



FEDERATION EUROPEENNE DE LA  
MANUTENTION

SECTION I

HEAVY LIFTING APPLIANCES

F.E.M.

1.001  
3<sup>rd</sup> EDITION  
REVISED  
1998.10.01

# **RULES FOR THE DESIGN OF HOISTING APPLIANCES**

**B O O K L E T 7**

**SAFETY RULES**

The total 3rd Edition revised comprises booklets 1 to 5 and 7 to 9  
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Document prepared by the technical commission of **FEM** (European Handling Federation) **Section I** « Heavy lifting and handling equipment ».

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The third edition of the "Rules for the design of hoisting appliances" dated 1987.10.01 included 8 booklets. An addition to this edition was compiled in 1998. This addition is incorporated in booklet 9, which also replaces booklet 6.

This booklet forms part of the "Rules for the design of hoisting appliances" 3rd edition revised, consisting of 8 booklets :

Booklet 1 - Object and scope

Booklet 2 - Classification and loading on structures and mechanisms

Booklet 3 - Calculating the stresses in structures

Booklet 4 - Checking for fatigue and choice of mechanism components

Booklet 5 - Electrical equipment

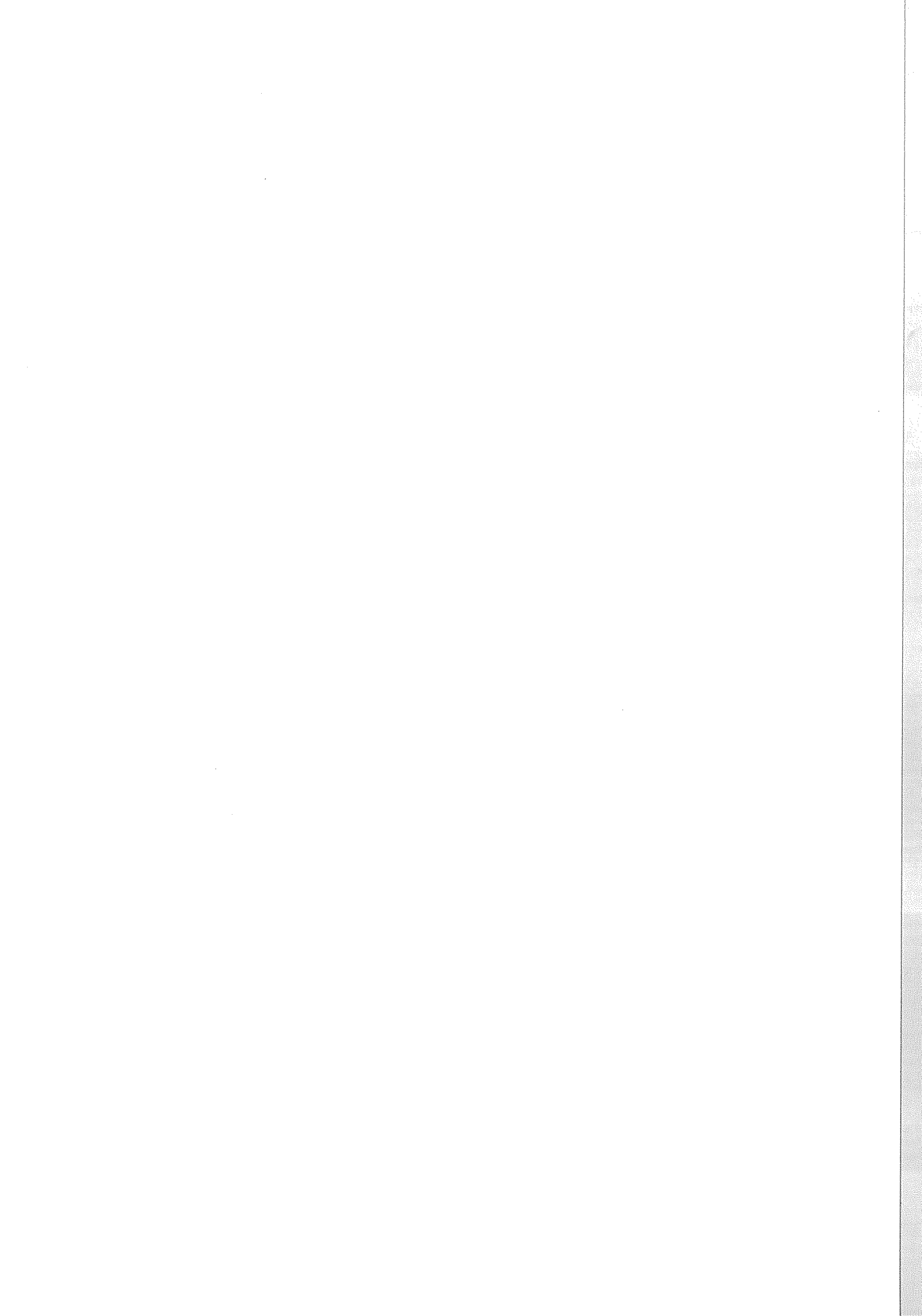
~~Booklet 6 - Stability and safety against movement by the wind~~

