

## **PART 3**

# **Electrohydraulic Lifts: Passenger and Goods**

## SECTION 31 - GENERAL

## 31.1 Scope

This part of the ~~New Zealand~~ Power Lift Rules applies to electrohydraulic lifts as defined in Rule 3.95. The liquid pressure is generated by a pump driven by an individual electric motor. These Rules are complementary to Parts 1 and 2. Should there be conflict, the requirements of these Rules take precedence over corresponding requirements of Parts 1 and 2.

## 31.2 Drawings and Particulars of the Lift Installation to be Submitted

- (a) See Rule 2.5, and
- (b) Lift particulars sheets (see Rule 31.3).

**31.3 Lift Particulars for Electrohydraulic Lifts**

(All dimensions in millimetres unless otherwise specified)

Owner's name \_\_\_\_\_

Address \_\_\_\_\_

Location of lift \_\_\_\_\_

Lift maker

Lift submitter

Reference number of submitter

Date of submission

Observation lift; Yes/No

Type of Lift: Passenger/Pass &amp; Goods/Attended Goods

Serial number(s) of lift(s) which comply with NZS 4121

Internal car floor particular (measured 1000 mm above the car floor, ignore handrails etc.):

internal car floor width

internal car floor depth

area (cm<sup>2</sup>)**Masses:**

car (kg)

rated load (kg)

no. of persons

flying counterweight (kg)

**Car details:**

platform weight (kg)

platform direct on buffer members/isolators

floor details

sides and top details

plank or platform support members

bow members

weight of additional machinery on bow members (kg)

buffer members

sling members

free length of sling member

**Miscellaneous:**

total lift travel (m)

no. of floors of travel/openings served

rated speed of car (m/s)

maximum full load down speed (m/s)

self-closing doors fitted? Yes/No

• top overtravel limiter; none/switch/cushioned ram

**For suspended lift:**

governor tripping speed (m/s)

overtravel limit switch; fitted/not fitted

**Guide shoe data:**

vertical distance between car guide shoes' centres  
 eccentricity of car guide shoes with respect to c.o.g. of car  
 toe-to-toe distance between guide rails (D.B.G.)  
 distance from toe of guide rail to centre of guide roller

**Clearances and overtravel: clearances at top landing above following equipment:**

above guide shoes  
 above equipment 300 mm within perimeter of roof  
 above region 450 mm either side of bows  
 above car roof  
 above all other equipment  
 top overtravel of car

**Bottom clearances:**

mechanical clearance  
 man clearance  
 car-Buffer clearance  
 clearance to landing sill  
 clearance to liftwell  
 compressed ram clearance

**Car Buffer type: solid/spring/hydraulic:**

no. of buffers  
 stroke of the buffers

**NZS 4203: Seismic categories.**

Building category	1	2a	2b	3a	3b	4
Risk Factor R	2	1.6	1.6	1.3	1.3	1.0

Cpmax: Zone A=0.6; Zone B=0.5; Zone C=0.4

Seismic Design Coefficient  $C_d = R \times Cpmax$

**Car guide rails' data: Type of rail:**

distance between fixings  
 tie bracket section description (if fitted):  
 modulus  $Z_{yy}$  (cm<sup>3</sup>)  
 height

**Safety gear type: None/A/B/C/D:****Flying counterweight guide rails' data: Type of rail:**

distance between fixings  
 buffer type  
 buffer stroke  
 buffer clearance  
 top clearance  
 bottom clearance

**Tie bracket section description (if fitted):**

modulus  $Z_{yy}$  (cm<sup>3</sup>)  
 height

**Liftwell enclosure (description):**

**Landing entrances:**

clear opening height  
clear opening width  
door locks type/maker

**Terminal stopping device:**

cam operated from car  
selector in machine room driven by car  
electro-mechanical inductors

**Normal limit switches; maker - description:****Anti-creep levelling device; fitted/not fitted:****Hydraulic system:**

working pressure (kPa)  
relief valve pressure (kPa)  
ram hollow and subject to external pressure: Yes/No

**Cylinder:**

outside diameter  
inside diameter  
corrosion allowance (if provided)

Cylinder material

Cylinder yield strength

**Type of end:**

flat/concave/convex to pressure  
thickness

**For dished end:**

radius to which end is dished

**Ram:**

Stage 1

Stage 2

Stage 3

outside diameter  
inside diameter  
free length  
mass (kg)  
ram follower guide fitted/not fitted  
ram material  
ram yield strength (N/mm<sup>2</sup>)

**Type of end:**

flat/concave/convex to pressure  
thickness

**For dished end:**

radius to which end is dished

Door lock valve (maker)

Check valve (maker)

Flow restriction valve (maker)

**For Roped (Suspended) hydraulic lifts:****Hoist ropes:**

roping 1:1 1:2 1:3 (for speed)

(for rope load)

rope diameter

ropes total length (m)

no. of ropes used.

breaking strength/rope (kg)

maker

rope construction

eye bolt dia.

**Machine position:**

diverter sheave dia.

diverter sheave shaft dia.

kW rating

rpm

governor type

governor rope dia.

**Drawing references****31.4 Certificates to be Submitted**

Relevant certificates mentioned in Rule 2.6 and 31.6 and 34.3.7.

**31.5 Maximum Permissible Speed**

The rated speed (see Rule 3.110) of an electrohydraulic lift shall not exceed 1 m/s.

For all lifts designed for carrying passengers or goods, the speed in the down direction, under full load conditions, shall comply with the requirements in Table 31.5

**TABLE 31.5**  
**MAXIMUM SPEED IN DOWN DIRECTION**

Rated Speed	Maximum down-speed increase over rated speed %
Not more than 0.5 m/s	50
More than 0.5 m/s but not more than 1 m/s	40

**31.6 Cylinder Supports and Foundations**

The adequacy of the design and construction of the supports and foundations for the hydraulic cylinder shall be certified by a ~~registered~~ <sup>an appropriately</sup> qualified and experienced engineer.

### 31.7 Pressure Test after Erection

After erection, before being put into service and in the presence of the Inspecting Engineer Surveyor, equipment subject to hydraulic pressure on the cylinder side of the check valve and down stop valve shall be tested in accordance with Section 69.

### 31.8 Devices to Hold Car Above Lowest Floor

For direct-acting electrohydraulic lifts, devices shall be provided to hold the car above the lowest floor, in accordance with the following requirements:

- (a) Suitable means shall be provided to -
  - (i) support the car above the lowest landing so as to give an access space of at least 600 mm during service and repair of hydraulic equipment in the pit;
  - (ii) hold down the car during pressure tests required by Rule 31.7. The supporting means required in (a)(i) above, or equivalent means, shall also be in position during such tests, as a precaution against the car descending in the event of any failure.
- (b) The equipment provided may be a combined unit to meet the requirements of (a) above.
- (c) The equipment under (a)(i) above shall remain on site and, where practicable, in the pit, provided that it will not restrict the mechanical and man clearances specified in Rule 38.1, alternatively this equipment shall be stored in the machine room.  
Such equipment shall be identified as to its use.
- (d) Permissible stresses in the supporting means shall comply with the requirements of approved standards, and fixings thereof, if used, shall be designed with a factor of safety of 2 on yield strength, based on the fully loaded car.

### 31.9 Materials, Components and Equipment Complying with Approved Standards

Materials, components, and equipment, which have been proven as follows:

- (a) in Australia and used under the Lift code SAA 1735 with the "approval" of the respective state inspection authorities, or
- (b) the U.S.A. and used under the ANSI/ASME A17.1 Lift code with the "approval" of the respective state inspection authorities, or
- (c) the United Kingdom and used under the Lift code BS 5655 with the "approval" of the authorised inspection authorities, or
- (d) in Europe and used under the CEN Lift standard EN81 with the "approval" of the authorised inspection authorities,

are approved for use with these Rules.

