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Aircraft ground equipment — Basic requirements —

Part 2: Safety requirements

Matériel au sol pour aéronefs — Exigences de base —

Partie 2: Exigences de sécurité

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

This second edition cancels and replaces the first edition (ISO 6966-2:2005), which has been technically revised for increased harmonization with EN 1915-1:2013.

ISO 6966 consists of the following parts, under the general title *Aircraft ground equipment — Basic requirements*:

— *Part 1: General design requirements*

— *Part 2: Safety requirements*

Annex A of this part of ISO 6966 is for information only.

Introduction

This part of ISO 6966 specifies the safety requirements to be taken into account by manufacturers for the design of aircraft ground support equipment. It identifies the various concerns to be taken into consideration to ensure ground equipment safety for operators and aircraft.

Throughout this International Standard, the minimum essential criteria are identified by use of the keyword “shall”. Recommended criteria are identified by use of the key word “should” and, while not mandatory, are considered to be of primary importance in providing safe, economical, and usable aircraft ground support equipment. Deviation from recommended criteria should only occur after careful consideration and thorough service evaluation have shown alternate methods to provide an equivalent level of safety.

The requirements of this International Standard are expressed in the applicable SI units, with approximate inch-pound units conversion between brackets for convenience in those countries using that system. Where it is deemed necessary to use exact values, the SI unit ones are to be used.

Aircraft ground equipment — Basic requirements —

Part 2: Safety requirements

1 Scope

This part of ISO 6966 specifies the minimum design requirements applicable to all aircraft ground support equipment (GSE), as defined in 3.1 hereafter, in order to ensure

a) safety of staff operating or maintaining the equipment or in its vicinity, and

b) protection of aircraft against interference or damage.

An informative list of the most commonly used pieces of ground equipment is provided in Annex A hereafter. Nevertheless, the requirements of this part of ISO 6966 apply to any piece of aircraft ground support equipment, as defined, used on airports.

This part of ISO 6966 does not intend to provide all the design requirements applicable for aircraft ground support equipment. Other requirements apply, and can be found in separate International Standards:

— ISO 6966-1 specifies the general, other than safety-related, requirements applicable to all aircraft ground support equipment;

— ISO 4116 specifies the additional requirements applicable for conveying surfaces of those pieces of aircraft ground support equipment intended for handling and loading of baggage and cargo unit load devices;

— specific International Standards, listed in the Bibliography, define the functional and performance requirements for certain types of aircraft ground support equipment.

In most countries, standing Government Health and Safety laws and regulations apply to machinery, implicitly or explicitly, including aircraft ground support equipment. Nothing in this part of ISO 6966, however, shall be deemed or otherwise used to supersede any locally applicable law or regulation, unless a specific exemption has been obtained for this purpose from the appropriate Authority.

This part of ISO 6966 does not apply to automotive vehicles or parts thereof approved for public vehicles, when used on aircraft ground support equipment for the purpose for which they are designed.

2 Normative references

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

ISO 3411, *Earth-moving machinery — Physical dimensions of operators and minimum operator space envelope*

ISO 3457, *Earth-moving machinery — Guards — Definitions and requirements*

ISO 3746, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

ISO 3795, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 6682, *Earth-moving machinery — Zones of comfort and reach for controls*

ISO 6966-1:2005, *Aircraft ground equipment — Basic requirements — Part 1: General design requirements*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 7731:2003, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

ISO 10254, *Air cargo and ground equipment — Vocabulary*

ISO 11228-2, *Ergonomics — Manual handling — Part 2: Pushing and pulling*

ISO 11532, *Aircraft ground equipment — Graphical symbols*

ISO 11995:1996, *Aircraft — Stability requirements for loading and servicing equipment*

ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*

ISO 14121-1, *Safety of machinery — Risk assessment — Part 1: Principles*

ISO 14122-1:2001, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means of access between two levels*

ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

IEC 60825-1, *Safety of laser products — Part 1: Equipment classification and requirements*

ECE 43[1)], *Uniform provisions concerning the approval of safety glazing and glazing material*

ECE 79[1)], *Uniform provisions concerning the approval of vehicles with regard to steering equipment*

ECE 104[1)], *Uniform provisions concerning the approval of retro-reflective markings for heavy and long vehicles and their trailers*

EN 1915-1:2013[2)], *Aircraft ground support equipment - General requirements — Part 1: Basic safety requirements*

EN 1915-2[2)], *Aircraft ground support equipment — General requirements — Part 2: Stability and strength requirements, calculations and test methods*

EN 1915-3[2)], *Aircraft ground support equipment — General requirements — Part 3: Vibration measurement methods and reduction*

DIN 51130:2014[3)], *Testing of floor coverings — Determination of the anti-slip property — Workrooms and fields of activities with slip danger, walking method — Ramp test*

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1) ECE 43, 79, and 104 are part of the United Nations Economic Commission for Europe agreement concerning the adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicles equipment and parts, and can be obtained from any United Nations office.

2) CEN European standards can be obtained from: Comité Européen de Normalization, Avenue Marnix 17, B-1000 Brussels, Belgium, or any of the European national standardization institutes, members of C.E.N.: Austria, Belgium, Bulgaria, Croatia, 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 United Kingdom.

3) DIN 51130 can be obtained from: Deutsches Institut für Normen, Burggrafenstrasse 6, D-10787 Berlin, Germany.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6966-1 and ISO 10254 and the following apply.

3.1
aircraft ground support equipment
GSE
ground equipment
ramp equipment, en US
any piece of mobile equipment, whether or not powered or self-propelled, purpose designed, built, and used for ground handling, servicing, or field maintenance of civil transport aircraft on the ramp area of an airport

Note 1 to entry: A non-comprehensive informative list of the most commonly used pieces of ground equipment is provided in Annex A hereafter.

3.2
ramp area
traffic area
apron, en GB
zone of an airport where aircraft manoeuvre and park for ground handling purposes

3.3
ramp
apron, en GB
tarmac, en US
surface of the ground in the ramp area

3.4
equipment restraint area
ERA
part of the ramp area located less than 7,5 m (25 ft) away from a parked aircraft, as defined by Airports Council International (ACI) Apron Markings and Signs Handbook (see Reference [20]), where vehicles and equipment are not to exceed a walking speed

3.5
service road
restricted access roadway used by airport equipment and vehicles to reach parts of the ramp area, as opposed to public roads

3.6
back-up
alternate system, which can include additional means exterior to the GSE, to ensure a GSE function in the event of failure of the system concerned

3.7
emergency
hazardous situation where time is of the essence to protect safety of persons and/or the aircraft

Note 1 to entry: Emergencies can include a need for immediate evacuation of persons.

3.8
braking ratio
ratio of the sum of the braking forces on the wheels circumference, divided by GSE weight (including maximum payload if designed for being driven with it), multiplied by 100

Note 1 to entry: It is expressed in per cent (%).

3.9
rated load
maximum mass (including persons) a vehicle is intended to carry

Note 1 to entry: It is the lowest of applicable constraints, general structural strength (including lifting), capability of usable floor surfaces, vehicle's driving gross mass, maximum allowable occupancy (e.g. emergency exits), etc.

