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Mining — Mobile machines working underground — Machine safety

Exploitation minière — Engins mobiles d'exploitation souterraine — Sécurité des machines

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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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 82, *Mining*.

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 -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 following assumptions were made in writing this standard:

a) the operators of the machines are well trained professionals and aware of potential risks of the working environment;

b) the machines are operated according to the instructions given by the manufacturer in the operating instructions;

c) administrative controls are in place for preventing unauthorized entry of persons to the area where machines are working;

d) components are:

   1) designed in accordance with the good engineering practice and calculation codes, taking account of shocks and vibration, including all failure modes;

   2) made of materials with adequate strength and of suitable quality; and

   3) free of defects;

e) harmful materials, such as asbestos are not used;

f) components are kept in good repair and working order, so that the required dimensions remain fulfilled despite wear.

Mining — Mobile machines working underground — Machine safety

1 Scope

This document specifies the safety requirements for self-propelled mobile machines used in underground mining, as defined in 3.1.

This document deals with hazards, hazardous situations and hazardous events (see Annex B) relevant to these machines when they are used as intended or under conditions of misuse reasonably foreseeable by the manufacturer.

For utility/service/support machines, this document only includes provisions to address the risks associated with the mobility (movement of the whole machine from one location to another). Risks for the additional functions (e.g. scaling, concrete spraying, bolting, charging, drilling, attachments) are not covered in this document.

This document specifies the appropriate technical measures for eliminating or sufficiently reducing risks arising from hazards, hazardous situations or hazardous events during commissioning, operation and maintenance.

This document does not address:

— the additional risks for machines operating in potentially explosive atmospheres;

— air quality and engine emissions.

This document is not applicable to:

— machines constrained to operate by rails;

— continuous miners, roadheaders, drill rigs, conveyors, long wall production equipment, tunnel boring machines (TBM), and mobile crushers.

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 2860:1992, *Earth-moving machinery — Minimum access dimensions*

ISO 2867:2011, *Earth-moving machinery — Access systems*

ISO 3411:2007, *Earth-moving machinery — Physical dimensions of operators and minimum operator space envelope*

ISO 3449:2005, *Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements*

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

ISO 3457:2003, *Earth-moving machinery — Guards — Definitions and requirements*

ISO 3471:2008, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements*

ISO 3795:1989, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 3864-3:2012, *Graphical symbols — Safety colours and safety signs — Part 3: Design principles for graphical symbols for use in safety signs*

ISO 4250-3:2011, *Earth-mover tyres and rims — Part 3: Rims*

ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 5006:2017, *Earth-moving machinery — Operator's field of view — Test method and performance criteria*

ISO 5010:—[1)], *Earth-moving machinery — Rubber-tyred machines — Steering requirements*

ISO 5349-1:2001, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1: General requirements*

ISO 6011:2003, *Earth-moving machinery — Visual display of machine operation*

ISO 6014:1986, *Earth-moving machinery — Determination of ground speed*

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

ISO 6395:2008, *Earth-moving machinery — Determination of sound power level — Dynamic test conditions*

ISO 6396:2008, *Earth-moving machinery — Determination of emission sound pressure level at operator's position — Dynamic test conditions*

ISO 6405-1:2017, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

ISO 6405-2:2017, *Earth-moving machinery — Symbols for operator controls and other displays — Part 2: Symbols for specific machines, equipment and accessories*

ISO 6483:1980, *Earth-moving machinery — Dumper bodies — Volumetric rating*

ISO 6682:1986, *Earth-moving machinery — Zones of comfort and reach for controls*

ISO 6683:2005, *Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests*

ISO 6750:2005, *Earth-moving machinery — Operator's manual — Content and format*

ISO 6805:1994, *Rubber hoses and hose assemblies for underground mining — Wire-reinforced hydraulic types for coal mining — Specification*

ISO 7130:2013, *Earth-moving machinery — Operator training — Content and methods*

ISO 7546:1983, *Earth-moving machinery — Loader and front loading excavator buckets — Volumetric ratings*

ISO 8030:2014, *Rubber and plastics hoses — Method of test for flammability*

1) Under preparation (revision of ISO 5010:2007). Stage at the time of publication: ISO/DIS 5010:2018.