**SECTION 32 - MACHINE ROOMS AND MACHINERY SPACES**

**32.1 Machine Rooms**

All central control operating equipment shall be grouped together in a machine room which shall comply with the relevant requirements of Section 7.

The machine room shall be located adjacent to the liftwell and shall be equipped with a means to see some part of the motion of the lift car from the lift control position.

**NOTE:** An opening fitted with a metal grid on the liftwell side in the common wall of the liftwell and machine room could achieve this objective. The construction of the grid should comply with Rule 12.2. The opening must be effectively plugged with a fire-resistant block of the appropriate rating (see Rule 12.1) when not in use.



**SECTION 33 - ACCESS TO OVERHEAD SHEAVES**

Where an electrohydraulic lift has overhead sheaves, such as for counterweight ropes, access to these shall be provided by means of a sheave room or platform.

Such sheave room or platform shall comply with relevant requirements of Rule 7.13.

## SECTION 34 - HYDRAULIC DRIVING MACHINES

## 34.1 Type

The requirements of this section apply particularly to hydraulic driving machines of the direct-acting ram type, but where a lift is of the suspended type, then the driving machine for such lift shall comply with the relevant Rules in this section.

## 34.2 Rams

34.2.1 General Requirements. Rams shall be of uniform diameter and have a uniform smooth finish on the outside to ensure maximum life of packings and minimum oil leakage. If of hollow construction, they shall have substantially uniform wall thickness.

34.2.2 Material. Rams shall be of steel or other approved ductile metal.

Grey cast iron or other brittle material shall not be used for the ram or its connecting couplings to the car.

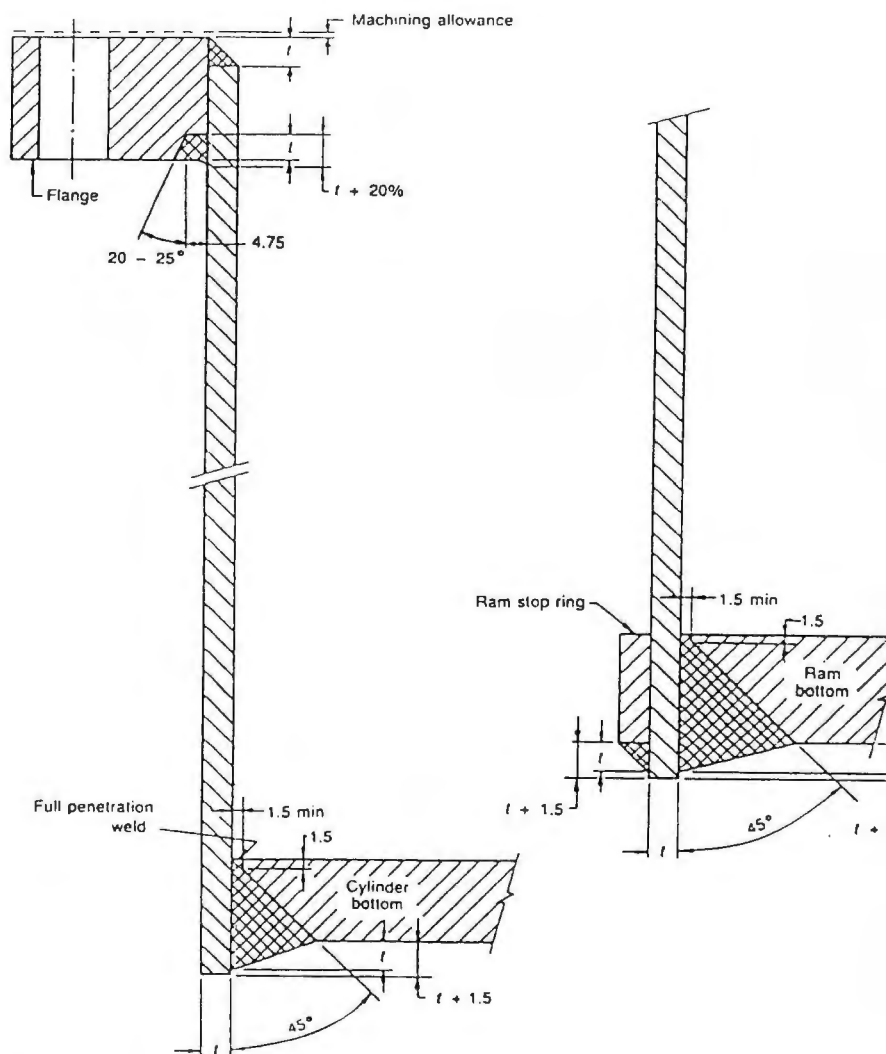
## 34.2.3 Ram Design

34.2.3.1 General. Rams shall be designed and constructed in accordance with one of the formulae in Rules 34.2.3.2 and 34.2.3.3, provided however that in no case shall the wall thickness, after machining, be less than 4.75 mm.

The slenderness ratio ( $L/r$ ) of a ram shall not exceed a value of 300.

Rams shall not be subjected to bending stresses or eccentric loading. Eccentric loading shall be taken by the car frame and guide shoes.

An acceptable method of welding the ram bottom is shown in Fig. 34.2.3.1.



NOTE: All welds continuous.

Dimensions are in mm.

FIG 34.2.3.1  
CYLINDER AND RAM WELDING DETAILS

34.2.3.2 Strength of solid or hollow rams. The strength of solid or hollow rams shall be determined by the following formulae, as appropriate:

- (a) Where slenderness ratio of ram is 120 or less -

$$\frac{W}{A} = 9.56 - 0.00034 (L/r)^2$$

- (b) Where slenderness ratio of ram is greater than 120 -

$$\frac{W}{A} = \frac{66800}{(L/r)^2}$$

where

- W = allowable gross mass to be sustained by ram, in kilograms. Where a counterweight is provided, the mass of the counterweight plus the unbalanced mass of the counterweight ropes may be deducted in determining W. In determining W, one-half of the mass of the ram shall be included provided that where a ram-follower guide is used three-quarters of the ram mass shall be included.
- A = net cross-sectional area of ram material (area of metal) allowing for any reduction of section of joints, in square millimetres
- L = maximum free length of ram, in millimetres. Where a ram-follower guide is used, L shall be taken as one-half the amount that the free length would be if no follower guide was provided.
- r = Radius of gyration of ram section, in millimetres.
- $\frac{W}{A}$  =  $\frac{1}{g}$  times maximum allowable fibre stress in MPa.

34.2.3.3 Hollow Rams Subjected to External Pressure. Hollow rams subjected to external pressure shall be designed so that the working pressure will be not more than that determined by the following formulae, as appropriate:

- (a) Where the ratio  $t/d$  is 0.023 or less -

$$p = 2.3 \left[ 1 - \sqrt{1 - 1600 (t/d)^2} \right]$$

- (b) Where the ratio  $t/d$  is greater than 0.023-

$$p = 199.2(t/d) - 3.2$$

where

- $p$  = working pressure, in MPa  
 $t$  = finished wall thickness, in millimetres  
 $d$  = external finished diameter, in millimetres.

**34.2.3.4 Telescoping Rams.** Telescoping rams shall have each ram section internally guided. If more than two movable sections are used, ram-follower guides shall be provided for each ram section. In the formulae in Rule 34.2.3.2(a) and 34.2.3.2(b) the valves of  $A$  and  $r$  shall be for the smallest ram section. When ram-follower guides are used the valve of  $L$  shall be the maximum free length of the smallest ram section in millimetres. Where ram-follower guides are not used, the valve of  $L$  shall be taken as 1.4. times the maximum free length of the smallest ram section.

