

# SVENSK STANDARD

## SS-EN 81-41:2010



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### **Säkerhetsregler för konstruktion och installation av hissar – Specialhissar för transport av personer och gods – Del 41: Vertikalgående plattformshissar avsedda för personer med nedsatt rörelseförmåga**

### **Safety rules for the construction and installation of lifts – Special lifts for the transport of persons and goods – Part 41: Vertical lifting platforms intended for use by persons with impaired mobility**

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Denna standard ersätter SS 2097-7, utgåva 1.

The European Standard EN 81-41:2010 has the status of a Swedish Standard. This document contains the official version of EN 81-41:2010.

This standard supersedes the Swedish Standard SS 2097-7, edition 1.

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EUROPEAN STANDARD

**EN 81-41**

NORME EUROPÉENNE

EUROPÄISCHE NORM

December 2010

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ICS 91.140.90; 11.180.10

English Version

**Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 41: Vertical lifting platforms intended for use by persons with impaired mobility**

Règles de sécurité pour la construction et l'installation des élévateurs - Elévateurs spéciaux pour le transport des personnes et des charges - Partie 41 : Plates-formes élévatrices verticales à l'usage des personnes à mobilité réduite

Sicherheitsregeln für die Konstruktion und den Einbau von Aufzügen - Spezielle Aufzüge für den Transport von Personen und Gütern - Teil 41: Senkrechte Plattformaufzüge bestimmt für den Einsatz von Personen mit eingeschränkter Beweglichkeit

This European Standard was approved by CEN on 7 October 2010.

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## Foreword

This document (EN 81-41:2010) has been prepared by Technical Committee CEN/TC 10 “Lifts, escalators and moving walks”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2011, and conflicting national standards shall be withdrawn at the latest by June 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive 2006/42/EC.

For relationship with EC Directive 2006/42/EC, see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.



## Introduction

The population of Europe is ageing and the prevalence of disability, including disability associated with the ageing process, is increasing. Older people and people with disabilities at present are estimated to number some 80 million people – a large and growing proportion of the European Union population. The changing demography presents both opportunities and challenges for the Union. The economic, social and cultural potential of older people and people with disabilities is underexploited at present. However there is a growing recognition that society needs to exploit this potential for the economic and social benefit of society generally.

This is one of the reasons that led to this standard on vertical lifting platforms for people with impaired mobility being one means to provide accessibility to buildings.

This standard is a type C standard as stated in EN ISO 12100 (all parts).

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this standard.

When provisions of this type C standard are different from those which are stated in type A and type B standards the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

The lifting platforms defined in this standard are suitable for type A and type B wheelchairs as defined in EN 12183 and/or EN 12184.

Those items relevant to lifting platforms referenced within EN 81-70 have been included within this standard.

This standard does not only address the essential health and safety requirements of the Machinery Directive, but additionally states minimum rules for the installation of lifting platforms into buildings/constructions. There may be in some countries regulations for the construction of building etc. which cannot be ignored.

It is essential that minimum passageways conform to national building regulations and are not obstructed by any open door or trap and/or any protection means provided for working areas outside of the enclosed liftway where fitted according to the maintenance instructions.

## Assumptions

With the aim of clarifying the intentions of the standard and avoiding doubts when applying it, the following assumptions were made when producing it:

- Vertical lifting platforms are installed in both new and existing buildings;
- For existing buildings where space is not available, other dimensions may be considered. Local building regulations should be observed;
- components without specific requirements are:
  - a) designed in accordance with the usual engineering practice and calculation codes, including all failure modes;
  - b) of sound mechanical and electrical construction;
  - c) general hazards due to hydraulic, pneumatic, etc. equipment are dealt with according to relevant B level standards for common use.
  - d) Materials known to be harmful materials, such as asbestos are not to be used as part of the machine;

- components are kept in good repair and working order, in accordance with the maintenance manual, so that the required characteristics remain despite wear;
- by design of the load bearing elements, a safe operation of the machine is assured for loading ranging from zero to, the dynamic operation maximum working load and static loading, to the maximum static load;
- to ensure the safe functioning, the operating temperature range of the equipment has to take into account the conditions of the place of use of the machinery, inside the maximum range of ambient temperature between + 5 °C and + 40 °C. For very hot or cold environments extra requirements may be necessary.
- negotiations have been made between the customer and the manufacturer about:
  - environmental conditions;
  - civil engineering problems;
  - other aspects related to the place of installation;
  - the use and places of use of the machinery;
  - the place of installation allows a safe use for the machine;
  - any additional fire protection requirements;
  - suitability for the user (see Annex B).