**Booklet 7 - Safety rules**

Booklet 8 - Test loads and tolerances

Booklet 9 - Supplements and comments to booklets 1 to 8

NOTE: Booklet 9 must not therefore be used separately.



# BOOKLET 7

## SAFETY RULES

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7.1.

## SCOPE

These rules are applicable to cranes and heavy lifting appliances covered by clause 1.4. of booklet 1 - "Object and Scope" (1).

7.2.

## BASIS OF CALCULATIONS

The calculation of crane structures and mechanisms shall be in accordance particularly with booklet 3 - "Design stresses in the structure" and booklet 4 - "Design and choice of mechanism components".

7.3.

## MARKING AND PLATES

Lifting appliances shall bear the following markings or plates, in the language of the country in which the appliance will operate, or in a language accepted by the user.

7.3.1.

### RATING PLATE

The lifting capacity (and radius where applicable) shall be permanently marked in a visible position and shall be easily legible from the ground.

The lifting capacity shall be the heaviest mass which may be hoisted by the crane, or by any hoisting accessory, either permanent or incorporated under certain conditions ; in the case of grabbing cranes, the lifting capacity shall be the permissible total weight of the grab and contents.

In the case of luffing cranes, the lifting capacity corresponding to each radius shall be indicated in durable form showing appropriate graduations, and shall be clearly legible from the ground. More detailed indications of permissible loads at different radii shall be obtainable from the manufacturer's operating manual.

In the case of cranes with more than one hoist, the lifting capacity of each hoist shall be indicated on the relevant hook block. It should furthermore be indicated if all the hoists can be used at the same time.

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(1) For builders tower cranes, the safety measures in preparation by the E.E.C. are also accepted by the F.E.M.

7.3.2.

MANUFACTURER'S PLATE

Each lifting appliance, independent crab or winch shall be fitted at a convenient point with the maker's plate, detailing the following :

- name of manufacturer,
- year of manufacture,
- manufacturer's serial number,
- lifting capacity in kgs and/or tonnes,
- type.

7.3.3.

WARNING NOTICES

A notice reading : "Do not stand under the load" shall be suitably located so as to be clearly visible. Crane access points shall be marked with a notice reading : "No access for unauthorised personnel". Particularly dangerous areas shall be marked with a notice reading : "Danger - Crane" and, where necessary, by means of warning colour stripes.

7.4.

CONSTRUCTION REQUIREMENTS

7.4.1.

CLEARANCES

7.4.1.1.

All moving parts of lifting appliances, with the exception of handling and grabbing devices, in their most unfavourable position and under the most unfavourable loading conditions shall be at least 0.05 m from any fixed part of a building, at least 0.1 m from any guard rail or handrail and a minimum of 0.5 m from access areas. Access areas are all access ways authorised to personnel. This does not apply to working platforms. For railway loading profiles, the appropriate loading gauge shall be used and there shall be a minimum clearance of 0.5 m in access areas. Under no circumstances shall fixed parts of any lifting appliance encroach upon the railway clearance gauge.