**34.2.4 Ram Connection.** Any direct-acting ram shall be attached to the car frame with a connecting coupling of sufficient strength to support the mass of the ram with a factor of safety of not less than 4.

**34.2.5 Ram Joints.** Rams composed of more than one section shall have the joints designed and constructed to -

- (a) carry in tension the mass of all ram sections below the joint; and
- (b) transmit in compression the gross load on the ram with a factor of safety of not less than 5 based on tensile strength.
- (c) withstand without damage any forces resulting from a ram stop as described in Rule 34.2.6.

**34.2.6 Ram Stops.** Rams shall be provided with solid metal stops with or without cushions and/or other means to prevent the ram from travelling beyond the limits of the cylinder. Stops shall be designed and constructed so as to ensure that the ram is retarded and stopped, or stopped from maximum speed in the up direction under maximum operating pressure, without damage to the connection to the driving machine, ram, ram connection, couplings, ram joints, cylinder, cylinder connecting couplings or any other parts of the hydraulic system.

For rated speeds exceeding 0.5 m/s, in addition to the normal limit switch either a hydraulically cushioned stop or a top overtravel limit switch (see Rule 60.2) shall be provided. This device shall be arranged so as to retard the lift to 0.5 m/s, with a retardation not greater than gravity, before striking the stop.

**34.2.7 Ram Ends Subject to Fluid Pressure.** Rams ends subjected to fluid pressure shall comply with the requirements of Rule 34.3.4.

### 34.3 Cylinders

**34.3.1 Materials.** Cylinders shall be of steel or other approved ductile metal.

34.3.2 Cylinder Design. Cylinders shall be designed and constructed in accordance with the following formula, with a minimum wall thickness of 4.75 mm:

$$t = \frac{Pd}{2S}$$

where

t = minimum thickness of wall, in millimetres

P = working pressure, in MPa

d = internal diameter, in millimetres

S = design stress, in MPa (83 MPa maximum for low carbon steel or 0.4 times the yield strength for other metals).

NOTE: An acceptable method of welding the cylinder head and bottom is shown in Figure 34.2.3.1.

34.3.3 Clearance at Bottom of Cylinder. Clearance shall be provided at the bottom of the cylinder so that the bottom of the ram will not strike the bottom of the cylinder when the car is resting on its fully compressed buffer.

#### 34.3.4 Cylinder and Ram Ends

34.3.4.1 General. Ends of cylinders and ends of rams subjected to fluid pressure shall be of integral or welded construction.

The thickness of ends shall be not less than 4.75 mm.

34.3.4.2 Thickness of cylinder and ram ends. The thickness of the cylinder and ram ends shall be determined by the following formulae, as appropriate:

(a) Flat unreinforced ends

$$t = d \sqrt{\frac{P}{4S}}$$

(b) Dished seamless ends concave to pressure

$$t = \frac{5Pr}{6S}$$

where

$t$  = minimum thickness of end, in millimetres.

$d$  = diameter of end between supporting edges, in millimetres.

$P$  = working pressure in MPa.

$S$  = design stress in MPa (83 MPa maximum for low carbon steel or 0.4 times the yield strength for other metals).

$r$  = radius to which end is dished, measured on concave side, but not greater than  $d$ , in millimetres.

34.3.4.3 Dished seamless ends convex to pressure. Dished seamless ends, convex to pressure, shall have a maximum allowable working pressure of not more than 60 percent of that for ends of the same dimension with pressure on the concave sides.

34.3.4.4 Reinforced ends. Reinforced ends shall be designed and constructed so that the maximum stress at rated capacity will not exceed 83 MPa for low carbon steel or 0.4 times the yield strength of the material for other metals.

34.3.4.5 Ends subjected to mechanical loads in addition to fluid pressure loads. Pressure ends subjected to mechanical load in addition to fluid pressure loads shall be designed and constructed so that the combined stresses will not exceed the limits specified in Rules 34.3.4.2 to 34.3.4.4.

34.3.5 Collection of Oil Leakage. Means shall be provided to collect any oil leakage as close to the gland as possible for convenient disposal. The amount collected before removal shall not exceed 2 gal. (0.009m<sup>3</sup>).

34.3.6 Bleeding-off Air or Gas. Cylinders shall be provided with means for bleeding-off air or gas.

34.3.7 Cylinder Protection. Where a cylinder or part thereof is below the ground level, it shall be enclosed in a waterproof caisson of asbestos cement, concrete, cast iron, steel or other approved material. Asbestos cement, concrete, cast iron and steel pipes shall comply with approved standards (see Section 4).

The minimum wall thickness for various sizes of pipe shall be as given in Table 34.3.

The caisson shall extend to at least 150 mm above the floor of the liftwell and the space between the caisson and cylinder shall be provided with a detachable cover or covers to facilitate inspection.

Adequate provisions shall be made to restrain the caisson from floating upwards. The lower end shall be capable of withstanding the hydrostatic pressures that can prevail.

The outer surfaces of the cylinder and any metal caisson shall be protected by an approved protective coating or wrapping.

For inspection purposes, the mean space between the cylinder and caisson shall be not less than 75 mm, i.e. the bore of the caisson shall exceed the outside diameter of any part of the cylinder by a minimum of 150 mm. The cylinder should be concentric with the caisson but any part of the cylinder and cylinder assembly shall be clear of the caisson by at least 25 mm. The space between the cylinder and caisson shall be left unfilled.

**TABLE 34.3**  
**MINIMUM WALL THICKNESSES FOR CAISSONS**

millimetres

Nominal inside diameter	Minimum wall thickness			
	Material			
	Asbestos cement	Concrete	Cast iron	Steel
200	12.0	-	9.0	6.3
225	12.7	25.0	-	-
250	13.2	-	10.0	6.3
300	14.5	28.0	11.0	6.3
350	-	-	11.5	6.3
375	16.0	31.0	-	-
400	-	-	12.5	6.3
450	17.5	34.0	13.0	6.3
500	-	-	14.0	6.3
525	19.1	37.0	-	-
600	20.3	40.0	15.0	6.3
675	-	-	-	10.0
700	-	-	-	10.0
750	-	46.0	-	10.0
900	-	52.0	-	10.0
1000	-	-	-	12.5
1050	-	58.0	-	-
1200	-	64.0	-	12.5

34.3.8 Cylinder supports. Cylinder shall be supported and maintained in place to effectively prevent any part from becoming loose or displaced under conditions imposed in service including earthquake. (See Rules 2.2 and 31.6).

The support and foundation shall comply with the appropriate design code or codes listed in Rule 6.2.3.



## SECTION 35 - HYDRAULIC LINES

### 35.1 General

35.1.1 Permitted Types. Hydraulic lines shall be either rigid metallic pipes, or flexible hydraulic hoses, or a combination of both.

35.1.2 Length. The length of hydraulic lines shall be as short as possible and the number of joints and fittings shall be kept to the reasonably practicable minimum.

Joints shall not be used in hoses to achieve the required length.

35.1.3 Supports. Hydraulic lines shall be supported to eliminate undue stresses in pipes, joints and fittings, particularly at any section subject to vibration (see also Rule 35.3.5). Piping supports to restrain transverse motion shall be provided near changes in direction and particularly near valves and joints and shall comply with the requirements of Rule 6.4.