3.10
aircraft contact
position where a part of the equipment is less than 120 mm (5 in) away from the aircraft fuselage skin

Note 1 to entry: It includes positions where actual physical contact is achieved.

4 Requirements

4.1 General

4.1.1 Considerable importance is attached to having aircraft ground support equipment into which the essential safety aspects have been incorporated as part of the basic design (design to safety). It is particularly necessary when designing aircraft GSE to take into account the adverse conditions which frequently prevail in airport ramp areas, e.g. congested vehicle movement, exposure to weather, night operation, noise from aircraft and other vehicles, and difficult communications.

4.1.2 Design to safety should be based on a specific comprehensive risk assessment for each type of aircraft GSE, to be conducted by the manufacturer in accordance with ISO 14121-1. The retained design should be commensurate with the results of the risk assessment, as well as take into account, if applicable, each area of potential concern listed hereafter.

4.1.3 Design should aim at providing intrinsically safe equipment, i.e. one where potentially unsafe occurrences are prevented by basic design features such as equipment and components geometry, layout, or mode of operation, minimizing inasmuch as feasible the necessity to use additive safety devices or circuits. Where such additional devices or circuits dedicated to safety purposes cannot be avoided, risk assessment shall include an evaluation of any potential drawbacks or unforeseen additional hazards resulting from this addition.

4.1.4 All equipment or any component thereof, the failure of which could be hazardous, shall be designed to be fail-safe, or, where impractical, duplicated. In the event of duplication, each of the duplicated components shall separately be capable of safely performing its function in the event of its alternate's failure.

4.1.5 The contents of this part of ISO 6966 were determined taking into account generally recognized assumptions as to the following:

a) the normally intended use of aircraft ground support equipment, when used on the ramp of international civil airports in order to handle, service, or maintain civil transport aircraft;

b) the foreseeable risks of equipment misuse evidenced by operating experience;

c) the environmental (surface, slope, weather, lighting, operating rules, staff qualification, etc.) conditions prevailing on the ramp area of the majority of international civil airports.

Manufacturers of aircraft ground support equipment should define in the relevant documentation (see Clause 6) the specifically intended conditions of use and environment for each equipment, and purchasers systematically review their own specific conditions of use and environment in order to determine

whether those stated are adequate, or negotiate with the manufacturer appropriate modifications to ensure they are.

NOTE For intended operation in Europe, additional EU Machinery Directive (see Reference [31]) requirements also legally apply. They can be met by complying with the requirements of European standards EN 1915-1, EN 1915-2, EN 1915-3, and EN 1915-4.

4.2 Personnel accommodation

4.2.1 Work areas

4.2.1.1 All personnel working surfaces, including work platforms, walkways, steps, landings, and crossings as well as stairs, ramps, ladder rungs, cleats, or treads shall be self-draining and have a high traction (non-slip) surface.

The operator's workplace as well as all work platform areas, including standing areas and walkways where staff is allowed at least in certain circumstances, shall have a durably slip-resistant floor surface, with a minimum R11 slip-resistance classification in accordance with DIN 51130:2014, Table 3.

Surfaces not allowed to staff shall as far as possible be made inaccessible, or if not possible be clearly marked.

4.2.1.2 Walkways shall have a minimum width of 0,4 m (16 in), except on unit load devices conveying surfaces where they shall have a minimum width of 0,3 m (12 in), and elbow/shoulder minimum passage width of 0,6 m (24 in) in a height range of 0,8 m (32 in) to 1,6 m (64 in) over the floor. Standing areas and landings shall have minimum floor dimensions of 0,4 m × 0,5 m (16 in × 20 in), and the elbow/shoulder space minimum criteria shall be met.

4.2.1.3 Ladder and stair treads shall be designed to support a minimum load of 890 N (200 lb). Landings and all personnel working surfaces shall be designed to support a minimum load of 1 100 N (250 lb) for each person occupying said landing and/or working surface at the same time, and withstand a minimum distributed load of 3 000 $N \cdot m^{-2}$ (63 lb/ft^2) over their whole surface, without incurring permanent deflection.

4.2.1.4 All operational personnel work platforms and walkways where there is a possibility of falling from a height exceeding 1,0 m (40 in) shall be protected against this risk in accordance with 4.5.2.

4.2.1.5 On vehicles with an open cabin, a hip guard shall be provided on the outside edge of the outer seat(s), with a minimum height of 80 mm (3 in) above the seat surface.

4.2.1.6 The access means to be used while operating the equipment shall meet the requirements of 4.5.3. Additional exterior access means may be used where access is needed for maintenance purposes only.

4.2.2 Driver/operator cabin

4.2.2.1 Where a cabin is provided, the minimum size of the driver's or operator's space envelope shall conform to the requirements of ISO 3411. For seated accommodation, individual restraint systems (safety belts) should be provided in accordance with locally applicable regulations.

4.2.2.2 Where transport of persons other than the driver/operator is specified, the GSE shall be equipped with

— seats, with a restraint system when located in the outer position directly behind the windshield, or

— standing accommodation with appropriate handholds.

4.2.2.3 All glass in doors and windows shall be safety glass meeting the requirements of ECE 43, or alternative material (e.g. polycarbonate) with at least the same performance characteristics. The windshield and all windows considered to be important for the driver's field of view when travelling shall be transparent and as distortion-free as possible.

4.2.2.4 When selecting driver or operator seats, consideration should be given to

— providing adjustment to the person's size and weight, and maintaining ergonomic access to controls regardless of the person's size, and

— protection against the vibrations encountered during vehicle travelling or operation (see 4.5.6).

4.2.2.5 The floor, upholstery, and insulation of enclosed cabins shall consist of flame retardant material that has a horizontal burning rate not greater than 250 mm (10 in) per min in accordance with ISO 3795.

4.2.2.6 The inside of the cabin shall not include any sharp edges or protrusions. All corners or edges shall be chamfered or rounded with a minimum radius of 6 mm (1/4 in), unless smooth corners are provided by the intrinsic design of the standard material profiles used in the construction.

4.2.2.7 Fully enclosed driver/operator cabins with doors shall meet the following additional requirements.

a) Devices, e.g. wiper, washing units, demister, window de-icing systems, etc., shall be provided to keep clear the windshield (see 4.2.3.2) and all windows necessary for operating the GSE, taking into account the operational and climatic conditions of the intended place of use.

b) Outward opening doors shall not open backward. All doors shall be provided with securing devices to retain them in the closed and, where required, in the open position (see 4.4.1.1).

c) Door mechanisms shall be designed and fitted in such a way that opening is only possible on intentional action and risk of injury is avoided.

d) An adequately sized system for cabin ventilation shall be provided. Provisions shall be made for heating and/or air conditioning where appropriate for the intended place of use. If fuel heaters are used, combustion air shall not be taken from the interior of the cabin, and it shall not be possible for exhaust fumes to escape into the heating air. In the event of burner flame-out, fuel supply shall be automatically cut off. Open flame heaters are prohibited in the vicinity of aircraft.

4.2.3 Visibility

4.2.3.1 Vehicle drivers and operators shall have clear and unimpaired visibility when travelling or operating the unit. The shape and arrangement of any driver's or operator's cabin shall not restrict the field of view for travel or operation. Where this cannot be achieved directly or through mirrors, other means such as closed-circuit TV shall be considered. There shall at least be mirrors designed and fitted in such a way that the driver is able to observe the rear sideward areas.