## 1 Scope

**1.1** This European Standard deals with safety requirements for construction, manufacturing, installation, maintenance and dismantling of electrically powered vertical lifting platforms affixed to a building structure intended for use by persons with impaired mobility:

- travelling vertically between predefined levels along a guided path whose inclination to the vertical does not exceed 15°;
- intended for use by persons with or without a wheelchair;
- supported or sustained by rack and pinion, wire ropes, chains, screw and nut, friction/traction between wheels and the rail, guided chain, scissors mechanism or hydraulic jack (direct or indirect);
- with enclosed liftways;
- with a speed not greater than 0,15 m/s;
- with platforms where the carrier is not completely enclosed.

**1.2** This standard deals with all significant hazards relevant to lifting platforms, when they are used as intended and under the conditions foreseen by the manufacturer (see Clause 4).

**1.3** This European Standard does not specify the additional requirements for:

- operation in severe conditions (e.g. extreme climates, strong magnetic fields);
  - lightning protection;
  - operation subject to special rules (e.g. potentially explosive atmospheres);
  - handling of materials, the nature of which could lead to dangerous situations;
  - vertical lifting platforms whose primary function is the transportation of goods;
  - vertical lifting platforms whose carriers are completely enclosed;
  - vertical lifting platforms prone to vandalism;
  - hazards occurring during manufacture;
  - earthquakes, flooding;
  - fire fighting, evacuation and behaviour during a fire;
  - noise and vibrations;
  - the design of concrete, hardcore, timber or other foundation or building arrangement;
  - the design of anchorage bolts to the supporting structure;
  - type C wheelchairs as defined in EN 12183 and/or EN 12184.
- NOTE For the actual type of machinery, noise is not considered a significant nor relevant hazard.

**1.4** This standard is not applicable to Vertical Lifting Platforms intended for use by persons with impaired mobility which are manufactured before the date of its publication as an EN.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 81-1:1998, *Safety rules for the construction and installation of lifts — Part 1: Electric lifts*

EN 81-2:1998, *Safety rules for the construction and installation of lifts — Part 2: Hydraulic lifts*

EN 81-58, *Safety rules for the construction and installation of lifts — Examination and tests — Part 58: Landing doors fire resistance test*

EN 349, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 953, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

EN 12015, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Emission*

EN 12016, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Immunity*

EN 12183, *Manual wheelchairs — Requirements and test methods*

EN 12184, *Electrically powered wheelchairs, scooters and their chargers — Requirements and test methods*

EN 12385-4, *Steel wire ropes — Safety — Part 4: Stranded ropes for general lifting applications*

EN 13411 (all parts), *Terminations for steel wire ropes*

EN 50214, *Flat polyvinyl chloride sheathed flexible cables*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60204-32, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 60664-1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests (IEC 60664-1:2007)*

EN 60747-5 (all parts), *Discrete semiconductor devices and integrated circuits — Part 5: Optoelectronic devices*

EN 60947-1:2007, *Low-voltage switchgear and controlgear — Part 1: General rules (IEC 60947-1:2007)*

EN 60947-4-1, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1:2000)*

EN 60947-5-1, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices (IEC 60947-5-1:2003)*

EN 60950-1, *Information technology equipment — Safety — Part 1: General requirements (IEC 60950-1:2005, modified)*

EN 61249-2 (all parts), *Materials for printed boards and other interconnection structures — Part 2: Sectional specification set for reinforced base materials, clad and unclad*

EN 61558-1, *Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests (IEC 61558-1:2005)*

EN 62326-1, *Printed boards — Part 1: Generic specification (IEC 62326-1:2002)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)*

EN ISO 13850, *Safety of machinery — Emergency stop — Principles for design (ISO 13850:2006)*

EN ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

ISO 606, *Short-pitch transmission precision roller and bush chains, attachments and associated chain sprockets*

ISO 6336 (all parts), *Calculation of load capacity of spur and helical gears*

ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*

IEC 60417-DB, *Graphical symbols for use on equipment*

HD 384.6.61 S1, *Electrical installations of buildings — Part 6-61: Verification — Initial verification*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100-1:2003 and the following apply.