35.1.4 Joints and Connections. Joints and connections of hydraulic lines external to the power unit shall be welded flange fittings welded in accordance with the relevant Part of AS CB15 or flared screwed connections complying with SAE J516 JUN84. However, where the pressure in a hydraulic line does not exceed 3.5 MPa, taper-to-taper screwed connections complying with AS 1722, Part 1, or ANSI B1.20.1, or other approved connections may be used.

35.1.5 Sound-isolating Joints. Approved sound-isolating joints may be used in the pressure pipe, provided that failure of the resilient sealing element shall not permit separation of the connected parts. Such joints, where used, shall be factory made and fitted requiring only assembly in the field.

### 35.2 Rigid Lines

35.2.1 Material. All hydraulic pipes, fittings and flanges shall be of steel and shall comply with an approved standard specification suitable for the use of pressurised oil lines in hydraulic lift installations, such as AS 1074, AS 1835, or AS 1836 for pipes; AS 1074, BS 1640, or BS 1740 for fittings.

35.2.2 Wall thickness. The wall thickness of steel piping shall be not less than that determined by the following formula:

$$t = \frac{PD}{2S + C}$$

where

D = outside diameter of pipe, in millimetres

t = minimum wall thickness, in millimetres

P = working pressure, in MPa.

C = for threaded pipe up to 9.5 mm .... 1.25

= for threaded pipe over 9.5 mm .... depth of thread, in millimetres

= for grooved pipe .... depth of groove, in millimetres

= for other pipe of unreduced thickness .... zero

S = allowable stress (i.e. 0.4 times the yield strength), in MPa.

35.2.3 Plain end metallic non-ferrous piping or tubing. Plain end metallic non-ferrous piping or tubing shall have a wall thickness not less than that determined by the formula in Rule 35.2.2 using  $C = \text{zero}$ .

### 35.3 Hoses

35.3.1 Material. Hoses shall be of double braided wire construction complying with approved standards such as Class 100 R2 Type A hose conforming to AS B226; SAE J517 100R2; BS 4586; BS 3832. The minimum burst pressure for the relevant hose shall be at least 10 times the maximum working pressure in the hose.

35.3.2 Hose Fittings. Hose fittings shall be factory fitted and of a non-reusable (swaged) type.

35.3.3 Location. Hose assemblies shall be visible and able to be inspected.

The locations of hoses and connections shall permit replacement of the hoses and the connections.

Flexible connections shall not be installed between the cylinder and flow-restriction valve required by Rule 36.5

35.3.4 Supports. Hoses shall be supported to prevent undue stress on the hose and its fittings. Distances between centres of adjacent supports shall not exceed 3000mm vertically or 1000mm horizontally.

Because of possible flexing of hoses during lift operation, they may require additional fixings to maintain the required car running clearances.

Loops and bends shall be adequately supported or guarded where they could be stood upon.

During construction, horizontal runs of flexible hose in the liftwell shall be covered to prevent damage caused by falling objects.

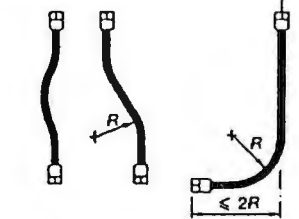
35.3.5 Installation. Hydraulic hoses shall be installed in accordance with recommended practice, examples of which are illustrated in Fig. 35.3.5(A). Incorrect practices, examples of which are illustrated in Fig. 35.3.5(B), shall not be used.

The radii of bends in hoses shall be not less than those recommended by the manufacturer nor less than the relevant minimum inside radius specified in Table 35.3.5.

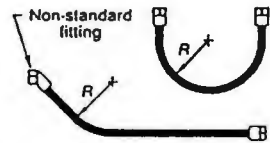
Long lengths of hose shall be supported before and after the bends to reduce strain on the hose and its fittings.

TABLE 35.3.5  
MINIMUM INSIDE RADIUS OF BENDS

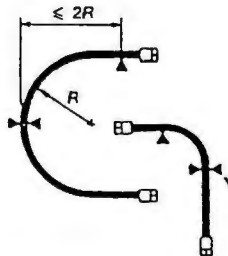
Hose size, BSP pipe thread inch	Minimum inside radius of bend mm
1 1/4	420
1 1/2	500
2	630



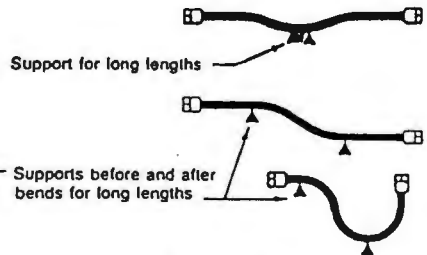
(a) Vertical unsupported applications



(b) Horizontal unsupported applications



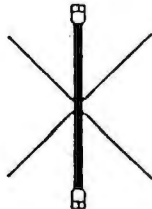
(c) Vertical supported applications



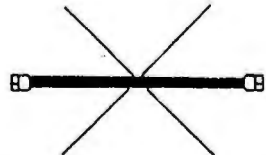
(d) Horizontal supported applications

NOTE: For minimum values of  $R$ , see Table 35.3.5.

Fig. 35.3.5(A). RECOMMENDED PRACTICES FOR POSITIONING HYDRAULIC HOSES



(a) Prohibited vertical applications



(b) Prohibited horizontal applications.

Fig. 35.3.5(B). PROHIBITED PRACTICES FOR POSITIONING HYDRAULIC HOSES

## SECTION 36 - VALVES

## 36.1 Working Pressures

Valves shall not be subjected to working pressures exceeding those recommended by the manufacturer for the type of service for which they are used.

The working pressure shall be legibly and permanently marked on the marking plate mounted on the power unit assembly.

## 36.2 Pump Relief Valve

36.2.1 Provision. Each pump or group of pumps shall be equipped with a relief valve.

36.2.2 Type and Location. The relief valve shall be located between the pump and the check valve, and shall be of such a type and so installed in a by-pass connection that the valve cannot be shut off from the hydraulic system.

36.2.3 Setting. The relief valve shall be pre-set to open at a pressure not greater than 125 percent of the design working pressure of the pump.

36.2.4 Size. The size of the relief valve and by-pass shall be sufficient to pass the maximum rated capacity of the pump without raising the pressure more than 20 percent above that at which the valve opens. More than one relief valve may be used to obtain the required capacity.

36.2.5 Sealing. Relief valves having exposed pressure adjustments shall have their means of adjustment sealed after setting to the correct pressure.

**NOTE:** No relief valve is required for centrifugal pumps driven by induction motors provided that the shut-off or maximum pressure which the pump can develop is not greater than 135 percent of the design working pressure at the pump.

## 36.3 Check Valve

A check valve shall be provided, and shall be installed so that it will hold the lift with rated load at any point when the pump stops or the maintained pressure drops below the minimum operating pressure.

## 36.4 Door Lock Valve

A door lock valve shall be provided in the machine room of every electrohydraulic lift and interposed between the cylinder and the lowering valve. The door lock valve shall:

- (a) be solenoid-operated and arranged so as to close and prevent down travel of the lift for so long as any landing door contact is open with the car away from the levelling zone; and
- (b) be of a cushion-closing type and allow fluid flow to move the lift car in the up direction while the valve coil is de-energised.

