

Safety requirements on suspended access equipment — Design calculations, stability criteria, construction — Tests

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National foreword

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Safety requirements on Suspended Access Equipment - Design calculations, stability criteria, construction - Tests

Exigences de sécurité aux plates-formes suspendues à
niveaux variables - Calculs, stabilité, construction - Essais

Sicherheitsanforderungen an hängende
Personenaufnahmemittel - Berechnung, Standsicherheit,
Bau - Prüfungen

This European Standard was approved by CEN on 19 February 1999 and includes Amendment 1 approved by CEN on 13 May 2010.

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Foreword

This document (EN 1808:1999+A1:2010) has been prepared by Technical Committee CEN/TC 98 "Lifting platforms", the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by December 2010, and conflicting national standards shall be withdrawn at the latest by December 2010.

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 includes Amendment 1, approved by CEN on 2010-05-13.

This document supersedes EN 1808:1999.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

A1 For relationship with EU Directives, see informative Annexes ZA and ZB, which are integral parts of this document. **A1**

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Introduction

 This European Standard is a type C standard as stated in EN ISO 12100. 

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

It is assumed that:

- Negotiations shall take place between manufacturer and user about specific local installation conditions;
- Risk analysis of each component that may be incorporated in a complete SAE installation has been made. Rules have been drawn up on the basis of this assumption;
- The safety requirements of this standard have been drawn up on the basis that the components 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) made of materials with adequate strength and of suitable quality, and
 - d) be free of defects;
- Harmful materials, such as asbestos are not used;
- The equipment is kept in good working order;
- Any mechanical device manufactured according to good practice and the requirements of this standard shall not deteriorate to the point of creating a hazard without being detected;
- The ambient temperature range is between - 10° C and + 55° C. Additional requirements for equipment intended for use outside the ambient temperature range are set out in annex D;
- The parapets and roofs are of adequate strength for the SAE equipment to be installed.

1 Scope

1.1 Application

This standard specifies the safety requirements for Suspended Access Equipment (SAE).

It is applicable to both permanent and temporary equipment which may be powered or hand operated and which are defined in clause 3.

1.2 Hazards

This European Standard deals with significant hazards pertinent to SAE, when they are used as intended and under the conditions foreseen by the manufacturer (See clause 4). This European standard specifies appropriate technical measures to eliminate or reduce risks arising from the significant hazards.

1.3 Exclusions

The following are not covered:

- a) operation in severe conditions (e.g. extreme environmental conditions, corrosive environment, strong magnetic fields, etc.);
- b) operation subject to special rules (e.g. potentially explosive atmospheres, work on live lines);
- c) transportation of passengers from one level to another;
- d) handling of loads, the nature of which could lead to dangerous situations (e.g. molten metal, acids/bases, radioactive materials, brittle loads);
- e) hazards occurring when handling suspended loads in conjunction with the suspended platform;
- f) hazards occurring when used on public roads, over water, or wherever it is not possible to lower the platform to a safe position;
- g) hazards arising from wind pressure acting on loads having a surface area in excess of 2 m²;
- h) SAE using cableless control systems.

The following applications for SAE are excluded from this standard:

- Access to working areas with an incline in excess of 45° compared to the vertical;
- Working platforms suspended by cranes;
- Silo access equipment;
- Access equipment using fibre ropes or chains for the suspension of the platform;
- SAE intended to be used underground;
- SAE powered by combustion engines;
- SAE intended to be used in shafts.

2 Normative references

^[A1] 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. ^[A1]

^[A1] EN 280:2001, *Mobile elevating work platforms — Design calculations — Stability criteria — Construction — Safety — Examinations and tests* ^[A1]

^[A1] *deleted text* ^[A1]

EN 294:1992, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*

EN 418:1992, *Emergency stop equipment, functional aspects — Principles for design*

EN 614-1:1995, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 954-1:1996, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

EN 982:1996, *Safety requirements for fluid power systems and their components — Hydraulics*

EN 983:1996, *Safety requirements for fluid power systems and their components — Pneumatics*

EN 1050:1996, *Safety of machinery — Risk assessment*

EN 60204-1:1992, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

EN 60529:1991, *Degrees of protection provided by enclosures (IP-code) (IEC 60529:1989)*

EN 60947-5-1:1991, *Low-voltage switchgear and controlgear — Part 5: Control circuit devices and switching elements — Section 1: Electromechanical control circuit devices and switching elements*

^[A1] *deleted text* ^[A1]

^[A1] 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)* ^[A1]

3 Definitions

For the purpose of this standard, the following definitions apply. They are classified in terms of key words.

3.1

building maintenance unit (BMU)

BMUs are SAE intended to be permanently installed and dedicated to a specific building or structure. BMUs consist of a platform, suspended from a suspension rig which is generally a trolley unit with hoist, operating either on rails or on a suitable surface, e.g. concrete track. Monorails with traversing trolleys or other suspension rigs, e.g. davits, fixed to the building, from which a platform may be suspended, shall be considered as parts of a BMU

NOTE BMU are intended to be used by operators for inspection, cleaning and maintenance of a building where the general public may have access below the suspended platform.

3.2

temporary suspended platforms (TSP)

TSPs are SAE which are temporarily installed on a building or structure for specific tasks. TSPs consist of a platform and suspension rig which are assembled prior to use on a work site. They are dismantled and removed from site on completion of the work for which they were installed

NOTE TSPs are intended to be used by operators for, e.g. construction, cladding, painting, maintenance and refurbishment of buildings, bridges, chimneys and other structures.

