The variations in jack location and arrangement account largely for the differences in well dimensions.

6.54 At least five different jack mounting arrangements are commonly used, three for direct-acting lifts and two for indirect-acting lifts:

a. direct-acting lift:

(i) centre-mounted jack. The traditional arrangement for the direct-acting lift is where the jack is mounted vertically in a borehole at a point midway between the guides. The ram is connected to the underside of the car. If the equipment is properly designed and installed, and apart from the effect of passenger and goods carried in the car, there are no permanent off-set or sideways forces or torques on the car, guides or ram. For a single stage jack (not telescopic), the depth of the borehole is approximately equal to the travel of the lift car;

(ii) double side-mounted jack. To excavate a borehole may be costly or inconvenient, or it may be quite impracticable because of site conditions or building design. In this case, at least for direct-acting, short-travel lifts, it is possible to mount two jacks one at each side of the well adjacent to the guides. They stand on the floor of the pit or in relatively shallow holes below the level of the pit floor. The rams can then be connected to the extended cross-head on the car sling above the car roof, one on each side of the car. If the two jacks act in synchronism, then as in the previous case, a system can be built which is free from any guides or rams. Such a twin-jack system may be used on short-travel lifts for heavy rated loads. There is sufficient headroom in the well to accommodate the overall height of the extended jack for a short-travel lift. If telescopic jacks are used, then the possible travel of such a lift is extended;

(iii) single side-mounted jack. In the conventional rope-suspended, electric lift and in the two types of direct-acting hydraulic lifts, particular care is taken in the design to avoid sideways forces and torques on the car and guides. In a single side-mounted jack, there are substantial sideways forces and torques, since the downward force of a load placed centrally in the car (and of the car mass itself) is out of line with the upward force of a ram placed at the side of the car. The effect of these out-of-line forces must be balanced by horizontal forces between the car and the guide rails, acting through the guide shoes. The lift should be designed to accommodate these forces, and some details of its mechanical construction will be significantly different from electric lifts. Like the double side-mounted jack system, a single side-mounted jack used in a direct-acting lift has limitations on lift travel. However, telescopic jacks may be used to extend the travel. While the term "side-mounted jack" is used, it is quite common to have a rear-mounted jack, with similar problems of out-of-line forces. In both cases the lift is frequently designed so that the car "guiding" is achieved at the same location in the well where the single jack is mounted;

b. indirect-acting lift:

(i) double side-mounted jacks. In this case, two jacks are used, one on each side of the car, adjacent to the guides. Suspension ropes are attached to extensions on either the car sling bottom beam or cross-head, then taken over the ram head pulleys and down to a termination point at the base of the jack. Provided the movement of the two rams is synchronised, the car construction will be very similar to a rope-suspended electric lift car, as it is not subject to any permanent sideways forces or torques;

(ii) single side-mounted jack. This is the most common configuration of the indirect-acting hydraulic lift. The jack is mounted on the base of the pit at the side or rear of the lift well, together with an assembly for guiding the car and the ram. The car and the guiding assembly are specially designed to accommodate the permanent off-centre loading and sideways forces associated with this configuration. For additional stability, a further guide rail may be provided in the well on the other side of the car;

c. other arrangements. Apart from the most common arrangements described above, jacks, pulleys and suspension ropes can be assembled to form many other systems. Suspension chains are sometimes used instead of suspension ropes, in order to save space: they do not require such a large diameter of ram-head pulley. It is this flexibility of arrangement that makes the standardisation of dimensions in hydraulic lifts less thorough than for electric lifts. Individual lift makers may have particular arrangements which they favour for manufacturing reasons. These may offer cost/benefit advantages. However, this should be weighed against operational and maintenance costs.

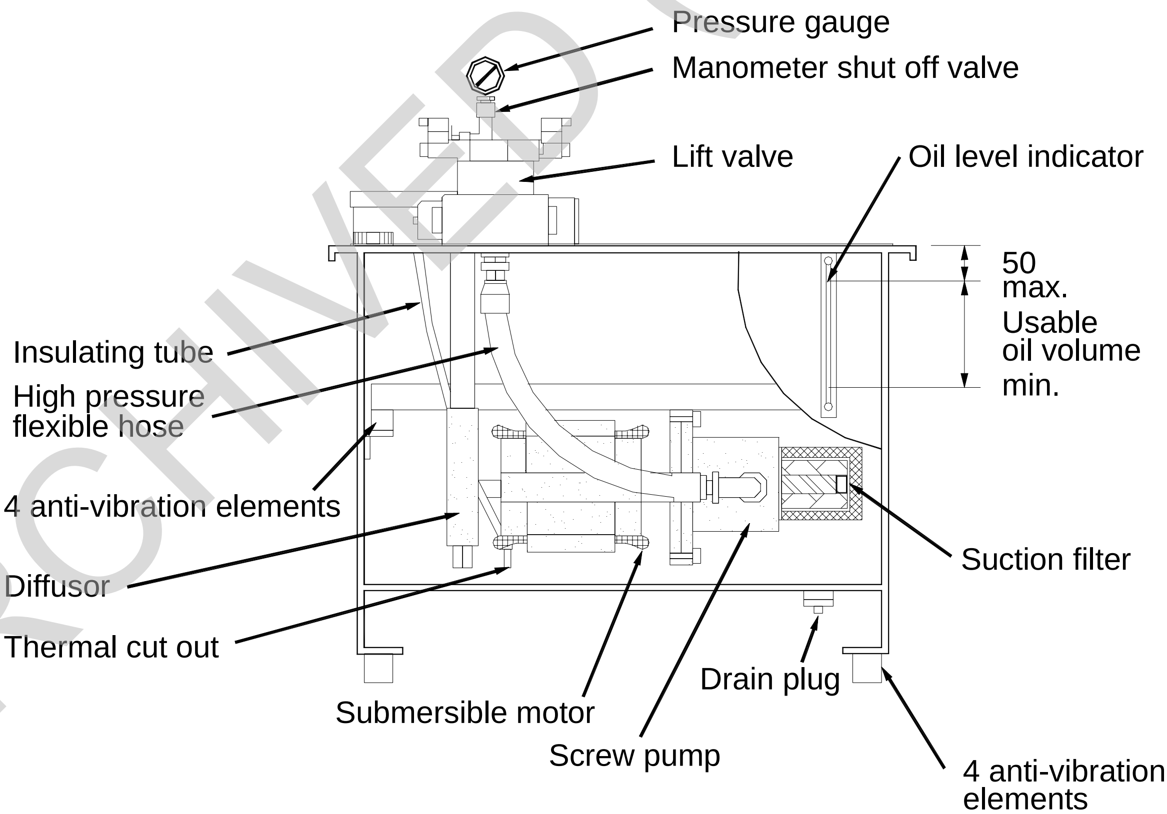
Pumps

6.55 For lift duty, a positive displacement pump is essential. This means that when the pump rotates at constant speed, it delivers fluid at approximately the same constant rate, whatever the load pressure may be. For non-positive displacement pumps, the greater the load pressure, the lower their delivery making them acceptable for lift duty. Since these pumps can pump against high pressures, the hydraulic system should always be protected by relief valves to prevent damage to the pump or its pipework, or even the motor. The pump outlet should not be closed off until the rotor has stopped moving since this is the only path the discharged fluid can take.

NOTE: For lift duty a rotary pump is always used to achieve a smooth ride.

6.56 It is common practice to mount the pump and motor as a complete unit below the surface level of the hydraulic fluid on a vibration absorbent frame attached to the tank structure (see Figure 10).

Figure 10: General layout of submersible pump unit



6.57 The hydraulic oils normally used in lift systems are good electric insulators. It is possible to design a.c. cage motors that will run when submerged in such oil. However, for operational reasons, the magnetic “air-gap” clearances, which are now “oil gaps”, and the shape and size of ventilating channels, which should suit the flow of oil instead of air, involve a number of changes in constructional details. The motors are considerably less efficient than the comparable air-cooled units. However, this disadvantage is outweighed by the benefit of the reduced noise level of the submerged motor-pump unit.

NOTE: Air should be carefully excluded from the hydraulic system for a variety of reasons, the most important of which is to reduce noise. The pump entry feed pipe should always be submersed in the fluid in the tank. The risk of cavitation should also be minimised by ensuring that there is no significant back pressure in the feed pipe, such as might be caused by placing the pump at some height above the tank and using a feed pipe of too small a bore. The major disadvantage of under-oil mounting of a pump is that it cannot be readily inspected under suspected fault conditions, for example for leakage or vibration, but in practical cases this is acceptable.

6.58 The two most commonly-used pumps for lift duty in hospitals are:

a. **the rotating vane pump**: this comprises a cylindrical driven rotor on which is mounted a set of almost radial sliding vanes. The pump revolves in a cylindrical casing and the tips of the vanes remain in contact with the casing through a combination of spring pressure, fluid pressure and centrifugal force. There is a close running clearance between the sides of the casing and the rotor to minimise leakage. The incoming fluid is trapped between successive vanes and carried round from the low pressure entry port to the high pressure exit port. The vanes are caused to retract into the rotor body when approaching the seal which divides the inlet and outlet ports. Thus there is minimal carry-through of fluid from outlet to inlet zones as the rotor revolves. To this effect also, there must always be at least one vane in the sealing zone. As the vanes sweep round the casing, in one revolution they move a volume of fluid from inlet to outlet, which is approximately equivalent to the volume of the space between the rotor body and the casing;

b. **the screw pump**: this comprises an “Archimedes” screw rotor operating in a cylindrical casing. Oil is moved from the inlet port to the outlet port by the action of the rotor. Running clearances requirements for this type of pump are similar to those for the “rotating vane pump”.

Pump motors

6.59 For hydraulic lifts, the single speed a.c. electric motor provides the unidirectional rotation of a hydraulic pump at a constant speed. It is brought up to speed before the load is applied. Its performance requirements are basically much simpler than for an electric traction lift motor and are generally similar to those of normal industrial motors.

NOTE: The performance characteristics of the lift car depend on the hydraulic system and not on the electric motor.

6.60 However, one widely-used type of motor for hydraulic lifts, the oil-immersed motor, has some special constructional features. The motor has a comparatively low starting torque, sufficient in the case of a hydraulic lift to accelerate the pump and motor itself in a state of no load to a speed approaching synchronous speed and exceeding the speed at which full load torque can be provided. At such a stage the pump is revolving but its output is being returned directly to the tank.

6.61 The load is applied to the motor when the hydraulic valves operate to direct the pump output into the jack at a pressure sufficient to raise the load. At this moment, the motor speed will reduce automatically, the slip increasing until the motor torque is sufficient to maintain the pump output at this working pressure.

6.62 The number of starts per hour of the motor are, in general duty, approximately half those of the corresponding electric lift, since the motor operates only during the upward journeys and is stationary during downward journeys.

Control panels

General

6.63 Lifts in healthcare premises are in operation for longer periods than typical office lifts. Their control panel components should therefore be specified accordingly to ensure that the "mean time between failures" (MTBF) of the individual components is not significantly reduced.

6.64 Where lift wells and machine rooms are located adjacent to ward areas or consulting rooms, the level of noise generated by the control panels should be as low as possible. Noise reduction can be effected by using anti-vibration mountings and, where necessary, insulation material on the insides of control panel cabinets. Further information is given in SHTM 2045; *Acoustics*.

Cabinets

6.65 Each control panel should be enclosed in a drip-proof steel cabinet.

NOTE: Hinged doors are preferred to lift-off covers.

6.66 The control panel of each lift should be fitted with a bold label, clearly identifying by number each item of lift equipment in the machine room. The control panel label should also bear the asset number of the lift.

NOTE: Control room cabinets are generally located in machine rooms.

6.67 Access to lift machine rooms should be restricted to competent persons (lifts). Under this policy, control cabinets do not need to be locked. However, where estate staff are trained to perform the first line of fault investigation, and complex electronic circuits are incorporated within the panel, extra care should be exercised.

6.68 Control panel doors, terminal covers and lids of all equipment connected to more than one phase of the electrical supply should have a yellow plastic label inscribed with 15 mm high black characters indicating the word **"DANGER"**. An appropriate electrical symbol and the voltage present should also be included.

NOTE: The labels should be secured by rivets or screws in preference to self adhesion.

Ventilation

6.69 Lift machine rooms are often located in plant room areas where a significant amount of heat is generated. Machine rooms should be ventilated to maintain the equipment within a specified temperature range. Ventilation of the control process can be improved by fitting pressed louvres to each side of the cabinet.

6.70 Where delicate electronic equipment is used in the control circuitry, filters are recommended in the rear of each louvre.

NOTE: Electronic equipment can be damaged by deposits of dust.

6.71 Where a single piece of equipment produces a large amount of heat, axial fans are recommended to be fitted within the control panel to increase air flow across the components and assist cooling.

Wiring

6.72 All control panel wiring should be of low smoke and flammability. Flammable materials should not be used in control gear assembly.

6.73 All external wiring entering the control panel should be identified by the use of an approved cable marker and terminated in a modular terminal rail assembly.

Terminals

6.74 To facilitate fault finding and future modifications, each terminal module socket should identified to correspond to the terminal reference on the wiring and schematic diagrams.

6.75 All modular terminals used for voltages in excess of 110 volts a.c. should be of the shrouded pattern and fitted with a printed warning label.

6.76 Wherever possible, control and power wiring should be segregated within the control panel.

6.77 The incoming supply and motor supply terminals should be shrouded and identified in their respective group of terminals.

Contactors

6.78 All contactors used should be of the enclosed pattern with all power terminals protected against direct finger contact.

6.79 The status of each contactor should be easily identified by the position of a brightly coloured plastic push plate on the contactor armature. All contactors used should have easily replaceable coils and switch contacts.

6.80 Circuits should include at least two independent contactors, which should be in series with the supply circuit, and either of which should be able to break the supply circuit at all poles.

Labelling

6.81 Each control panel component should be clearly and permanently identified by plastic labels and abbreviations used should be identical to those on the wiring diagrams.

Protection

6.82 Each control panel supplying a poly-phase motor should include a phase failure and phase reversal protection. Protection relays could include an LED status display to remain illuminated during "healthy" operating conditions of the relay.

6.83 All thermistors protecting each individual armature winding should be connected in a series circuit, with only its end connections being wired back to the thermistor control unit within the control panel.

6.84 When an operating resistance change takes place which is an appreciable increase in resistance of the thermistor probes, the relay should operate an auxiliary circuit tripping the supply to the motor.

NOTE: If an LED is fitted to the relay, this should illuminate to indicate a motor over-temperature trip.

6.85 In the event of a thermistor trip, the lift controls should allow the lift to travel to the next floor level in its direction of travel; rather than stopping the lift immediately which could entrap passengers.

6.86 On failure, or operation, of any of the safety devices or accidental earthing of any of the components, the control system should automatically cut off the power supply and bring the car to rest. All control circuits should be arranged to fail safe.

6.87 Brake coils of hauling machines should be de-energised by being disconnected at both poles or by the opening of at least two independent contacts.

Fuses

6.88 Cartridge-type fuses are recommended for the control panel. They should be housed in modular holders and be easily accessible. They should be individually labelled to indicate the circuit protected, fuse number and the fuse rating.

6.89 The main supply to the lifts should be derived from a suitably rated switch-fuse located within the machine room. If this is not applicable, for example a refurbishment retaining existing supplies, then overload circuit breakers are recommended.

NOTE: This should be in accordance with BS 5655 Part 6: 1990.

6.90 Main fuses, where provided, should be high rupture capacity (HRC) types.

Earthing

6.91 A main earth terminal or earthing "bus" should be provided at each control panel. The incoming earth and all loom and control panel earths should be connected.

6.92 Each control panel door should be earth bonded, with a flexible tinned copper braid in preference to a coiled earth wire.

NOTE: Coiled earth wires will increase the inductance to earth.

6.93 In control panels containing electronic or other equipment that could be damaged by the use of insulation resistance test equipment on the earth, an isolatable link should be provided, wherever practicable, in the earth/ground conductor of each circuit susceptible to such damage.

6.94 Each link should be clearly identified with its associated circuit label or reference (as per the wiring diagram) and should be able to be isolated easily.

NOTE: It is recommended that links should be clearly labelled stating: **"THIS LINK SHOULD BE ISOLATED BEFORE INSULATION RESISTANCE TESTS"** or similar wording.

6.95 Earth links should be grouped together in the control panel.

Fault indication

6.96 In buildings containing a large number of lifts, a remote monitoring system is an option for consideration (see Chapter 10).

Maintenance control

6.97 It will sometimes be necessary to operate the lift car manually, for instance during routine maintenance or for insurance inspection. A manually-operated switch should therefore be provided on the door of the control panel. This is identical to the car top control station, however the car top controls should always override other controls in the interest of safety for the service engineer.

> **NOTE:** This function has different terminology amongst various lift manufacturers. It is sometimes referred to as electrical recovery operation.

6.98 In the "test" position the switch should make UP/DOWN test buttons on the panel effective and render all push buttons, with the exception of the car top control station button when on test, inoperative. It should also render the door opening and closing functions inoperative.

> **NOTE:** The preferred method is to have an audible signal to sound when the lift is at, or within, 75 mm of level.

Manual winding levelling signal

6.99 During periods of emergency hand-winding (hand-lowering on hydraulic drives) on multi-floor lift installations, it should be possible to identify the position of the lift from the machine room.

> **NOTE:** Operation of the switch should not cut out the door locks or safety contact. Push buttons of the shrouded, constant pressure pattern are recommended.

6.100 This can be achieved by fitting a bell or buzzer adjacent to each hauling machine. The supply to the alarm bell should be derived from a maintained source with a toggle switch in circuit for isolating the device during normal running of the lift. A second pair of contacts on the toggle switch should prevent the lift motor from running under power during hand-winding periods.

6.101 The bell or buzzer should have a permanent label affixed to it bearing the characters "HAND WINDING FLOOR LEVELLING INDICATOR" and instructions on the use of the equipment should be fitted close to the toggle switch.

Solid state circuits

6.102 An electronic control panel is defined as a control panel where the control logic and despatch is provided by means of solid state components (see Chapter 7).

6.103 All electronic components should be mounted upon printed circuit boards (PCB) installed on a PCB rack in a common section of the control panel.

6.104 Each PCB should be connected to the remainder of the control circuit by a plug/socket connector to ensure good continuity.

