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Earth-moving machinery — Collision warning and avoidance —

Part 4: Risk area and risk level for swing and rotation motion

Engins de terrassement — Avertissement et évitement de collision —

Partie 4: Zone de risque et niveau de risque pour les mouvements d'orientation et rotation

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Foreword

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

A list of all parts in the ISO 21815 series can be found on the ISO website.

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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

The increasing use of detection systems and avoidance technology has been supporting operators to safely operate machines in the field of mining and construction. At the same time, there are demands to set standards for machines and systems detecting, alerting and intervening to mitigate collision risk. This document addresses collision risk areas and collision risk levels (CRLs) for machines utilizing detection systems and avoidance technology in the area of earth-moving machinery that exhibit swing and rotation motion.

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);

— providers of collision warning and avoidance technology;

— system integrators.

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

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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.

The intention of this document is to address requirements for detecting, alerting and intervention in mitigating collision risk.

There are currently two standards addressing object detection in the earth moving machinery field: ISO 16001 and ISO 17757. These standards provide guidance for visibility aids and object detection system and for autonomous and semi-autonomous machines, however, there is currently no standard that describes collision risk awareness, warning signals and collision avoidance actions of manually operated machinery when there is a risk of collision.

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Earth-moving machinery — Collision warning and avoidance —

Part 4:
Risk area and risk level for swing and rotation motion

1 Scope

This document specifies requirements for collision warning systems (CWS) and collision avoidance systems (CAS) that address swing and rotation motion for:

— earth moving machinery as defined in ISO 6165;

— mobile underground mining machinery as defined in ISO 19296;

— rock drill rigs as defined in ISO18758-1;

— road construction machinery as defined in ISO 22242.

This document covers the risk of collision with an intended object between the ground plane of the machine and the top of the machine operator cabin. This document does not cover the risk of collision with parts of the intended objects that are higher than the top of the machine operator cabin. This document does not consider machine height of working tool (e.g. height of boom and arm).

This document covers collision avoidance by motion inhibition or collision warning by providing warning to the operator, prior to initiation of swing and rotation motion around vertical axis of a machine (e.g. excavators) or swing and rotation parts of a machine about an axis (e.g. backhoe portion of backhoe loaders, conveyer part of mobile screens, booms on rock drills).

It does not cover collision avoidance by automatic application of the braking or automatic manoeuvring (e.g. raise bucket) away from the intended object.

The system described in this document is intended to assist the operator of the machine. The responsibility for safe operation of the machine remains with the machine operator.

This document is not applicable to collision warning and collision avoidance systems installed/manufactured before the date of its publication.

For the purpose of this document, the term "machine" means swing and rotation machine or swing and rotation parts of machine.

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 6750-1, *Earth-moving machinery — Operator's manual — Part 1: Contents and format*

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

ISO 21815-1, *Earth-moving machinery — Collision warning and avoidance — Part 1: General requirements*

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ISO 21815-3, *Earth-moving machinery — Collision warning and avoidance — Part 3: Risk area and risk level for forward/reverse motion*

ISO 21815-5, *Earth-moving machinery — Collision warning and avoidance — Part 5: Risk area and risk level for other motions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21815-1, ISO 21815-3, and ISO 21815-5 apply.

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 https://www.electropedia.org/

4 Performance requirements

4.1 General requirements

Machinery shall conform with the safety requirements and/or protective/risk reduction measures of this clause. In addition, the machine shall be designed according to the principles of ISO 12100 for relevant, but not significant hazards which are not dealt with by this document.

CxS, as defined in ISO 21815-1:2022 3.10, shall conform to the requirements of ISO 21815-1, in as far as those are not modified or added to by the requirements in this document.

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The CxS shall determine a collision risk level (CRL)of each intended object and communicate the appropriate action.

The CxS must re-evaluate the risk level at a frequency high enough to address the relative movement of the machine and intended objects.

Since this document deals with inhibition of rotational motion, this section defines the CxS requirements related to inhibiting the initiation of motion prior to machine rotation.

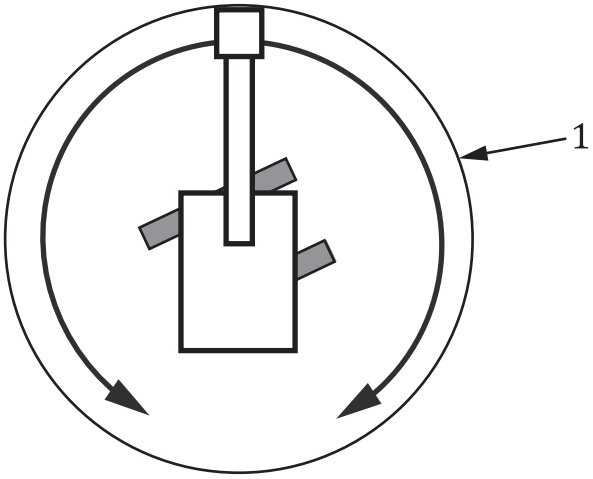
The detection zone of CxD, as defined in ISO 21815-1:2022 3.15, should be the same or larger than the collision risk area. However, due to limits of the system, the detection zone can be smaller than the collision risk area.

Some CxS products can have limited detection zone to maximum reach of work equipment while other products have "only around the tail of rotating machine that is out of the operator's field of vision''. In such cases, the limits of the system and the selection of detection zone according to the application shall be defined in the information for use as system limitations.

This document illustrates excavator-type machine which rotates 360° (e.g. see Figure 1). However, machines with swing and rotation angle limited to less than 360° (e.g. backhoe loader in Figure 2) are also covered in this document.

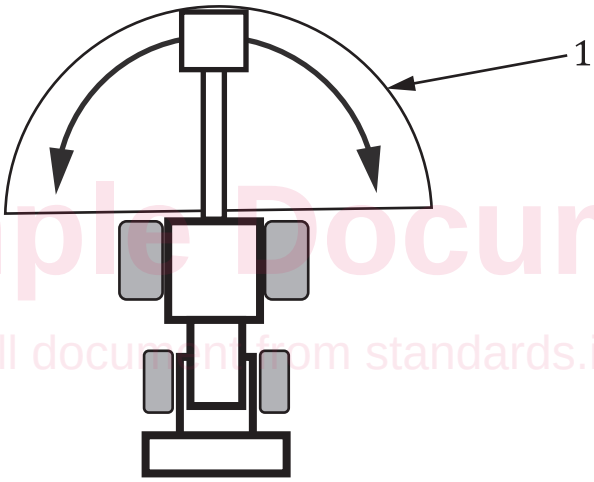
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Key
1 maximum reach

Figure 1 — Excavator-type machine which rotates 360°



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Key
1 maximum reach

Figure 2 — Machines where swing and rotation angle is limited to less than 360°

4.2 Calculating CxS distance

4.2.1 Swing and rotation motion

The CxS distance for swing and rotation motion shall be large enough to allow the machine to inhibit initiation of rotation to avoid a collision with an intended object.

There are two cases considered for calculating CxS distances.

— Rotation angle with stationary object: when there is a risk of collision due to the presence of a stationary intended object before the start of machine rotation.

— Distance when moving object exists: when the intended object itself moves and comes towards the machine and increases the risk of collision.

An appropriate CxS distance calculation method shall be selected according to the application.

NOTE 1 A CxS distance calculation example for distance with moving object is shown in Annex C.

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