3.3 Personnel

3.3.1

competent person

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

3.3.2

operator

Designated person, suitably trained for working at height, qualified by knowledge and practical experience and provided with the necessary instructions to enable operations to be carried out on SAE

3.4 Hoist

3.4.1

drum hoist

hoist with a drum onto which the suspension ropes are reeled in one or more layers

3.4.2

traction hoist

assembly through which the wire rope is conveyed as a result of friction between the wire rope and the traction assembly, with no tail load

3.4.3

twin capstan drum hoist

hoist system which lifts and lowers the suspension rope by passing the rope around two gear driven grooved multi-wrap capstan drums, and transferred to a wire rope winder designed to apply a "tail load" to the capstan drum system

3.4.4

jaw operated traction hoist

hoist where the traction assembly consists of two pairs of jaws

3.4.5

prime mover

Source of power for the hoist, e.g. electric, hydraulic, pneumatic motors and hydraulic jack

3.4.6

rated speed

average speed measured during the upward and downward hoisting travel of the platform with its rated load for a travel length of 10 m or more and with the rated power supply applied

3.4.7

service brake

mechanical brake, automatically applied by stored energy (e.g. spring force) until released with an external sustained power supply (electrically, hydraulically, pneumatically, etc.) under the control of the operator or automatically

3.4.8

secondary device

device intended to stop the descent of the platform under emergency conditions, e.g. breaking of a suspension wire rope or failure of a hoist

3.4.8.1

fall arrest device

device acting directly on a secondary wire rope, which automatically stops and holds the platform

3.4.8.2

secondary brake

brake acting directly on the drum, traction sheave, or final drive shaft, intended to stop the descent of the platform

3.4.9

anti-tilt device

device which detects when the longitudinal slope of the platform exceeds a pre-set angle

3.4.10

no-power descent

manually operated system that allows controlled descent of a power operated platform

3.4.11

manual lever/wheel/handle

device on the hoist which allows the platform to be lifted or lowered manually

3.4.12

wire rope winder

storage drum onto which wire rope is reeled

3.4.13

cable reeler

storage drum onto which electric cable is reeled

3.4.14

hoist operation cycle (for test purposes only)

one cycle shall consist of lifting and lowering over a minimum vertical distance. This distance being where either:

- the wire rope passes through all wire rope related parts of the traction hoist and its pulleys and reeler system, or
- the wire rope passes through four turns around the drum hoist and its related pulleys

3.4.15

platform-mounted hoist

hoist which is mounted on the platform

3.4.16

roof-mounted hoist

hoist which is mounted on the suspension rig or trolley

3.4.17

overload detection device

device which trips and acts automatically to stop the upward motion of a platform if the load in the suspension wire rope(s) reach(es) the tripping limit

3.4.18

tripping limit

static load which causes the overload detection device to operate

3.5 Suspended platforms

3.5.1

suspended platform

that portion of the assembly designed to carry persons and their equipment

3.5.1.1

single point suspended platform

platform which incorporates 1 anchor point

3.5.1.2

double point suspended platform

platform which incorporates 2 anchor points

3.5.1.3

multi-point suspended platform

platform which incorporates 3 or more anchor points and which is not hinged

3.5.1.4

hinged continuous platform

long platform which incorporates more than 2 anchor points having articulated sections to ensure tension in each suspension wire rope

3.5.1.5

multi-deck suspended platform

platform made up of 2 or more decks, connected vertically (See Figure 17)

3.5.1.6

suspended chair

chair which incorporates one anchor point, for one person to use

3.5.1.7

cantilevered platform:

platform where the deck extends beyond the anchor point

3.5.2

restraint system

system attaching the suspended platform to the mullions or other fixtures on the building and which limits the lateral movement of the suspended platform due to the wind

3.5.3

suspension wire rope restraint system

vertical series of plugs on the building, each with a lanyard and end ring which is fitted to the suspension ropes on descent and removed on lifting (See Figure 19)

3.5.4

anchor point

point provided on the platform or chair for the independent attachment of the hoist(s)/suspension rope(s) and secondary rope(s)/fall arrest device(s)

3.6 Loads

3.6.1

total suspended load (TSL)

static force imposed on the suspension point(s), consisting of the rated load of the platform, the self-weight of the platform, the ancillary equipment, the wire ropes and the electric cable, if any

3.6.2

rated load (RL)

maximum mass which the suspended platform has been designed to carry as designed by the manufacturer. The rated load comprises persons and equipment

3.6.3

working load limit (WLL)

maximum load which a piece of equipment is authorised to sustain as designed by the manufacturer. The WLL is specified by the manufacturer

3.6.4

working coefficient

arithmetic ratio between the load guaranteed by the manufacturer up to which a piece of equipment or the SAE, is able to hold it and the WLL marked on a piece of equipment or SAE

3.6.5

test coefficient

arithmetic ratio between the load used to carry out the static or dynamic tests on a SAE or a piece of equipment, and the WLL marked on the SAE or a piece of equipment

3.6.6

static test

Test during which the SAE or a piece of equipment is first inspected and then subjected to a force corresponding to the WLL multiplied by the appropriate static test coefficient and then re-inspected once the said load has been released to ensure no damage has occurred