> **NOTE:** Edge mounted connections are not recommended as the continuity may be affected by ambient conditions.

Ropes and roping systems

Rope types and construction

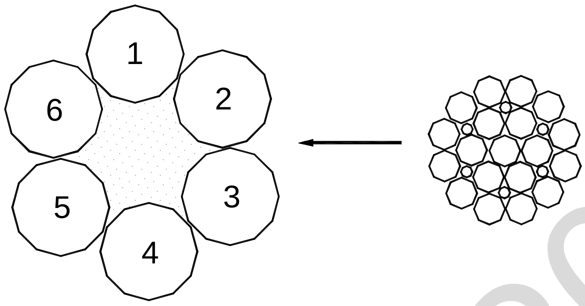
6.105 Ropes (see Figure 11) can be categorised as follows:

a. **langs lay ropes.** In langs lay configuration, the direction of twisting of the wires in the strand is the same as the direction of twisting of the strands that form that rope. This method of rope construction requires careful handling during installation to avoid kinking or lay disturbance. For any given load in a wire rope, the torque generated in a langs lay rope may be as much as double that in an ordinary lay rope. Langs lay ropes have a higher fatigue rate and fatigued wires within the rope are not easily identified. This method of rope construction is not recommended for hospital lifts.

b. **ordinary lay ropes.** In ordinary lay ropes, the direction of twisting the wires in the strand is opposite to that of twisting the strands which form the rope. Ordinary lay ropes are easier to handle and, if properly designed and applied, should give adequate life.

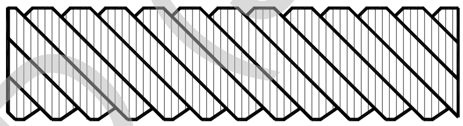
Figure11: Rope tyres

Rope section

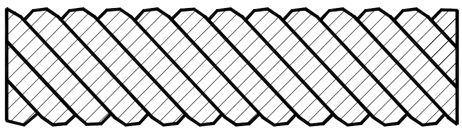


The rope consists of bundles of wire strands around a flexible core

Langs (right hand) lay



Ordinary lay



Safety factor

6.106 The safety factor is the ratio between the minimum breaking load of core rope and the maximum force in the rope when the car is stationary at the lowest landing.

> **NOTE:** BS 5655 Part 1:1986 states that a safety factor of 12 shall be used for traction lifts with three or more ropes; 16 in the case of traction drive with two ropes, and 12 for drum drive arrangements.

Sr = n F K/w where:

Sr = safety factor for the rope;

n = number of separate suspension ropes;

F = nominal breaking strength of one rope (N);

K = roping factor (1 for 1: 1, 2 for 2: 1, etc);

w = load suspended on the ropes with the car at rest at the lowest floor (N)

The load suspended includes the weight of the rope, the car and load, a percentage of the suspension ropes plus a percentage of the compensation, if provided.

Rope length

6.107 When installed on a traction lift, the rope length should be such that when the car is on its buffers, and the buffers are fully compressed, the counterweight is clear of the underside of the top of the lift shaft or any other obstruction. When the counterweight rests on its fully compressed buffers, no part of the car may touch the top of the shaft or any obstruction in it. The actual clearance depends upon car speed.

NOTE: BS 5655 Part 1:1986 and BS EN 81-1: 1998 provides guidance on these dimensions.

Rope lubrication

6.108 The fibre core of the rope is impregnated during manufacture with an anti-slip lubricant material which facilitates slight relative motion between the wires as the ropes bend. The lubricant is released slowly throughout the life of the lift rope which can be between three and ten years depending upon application and working conditions. The lubricant also offers some protection against corrosion and itself is chemically neutral.

6.109 Depending on the environment or extreme working conditions, it may be necessary to redress the ropes in service with an anti-slip lubricant compatible with the manufacturer's original lubricant.

6.110 If there is insufficient lubricant, the dry wires may rub against one another causing a condition known as fretting corrosion which is identified by rouge or red dust emanating from between the strands. This can lead to weakening of the rope and, in some cases, premature replacement.

Terminations

6.111 Rope termination, either to the car or counterweight on direct roping systems, or to a hitch in 2:1 arrangements, should provide at least 80% of the minimum breaking-load of the rope.

6.112 Termination types (some shown in Figure 12) include:

a. **bulldog grip.** It is important to use the correct size of saddle and U-bolt, with the correct number and spacing of the bulldog grips used in relation to the diameter of the rope. Bulldog grips should be tightened to the correct torque at:

(i) the time of installation;

(ii) after the lift has been fully loaded;

(iii) the time the lift is tested;

(iv) one month after the lift going into service;

(v) six-monthly thereafter in accordance with the manufacturer's instructions;

NOTE: On large lifts with multiple ropes it may be impractical to mount the rope grips to allow the application of a torque wrench.

d. **ferruled eyes.** Ferruled eyes are produced at the rope manufacturer's works under controlled conditions and provide a highly reliable, maintenance-free termination arrangement. This type of termination is applied to one end of the rope to allow shortening of the rope during future maintenance;

e. **socketed type termination.** In this type of termination, the rope is inserted through a conical-shaped socket. The ends of the rope are seized to prevent the lags unwinding, the rope ends cleaned and turned in to form a hook at least 2½ times as long as the rope diameter. The conical socket is then heated and molten white metal poured into it. This method of termination is reliable and provides 100% of the minimum breaking load of the rope. However, as the pouring temperature of the white metal is between 330°C and 360°C this process requires hot methods of working which are not suitable for operational hospitals. As most lifts will eventually require rope replacement, this method of termination should not be used on new installations;

f. **self-tightening wedge sockets.** This method consists of a housing which is either attached to the end of a threaded rod or has an eye into which the housing may be connected via a fulcrum pin, and a pear-shaped wedge. The rope is passed through the housing, around the wedge and back through the housing. A rope grip is fitted to prevent the rope pulling through if the wedge is slackened. A split pin prevents any further slackening of the wedge.

Traction

6.113 In all rope systems, the power developed by the machine is transmitted to the ropes either by a single- or double-wrap traction system (see Figure 13).

6.114 In the single-wrap system, the ropes pass once over the sheave, into which specially-shaped grooves are cut. These are known as traction grooves. The traction force depends on the friction between the ropes and the sheave, the groove angle and the amount by which the ropes wrap around the sheave.

6.115 These factors govern the traction ratio which is the ratio between the rope tensions on the two sides of the sheave before slipping occurs. The traction developed must be sufficient to enable the car plus 125% load to be safely operated but must be low enough to ensure that, if the tension in either the car or counterweight side of the rope is reduced to zero, for example the car or counterweight buffered, the traction will be insufficient to permit the car or counterweight to be raised. Excessive traction will also result in excessive sheave and rope wear.

NOTE: BS 5655 Part 1: 1986 and BS EN 81-1: 1998 provides formulae for the calculation of traction.

Figure 12: Typical rope termination by rope end fittings (Courtesy of NALM)

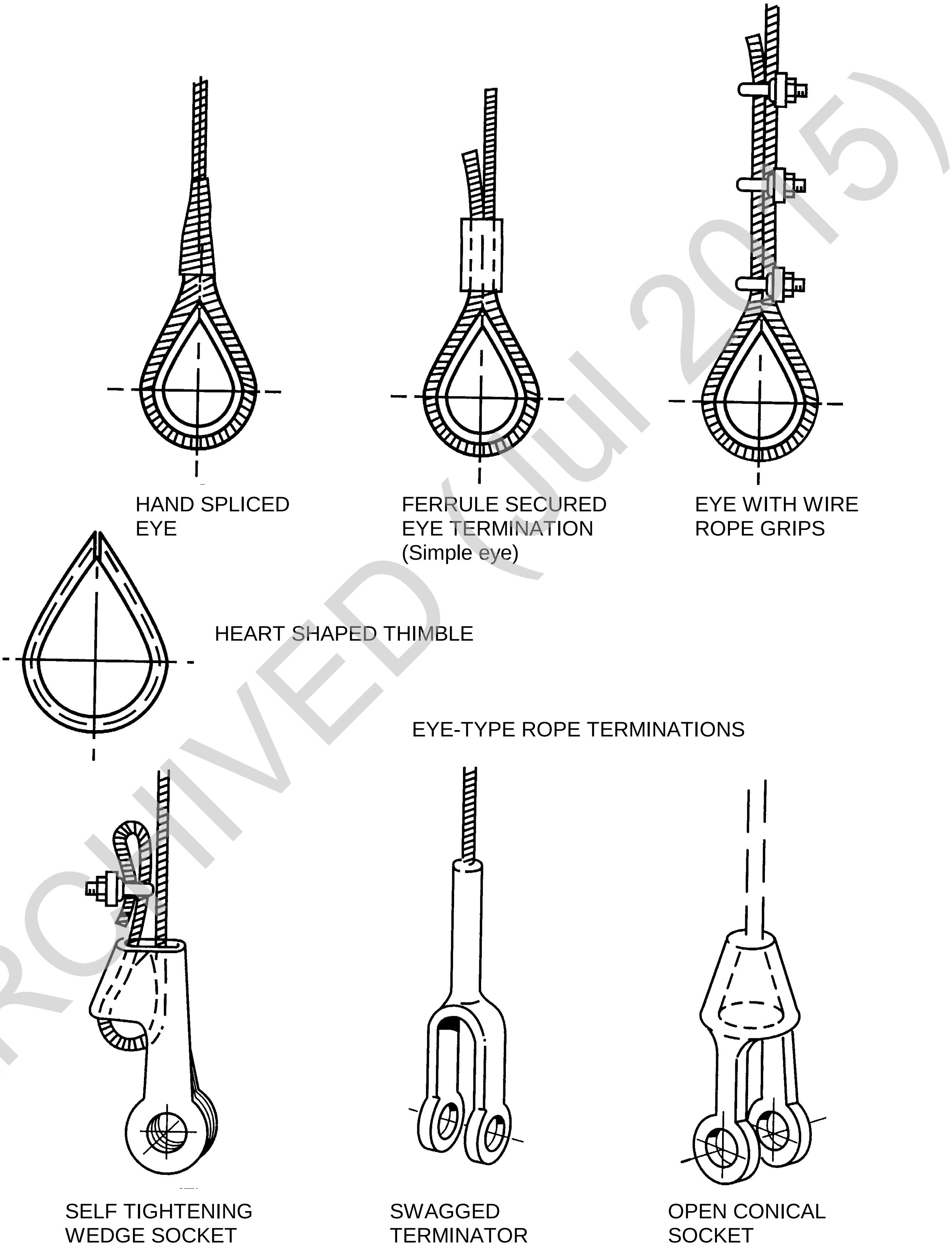
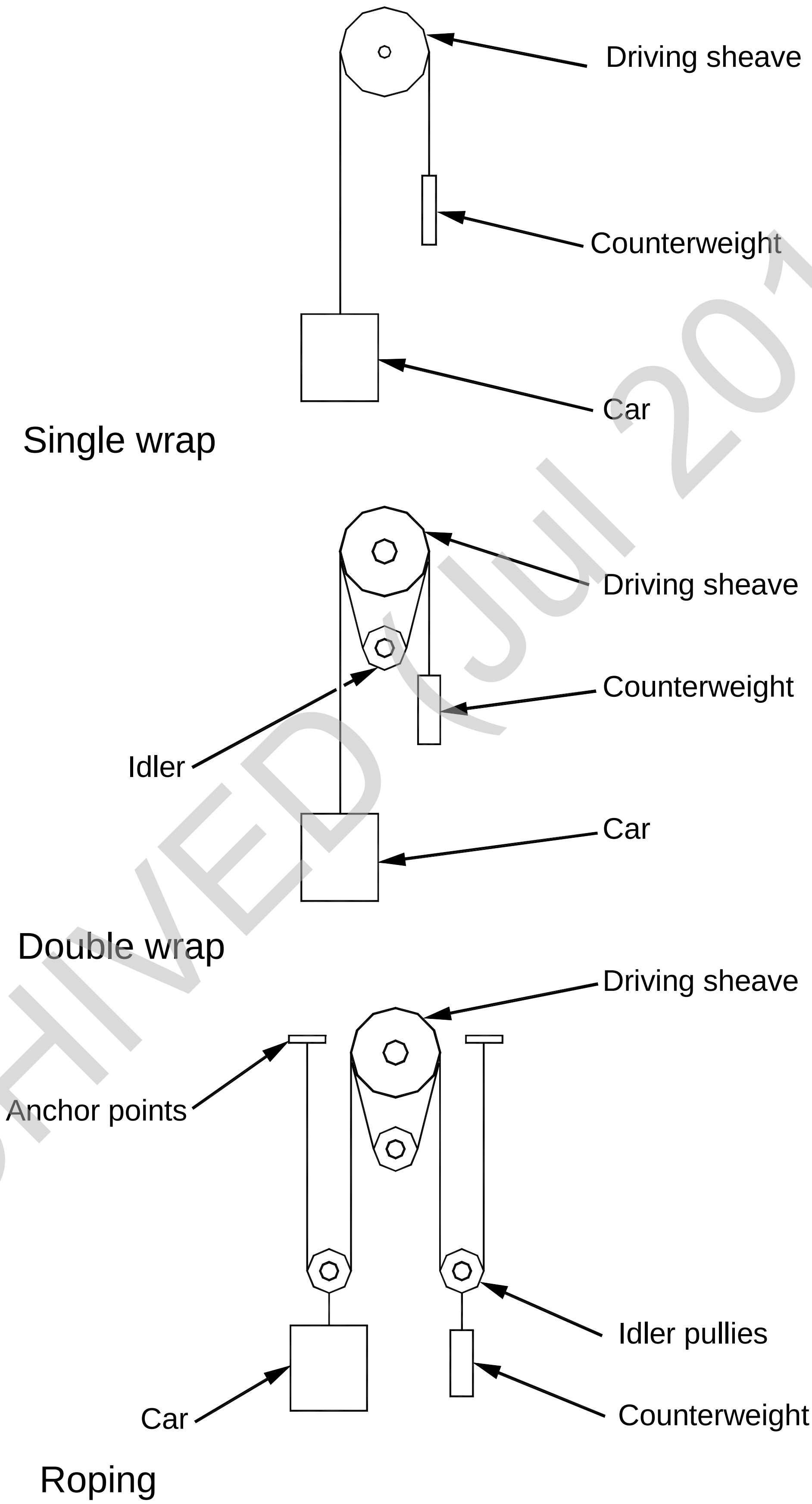


Figure 13: Typical methods of lift roping



Rope tension equalisation

6.116 To ensure that the load is evenly distributed between the ropes, it is important that the tension in each rope is equal. Where one rope is carrying a greater load, implying a higher tension, this will cause the rope and the sheave groove to wear more rapidly (see Figure 14).

6.117 To assist in maintaining even tension in the ropes, some form of rope tension equalisation device should be installed in the rope hitch attached to the car and counterweight. The simplest and most effective method of achieving this is to incorporate helical steel springs in each rope anchorage.

Rope compensation cable

6.118 With lift travel exceeding 2.5 m/s, the changing mass of the ropes between the sheave and the car has an effect upon the drive system and the traction of the ropes in the sheave grooves. To compensate for this, ropes or chains of equal mass to the suspension ropes are attached to the counterweight from the underside of the car.

6.119 Compensation is therefore required to ensure that adequate traction is maintained, wherever the car is in the shaft, and to reduce the input power requirement to the drive. For lifts up to 2.5 m/s, chains or free ropes may be used, tensioned by gravity. For speeds above 2.5 m/s, a tensioning device is required. This prevents the counterweight from rising through its own inertia if the car should be stopped abruptly and prevents the car from continuing upwards if the counterweight should be stopped suddenly. This is sometimes referred to as “tied-down” compensation.

6.120 In order to prevent noise, preference should be given to chains which are encapsulated in a plastic sheath, which is sometimes filled with shot-weighted foam to provide a silent “loop”.

Overspeed governors

General

6.121 Overspeed governors are provided on all lifts that have suspension ropes or chains. They are normally located in the lift machine room or within the well where they can be accessed from an external position (see Figure 15).

6.122 The function of the overspeed governor is twofold:

a. to monitor the speed of the lift relative to the normal (contract) speed and activate the electric trips when the speed exceeds the set limit;

b. to activate the safety gear by mechanical means if the car speed exceeds the electric set speed limits (see paragraph 6.127).

6.123 The overspeed governor should exert a force of 300N, or twice the force necessary to operate the safety gear, whichever is the greater. Matching of the overspeed governor with a safety gear is essential. Where an overspeed governor is to be fitted to an existing safety gear, the pull-in or operating force should be determined by operation of the safety gear with a strain gauge type load-weighing device applied to the operating linkage of the safety gear.

6.124 The wiring to the overspeed governor should be positioned such that it does not cause a tripping hazard and is suitably mechanically protected. Where necessary, the wiring should be run below the machine slab to achieve this.