7.4.1.2. The minimum vertical distance between the lower clearance line of a lifting appliance and areas of general access below (from the floor as well as from fixed or movable equipment belonging to the building, with the exception of working or service platforms or similar shall be at least 1.8 m in areas of general working access. From parts of stationary or mobile installations with limited walk-on or step-on access (such as roofs, heaters, machinery parts and cranes travelling below etc.) as well as from guard rails, the minimum vertical distance shall be 0.5 m.

7.4.1.3. The minimum vertical distance between the upper clearance line of a lifting appliance and fixed or moving parts above (e.g. between crab structures or guardrails on the one hand and roof joists, pipelines or lifting appliances travelling overhead on the other) shall be not less than 0.5 m in maintenance areas and in the vicinity of platforms. This distance may be reduced to 0.1 m in the case of individual structural members, provided no danger to personnel results or that adequate precautions are taken to eliminate the risks.

7.4.2.

#### DRIVER'S CABS IN GENERAL

7.4.2.1. Driver's cabs shall be designed so that the driver has a clear view of all work areas or so that he may adequately follow all operations with the aid of suitable equipment.

7.4.2.2. The driver's cab shall have sufficient room for the driver to be able to reach or leave the controls without hindrance. Controls shall preferably be operated from a sitting position, but also from a standing position when necessary.

Driver's cabs shall have a minimum headroom of 1.9 m and shall be fitted with a guard rail of at least 1.0 m high.

Outdoor cabs, or those operating in unheated bays, shall be of enclosed construction, except in warm climates. Driver's cabs in heated bays, or which are seldom used or of an auxiliary nature may be of open construction.

A protective shield shall be installed above the driver's cab when there is any danger of falling objects.

The layout of the cab and controls shall be ergonomically designed.

7.4.2.3. The structural framework of the driver's cab shall be of non-combustible material, and the side panels and roof may optionally be of fire resistant materials. The floor of the driver's cab shall be covered with non-metallic, heat-insulating material.

- 7.4.2.4. In cabs with windows less than 1.0 m from the floor and glazed areas in the floor, the glazing shall be constructed or protected to a height of 1.0 m so that personnel cannot fall through them ; walkover windows shall be tread proof.

Entrances shall be protected against accidental opening. Sliding doors and outward opening doors of driver's cabs must lead on to landings.

It must be possible to clean the windows of the driver's cab without risk. Glazed openings let into the floor of the driver's cab and those which are exposed to an increased risk of breakage or subjected to heat radiation when the crane is in operation shall be made of suitable safety glass.

- 7.4.2.5. Driver's cabs shall be provided with adequate anti-glare lighting to allow handling of the controls and, if necessary, can be ventilated.

Enclosed driver's cabs for outdoor operation and cabins located in unheated bays must be provided with heating.

- 7.4.2.6. Driver's cabs which are exposed to radiant heat shall be protected against heat radiation and of a heat-proof design, and they shall be air-conditioned in order to ensure tolerable working conditions.

- 7.4.2.7. Driver's cabs exposed to conditions presenting a health hazard, such as dust, vapours or gases, shall be protected against their entry and provided with a clean air supply.

7.4.3. **ADDITIONAL REGULATIONS REGARDING  
HOIST-SUSPENDED DRIVER'S CABS**

- 7.4.3.1. The permitted number of persons and maximum load of the driver's cab shall be permanently and clearly indicated. Additional "Operating and maintenance instructions for hoist-suspended driver's cabs" shall be posted in the cab.

- 7.4.3.2. It must not be possible for the driver's cab to spin or swing dangerously.

- 7.4.3.3. Hoist suspended driver's cabins shall be provided with an anti-fall device. Alternatively, there may be two independent means of suspension, provided that the driver's cabin remains secure should one means of suspension break, or should the drive or service brake fail. Each individual means of suspension shall be designed with a safety factor of not less than five times the full working load.

If there is an anti-fall device and only one means of suspension, a minimum safety factor of eight is necessary.

Rope drives shall be designed as a minimum in accordance with mechanism group M8. The diameter of the rope shall be not less than 6 mm. Ropes for outdoor duty shall be made of galvanised steel wire.

7.4.3.4. On reaching a speed of 1.4 times the nominal lowering speed the driver's cab shall automatically be brought to a halt.