ISO 8084:2003, *Machinery for forestry — Operator protective structures — Laboratory tests and performance requirements*

ISO 8152:1984, *Earth-moving machinery — Operation and maintenance — Training of mechanics*

ISO 9244:2008, *Earth-moving machinery — Machine safety labels — General principles*

ISO 9533:2010, *Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria*

ISO 10262:1998, *Earth-moving machinery — Hydraulic excavators — Laboratory tests and performance requirements for operator protective guards*

ISO 10263-2:2009, *Earth-moving machinery — Operator enclosure environment — Part 2: Air filter element test method*

ISO 10263-3:2009, *Earth-moving machinery — Operator enclosure environment — Part 3: Pressurization test method*

ISO 10264:1990, *Earth-moving machinery — Key-locked starting systems*

ISO 10265:2008, *Earth-moving machinery — Crawler machines — Performance requirements and test procedures for braking systems*

ISO 10268:1993, *Earth-moving machinery — Retarders for dumpers and tractor-scrapers — Performance tests*

ISO 10532:1995, *Earth-moving machinery — Machine-mounted retrieval device — Performance requirements*

ISO 10533:1993, *Earth-moving machinery — Lift-arm support devices*

ISO 10570:2004, *Earth-moving machinery — Articulated frame lock — Performance requirements*

ISO 10968:2004, *Earth-moving machinery — Operator's controls*

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

ISO 12508:1994, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*

ISO 13031:2016, *Earth-moving machinery — Quick couplers — Safety*

ISO 13333:1994, *Earth-moving machinery — Dumper body support and operator's cab tilt support devices*

ISO 13766-1:2018, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 1: General EMC requirements under typical electromagnetic environmental conditions*

ISO 13766-2:2018, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 2: Additional EMC requirements for functional safety*

ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 14397-1:2007, *Earth-moving machinery — Loaders and backhoe loaders — Part 1: Calculation of rated operating capacity and test method for verifying calculated tipping load*

ISO 14990-1:2016, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 1: General requirements*

ISO 14990-2:2016, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 2: Particular requirements for externally-powered machines*

ISO 14990-3:2016, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 3: Particular requirements for self-powered machines*

ISO 15817:2012, *Earth-moving machinery — Safety requirements for remote operator control systems*

ISO 15818:2017, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements*

ISO 20474-1:2017, *Earth-moving machinery — Safety — Part 1: General requirements*

ISO 21507:2010, *Earth-moving machinery — Performance requirements for non-metallic fuel tanks*

ISO 22448:2010, *Earth-moving machinery — Anti-theft systems — Classification and performance*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 3450 and the following apply.

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

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

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

3.1
underground mobile machine
self-propelled machine designed to operate underground for carrying persons or material, for lifting or loading materials, or to work with attached equipment

Note 1 to entry: These machines are designed to operate in locations which have restricted widths and heights: therefore the machines are generally compact.

3.1.1
load haul dump
LHD
machine whose primary purpose is for loading, hauling and dumping material but can be extended to other applications by utilizing attachments in place of the bucket

Note 1 to entry: See Figure 1.

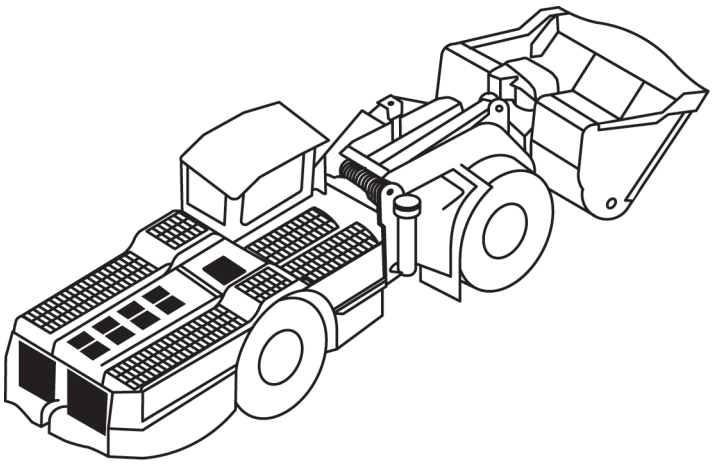

Figure 1 — Load haul dump

3.1.2
underground dumper hauler
rigid frame or articulated machine with an open body, for hauling and dumping materials, without the capability for self loading

Note 1 to entry: See Figure 2.