#### 3.1

##### **balancing weight**

mass which saves energy by balancing all/or part of the mass of the unloaded lifting platform

#### 3.2

##### **competent person**

person, suitably trained and qualified by knowledge and practical experience, and provided with the necessary instructions to enable the required work to be carried out safely

#### 3.3

##### **down direction valve**

electrically controlled valve in a hydraulic circuit for controlling the descent of the lifting platform

#### 3.4

##### **drive system**

system that causes the lifting platform to move under power input

#### 3.5

##### **drive unit**

unit, including the motor, that drives and stops the lifting platform

**3.6**  
**electric safety chain**  
total of the electric safety devices, which can either be switches or safety circuits, connected in series with each other

**3.7**  
**electrical safety circuit**  
electrical or electronic circuit with an equivalent degree of safety to a switch containing electrical safety contacts

**3.8**  
**electrical safety contact**  
contact in which the separation of the circuit breaking elements is made by positive means

**3.9**  
**electrical safety device**  
either an electrical switch incorporating one or more electrical safety contacts, or a safety circuit

**3.10**  
**enclosed liftway**  
space that is fully bounded by the bottom of the pit and a solid enclosure (but not necessarily a ceiling) and landing doors

**3.11**  
**existing building**  
building which has been previously occupied and constructed prior to the requirement for a lifting platform

**3.12**  
**final limit device**  
electrical safety device operated by the lifting platform in the event of over-travel of the normal operation stop

**3.13**  
**full load pressure**  
static pressure exerted on the piping directly connected to the jack, the platform with the rated load being at rest at the highest landing level

**3.14**  
**guide rail**  
rigid components that provide guiding for the platform

**3.15**  
**guided chain**  
chain, which can be either fixed or moving, and which is completely guided over its entire length such that it can transmit a load either in thrust or tension

**3.16**  
**guided chain system**  
platform supported, raised and lowered by means of one or more chain transmission units

**3.17**  
**impaired mobility**  
difficulty in using stairs because of impairment

NOTE Examples of persons with impaired mobility include, but are not restricted to: wheelchair users, persons with pushchair, persons with walking difficulties, persons using walking aids, carers for persons with impaired mobility and/or children with impaired mobility, and elderly persons.

**3.18**

**lifting platform**

device permanently installed to serve predefined landings comprising a guided platform whose characteristics are primarily intended to permit the access of persons with impaired mobility

**3.19**

**load carrying nut**

internally threaded component which carries the load in conjunction with a screw

**3.20**

**maximum static load**

rated load + additional overload possible as a relationship of EN 81-1 and EN 81-2 floor area calculations

**3.21**

**maximum working load**

rated load + overload of one person

**3.22**

**mechanical blocking device**

device that, when set in position, guarantees a minimum safety space beneath the platform for the purposes of maintenance and inspection

**3.23**

**over-speed governor**

device which, when the lifting platform attains a pre-determined speed, causes the lifting platform to stop and if necessary causes the safety gear to be applied

**3.24**

**overload**

additional load which is permissible based upon one person

**3.25**

**pressure relief valve**

valve which limits the pressure to a pre-determined value by exhausting fluid

**3.26**

**public access**

location where the user is unknown

**3.27**

**rack**

bar with teeth with which a driving pinion engages to form a slip free driving means converting rotary motion into linear motion

**3.28**

**rated load**

load for which the equipment has been designed

**3.29**

**rated speed**

speed of the lifting platform for which the equipment has been designed

**3.30**

**restrictor**

valve in which the inlet and outlet are connected through a restricted passageway

**3.31**

**rupture valve**

valve designed to close automatically when the pressure drop across the valve, caused by the increased flow in a pre-determined flow direction exceeds a pre-set amount

### 3.32

#### **safety circuit**

electrical or electronic circuit with an equivalent degree of safety to a circuit containing electrical safety contacts

### 3.33

#### **safety factor**

ratio, either of the yield load, or the ultimate tensile load to the load that can be imposed upon a member by the rated load for a particular material under static or dynamic conditions

### 3.34

#### **safety gear**

mechanical device for stopping and maintaining the platform stationary in case of over-speeding in the downward direction and/or breaking of the suspension

### 3.35

#### **safety nut**

internally threaded component which is linked to the load carrying nut but is unloaded during normal service which is capable of carrying the load if the load carrying nut should break