### 36.5 Flow Restriction Valve

A flow restriction valve shall be provided for every direct-acting electrohydraulic lift and shall comply with the following requirements:

- (a) The valve shall not be electrically operated.
- (b) The valve shall be installed in the pressure-line as close as practicable to the cylinder.
- (c) In the event of pressure-line failure, the valve shall operate to restrict the full-load down speed to not more than 0.05 m/s.
- (d) The valve shall be set to operate at a lift speed not exceeding 30 percent above the normal full-load down speed of the lift.
- (e) Where the rated speed exceeds 0.5 m/s the valve shall be of a cushion-closing type.
- (f) The valve shall be tested as follows:
  - (i) An overspeed test, simulating a broken line condition or loss of pressure, shall be carried out on site to demonstrate its effective operation.
  - (ii) Where the pipe or valve capacity limits the ability to overspeed the lift, factory certified test certificates detailing the flow required to actuate the valve shall be provided by the manufacturer.
  - (iii) Where external adjustment to the valve is provided, the overspeed test on site shall be performed.

### 36.6 Manual Lowering

Means shall be provided within the machine room to lower the lift in an emergency, under manual control, with a lowering speed not exceeding 0.2 m/s.

**SECTION 37 - TANKS****37.1 Material**

Atmospheric storage and discharge tanks shall be of metal.

**37.2 Capacity**

Tanks shall be of sufficient capacity to provide for a liquid reserve adequate to prevent the entrance of air or other gas into the system.

**37.3 Means for Checking Liquid Level**

Tanks shall be provided with means for checking the liquid level. Such means shall be accessible without the removal of any cover or other part. A dipstick is permissible.

The permissible minimum liquid level with the car at the highest landing served shall be permanently marked with the words -

LOWEST PERMISSIBLE LEVEL - CAR AT HIGHEST LANDING.

If a dipstick is used it shall be marked with a line worded MIN. and the above notice shall be affixed to the tank adjacent to the dipstick.

If external glass gauges are used they shall be suitably protected.

**37.4 Covers and Venting**

Tanks shall be covered and suitably vented to atmosphere.

**37.5 Factor of Safety**

Tanks shall be designed and constructed so that when they are completely filled the factor of safety will be at least 4 based on the tensile strength of the material.

**37.6 Fittings and Protection**

Tanks and feed pipe connections shall be of fluid-tight construction.

The system shall incorporate a continuous full flow removable oil filter.

Means for draining the tank shall be provided.

All sides of the tank shall be fully visible for examination and protected by a substance unaffected by the working fluid. Where a tank has one or two sides adjacent to walls, there must be a minimum clearance of 100 mm to the wall.

Means shall be provided to prevent the tank from being overturned or displaced. Such means shall comply with Rule 6.4.

**SECTION 38 - DIRECT-ACTING ELECTROHYDRAULIC LIFTS -  
CLEARANCES FOR CARS AND COUNTERWEIGHTS**

**38.1 Clearance at Bottom of Car**

**38.1.1 General.** For direct-acting electrohydraulic lifts, when the car rests on the stop or fully compressed buffer, there shall be vertical clearances at the bottom of the car which comply with Rules 38.1.2 and 38.1.3.

**38.1.2 Mechanical Clearance.** The mechanical clearance shall be not less than 50 mm between any fitting attached to the car and the floor of the pit.

**38.1.3.1 Man Clearance.** The man clearance shall be not less than 600 mm between the pit floor and the lowest mechanical part, equipment or device installed beneath the car platform. This clearance shall be maintained over the whole car area except for:

- (a) guide shoes or rollers;
- (b) platform aprons, guards or other equipment located within 300 mm measured horizontally from the sill line of any lowest floor entrance;
- (c) floor selector tape or rope sheaves; and
- (d) hydraulic lines and fittings;
- (e) buffer members for cantilevered lifts.

**38.1.3.2** Provided that in all cases, including small cars, the following requirements are complied with:

- (a) A minimum space for man clearance shall be provided adjacent to the underbeam of the car. Such space shall be not less than 1370 mm long by 450 mm wide by 600 mm high; provided however that if the length of 1370 mm is not available the space shall be not less than 600 mm long by 450 mm wide by 1200 mm high. Where the attachment of travelling cables unavoidably occurs in this man clearance space, the height shall be measured from the lowest part of the cable support.
- (b) The pressure pipe and fittings shall have a clearance of not less than 450 mm in all directions from its axis to the under side of the car platform or equipment installed beneath the car platform and not less than 300 mm from the buffer striker plate and underbeams, excluding the area immediately adjacent to the cylinder.
- (c) There shall be a vertical clearance of 300 mm between the car underbeam and any cylinder support or buffer-beam.

**38.2 Car Buffer Clearance**

When the car floor is level with the bottom landing, the car buffer clearance shall be as follows:

- (a) Not more than 230 mm, but such clearance may be increased up to a maximum of 600 mm, provided that the lowest landing door, or doors, are self-closing, in accordance with the requirements of Rule 43.
- (b) Not less than 75 mm for rated speeds of 0.5 m/s or less.
- (c) Not less than 150 mm for rated speeds exceeding 0.5 m/s.

### 38.3 Top Overtravel

The travel of the car above the top landing before the ram engages its stop shall be not greater than 600 mm for any rated speed and not less than the distance given in Table 38.3.

**TABLE 38.3**  
**MINIMUM TOP OVERTRAVEL**

Rated Speed m/s	Minimum overtravel, mm	
	Without hydraulic cushioning	With hydraulic cushioning
$\leq 0.25$	150	100
$> 0.25 \leq 0.5$	225	150
$> 0.5 \leq 0.75$	300	225
$> 0.75 \leq 1.0$	450	300

### 38.4 Clearances Above Car (with Ram Fully Extended Against its Stop)

The vertical clearances from overhead obstructions, with the ram fully extended against its stop, shall be not less than the following:

- (a) 150 mm to guide shoes.
- (b) 230 mm for rated speeds not greater than 0.25 m/s and 300 mm for rated speeds greater than 0.25 m/s, to equipment other than guide shoes which is not more than 300 mm inside the perimeter of the car roof.
- (c) Where the crosshead does not encroach over the car by more than 75 mm, 380 mm to the crosshead.
- (d) Where the crosshead spans the car or encroaches over the car by more than 75 mm, 760 mm to the crosshead. Where any beam or projection from the ceiling is within 450 mm measured horizontally from the crosshead, a vertical clearance of 760 mm shall be provided between the underside of such beam and the upper plane of the crosshead.
- (e) 900 mm to the car roof.
- (f) 450 mm to all other equipment.



### 38.5 Clearance at Top of Flying Counterweight

Where a flying counterweight is provided, the clearance in millimetres at the top of the flying counterweight when the car floor is level with the bottom terminal landing shall be not less than that determined by the following formula:

$$f = h + i + 150$$

where

$f$  = distance from the highest point of the flying counterweight, e.g. the frame, guide shoes or flying counterweight sheave, to the nearest obstruction directly above it when the car is level with the bottom terminal landing, in millimetres.

$h$  = car buffer clearance, in millimetres.

$i$  = stroke of car oil or spring buffer, where provided, in millimetres.

### 38.6 Clearance at Bottom of Flying Counterweight

Where a flying counterweight is provided, such counterweight shall not land on an emergency block when the car ram is fully extended. The clearance to be maintained between the flying counterweight and the emergency block shall be not less than the sum of the following:

- (a) The distance the car can travel above the top landing until the ram engages its mechanical stop.
- (b) 150 mm.
- (c) For lifts with newly installed ropes, an allowance for rope stretch (in millimetres) of 6.5 times the length of suspension rope in metres measured between terminations.

**SECTION 39 - SUSPENDED ELECTROHYDRAULIC LIFTS -  
CLEARANCES FOR CARS AND COUNTERWEIGHTS**

**39.1 Clearance at Bottom of Car**

**39.1.1 General.** For suspended electrohydraulic lifts, when the car rests on the stop or fully compressed buffer, there shall be vertical clearances at the bottom of the car which comply with Rules 39.1.2 and 39.1.3.