4.2.3.2 Any vehicle equipped with a windshield shall be provided with a powered windshield wiper giving a wipe area of no less than 60 % of the glazed area. A sun visor of suitable size shall be provided. Overhead view panels should also be fitted with wiping and, where climatic conditions require, defroster mechanisms.

4.2.3.3 All windows affecting the driver's or operator's field of view shall be transparent and distortion free. On vehicles equipped with an enclosed cabin, the windshield shall be provided with a defogger and/or defroster.

4.2.3.4 Lighting shall be arranged in such a way that no disturbing dazzling effect is caused in conjunction with the windshield and other windows that are in the driver's field of view.

4.2.3.5 Passive visibility of the vehicle at night or by poor visibility shall be enhanced by fluorescent paint, using safety colours in accordance with ISO 7010, or preferably retro-reflective material in accordance with ECE 104, being applied on all its outer corners.

4.2.4 Controls

4.2.4.1 Controls and warning lights shall be grouped and located so as to be convenient to the operator from his normal operating station or stations, within his reach in accordance with ISO 6682. All control device actuators shall be constructed and mounted so as to minimize the risk of inadvertent operation.

4.2.4.2 Where there is more than one control station, interlocks shall be provided at each station to render inoperative the controls of all other stations. The interlock systems shall ensure the performance level (PLr) required for the function(s) concerned, determined according to ISO 13849-1 (see 4.4.3).

4.2.4.3 Controls and warning lights shall be properly and permanently identified, preferably by graphic symbols in accordance with ISO 11532.

NOTE IATA Airport handling Manual (AHM) 915 (see Reference [22]) provides recommendations for the respective layout of controls and displays on control panels.

4.2.4.4 Controls and controlling circuits shall be designed in such a manner that failure within a control or its circuitry will not introduce an unsafe operating condition.

4.2.4.5 All operational controls shall move in the direction of travel for the function which they control. As an exception, the transmission shift lever sequence on automatic transmissions of vehicles may conform to local highway vehicles practice with a shift positions sequence P, R, N, D, L starting from the front of the vehicle.

4.2.4.6 All controls for movements except travelling functions shall be designed so that when they have been released, the energy initiating the controlled movement is cut off ("hold-to-run" or "deadman" type). Controls with a lock-on facility shall be used only if functionally required and if other measures were taken to reduce the risk. In this case, such set controls shall be detented or similarly locked into the operating position to prevent inadvertent deactivation or reversing, and remain readily available to the operator(s). Operating controls used only in emergencies need not meet this requirement.

4.2.4.7 On-off switches shall be "on" in the up position, or away from the operator if mounted on a horizontal plane.

4.2.4.8 Hand and foot controls, including those for driving purposes, shall be sized and spaced to provide easy operation with a gloved hand and/or booted foot dependent on the control. Consideration shall be given to the environmental weather conditions in which the unit will operate. Furthermore,

— hand controls actuation shall not require a force of more than 60 N (15 lbf) except for vehicle steering (see 4.8.3.4), and

— foot controls shall be a minimum of 50 mm × 80 mm (2 in × 3 in) and provided with a non-slip surface material, and their actuation shall not require a force of more than 200 N (45 lbf) except for vehicle braking (see 4.8.2.1).

4.2.4.9 Conventional automotive driving controls shall be used whenever possible.

4.2.5 Displays

4.2.5.1 The driver's station and any operator's station(s) control panels shall have the monitoring devices and displays necessary to ensure safe operation and monitoring of the functions they control.

4.2.5.2 Monitoring devices or displays should be located as close as possible from the control(s) they relate to, and arranged in a functional layout as representative as possible of the GSE's geometry in order to facilitate intuitive identification (see IATA AHM 915[22] for example).

4.2.5.3 Monitoring devices or displays shall be weatherproof and protected against accumulation of snow, as well as any possible interference from inadvertent personnel movements or elements of load being handled.

4.2.5.4 Control panels, monitoring devices, and displays shall remain legible at all times regardless of ambient conditions and, unless located in a permanently shaded area, be duly protected against sunlight or reflections thereof. Illumination shall be provided to ensure a minimum of 50 lx (5 fc), and be of anti-glare and non-reflecting quality.

4.3 Stability and strength

4.3.1 Stability

4.3.1.1 Unless intrinsically stable to the same extent, lifting type units exposed to jet blast, wind, and/or irregular surfaces shall be equipped with stabilizing devices which preclude the unit overturning when exposed to

a) wind or blast up to 20,8 $m \cdot s^{-1}$ (75 $km \cdot h^{-1}$, 40 kn) with all the static parameters in the worst case conditions (most unfavourable load distribution, ramp slope, etc. conditions in fully erected position) defined by ISO 11995:1996, 4.3 a), and

b) wind or blast between 20,8 $m \cdot s^{-1}$ (75 $km \cdot h^{-1}$, 40 kn) and 33,3 $m \cdot s^{-1}$ (120 $km \cdot h^{-1}$, 65 kn), subject to appropriate operating constraints and precautions to be determined and implemented by the operator, as per ISO 11995:1996, 4.3 b).

Stability shall be calculated in accordance with ISO 11995. Stability calculation in accordance with EN 1915-2 constitutes an acceptable alternative method.

4.3.1.2 Where stability is achieved through power operated stabilizing devices, self-propelled type units shall have an operator warning light to indicate when the stabilizers are not in the stowed position.

4.3.1.3 The stability outlined in 4.3.1.1 shall determine at which point during elevation the stabilizing devices will be necessary. A safety circuit shall be provided to ensure this elevation is not exceeded unless stabilizing devices are extended and/or engaged. Retraction of the stabilizing devices shall not be possible under normal or back-up/emergency conditions until the unit has been lowered to within the stability requirement outlined in 4.3.1.1. The relevant interlock system shall ensure the performance level (PLr) required for this function, determined according to ISO 13849-1 (see 4.4.3).

4.3.1.4 Stabilizers design shall meet the following requirements:

a) stabilizer activating devices shall be located so as not to expose the operator to personal injury;

b) an interlock system shall be provided to prevent driving the vehicle when stabilizers are not fully retracted. The interlock system shall ensure the performance level (PLr) required for this function, determined according to ISO 13849-1 (see 4.4.3);

c) the stabilizers shall not collapse in the event of a system failure;

d) they shall be secured against unintentional shifts in both the extended and retracted positions by means of a mechanical restraint device;

e) they shall be able to compensate gradients up to at least 1,5° (2,5 %) and unevenness in the ground. Base plates shall be capable of being pivoted in all directions at least 5° (8,7 %) from the horizontal plane when in the working position;

f) the stabilizers shall be marked with black and yellow reflective stripes, and stabilizer pads shall be painted red, using safety colours in accordance with ISO 7010.

4.3.1.5 The stabilizers in the retracted position shall not protrude out of the overall width of the vehicle. Whenever possible, they should not either protrude out of this overall width when in the extended position.