### 3.36

#### **screw**

external threaded component which carries the load in conjunction with the load carrying nut and in certain circumstances the load imposed by the safety nut

### 3.37

#### **self-sustaining system**

screw and nut system that, under free running conditions ensure that the speed of the platform decreases

### 3.38

#### **sensitive edge**

device attached to an edge to provide protection against a trapping, shearing or crushing hazard

### 3.39

#### **"shut-off" valve**

manually operated two-way valve which can permit or prevent flow in either direction

### 3.40

#### **slack rope/chain device**

device, or combination of devices, arranged to stop the lifting platform should any suspension rope or chain slacken by a pre-determined amount

### 3.41

#### **stopping safety device**

mechanical device for stopping the relative rotation between screw and nut in case of over-speeding and stopping the lifting platform and maintaining it stationary

### 3.42

#### **toe guard**

vertical component extending downwards from the platform entrance

### 3.43

#### **transmission unit**

assembly comprising the chain, and its associated elements, sprocket wheel, return housing, guided elements for the chain

### 3.44

#### **unlocking zone**

zone, extending above and below a landing, in which the platform floor must be positioned to enable the corresponding landing door/s to be unlocked



**3.45****user**

person making use of the services of the platform

**4 List of significant hazards**

This clause contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

Table 1 shows the hazards which have been identified and where the corresponding requirements have been formulated in this standard, in order to limit the risk or reduce these hazards in each situation.

The significant hazards are based upon EN ISO 14121-1. Also shown are the sub clause references to the safety requirements and/or protective measures in this standard.

Before supplying any lifting platform, it is important to review the risks in Table 1 to check that all site specific hazards have been identified in this clause.

NOTE Hazards resulting from allergic reactions to persons are not addressed in this standard, but advice on such materials is given in Annex D of EN 81-70:2003.

**Table 1 — Significant hazards relating to the general design and construction of lifting platforms**

|          | Hazards  | Relevant clauses in EN 81-41  |
|----------|--|---|
| <b>1</b> | <b>Mechanical hazards</b>  |   |
|          | a) shape;  | 5.9, 5.6.4.1, 5.6.4.2   |
|          | b) relative location;  |   |
|          | c) mass and stability (potential energy of elements may move under the effect of gravity); | 5.1.6, 5.3, 5.4.6, 5.4.1  |
|          | d) mass and velocity (kinetic energy of elements in controlled motion);                    |   |
|          | e) inadequacy of energy inside the machinery e.g.);  |   |
|          | — accumulation of energy inside the machinery e.g.:  | 5.4.10  |
|          | f) elastic elements (springs);   |   |
|          | g) liquids and gasses under pressure;  |   |
|          | h) the effect of vacuum.   |   |
| 1.1      | Crushing hazard  | 5.1.3, 5.1.4.1.2, 5.1.4.2.1, 5.6.2, 5.6.4, 5.9                                    |
| 1.2      | Shearing hazard  | 5.1.3, 5.6.4, 5.8.4, 5.9  |
| 1.3      | Cutting or severing hazard   | 5.1.4.1.2, 5.1.4.4.1, 5.6.4, 5.6.6, 5.8.2, 5.9                                    |
| 1.4      | Entanglement hazard  | 5.1.3, 5.1.4.1.2, 5.1.4.4.1, 5.5.5, 5.6.4, 5.9, 5.4.1.7                           |
| 1.5      | Drawing-in or trapping hazard  | 5.1.3, 5.1.4.1.2, 5.1.4.4.1, 5.1.11.3, 5.4.5.4.4, 5.4.5, 5.5.5, 5.6.6, 5.8.4, 5.9 |

(to be continued)

Table 1 (continued)