3.6.7

dynamic test

test during which the SAE is operated in all its possible configurations at WLL with account being taken of the dynamic behaviour of the SAE in order to check that the SAE and safety features are functioning properly

3.7 Steel wire ropes

3.7.1

calculated coefficient

ratio between the guaranteed breaking load of a steel wire rope and the maximum static force that shall be applied to that rope

3.7.2

guaranteed breaking load

breaking load of a steel wire rope guaranteed by the manufacturer

3.7.3

suspension rope

active steel wire rope carrying the suspended load

3.7.4

secondary rope

steel wire rope not normally carrying the suspended load but rigged in conjunction with a fall arrest device

3.7.5

single active rope suspension system

two steel wire ropes attached to a suspension point, one rope being the suspension rope and the other rope being the secondary rope

3.7.6

double active rope suspension system

two steel wire ropes attached to a suspension point and each carrying part of the suspended load

3.8 Suspension rig

3.8.1

suspension rig

that portion of the equipment from which the platform is suspended (excluding the track system)

3.8.2

trolley unit

suspension rig mounted on wheels which is capable of traversing

3.8.3

suspension point

designated area provided on the suspension rig assembly for the independent attachment of the suspension and secondary wire ropes, diverter pulleys or hoists

3.8.4

fulcrum

pivoting point or line about which the balancing moments of the suspension rig are calculated

3.8.5

stability coefficient

coefficient by which the overturning moment is multiplied

3.8.6

inboard portion

that portion of the suspension rig which is on the building side of the fulcrum

3.8.7

outboard portion

that portion of the suspension rig which projects from the fulcrum over the edge of the building

3.8.8

counterweights

weights which are attached to the suspension rig to counterbalance the overturning moment

3.8.9

counterweighted suspension beam

static beam where the stability is assured by counterweights

3.8.10

mechanically anchored suspension rig

structure where the stability is assured by a mechanical anchor

3.8.11

stationary suspension rig

structure which is positioned and fixed before suspending the platform

3.8.12

parapet clamp

structure attached to the roof parapet and dependent on the parapet for location and anchorage

3.8.13

davit

structure anchored to the roof (See Figure 12)

3.8.14

rail track

rails normally installed at roof level to support and guide a trolley unit

3.8.15

guide rail

rail normally installed at roof level to guide a trolley unit

3.8.16

monorail track

track normally fixed along the perimeter of a building at roof level to support and guide a traversing trolley

3.8.17

traversing trolley

wheeled block designed to run on a monorail track, used to suspend a platform below the monorail and to incorporate a traversing system for the platform

3.8.18

lifting

all operations which move a platform to a higher level

3.8.19

lowering

all operations which move a platform to a lower level

3.8.20

platform rotation

circular movement of the platform about its vertical axis passing through the platform itself

3.8.21

suspension rig slewing

circular horizontal movement of the suspension rig about a vertical axis

3.8.22

traversing

longitudinal movement of a suspension rig

3.8.23

luffing

rotational movement of the jib(s) about a horizontal axis to allow positioning of the platform