Figure 14: Typical arrangements for rope tension equalising

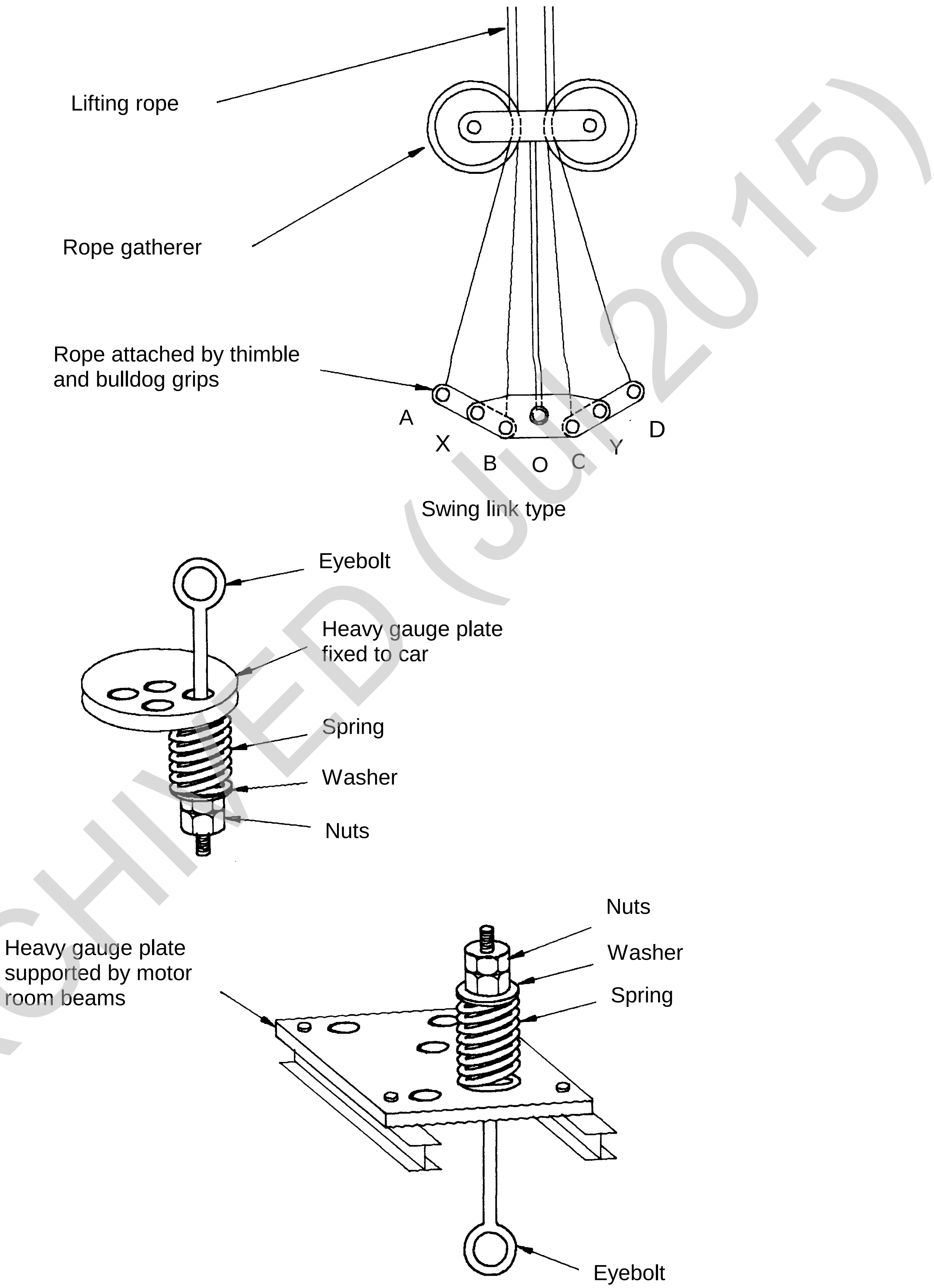
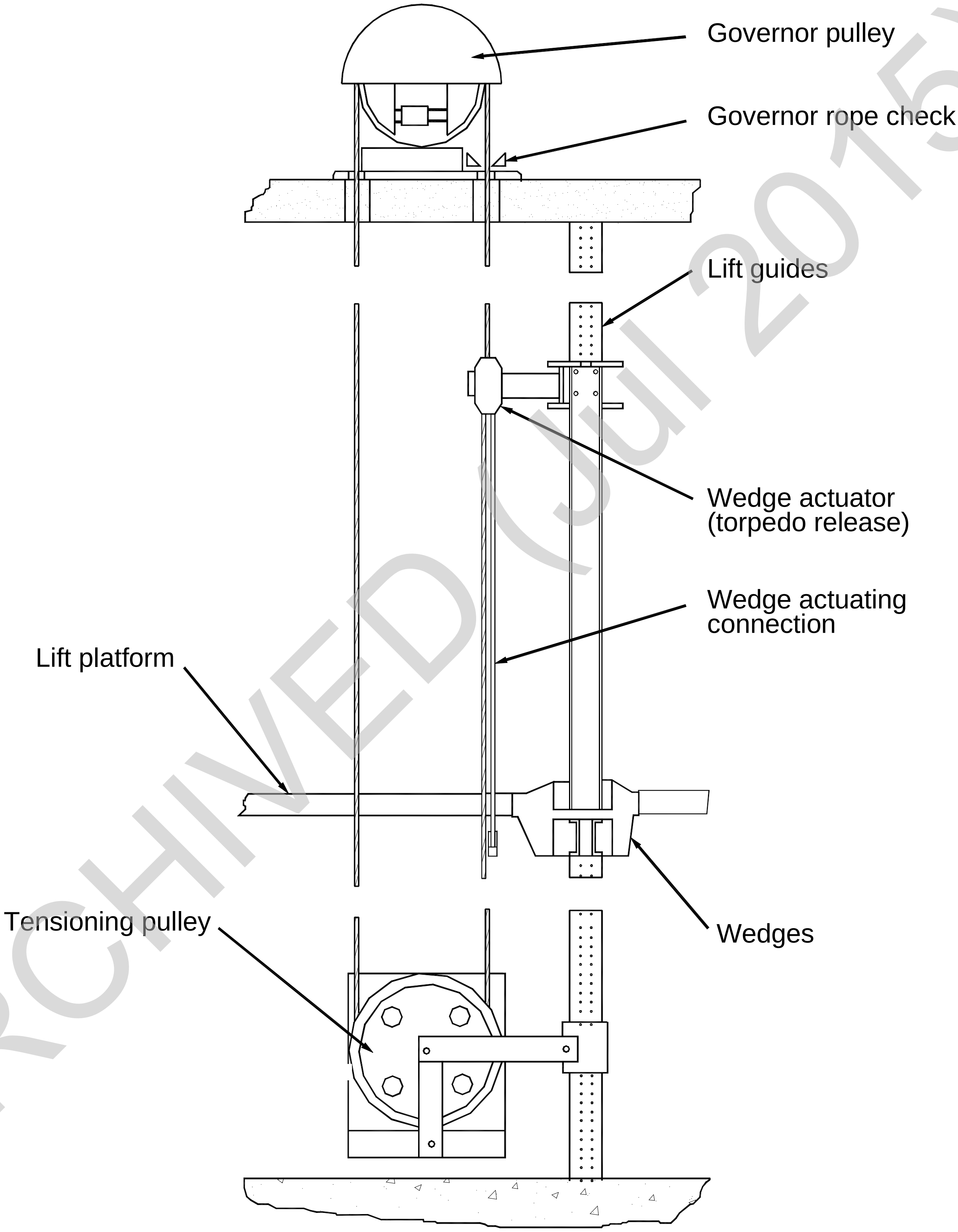


Figure 15: Typical arrangement of overspeed governor



Types

6.125 There are two basic types of overspeed governor:

a. **traction types**: in this type of governor, the safety gear rope is operated by the friction of the rope on the groove as the tripped governor sheave is clamped in a stationary position;

b. **clamp types**: for clamp type governors, the safety gear rope is operated by jaws on the governor which are tripped and tightened onto the rope as the descending lift pulls the rope tighter into the jaws.

6.126 For all bed/passenger lifts and lift refurbishment the clamp type governor is recommended.

Tripping speeds

6.127 Tripping of an overspeed governor can be activated:

a. electrically, when the speed exceeds the rated speed by 15%;

b. mechanically (by operation of the safety gear) when the speed exceeds the rated (contract) speed by 25%.

Resetting

6.128 All overspeed governors, whether located in the machine room or in the lift well, should be accessible to be manually reset.

6.129 For traction type governors, the upward movement of the lift car (or counterweight) should allow for the overspeed governor to be mechanically reset.

6.130 In the case of a clamp type overspeed governor, the jaws should be reset, with a suitable lever, before the lift car can be raised.

6.131 For both types of overspeed governor, the resetting of the electrical trip switch should be done by a competent person (lifts) who should investigate the cause of overspeeding before returning the lift to service.

NOTE: This function would normally be undertaken by the lift maintenance contractor.

Remote operation tests

6.132 On hydraulic lifts, where the governors are located on the top of the lift well, it is desirable to have a remote test facility to allow the governor to be operated by an electrical solenoid device.

6.133 On bottom, or side-mounted, traction lifts, the overspeed governor should always be diverted into the machine room through a pulley arrangement, but should retain the tension pulley facility.

Guarding

6.134 Overspeed governors should be fitted with a full sheet metal guard to cover the sheave, ropes and linkage. The openings around the rope holes should be fitted with plates to restrict the opening to a practical minimum. It should be possible to view the position of the trip switch without having to remove the guard.

Safety gear

General

6.135 Safety gear is normally associated with an over-speed governor.

NOTE: Refer to BS 5655 Part 1: 1986 and BS EN 81-1: 1998.

6.136 For a descending lift car, the overspeed governor can be thought of as the first line of protection, and the safety gear as the final protection. For an ascending lift car, only the overspeed governor is effective, although the rope traction behaviour of the traction sheave itself provides a safety back-up.

6.137 Overspeeding in the downward direction has always been considered to be the most serious hazard that can arise with a rope-suspended lift. One of the common causes is lift machine failure, although failure of the output shaft, control system (for example brake contactor fault) or suspension ropes may also occur.

6.138 In the event of the lift speed exceeding a critical value, the safety gear is designed to function as the ultimate back-up device when all normal and electrical means fail. In most cases of lift overspeeding, the overspeed governor will act electrically to stop the lift before the safety gear operates.

6.139 The safety gear is designed specifically not to function on an upward-moving lift car. If a lift car overspeeds upwards and is not stopped by the overspeed governor, the downward moving counterweight will be brought to rest eventually by striking the counterweight buffers, or by the operation of a counterweight safety gear (if fitted). If the sheave continues revolving when the counterweight strikes the buffers, the resultant loss of tension in the suspension ropes will cause these to slip on the traction sheave. The lift car will come to rest, since there is no longer a rope force pulling it upwards.

6.140 It is quite clear that only in exceptional circumstances will the safety gear operate. Most cases of overspeeding will be dealt with by the drive supervision circuits or through the interruption of the circuit by the overspeed governor electrical trip. The risk of overspeeding itself should be minimised by the design and operational features of the lift installation.

Types

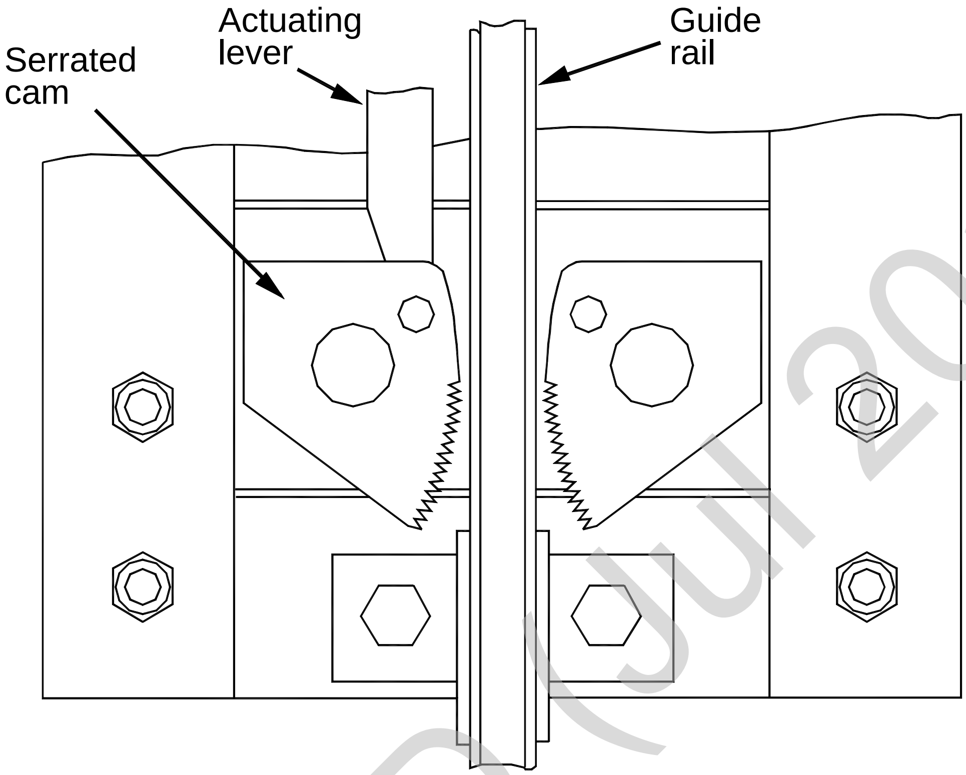
6.141 There are two basic types of safety gear in general use, these are:

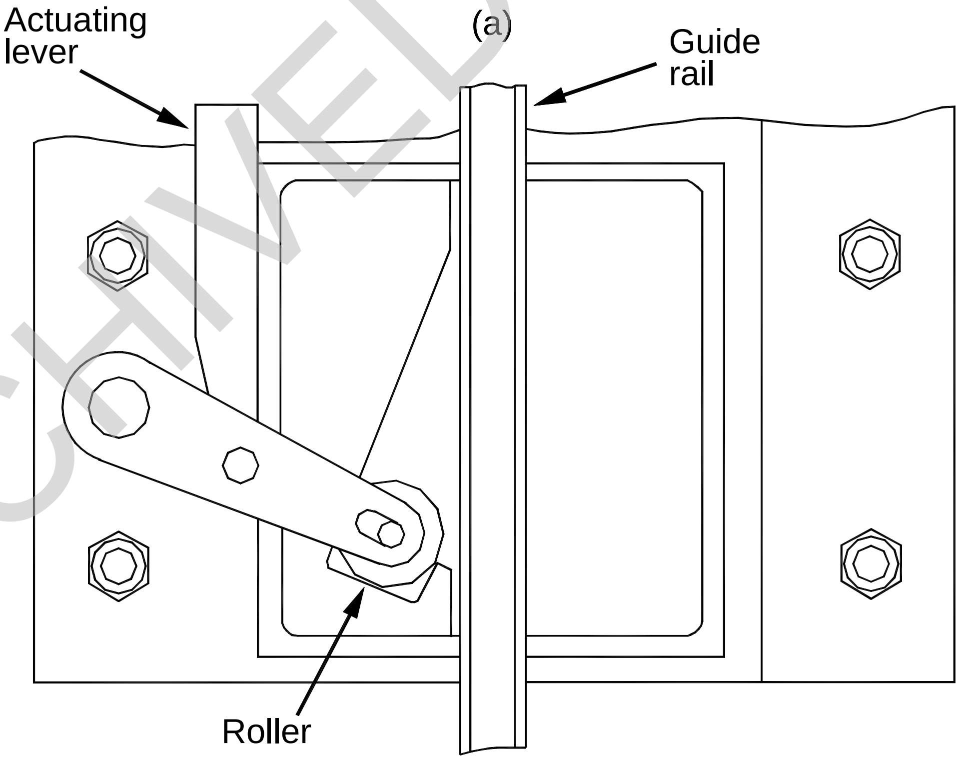
a. **instantaneous**: see Figure 16. In this type of safety gear, the stopping distances are very short and the rate of retardation is therefore high. The higher the coefficient of friction between the jaws and the guide rails, the greater the impact which results in discomfort to the passengers. For this reason, instantaneous safety gear is not recommended for use on lifts which are intended to carry medical cases, for example theatre lifts. This safety gear is sub-divided by means of its operation into:

   (i) **captive roller safety gear**: this is probably the most common of the two most widely-used types of “instantaneous” safety gear and is suitable for lower speed lifts normally not exceeding 0.63 m/s rated speed. As the name “instantaneous” suggests, the action is severe and abrupt and there is usually no scope for site adjustment of its basic behaviour. The active element is a hardened steel knurled roller maintained “captive” so that it cannot slip out of position either when at rest or when in action, but able to roll up the surface of an inclined steel wedge. This wedge is placed so that the knurled roller is driven up its surface by the safety gear triggering mechanism until the roller makes contact with the surface of the guide rail blade. From this point onwards, the relative vertical movement of the guide rail and the wedge force the knurled roller to move into increasingly close contact with the guide rail surface. To release the safety gear, it is normally sufficient to raise the car slowly under power or by hand. A competent person (lifts) should investigate the cause of the event before returning the lift to service. Provided the guide rail is not too severely indented, reversal of the roller wedging action is quite easily achieved. It is often aided to an extent by a spring which is fitted for the purpose of holding the roller out of the engagement to prevent the accidental tripping of the safety gear during normal running in the down direction;

> **NOTE:** Refer to Part 4 ‘Operational management’ of this SHTM.