4.3.2 Strength

4.3.2.1 GSE shall be designed and built so that its mechanical strength is ensured during intended use. Strength calculations shall be based on the most unfavourable combination of equipment position, rated load, local and snow loads, dynamic forces and wind conditions, in accordance with either

— recognized engineering design methods and codes of practice,

— finite elements analysis,

— actual testing and stress measurement, or

— combinations of these, commensurate with the type of GSE concerned.

Strength calculation in accordance with EN 1915-2 constitutes an acceptable method.

4.3.2.2 The rated load capacity shall be defined by the manufacturer, and consistent with maximum allowed occupancy. See 5.2 for rated load marking requirements.

4.3.2.3 The general stress analysis shall be carried out to ensure safe levels of stress in relation to the yield stress of the materials used. In addition to the most unfavourable combination defined in 4.3.2.1, dynamic forces, including consideration of the high dynamic forces which can be caused by the operation of a safety device for the prevention of unintentional movements, and significant effects of elastic deflection shall be taken into account.

4.3.2.4 The stress factors used to determine acceptable yield stress ratios shall be stated, consistent with the materials, assembly techniques (e.g. welding) and calculation methods used, and all the requirements of locally applicable regulations or national standards.

4.3.2.5 A fatigue calculation shall be carried out, taking into account the intended load spectrum (average load and number of cycles) throughout the expected life of the GSE, to be stated in manufacturer's documentation.

4.3.2.6 The rated load taken into account in stress calculations for each area capable of supporting a load shall be stated and, unless otherwise specified in the relevant specific standard, shall not be less than 3 000 $N \cdot m^{-2}$ (63 lb/ft^2) distributed over the whole accessible surface.

4.3.2.7 Where a standard automotive chassis is used, appropriate gross weight rating shall be determined based on chassis manufacturer's allowances, vehicle intended use, and any maximum speed limitation per construction.

4.3.3 Lifting

4.3.3.1 All lifting systems shall be so designed and equipped that failure in any element of the lifting mechanism does not result in uncontrolled descent or hazardous movement of the lifting platform.

Where self-lowering is acceptable in the event of a failure, the lowering speed shall not exceed 1,5 times the maximum rated lifting speed. Where protection is achieved by limiting the possible fall range of the platform, this shall not exceed 100 mm (4 in), and any platform tilting shall not exceed 3°.

4.3.3.2 Elements used as safety devices against unintentional lowering shall be independent from the regular lifting elements and shall remain unloaded during usual operation. They shall be functional in all positions of the lifting platform. If they can be overridden after they have tripped, this shall be only in order to move the platform into the lowered position, and they shall automatically become operative again.

4.3.3.3 Where a lifting system has two or more load bearing elements in parallel, they shall be designed so that the loads resulting from failure of one element shall not have effects jeopardizing safety; the remaining element shall be capable of carrying the total load, and the GSE shall remain stable.

Note For calculation purposes, this situation can be considered as exceptional loading.

4.3.3.4 Where chains or ropes are used as a lifting element for lifting persons, at least two independent chains or ropes shall be used, each with its own anchorage. They shall meet the requirements of 4.3.3.3. Wire rope grips shall not be used to secure ropes used as lifting elements.

4.3.3.5 The safety factors used to determine acceptable stress and pressure levels in lifting elements, including chains, wire ropes, mechanical and hydraulic elements, shall be stated, consistent with the techniques used and all the requirements of locally applicable regulations or national standards.

4.3.3.6 Maintenance supports painted in a safety colour in accordance with ISO 7010 shall be provided to secure the raised platform(s) or other lifting element(s) in order to protect maintenance staff working underneath against the risk of lowering.

4.4 Components

4.4.1 General

4.4.1.1 All GSE cabin or access doors and panels shall be provided with securing devices to retain them in the closed and, where required, in the open positions. They shall be capable of withstanding jet blast or ambient winds as specified in 4.3.1.1, and shall be installed so that the doors, when open, do not create a personnel injury hazard.

4.4.1.2 It shall be possible to positively secure all movable elements or attachments, e.g. doors, covers, flaps, access panels, tilting or lifting bodies, adjustable guard rail parts, etc. in selected positions by means of mechanical restraint or friction type devices. Fixed mechanical stop devices shall prevent movement farther than the designed end positions. Where safeguards using friction type devices are used, they shall be in duplicate and designed so that one safeguard on its own is capable of securing the moveable parts in the intended position.

4.4.1.3 All components that exceed a mass of 36 kg (80 lb), or that exceed a mass of 23 kg (50 lb) where only one person has access to the unit for handling, shall have provisions for attaching lifting or handling devices.

4.4.1.4 Internal combustion engines shall be fitted with a baffle type muffler. The exhaust system, beyond the manifold, shall be supported at least 75 mm (3 in) clear of any combustible material, excluding flexible mountings, and at least 50 mm (2 in) clear of any fuel, hydraulic and electrical system parts, and shall not be subject to dripping of fuel, oil, or grease. The exhaust outlet flow shall be out of reach of persons at work positions or on platforms or walkways (see 4.5.1.4).

4.4.2 Towing devices

4.4.2.1 Towing devices shall meet the requirements of ISO 6966-1:2005, 6.4.1. They shall be of rigid construction and secured against unintentional disconnection by means of a mechanical restraint device. It shall be possible to determine easily and without risk the efficiency of the mechanical restraint device by means of a visual examination.

4.4.2.2 The location of towing hitches and tow bars shall be selected to ensure inasmuch as possible a horizontal tow-bar position.

NOTE IATA AHM 916 (see Reference [23]) provides the recommended towing vehicle interface (hitch) standard.

4.4.2.3 It shall be possible to operate coupling and de-coupling easily and without hazard. Towable GSE and GSE intended to be moved by hand shall be equipped for pushing and pulling with ergonomic handles or handle depressions compatible with gloved hands. The positions of handles and maximum forces to manually push/pull the GSE shall be determined in accordance with ISO 11228-2.

4.4.2.4 Tongues, tow bars, draw bars, hitches, and their restraint devices shall be designed to minimize exposure of fingers to pinch points during coupling and de-coupling.

4.4.2.5 A stop shall be provided to prevent the tow bar from coming into contact with the ground when dropped. The ground clearance of the eye shall be at least 120 mm (5 in). Tow bars in the vertical position shall be secured by an automatically engaged mechanical restraint device requiring deliberate action for release.

4.4.2.6 Tow bars and any protruding towing hitches shall be made clearly visible in poor lighting conditions in order to avoid accidents, using safety colours; preferably light reflecting, in accordance with ISO 7010.

4.4.3 Safety components

4.4.3.1 All safety related components or parts, e.g. trip devices, ultimate position switches, over-speed governors, interlocking switches, emergency stops, etc., shall be designed, selected, located, and protected in order to reliably meet the most extreme intended environment conditions, and at least those specified in ISO 6966-1:2005, 6.8.

4.4.3.2 All safety related components, parts, or circuitry shall be designed or selected in accordance with the requirements of ISO 13849-1. Safety related components or parts, together with the associated circuitry, shall meet the appropriate performance level (PLr) for the safety function(s) they ensure, to be determined by risk assessment according to ISO 13849-1.

NOTE In certain instances where a programmable electronic system or software is used to control safety functions, it can be necessary to also refer to the Safety Integration Level (SIL) classification and requirements of IEC 62061 (see Reference [19]).