3.8.24

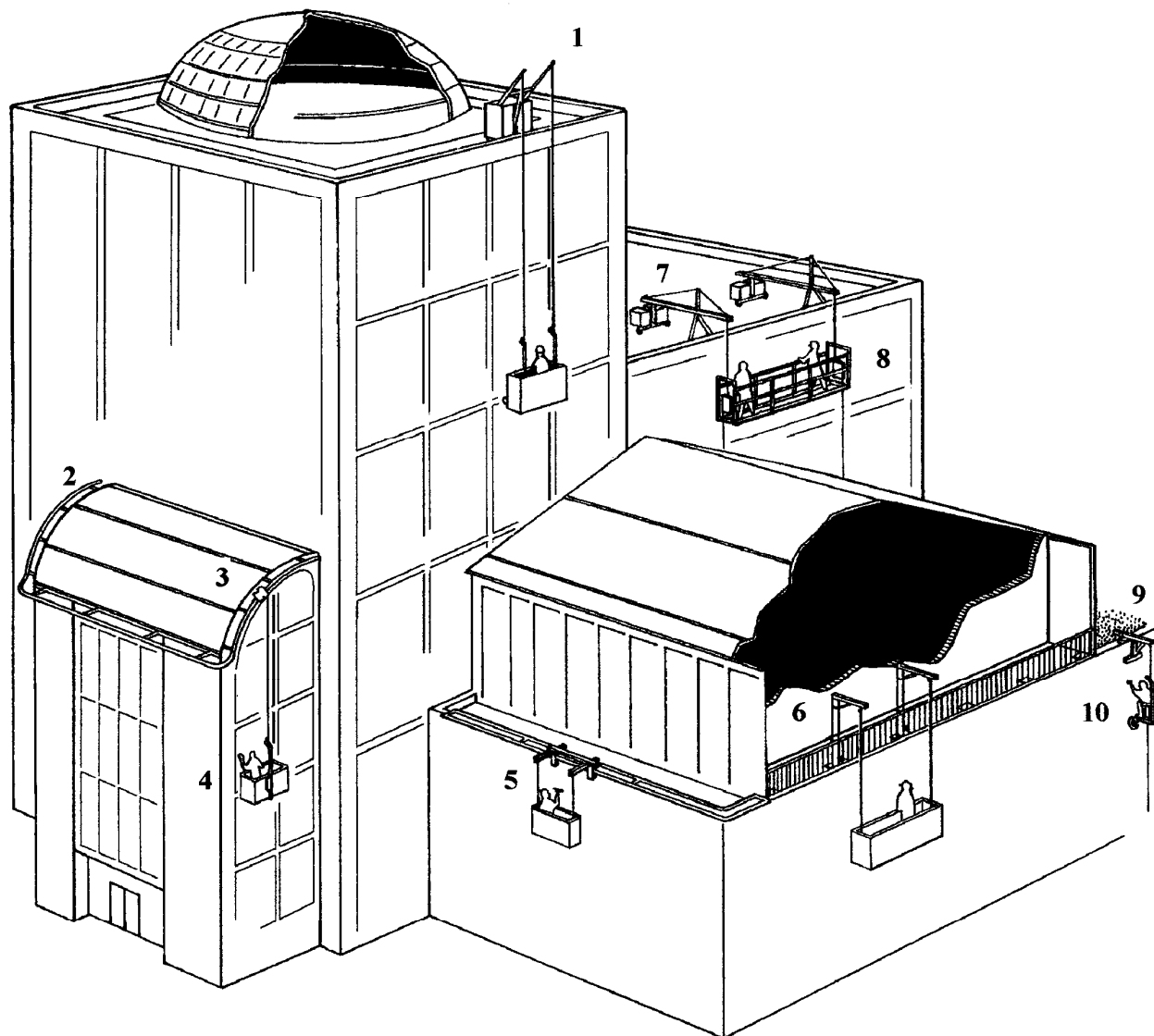
jib telescoping

movement to extend or retract a jib

3.8.25

jib slewing

circular movement of the jib relative to the suspension rig



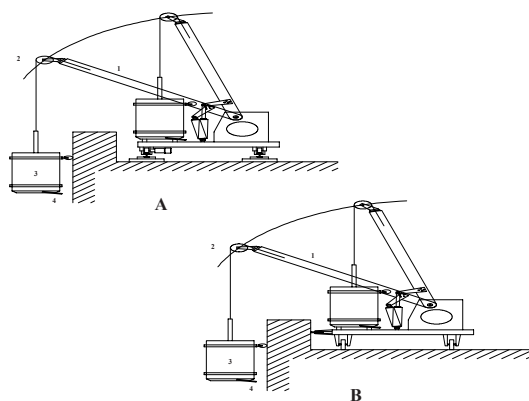
- 1 = Trolley unit
- 2 = Monorail track
- 3 = Traversing trolley
- 4 = Single point suspended platform
- 5 = Traversing trolley
- 6 = Fixed davit

Typical BMU

- 7 = Counterweighted suspension beam
- 8 = Suspended platform
- 9 = Parapet clamp
- 10 = Suspended chair

Typical TSP

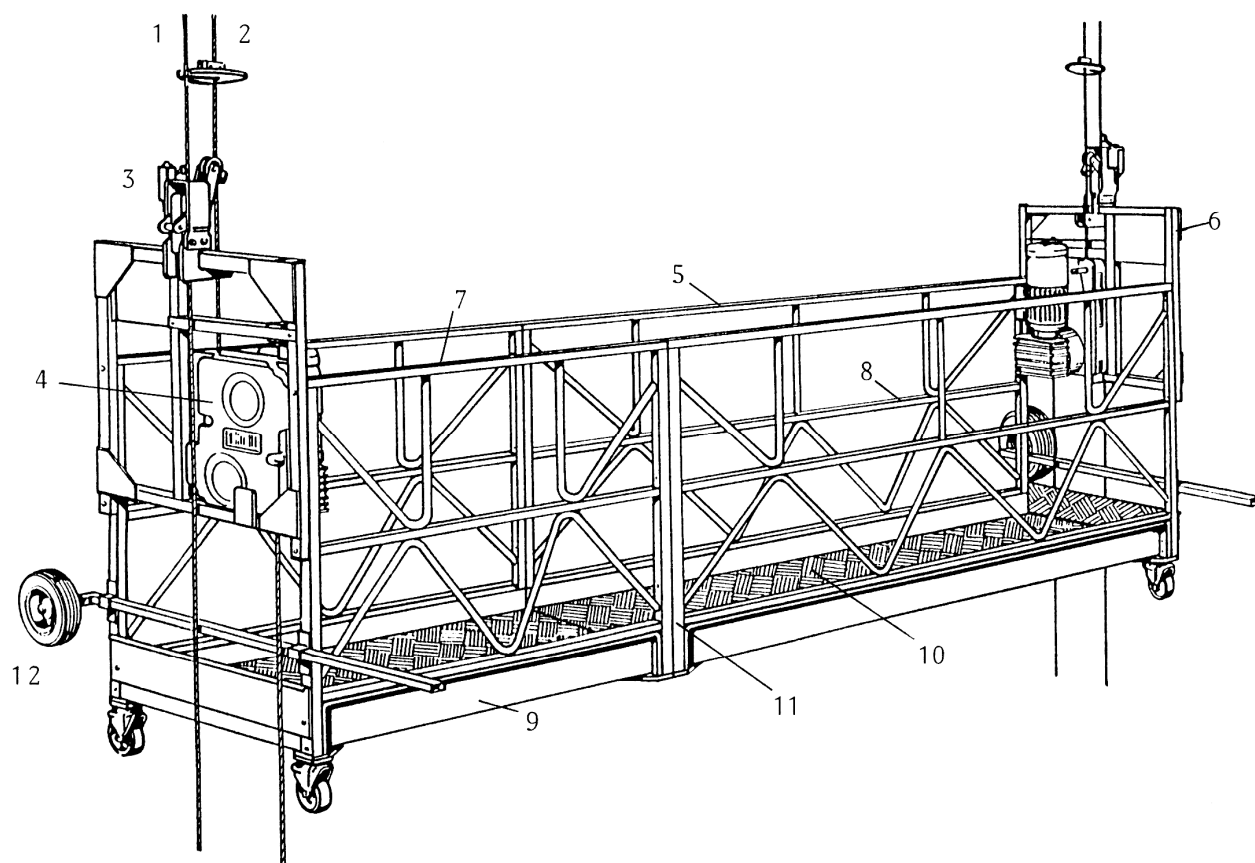
Figure 1 — Example of different types of SAE