Figure 16: Typical arrangement of instantaneous safety gear: (a) serrated cam, (b) roller type (courtesy of CIBSE)



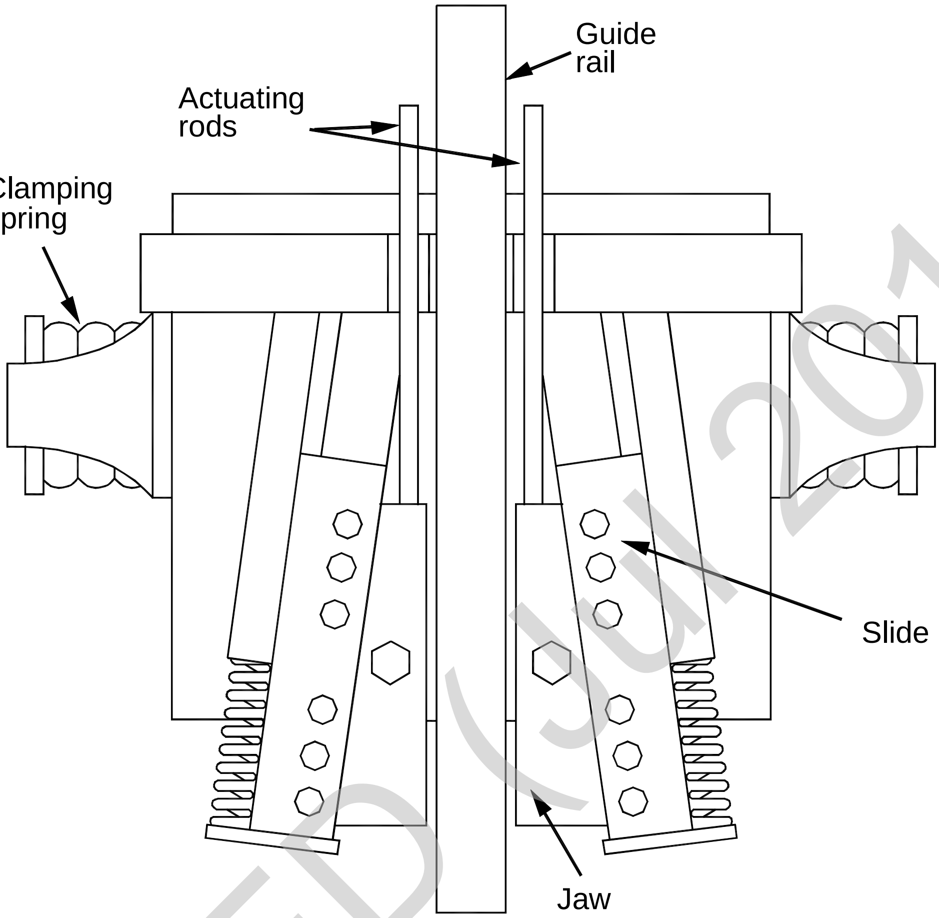


(ii) **serrated cam safety gear**: this safety gear comprises cams normally mounted as a pair in opposition to act on each side of the guide rail blade. Their rotary movement is synchronised through a mechanical linkage connecting the shafts on which they are mounted. Their active profile has a gradually increasing radius, with a hardened serrated surface. When brought into contact with the guide rail surfaces by the triggering mechanism, each cam will be turned on its axis through movement relative to the guide rail and be driven with increasing force into closer contact with the guide rail surface. In practice, the forces developed under quite a small deformation of the guide rail surface are sufficient to bring the car to rest. Like the captive roller safety gear, there is little scope for adjustment of the gripping force of a cam-type safety gear and its action is swift and severe.

b. **progressive safety gear**: this safety gear, as its name implies, has a progressive action and the clamping forces which it applies to the guide rail surfaces are adjustable. However, the resultant braking force on the car varies, according to site conditions, the load in the car and the coefficient of friction on the guide rail surface. The principle of operation is commonly referred to as the "wedge clamp". The actual jaws which grip the guide rail surfaces are in the form of wedges which are guided in low-friction tracks as they come into increasingly close contact with the guide rail. They are raised into initial contact with the guide rail surfaces by a triggering mechanism, after which, as with the instantaneous safety gear, the gripping elements feed themselves into closer contact with increasing force. The tracks themselves are in spring-loaded blocks and the springs can be adjusted. When the wedges have moved to the full extent permissible in their housing, a pre-determined clamping force is imposed through the wedges on to the guide rail surface (see Figures 17 and 18). In contrast to the instantaneous safety gear mechanism, the elements which grip the guide rails function as brake shoes relying on friction. They are not designed or intended to bite deep into the surface of the guide rail. Different rubbing surfaces may be used on the two wedges. Cast iron is commonly used and sometimes a pair comprising steel and bronze. The contact area is designed according to the materials and the optimum pressure of contact, The type of guide rail lubricant used will affect the coefficient of friction between the safety jaws and the guide rail. A metal plate should be fitted on the car top crown bar stating the type of lubrication to be used.

NOTE: A number of different arrangements are available from different manufacturers.

Figure 17: Typical arrangement of progressive safety gear (courtesy of CIBSE)

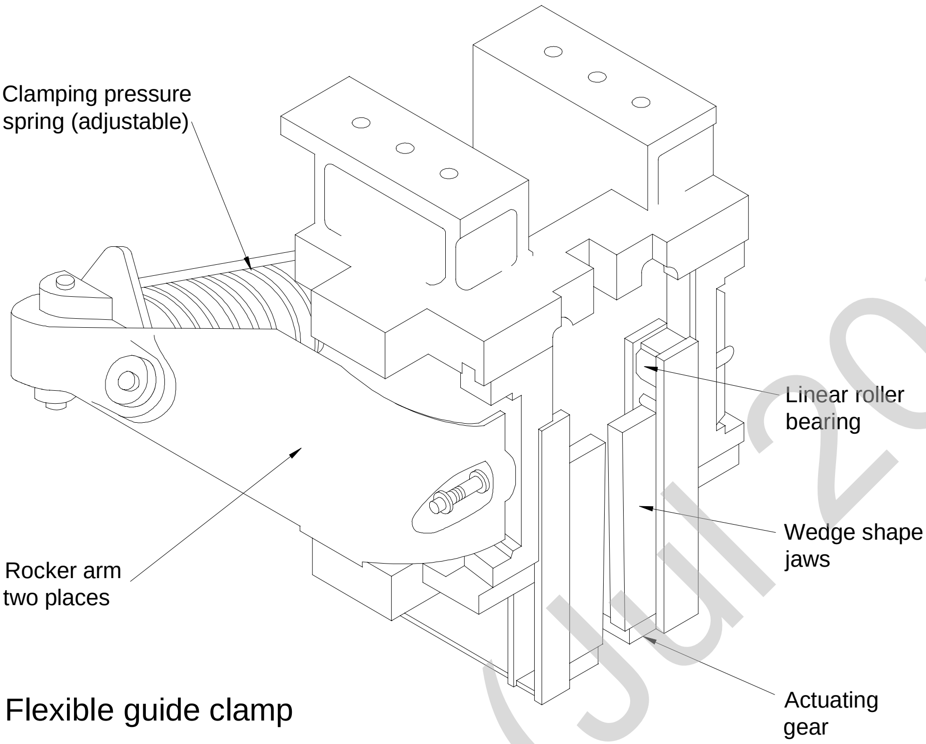


Electrical interlock

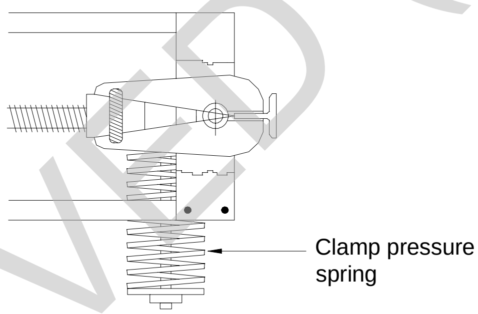
6.142 The safety gear, being the ultimate safety device for a lift, is designed to operate even if there is failure in the power supply or an electrical fault in the lift control system. An electric safety switch (the safety gear contact) is fitted to initiate the stopping of the motor and application of the brake. It is normally a simple safety contact mounted on the safety gear assembly, or on the car sling. The switch contacts are in series with the safety control circuit. The switch is held closed so long as the safety gear jaws are held open. To avoid intermittent operation, the contacts are held closed with the assistance of a spring.

6.143 The purpose of this contact is to ensure that if there has been a fault which led to the tripping of the safety gear, and this fault has been remedied, the lift remains inoperative until the safety gear has been released and the associated electrical safety device has been reset.

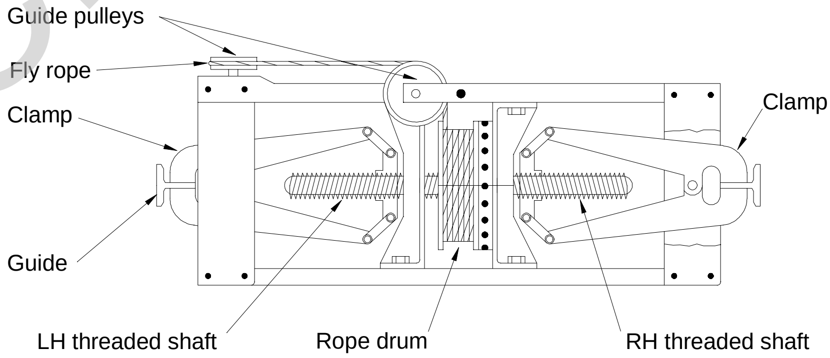
Figure 18: Typical arrangement of safety wedges



Flexible guide clamp



Spring assisted pre-set guide clamp



Gradual wedge safety gear

Location of safety gear

6.144 The safety gear can be located either on the top of or below the car frame. An obvious reason for placing it below is, of course, that whatever else may fail in the car suspension system or even in the construction of the car frame itself or the car enclosure, it is expected that the safety gear will remain to support the whole assembly. However, if it is mounted below the car, inspection and adjustment of the safety gear jaws and mechanism may be more awkward. If the safety gear is mounted on top of the car, the construction of the car sling should safely withstand all the additional loads that will be imposed on it, through application of the safety gear forces.

Counterweight safety gear

6.145 In the unlikely event of suspension failure and the possible free fall of the counterweight, unlike the car, the counterweight normally has no safety gear. It can accelerate to a very high speed before striking the buffers and its impact could be very great.

NOTE: For this reason, BS 5655 Part 1:1986 requires a counterweight to be fitted with safety gear if there are accessible spaces below the portion of the well where the counterweight travels. Reference should also be made to BS EN 81-1: 1998.

6.146 The type of safety gear used is basically the same as for a car: it functions only on a downward-moving counterweight. It is normally fitted to the bottom of the counterweight frame and its dimensions are rather restricted because of the limited space available for a counterweight.

NOTE: In such cases, BS 5655 Part 5:1989 recognises the problems and offers the concession that the plan dimensions of the well may sometimes need to be increased beyond the standard value.

Guide rails

General

6.147 Guide rails are provided to maintain the lift car, and counterweight where provided, in a uniform vertical direction as it ascends or descends in the lift well.

6.148 The safety gear for a lift car or counterweight is designed to operate to clamp onto the guide rails and arrest the descent of the lift. This exerts large stresses and compressive loads on the guide rails which they should withstand without undue damage or distortion.

NOTE: BS 5655 Part 9:1985 details the method of guide rail selection and stress analysis.

6.149 Guide rails are generally of an under-cut "T" section with a machined running surface for the guide shoes (see Figure 19).

6.150 The size, alignment, position and surface finish of the guide rails have a significant effect upon the quality of the resulting lift ride. Great care should be taken to ensure that they are correctly installed to avoid later problems.

6.151 It is virtually impossible to align guide rails correctly when the car has been installed within the well. Thus is particularly true in high-rise installations. It is important to ensure therefore that guide rails are installed before other pieces of equipment.

6.152 Misalignment of the guide rails may result in "tight spots", where the guide shoe friction increases, causing the lift drive to draw additional current from the supply, or vibrate the lift car.

Guide loadings

6.153 The guide rails provide structural support to the lift car sling during travel, loading and unloading operations. If the lift car is well-balanced around the point of suspension and the load is evenly distributed, the guide rail loading will be minimal during travel.

6.154 The loading and unloading operations of the lift car at a particular floor could exert a twisting movement on the guide rails. The size of this force is dependent upon the depth of the lift car, for example the distance from the sill to the point of suspension, and the mass of the load being exerted upon the sill.

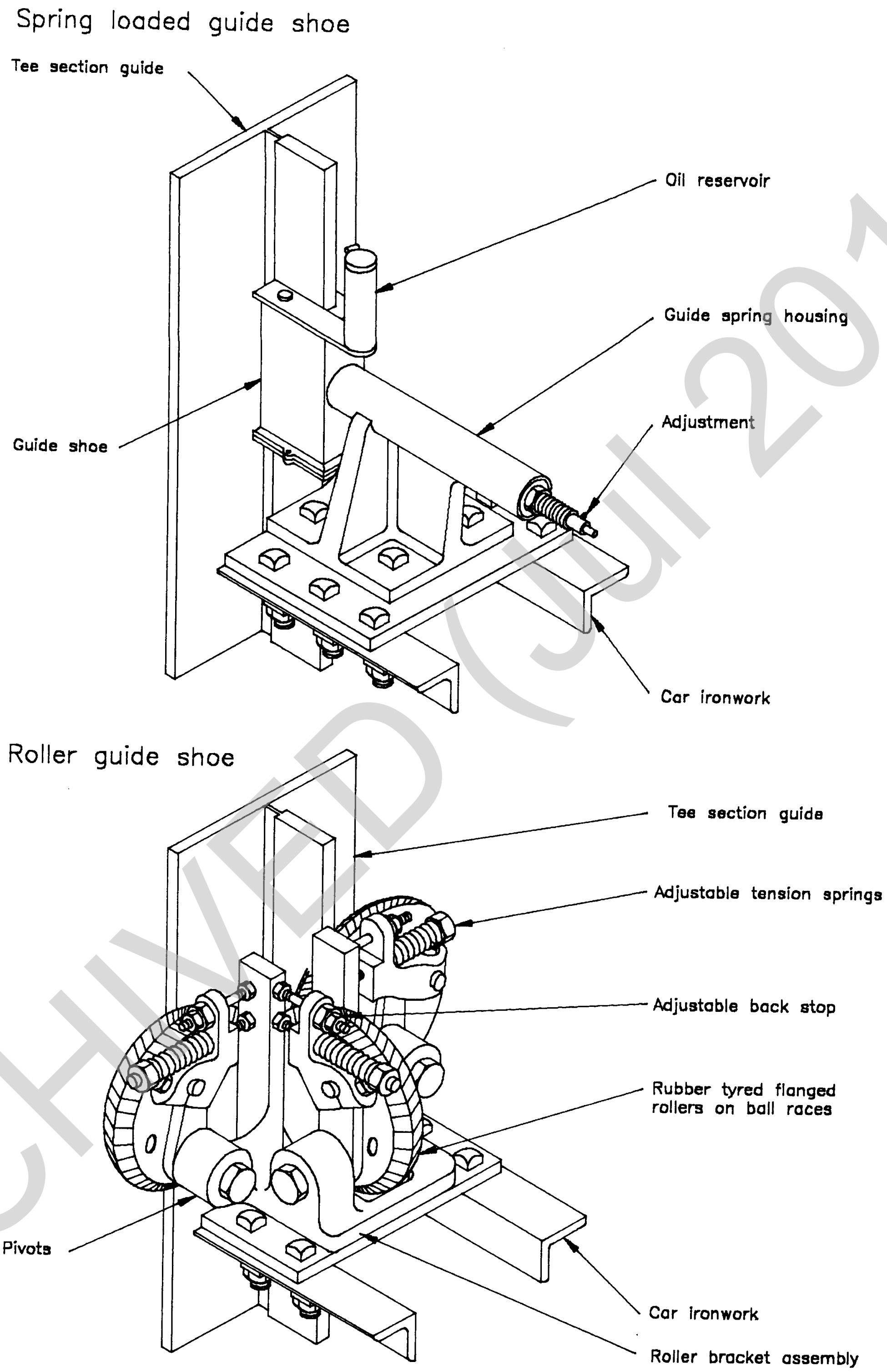
6.155 Passenger lifts and bed/passenger lifts have a Class A loading which restricts the maximum single piece load that can be placed in the lift car to 25% of the rated load. When assessing the lift requirements for a particular building, the designer should establish the maximum probable loads to be transported in the lift car so as to determine the required class of loading of the lift.

NOTE: For example a 28-person bed/ passenger lift has a rated load of 2100 kg. The maximum single piece load that may be transported in the lift, if it is Class A loading, is 525 kg. Refer to HBN 40, volume 4.

6.156 For anticipated loads in excess of Class A loading, special provision should be made by installing a lift in a strategic location of the hospital to allow a lift rated as Class C to serve all floors.

NOTE: Loading in excess of Class A is generally rare. Hydraulic lifts are not suited to Class C loading due to the compression of the hydraulic oil under load conditions.

Figure 19: Typical arrangements of guide shoes



Position of guide rails

6.157 Guide rails should be positioned as near as possible to the centre of gravity of the lift car with due consideration to the size of the car, door positions, etc. The guide rails are generally positioned in pairs, one each side of the lift car.

NOTE: There is no restriction as to the number of guides a car may have.

6.158 Hydraulic lifts, up to 1100 mm wide, may use a cantilevered arrangement with both guide rails at the same side of the lift car. However, for wider cars and lift speeds in excess of 1.0 m/s, guides should be located on opposite sides of the lift car.

Guide rail fixings

6.159 The position of guide rail fixings can help to prevent excessive deflection of the guides both during safety gear operation and during loading and unloading operations of the lift car.

6.160 A guide to good practice in determining guide fixing locations is to ensure that there is a guide fixing within 400 mm of the upper and lower car guide shoes when the car is level at any floor, and to ensure that there is also a fixing within 400 mm of each guide rail joint.

NOTE: The guide rail fixings will generally be at pitches of no more than 2.5m when calculated in accordance with BS 5655 Part 9:1985 requirements.

Guide rail lengths

6.161 Lift guide rails should be provided in the metric standard of 5 m lengths.

NOTE: Although it remains possible to obtain guide rails in 16 ft lengths, these are not recommended for use in healthcare lifts since they increase the possibility of incorrect pitch of guide fixings.

6.162 Guide rails should be installed so that there is sufficient guided travel remaining above the car or counterweight guide shoes when the car, or counterweight, rests on its fully compressed buffer. This is to allow for the inertia and bounce of the car or counterweight on the buffers.

NOTE: The distance should be 0.1 m + (0.035 V^2) where “V” corresponds to the speed of the lift.

6.163 The guide rails should not be installed hard up to the underside of the slab over the lift well. This allows adequate clearance for building compression, thus preventing any compression in the guide rails.

NOTE: As a general rule, a distance of approximately 5 mm per 3.5 m of lift well, or lift travel should be allowed as a minimum.

Buffers

General

6.164 Buffers should be mounted in the lift pit under each lift car and counterweight. Wherever possible, they should be positioned in-line with and symmetrically between car and counterweight guide rails upon steel piers so as to obtain the necessary over-travels.

6.165 A data plate should be fitted in a conspicuous position on the buffer reservoir providing details of the type, grade, viscosity and quantity of oil to be used.

Energy accumulation

6.166 Energy accumulation buffers are typically steel springs or polyurethane, cylindrical blocks which are placed on piers beneath the car or counterweight. They achieve a suitable clearance to accommodate a rectangular block of 1000 mm x 600 mm x 500 mm, representing a man refuge space.

6.167 The buffers provide a progressively increasing retardation force as the spring compresses to its maximum thereby storing the energy of the lift compressing it. In operation, the lift will bounce up a little as the spring under maximum compression expands slightly. When the lift car is raised, the buffer expands to its normal length.

6.168 Spring buffers are specified in relation to the maximum rated load that may be applied, that is, the mass of the car and the rated load.

6.169 The stroke of buffers should not be less than twice the gravity stopping distance at 115% of the rated speed. This should not be less than 65 mm.

NOTE: This approximates to 0.135 V^2, where the stroke is in metres and the rated speed (V) is in m/s.

6.170 The retardation with an energy accumulation buffer is severe. Even a lightly-loaded spring buffer may cause the lift car to oscillate violently.

6.171 Energy accumulation buffers are not recommended for patient-carrying lifts that travel at speeds exceeding 0.75 m/s.