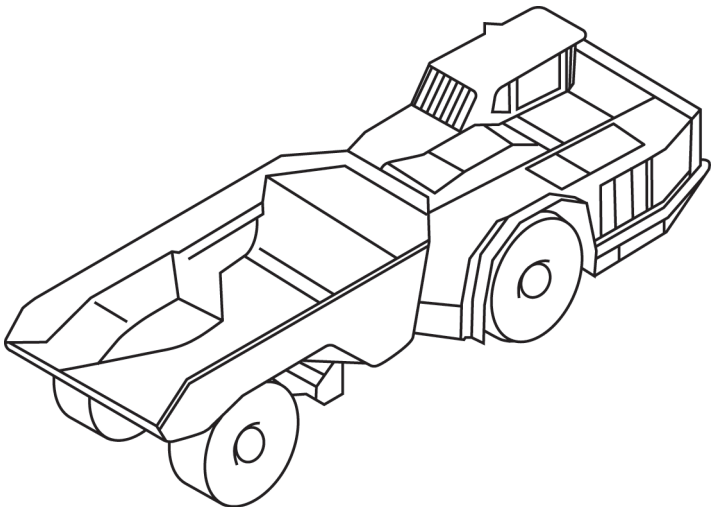

Figure 2 — Dumper hauler

3.1.3
underground dozer
self-propelled crawler or wheeled machine designed or modified to be used underground with equipment having either a dozing attachment which cuts, moves and grades material through forward motion of the machine or a mounted attachment used to exert a push or a pull force

3.1.4
underground utility/service/support machine
mobile machine that supports the primary production of the underground process, e.g. concrete spraying, charging, lifting and installation, servicing, scaling, transporting material

Note 1 to entry: See Figure 3 through Figure 6.