**39.1.2 Mechanical Clearance.** The mechanical clearance shall be not less than 50 mm between any fitting attached to the car and the floor of the pit.

**39.1.3 Man Clearance.** The man clearance shall be not less than 600 mm between the pit floor and the lowest mechanical part, equipment or device installed beneath the car platform. This clearance shall be maintained over the whole car area except for -

- (a) guide shoes or rollers and safety gear components;
- (b) platform aprons, guards or other equipment located within 300 mm measured horizontally from the sill line of any lowest floor entrance; and
- (c) at compensation or tape sheaves.

A minimum space for man clearance shall be provided adjacent to the underbeam of the car. Such space shall be not less than 1370 mm long by 450 mm wide by 600 mm high; provided however that if the length of 1370 mm is not available the space shall be not less than 600 mm long by 450 mm wide by 1200 mm high. Where the attachment of travelling cables unavoidably occurs in this man clearance space the height shall be measured from the lowest part of the cable support.

**39.2 Car Buffer Clearance**

The car buffer clearance shall be as follows:

- (a) For oil buffers, not less than 230 mm nor more than 600 mm.
- (b) For spring buffers, not less than 300 mm nor more than 600 mm.

**39.3 Compressed Ram Clearance**

When the car is resting on its bottom stop or fully compressed buffer and with newly installed unstretched suspension ropes, the ram shall have available a further travel of not less than 75 mm before it is fully retracted.

### 39.4 Clearance of Car at Top Landing

39.4.1 Top Car Mechanical Clearance. The clearance between any equipment mounted on top of the car and the nearest obstruction overhead, measured vertically, shall be not less than that determined by the following formula:

$$C = X + R + Y + K$$

where

C = mechanical clearance when the car platform is level with the top landing, in millimetres

X = allowance for ram overtravel

$$= O \times M$$

O = available overtravel of ram to its stop when the car is at the top landing, in millimetres

M = 1 for 1:1 roping, and  
= 2 for 1:2 roping, etc

R = rope stretch, in millimetres  
= 6.5 mm per metre of suspension rope measured between terminations

Y = 50 mm, to allow for car jump (equivalent to gravity stopping distance for 1 m/s)

K = 150 mm.

39.4.2 Top Car Man Clearance. The clearance measured vertically between the car roof and the nearest overhead obstruction within 500 mm horizontally to the nearest part of the bow members shall be not less than that determined by the following formula:

$$A = X + R + Y + L$$

where

A = top car clearance when the car platform is level with the top landing, in millimetres

300 X = allowance for ram overtravel, as given in Rule 39.4.1

13p R = rope stretch, in millimetres  
= 6.5 mm per metre of suspension rope measured between terminations

Y = 50 mm, to allow for car jump (equivalent to gravity stopping distance for 1 m/s)

L = 750 mm.

**39.5 Top Overtravel**

With newly installed unstretched suspension ropes (for any rated speed), the travel of the car above the top landing before the ram engages its stop shall be not greater than 900 mm and the minimum top overtravel values given in Table 38.3 shall be increased by a rope stretch allowance of a value equal to the factor R in Rule 39.4.1.

**39.6 Clearance at Top of Flying Counterweight**

The clearance at the top of a flying counterweight shall be in accordance with Rule 38.5.

**39.7 Clearance at Bottom of Flying Counterweight**

The clearance at the bottom of a flying counterweight shall be in accordance with Rule 38.6.

## SECTION 40 - CAR AND COUNTERWEIGHT BUFFERS

## 40.1 Car Buffers

Car buffers shall be provided and shall comply with the relevant requirements of Rules 10.2 to 10.6. The types of buffers provided shall be in accordance with Table 40.1(A) according to the full load down speed of the car. The strokes of such buffers shall be in accordance with Tables 40.1(B) and 40.1(C).

TABLE 40.1(A)  
TYPES OF STOPS AND BUFFERS FOR CARS

Full load down speed of car m/s	Minimum buffer requirement
$\leq 0.45$	Solid buffers or impact absorbing stops
$> 0.45 \leq 1.2$	Spring buffers or oil buffers
$> 1.2 \leq 1.4$	Oil buffers

TABLE 40.1(B)  
MINIMUM STROKE OF SPRING BUFFERS FOR CARS

Full load down speed of car m/s	Minimum stroke mm
$\leq 0.6$	38
$> 0.6 \leq 0.9$	63
$> 0.9 \leq 1.2$	100

TABLE 40.1(C)  
MINIMUM STROKE OF OIL BUFFERS FOR CARS

Full load down speed of car m/s	Minimum stroke mm
$\leq 1.3$	110
$> 1.3 \leq 1.4$	130

Car buffers shall be located so that the car will come to rest on the fully compressed buffer before the ram reaches its downward limit of travel.

## 40.2 Counterweight Buffers

Where counterweight buffers are provided, counterweight stops for suspended electrohydraulic lifts shall be integral with the machine, and shall be designed so as to prevent the ram leaving the cylinder under the erection test pressure conditions specified in Rule 31.7.

**40.3 Flying Counterweight Buffers**

Flying counterweights, where provided, shall not be fitted with buffers; however emergency blocks shall be provided at the pit floor to ensure that a vertical clearance of not less than 50 mm will be maintained between any fitting attached to the counterweight and floor of the pit, in the event of excessive stretch of the counterweight ropes. (See Rule 38.6 for clearance at bottom of flying counterweight).

**SECTION 41 - PITS****41.1 General Requirements**

Pits shall be provided in accordance with the requirements of Rules 11.1 to 11.10. In addition, the requirements of Rule 41.2 shall be complied with.

**41.2 Pits not Extending to Lowest Floor of Building**

Where the space below the liftwell is used for a passageway or is occupied by persons or, if unoccupied, is not secured against unauthorised access, the following requirements shall be complied with:

- (a) The cylinder and car buffer shall be supported by a structure, or structures, of sufficient strength to support the entire load that may be imposed upon it.
- (b) The car buffer shall be capable of fully absorbing the impact of the fully loaded car descending at 125 percent of the full load down speed or, for a rope-suspended lift, at governor tripping speed where a governor-operated safety gear is used.
- (c) The car buffer supports shall be of sufficient strength to withstand, without permanent deformation, the impact resulting from the conditions under paragraph (b) above.
- (d) Where a flying counterweight is provided, the pit shall be arranged so that the counterweight will land on solid earth or an abutment which extends down to solid earth.
- (e) For rope-suspended electrohydraulic lifts with downward-acting rams, such rams shall be positioned so that the ram head, sheaves or counterweight lands on solid earth or an abutment thereto at a distance of not less than 75 mm nor more than 150 mm beyond the permanent stop, and in no case shall the ram leave the gland assembly.

#### SECTION 42 - LIFTWELL ENCLOSURES

Liftwell enclosures shall comply with the requirements of Section 12.

#### SECTION 43 - LANDING DOORS

Liftwell landing entrances shall be provided with landing doors which shall comply with Rules 13.1 to 13.8.

#### SECTION 44 - LOCKING OF LANDING DOORS

##### 44.1 General Requirements

Locking of landing doors shall comply with the requirements of Section 14.

##### 44.2 Door Locks

Door locks shall comply with the requirements of Section 14.

#### SECTION 45 - CLEARANCES IN LIFTWELLS AND ENCLOSURES

Clearances in liftwells and enclosures shall comply with the requirements of Section 15.

#### SECTION 46 - PIPING ETC. IN MACHINE ROOMS OR LIFTWELLS

Refer to the requirements of Rules 7.2 and 12.5.