Energy dissipation

6.172 Energy dissipation type buffers should be fitted on all lifts having a contract speed exceeding 1.6 m/s or on bed/passenger lifts where the speed exceeds 0.75 m/s.

6.173 The design of hydraulic buffers can vary between manufacturers. All buffers should be capable of converting the kinetic energy of the car, or counterweight, at the instant of impact into heat as well as potential energy equal to the stroke of the buffer.

Counterweights

6.174 Each traction lift should include a counterweight having a mass equal to that of the lift car, plus approximately 50% of the contract load.

6.175 The counterweight consists of a set of removable metal filler weights securely contained in a rolled-steel frame.

NOTE: This ensures that no filler weight can be displaced by impact on the buffers.

6.176 The counterweight is required to move smoothly up and down the guide rails and as such is fitted with spring-loaded guide shoes. The top shoes should be fitted with generously rated oil reservoir lubricators.

6.177 Each completed counterweight assembly should be painted bright yellow with black diagonal stripes to denote a "hazard". Mid-point counterweight screens are considered a greater hazard than the protection they afford and are not recommended.

6.178 The front and two sides of each counterweight should be guarded in the pit area by a rigid metal screen secured to the counterweight guide rails.

6.179 The counterweight screen should be constructed of either sheet metal or wire mesh of pitch not exceeding 13 mm in the horizontal or vertical planes.

6.180 The bottom of the screen should cover the lowest projection of the counterweight under buffer compression and should extend to a minimum height of 2.5 m above the base of the pit.

Landing entrances

General

6.181 Each lift provided for the purposes of passenger or bed-passenger traffic should be fitted with a landing entrance assembly comprising horizontally sliding doors which are automatically-operated by the power-operated car doors.

NOTE: Refer to HBN 40, Volume 4, for the minimum dimension of landing entrances used on hospital lifts.

6.182 Landing entrances should have a fire certificate for a period of not less than the structure in which they are installed (maximum of two hours) and be a complete assembly comprising:

a. door panels;
b. top tracks;
c. hanger assembly;
d. sill;
e. entrance surround.

Types of entrance and configurations

6.183 Other types of entrance exist. These are mostly manually-operated and not suitable for passenger use. Manually-operated entrance types include:

a. folding shutter gates;
b. horizontally-sliding, multi-leaf gates;
c. single panel hinged.

NOTE: If a fire certificate is required, these types of entrances may not be appropriate.

6.184 Various types of landing entrance configuration are show in Figure 20.

Fire rating

6.185 Each complete landing entrance assembly should provide a fire integrity that is at least equal to the fire rating of the landing entrance wall. The entrance assembly should have a fire test certificate. For a fire integrity in excess of half an hour, vision panels may not be installed as these reduce the fire integrity to that of the glass.

Locking

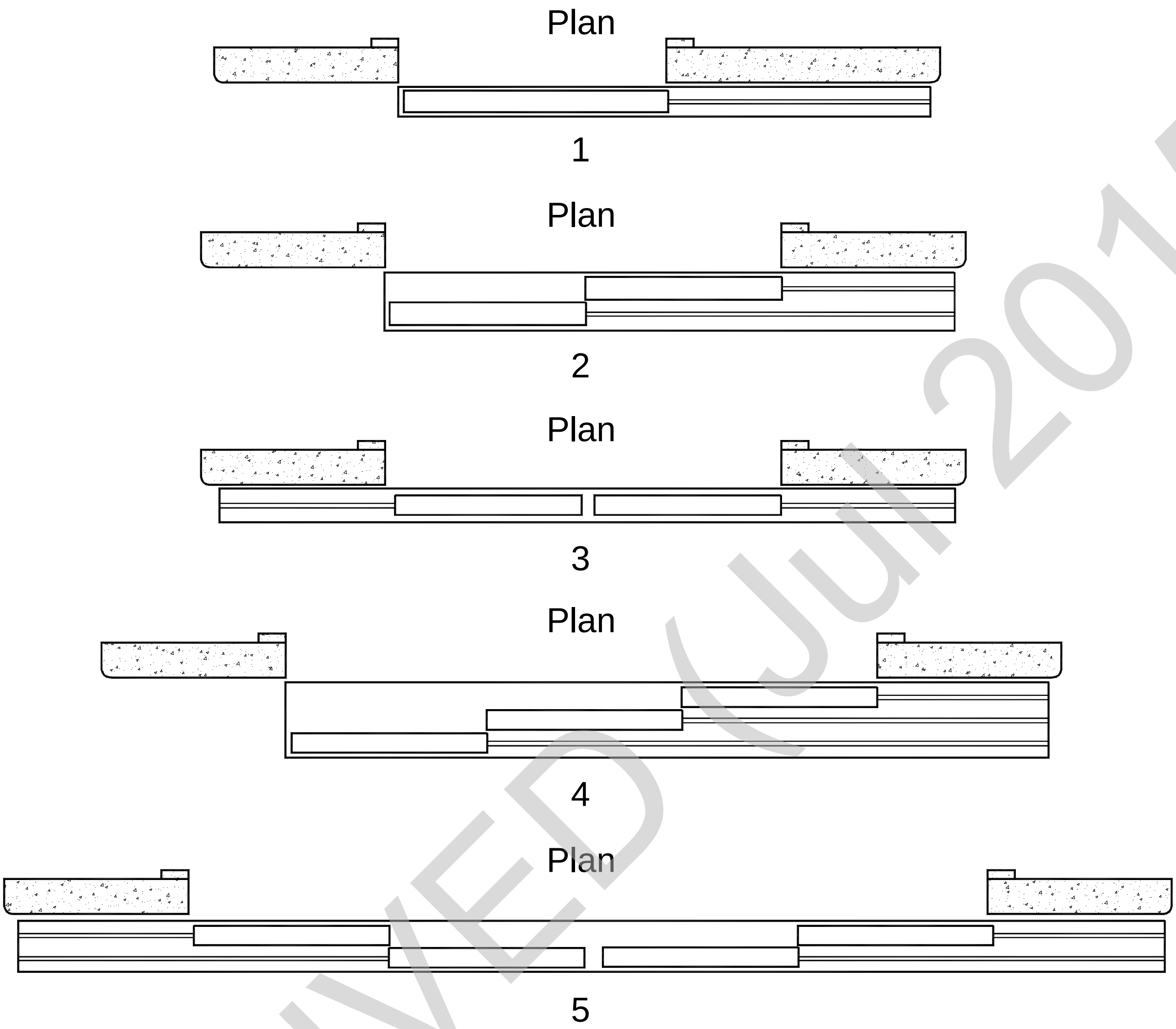
6.186 Each landing entrance door panel/leading door panel should be mechanically and electrically interlocked. All other door panels in the door assembly should be electrically interlocked if they are not mechanically coupled. The type of locking used should allow the locking mechanism to be inspected from within the well.

> **NOTE:** This requires regular examination without removing the cover assemblies.

Materials and construction

6.187 The landing entrance assemblies in healthcare buildings are subject to varying traffic types and often to abuse. They should be suitably constructed to sustain such abuses without affecting lift operation. Lifts are often used to transport trolleys which are heavily laden. The trolleys are often not braked and are difficult to steer, and a collision between a trolley and a lift landing door is a common event. Lift landing doors should therefore be robust. The door panels should be reinforced at a height of anticipated trolley impact and the door gibs reinforced with a steel flange (which should not be in contact with the sill groove) to prevent the door being forced out of the bottom track.

Figure 20: Typical arrangement for horizontal power-operated landing entrance doors



1 – single slide
2 – two-speed side-opening
3 – single-speed centre-opening
4 – three-speed side-opening
5 – two-speed centre-opening
(courtesy of CIBSE)

6.188 The exposed face of the landing door panels, whilst providing a decorative finish, should be practical enough to sustain a serviceable finish which will sustain the rigours of use in healthcare buildings.

NOTE: Typical finishes for lift landing doors are rolled, patterned or brushed finish stainless steel.

Vision panels

6.189 The practice of providing vision panels in car and landing doors of lifts has been traditional in healthcare buildings. However the perforation of the door structure reduces the fire integrity to that of the glass in the vision panel. Vision panels should only be specified where a fire integrity of half an hour is required.

Emergency opening

6.190 The emergency opening of lift landing entrances should be restricted to competent persons (lifts). To prohibit access by unauthorised persons, the landing door release key should be of a type that is not widely available.

NOTE: Refer to BS 5655 Part 1:1986 and BS EN 81-1: 1998 for the recommended release key type.

6.191 The same type of emergency release should be used for all lifts in the same building.

Landing door closing

6.192 In accordance with BS 5655 Part 1:1986/BS EN 81-1:1998, landing doors should be automatically closed if they are opened in the absence of the lift car. Due to the duty cycle of lifts in healthcare buildings compared with commercial premises, the landing doors will operate more frequently and as such will wear more quickly. A steel wire type closer is not recommended for healthcare buildings as it will require replacement on a regular basis; a spring lever type door closer is preferred.

Car entrances

Types of entrance and configurations

6.193 The car doors should generally be identical to the landing door arrangement.

6.194 Car doors for passenger and bed/passenger lifts should be power operated to provide automatic or semi-automatic control.

Power operation

6.195 On passenger and bed/passenger lift installations, electric power-operated car doors should be placed on the top of the lift car. When the lift arrives at a floor, the car and landing doors will be coupled, so that as the operator opens the car door it will also open the landing doors.

6.196 The door operator converts the rotary action of the motor to a linear movement of the door. The operation of the door has to be achieved within adjustable time constraints. The kinetic energy should be limited to the British Standard recommendations.

Car door safety devices

6.197 Various types of passenger obstruction detection devices are available for lifts, each with different operating characteristics. The main ones are:

a. **electronic safety edge**: this device projects a number of infra-red beams across the entrance opening and the interruption of any of the beams for a period of greater than one second will cause the doors to be re-opened;

b. **optical passenger detectors**: this device is used to provide a higher degree of door protection where heavy objects are to be moved through the entrance and are used in addition to door safety edges. Optical passenger detectors are simple video cameras mounted over the car entrance which work with an image processing circuit to detect movement of passengers or objects approaching the lift door. The view of the camera can be adjusted to allow detection only in front of the lift entrance and not too far into the lobby;

c. **mechanical safety devices**: the door is retracted when the leading edge contacts a solid object.

Locking

6.198 It is essential that the car doors are electrically interlocked and that shaft fascia panels are provided where the distance between the car sill and the shaft front exceeds 150 mm. Whilst the lift is in-between floors, the car door should be mechanically locked to prevent it from being opened maliciously thereby stopping the lift on the electrical interlock. This requirement should be provided in addition to shaft fascia panels.

Materials and construction

6.199 Lift car doors operate more frequently than the landing entrances and therefore should have durable finishes.

6.200 Compared with the landing doors, the car doors are less likely to be subjected to impacts from large loads and therefore do not require additional reinforcement.

Vision panels

6.201 Vision panels should only be fitted in the car doors where they are provided in the landing doors.

Lift car and sling

Sling

6.202 The car sling is the frame in which the lift car is mounted. It bears the stresses that the lift car is subjected to when accelerating, buffering or upon application of the safety gear.

6.203 The car sling of larger lifts, for example, bed/passenger lifts, should be reinforced with diagonal bracing between the platform and the uprights.

Platform

6.204 Passenger lifts require a platform that is insulated from the car sling. This reduces the amount of vibration transmitted to the lift car. The lift platform of healthcare passengers or bed/passenger lifts should be manufactured from steel in preference to timber. The steel platform may be surmounted by a timber floor to further reduce noise. However, where timber is used it should be protected on the underside by 0.5 mm thick sheet steel.

Car construction and internal finishes

6.205 The lift car is constructed on the car platform and should constitute a number of steel panels to provide a rigid enclosure. The roof of the enclosure should be strong enough to accommodate at least two service persons and their tools.

6.206 Car finishes are applied to the inside of the sheet steel panels. They should be of a robust nature and include vandal-resistant fixtures.

6.207 Hospital lifts are subjected to trolley traffic. This requires the finishes to be protected by a bump rail on three sides of the lift car. Where a combined hand and bump rail is provided, the height should be sufficient to support patients and protect the car when trolleys are in use. It should be fitted to three sides of bed/passenger lifts, however, for smaller lift cars, a handrail on three sides of the car may restrict the available car area. In this situation, the handrail should only be mounted on the side car wall adjacent to the car control station.

6.208 The car internal finishes may be applied to separate non-flammable panels which should be installed in an easily demountable arrangement so that damaged panels may be removed for repair without rendering the lift out of service for a prolonged period.

6.209 The car floor should be covered in a watertight floor covering laid in a one piece construction which is coved and attached to the car walls. The car floor covering should have non-slip properties and have a surface that will allow small wheeled trolleys to be easily steered.

6.210 Consideration may be given to providing a half-height mirror on the rear wall to give the appearance of a more spacious lift car.

Lighting

6.211 The car should be illuminated to a level of approx. 100 lux at floor level using a method of illumination that would not cause discomfort to patients laid viewing upwards on a trolley.

6.212 Hospital lifts often transport passengers who may panic if trapped in a darkened lift car during a power failure; therefore, the lift car should be provided with emergency lighting.

Ventilation

6.213 Lift cars should be ventilated in accordance with British Standard requirements. For bed/passenger lifts, mechanical extraction should be considered; this should be installed in the car ceiling and should operate while the lift is running and for a short time afterwards. The air inlet should be provided via concealed slots around the base of the wall panels.

Car and landing fixtures

Landing indicators

6.214 Landing indicators are intended to assist and inform the lift user. They should be of a type that will be comprehended by sight-impaired and hearing-impaired passengers.

6.215 The landing indicators at the main floor should provide a visual indication of the position of each lift. For the benefit of sensory-impaired passengers, the arrival of the lift at the floor, in response to a landing call, should be announced by the illumination of an intended direction of travel indicator and an audible announcement.

6.216 It is recommended that the landing indicators should be illuminated by light emitting diodes (LEDs).

Car indicators

6.217 The lift car should indicate at which landing floor level it is about to stop as well as indicating the intended direction of travel. The indicators should be both visual (by LED indicators as for the main floor) and audible (from a voice annunciation unit). See also Chapter 7 – ‘Lift controls’.

Landing controls

6.218 Passenger landing controls should be mounted at a height accessible to wheelchair-bound disabled passengers. The controls should be as obvious as possible and be limited to push buttons with tactile legends.

Car controls

6.219 Car controls should also be mounted at a height accessible to wheelchair-bound disabled users, as above.

NOTE: Refer to BS 5655 Part 7: 1983 for definition of notations.

6.220 The upper-most push button should be the alarm push which is identified by a yellow push button. A floor push button should be provided for each level served, each having a tactile notation on the button. A car door open/hold button should be provided towards the bottom of the car-operating panel.

Special controls

6.221 Where special controls are provided, the designer should clearly specify the required operation in respect to all operating devices so that the lift maker may confirm how his equipment will achieve the requirements at the time of tender.

NOTE: Special controls are detailed in Chapter 7.

7. Lift controls

General

7.1 A lift control system comprises a number of elements which combine to ensure safe, reliable, and efficient operation of the lift, or lifts. The principal elements are:

a. **power system**: operation of the all of the supply voltages exceeding 220V for the lift motor, door motor etc;

b. **safety system**: the monitoring, by electrical means, of the control circuit to ensure safe movement of the lift prior to power being applied to the motor. All circuits on a lift should fail safe;

c. **call logic system**: that part of the control circuit which receives inputs from the car and landing pushes. It determines the most appropriate method of operating the lift to allow passengers to arrive at their intended destination. This is achieved in response to a particular control concept which is installed in the control panel either as a programme or by circuit arrangement.

Control technology

7.2 The number of floors served by the lifts, the number of lifts in a group, and the complexity of the lift operation will determine the technology required for the controller.

7.3 Mechanical switching is required to power lift controllers. At least two independent sets of contacts should be provided between the supply and the motor. This is to prevent the possibility of the power contacts welding closed in the event of a fault. Other power controls can be provided using semi-conductor switching for the drive.

7.4 Control systems using microprocessor-based systems offer greater flexibility to change and can provide more sophisticated control requirements.

Electromechanical switching

7.5 Electromechanical control panels include electro-magnetic relays, electromechanical contactors, mechanically-driven floor selection devices and shaft-switching devices.

7.6 Electromechanical devices have a limited life span in terms of operational life and are affected by ambient temperature, pollution, dirt, etc.

> **NOTE:** Controllers are manufactured for average operating conditions, for example an office building with a work cycle of five days per week. A hospital work cycle is far longer.

7.7 For a typical two- or three-stop lift in a hospital, the call logic is not complex and may be adequately performed by electromechanical switching. However, the reliability of electromechanical switching is typically two failures for every one million operations, which equates to approximately one failure every two years. As the lift equipment ages, the failure rate will increase accordingly and, after six to eight years, 70% of all lift failures will be as a result of relay failures.

7.8 A relay system is very simple and fault finding can often be achieved by a multi-meter. This may be an advantage in that the need for trained staff and standby/call-out facilities may be reduced.

Solid state technology

7.9 Solid state technology includes discrete transistor/semi-conductor circuits, integrated circuits etc. This provides improved reliability and lower energy consumption than relay systems. It also allows the incorporation of a fault diagnosis system by connecting LEDs at strategic points of the control circuit.

7.10 Solid state circuits are assembled on printed circuit boards which require connection to other parts of the control circuit. This should be achieved by positive operation connectors, for example plug/sockets, in contrast to edge connectors which are prone to intermittent problems where the machine room conditions are not favourable.

7.11 Where solid state circuits are used, the machine room ambient temperature should be maintained above 5°C for traction lifts and 15°C for hydraulic lifts.

> **NOTE:** If this temperature is allowed to approach the BS maximum value (40°C), the life span of the electronics is reduced by a factor of 10 for every 25°C increase in ambient temperature.

Microprocessor technology

7.12 Computer-based control systems allow complex computations to take place very rapidly so that the lift may respond in the most appropriate manner to the prevailing conditions. The computer continually re-evaluates the status of the calls on the system and executes the requirements of the control algorithm accordingly.

7.13 The use of microprocessors allows flexibility of controls, however non-standard functions are not recommended as these will incur expensive software development and prototypes.

7.14 Microprocessor controls require the same attention to the machine room ambient temperatures as for solid state applications.

7.15 Microprocessor controls can also be used in solid state drive systems where the drive makes numerous computations of load, speed and travel distance. It can adjust the drive output accordingly which is often at a rate of many times per minute.

