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Earth-moving machinery — Wheeled machines — Steering requirements

Engins de terrassement — Engins équipés de pneumatiques — Systèmes de direction

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety requirements and human factors*.

This fourth edition cancels and replaces the third edition (ISO 5010:2007), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the title has been changed to “Wheeled machines” to include machines with drums and crawler wheel assemblies;

— requirements have been provided for earth-moving machinery (EMM) with a maximum machine speed <20 km/h.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organisations, market surveillance etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e. g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

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

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

As functional safety of steering system is not covered in this document, guidance for functional safety of steering systems can be found in the following standards: ISO 15998, ISO/TS 15998-2, ISO 13849-1, ISO 19014-1, ISO 19014-2[1)], ISO 19014-3, ISO 19014-4[2)] and ISO/TS 19014-5[3)].

1) Under preparation. Stage at the time of publication: ISO/DIS 19014-2:2019.

2) Under preparation. Stage at the time of publication: ISO/DIS 19014-4:2019.

3) Under preparation.

Earth-moving machinery — Wheeled machines — Steering requirements

1 Scope

This document specifies steering system tests and performance criteria for evaluating the steering capability of wheeled, ride-on earth-moving machinery as defined in ISO 6165:2012. Wheeled machines include machines equipped with wheels, one or more drums or crawler wheel assemblies.

This document deals with the following significant hazards, hazardous situations or hazardous events relevant to wheeled machines, when used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer:

— mechanical hazards;

— ergonomic hazards;

— hazards due to maintenance;

— hazards due to the control system;

— hazards related to travelling function.

Functional safety of the steering system is not covered in this document.

This document is not applicable to wheeled machines manufactured before the date of its publication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 3450:2011, *Earth-moving machinery — Wheeled or high-speed rubber-tracked machines — Performance requirements and test procedures for brake systems*

ISO 6016:2008, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

ISO 7457:1997, *Earth-moving machinery — Determination of turning dimensions of wheeled machines*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 10968:—[4)], *Earth-moving machinery — Operator's controls*

ISO 18752:2014, *Rubber hoses and hose assemblies — Wire- or textile-reinforced single-pressure types for hydraulic applications — Specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and the following apply.

4) Under preparation. Stage at the time of publication: ISO/DIS 10968:2019.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
steering system
system including all machine elements between the operator and the ground-contacting *wheels* (3.2), drums or *crawler wheel assemblies* (3.3) participating in steering the machine

3.1.1
manual steering system
steering system (3.1) depending exclusively on the muscular power of the operator to affect steering of the machine

3.1.2
powered steering system
steering system (3.1) employing auxiliary power sources to supplement or replace the muscular power of the operator to affect steering of the machine

3.1.3
primary steering system
steering system (3.1) used to steer the machine when the steering system functions as intended

3.1.4
secondary steering system
steering system (3.1) used to steer the machine in the event of a loss of the *primary steering power source* (3.5.1)

3.2
wheel
circular structure able to rotate on an axle, either directly or with the use of bearings, with the external part in contact with the ground

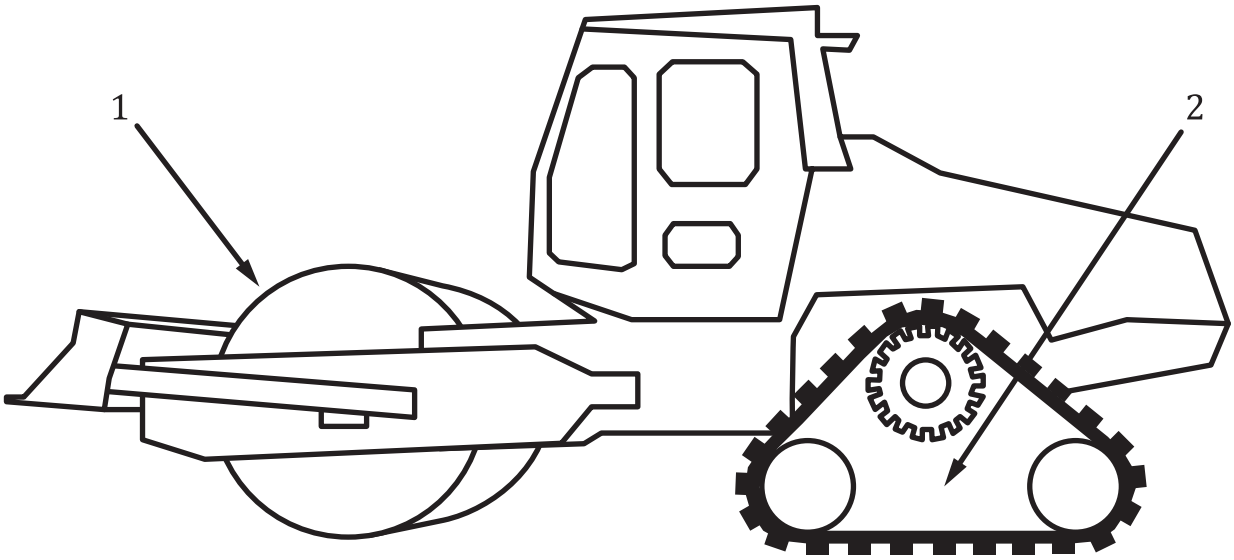
3.3
crawler wheel assembly
crawler system used in place of a *wheel* (3.2) on a single axle

Note 1 to entry: See Figure 1.

Note 2 to entry: Machines with crawler wheel assemblies are steered using techniques common to rubber-tyred machines, for example Ackermann steering, articulated steering.

