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Earth-moving machinery — Functional safety —

Part 5: Tables of performance levels

Engins de terrassement — Sécurité fonctionnelle —

Partie 5: Tableaux des niveaux de performance

Reference number
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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 document 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).

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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, ergonomics and general requirements*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 151, *Construction equipment and building material machines - Safety,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces the first edition (ISO/TS 19014-5:2021), which has been technically revised.

The main changes are as follows:

— revision of machine control system safety analysis (MCSSA) discrepancies in Annex A through Annex AA.;

— addition of alternative control outcomes to all scenarios in Annex A through Annex AA.

A list of all parts in the ISO 19014 series can be found on the ISO website.

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.

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Introduction

This document addresses systems of all energy types used for functional safety in earth-moving machinery.

The structure of safety standards in the field of machinery is as follows.

Type-A standards (basic standards) give basic concepts, principles for design and general aspects that can be applied to machinery.

Type-B standards (generic safety standards) deal with one or more safety aspects, or one or more types of safeguards that can be used across a wide range of machinery.

— Type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise).

— Type-B2 standards on safeguards (e.g. two-hands controls, interlocking devices, pressure sensitive devices, guards).

Type-C standards (machinery safety standards) deal with detailed safety requirements for a particular machine or group of machines.

This document contains a list of machine performance level requirements (MPL_r) by function and earth-moving machinery type, determined through the process outlined in ISO 19014-1:2026.

This document is a type-C standard as stated in ISO 12100:2010.

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

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

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

Others can be affected by the level of machinery safety achieved in accordance with this document:

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

— machine users and 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 in the drafting process of this document.

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

When requirements of this type-C standard differ from those 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.

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Earth-moving machinery — Functional safety —

Part 5:
Tables of performance levels

1 Scope

This document specifies machine performance levels required (MPL_r) by common function and type for earth-moving machinery as defined in ISO 6165:2022. These MPL_r can then be mapped or applied to safety control systems (SCS) used to control or that affect the functions defined in Tables A.1 to AA.1.

To cover all the relevant safety requirements for the products in its scope, this document is used in combination with ISO 19014-1:2026, ISO 19014-2:2026, ISO 19014-3:2026, and ISO 19014-4:2026.

This document is not applicable to earth-moving machinery 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 6165:2022, *Earth-moving machinery — Basic types — Identification and vocabulary*

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

ISO 19014-1:2026, *Earth-moving machinery — Functional safety — Part 1: Methodology to determine safety-related parts of the control system and performance requirements*

ISO 19014-2:2026, *Earth-moving machinery — Functional safety – Part 2: Design and evaluation of hardware and architecture requirements for safety-related parts of the control system*

ISO 19014-3:2026, *Earth-moving machinery — Functional safety — Part 3: Environmental performance and test requirements of electronic and electrical components used in safety-related parts of the control system*

ISO 19014-4:2026, *Earth-moving machinery — Functional safety — Part 4: Design and evaluation of software and data transmission for safety-related parts of the control system*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6165:2022, ISO 12100:2010, ISO 19014–1:2026, ISO 19014-2:2026, ISO 19014-3:2026, ISO 19014-4:2026 and the following apply.

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

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

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

3.1
hold still
function that keeps the wheels or crawler tracks stationary, preventing the machine from moving

EXAMPLE An SCS that controls the hold still function is a park brake.

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3.2
slow / stop
function which reduces or brings to zero the *machine speed* (3.4)

EXAMPLE An SCS that controls the slow / stop function is a service brake.

3.3
machine speed
function which controls the rate of travel

EXAMPLE An SCS that controls the machine speed function is a throttle control, propel control or gear selection control.

3.4
engine speed
function which controls the rotational speed of the engine

EXAMPLE An SCS that controls the engine speed function is a throttle control.

3.5
machine direction
function which controls the longitudinal direction of the machine travel

EXAMPLE An SCS that controls the machine direction function is a forward, neutral, or reverse selection control.

3.6
steering
function which controls the lateral direction of machine travel

EXAMPLE An SCS that controls the steering function is a steering wheel or joystick.

3.7
swing / slew
function which controls the clockwise or anti-clockwise rotation of the upper structure of an excavator or digging linkage

EXAMPLE An SCS that controls the swing / slew function is a joystick.

3.8
roading
machines moving on a *road* (3.12)

Note 1 to entry: A suitably designed machine and road homologation can be required.

3.9
travelling
machine moving from one point on a worksite to another without going on a *road* (3.12)

EXAMPLE On a haul road, unimproved road or other thoroughfare on a site.

3.10
high wall
mine, quarry or other similar type wall associated with the worksite that a machine is working near

Note 1 to entry: It is considered machine abuse to operate machines near high walls without *berms* (3.11) in place.

3.11
berm
pile of dirt, rocks or other material intended to prevent a machine from passing into an area it is not intended to be operated in

Note 1 to entry: Some regions use different terms, e.g. bund, windrow.

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3.12
road
public traffic area for use by automotive vehicles for travel or transportation

Note 1 to entry: Public traffic area does not include the sites of temporary road works (e.g. for repairs, maintenance, alterations, improvements, installations, or any other works to, above or under the road, including works to road equipment, lighting, barriers, walls etc) or roads not open to the public (e.g. on new housing and industrial developments), or on which public traffic is not permitted.

[SOURCE: ISO 17253:2014, 3.2]

3.13
operator presence system
system fitted to a machine that detects if an operator is positioned in an operator station and automatically takes a control system action based on that determination

4 General

4.1 General principles

4.1.1 Safety requirements

The MPL_r in this document are determined through the machine control system safety analysis (MCSSA) process outlined in ISO 19014-1:2026. A brief explanation of how the levels were derived, and the associated assumptions are contained herein.

The MPL_r provided in this document can be used as an alternative to performing an MCSSA for like machinery per ISO 19014-1:2026 and were derived using that process. The functions, applications and use cases used to determine these levels are based on generic limits of machine application for the machine type. If the MPL_r in this document are used, the MPL_r shall be in accordance with Annexes A to AA after following the review outlined in, 4.2, 4.3, 4.4, 4.5, 4.6, and 6.1.

Machinery shall conform to the safety requirements and risk reduction measures of ISO 19014-1:2026, ISO 19014-2:2026, and ISO 19014-4:2026. In addition, the machine shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

All exposure calculations in this document are rounded up to the nearest whole number.

4.2 Mapping of functions to a safety control systems (SCS)

The MCSSA supporting these MPL_r were carried out by function rather than system. In practice, there can be several SCS that can fail in a way that is described by the failure type listed for any particular function. All SCS on a machine shall be reviewed to determine if any failure can cause a hazardous outcome associated with a failure type of the functions listed. For example, a brake system can be mapped from a slow / stop or hold still function, as can another system that interferes with the ability of the machine to brake at an appropriate rate to meet the ISO 3450:2011 stopping distance.

Measures beyond SCS can be applied to mitigate hazardous failures (e.g. mechanical lock outs, guards, administrative controls). In such a case, a MCSSA shall be completed to assess the MPL requirements of any residual risk associated with the SCS.

4.3 Applicability of the listed machine performance levels required (MPL_r) to machines

This document does not eliminate the need to do a risk assessment in accordance with ISO 12100:2010 as required by ISO 19014-1:2026.

The MCSSA supporting these MPL_r were carried out considering the limits of the machine type usage across the industry. Unique or limited applications or use cases can result in a different MPL_r for the machine

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