7.16 Complex microprocessor faults often require skills which are not always readily available in rural areas where such equipment is not as common as in urban hospitals.

Control systems

7.17 There are many recognised, and standard, control principles which are applied to suit specific types of traffic. The most common types of control, identified against typical applications, are detailed as follows:

a. **single automatic push button (SAPB)**: only one push button is provided at each landing and the car will only respond to one landing call at a time. When a car call is entered, the car will bypass any subsequent landing calls until it has answered this call. These controls are restricted to general purpose goods lifts with manual doors or to passenger lifts serving two or three floors only;

b. **non-directional collective control**: again, only one button is provided at each landing and the lift will stop at the landing to collect the call, regardless of the required direction of travel of the lift. The system offers a high probability of long waiting times and unnecessary trips in the wrong direction.

NOTE: This system was developed for outdated relay systems. With solid state panels, a number of functions are often included in the control panel as standard and switched in as required.

c. **down collective:** this control also has only one button per landing. The lift control panel considers all calls above ground floor to be down calls and all calls at the ground floor to be up calls. As the lift moves down the building, it stops and collects all calls continuing in the downward direction until all landing calls are answered. When the lift moves up the building it will travel to the highest call, passing all landing calls en route, and upon reaching the highest call, it will reverse direction to collect all calls on the way down;

NOTE: This type of system is suited to such applications as multi-storey car parks where there is no inter-floor traffic. It is not recommended for hospital lift applications.

d. **full collective control**: for this type of control system, both up and down buttons are provided on the landings so that calls may be registered separately for each intended direction of travel. The lift will stop only for calls in the direction of its travel, unless no calls are present on the car control station or no other landing calls have been assigned. The lift will answer calls for the opposite direction of travel when it has answered all calls for its present direction of travel.

NOTE: This type of control system is adopted for multiple lifts where the controller will determine the most appropriate lift to despatch to answer a particular call.

Emergency power operation

7.18 It is recommended that where lifts are required for movement of patients, at least one lift is installed in each section of the hospital. All lifts that are of orthopaedic bed capacity should be connected to the essential services supply.

NOTE: Refer to SHTM 2011; SHPN 40 and HBN 40 Volume 4.

7.19 It is an important consideration when using semiconductor-controlled static drives that the harmonic currents and voltages are limited to a level tolerable to the generator and essential services system. Harmonic values produced by a lift system will vary with different supply configurations.

7.20 It is sometimes impractical to supply all lifts from the essential services board. A method of manually switching the essential services power supply should be incorporated in the lift switchboard to allow each lift to be recovered in turn.

7.21 During times of emergency power supply, the hospital engineering staff will have a number of priorities to attend to, such as releasing trapped passengers from lifts or manually switching the supply to each lift. As an alternative to manual switching, an inexpensive circuit may be provided by the lift maker so that under loss of normal supply, all lifts will respond in the following manner:

a. stop on loss of supply;

b. the essential services supply will be made available to a bus feeding all lifts;

c. a sensing circuit connected to the non-essential services board will signal that the lifts should operate in emergency power mode;

d. upon receiving the signal from the sensing circuit, the lift group despatcher will recover one lift at a time to the main floor level where they will park up;

e. when all lifts are recovered in sequence to the main floor, one lift may be returned to normal service. This lift will normally incorporate the fireman's controls.

Fire-fighting control

7.22 Fire-fighting controls should not be confused with the requirements for "Fireman's control". Fire-fighting lifts require several distinct building and services provisions which have significant cost implications.

> **NOTE:** Fire-fighting control is detailed in BS 5588 Part 5: 1991.

7.23 The requirements for fire-fighting control are summarised below:

a. the speed of the lift is such that it can travel to the highest floor in less than 60 seconds.

b. automatic power-operated doors should be provided and should be at least 800 mm wide x 2000 mm high;

c. lift position indicators should be provided in the lift car and at the fire brigade access level;

d. two-way communications are required between the car, the machine room, and the fire brigade access level. The communication link should be switched on automatically when the fire-fighting switch is activated. It should comprise a speaker/microphone behind a grille in the lift car and handsets both in the machine room and the lift car;

e. car controls should not be prone to damage by water and should indicate the fire service access level;

f. electrical equipment on the landing and up to 1 m in front of the lift well should be protected from water falling from above;

g. an audible signal should be provided on the car top and within the machine room.

> **NOTE:** Reference should be made to Part E of the Technical Standards for compliance with the Building Standard (Scotland) Regulation 1990 'Means of escape from Fire, Facilities for Fire Fighting and means of warning of Fire in dwellings'.

Fireman's control

7.24 Where the building construction does not accommodate the full requirements of a fire-fighting lift, the principle of fireman's control should be applied.

NOTE: Fireman's control is no longer defined in BS 5655 due to the provision of fire-fighting lifts which are detailed in BS 5588 Part 5:1991.

7.25 A fireman's control facility should be operated from a break-glass toggle switch positioned adjacent to the landing entrance of the fire service access floor.

NOTE: Under fireman's control, any optical devices which may be affected by smoke should be rendered inoperative.

7.26 Operation of the fire-switch should override all other controls, except service and maintenance switches. It should also prevent the car from responding to existing calls, and automatically despatch the car to the floor at which the switch is located. On arrival at this floor, the car should not park with the doors open.

7.27 Under fireman's control, the car should only respond to calls made from the car control station within the car. The car doors should only close upon constant pressure of a car push button for a particular floor. Upon arrival at the floor, the car doors should only be opened by constant pressure upon the door open button. Releasing the door open button before the doors are fully opened should re-close the doors.

Emergency bed service (code blue control)

7.28 An emergency bed service (EBS) facility should be available in any lift which serves a theatre area and is also available for general use. The facility should also be provided in accident and emergency (A and E) areas where the entrance level is above or below the A and E reception.

7.29 In order to standardise, the following system has been adopted for to healthcare buildings:

NOTE: This enables the users, for example ambulance technicians/paramedics, to become familiar with one system and also to allow lift makers to produce a uniform control system or software algorithm.

a. the EBS facility should be operated from key switches or card readers on each landing and within the lift car;

b. upon operation of any landing key switch or card reader, the corresponding lift must respond in the following manner:

   (i) if the lift is travelling away from the EBS control that has been operated, the lift will stop at the next landing and without opening its doors and return immediately to the floor level where the EBS key switch was operated;

   (ii) as soon as the lift has been summoned on EBS, the speech synthesis unit should announce the following:

"LIFT ON EMERGENCY BED SERVICE PLEASE EXIT ON ARRIVAL"

(iii) the car position indicator will illuminate as an "E" if the indicator is a single digit unit or, if more digits are available, a more descriptive notation should be used;

(iv) upon arrival at the floor where the EBS switch was operated, the lift will park with its doors open awaiting operation of the key switch on the car control station;

(v) when the key switch on the car control station has been operated, the lift will respond only to car calls on a non-collective arrangement, stopping at the nearest call placed in the direction of travel of the lift;

c. an indicator should be provided in the faceplate above the EBS switch to indicate that the lift is engaged on emergency bed service, thereby preventing calls at other landings being placed on that lift.

Theatre service

7.30 Where possible, it is desirable to have a dedicated lift, or lifts, to serve an operating theatre to segregate the public from theatre patients.

7.31 Where it is not practical or economical to have a dedicated theatre lift, a lift which is available for general public use may be provided with controls to remove the lift from normal service and temporarily dedicate its use to the theatre staff.

7.32 Theatre control may be provided on the landing at the theatre floor, if this is a restricted access floor or within the theatre area. The control should be initiated by a push button which is clearly labelled to indicate that it is not part of the normal lift controls.

> **NOTE:** This can be achieved by having a large button (50 mm x 50 mm) painted bright red and above which is mounted a notice stating: **"THEATRE LIFT SERVICE ONLY"**.

7.33 When the theatre service push is operated, the lift will complete the call in the direction it is travelling at that time. It will then return directly to the theatre level. Upon arrival at the theatre level, the lift will park with its doors open for a sufficient time to allow the theatre staff to take control of the lift via an "independent service key switch" mounted on the car-operating panel. Control of the lift shall then be vested in the car-operating panel pushes and all landing calls will be bypassed.

7.34 If, after operation of the theatre service push, the lift is not taken into independent service within a predetermined period, the lift will return to normal service.

Voice annunciation

7.35 To assist partially-sighted or blind passengers, each lift should be fitted with a voice annunciation (speech synthesis unit) to provide an audible indication of the following:

a. the floor level reached (this can be further supplemented by department names);
b. the direction in which the lift is about to travel;
c. the actions of the doors (for example "stand clear doors closing").

Special controls

7.36 Some specialist healthcare buildings may require special lift control features to restrict access in secure areas.

7.37 It is normally sufficient to restrict access to the lift lobby. However, where high security is required, for example in **psychiatric wards**, it may be necessary to provide special facilities on the control panel to prevent unauthorised use of the lift.

7.38 This can be achieved by replacing landing call pushes with key switches or swipe card reader switches. In some cases, however, there is a risk that an authorised user may inadvertently press the incorrect push, alight at the wrong floor level, leaving the lift to travel to the **secure ward** empty and thereby allowing an unauthorised person to enter the lift without operating the landing key switch. The installation of key switches in the lift car itself will prevent such a breach of security.

8. Engineering services

General

8.1 Engineering services provided for a lift in a healthcare building will generally be the same as provided for any lift. However, due consideration should be given to the longer working day in a healthcare building compared with a commercial building and to the fact that lift failure or entrapment could prove fatal for some patients.

Power supplies

8.2 Lift power supplies should, wherever practical, be derived from a dedicated power supply near to the supply transformer.

8.3 For groups of lifts, at least one lift in the group should be supplied from the essential service supply.

8.4 The essential supply should be capable of being switched to each of the lifts in a group to allow evacuation. The switching should be mechanically interlocked to ensure that the essential services supply is not overloaded by the operation of too many lifts at the same time.

8.5 During periods of mains power supply failure, the hospital engineering staff will be under pressure to investigate the failure and restore essential electrical services. Further duties of manually switching supplies between lifts would impose extra burdens on them. An automatic system of supply transfer by the lift control system should be considered.

8.6 The supply to each lift should be terminated in the lift machine room to allow the lift engineer direct access to the supply protection gear.

NOTE: Lift power supplies should comply with the requirements of: SHTM 2007 and SHTM 2011.

Harmonic distortion and interference

8.7 Lift drive systems draw non-sinusoidal currents from the supply source which include harmonic currents. If these currents are not suppressed, they will react with the distribution system impedance to generate harmonic voltages which can interfere with other equipment on the supply system.

NOTE: Refer to SHTM 2014.

8.8 Semi-conductor drives will draw large harmonic currents which should not be allowed to exceed the limits set in The Electricity Association and Engineering Recommendation G53 when added to the harmonic content of the rest of the equipment connected to the network.

8.9 Where multiple lifts are to be provided and connected to the same supply source, an assessment is required of the magnitude of harmonic currents drawn from the supply and the arithmetic sum of the individual currents with a coincidence factor applied.

8.10 When lift equipment (that can produce harmonics) is to be supplied from standby generators, designers should advise equipment suppliers of the estimated magnitude of the harmonics to allow them to assess if any potentially damaging condition exists.

8.11 Where problems are anticipated, alternative drive systems should be considered. This does not rule out the potential use of semi-conductor drives, as the harmonic content can be reduced by other means.

NOTE: Harmonics reduction can be achieved by either increasing the pulse number of the drive or providing a convertor input to the drive to keep currents in-phase with the supply.

8.12 Lift control equipment in a healthcare building may be subject to varying forms of interference from sources such as operating radio equipment, large scanning machines, etc. The lift controls should be protected so that they will not suffer any malfunction as a result of interference.

NOTE: Refer to the 'Electromagnetic Compatibility Regulations 1992' and SHTM 2014.

8.13 The lift installation itself may produce interference which could affect the operation of sensitive electronic equipment such as radio paging systems or diagnostic equipment commonly used in healthcare buildings. The location of such equipment in the vicinity of the lift machine room should be avoided where possible.

NOTE: Refer to SHTM 2014.

Lighting

8.14 General lighting should be provided in the lift machine room to provide a level of illumination of 200 lux at floor level around the hauling machine and to the front of the control panel.

8.15 In the event of a power failure it may be necessary to gain access to the lift machine room to perform such functions as emergency hand winding, etc. It is necessary to provide emergency lighting in the lift machine rooms to facilitate this.

8.16 Consideration should be given to providing emergency lighting within the lift well as it may be necessary to gain access to the top of the lift to assist the release of trapped passengers.

NOTE: Lift well lighting should comply with the recommendations of BS 5655 Part 1:1986 and BS EN 81-1: 1998.

8.17 It is recommended that lift cars within healthcare buildings be provided with a self-contained emergency lighting system capable of powering a 13W lamp for at least three hours.

NOTE: BS 5655 Part 1: 1986 and BS EN 81-1: 1998 recommends that emergency lighting, within the lift car; be a minimum of a 1W lamp operating for 1 hour.

Small power

8.18 Adequate "single pole and neutral" (SPN) supplies should be provided in the lift machine room to supply the following:

a. car lights;

b. car top socket outlet;

c. alarm charger supply;

d. well lights;

e. pit socket-outlets;

f. machine room socket-outlets;

g. machine room lighting.

NOTE: A consumer unit may be installed in the lift machine room to supply the machine room lighting, car lighting, well lighting and small power socket-outlets.

Heating and ventilation

8.19 Lift equipment will only provide stable operation if the machine room ambient temperature is maintained within reasonable limits. For traction lifts, this is between 5°C and 40°C. Hydraulic lifts are more heat sensitive and the temperature range for the pump room is 15°C to 35°C.

NOTE: This is due to the requirement for a stable viscosity of the hydraulic fluid.

8.20 Lift equipment will generate heat and the quantity of heat produced will be largely dependent upon the efficiency of the drive and the usage of the lift. The amount of heat that will be generated should be determined with the assistance of the lift equipment supplier. Suitable ventilation should be provided to maintain the temperature within the limits set out in paragraph 8.19.

8.21 Lift machine rooms may require heating if they are in an exposed location or to prevent the temperature in the machine room dropping below the prescribed limits set in paragraph 8.19.

8.22 It may be necessary to provide cooling where a group of lifts share a common machine or pump room, or where the room is internal.

8.23 It is not normal to provide heating to the lift wells as there is generally sufficient heat loss from the lobbies via the landing doors to prevent the temperature within the well dropping to a level where it will have adverse effects on the lift equipment.

8.24 Lift wells require ventilation in accordance with local authority planning requirements. However, where no requirements exist, the wells should be vented to atmosphere by a vent of a minimum free area.

NOTE: BS 5655 Part 1:1986 and BS EN 81-1: 1998 provides information for ventilation openings.

8.25 Ventilation of lift cars can either be by mechanical or natural means.

Standby generation

8.26 Where standby generation is provided, reference should be made to SHTM 2011.

8.27 Care should be taken to ensure that lift drives which are to be operated on generator supplies will not cause harmonic distortion (see paragraph 8.10).

8.28 Where a group of lifts is installed, it can be impractical to operate all of the lifts from the standby generator supply. A method of automatic changeover between lifts to provide a sequential recovery of each lift is desirable (see paragraph 8.5).

NOTE: Lift equipment manufacturers can provide automatic changeover systems. If a manual changeover switching system is installed, care should be taken to ensure that the generator circuit cannot be overloaded.

Telephones

8.29 Some form of communication should be provided for emergency use by passengers in lift cars. Conventional telephone handsets may be liable to damage by acts of vandalism. Consideration should be given to the use of a speaker/microphone protected by a grille or recessed in a box.

NOTE: This communication system should connect the passenger to a 24-hour manned location such as a reception area, telephone exchange, etc.

8.30 A telephone should be provided in each lift machine room to co-ordinate emergency operations.

9. Environmental and human comfort considerations

Noise

9.1 A lift installation can be the source of noise, arising from:

a. operation of the machinery or pumps within the lift machine room;
b. the lift car travelling through the building;
c. the operation of the car and landing doors.

NOTE: The criteria for noise ratings (NR) of various buildings are provided in CIBSE Guide "A" which recommends a value of NR 35 for hospitals. Further information is also given in SHTM 2045; *Acoustics*.

9.2 The lift equipment should be specified to achieve the relevant noise criteria, bearing in mind that the performance of the equipment will deteriorate over time owing to normal wear and tear.

9.3 Care should be taken in determining the NR criteria as the building fabric will not always attenuate any noise generated.

9.4 On hydraulic lifts, the noise of the hydraulic fluid passing along the pipes can generate wide band, high frequency noise. The noise may be attenuated by the provision of a “muffler” device connected to the valve output line.

9.5 The noise associated with lift travel may be attenuated by suitable lubricants to the guide rails and the specification of self lubricating rubbing surfaces, for example nylon gibs, etc.

Vibration

9.6 The lift equipment may cause low frequency vibration audible in either the building fabric or the lift car.

9.7 Vibration caused by the hauling machine may be minimised by dynamic balancing of the equipment and by providing insulating mountings for the hauling machine and the lift control panels.

9.8 Vibration of the lift car will be as a result of either vibration of the hauling machine or vibration caused by the travel of the lift. The vibration of the machine is transmitted to the lift car via the suspension ropes, therefore, suitable isolation of the rope hitch to the lift car will reduce the transmitted vibration.

NOTE: Vibration from the hauling machine will relate to the input (motor) RPM or to the output (sheave) RPM.

9.9 The lift car should also be isolated from the sling so that vibrations from the movement of the car running on the guide rails may be prevented from being transmitted to the car.

9.10 The construction and finishes of the lift car should be selected to attenuate noise, for example sheet metal finishes will amplify vibration, but properly secured laminates on backing boards will attenuate the vibrations.

Acceleration/deceleration restrictions

9.11 So as not to impose undue pressure on patients, particularly those on trolleys who may have just had surgery, the acceleration and deceleration of the lifts should not exceed $0.6m/s^2$.

9.12 The rate of change of acceleration and deceleration, termed "jerk" and measured in m/s^3, will be dependent upon the type of drive system selected. For hydraulic lifts, this will be low, however for traction lifts this should be restricted to $1.2\ m/s^3$.

Psychological considerations

9.13 Some people may experience feelings of claustrophobia when travelling in a lift car. Lift car interiors should therefore give the impression of space and be well lit.