|           | Hazards   | Relevant clauses in EN 81-41  |
|-----------|---|---|
| 1.6       | Impact hazard   | 5.1.4.1.2, 5.1.4.4.1, 5.8.7   |
| 1.7       | Stabbing or puncture hazard   | 5.1.4, 5.9  |
| 1.8       | Friction or abrasion hazard   | 5.1.3, 5.6.4, 5.9   |
| 1.9       | High pressure fluid ejection hazard   | 5.1.4.4.1, 5.4.10   |
| 1.10      | Falling hazard  | 5.1.3, 5.1.4.1.2, 5.1.4.2.3, 5.3, 5.6.4, 5.8.2, 5.8.3, 5.9.5.1, 7.3.1.6.5 |
| <b>2</b>  | <b>Electrical hazards</b>   |   |
| 2.1       | Electrical contact of persons with live parts   | 5.1.4.4.1, 5.5.1, 5.5.3, 5.5.8, 5.5.13                                    |
| 2.2       | Electrical contact of persons with parts which have become live under faulty conditions                     | 5.5.3   |
| 2.3       | Approach to live part under high voltage  | 5.5.1.2, 5.5.8, 5.5.2   |
| <b>3</b>  | <b>Thermal hazards</b>  |   |
| 3.1       | Burns and scalds  | 5.1.4.4.1, 5.1.5, 5.5.12, 5.5.14  |
| 3.2       | Health-damaging effects   | 5.1.5, 5.5.14.9   |
| <b>6</b>  | <b>Hazards generated by radiation</b>   | 5.5.9   |
| 7.1       | Contact with or inhalation of harmful fluids, gases, mists, fumes and dusts                                 | 5.5.14.9  |
| 7.2       | Fire or explosion   | 5.5.14.9  |
| <b>8</b>  | <b>Hazards generated by neglecting ergonomic principles in machine design</b>                               |   |
| 8.1       | Unhealthy postures or excessive effort  | 5.1.4.2.2, 5.1.8, 5.4.3, 5.5.15, 5.8.2, 5.8.7                             |
| 8.2       | Inadequate consideration of human hand/arm or foot/leg anatomy  | 5.4.3, 5.5.14, 5.8.7  |
| 8.4       | Inadequate area lighting  | 5.5.3, 5.5.4  |
| 8.6       | Human error   | 5.4.3, 5.5.15   |
| 8.7       | Inadequate design, location or identification of manual controls  | 5.5.15  |
| 8.8       | Inadequate design or location of visual display units   | 5.5.15  |
| <b>9</b>  | <b>Hazard combinations</b>  | Considered satisfied when all individual hazards have been addressed      |
| 10        | Hazards caused by failure of energy supply, breaking down of machinery parts and other functional disorders |   |
| 10.1      | Failure/disorder of the control system  | 5.1.12, 5.4.2, 5.4.3, 5.5.11, 5.5.7                                       |
| 10.2      | Restoration of the energy after an interruption   | 5.5.11  |
| 10.3      | External influences on the electrical equipment   | 5.1.11  |
| 10.4      | Other external influences (gravity, wind, etc.)   | 5.1.4, 5.1.11   |
| 10.5      | Errors in software  | 5.5.15.5, 5.5.15.6  |
| 10.6      | Errors made by the operator ( due to mismatch of machinery with human characteristics and abilities)        | 5.4.3, 5.5.15   |
| <b>11</b> | <b>Impossibility of stopping the machine in the best possible conditions</b>                                | 5.5.15.5, 5.5.15.7  |
| 11.1      | Unsafe position   | 5.4.2   |
| 11.2      | Over-speeding   | 5.3, 5.4.2  |
| <b>13</b> | <b>Failure of the power supply</b>  |   |
| 13.1      | Over-speeding   | 5.3, 5.4.2  |
| 13.2      | Unexpected start  | 5.4.2, 5.5.11, 5.5.13   |
| 13.3      | Change of direction   | 5.5.6.4, 5.5.11, 5.5.13   |
| 13.4      | Loss of memory  | 5.5.11, 5.5.14  |
| 13.5      | Unsafe position   | 5.4.2   |
| 13.6      | Entrapment  | 5.4.3, 5.5.4, 5.5.11, 5.5.14, 5.5.16, 5.8.6                               |
| <b>14</b> | <b>Failure of the control circuit</b>   |   |
| 14.1      | Errors on software  | 5.5.15.5, 5.5.15.6  |
| 14.2      | Failure to stop   | 5.5.6, 5.5.7, 5.5.11, 5.5.11.5, 5.5.17                                    |
| 14.3      | Unexpected stop   | 5.5.6, 5.5.7, 5.5.11, 5.5.14, 5.5.17                                      |

(to be continued)