1 = Luffing jib
2 = Pulley
3 = Suspended platform
4 = Anticollision device

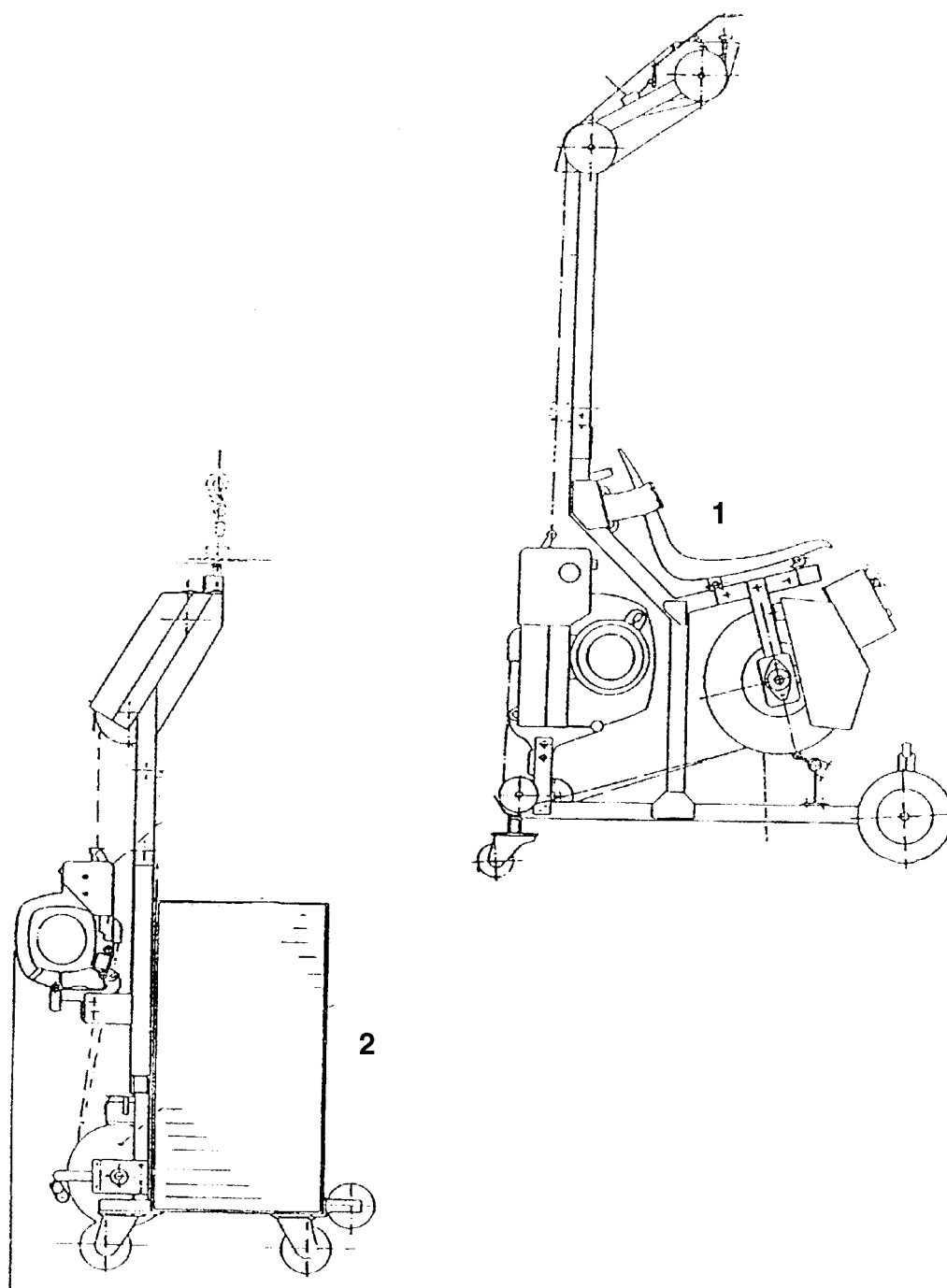
A = on rails, B = on concrete track

Figure 2 — Example of trolley unit (power operated)