The driver's cab must be able to move independently of the load.

7.4.3.5. All controls shall stop automatically as soon as the driver releases them.

7.4.3.6. Normal and emergency limit switches shall be provided for the highest and lowest positions of the cab, with separate switching and operating systems. Emergency limit switches shall directly switch off the main power circuit and activate an audible warning signal.

In the event of the driver's cab striking an obstacle or a suspension means becoming slack, all crane motions shall automatically shut down. Devices for returning the crane to service shall not be of self re-setting type.

7.4.3.7. If the travel speed of the driver's cab is greater than 40 m/min, devices shall be provided to reduce the speed promptly so that the buffers cannot be struck at a speed greater than 40 m/min. If the impact velocity is greater than 20 m/min, energy absorption buffers shall be provided.

7.4.3.8. The driver's cab shall be provided with a distress signal system independent of the electrical supply of the crane. It shall also be provided with a means of emergency descent, e.g. a rope ladder or escape apparatus, which is always in the cab.

7.4.3.9. The user shall ensure that with the maximum stacking height of goods there is a safety headroom of 0.5 m to the underside of the driver's cab in its highest working position.

7.4.3.10. It must only be possible to remotely operate the crane from the ground with the driver's cab in its highest working position (see also 7.7.).

7.4.4.

GANGWAYS AND PLATFORMS

- 7.4.4.1. Easy and safe access to the driver's cab must be possible with the lifting appliance in any position under normal working conditions. If the floor of the driver's cab is less than 5 m above ground level, access may be restricted to certain positions of the lifting appliance, provided the driver's cab is fitted with appropriate emergency exit means, e.g. a rope ladder.

Entry to the driver's cab should be preferably from a platform at the same level as the floor of the cab and provided with guard rails. Entry through the floor, or through the ceiling of the driver's cab shall be permissible only when necessitated by virtue of space restrictions.

Where entry is made directly via a staircase, a platform or a gangway, the horizontal gap to the driver's cab entrance shall not exceed 0.15 m and the difference in level between the platform and the driver's cab floor shall not exceed 0.25 m.

- 7.4.4.2. When the driver's cab cannot be reached directly from ground level in any position of the crane, and where the driver's cab floor is higher than 5 m from ground level, the crane installation shall be provided with appropriate gangways. For certain appliances, such as overhead travelling cranes, access may be limited to certain positions of the crane, if appropriate devices are provided which enable the driver to leave the cab.

- 7.4.4.3. Gangways, stairways, and platforms must have safe access with the lifting appliance in any position. Stairways and ladders in frequent use shall lead on to platforms or gangways. For such access, stairways are preferable to ladders.

- 7.4.4.4. All operating locations and all equipment of the crane which requires regular inspection or maintenance must be provided with safe access, or be reached by means of portable work platforms.

- 7.4.4.5. The above-mentioned locations when more than 2 m above floor level, and also crane jibs must be accessible via stairways, platforms, walkways or ladders. Steps shall be fitted with guard rails on both sides (see also 7.4.5.2.).

- 7.4.4.6. When work is carried out during erection, dismantling, testing, repairs and maintenance at points situated more than 2 m above floor level, appropriate measures shall be taken on cranes and jibs to ensure the safety of personnel (such as handrails, handgrips, safety devices, etc.) and to permit access of personnel to these points. Pulleys and moving parts placed at the end of jibs shall be designed so that no lubrication is necessary between erecting and dismantling the crane. If this is not the case, the jib must be provided with access.

7.4.4.7. The above-mentioned access to the jib may be omitted when the latter can be lowered for the purpose of a complete visual check or when other constructions permit a visual check.

7.4.4.8. Stairways, gangways and platforms shall have a headroom of not less than 1.8 m. A clear passageway not less than 0.5 m wide must be provided in the vicinity of driven parts which move relative to gangways and platforms ; this dimension may be reduced to 0.4 m up to a height of 0.6 m by providing a handrail. The clear width of passageway between stationary parts shall be not less than 0.4 m.

The clear headroom of little used access ways inside crane structures may be reduced to a minimum of 1.3 m, whilst at the same time the width shall be increased to 0.7 m, varying linearly with the reduction in height. The headroom above platforms used only for maintenance purposes may be reduced to 1.3 m.