4.5 Personnel protection

4.5.1 General

4.5.1.1 All potential nip or pinch hazard points such as sprockets, gears, chains, belts, fans, pulleys, etc. which are not protected by vehicle structures or covers shall be guarded in accordance with ISO 3457.

4.5.1.2 All potential crushing and shearing hazard points should be prevented from access by design. If this is not possible, they shall be protected as specified in 4.5.1.1 or, in the case occurring under lifting

equipment, other safety measures shall be provided to reduce the risk of injury to persons resulting from the lifting equipment.

NOTE Such measures can include, but are not limited to, flexible mounted guards extending to the outside edge of the GSE with hatching of the guards or the crushing and shearing points in safety colours in accordance with ISO 7010, and/or a reduced lowering speed, flashing warning light, audible warning signals, dedicated emergency stops, etc.

4.5.1.3 All potential tripping hazards such as floor protrusions, unevenness, or steps other than a stair's should be prevented by design. Where this is not possible, they shall be identified on the floor by black and yellow diagonal stripes hatching in safety colours in accordance with ISO 7010.

4.5.1.4 The discharge of exhaust systems shall be located so that it will not expose personnel to injury or absorption of exhaust gases. The surface of exhaust systems or any other hot surfaces reachable from work areas, walkways, or ground shall be guarded if their temperature exposes personnel to a risk of burn.

4.5.1.5 Means shall be provided to secure all loads, loose parts, or accessories against hazardous movement when travelling or operating, and to safely store any load securing equipment (e.g. ropes, straps, chocks) carried.

4.5.2 Safeguards against falling

4.5.2.1 Standing areas, walkways, and any area with items requiring staff action during operation on the GSE where there is a possibility of falling from heights greater than 1 m (40 in) shall have guard-rails with a minimum height of 1,1 m (43 in). If there is an opening in the guard-rails larger than 120 mm (5 in), a self-closing gate shall be used (see 4.5.2.4).

4.5.2.2 Guard-rails shall be constructed in accordance with ISO 14122-3. In addition, in the case of overhanging or telescoping guard-rail part, the individual minimum static load shall be F = 300 N per m (20 lbf per ft) maximum distance between the last stanchion and the end of the handrail section in the deployed position. The total displacement caused by elastic deflection at the load application point on the overhanging or telescoping guard-rail's end shall not exceed 30 mm (1 1/4 in).

4.5.2.3 Guard-rails shall at least consist of

— a handrail,

— a knee rail, and

— a toe-plate with a minimum height of 0,1 m (4 in).

The guard-rail, or knee-rail and toe-plate, may be replaced by an equivalent full panel.

The gap between two rails or between knee rail and toe-plate shall not exceed 0,5 m (20 in). In the case of an interrupted handrail, to prevent hand traps, any gap between two handrail segments shall be not less than 75 mm (3 in) and not greater than 120 mm (5 in). The distance between stanchions or anchorages is preferred to be limited to 1 500 mm (60 in). If this distance is exceeded, specific attention shall be paid to the stanchion anchoring strength and the fixing devices. Any overhanging or movable parts shall also provide a handrail, a knee rail and a toe-plate, and generally meet the same requirements as the fixed guard-rail parts.

4.5.2.4 Where access through the guard-rail is required, a self-closing gate shall be used. A gate shall have a handrail and knee rail positioned at the same level as that of the guard-rail that it extends to. Gates shall be self-closing and shall be designed to open onto the platform or floor and to close against a firm stop. They shall not open outward. Gates shall be subject to the same loading criteria as guard-rails.

4.5.2.5 Moveable parts of the guard-rails shall meet the same requirements as fixed guard-rails, and shall be automatically secured by a mechanical restraint device, requiring deliberate action for release, in the protecting position. Parts adjustable to the aircraft shall be secured against retraction by a force of at least 200 N (45 lbf), but not exceeding 400 N (90 lbf). Their adjustment after unlatching shall be possible by a single agent with a maximum horizontal hand force of 60 N (15 lbf), and shall take place at a location at least 1,0 m (20 in) away from the end of the fixed guard-rail and the platform's edge.

4.5.2.6 Where an item of GSE interfaces with the aircraft, clearances between guard-rails and aircraft shall be adjustable by increments not exceeding 120 mm (5 in). The maximum unguarded distance between the adjusted guard-rail's protective padding and the aircraft shall not exceed 120 mm (5 in).

4.5.2.7 Folding or drop guard-rails shall be used only where it is not possible to install fixed guard-rails. They shall meet the requirements for fixed guard-rails. The direction of swing or tilt shall not be outwards and, in the protective position, these guard-rails shall be secured against moving by an automatic mechanical restraint. Where it is not possible for knee rails to be made from rigid material they shall conform to 4.5.2.8.

4.5.2.8 Guard-rails made from flexible material shall be used only at locations not part of the workplace, and if it is not possible to use rigid materials. They shall provide the same degree of safety as the guard-rails per 4.5.2.2. They shall be at least 1,1 m (43 in) high and shall consist of at least four weather-resistant, tensioned, and adjustable ropes or straps arranged one above the other with equal spacing.

NOTE Typical use of flexible guard-rails is in order to store them at places used only for occasional maintenance access.

4.5.2.9 Where an area cannot be fully enclosed by guard-rails or is covered by a movable guard-rail, the potentially hazardous area with a risk of falling from a height, located less than 1,0 m (20 in) away from a fixed guard-rail end and from the platform's edge, shall be identified on the platform's floor by high visibility markings, such as wide black and yellow diagonal stripes in safety colours in accordance with ISO 7010 across the whole potential hazard area's floor.

Additional warning against the risk of falling shall be materialized by the graphic symbol in Annex B, at least 200 mm (8 in) high, located at readily visible positions on the piece of GSE concerned, adjacent to any unprotected edge.

4.5.3 Means of access

4.5.3.1 Means of access shall be provided where entrances to driver or operator accommodation, standing areas and walkways are higher than 0,5 m (20 in) above the ground. The preferred means of access shall be in the following order: lifts, ramps, stairs, stepladders, ladders, or footholds. Selection of ladders, stepladders, stairs, or ramps shall be carried out in accordance with ISO 14122-1:2001, 5.3. Footholds shall be considered only when the requirements for ladders or stepladders cannot be met.

4.5.3.2 The design of stairs, stepladders, ladders or footholds shall comply with the requirements of EN 1915-1:2013, Annex D, unless superseded by locally applicable regulations. Handholds, handrails, or at least grab handles shall be provided along any such means. Lifts shall be protected against the risk of falling in accordance with 4.5.2 above. Ramps used for access shall not exceed a 20° (36 %) gradient according to ISO 14122-1, and shall have an increased slip-resistance surface with a minimum R13 classification according to DIN 51130:2014, Table 3.

4.5.3.3 Where ladders are used for access, the incline angle shall not be less than 75°, with a maximum of 90°. Where stairs are used, the incline angle shall not be less than 20°, with a maximum of 50°. Equal spacing between rungs or steps, not to exceed 0,3 m (12 in), shall be maintained above the first one. Steps shall have a minimum depth of 80 mm (3 in). Rungs shall have a minimum diameter of 20 mm (0,8 in). A minimum 150 mm (6 in) clearance shall be maintained from any obstruction, including between parallel elements of a telescopic ladder, stepladder, or stair.