- | | |
|--------------------------|-----------------------------|
| 1 = Secondary wire rope | 7 = Rear guard rail |
| 2 = Suspension wire rope | 8 = Intermediate guard rail |
| 3 = Fall arrest device | 9 = Toe guard |
| 4 = Traction hoist | 10 = Decking |
| 5 = Front guard rail | 11 = Vertical member |
| 6 = Stirrup | 12 = Stabilizing device |

Figure 3 — Example of typical TSP platform



2 = Single point suspended platform 1 = Suspended chair

Figure 4 — Example of typical single point suspended platform and suspended chair

3.9 Symbols and abbreviations

A	Area exposed to wind	(m ²)
a	Deflection of the platform under load	(mm)
B	Width of the platform	(m)
b	Residual deflection of the platform	(mm)
BMU	Building Maintenance Unit	(-)
c	Shape factor	(-)
Cwr	Working coefficient for suspension rig	(-)
D	Pitch diameter on pulley or drum hoist	(mm)
d	Nominal diameter of wire rope	(mm)
F	Force	(N)
Fh	Horizontal force	(N)
Fo	Minimum guaranteed breaking load of wire rope	(N)
Fv	Vertical force	(N)
Fs	Shearing force	(N)
Fw1	Wind force in service	(N)
Fw2	Wind force out of service	(N)
H	Pitch ratio	(-)
L	Length of platform	(m)
Lb	Distance between fulcrum and the point where the selfweight of the suspension rig acts	(m)
Lc	Length of cantilevered section of platform	(m)
Lf	Free span of guard rail between two vertical members	(m)
Li	Length of inboard portion of suspension rig	(m)
Lo	Length of outboard portion of suspension rig	(m)
Lpi/Lpo	Horizontal projection between the fulcrum line and the point where SWP/W acts	(m)
Ls	Distance between the bolts or supports which withstand the overturning moment	(m)
Lmi/Lmo/ Ls1/LW	Horizontal projection between the fulcrum and the point where SL, Mi, Mo and Fw act	(m)

Mc	Mass of electric cable	(kg)
Me	The minimum weight of personal equipment	(kg)
Mi	Mass of inboard portion of suspension rig	(kg)
Mm	Mass of material on work platform	(kg)
Mo	Mass of outboard portion of suspension rig	(kg)
Mp	Assumed mass of a person	(kg)
Mw	Mass of the counterweights	(kg)
Mwr	Mass of wire ropes when the platform is completely lowered	(kg)
n	Number of persons on the platform	(-)
Nr	Number of steel wire ropes or falls supporting the platform	(-)
q	Wind pressure	(N/m ²)
Ra	Standard of smoothness	(μm)
RF	Minimum load capacity of platform deck	(kg/m ²)
Rh	Horizontal support reaction on suspension rig	(N)
RL	Platform Rated Load	(kg)
Rv	Vertical support reaction on suspension rig	(N)
S	Maximum static force in the wire rope	(N)
Sa	Surface of deck	(m ²)
SAE	Suspended Access Equipment	(-)
Sd	Shock load coefficient	(-)
SWR	Mass of suspension rig	(kg)
SWP	Mass of the platform	(kg)
T	Length over which the load is distributed	(m)
Tm	Maximum traction force in the wire rope	(N)
TSL	Total suspended load	(kg)
TSP	Temporary Suspended Platform	(-)
v	Wind speed	(m/s)
W	Save working load on the cantilevered deck	(kg)
WLL	Working Load Limit	(kg)

Wtd	Dynamic test load	(kg)
Wts	Static test load	(kg)
Zp	Calculated coefficient of steel wire rope	()
σ_E	Elastic yield limit	(N/mm ²)
σ_R	Breaking limit	(N/mm ²)
σ_a	Allowable stress	(N/mm ²)
v_E	Safety coefficient compared to elastic yield limit	(-)
v_R	Safety coefficient compared to breaking limit	(-)

4 List of hazards

This chapter contains hazards and hazardous situations, identified by risk assessments significant for SAE and which require action to eliminate or reduce risk.

A hazard which is not relevant (NR), is not significant (NS) or not dealt with (ND) is shown in the corresponding requirements column of Table 1.

Table 1 — List of hazards

Line No.	HAZARDS	Relevant clauses in this standard
1	Mechanical hazards	
1.1	Generated by machine parts or workpieces caused by	
1.1.1	Shape	0, 9.3.1
1.1.2	Mass and stability (potential energy of elements which may move under the effect of gravity)	See Line 27.1.1 of this table
1.1.3	Inadequacy of mechanical strength	See Line 27.4 of this table
1.2	Accumulation of energy inside the machinery caused by	
1.2.1	Elastic elements (springs) loaded wire rope winder	14.7
1.2.2	Liquid and gases under pressure	10.2
1.3	Elementary forms of mechanical hazards	
1.3.1	Crushing hazard due to lack of clearance	9.2.1.5
1.3.2	Shearing hazard	8.1.4, 8.10.6
1.3.3	Cutting or severing hazard	8.1.4, 8.10.6
1.3.4	Entanglement hazard	8.1.4
1.3.5	Drawing in or trapping hazard	8.3.4
1.3.6	Impact hazards due to swinging of the platform against the facade	7.7, 7.8
1.3.7	Stabbing or puncture hazard	NS