7.4.4.9. Parts of crane installations with access shall be provided with continuous guard rails on those sides where there is a danger of falling from a height of over 1 m. Toe guards shall be not less than 0.1 m high. Openings in guard rails shall be permissible where adequate protective measures against falling are provided. Guard rails shall, as a rule, be not less than 1 m high and shall be provided with toe guards and intermediate rails. The height of the guard rails may be reduced to 0.8 m for passageways where a clear height of 1.3 m is permissible. Along gangways there shall be at least one handrail.

For gangways alongside building walls or a solid wall construction, handrails shall be permissible in lieu of guard rails. Interruptions in the length of these shall not exceed 1 m (e.g. for building columns, door openings).

7.4.4.10. Platform surfaces shall be suitably slip-proof. Holes, gaps and openings in the flooring shall be restricted in size so that a 0.02 m diameter ball cannot pass through.

Gangways which are less than 0.5 m above exposed power lines must be provided with solid flooring in those areas.

7.4.4.11. When gangways are located adjacent to power lines, these lines must be protected against accidental contact.

7.4.5.

#### STAIRWAYS AND LADDERS

7.4.5.1. Stairways and ladders shall be provided wherever the difference in level exceeds 0.5 m. Footholds provided with hand grips may be installed on vertical surfaces where the height does not exceed 2 m (e.g. end carriages).

Ladders shall be interrupted by intermediate landings if they exceed a height of 8 m. For great heights as, for example, in builder's tower cranes, additional intermediate platforms may be provided for which the vertical interval must be a maximum of 8 m. Where there are space problems, a single continuous ladder with platforms alongside may be installed.

#### 7.4.5.2. STAIRWAYS

The slope of stairways shall not exceed 65°, the height of individual steps shall not exceed 0.25 m (0.2 m for tower cranes) and their depth shall not be less than 0.15 m.

If possible, the following ratios shall be observed :

$$2 \times \text{step height} + 1 \text{ tread width} = 0.63 \text{ m}$$

The height interval between steps shall be constant. In the case of main stairways the guard rail posts shall be spaced not less than 0.6 m apart, but in the case of other stairways 0.5 m shall suffice.

Surface of treads shall be anti-slip.

Stairways shall be provided with guard rails on each side ; where there is a wall on one side of the stairway a handrail shall be sufficient on the wall side.

#### 7.4.5.3. LADDERS

The length of rungs between side frames shall be no less than 0.3 m ; their pitch shall be constant and not exceeding 0.3 m. The rungs shall be at least 0.15 m away from fixed structural members. A rung shall be able to withstand a force of 1200 N at the centre without suffering permanent deformation.

Climb-through openings shall not be smaller than 0.63 m x 0.63 m or less than 0.8 m in diameter.

Ladders over 5 m in height shall be provided with safety hoops starting at a height of 2.5 m.

The distance between safety hoops shall be not greater than 0.9 m. They must be interconnected by at least three equally spaced longitudinal stringers.

In all cases, one longitudinal stringer must be placed at a point which is exactly opposite the vertical centre line of the ladder.

The strength of safety hoops, reinforced by the longitudinal stringers, must be adequate to withstand a force of 1000 N distributed over 0.1 m acting on any point of the hoop, without any visible deformation.

The sides of ladders shall extend at least 1 m above the top rung, unless some other appropriate handhold is provided. Where space is limited, 0.8 m shall be acceptable.

Safety hoops are not necessary on ladders placed on the inside of structures which can act as a safety guard and where there is a clearance of 0.7 m to 0.8 m between the ladder and the opposite side. Structural members can be considered equivalent to safety hoops provided they are arranged so that the perpendicular distance between bars in the danger zone is always less than 0.75 m and the inscribed circle between the ladder and the struts is less than 0.75 m.

The ladders must be provided with rest platforms spaced so that the first stretch does not exceed 10 m and there are then rest platforms at every 8 m.

