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Earth-moving machinery — Sustainability — Terminology, sustainability factors and reporting

Engins de terrassement — Durabilité — Terminologie, facteurs de durabilité et rapport

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10987 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*.

Introduction

Sustainability has become a global concern for all products, including earth-moving machines. Customers buying the machines are requesting information that can be used to promote sustainability for their work projects. With the increased interest in the subject, many organizations are preparing sustainability guidelines and many manufacturers of earth-moving machinery are beginning to provide general information. This International Standard is the first on sustainability for earth-moving machines: a beginning in the definition of the sustainability information that customers can use for their projects.

Sustainability covers a wide range of areas related to social, environmental and economic considerations for the development, manufacturing, useful life and end-of-life phases for earth-moving machines. This International Standard covers

— general sustainability principles,

— terminology, and

— sustainability factors and formats for summarizing sustainability information.

Further International Standards on sustainability for earth-moving machines are planned to cover other areas, including test methods, performance criteria and means of compliance.

Potential sustainability issues relevant to earth-moving machines include the following:

— greenhouse gas/carbon emissions;

— energy use;

— general processes during design, manufacture, machine life, end-of-life;

— management system for sustainability communication, training, development;

— training for machine use — worksite managers, operators, maintenance;

— social aspect: health, safety, comfort, ergonomics;

— noise and vibration (operator);

— impact on environment — noise, dust, ground disturbance, noise and vibration (spectator);

— manufacturing and remanufacturing;

— dismantling and recycling;

— emissions, after treatment;

— bio fuels and oils;

— hazardous substances.

Other existing International Standards on earth-moving machines, while not dealing with sustainability itself, address many of the areas covered in this International Standard:

— general machine safety, ISO 20474 and the safety standards it references;

— noise, ISO 6393, ISO 6394, ISO 6395, ISO 6396;

— ergonomics, ISO 3411 (operator space), ISO 6682 and 10968 (controls), ISO 11112 (seats), and others;

— recyclability, ISO 16714;

— vibration, ISO 7096 and ISO/TR 25398;

— electromagnetic compatibility, ISO 13766;

— training, ISO 7130 and ISO 8152.

Earth-moving machinery — Sustainability — Terminology, sustainability factors and reporting

1 Scope

This International Standard sets out general principles for addressing the sustainability of the earth-moving machinery defined in ISO 6165. It establishes a sustainability terminology, identifies significant sustainability factors for earth-moving machines and provides an example of a reporting format for sustainability information.

This International Standard is applicable to the development and manufacturing processes and the useful life and end-of-life of earth-moving machines.

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 5349-2, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2: Practical guidance for measurement at the workplace*

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

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

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

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and Guidelines*

ISO 16714, *Earth-moving machinery — Recyclability and recoverability — Terminology and calculation method*

ISO 20474 (all parts), *Earth-moving machinery — Safety*

ISO/TR 25398, *Earth-moving machinery — Guidelines for assessment of exposure to whole-body vibration of ride-on machines — Use of harmonized data measured by international institutes, organizations and manufacturers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
sustainability
balance between social, environmental and economic needs that optimizes the current quality of life without sacrificing future quality of life

3.2
machine load factor
parameter used to indicate how a machine is working relative to the capability of the machine, defined by the manufacturer for different types of machine applications, generally using three load factor categories — low, medium and high

Note 1 to entry: It is usually expressed as a percentage of maximum machine capability.

3.3
machine productivity
work performed by a machine as a function of time

3.4
remanufacturing
reconditioning process for a component to return it to a level making it suitable for re-use

3.5
re-use
any operation by which component parts of end-of-life machines are used for the same purpose for which they were conceived

[SOURCE: ISO 16714]

3.6
life cycle assessment
compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

3.7
end-of-life machine
machine that has completed its useful life and is taken out of service for disposal

[SOURCE: ISO 16714]

3.8
recycling
reprocessing in a production process of the waste materials for the original purpose or for other purposes, excluding processing as a means of generating energy

[SOURCE: ISO 16714]

3.9
recyclability
ability of component parts, materials or both that can be diverted from an end-of-life stream to be recycled

[SOURCE: ISO 16714]

3.10
useful life
period in which a machine is economical to continue to use

Note 1 to entry: The determination of useful life can vary depending on user needs.

3.11
energy efficiency
effectiveness of converting energy into useful work

3.12
greenhouse gas
GHG
gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, the atmosphere, and clouds

Note 1 to entry: For the purposes of this International Standard, GHGs are the six gasses listed in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).

3.13
recovery
reprocessing in a production process of the waste materials for the original purpose or for other purposes, together with processing as a means of generating energy

[SOURCE: ISO 16714]

3.14
recoverability
ability of component parts, materials or both that can be diverted from an end-of-life stream to be recovered

[SOURCE: ISO 16714]

3.15
CO_2 equivalent
common unit of measure for greenhouse gas emission used to calculate the total greenhouse gas effect (global warming potential) of different greenhouse gas emissions

3.16
global warming potential
GWP
relative measure of how much heat a greenhouse gas traps in the atmosphere

4 Sustainability factors

4.1 General

The sustainability factors presented in Table 1 apply for achieving the sustainability balance between environmental, social and economic needs during an earth-moving machine's useful life and end-of-life. The useful life typically has the greatest impact on that balance. This impact is taken into account in the development process and the sustainability information for both useful life and end of life is covered in Table 1.

The general sustainability principles of ISO 14040 and ISO 14044 apply for the machine development process and manufacturing process.

Estimates taken from the application of these sustainability factors can be used to provide information for the work site or work project. The work-site energy efficiency (see 4.2) and GHG (see 4.3) factors are best evaluated at the actual work site or work project level, where the total amount of energy/fuel used can be measured relative to the amount of work done to complete the work project.