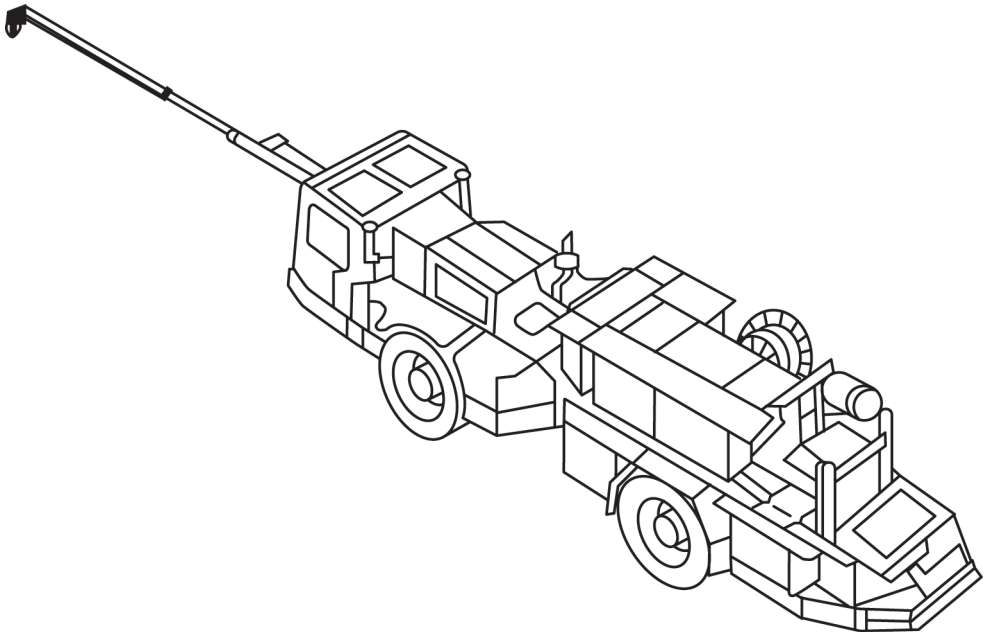

Figure 3 — Concrete spraying machine

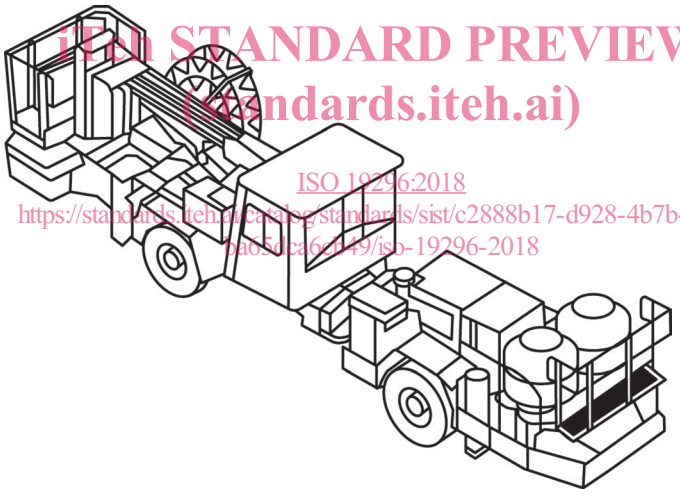

Figure 4 — Charging machine

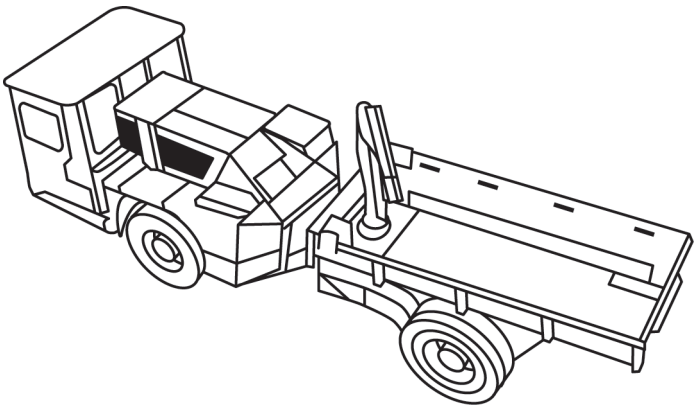

Figure 5 — Utility and service machine

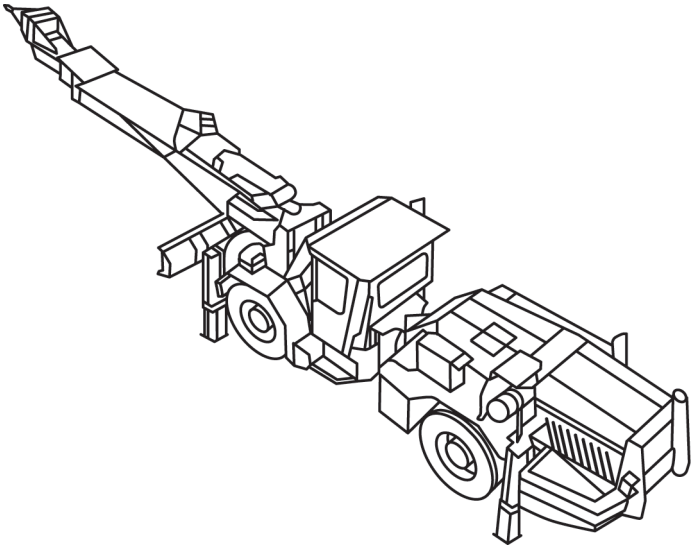

Figure 6 — Scaling machine

3.1.5
underground personnel transporter
machine whose primary function is to transport people at the mine site

Note 1 to entry: See Figure 7.

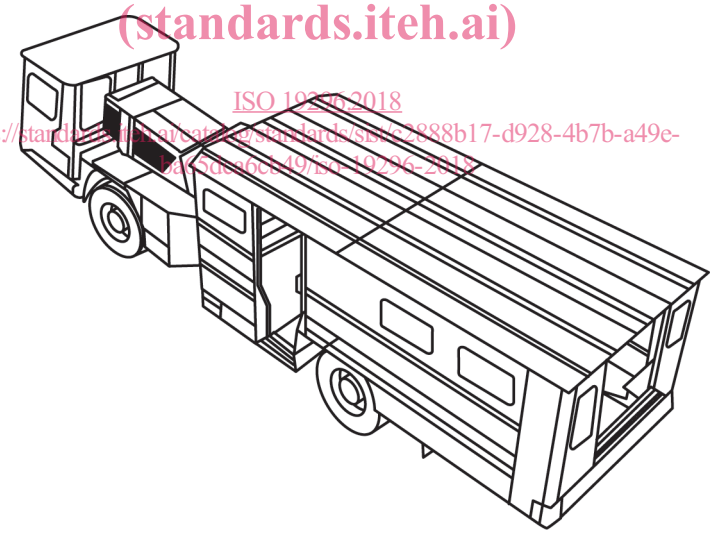

Figure 7 — Personnel transporter

3.1.6
continuous loader
machine equipped with digging arms or buckets that feed a conveyer transporting the material to the back of the machine for loading dumpers, conveyors, etc.

Note 1 to entry: See Figure 8.