## 7.5.

### MECHANICAL DEVICES

#### 7.5.1.

#### ROPE AND CHAIN DRIVES

##### 7.5.1.1.

Rope drums shall be provided with rope grooves. The rope, as a rule, shall be wound in one layer. If winding is done in more than one layer, an appropriate spooling device or winding system shall be provided ; such a device is not necessary in the case of two layers where the rope is self-guided during winding.

If there is a possibility of the rope becoming slack on the drum during operation or of not being wound on properly, means shall be provided to prevent this.

Drums shall be provided with end flanges unless other measures are taken to prevent the ropes from overriding the ends or falling.

The diameter of the flanges of the drum shall be such that, with the rope fully wound on, the flange shall project a distance of not less than one-and-a-half rope diameters above the top layer of the rope (for builders cranes, twice the rope dia).

##### 7.5.1.2.

At the lowest permissible hook position, there shall still be at least two turns on the drum before the rope anchorage. If the rope end is fastened to the drum with bolted clamps, there shall be at least two separate clamps held by bolting fitted with positive locking devices.

##### 7.5.1.3.

Ropes shall be protected wherever possible against the influence of direct radiant heat and against being sprayed with molten and other dangerous substances. Special ropes shall be used when operating under conditions of excessive influence of heat, corrosive materials etc...

- 7.5.1.4. Chain drives shall be provided with a device ensuring smooth running of the chain on the sprocket wheel and preventing it from jumping. An effective chain guard shall be provided.

7.5.2. HOOK BLOCKS, PULLEYS AND OTHER LOAD CARRYING DEVICES

- 7.5.2.1. Adequate means shall be provided to prevent the rope or chain from jumping off the pulleys.
- 7.5.2.2. An adequate guard shall be provided where there is any danger of a hand being trapped between the rope and the pulley of the hook block.
- 7.5.2.3. Rope pulleys shall be designed so as to be accessible for maintenance.
- 7.5.2.4. Safety hooks or specially designed hooks shall be required where the method of operation induces increased danger of accidental un-hooking of the load or of the hook becoming snagged.
- 7.5.2.5. Interchangeable load carrying devices, such as grabs, lifting magnets, buckets, tongs and beams, shall be permanently marked with their safe working load and dead weight and also, in the case of grabs and buckets for bulk materials, with their capacity and name of manufacturer.

7.5.3. BRAKES

The provisions of this clause shall not apply to cylinder operated mechanisms e.g. hydraulic jack hoists.

- 7.5.3.1. Drives shall be provided with mechanical brakes. If in exceptional cases the drive is through a self-locking gear, the brake may be omitted, provided it has been ensured that no excessive stresses or movements can occur.

Brake mechanisms shall be easy to inspect. Brake springs shall be of the compression type. Brakes must be adjustable and brake linings must be replaceable.

- 7.5.3.2. Hoist units must be provided with brakes which are automatically applied and which can safely hold the test load in the event of switching off or failure of the hoist drive.

Brake systems shall be designed for 1.6 times the hoist load and they shall be capable of braking the dynamic test load without a damaging snatch effect and without unacceptable overheating.

Brakes of hoist units shall be arranged so that there is a positive mechanical link between the winch components which, on the one hand, generate the braking moment and, on the other hand, support the load.



The electrical and mechanical gear shall make it possible to keep the lowering speed under load within the permissible limits.

Hoist units for carrying molten materials shall be provided with two mechanical brakes which operate independently of each other, each of which shall meet the preceding requirements ; the second brake shall be applied with a time lag in relation to the first one.

In special critical cases where failure of a driving unit must be catered for the second brake shall act on the rope drum ; this brake shall be so controlled that it is applied automatically, not later than the instant a speed of 1.5 times the nominal lowering speed has been reached. In such cases the control gear of the crane shall include an emergency stop which shall also activate the brake.

- 7.5.3.3. Power driven travel drives of cranes and crabs shall be equipped with an automatic brake, or a brake which may be operated from the control position. Excluded from this category are cranes not subjected to wind, operating on a horizontal track at a speed not exceeding 40 m/min., or when on wheels with antifriction bearings, not exceeding 20 m/min. For cranes intended to carry molten materials, a brake is required independently of speed.