3.4
wheeled machine
machine on *wheels* (3.2), drums or *crawler wheel assemblies* (3.3)

Note 1 to entry: See Figure 1.



Key

1 drum

2 crawler wheel assembly

Figure 1 — Wheeled machine with drum and crawler wheel assemblies

3.5 steering power sources

3.5.1
primary steering power source
means for providing power to effect steering in a *powered steering system* (3.1.2)

EXAMPLE Hydraulic pump, air compressor, electric generator.

3.5.2
secondary steering power source
means for providing power to the *secondary steering system* (3.1.4) in the event of *primary steering power source failure* (3.5.3)

EXAMPLE Hydraulic pump, air compressor, accumulator, battery.

Note 1 to entry: It is assumed that not more than one failure will occur at the same time.

3.5.3
primary steering power source failure
complete and instantaneous loss of the *primary steering power source* (3.5.1)

3.6
steering control element
control element used by the operator to transmit the steering command for the desired direction or to control the relative speed of the left-hand and right-hand sides of the drive system

EXAMPLE Steering *wheel* (3.2), lever controls, joystick controls, pushbutton/touch pad controls and foot pedal controls.

Note 1 to entry: For a machine that has equal alternative operator's position both at the left-hand and right-hand sides of the machine equipped with a conventional steering wheel at each position (e. g. some types of rollers), these two steering wheels are considered as one steering element.

3.6.1
principal steering control element
steering control element (3.6) at the operator's positions that is primarily used to fulfil the primary steering and, if applicable, the secondary steering

3.6.2
alternative steering control element
additional *steering control element* (3.6) that can be used instead of the *principal steering control element* (3.6.1) to fulfil primary steering

3.7
steering effort
necessary force exerted by the operator on the *steering control element* (3.6) in order to steer the machine

3.8
steering angle
total displacement angle between the front *wheels* (3.2) and the rear wheels as they move about one or more vertical steering axes from their normal straight-ahead condition to a turned condition

Note 1 to entry: The steering angle for multiple-axle machines is determined between the wheels at the farthest forward and farthest rearward axles.

Note 2 to entry: Ackermann steering inherently has a greater steering angle on the side of the machine toward the inside of the turn as compared to the wheels on the outside of the turn. Therefore, where Ackermann steering is involved, the location of the steering angle measurement also needs to be specified.

Note 3 to entry: A steering angle accomplished by a combination of geometries incorporating Ackermann steering is included, and also requires the location of the steering angle measurement to be specified.

3.9
width over wheels
distance on Y coordinate between two Y planes passing through the farthest points of the machine on both sides of the zero Y plane measured at the location of the *wheels* (3.2)

3.10
outer wheel clearance diameter
diameter of the circular path described by the outermost point of the loaded (lower) section of the *wheel* (3.2) located on the vertical diameter of the outermost wheel when the machine is executing its sharpest practical turn under the conditions described in ISO 7457:1997, Clause 7

3.11
wheel circle
outer wheel clearance diameter (3.10) determined in accordance with Clause 7

3.12
maximum machine speed
maximum speed determined in accordance with ISO 6014

[SOURCE: ISO 3450:2011, 3.12, modified — The words ", or equivalent" have been removed.]

4 General requirements

4.1 General

Earth-moving machinery shall comply with the safety requirements and/or protective measures of this clause, unless modified by requirements of the relevant specific part of the standard series. In addition, the machine shall be designed according to the principles of ISO 12100:2010 for hazards relevant but not significant which are not dealt with by this document.

4.2 Required steering systems

4.2.1 All machines shall have a primary steering system.

4.2.2 Machines with a maximum machine speed ≥20 km/h shall have a secondary steering system. This does not apply to machines equipped with a manual steering system as the primary steering system.

4.3 All steering systems

4.3.1 The steering control element shall continue to be the steering control means for the operator in case of primary steering power source failure. If multiple steering control elements are provided, see requirements in 4.8.

4.3.2 When the steering control element is released, the selected wheel circle shall remain constant or become larger during travel in the forward direction.

NOTE For more information on primary steering control requirements see 8.1.2.

4.3.3 The steering system shall be designed so that the movement of the steering control element is consistent with its effect. If control operation is not obvious, an operational sign shall be provided (e.g. using symbols). Operation of the steering control element shall be in accordance with ISO 10968:— and, as applicable, with the normal functioning of the machine.

4.3.4 During machine operation, no uncontrolled steering movement shall occur due to the operation of the steering control element.

4.3.5 Steering system reliability shall be enhanced by the selection and design of components arranged so that inspection and maintenance can be readily performed.

4.3.6 Steering system disturbances shall meet the conditions given in 4.3.6.1 and 4.3.6.2.

4.3.6.1 Steering system disturbances due to other machine functions shall be minimized by appropriate arrangement and geometry. Examples of influences to be minimized are:

— axle oscillations, and

— braking torque at the wheels.

4.3.6.2 Steering system disturbances due to the influences of external forces on the machine within the applications for which the machine is designed (e.g. articulated machine navigating ruts on typical job sites) shall not significantly affect steering control.

4.3.7 All steering control elements, except for the conventional steering wheel, shall be designed, arranged (i.e. operator station layout), taken out of service (i.e. interlocked) or secured such as to reduce the possibility of unintentional activation when a person is entering or leaving the operator area.

4.3.8 Machines shall have similar steering system forces, rates and duration capability in both forward and reverse for primary and secondary steering systems. This requirement does not apply to machine with a speed <20 km/h in reverse. This may be verified by system schematics or calculations. A test in reverse is not required.