#### SECTION 47 - SUSPENSION ROPES

Suspension ropes shall comply with the requirements of Section 16 however, for suspended electrohydraulic lifts or flying counterweights, a minimum of two ropes shall be used. The wire rope data plate specified in Rule 16.6 shall be permanently fixed, adjacent to the hitch point, to the crosshead or the flying counterweight or the machine.

#### SECTION 48 - ROPE ATTACHMENTS AND FITTINGS

Rope attachments and fittings shall comply with the relevant requirements of Section 17.

#### SECTION 49 - SHEAVES AND PULLEYS

Sheaves and pulleys shall comply with the relevant requirements of Section 18.



**SECTION 50 - COUNTERWEIGHTS AND FLYING COUNTERWEIGHTS****50.1 General Requirements**

**50.1.1 Compliance with Section 19.** Counterweights and flying counterweights shall comply with the requirements of Section 19.

**50.1.2 Pit Guards.** The path of travel of the counterweight in the pit of the liftwell shall be screened to a height of 1800 mm, measured from the pit floor or auxiliary pit floor, and the lower edge of the screen shall be substantially level with the bottom of the counterweight, when the car is at its uppermost point of overtravel.

In no case shall the lower edge of the screen be more than 600 mm from the pit floor.

**50.1.3 Flying Counterweight Overtravel Limit Switch.** A flying counterweight overtravel limit switch shall be provided and positioned so that if any flying counterweight approaches within 150 mm of the bottom emergency blocks, the switch will open the main control circuit and prevent further movement of the lift in either direction.

**50.2 Mass of Flying Counterweight**

The mass of a flying counterweight for a direct-acting or suspended electrohydraulic lift shall not exceed either of the following:

- (a) A value that ensures reliable descent of the empty car under normal operation and also, for direct-acting lifts, in the event of the ram becoming detached from the car.
- (b) 50 percent of the combined value of the mass of the car and the rated load and also, for direct-acting lifts, 50 percent of the mass of the ram.

**SECTION 51 - GUIDES FOR LIFT CARS AND COUNTERWEIGHTS**

Guides for lift cars and counterweights shall comply with the requirements of Section 20.

Upper and lower position restraints attached to the car frame shall be provided. The distance between the upper and lower position restraints shall be not less than the height of the car frame. (See Figure 20.16 of Section 20 for details of restraining plates).

**SECTION 52 - RATED CAR CAPACITY**

The rated loading capacity for passenger and/or goods lifts shall comply with Section 21.

**SECTION 53 - CAR CONSTRUCTION****53.1 General Requirements**

The construction of lift cars shall comply with relevant requirements of Section 22, except that for direct-acting lifts Rules 22.1, 22.10.2(a) and (c) do not apply and in lieu of which the requirements of Rule 53.2 shall apply.

**53.2 Car Frames for Direct-Acting Lifts**

Every direct-acting lift shall have a car frame consisting of a bow, sling and buffer members or their equivalent for Cantilevered Cars. Stresses and deflections in the car frame and platform members shall be determined by the formulae listed in Section 65.

**SECTION 54 - CAR DOORS**

Car doors shall comply with the requirements of Section 13.

**SECTION 55 - POWER OPERATION OF CAR AND LANDING DOORS**

Power operation of car and landing doors shall comply with the requirements of Section 23.

**SECTION 56 - ELECTRICAL INSTALLATION**

Electrical installation shall comply with the requirements of Section 24. In addition, the circuit-breaker or isolator specified in Rule 24.21 therein shall be provided with a notice on, or adjacent to it, bearing the following words:

THIS SWITCH SUPPLIES A LIFT.

**SECTION 57 - EARTHING**

~~Earthing of main current devices, control current devices, ball transformers, electrical apparatus installed on lift cars shall comply with the requirements of Rules 24.13 to 24.17.~~

**SECTION 58 - PRECAUTIONS IN WIRING**

The precautions to be taken in the general wiring of a lift installation shall be in accordance with Section 24.

**SECTION 59 - OPERATING DEVICES AND CONTROL EQUIPMENT**

Operating devices and control equipment shall comply with the requirements of Section 25.

**NOTE:** Where a manual inching device is provided, this is to be supplementary to the anti-creep levelling device required by Rule 61.4.

**SECTION 60 - ELECTRICAL PROTECTIVE DEVICES****60.1 General Requirements**

Electrical protective devices shall comply with the relevant part of Section 26.

**60.2 Top Overtravel Limit Switch**

A top overtravel limit switch complying with Rule 61.3 shall be provided, where the rated speed exceeds 0.5 m/s and a hydraulically cushioned stop is not provided (see Rule 34.2.6).

**60.3 Anti-Creep Levelling Device**

An anti-creep levelling device complying with Rule 61.4 shall be provided for every electrohydraulic lift.

**60.4 Normal Limit Switches**

Normal limit switches shall be provided for every electrohydraulic lift in accordance with Rule 61.2.

**60.5 Door Lock Valve**

A door lock valve and test switches shall be provided for every electrohydraulic lift in accordance with Rule 36.4.

**60.6 Flying Counterweight Overtravel Limit Switch**

A flying counterweight overtravel limit switch shall be provided for every flying counterweight in accordance with Rule 50.1.3.

**SECTION 61 - TERMINAL STOPPING DEVICES****61.1 General Requirements**

Normal and overtravel limit switches shall comply with Rule 27.1.

**61.2 Normal Limit Switches (Slowing Down and Stopping)**

61.2.1 General. Upper and lower normal limit switches shall be provided and arranged to slow down and stop the lift automatically, at or near the top and bottom landings, with any load up to and including rated load in the lift and from any speed attained in normal operation. Such switches shall function independently of the operation of the operating device and of the top overtravel limit switch. The switch shall be designed and installed so that it will continue to function until the ram is fully extended against its stop, or the car is resting on the fully compressed buffer.

61.2.2 Location. Normal limit switches for electrohydraulic lifts shall be operated by the movement of the lift and located -

- (a) on the lift car; or
- (b) in the liftwell; or
- (c) in the machine room.

61.2.3 Switches in Machine Rooms. Normal limit switches located in a machine room shall comply with the following requirements:

- (a) The switch contacts shall be mounted on and operated by a device mechanically connected to and driven by the lift. Devices depending on friction or traction shall not be used.
- (b) Tapes, chains, ropes or similar devices, mechanically connecting a normal limit switch device to the lift and used as a driving means, shall be provided with a broken tape switch complying with Rule 26.1.6 which will open the control circuit and stop the lift machine if such driving means fails.

NOTE: A floor controller or selector may be used as a normal limit switch if its contacts and the means for operating them comply with the relevant requirements of Rules 61.1 and 61.2.

**61.3 Top Overtravel Limit Switches**

61.3.1 Operation. Top overtravel limit switches, where required under Rule 60.2 shall comply with the following:

- (a) Be located in the liftwell.
- (b) Be operated by a metal cam on the car.
- (c) Comply with Rule 61.1.

- (d) Not control the same controller switches or contactors as the normal limit switches unless two or more separate and independent controller switches or contactors are provided, two of which shall be closed to complete the circuit of the pump motor and of the upvalve solenoid where such is used. The control circuit shall be designed and installed so that a single earth fault or short-circuit may prevent either one but not both the normal stopping limits and top overtravel limit switch circuits from stopping the pump motor.

61.3.2 Setting. The setting of top overtravel limit switches shall be such that the following requirements will be complied with:

- (a) The switch shall not function with the normal operation of the lift.
- (b) The switch shall open before the lift car has travelled beyond the top landing, by a distance not exceeding one-third of the available top overtravel provided in Rule 38.3.
- (c) The switch shall be designed and installed so that it will remain opened when the ram is fully extended against its stop.
- (d) Where top overtravel limit switches are provided with adjustable mountings, they shall be pinned in position after final adjustment of position has been made.