The brakes must be so designed that the crane or crab can be brought to rest in a suitable time and held stationary in all operating conditions, under wind load when applicable and also in the case of power failure.

Non-automatic travel brakes of cranes and crabs exposed to the wind shall be provided with a clamping device.

Automatic travel brakes or anchoring devices shall be designed with a factor of safety not less than 1.1 against the maximum forces in out of service conditions.

- 7.5.3.4. Power driven slewing drives shall be provided with brakes designed to bring to a halt, in a suitable time and to hold the slewing part stationary in all service conditions, under wind load when applicable and in the event of power failure.

- 7.5.3.5. Luffing systems shall be provided with brakes designed so that in the event of shut down or failure of the luffing gear drive they shall be applied automatically and safely hold the jib with the test load in the most unfavourable position.

Brake mechanisms shall be designed for a minimum braking moment equivalent to 1.6 times the moment due to the hook load and the dead weight of the jib system plus 1.0 times the moment due to the wind load, in the most unfavourable operating configuration (i.e. maximum wind load in service).

For the crane out of service this shall be at least 1.1 times the moment due to the dead weight of the jib system and due to the wind (max. out of service storm wind) in the most unfavourable jib position or in a specified out of service jib position.

7.6.

HYDRAULIC EQUIPMENT

- 7.6.1. Precision seamless steel pipe shall be used for pressure lines up to 3 cm outer diameter ; no welding shall be done on these except for welding on the flanges of bolted connections.
- 7.6.2. When hoisting and luffing mechanisms are driven by hydraulic jacks, automatic devices (burst protection valves) shall be installed immediately adjacent to the connections to pressure lines to avoid any undesirable lowering of the load, particularly in the event of pipe failure. When there is a risk of dangerous lowering of the load due to oil leakage or leaking components, mechanical devices shall be provided to prevent this.
- With other hydraulic drives, the above motions must be stopped by means of automatic brakes, actuated by self-resetting controls, as specified under paragraph 7.5.3.
- 7.6.3. Exceeding of the maximum specified working pressure shall be prevented by means of pressure relief valves. Appropriate provisions or constructional measures shall be taken to prevent the working pressure from being exceeded by more than 1.6 times, including the case of transient peak pressure.
- 7.6.4. Prior to start-up, the hydraulic system shall be free from foreign bodies such as turnings, splinters or scale. The system shall be designed so that such foreign bodies can be readily removed when making repairs.
- 7.6.5. Each hydraulic circuit shall have at least one connection outlet for a pressure gauge, enabling the measurement of pressure without any dismantling of pipework.
- 7.6.6. Hydraulic systems shall be fitted with breathers at suitable points.
- 7.6.7. Overrunning of limit positions shall be prevented by means of appropriate devices.
- 7.6.8. Pipework and hoses must be designed with a factor of safety of four against bursting pressure ; this applies also to connections and flange joints. For stationary lifting appliances which are free from hydraulic shocks and vibration , a factor of safety of 2.5 shall suffice.
- 7.6.9. Hydraulic fluids used in the hydraulic installations of cranes and winches shall comply with the requirements of service conditions and with the technological and safety requirements. The hydraulic fluid shall be specified to the user. It must be possible to check the maximum and minimum levels of the hydraulic tank.

- 7.6.10. Unintentional start-up of drives following the renewal of power supply after failure or the switching on of the isolator switch or of the main crane switch must be prevented ; e.g. by means of electrical interlocks or by means of an automatic mechanical return of the controller.

## 7.7. SAFETY DEVICES

### 7.7.1. DEVICES FOR LIMITING WORKING MOTIONS

#### 7.7.1.1. HOIST MECHANISMS

The range of power driven hoist mechanisms shall be restricted at the highest and the lowest permissible positions of the load supporting means by automatic limit switches (emergency limit switches), having regard to the distance required to slow down. The return from the limit positions must be possible by means of the controller. If a limit position is reached during normal operation, there shall be an additional and independent service limit switch. In this case, when the service limit switch has been tripped, it shall be possible to effect the return movement by use of the controller, but if the emergency limit switch has been tripped, this return movement shall not be possible.

Hoists powered by an internal combustion engine and mechanically coupled with non intermediate electrical, hydraulic or pneumatic link may be provided with visual or acoustic warning devices instead of limit switches.