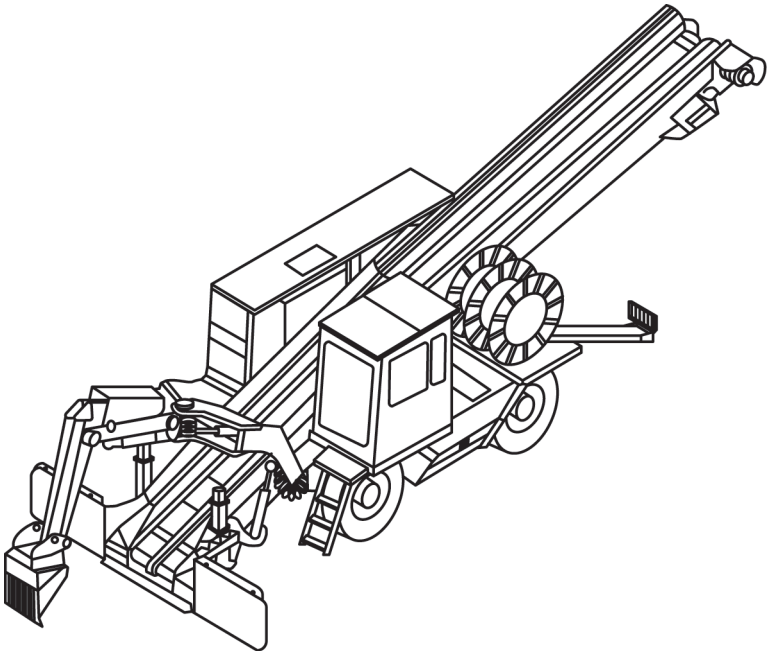

Figure 8 — Continuous loader

3.1.7
shuttle car
self-propelled wheeled haulage vehicle for transporting mined material between a mining machine and a feeder breaker

Note 1 to entry: See Figure 9.

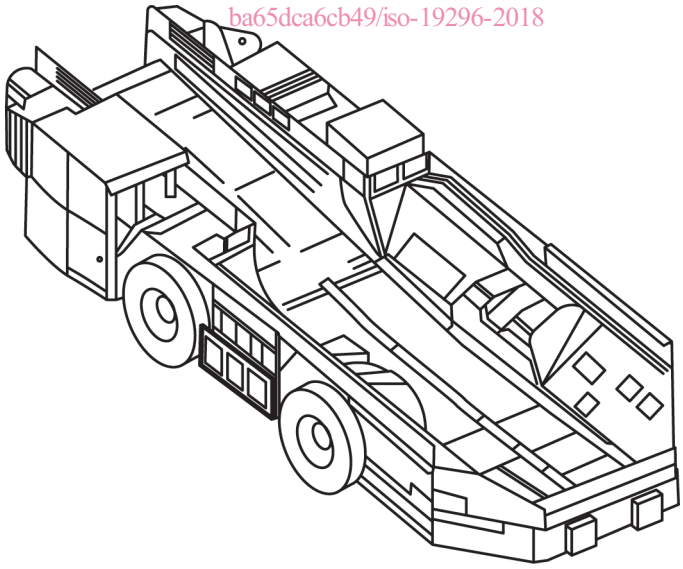

Figure 9 — Shuttle car

3.2
operator
designated, competent person, suitably trained and qualified by knowledge and practical experience and provided with the necessary instructions to ensure safe use of the machine for all operations it is designed for and within the limits of safe operation of the machine

3.3
brake system
all components which combine together to stop or hold the machine, including the brake control, brake actuation system, the brakes themselves and, if the machine is so equipped, the retarder

3.3.1
service brake system
primary system used for stopping and holding the machine

3.3.2
secondary brake system
system used to stop the machine in the event of any single failure in the *service brake system* (3.3.1)

3.3.3
parking brake system
system used to hold a stopped machine in a stationary position

3.4
maximum speed
speed the machine has been designed by the manufacturer to achieve on level ground per ISO 6014

3.5
gross machine mass
maximum machine mass as approved by the manufacturer, which combines the operating mass of the machine with the heaviest combination of equipment and attachments, the heaviest combination of optional equipment, the rated payload (mass that can be carried by the machine, as specified by the manufacturer), and the rated ballast mass (maximum mass of ballast that can be added to the machine, as specified by the manufacturer)

3.6
routine maintenance
maintenance that is specified in the periodic maintenance schedule of the operator's manual for performing scheduled daily/weekly/monthly maintenance on the machine

[SOURCE: ISO 2867:2011, 3.1.3 - Modified.]

4 Safety requirements and/or protective/risk reduction measures

4.1 General requirements

4.1.1 General

Machines shall comply 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 12100:2010 for relevant but not significant hazards which are not dealt with by this document. The manufacturer shall undertake a process of risk assessment for the design and functions of the machine. The manufacturer shall include a process of risk assessment for typical operations over the machine life cycle. Risk assessment processes shall be in accordance with ISO 12100.

4.1.2 Moving parts

All moving parts that create a hazard of crushing, shearing or cutting shall be designed, constructed, positioned or provided with guards or protective devices that minimize the risk. Guards shall comply with ISO 3457. Fixed guards that are to be removed as a part of routine maintenance, described in the operator's manual, shall be fixed by systems that can be opened or removed only with tools. Fixed guards that are removable for routine maintenance shall have a means of fastening that shall remain attached to the guards or to the machinery when the guards are removed.