NOTE: The use of mirrors on the rear wall and the use of soft pastel tones for car interior finishes can help to give an impression of greater space and tranquillity.

10. Fault indications and monitoring

General

10.1 The installation of a fault indication system should be considered to allow prompt response to lift failures so that lifts may be returned to normal operation as quickly as possible. The indication may be presented locally to the lift equipment or remote from it.

Local indications

10.2 Local indication of a lift failure should be provided on the lift control panel by an LED array or by a simple analyser to provide an interrogation facility.

10.3 The local fault indications should not necessitate the use of portable equipment or complex facilities, such as a "lap top computer", which are not part of the lift installation and may not be available to the service person in attendance.

Lift monitoring systems

General

10.4 The aim of monitoring is to assist in maintaining a high lift availability.

10.5 The use of microprocessors for the control of vertical transportation provides enhanced performance and a reduction in maintainable components compared to previous systems. It also provides an inexpensive means to accumulate data retrieval and analysis.

Benefits of lift monitoring

10.6 A two-stop hydraulic lift would be unlikely to warrant the expense of lift monitoring. However, such expense may be justified for a multi-floor traction lift serving areas which are critical to the hospital operation.

NOTE: The need for a lift monitoring system will be determined by the client, with the advice of the lift designer: costs and operational procedures will need to be taken into consideration.

10.7 The benefits likely to be derived from the provision of lift monitoring should be considered at an early stage in the planning of a lift installation.

10.8 The designer should ensure that the system adopted performs the main task of identifying faults, or potential faults, and reports them to either the lift maintenance contractor or the hospital estate department so that they may be acted upon. The system should be efficient however; the virtually limitless capacity of modern data storage systems could result in generally useless data being stored in such large volumes that it would never be assessed and acted upon.

NOTE: Any "free" enhancements available from a particular supplier should be considered of secondary benefit.

10.9 Beneficiaries of monitoring fall into three main categories:

a. **client**: (the hospital) where the benefits include:
   - (i) increased safety;
   - (ii) increased reliability and thus availability;
   - (iii) faster response to call backs;
   - (iv) elimination of repetitive call backs;
   - (v) anticipation of breakdowns;
   - (vi) achievement of maximum performance;
   - (vii) monitoring maintenance service;
   - (viii) monitoring performance;

b. **passengers**: where benefits include:
   - (i) increased safety;
   - (ii) increased reliability;
   - (iii) quicker response in event of breakdown;
   - (iv) action on non-reported, non-disabling faults;

c. **lift maintenance contractor**: where benefits include:
   - (i) the provision of information to service engineers enabling a more rapid response to breakdown and to rectify faults more quickly (improves availability);
   - (ii) the identification of genuine call backs (where performance-related contract is in place),
   - (iii) improved fault detection and monitoring of maintenance procedures.

Types of signal

10.10 Lift controllers incorporate many different "signals" within the control system. These signals may be internal to the microprocessor or external as part of the low voltage control circuit.

10.11 When accessed and displayed in some form of a message, the signals can provide useful information regarding the operation or failure of the lift.

10.12 All signals may be classified as one, or a combination, of three categories of message:

a. **failures:** it may be sufficient to know that the lift is not operating. However, it is often useful to have the reason for the failure identified to some degree. The failures which are considered useful to report are:

(i) **power supplies:**

- mains supply lost;
- mains circuit breaker open;
- controller power supply lost;
- controller logic supply lost;
- phase failure;
- phase rotation;

(ii) **safety:**

- alarm bell activated;
- car gate lock lost whilst running;
- gate lock power supply lost;
- landing gate lock lost whilst running;
- lift overtravel bottom;
- lift overtravel top;
- transfer door switch open;
- stop switch operated lift running;
- policing limit operated (high speed travel into top floor);
- lift overspeed;
- lift car safety gear operated;
- buffer switch operated;

(iii) **doors:**

- door closing timer timed out;
- door overload operated;
- door opening timed out;
- car stopped outside door zone;
- landing door lock not made car at floor level;
- car door lock not made car at floor level;

(iv) **machine:**

- failed to start;

- brake failed to lift;
- motor run time exceeded;
- motor overload tripped;
- brake resistor over temperature;

b. **errors**: events which do not render the lift out of service but require attention before they cause a failure. These include:

(i) car stopping outside of levelling tolerance;

(ii) re-levelling x times in x events;

(iii) well light supply lost;

(iv) push stuck;

(v) landing indication failure;

(vi) doors “pumping” before closing;

(vii) machine temperature high;

NOTE: Errors of a repetitive nature should be arranged to give a single indication on a BMS scheme and not report repeatedly every time the lift moves.

c. **performance or service data**: the current operation of the lift may be monitored and/or the operating history of the lift submitted to memory. This is particularly useful to ensure that the traffic is being dealt with adequately by the lift system. These include:

(i) the position of the lift car;

(ii) the position of the doors at particular floor (front and rear);

(iii) the direction of travel;

(iv) the door dwell time;

(v) landing calls;

(vi) car load data;

(vii) flight times;

(viii) parked position;

(ix) operational mode auto, semi-auto, bus stop;

(x) landing controls engaged;

(xi) inspection mode operated.

Information retrieval from lift control panels

10.13 The increasing use of microprocessor-based lift control systems, for even the simplest of control functions, allows the use of the communication part of the microprocessor to send and receive data.

10.14 It is possible to monitor those functions that are not controlled by the microprocessor by deriving information from a hard-wired interface or programming the function into the microprocessor from an input/output (I/O) port.

Method of data transmission (communications)

10.15 Due to the geographical distribution of some hospital sites, a hard-wired local area network system may not be practical. Practical applications of hard-wired networks are usually restricted to distances of approximately 1 km when operated independently of a "building management system".

NOTE: Communication methods should conform to the recommendations of BS 4737 Part 1:1986.

Integration with hospital building management system

General

10.16 Due to the absence of any monitoring standards, lift makers and suppliers to the lift industry have developed their own systems which have different protocols and are not compatible with one another.

10.17 Building management systems (BMS) generally consist of one or more microprocessor-based outstations which monitor, control and record details such as electrical consumption, fire alarms, security surveillance and other data. The outstations are generally distributed throughout the building in close proximity to the plant under control.

10.18 Building energy management systems (BEMS) can monitor other pieces of equipment which have their own on-board intelligence, for example heating, ventilation and air-conditioning. However, since different systems may be used in a hospital, a method of communication between the respective protocols is required.

NOTE: Building management systems and building energy management systems are commonly used in healthcare premises and can readily accept signals from lift monitoring equipment. The BMS should only receive data or alarms and should not issue or control the lifts in any manner. Further information is available from SHTM 2005; *Building management systems*.

10.19 The most widely adopted principle is to produce a communication driver. This is a self-contained software interface to allow different manufacturers' systems to communicate with the selected management system or display apparatus.

NOTE: Confidentiality of the manufacturers' protocols is normally achieved by using a "third party" software developer.

10.20 Where a BMS is not installed, a wide area network using a full modem-based automatic dialling system via the telephone network is considered to be the most practical method of communication.

10.21 Several monitoring systems may be connected to one auto-dial modem system, however each lift should be individually identifiable.

10.22 In order to ensure communications are maintained during power supply failures, which are likely to cause a fault alarm report condition, the communications equipment should be backed by a battery power supply.

NOTE: The communications system should be able to monitor the telephone line connection to trigger an "alarm" report in the event of line failure.

Presentation of data

10.23 Data should be presented in a format compatible with the display system being used. Windows-style presentation systems are widely used; however, this may change with the rapid developments in software technology that are likely to occur.

11. Modernisation of hospital lifts

General

11.1 Hospital lifts are subject to more intensive use than lifts in other types of buildings. This often shortens their life span. Lifts in non-healthcare buildings will typically require modernisation after 15 to 20 years of service. In hospitals, however, this may be reduced to 10 to 15 years.

NOTE: The modernisation cycle depends on the specification and supplier.

11.2 The need for modernisation can be attributed to:

a. reduced reliability,

b. poor performance;

c. change in use at location (making the lift unsuitable).

NOTE: This can be a departmental change or even a change in hospital category.

Limitations

11.3 The confines of the existing lift well are often a major limiting factor in any refurbishment consideration. These will restrict the following:

a. available door opening width;

b. the speed of the lift;

c. the size of the lift car.

11.4 In older hospitals, where existing lifts are often slow and have manually operated gates, the confines of the lift well will restrict refurbishment and only minimal improvements can be made without major alteration to the structure.

Forecasting improvements

11.5 Before any major refurbishment work is undertaken on existing lifts, a cost/benefit analysis should be carried out. This requires specialist knowledge of available options.

Equipment considered for modernisation

11.6 Cost considerations are a prime factor in any lift modernisation scheme. However it may be possible to meet budgetary constraints by carrying out improvements in a phased programme.

11.7 While this will not offer an immediate solution to the problems being encountered, it may relieve the symptoms to a tolerable level.

11.8 The following list (which is not exhaustive) suggests pieces of equipment which may be refurbished as single items:

a. door operators;
b. safety edges on car doors;
c. drive systems (upgrading of single or two-speed a .c. motors);
d. over-speed governors;
e. call pushes and indicators (if not a latching type);
f. car operating panel;
g. car interior finishes and lighting;
h. well equipment.

NOTE: Refer to the requirements of BS 5655 Part 1: 1986 and Part 2: 1988. Reference should also be made to BS EN 81-1: 1998 and BS EN 81-2: 1998.

12. Designated staff functions

12.1 Only trained authorised and competent persons (lifts) should be appointed by management to control the operation and maintenance of lifts.

12.2 **Management**: the owner, occupier, employer, general manager, chief executive or other person who is accountable for the premises and is responsible for issuing or implementing a general policy statement under the HSW Act 1974.

12.3 **Designated person (electrical)**: an individual who has overall authority and responsibility for the premises containing the electrical supply and distribution system within the premises and has a duty under the HSW Act 1974 to prepare and issue a general policy statement on health and safety at work, including the organisation and arrangements for carrying out that policy. This person should not be the authorising engineer.

12.4 **Designated person (lifts)**: an individual who has been nominated by management to ensure that lift operations are kept to a satisfactory standard including mandatory examinations, record keeping and emergency procedures.

12.5 **Duty holder**: a person on whom the Electricity at Work Regulations1989 impose a duty in connection with safety.

12.6 **Competent person (lifts)**: a person with adequate training, both theoretical and practical, and with experience of the equipment (lift installation) under examination to enable a true assessment of its continued safe operation to be made and who is supported within an appropriate organisation.

> **NOTE:** This definition of competent person (lifts) is synonymous with the definition of authorised person as defined in BS 7255: 2001.

12.7 **Employer**: any person or body who:

a. employs one or more individuals under a contract of employment or apprenticeship;
b. provides training under the schemes to which the Health and Safety (Training for Employment) Regulations 1990 (SI 1380) apply.

12.8 **Authorising engineer (high voltage)**: a chartered electrical engineer with appropriate experience and possessing the necessary degree of independence from local management who is appointed in writing by management to implement (as appropriate), administer and monitor the safety arrangements for the high voltage electrical supply and distribution systems of that organisation to ensure compliance with the Electricity at Work Regulations 1989, and to assess the suitability and appointment of candidates in writing to be authorised persons. (See SHTM 2021; *Electrical safety code for high voltage systems*.)

12.9 **Authorising engineer (low voltage)**: a chartered engineer or incorporated electrical engineer with appropriate experience and possessing the necessary degree of independence from local management who is appointed in writing by management to advise on and monitor the safety arrangements for the low voltage electrical supply and distribution systems of that organisation to ensure compliance with the Electricity at Work Regulations 1989, and to assess the suitability and appointment of candidates in writing to be authorised persons. (See SHTM 2020; *Electrical safety code for low voltage systems*.)

12.10 **Authorised person (electrical)**: an individual possessing adequate technical knowledge and having received appropriate training, appointed in writing by the authorising engineer to be responsible for the practical implementation and operation of management's safety policy and procedures on defined electrical systems (see SHTM 2021 and SHTM 2020).

12.11 **Competent person (electrical)**: an individual who, in the opinion of an authorised person, has sufficient technical knowledge and experience to prevent danger while carrying out work on defined electrical systems (see SHTMs 2021 and SHTM 2020).

13. Definitions

13.1 **Department**: an abbreviation of the generic term "UK Health Departments": Scottish Executive Health Department.

13.2 **Lift**: an appliance for transporting persons or goods between two or more levels by means of a guided car moving in a substantially vertical direction and travelling in the same path in both upward and downward directions (BS).

13.3 **Traction lift**: a lift whose lifting ropes are driven by friction in the grooves of the driving sheave of the machine (BS).

13.4 **Hydraulic lift**: a lift in which the lifting power is derived from an electrically-driven pump transmitting hydraulic fluid to a jack, acting directly or indirectly on the car (BS).

13.5 **System**: a system in which all the electrical equipment is, or may be, electrically connected to a common source of electrical energy, including such source and such equipment.

13.6 **Injury**: death or personal injury from electrical or mechanical failures.

13.7 **Danger**: a risk of injury.

13.8 **Essential circuits**: circuits forming part of the essential services electrical supply so arranged that they can be supplied separately from the remainder of the electrical installation.

13.9 **Emergency supply**: any form of electrical supply which is intended to be available in the event of a failure in the normal supply.

13.10 **Essential service electrical supply**: the supply from an engine-driven a.c. emergency generator which is arranged to come into operation in the event of a failure of the normal supply and provide sufficient electrical energy to ensure that all basic functions of the healthcare premises are maintained in service.

13.11 **Electrical equipment**: includes anything used, intended to be used or installed for use to generate, provide, transmit, transform, conduct, distribute, control, measure or use electrical energy.

13.12 **High voltage (HV)**: the existence of a potential difference (rms value for a.c.) normally exceeding 1000 volts a.c. between circuit conductors or 600 volts between circuit conductors and earth.

13.13 **Low voltage (LV)**: the existence of a potential difference (rms value for a.c.) not exceeding 1000 volts a.c. or 1500 volts d.c. between circuit conductors or 600 volts a.c. or 900 volts d.c. between circuit conductors and earth.

13.14 **Access doors**: means of access to equipment areas and other spaces pertaining to a lift installation such as machine rooms, overhead machine spaces, etc, and with access usually restricted to authorised persons.

13.15 **Alarm system**: an emergency system installed on all lifts, which comprises a bell, a push button installed in the car and an uninterruptible source of power (usually a battery).

13.16 **Algorithm**: a set of rules to which a system (often a control system) must conform.

13.17 **Annunciator**: a signalling device which provides passengers with information regarding lift car position, etc, by means of indicator lamps or audible announcements.

13.18 **Armature**: the rotor or moving part of a direct current (d.c.) machine.

13.19 **Automatic control**: a generic term used to define any error-activated, power-amplifying, negative feedback, closed-loop, control system.

13.20 **Brake**: an electromechanical device consisting of a spring assembly, which is held in compression by the energising of an electromagnet, and which holds the friction shoes from the contact with the brake drum or disc, thus allowing the lift car to move. In the event of the car exceeding its rated speed, or a power failure, or a control system demand to hold the car stationary, the brake is de-energised and operated, thus stopping the car in a safe distance or holding the car in position.

13.21 **Buffer**: device capable of absorbing the kinetic energy of motion of a descending car, or counterweight, when they have passed a normal limit of travel, by providing a resilient stop, and comprising a means of braking using fluids or springs (or similar means).

13.22 **Buffer (car)**: a final emergency device to bring a lift car to rest by absorbing the energy of motion should the car pass the normal downward limit of travel.

13.23 **Buffer (counterweight)**: a final emergency device to bring a counterweight to rest by absorbing the energy of motion should the counterweight pass the normal downward limit of travel.

13.24 **Buffer (stroke)**: the distance that a buffer can be compressed.

13.25 **Call**: a demand for service by a passenger which is entered into a lift supervisory control system by the passenger pressing either a landing or car call push button.

13.26 **Call back**: a service visit, at the request of a lift operator, made by a lift maintenance technician, which is not scheduled and which arises because the lift has gone out of service owing to a fault condition.

13.27 **Call push button**: a push button situated either in a car or on a landing by which passengers may indicate their travelling intention.

13.28 **Car**: the load-carrying unit comprising enclosure, car frame, platform and door(s).

13.29 **Circulation**: the process by which persons in a building move around the building in both horizontal and vertical modes.

13.30 **Counterweight**: a component which is employed to ensure traction between the drive sheave and the suspension ropes and which comprises a set of weights to balance the weight of the car and a proportion of the load in the car, often taken as 50% of the contract load.

13.31 **Counterweight (car)**: a counterweight which is directly roped to the lift car on a winding drum installation and which is approximately 70% of the car weight.

13.32 **Counterweight (guard)**: a screen installed in the pit to prevent persons from encroaching into the counterweight runway space.

13.33 **Counterweight (guides)**: steel T-shaped sections which guide the counterweight in its vertical travel.

13.34 **Counterweight (safety)**: a mechanical device attached to the counterweight frame designed to stop and hold the counterweight in the event of an overspeed or free fall or the slackening of the suspension ropes.

13.35 **Contract speed**: the rated speed of the lift that has been specified by the designer and agreed with the manufacturer.

13.36 **Control (directional collective)**: where landing calls are registered on a set of up and down landing call push buttons, the landing and car calls being registered in any order but answered strictly in floor sequence in the direction of travel, taking account of the direction of travel of the registered landing calls.

13.37 **Control (group collective)**: a simple form of group control system, where two (duplex) or three (triplex) cars are interconnected and collectively controlled, but providing a means of allocation of the best placed car to each landing call.

13.38 **Control (non-collective)**: the simplest form of control whereby a car will only answer a landing call if it is available.

13.39 **Cylinder**: the outermost lining of a hydraulic jack.

13.40 **Device (levelling)**: a mechanism which will move a lift car, when it is in the levelling zone, at a reduced speed towards a landing and stop it there.

13.41 **Device (signalling)**: an annunciator (light, indicator, bell, buzzer, etc,) which provides information to passengers about car direction, car position, car arrival, call acceptance, etc.

13.42 **Diversity factor**: a factor which may be applied to reduce the sizing of services, for example electric power cables, on the basis of a mathematical probability that not all connected equipment will require serving at the same time.

13.43 **Door**: the portions of the car or landing entrance which control the safe access to and from the moving car.