#### 7.7.1.2. TRAVEL DRIVES

Power driven cranes and crabs shall be provided with devices such as shoe brakes, rubber, spring or hydraulic buffers or other special devices, which are capable of absorbing one half of the energy of the moving masses at normal travelling speed and such that the maximum deceleration in the driver's cab does not exceed  $5 \text{ m/sec}^2$ .

If the limit of travel is frequently reached during normal operation, the maximum deceleration in the driver's cab shall not exceed  $2.5 \text{ m/sec}^2$ .

Cranes and crabs with radio control shall be provided with limit switches when the travel speeds are in excess of 40 m/min.

Cranes and crab mounted driver's cabs, which are subject to wind, shall be provided with storm anchors for "Out of Service" conditions.

When operating conditions require that certain wind conditions be taken into account in the operation of the crane, a wind indicator and alarm must be provided on the crane.

Cranes shall be fitted with rail sweeps where material obstructions can come to rest in the track.

When two or more cranes run on the same track special devices shall be provided to prevent a dangerous collision. Under no circumstances shall the deceleration in the driver's cab exceed  $5 \text{ m/sec}^2$ .

In areas which are dangerous due to their being within the operational area of cranes or crabs, adequate measures shall be taken to protect personnel ; e.g. by the use of warning notices, flashing lights, acoustic warnings or, if necessary, automatic stopping devices.

#### 7.7.1.3. LUFFING AND SLEWING MECHANISMS

With power driven luffing mechanisms the movement of the jib at the limit of the travel shall be restricted by means of automatic limit switches (emergency limit switches) having regard to the distance required to slow down.

The return from the limit positions must be possible by means of the controller.

Luffing mechanisms powered by an internal combustion engine and mechanically coupled with no intermediate electrical, hydraulic or pneumatic link, may be provided with visual or acoustic warning devices instead of limit switches.

Similarly, power driven slewing mechanisms with limited slewing range shall have the slewing movement limited by means of an automatic emergency limit switch.

Furthermore, there shall be devices in accordance with the spirit of the provisions of paragraph 7.7.1.2. at the limits of travel of restricted slewing range or luffing range.

#### 7.7.2. SAFETY AGAINST OVERLOADING AND OVERTURNING

7.7.2.1. Cranes and crabs shall be so designed, or provided with such additional safety devices that, even in the event of derailment or failure of a runner wheel or a wheel shaft or bearing, the maximum drop is limited to 3 cm and falling or overturning is prevented.

In addition, exceptional forces such as those due to impact on buffers, collision and erection shall not cause the crane or the crab to overturn or fall.

7.7.2.2. Cranes and trolleys equipped with jibs and outriggers which can overturn due to an overload, and having a load lifting capacity independent of radius, shall be provided with an overload protection switch ; however, when the load lifting capacity varies with the outreach, the switch shall also act as a load moment switch. It should be possible to return into the permissible range of the load moment by reversing the movement or, where the overload has been caused by lifting the load, by setting it down using the controller.

Cranes with hoists and/or luffing mechanism powered by an internal combustion engine and mechanically coupled with no intermediate electrical, hydraulic or pneumatic link may be provided with a visual or acoustic warning device instead of an overload switch.

7.7.2.3. Cranes and lifting appliances with the lifting capacity dependent on radius shall be provided with a permanent notice, clearly visible from the driving position and stating, in suitable graduations, the hook loads corresponding to the various radii.

7.8.

#### AGEING OF APPLIANCES

Like other machines and lifting appliances, those pertaining to Section I of the FEM are also designed for a certain duration of life.

They are, in addition, covered by Design Rules which have been developed from the scientific knowledge and experience of users and manufacturers for application to the various types of appliances.

This notion of ageing applies mainly to the structure and the mechanisms, and not so much to the consumable components (such as : ropes, brake linings, brushes, heat engines, etc...).

The principal factors contributing adversely to the ageing of appliances are :

- fatigue phenomena
- corrosion
- operational, assembly and dismantling accidents
- overloading
- inadequate maintenance.

The user must always bear in mind the importance of ageing.