4.5.3.4 The following parts of GSE shall not be considered as acceptable means of access:

— any part of a tyre, wheel rim, or hub;

— plain rungs of round cross-section;

— rungs without any ribbing or permanently attached slip-resistant surfaces.

NOTE Suitable parts of the GSE structure may be designed as means of access, if fitted with a slip-resistant surface.

4.5.4 Warnings

4.5.4.1 Visual and/or auditory warning signals shall be provided whenever a condition identified as potentially unsafe exists. Where a hazard is permanent and cannot be eliminated by design, the warning may be in the form of high visibility markings in safety colours in accordance with ISO 7010.

4.5.4.2 Visual signal warning lights shall be located at the driver's and/or operator's station(s) as appropriate and be shaded in order to ensure good visibility even in sunlight. The colour codes of green to indicate a safe condition, yellow to indicate a potential hazard and red, preferably flashing, to indicate an unsafe condition, shall be used.

4.5.4.3 Self-propelled GSE shall have operator initiated devices at the driver's station for emission of unambiguous auditory warning signals.

4.5.4.4 Where additional auditory warning signals are used, they shall be in accordance with the requirements of ISO 7731:2003, Clause 4.

4.5.4.5 Intermittent single-frequency tones shall only be used to indicate reversing travelling movement.

4.5.5 Noise

4.5.5.1 The equipment shall meet the maximum perceived noise objective of ISO 6966-1:2005, 6.8.4, and while operating should not exceed an effective perceived noise level of 85 EPN dB measured at the driver's or any operator's station(s) for more than 1 min.

4.5.5.2 Selective soundproofing should be used in order to reduce inasmuch as possible perceived noise levels at operating stations.

4.5.5.3 Noise measurement shall be performed in accordance with ISO 3746 (EN 1915-4 constitutes an acceptable alternative method), and its results recorded in the manufacturer's documentation (see Clause 6).

NOTE Measurement in accordance with SAE/ARP 1801 (see Reference [28]) is an acceptable alternative for equipment to be operated elsewhere than in Europe (EU and EFTA) where EN 1915-4 is a requirement.

4.5.6 Vibration

4.5.6.1 Equipment design shall minimize the amount of vibration emitted while operating or resulting from driving on uneven ground.

4.5.6.2 Vibration resulting from driving shall be alleviated by using seats designed so that damage to the human body is avoided, taking into account duration, purpose, and conditions of use, size, and weight of the drivers. Seats of commercial vehicles are acceptable when used on a vehicle for which they were intended.

4.5.6.3 Vibration measurement shall be performed in accordance with EN 1915-3, and its results recorded in the manufacturer's documentation (see Clause 6).

4.6 Aircraft protection

4.6.1 Docking speeds

4.6.1.1 Positively controlled non jerking slow speeds are required for the approach and, on GSE the function of which requires contact with the aircraft being serviced, final positioning, of GSE to the aircraft.

4.6.1.2 For circulation within the Equipment Restraint Area and approach to the aircraft, all self-propelled GSE shall be capable of a speed not exceeding 1,6 $m \cdot s^{-1}$ (approximately 6,0 $km \cdot h^{-1}$/3,5 mph), to be identified by the "turtle" symbol (ISO 11532 N° 52) on or adjacent to the relevant control actuator.

4.6.1.3 For final positioning to aircraft contact of GSE, the function of which requires it, i.e. passenger stairs, boarding bridges and boarding vehicles, catering trucks, and container and pallet loaders, the equipment should be capable of an inching speed not exceeding 0,2 $m \cdot s^{-1}$ (approximately 0,8 $km \cdot h^{-1}$ or 1/2 mph). It is recommended that this be automatically ensured by equipment elevation. If not, the inching speed shall be identified by a "snail" symbol (not included in ISO 11532, see Annex C) on or adjacent to the relevant control actuator.

4.6.1.4 Alternately, final positioning to aircraft contact of the equipment in 4.6.1.3 may be provided by a telescopic platform or body. In this case, telescoping speed shall not exceed 0,1 $m \cdot s^{-1}$ (4 in/s).

4.6.1.5 In order to allow phased development by the manufacturing industry, the requirements of 4.6.1.3 (where those of 4.6.1.4 are not met) are recommended, but proposed to be reconsidered as mandatory within this part of ISO 6966 at its next systematic review (5 years from its publication date).

4.6.2 Contact protection

4.6.2.1 On GSE the function of which requires contact with the aircraft being serviced, any part of the GSE coming close to or liable to touch the aircraft shall have suitable protective padding.

4.6.2.2 The leading edge of the equipment's platform shall be designed so that damage to the aircraft is avoided, including a full-width aircraft interface device designed to protect the aircraft, that

— is of a non-marking semi-soft material,

— ensures a minimum 60 mm (2 1/2 in) crushing capability, and

— is designed to minimize any force exerted onto the aircraft.

4.6.2.3 It is recommended that the static force equivalent exerted by the leading edge of the platform onto the aircraft should not exceed 1 500 N (350 lbf) distributed over the contact length, or 1 500 N (350 lbf) on a 100 mm × 100 mm (4 in × 4 in) contact area.

4.6.2.4 All other components of the equipment that can come into contact with the aircraft, e.g. guard-rails, or side panels edges, shall also be padded in a similar manner to protect the aircraft. The static force equivalent exerted onto the aircraft should not exceed 400 N (90 lbf). See 4.5.2.5.

NOTE SAE AIR 1558A (see Reference [27]) contains information on some commonly used padding materials.

4.6.2.5 Where a lifting element might project or be moved beyond the outer limit of the GSE, or has to keep within a specified working height relative to the aircraft, any unintentional movement shall be prevented if there is e.g. a leakage in the hydraulic system or a failure of a lifting element. An interlock

shall be provided so that intentional lowering is possible only after the projected element was retracted. The interlock system shall ensure the performance level (PLr) required for this function, determined according to ISO 13849-1 (see 4.4.3).

4.6.3 Detection systems

4.6.3.1 The aircraft interface device of GSE the function of which requires contact should include a detection feature able to provide an electrical signal when contact with the aircraft is achieved at any point that as a minimum shall provide a warning to the operator, and may be used to automatically stop movement. In this case, the power source shall be stopped or the engine brought to idle, and the travelling brakes automatically activated so that the GSE, travelling at the inching speed defined in 4.6.1.3, comes to a complete stop before the criteria in 4.6.2.2 and 4.6.2.3 are exceeded. The related interlocking systems shall ensure a performance level (PLr) "b" according to ISO 13849-1.

4.6.3.2 Alternately, the GSE can be fitted with a detection system operating at a distance. Detection shall as a minimum provide a warning to the operator, and can result in the power source being stopped or the engine brought to idle and the travelling brakes automatically being activated, so that the GSE, travelling at the inching speed defined in 4.6.1.3, comes to a complete stop before touching the aircraft, but leaving no more than 120 mm (5 in) horizontal clearance to the fuselage. The related interlocking systems shall ensure a performance level (PLr) "b" according to ISO 13849-1.