#### 61.4 Anti-Creep Levelling Device

Every electrohydraulic lift shall be provided with an anti-creep levelling device complying with the following requirements:

- (a) It shall prevent the car from sinking more than 150 mm below the landing, irrespective of whether the landing door is open or closed.
- (b) It shall comply with the relevant requirements of Rule 25.4.
- (c) Its operation may depend on the availability of electric power, and to this end the circuit-breaker or isolator shall be kept in the closed position at all times except during maintenance, repairs and inspection and during an emergency.
- (d) The electrical protective devices required in Section 60 shall not, as far as practicable, cause power to be removed from the anti-creep device, provided however that the following switches shall cause power to be removed from the anti-creep device:

- ~~(i) Emergency stop button or switch in car (if fitted).~~
- (ii) Stop switch on top of car.
- (iii) Pit stop switch.

#### 61.5 Flying Counterweight Bottom Overtravel Limit Switch

A flying counterweight bottom overtravel limit switch shall be provided in accordance with Rule 50.1.3.

## SECTION 62 - INDICATORS, ANNUNCIATORS, ALARMS, TELEPHONES, ETC

Indicators, annunciators, alarms, telephones, etc, shall comply with the requirements of Section 28.

## SECTION 63 - CAR AND COUNTERWEIGHT SAFETY GEAR

Car and counterweight safety gear shall comply with the relevant requirements of Section 29 provided that -

- (a) for electrohydraulic lifts under the conditions of Rule 41.2(b) Type A safety gear (see Rule 29.8.1) may be permitted on counterweights for rated speeds up to 1 m/s and arranged to operate on free fall; and
- (b) safety gear shall not be installed on the car of a direct-acting electrohydraulic lift.

## SECTION 64 - SPEED GOVERNORS

Speed governors shall comply with the relevant requirements of Section 30 provided that -

- (a) for safety gears on suspended cars and for Types B, C and D safety gears on roped counterweights, the speed values in column 1 of Table 30.2 shall refer to the full-load down speed of the car, and columns 2 and 3 shall apply as shown therein; and
- (b) for safety gears on counterweights where a governor is used, the governor shall be provided with a switch which shall open the control circuit before or at the time the governor grips the governor rope. The setting of the switch and of the speed of mechanical trip shall be such as will prevent operation of the switch or mechanical tripping (or striking of flyweights) when the fully loaded car is travelling downwards.

**SECTION 65 - CAR FRAME AND PLATFORM STRESSES AND DEFLECTIONS  
FOR DIRECT-ACTING ELECTROHYDRAULIC LIFTS**

**65.1 General**

The stresses and deflections in the car frame and platform members of direct-acting hydraulic lifts shall be based on the formulae in this section and evaluated for -

- (a) the operating condition;
- (b) the buffer engagement condition.

For assessing the stresses and deflections in the car frame and platform members of suspended electrohydraulic lifts the relevant sections of Part 2 of the Rules shall be applied.

For cars with car frame located off the platform centre-line by more than  $\frac{1}{8}$  of the distance from front to back of the platform or other special car frame and platform construction, the formulae and specified methods of calculation of loads and the resulting stresses and deflections shall be modified to suit the specific conditions and requirements in each case.

The conditions of loading shall be determined in accordance with the relevant requirements of Rules 22.10.1 and 22.10.2.

The maximum permissible stresses and deflections of car frame and platform members shall not exceed those permitted by Rules 22.10.3 and 22.10.4 unless otherwise specified in this section.

**65.2 Bow Members**

The stresses in the bow members shall be based on the dead load of the members and the total load if any, supported by the bow members.

The bow members and connection between the bow member and sling shall be designed to resist the bending moment, shear and axial forces transferred between the sling and the bow members.

**65.3 Buffer Members**

**65.3.1** Platform members supported directly by buffer members. The bending stresses in the buffer members shall be based on the maximum rated load uniformly distributed over the length of the buffer members and half the total weight of the car acting at each end of the buffer members.

**65.3.2** Platform members supported on isolators at or adjacent to the ends of the buffer member. The concentrated loads equal to  $\frac{1}{2}$  of the total maximum static load on the ram shall be applied at each end of the buffer members to determine the bending stresses in the buffer members.

#### 65.4 Platform Members

The bending stresses in the platform members shall be based on the rated load and the platform weight uniformly distributed along the length of the members for conditions of loadings as specified in Rule 22.10.1. For passenger and goods lifts, the stresses in the platform members shall also be determined for the condition specified in Rule 22.10.1(c).

#### 65.5 Sling Members

The stresses in each sling member due to bending and compression and the slenderness ratio of each sling member and its moment of inertia under the conditions of loading as specified in Rule 22.10.1 shall be determined in accordance with the following formulae.

##### 65.5.1 Bending Stresses

$$f_b = \frac{ML}{4HZ}$$

where

$f_b$  = the bending stress in each sling member about the axis normal to the plane of the car frame (MPa)

$M$  = turning moment due to one half of the rated load distributed over half the area of the total platform (N-mm)

$$M = \frac{WD}{8}$$

where

$W$  = rated load (N)

$D$  = inside width of car (mm)

$L$  = free length of sling member (distance from lowest fastening in bow member to top fastening in buffer member) (mm)

$H$  = vertical centre distance between guide shoes or rollers (mm)

$Z$  = section modulus of one sling member about the neutral axis normal to the plane of the car frame which is usually the weaker axis (mm<sup>3</sup>).

**65.5.2 Compressive Stresses.** The compressive stresses in the sling members shall be based on the weight supported on the bow members if any and also the dead loads of the bow member and sling members.

If side braces are used to fasten the sling members and the platform, the compressive loads in the sling member due to the platform loads coming up through the side braces shall be considered in addition to the above loadings

$f_a$  = compressive stress in each sling member.



65.5.3 Combination of stresses in the sling members. The maximum stresses in the sling members subject to bending and axial compression shall be so proportioned that the quantity  $[(f_a/P_a) + (f_b/P_b)]$  does not exceed unity.

where

$f_a$  = actual axial compressive stress (MPa)

$f_b$  = actual bending stress (MPa)

$P_a$  = permissible axial compressive stress [not exceeding  $117 - 0.0033 (L/R)^2$ ] (MPa)

$P_b$  = permissible bending stress as specified in Rule 22.10.3 (MPa)

$L$  = free length of sling member (mm)

$R$  = least radius of gyration of sling member (mm).

65.5.4 Slenderness Ratio. The slenderness ratio  $L/R$  for sling members subject to compressions other than those resulting from buffer engagement shall not exceed one hundred and twenty (120). Where no side-brace is fitted or the upper side - brace connections on the sling members are located at a point less than  $2/3$  of  $L$  from bottom, (top fastening in buffer member) a slenderness ratio of  $L/R$  not exceeding 160 shall be permissible.

65.5.5 Moment of Inertia. The moment of inertia of each sling member shall be not less than that derived by the following formula:

$$I = \frac{ML^3}{457EH}$$

where

$I$  = moment of inertia about the neutral axis normal to the plane of the car frame ( $\text{mm}^4$ )

$E$  = modulus of elasticity of the material used (MPa).

other symbols are as defined in Rule 65.5.1.

## 65.6 Buffer Engagement

The decelerating force [as specified in Rule 22.10.2(b)] resulting from buffer engagement shall be applied to determine the stresses in the bow, the sling and the buffer members.