Line No.	HAZARDS	Relevant clauses in this standard
1.3.8	Friction or abrasion hazard	NS
1.3.9	High pressure fluid injection or ejection	10.2
2	Electrical hazards	
2.1	Contact of persons with live parts (direct contact) shall be considered in relation to the degree of protection	10.1.5
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact) shall be considered in relation to: main power supply protection continuity of the protective bonding circuit	10.1.2 14.4
2.3	Approach to live parts under high voltage	ND
2.4	Electrostatic phenomena	NR
2.5	Thermal radiation or other phenomena such as the projection of molten particles and chemical effects from short circuits, overloads, etc.	NS
3	Thermal hazards resulting in: burns by a possible contact of persons	NS
4	Hazard generated by noise	9.1.4.1
5	Hazard generated by vibration	NS
6	Hazard generated by radiation	ND
7	Hazard generated by materials and substances	ND
8	Hazard generated by neglecting ergonomic principles in machinery design as hazards from	
8.1	Unhealthy postures or excessive effort: minimum free height maximum force applied to a crank or lever maximum weight of portable components	7.6.3, 7.5.2 8.2.2, 8.2.3 9.3.2, 9.3.4
8.2	Inadequate consideration of hand-arm or foot-leg anatomy: platform dimensions	7.1
8.3	Neglected use of personal protection equipment	14.6
8.4	Inadequate local lighting	14.6
8.5	Mental overload and underload stress	14.6
8.6	Human error, human behaviour unintentional command by the operator assembly of modular platforms using fool-proof connections	11.2 11.1, 11.3, 11.4 11.5 7.2.1
9	Combination of hazards	ND

Line No.	HAZARDS	Relevant clauses in this standard
10	Unexpected start-up, unexpected overrun/over-speed	
10.1	Failure/disorder of the control system may result: in being trapped on the platform in unintentional movement	11.8 11.8
10.2	Restoration of energy supply after interruption	11.8
10.3	External influences on electrical equipment	10.1.5, 11.8
10.4	Other external influences	Annex D
10.5	Error in the software	11.8
10.6	Errors made by the operator (due to mismatch of machinery with human characteristics and ability)	NR
11	Impossibility of stopping the machine in the best possible condition	8.1.6, 8.3.2, 11.1 11.6, 11.8
12	Variations in the rotational speed of tools	NR
13	Failure of the power supply	8.3.4, 9.2.2.2
14	Failure of the control circuit	11.8
15	Errors of fitting	7.2.1, 14.4
16	Break-up during operation	11.8, 14.6
17	Falling or ejected objects or fluid	7.1
18	Loss of stability/overturning of machinery	<i>See Line 27.1.1 of this table</i>
19	Slip, trip and fall of persons	<i>See Line 27.2 of this table</i>
	Additional hazards and hazardous events due to mobility	
20	Relating to the travelling function	
20.1	Excessive speed of pedestrian controlled machinery	9.2.1.6.1
20.2	Excessive oscillation of platform when moving	9.2.1.6.1, 9.2.1.7, 9.2.1.8.1
20.3	Insufficient ability of machinery to be slowed down, stopped and immobilised	8.1.6, 8.3.2, 8.3.3, 9.2.1.6.2, 9.2.1.8.2
21	Linked to work position	
21.1	Fall of persons during access to the work position	9.2.2.2, 9.2.3.2
21.2	Mechanical hazards at the work position: contact with the wheels contact of persons with machine pedestrian controlled machines	9.2.1.5 9.2.1.6.4 9.2.1.6.3
21.3	Insufficient visibility from work position	ND
21.4	Inadequate seating	7.6

Line No.	HAZARDS	Relevant clauses in this standard
22	Due to the control system	
22.1	Inadequate location of controls/control devices	11.4
23	From handling the machine, lack of stability	14.3
24	Due to the power source and to the transmission of power	
24.1	Hazards from the batteries	9.1.4.3
25	From/to third persons	
25.1	Unauthorised start up/use	9.3.3.2, 11.4, 14.6
25.2	Lack or inadequacy of visual or acoustic warning means	8.3.5.7, 9.2.1.6.3, 13
26	Insufficient instructions for the operator	14.6
	Additional hazards and hazardous events due to lifting	
27	Mechanical hazards and hazardous events	
27.1	Hazards due to falling caused by:	
27.1.1	Lack of stability due to: - an excess of overhang - an insufficient quantity of counterweights - counterweights not properly located and fixed - insufficient strength of building structure	13.2.5 6.5 9.2.1.9, 9.3.3.2 14.4
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded due to: - unknown weight of load - underhooking of the platform - interaction of two or more hoists with unequal load distribution on platform - load self-oscillation in the rope by rapid switching of UP/DOWN controls	8.3.5
27.1.3	Uncontrolled amplitude of movements	8.3.10, 9.1.1
27.1.4	Unexpected/unintended movements of loads	8.9.1
27.1.5	Inadequate holding devices /accessories	8.1.6, 8.3.2, 8.3.3
27.2	From lifting of persons, and hazards due to falling shall be considered in relation to:	
27.2.1	Decking, sides guard rails and toe boards of platform	7.1, 7.4, 7.6
27.2.2	Control of the platform level	8.3.8, 8.9.3
27.2.3	Safe access to the platform	7.4, 9.2.3.2
27.2.4	Safe access to the wire rope anchorage points	9.2.3.3
27.2.5	Falling objects from the platform	7.1, 7.2.3
27.3	From derailment	9.2.1
27.4	From insufficient mechanical strength of parts	6
27.5	From inadequate design of pulleys, hoists	8
27.6	From inadequate selection/integration into the machine of	6.6, 6.8