4.6.3.3 Where the distance detection system operates with a laser device, this should be class 1 of IEC 60825-1. In the event of a higher class device being used, additional precautions required by IEC 60825-1 shall be applied.

4.6.4 Alerting system

4.6.4.1 When a maximum aircraft impact load limit has been defined by an (the) aircraft manufacturer(s) in order to require fuselage structural inspection in the event of not externally visible damage, and the aircraft design includes no impact alerting system of its own, the aircraft contact detection system per 4.6.3.1 should include an alerting system that

a) activates a flashing amber warning light and audible alarm to the operator to indicate the defined maximum aircraft impact load limit may have been exceeded, and

b) requires a recordable action to complete the vehicle's task, in order to make it unmistakable to the driver that aircraft maintenance must be informed and consider whether a structural inspection of the fuselage is required.

NOTE This is in line with the published airworthiness Authorities requirements where the aircraft's structural integrity might have been compromised without it being visibly obvious. See e.g. ISO 20683-1, 4.4. However, defined impact load limits are not yet available from aircraft manufacturers, and will be integrated in this part of ISO 6966 once available. This should not preclude GSE manufacturers' researching and testing alerting systems for future use.

4.6.4.2 In order to allow phased development by the manufacturing industry, the requirements of 4.6.3 and 4.6.4.1 are recommended, but proposed to be reconsidered as mandatory within this part of ISO 6966 at its next systematic review (5 years from its publication date).

4.7 Systems

4.7.1 Fuel

4.7.1.1 Fuel lines shall be constructed of steel or seamless annealed copper tubing. Flexible fuel lines produced to the relevant performance standard may also be used, to assist with routing, ease of maintenance, and where it is necessary to absorb vibration and prevent fatigue. Fuel lines shall be secured

with a minimum 50 mm (2 in) clearance from exhaust and electrical systems. In the case of flexible fuel lines, additional clearance shall be provided around exhaust or any other heat-producing components.

4.7.1.2 Fuel tank(s) and lines shall be located and installed so that any overflow during filling, or any leakage from the tank, lines, or fittings will not impinge on the engine, exhaust, electrical system, or other ignition sources or enter the driver's or operator's station(s). Consideration should be given to avoiding spilled fuel making work or access surfaces slippery.

4.7.1.3 Fuel tanks shall be located for maximum protection from collision damage.

4.7.2 Hydraulic

4.7.2.1 Pressure limiting valves shall ensure that pressurized pipes in GSE hydraulic systems are not subjected to more than 1,4 times the static pressure at the maximum permissible operating load. Pressure limiting valves shall be safeguarded against tampering by unauthorized persons.

4.7.2.2 Hydraulic hoses shall be installed and fixed in such a way that damage, e.g. by crushing, abrasion, heating up, twisting, etc. is avoided, and, in the case of potential leakage, protection shields shall be installed to prevent fluid coming into contact with the exhaust or any other heat producing components. Hydraulic hoses with an operating pressure of more than 15 MPa (2 175 psi) shall not have reusable end fittings.

4.7.2.3 Hydraulic hoses in the working or access areas of GSE containing fluid at a pressure exceeding 5 MPa (725 psi) and/or a temperature exceeding 50 °C (120 °F) shall have covers as specified in ISO 3457.

4.7.2.4 Hydraulic systems where hydraulic fluid contamination could lead to hazardous operating conditions, e.g. on lifting devices or hydrostatic drives, shall be equipped with filters which have an easy-to-read contamination indicator.

4.7.3 Electrical

4.7.3.1 Electrical wires, components, and conductors shall be installed in such a way as to avoid wear and tear and exposure to environmental conditions which could cause deterioration. The protective conductor of any electrical systems shall be connected to the chassis. Electrical components located in areas directly exposed to weather shall be protected, to a degree to be determined based on risk assessment. Electrical interlocks shall be of fail-safe design, of a category to be determined by risk assessment.

NOTE The above requirements do not apply to an automotive chassis meeting applicable road traffic regulations.

4.7.3.2 Batteries shall be positioned and secured to prevent mechanical damage. Battery housings shall be fire-resistant. Suitable ventilation openings shall be provided in the battery container, compartment, or cover so that dangerous accumulations of gases do not occur during GSE's intended use.

4.7.3.3 Batteries and/or battery locations shall be designed and built or covered so that there is no risk to the operator from battery acid or vapours even in the case of overturning of the GSE.

4.7.3.4 Battery terminals shall be protected against inadvertent contact, e.g. by insulating covers and shrouds. An easily accessible battery disconnecting switch of appropriate nominal capacity shall be fitted close to the batteries.

4.7.3.5 Any external battery connectors, e.g. for recharging purposes, shall be safely stowed and marked with a safety colour in accordance with ISO 7010.

4.8 Mobility

4.8.1 Operating speeds

4.8.1.1 The travelling speed of GSE shall be limited to a maximum of 6 $km \cdot h^{-1}$ (3,5 mph) by design

a) during pedestrian-controlled operation, directly or through remote control,

b) whenever a lifting platform or basket has been moved over the resting position, and

c) whenever the "turtle" slow speed control is activated for circulation in the equipment restraint area and approach to the aircraft (see 4.6.1.2).

Whenever GSE's intended use does not require circulation on public roadways, consideration should be given to limiting by construction maximum speed to that allowed on the ramp area and service roads of the airport of use.

NOTE The most frequently applicable speed limit on airport ramp service roads is 30 $km \cdot h^{-1}$ (20 mph).

4.8.1.2 The movement speed of lifting/work platforms in any direction, vertical or horizontal, shall not exceed

a) 0,2 $m \cdot s^{-1}$ (0,7 ft/s) for single speed movements,

b) 0,4 $m \cdot s^{-1}$ (1,3 ft/s) for dual speed movements (with starting and stopping at reduced speed), and

c) 0,6 $m \cdot s^{-1}$ (2 ft/s) for smooth, non-jerking, starting, and stopping proportionally controlled movements.

4.8.1.3 The conveying speed for unit load devices should not exceed 0,3 $m \cdot s^{-1}$ (1 ft/s), and shall never exceed 0,6 $m \cdot s^{-1}$ (2 ft/s).

4.8.2 Braking

4.8.2.1 The travelling (service) brake system shall safely stop vehicles under empty and full load conditions, and shall meet all locally applicable requirements and regulations, or at least the minimum values in Table 1 with the vehicle under maximum allowed load braking from a speed of 30 $km \cdot h^{-1}$ (19 mph), under a pedal force not exceeding 300 N (67 lbf).

NOTE This maximum pedal force value is more restrictive than ECE 79 requirements for industrial vehicles.

Table 1

Vehicle gross mass range	less than 2 250 kg (5 000 lb)	2 250 to 4 500 kg (5 000 to 10 000 lb)	Over 4 500 kg (10 000 lb)
Maximum stopping distance	7,5 m (25 ft)	9,0 m (30 ft)	12,0 m (40 ft)

4.8.2.2 In the case of GSE with hydrostatic drive, the drive may be used as a travelling (service) brake if there is no short-circuit valve in the hydraulic circuit or if the short-circuit valve is located in such a manner as to prevent its direct access by the operator.