13.44 **Drive (direct)**: a drive where the driving part is directly connected to the driven part, either with or without intermediate gears.

13.45 **Drive (indirect)**: a drive system where the driving part is connected to the driven part by means of V-belts, tooth drive belts, or drive chains.

13.46 **Drive (drum)**: a positive drive system whereby the car and the counterweight are secured to a multi-grooved drum so that as one set of ropes unwinds from the drum the other set winds on.

13.47 **Drive-unit**: a power unit which provides the means for raising and lowering the car and which comprises: an electric motor or hydraulic power unit; gearing; brake; sheave or drum; couplings and bedplate.

13.48 **Entrance (car)**: the protective assembly which closes the lift enclosure openings normally used for entrance to and exit from the car.

13.49 **Error**: an event which is not fatal to the operation of a lift system, but which could result in degradation, malfunction, interruption or failure and which should be corrected as soon as possible.

13.50 **Failure**: an event which results in a lift system becoming unserviceable.

13.51 **Floor (car)**: the under-surface of the interior of a lift car on which passengers stand.

13.52 **Floor (main)**: the main or principal floor of a building.

13.53 **Floor (parking)**: a floor at which a lift car is parked when it has completed serving its car calls and the supervisory control system does not reallocate it to serve further landing calls.

13.54 **Front**: the front (of a lift car) is the side in which the entrance situated or in the case of multiple entrances, the side containing the entrance nearest to the car operating panel.

13.55 **Gear**: wheels working one upon another, by means of teeth (or otherwise), for transmitting or changing motion and power.

13.56 **Gear (helical)**: gear wheels running on parallel axes with the teeth twisted obliquely to the gear wheel axles.

13.57 **Gear (worm)**: a gear used to connect non-parallel, non-intersecting shafts with the teeth of the intersecting wheels cut on an angle.

13.58 **Governor**: strictly a mechanical device which is a closed loop, error-activated means of automatically controlling the speed of a machine, but in the lift context it is used to detect an overspeed situation.

13.59 **Governor (centrifugal)**: a mechanical device which utilises the effects of centrifugal forces operating on weights rotating in a horizontal or vertical plane to provide a movement which can in turn be used to operate a control device.

13.60 **Governor (over-speed)**: a governor used to detect the occurrence of a predetermined speed.

13.61 **Groove (U-profile)**: a groove cut into a drive sheave, which is semi-circular in shape, and of a radius which is approximately equal to the diameter of the suspension rope.

13.62 **Groove (undercut)**: a groove cut into a drive sheave, which is a modified V-groove having the lower sides cut in the shape of a "U".

13.63 **Groove (V-profile)**: a groove cut into a drive sheave in the shape of a "V".

13.64 **Group**: a group of cars is a number of cars placed physically together, using a common signalling system, and under the control of a supervisory control system.

13.65 **Guide rail**: a set of vertical, machined surfaces installed in the lift to guide the travel of a lift car or counterweight.

13.66 **Guide shoes**: devices used to guide the movement of doors, cars and counterweights along their associated guide rails.

13.67 **Hand-winding**: the action of using a manual lowering device to permit the emergency lowering/raising of a lift.

13.68 **Harmonic currents**: alternating currents at multiples of the mains frequency which flow when a non-linear load is connected to the supply.

13.69 **Hydraulic power unit**: part of the lift drive system and comprising pump, pump motor, control valves and fluid storage tank.

13.70 **Indicator (car position)**: an indicator adjacent to, or above, a car or landing entrance, which is illuminated to indicate the position of the lift car in the well.

13.71 **Indicator (landing direction)**: an indicator adjacent to, or above, a car entrance, which is illuminated whenever that car is to stop at that landing and which indicates the intended direction of travel for the car.

13.72 **Indicator (lift in use)**: an indicator adjacent to, or contained within, a landing call push button, which is illuminated whenever the lift is busy serving a demand, usually fitted on installations controlled by a very simple supervisory control system.

13.73 **Interference (electrical)**: unwanted signals transmitted via the electrical supplies or as electromagnetic radiation, which can interact with properly generated signal sequences to produce incorrect or hazardous operation of equipment.

13.74 **Interval**: the average time between successive car arrivals at the main terminal (or other defined) floor with no specified level of car loading or traffic condition.

13.75 **Jack**: the piston (plunger) and cylinder of a hydraulic lift.

13.76 **Jaws**: parts of overspeed safety gear which grip the governor rope (in the case of an overspeed governor) and grip the machined surfaces of the guide rails (in the case of car or counterweight safeties).

13.77 **Jerk**: the rate of change of acceleration with time.

13.78 **Landing**: a portion of floor or corridor adjacent to lift car entrances, where passengers may enter or leave.

13.79 **Lay**: the twisting of yarn (wires) to form a strand or the twisting of strands to form a rope.

13.80 **Lay (Lang's)**: the direction of the lay of the wires in the strand is the same as the direction of the lay of the strands in the rope.

13.81 **Lay (left)**: the strands of a rope are spun in an anticlockwise direction.

13.82 **Lay (ordinary)**: the direction of the lay of the wires in the strand is opposite to the direction of the lay of the strands in the rope.

13.83 **Lay (right)**: the strands of a rope are spun in a clockwise direction.

13.84 **Levelling**: an operation which Improves the accuracy of stopping at a landing and which ensures that the car platform is level with the floor.

13.85 **Lift (bed/passenger)**: lifts for the conveyance of patients being moved on beds or trolleys in hospitals, clinics, nursing homes, etc.

13.86 **Lift (electric)**: a power lift which uses an electrical drive machine to provide energy for the movement of the car.

13.87 **Lift (fireman's)**: a lift which may or may not be supplied with additional fire resistant protection, designated to have controls that enable it to be used under the direct control of the fire-fighting services for emergency purposes.

13.88 **Lift (goods)**: a lift primarily used to transport freight and goods, where only the operator and persons necessary to load and unload the freight are permitted to travel.

13.89 **Lift (hydraulic)**: a power lift which uses a liquid under pressure to provide the energy for the movement of the car.

13.90 **Lift (passenger)**: a lift primarily used to carry passengers.

13.91 **Lift (service)**: a lift that is not designed to carry passengers and is generally used for small loads. It is called and despatched externally, normally by a call point adjacent to each level hatch or access door.

13.92 **Lighting (emergency)**: lighting provided in a lift car in the event of a power failure and supplied from a standby generator or emergency batteries.

13.93 **Machine (direct drive)**: an electric driving machine where the motor is directly connected mechanically to the driving sheave, drum or shaft with or without intermediate mechanical gearing.

13.94 **Machine (electric drive)**: a driving machine where the energy is supplied by an electric motor.

13.95 **Machine (geared traction gear drive)**: a traction drive machine utilising a gear for energy transmission.

13.96 **Machine (gearless traction drive)**: a traction drive machine with no intermediate gearing.

13.97 **Machine (hydraulic drive)**: a driving machine where the energy is supplied by a hydraulic fluid applied by means of a moving ram in a cylinder.

13.98 **Machine (indirect drive)**: an electric driving machine, where the motor is connected indirectly by means of belts, chains etc to the sheave, shaft or gearing.

13.99 **Machine room**: a room or space in which the machine(s) and associated equipment are located.

13.100 **Machine (traction)**: a direct drive machine where the motion of the car is obtained through fiction between the suspension ropes and the driving sheave.

13.101 **Motor**: a device which can convert electrical energy into mechanical energy.

13.102 **Noise (acoustic)**: noise which is transmitted through air and which may be generated by parts of a lift installation, such as the machine, car movement, ropes and chains in the well, and transmitted via parts of the structure to remote parts of a building.

13.103 **Operator (door)**: a power operated device which opens and closes the car doors.

13.104 **Panel (vision)**: a small window located in lift doors fitted with safety glass which permits passengers to see when a car has reached a landing.

13.105 **Parking**: action of moving a lift car to a specified floor or leaving it at its current floor, whenever the car has no further calls (landing or car) assigned to it for service.

13.106 **Platform (car)**: load-bearing floor of the car enclosure.

13.107 **Push button**: an insulated button which operates electrical contacts when pushed.

13.108 **Pump**: a hydraulic machine which converts mechanical energy into hydraulic energy. In lift practice, the mechanical energy is itself first produced from electrical energy by means of an electric motor, which is coupled directly to the pump.

13.109 **Ram**: the smooth circular moving part of a hydraulic jack which is forced out of the cylinder by fluid pressure.

13.110 **Rope**: a construction of twisted fibres or wire (wire rope) to form a continuous load-bearing element.

13.111 **Rope (compensating)**: wire rope used to counterbalance or partially counter-balance the weight of the suspension ropes as the lift car moves up and down the well.

13.112 **Rope (safety)**: rope attached between the governor rope and the safety gear.

13.113 **Safe-edge**: a mechanically-actuated door re-opening device mounted on the leading edge of a car door which, on colliding with a passenger or other object, causes the car and landing doors to re-open.

13.114 **Safety (car)**: mechanical device attached to the car frame to stop and hold the car should any of three conditions occur: free fall, predetermined overspeed or rope slackening.

13.115 **Safety gear**: a mechanical device for stopping and maintaining the lift car or counterweight stationary on the guides in case of overspeeding in the downwards direction or breaking of the suspension.

13.116 **Safety gear (instantaneous)**: a form of safety gear which applies a rapidly increasing pressure on the guide rails during the stopping period.

13.117 **Safety gear (progressive)**: a form of safety gear which applies a limited pressure on the guide rails during the stopping period.

13.118 **Sheave**: a wheel having a groove or grooves in its circumference in order to receive a rope or ropes; a pulley.

13.119 **Sheave (guard)**: a protective guard around a rope-carrying sheave.

13.120 **Sheave (drive)**: a wheel, the rim of which is grooved to receive the suspension ropes, and which allows the motion of the driving machine to be transmitted to the ropes by friction.

13.121 **Sling**: a device for lifting bulky or heavy articles.

13.122 **Solid state**: electronic circuits making use of semiconductors.

13.123 **Stroke (oil buffer)**: distance the buffer piston or plunger moves, excluding the travel of the buffer plunger accelerating device.

13.124 **Stroke (spring buffer)**: distance the contact end of the spring moves before all the coils are in contact or a fixed stop is reached.

13.125 **Switch (car)**: a switch mounted in the car used to control the motion (starting and stopping) of the car.

13.126 **Switch (final limit)**: emergency switch used to stop a lift automatically in the event that the car travels a predetermined distance past the terminal landing.

13.127 **Switch (fireman's)**: switch which, when operated, brings the designated car under the control of the fire-fighting service.

13.128 **Traffic analysis**: determination of the statistical characteristics of passenger movements in a lift system.

13.129 **Travel**: the vertical distance a lift can move, measured between the bottom terminal floor and the top terminal floor of a building zone.

13.130 **Ventilation (car)**: means of removal of heat, generated inside the car, by natural or mechanical means, via suitable vents placed in the car enclosure.

13.131 **Viscosity**: the specific resistance of a fluid to flow.

13.132 **Well**: the space bounded by the bottom of the pit, the walls and the roof in which the car and counterweight travel.

References

NOTE:
Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.

Publication ID	***Title***	***Publisher***	***Date***	***Notes***
Acts and Regulations				
	The Building (Scotland) Act	HMSO	1959	
	Clean Air Act	HMSO	1993	
	Disabled Persons Act	HMSO	1981	
	Electricity Act	HMSO	1989	
	Factories Act	HMSO	1961	
	Fire Precautions Act	HMSO	1971	
	Fire Safety and Safety of Places of Sport Act	HMSO	1987	
	Health and Safety at Work etc Act	HMSO	1974	
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	The Water (Scotland) Act	HMSO	1980	
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SI 2179 & 187	The Building Standards (Scotland) Regulations (as amended)	HMSO	1990	
SI 1460	Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP2)	HMSO	1997	
SI 3140	Construction (Design and Management) Regulations	HMSO	1994	
SI 437	Control of Substances Hazardous to Health Regulations (COSHH)	HMSO	1999	
SI 635	Electricity at Work Regulations	HMSO	1989	
SI 1057	Electricity Supply Regulations (as amended)	HMSO	1988 (amd 1994)	
SI 2372	Electromagnetic Compatibility Regulations (as amended)	HMSO	1992	
SI 2451	Gas Safety (Installation and Use) Regulations	HMSO	1998	

Publication ID	Title	Publisher	Date	Notes
SI 917	Health & Safety (First Aid) Regulations	HMSO	1981	
SI 682	Health & Safety (Information for Employees) Regulations	HMSO	1989	
SI 2792	Health and Safety (Display Screen Equipment) Regulations	HMSO	1992	
SI 341	Health and Safety (Safety Signs and Signals) Regulations	HMSO	1996	
SI 1380	Health and Safety (Training for Employment) Regulations	HMSO	1990	
SI 2307	Lifting Operations and Lifting Equipment Regulations (LOLER)	HMSO	1998	
SI 3242	Management of Health and Safety at Work Regulations	HMSO	1999	
SI 2793	Manual Handling Operations Regulations	HMSO	1992	
SI 1790	Noise at Work Regulations	HMSO	1989	
SI 849	Office, Shops and Railway Premises (Hoists and Lifts) Regulations	HMSO	1968	
SI 3139	Personal Protective Equipment (EC Directive) Regulations (as amended)	HMSO	1992	
SI 2966	Personal Protective Equipment at Work (PPE) Regulations	HMSO	1992	
SI 2306	Provision and Use of Work Equipment Regulations (PUWER)	HMSO	1998	
SI 3163	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)	HMSO	1995	
SI 3073	The Supply of Machinery (Safety) Regulations	HMSO	1992	
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BS 4737	**Intruder alarm systems** **Part 1**: Specification for installed systems with local audible and/or remote signalling	BSI Standards	1986	(AMD 5804, 12/87)
BS 5588	**Fire precautions in the design, construction and use of buildings** **Part 5:**Code of practice for fire-fighting stairs and lifts	BSI Standards	1991	
	Part 8: Code of practice for means of escape for disabled people		1999	
	Part 11: Fire Precautions in design construction and use of buildings		1997	
BS 5655	**Lifts and service lifts** **Part 1:** Safety rules for the construction and installation of electric lifts	BSI Standards	1986	
	Part 2: Safety rules for the construction and installation of hydraulic lifts		1988	(AMD 6220, 4/89)
	Part 3: Specification for electric service lifts		1989	(AMD 6377, 9/91)
	Part 5: Specification for dimensions of standard lift arrangements		1989	
	Part 6: Code of practice for selection and installation		1990	
	Part 7: Specification for manual control devices, indicators and additional fittings (implementing ISO 4190-5)		1983	(AMD 4912, 9/85)
	Part 8: Specification for eyebolts for lift suspension		1983	
	Part 9: Specification for guide rails		1985	(AMD 5186, 7/86; AMD 5786, 1/88)

Publication ID	***Title***	***Publisher***	***Date***	***Notes***
	Part 10: Specification for testing and inspection of electric and hydraulic lifts		1986	(AMD 6002, 5/89)
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	Part 11: Recommendation for the installation of new, and the modernisation of, electric lifts in existing buildings		1989	(AMD 8097, 3/94)
	Part 12: Recommendation for the installation of new, and the modernisation of, hydraulic lifts in existing buildings		1989	(AMD 6762, 9/91; AMD 8098, 3/94)
BS 5810	**Code of practice for access for the disabled to buildings**	BSI Standards	1979	
BS 7255	**Code of practice for safe working on lifts**	BSI Standards	2001	
BS EN 81-1	**Safety rules for the construction and installation of lifts. Electric lifts**	BSI Standards	1998	
BS EN 81-2	**Safety rules for the construction and installation of lifts. Hydraulic lifts**	BSI Standards	1998	
BS EN ISO 9000	**Quality management and quality assurance standards**	BSI Standards		
Scottish Health Technical Guidance				
SHTM 2005	Building management systems	P&EFEx	2001	CD-ROM
SHTM 2007	Electrical services supply and distribution	P&EFEx	2001	CD-ROM
SHTM 2011	Emergency electrical services	P&EFEx	2001	CD-ROM
SHTM 2014	Abatement of electrical interference	P&EFEx	2001	CD-ROM
SHTM 2020	Electrical safety code for low voltage systems (Escode – LV)	P&EFEx	2001	CD-ROM
SHTM 2021	Electrical safety code for high voltage systems (Escode – HV)	P&EFEx	2001	CD-ROM

Publication ID	Title	Publisher	Date	Notes
SHTM 2023	Access and accommodation for engineering services	P&EFEx	2001	CD-ROM
SHTM 2025	Ventilation in healthcare premises	P&EFEx	2001	CD-ROM
SHTM 2045	Acoustics	P&EFEx	2001	CD-ROM
SHPN 1	Health service building in Scotland	HMSO	1991	
SHPN 2	Hospital briefing and operational policy	HMSO	1993	
SHTN 1	Post commissioning documentation for health buildings in Scotland	HMSO	1993	
SHTN 4	General Purposes Estates and Functions Model Safety Permit-to-Work Systems	EEF	1997	
	NHS in Scotland – PROCODE	P&EFEx	2001	Version 1.1
NHS in Scotland Firecode				
SHTM 81	Fire precautions in new hospitals	P&EFEx	1999	CD-ROM
SHTM 82	Alarm and detection systems	P&EFEx	1999	CD-ROM
SHTM 83	Fire safety in healthcare premises: general fire precautions	P&EFEx	1999	CD-ROM
SHTM 84	Fire safety in NHS residential care properties	P&EFEx	1999	CD-ROM
SHTM 85	Fire precautions in existing hospitals	P&EFEx	1999	CD-ROM
SHTM 86	Fire risk assessment in hospitals	P&EFEx	1999	CD-ROM
SHTM 87	Textiles and furniture	P&EFEx	1999	CD-ROM
SFPN 3	Escape bed lifts	P&EFEx	1999	CD-ROM
SFPN 4	Hospital main kitchens	P&EFEx	1999	CD-ROM
SFPN 5	Commercial enterprises on hospital premises	P&EFEx	1999	CD-ROM
SFPN 6	Arson prevention and control in NHS healthcare premises	P&EFEx	1999	CD-ROM
SFPN 7	Fire precautions in patient hotels	P&EFEx	1999	CD-ROM
SFPN 10	Laboratories on hospital premises	P&EFEx	1999	CD-ROM
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