Line No.	HAZARDS	Relevant clauses in this standard
	chains, ropes, lifting accessories	
27.7	From lowering of the load by friction brake	8.1.6
27.8	From abnormal conditions of assembly/testing use/maintenance. Mixing of inadequate components	14.2, 14.4
27.9	From load-person interference (impact by load counterweight)	8.1.2, 9.3.3.2
28	Electrical hazard	
28.1	From lightning	14.2
29	Hazards generated by neglecting ergonomic principles	<i>See Line 8.1 of this table</i>
29.1	Insufficient visibility for the operator	NS

5 Safety requirements and/or measures

The SAE shall meet the requirements detailed in clauses 6 to 14. ^{A1} In addition, machines shall comply, as appropriate, with EN ISO 12100-1 and EN ISO 12100-2 for hazards which are not covered by this European Standard. ^{A1}

6 Structural, stability and mechanical calculations

6.1 General

The calculations shall be carried out in accordance with the accepted calculation codes and engineering practices including if necessary the effect of the elastic deformations. All failure modes of the material shall be considered including fatigue and wear.

In the absence of a harmonised standard, relevant FEM rules for the method of calculation of lifting equipment are referred to. The load cases are specified in this standard:

FEM 9.511 Classification of Mechanisms;

FEM 9.341 Local girder stresses;

FEM 1.001, booklet 2. Classification and loading on structures and mechanisms;

FEM 1.001, booklet 3. Calculating the stresses in structures;

FEM 1.001, booklet 4. Checking for fatigue and choice of mechanism components.

The design calculations shall be carried out in accordance with the permissible stress method and if the limit state method is used it shall result in the same level of safety.

6.2 Safety margin allowed within the calculation

6.2.1 Calculating the stresses in structures

See also FEM 1.001 booklet 3.

For the 3 load cases defined in Table 2, the calculation of the different members is set out, allowing a safety margin for the critical stresses, taking the 3 failure modes into account:

- yield strength exceeded;
- critical load for buckling exceeded;
- fatigue limit exceeded.

6.2.1.1 Type of steel for which the ratio between the elastic yield limit σ_E and the breaking limit σ_R is less than 0,7 (Where the result is higher than 0,7 refer to FEM 1.001 booklet 2.).

The calculated stress must not exceed the allowable stress σ_a obtained by dividing σ_E by a coefficient depending on the load cases set out in Table 2 except as otherwise indicated in the standard.

Table 2 — Value of V_E

	Load case 1	Load case 2	Load case 3
Value of v_E	1,5	1,33	1
Allowable stress σ_a	$\sigma_E / 1,5$	$\sigma_E / 1,33$	σ_E

Load case 1: in service conditions, SAE with RL, affected by wind.

Load case 2: under occasional conditions e.g. static and dynamic tests, tripping of overload detection device.

Load case 3: under extreme conditions e.g. operation of the secondary device, out of service wind.

6.2.1.2 Checks against fatigue

For structures subject to fatigue, the conventional number of cycles and load spectrum to take into account are set out in Table 3.

Table 3 — Parameters for checking against fatigue

Type of SAE	Number of loading cycles	Load spectrum
TSP	30.000 (U1)	Q3
BMU	60.000 (U2)	Q4

6.2.2 Calculating the stress in mechanisms

Mechanical parts are calculated by checking that they have a sufficient safety margin compared to the failure modes arising from breaking, buckling, fatigue and wear.

6.2.2.1 Check against breaking

Verifying the mechanical parts against breaking are carried out by checking that the calculated stress does not exceed the allowable stress taking into account the breaking stress of the material used.

The value of the allowable stress σ_a is given in the following formula:

$$\sigma_a = \frac{\sigma_R}{v_R}$$

Table 4 — Parameters for checking against breaking

	Load case 1	Load case 2	Load case 3
Value of v_R	4	2.2	1.5
Allowable stress	$\sigma_R/4$	$\sigma_R/2.2$	$\sigma_R/1.5$

6.2.2.2 Checks against fatigue and wear

For mechanical parts subject to fatigue, the conventional number of cycles and load spectrum to take into account are set out in Table 5.

Table 5 — Parameters for checks against fatigue and wear

Type of SAE	Number of loading cycles	Total operating time (hours)	Load spectrum
TSP	30.000	2000 (T4)	L3
BMU	60.000	4000 (T5)	L4

6.3 Design loads and forces**6.3.1 General**

The rated load (RL) of the platform and the maximum number of persons on the platform are to be stated by the manufacturer.

Since TSPs are modular equipment the WLL of the suspension rig and its accessories shall be equal to or greater than the WLL of the hoist(s) which shall be equal to or greater than the reactions transmitted by the suspended platform. There shall be compatibility between the WLL of the hoist(s) and the loading range of the platform.

NOTE For purposes of calculations of SAE covered by this standard it is considered that a mass of 1 kg produces a force of 10 N

6.3.2 Rated load on the platform**6.3.2.1 Platform for one person:**

$$RL = Mp + Me + Mm \quad \dots \quad (1)$$

Platform for two or more persons:

$$RL = (n \times Mp) + (2 \times Me) + Mm \quad \dots \quad (2)$$