NOTE Due to the variability and variety of machine operations (e.g. applications, operator skill or terrain), the estimates of energy use are not sufficiently accurate to enable comparisons between different machine models and sizes.

Table 1 — Sustainability factors for earth-moving machinery

Sustainability factor	Sustainability area(s)	Description	Information or references supplied by manufacturer
Work-site energy efficiency (see 4.2)	Environmental/ Economic	Work performed on a work site per the amount of energy used/fuel consumed	Information used to estimate machine work done/unit of energy
Work-site greenhouse gas (GHG) emissions (see 4.3)	Environmental	Work-site GHG emissions per amount of work done defined by CO_2 equivalents	Information used to estimate kilograms of CO_2 equivalents produced during a work-site project
Product support for improving machine efficiency and use (see 4.4)	Environmental/ Economic	Information and training to improve machine operation efficiency as a function of machine capability	Manufacturer's information used to improve machine efficiency and use
Machine air quality emissions (see 4.5)	Environmental	Engine emission rating	Engine rating level, such as tier or stage level
Machine material re-use, recyclability and recoverability (see 4.6)	Environmental	Remanufactureable content Recyclable content Recoverability	As a percentage of machine mass in accordance with ISO 16714
Safety (see 4.7)	Social/ Economic	Complying with International Standards on safety of earth-moving machinery	List of International Standards on safety with which the machine complies
Sound and vibration (see 4.8)	Social/ Environmental	Sound levels of machine	A-weighted decibels (dB) in accordance with ISO 6393, ISO 6394, ISO 6395 and ISO 6396
		Vibration levels of machine	Metres per second squared (m/s^2) — see ISO/TR 25398 and ISO 5349-2
Total useful life cost parameters (see 4.9)	Economic	Owning and operating costs versus productivity for the machine life cycle	Information on parameters to assist customers to estimate total useful life cost

4.2 Work-site energy efficiency

The work-site energy efficiency factor is defined as the energy used for the work done to complete the project. It is generally expressed in units of material moved per amount of energy used/fuel consumed. Common units are cubic metres or tonnes of material per kilowatt hour of energy used. For some applications, the distance that material is moved can be an important parameter, so the energy efficiency could be given in units of cubic metres or tonnes of material per distance in metres per kWh energy used. Determining energy efficiency for machines requires measuring both their energy use and the machine productivity.

The contributions of individual machines to the work-site energy efficiency can be estimated by the energy use/fuel consumption of machines versus the amount of work done. The amount of energy/fuel that a machine uses depends upon the particular application and on the machine load factor for the application. An example of a method for estimating machine energy efficiency is provided in Annex B.

4.3 Work-site greenhouse gas emissions

The work-site greenhouse gas (GHG) emissions factor for earth-moving-machinery consists of GHGs generated as a by-product of the energy/fuels used within earth-moving machines on a project to

complete the work. This source of work-site GHG emissions considered includes the use of earth-moving machinery within the boundaries of a worksite over a typical eight-hour workday and does not include GHG emissions attributed to any additional stages of a product's lifecycle. GHG emissions from all forms of energy/fuel used, such as fossil fuels, renewable fuels and electrical power, should be included in the accounting to determine the total of GHGs generated.

Hydrofluorocarbon emissions potentially associated with leakage and service within the worksite boundary on machines fitted with air conditioning should be identified by listing the amount of refrigerant charge in the air-conditioning system in kilograms.

4.4 Product support for improving machine efficiency and use

The work-site energy efficiency and resulting work-site GHG emission for earth-moving-machine applications vary significantly depending upon the skill of and technique used by the operator, as well as the specific work-site operations. Operator training and work-site management aids can be used to improve the energy efficiency for machines. Manufacturers should provide operator training instruction and work-site operation aids that can enable the improvement of the machine application efficiency. Such information and aids provide an immediate short-term opportunity for work sites to reduce the amount of GHGs.

NOTE Experience has shown that the most significant improvement in sustainability is from operator training and work-site management.

4.5 Machine air quality emissions

The machine air quality emissions factor refers to the engine emissions measured during engine emissions testing. The air quality emissions factor can be defined by providing the engine emissions level, such as the tier or stage level. These ratings define the maximum engine emission levels for nitrogen oxide (NO_x), hydrocarbon (HC), carbon monoxide (CO) and particulate matter (PM).

4.6 Machine material re-use, recyclability and recoverability

The machine material re-use factor provides information related to disposing of or dismantling machines at the end of their life. The three material re-use categories are as follows:

— **remanufactureable content** is the percentage of the machine mass that could be used again after a remanufacturing process in accordance with ISO 16714;

— **recyclable content** is the percentage of a machine that could be recycled in accordance with ISO 16714;

— **recoverability** is the percentage of the machine that can be diverted from an end-of-life stream to be recovered in accordance with ISO 16714.

4.7 Safety

The safety sustainability factor for earth-moving machinery shows that a machine has been developed to be safely used during its useful life with trained operators, maintained machines and safe work-site organization. International Standards are available that define the technical performance parameters for earth-moving machinery safety, and machine safety levels may be determined by listing the standards with which the machine is compliant. ISO 20474 is one such standard addressing significant safety aspects of earth-moving machines. National or regional standards may also be listed, as appropriate.

4.8 Sound and vibration

The sound and vibration factor provides information relative to the sound and vibration levels of machines. Machine sound levels, if included in the sustainability factor information, shall be according to the test methods specified in ISO 6393, ISO 6394, ISO 6395 and ISO 6396 for both the operator of, and spectators around, the machine. Machine vibration levels should be estimated using ISO/TR 25398 for whole body vibration and ISO 5349-2 for hand and arm vibration.