**Table 1 (continued)**

|           | <b>Hazards</b>  | <b>Relevant clauses in EN 81-41</b>  |
|-----------|---|--|
| 14.4      | Unexpected start  | 5.5.1.1, 5.5.6, 5.5.7, 5.5.8.2, 5.5.12, 5.5.13, 5.5.11.5, 5.5.17                                 |
| 14.5      | External influences   | 5.4.3, 5.5, 5.5.8, 5.5.17  |
| 14.6      | Unexpected start See 14.4 above   |  |
| 14.7      | Failure to start  | 5.4.3, 5.5.6, 5.5.11.3, 5.5.17   |
| 14.8      | Maintenance Operation   | 5.5.1, 5.5.5, 5.5.6.3, 5.5.6.4, 5.5.11, 5.5.13   |
| 14.9      | Unexpected Activation   | 5.5.1.1, 5.5.13, 5.5.17  |
| 14.10     | Brake remains lifted  | 5.4.2  |
| 14.11     | Prevent stopping  | 5.4.2, 5.5.11  |
| 14.12     | Ineffective protection  | 5.5.1  |
| 14.13     | Isolation   | 5.5.1  |
| <b>15</b> | <b>Errors of fitting</b>  | 5.3, 5.5.13  |
| <b>16</b> | <b>Break-up during operation</b>  |  |
| 16.1      | Stress failure (and fatigue)  | 5.1.2, 5.1.10, 5.1.6, 5.3, 5.4.1, 5.4.2, 5.4.4, 5.4.5, 5.4.6, 5.4.7, 5.4.8, 5.4.9, 5.4.10        |
| 16.2      | Falling   | 5.1.4.1.2, 5.1.4.2.3, 5.1.6, 5.3, 5.4.1, 5.4.2, 5.4.4, 5.4.5, 5.4.6, 5.4.7, 5.4.8, 5.4.9, 5.4.10 |
| <b>17</b> | <b>Falling or ejected objects or fluid</b>  |  |
| 17.1      | Falling objects   | 5.6.4, 5.6.5, 5.6.6, 5.8.2, 5.8.3  |
| <b>18</b> | <b>Loss of stability / overturning of machinery</b>   |  |
| 18.1      | Overturning   | 5.1.7, 5.2.1   |
| 18.2      | Falling   | 5.1.7, 5.2.1   |
| <b>19</b> | <b>Slip, trip and fall of persons (related to machinery)</b>  |  |
| 19.1      | Slipping  | 5.5.4, 5.8.4.6, 5.9  |
| 19.2      | Tripping  | 5.4.2, 5.5.4, 5.5.15.7, 5.8.4.6, 5.8.5, 5.9  |
| 19.3      | Falling   | 5.1.4.3, 5.5.4, 5.5.15.7, 5.6.4, 5.6.5, 5.6.6, 5.8.2, 5.8.3, 5.8.5                               |
| 19.4      | Falling from the landing  | 5.1.4.3, 5.5.4, 5.6.4, 5.6.5, 5.8.2, 5.8.3, 5.8.4, 5.8.4.7, 5.8.5                                |
| <b>27</b> | <b>Mechanical hazards and hazardous events</b>  |  |
| 27.1      | From load falls, collisions, machine tipping caused by:   | 5.6.4  |
| 27.1.1    | Lack of stability   | 5.2.1.1, 5.2.1.2   |
| 27.1.2    | Uncontrolled loading- overloading- overturning moments exceeded   | 5.1.5, 5.1.7, 5.4.2, 5.4.3   |
| 27.1.3    | Uncontrolled amplitude of movements   | 5.1.5, 5.4.2, 5.5.7  |
| 27.1.5    | Inadequate holding devices/accessories  | 5.9.7  |
| 27.2      | From access of persons to load support  | 5.4.4, 5.4.5, 5.4.6, 5.3, 5.4.7, 5.4.8, 5.8  |
| 27.3      | From derailment   | 5.1.10, 5.2.1  |
| 27.4      | From insufficient mechanical strength of parts  | 5.1.2, 5.1.10, 5.4.4, 5.4.5, 5.4.6, 5.4.7, 5.4.8, 5.4.9, 5.4.10, 5.9, 5.8.4.7, 5.6.4.3, 5.6.4.4  |
| 27.5      | From inadequate design of pulleys, drums  | 5.4.5.4  |
| 27.6      | From inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine | 5.4.5, 5.4.8   |
| 27.7      | From lowering of the load under the control of the friction brake   | 5.4.2<br>5.4.3   |
| 27.8      | From abnormal conditions of assembly / testing / use / maintenance  | 7, 6.3   |
| 27.9      | From the effect of load on the persons (impact by load or counterweight)  | 5.8.5, 5.8.7   |

(to be continued)