4.8.2.3 The parking/emergency brake shall restrain the vehicle when fully loaded on an incline of 4° (7 %), or more if specified by locally applicable requirements, regulations, or conditions of use. Stabilizers, if provided, may be used for additional parking brake capability but shall not be taken as part of the emergency brake function.

4.8.2.4 In the case of self-propelled GSE the function of which is towing other equipment, the vehicle's travelling (service) and parking brakes efficiencies should be increased in accordance with the maximum allowed towed load. The maximum allowed stopping distance from full speed of a towed train of un-braked trailers with maximum allowed load shall be 30 m (100 ft). The parking brake shall secure the GSE itself without trailer and load against rolling away with a minimum braking ratio of 18 % (equivalent to an incline of 10°).

4.8.2.5 Non self-propelled GSE shall have either a parking brake or equivalent means (e.g. chocks) capable of restraining it on an incline of 8° (15 %) or under the maximum blast or wind velocity specified in 4.3.1.1. Stabilizers, if provided, may be used.

4.8.2.6 It shall be possible to disable braking and any drive function inhibiting vehicle movement in order to allow towing the vehicle away from the aircraft in the event of a systems or main power source failure (see 4.9.2.3). Controls for such intervention shall be located under cover, apart from normal vehicle controls, in order not to be misused.

4.8.3 Steering

4.8.3.1 The steering system's design shall meet the locally applicable requirements and regulations, and at least the requirements of ECE 79 and the following.

4.8.3.2 Self-propelled GSE capable of a driving speed in excess of 50 $km \cdot h^{-1}$ (30 mph) shall have a dual circuit hydraulic steering system or a power-assisted mechanical steering system. Steering systems with pneumatic transmission means are not permissible.

4.8.3.3 In the event of power cut-off on a power-assisted steering system, it shall remain possible to tow the GSE with back-up means, e.g. an emergency pump system.

4.8.3.4 The maximum steering force measured at the steering wheel shall not exceed 100 N (22 lbf) with intact steering equipment, and 250 N (56 lbf) in the event of a system failure. For self-propelled GSE capable of a driving speed in excess of 15 $km \cdot h^{-1}$ (10 mph), the system shall provide the driver with an adequate feedback at the vehicle's steering wheel.

NOTE These values are more restrictive requirements than those of ECE 79 for industrial vehicles.

4.8.3.5 GSE with hydraulic steering shall have

— a pressure relief valve actuated at the maximum operating pressure (P) installed in the primary (supply) circuit to protect the unit against overpressure, and

— a pressure relief valve actuated at a pressure of at least 5 MPa (725 psi) above the maximum operating pressure (P), or a maximum of 2,2 × P, whichever is lowest, installed in the secondary (steering) circuit.

In order to preclude failure, the bursting pressure of all hydraulic hoses shall be four times higher than the maximum permissible operating pressure.

Loss of fluid pressure shall not prevent towing of the GSE (see 4.8.3.3).

4.8.4 Engine operation

4.8.4.1 For self-propelled vehicles, it shall not be possible to start the engine unless the shifting lever is on the neutral or park position.

4.8.4.2 For self-propelled equipment with a hand throttle, it shall not be possible to engage the forward or reverse gear unless the hand throttle is in the idle position.

4.8.4.3 Where the equipment includes an engine power take-off (PTO), interlocks shall be provided so that

a) the PTO cannot be engaged unless the vehicle's gear selection is in parking or neutral position and the parking brake is set, or

b) engine rpm cannot increase while the PTO is engaged, unless the vehicle's gear selection is in parking or neutral position and the parking brake is set.

The related interlocking systems shall ensure a performance level (PLr) "a" according to ISO 13849-1.

4.9 Back-up and emergency systems

4.9.1 Emergency stop devices

4.9.1.1 Emergency stop buttons in accordance with ISO 13850 (red mushroom-type on yellow background, in accordance with symbol E20 of ISO 7010) shall be provided on powered GSE. These should be installed and readily accessible at convenient positions, including any operator station, on the unit to enable immediate shutdown in the event of an emergency. At least one of these should be readily accessible from outside the equipment on the ground level.

4.9.1.2 Actuation of an emergency stop button shall inhibit all equipment functions, except back-up retraction and lowering (see 4.9.2). Cancelling the emergency stop command should be possible only by deliberate action.

NOTE Such deliberate action can, optionally, be by the use of a key or code available only to authorized personnel.

4.9.2 Back-up lowering

4.9.2.1 In a systems or main power source failure situation, it shall be possible to

— retract, if applicable, and lower any lifting element of the GSE, and

— retract stabilizers after the safe height (see 4.3.1.3) has been reached

by means of a back-up lowering system activated by a power source independent from the main engine.

4.9.2.2 The controls for back-up retraction/lowering shall be clearly marked and easily accessible, at least from the ground level, but located under cover, apart from normal vehicle controls, in order not to be misused.

4.9.2.3 In addition, means shall be provided to enable towing away from the aircraft with the GSE's main source of power being unavailable, including e.g. towing eyes or a stowed tow bar, and a by-pass system on hydrostatic drives. It shall be possible to disable braking or any drive function inhibiting towing (see 4.8.2.6), and steering shall remain possible (see 4.8.3.3 and 4.8.3.5).

4.9.3 Fire prevention

4.9.3.1 A fire extinguisher of suitable type and capacity shall be provided on any self-powered equipment.

4.9.3.2 Where the GSE's intended use includes being allowed to operate in an aircraft's fire safety perimeter while aircraft refuelling is in progress, the following additional fire protection requirements shall be met:

a) a readily accessible engine stop device, spark proof in the event of an electrically powered GSE;

b) a spark arrestor or equivalent device in the exhaust of any internal combustion engine, able to prevent the emission of sparks or ignited particles.

5 Markings

5.1 A name plate shall be securely (e.g. riveted, welded) fastened on all GSE, and include the following legibly and permanently marked data:

— name and address of the manufacturer;

— year of manufacture;

— type and serial number;

— unladen mass;

— maximum driving total mass, if the GSE is designed for transportation of persons or load;

— any other marking or data legally required in accordance with locally applicable regulations.

5.2 In addition, the following safety-related warnings shall be visibly and permanently marked at prominent relevant locations on the GSE, if applicable:

— maximum allowed travelling speed (if the GSE can exceed it);

— maximum allowed wind velocity (if the GSE presents a stability hazard);

— maximum travelling and elevated position rated loads;

— maximum allowable occupancy;

— tires pressure (if GSE is equipped with pneumatic tires);

— maximum ground pressure of stabilizers (if the GSE is equipped with such);

— any safety-related operating instructions specific to the GSE concerned.

5.3 The following hazards shall be identified by markings using safety colours in accordance with ISO 7010 and/or graphic symbols in accordance with ISO 11532:

— passive outer visibility (see 4.2.3.5);

— stabilizers (see 4.3.1.4 list item e);

— maintenance supports for lifting equipment (see 4.3.3.6);

— towing eyes and tow bars (see 4.4.2);

— battery connectors (see 4.7.3.5);

— power take-off (see 4.8.4.3);

— emergency stops (see 4.9.1.1);

— emergency lowering controls (see 4.9.2.2);

— emergency towing equipment (see 4.9.2.3);

— any area where standing is prohibited;

— falling hazard (see 4.5.2.9 and Annex B);