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# Machine tools — Environmental evaluation of machine tools —

## Part 2: Methods for measuring energy supplied to machine tools and machine tool components

*Machines-outils — Évaluation environnementale des machines-outils —*

*Partie 2: Méthode pour mesurer l'énergie apportée aux machines-outils et aux composants de machines-outils*

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# Contents

Page

**Foreword** ... **iv**

**Introduction** ... **v**

**1 Scope** ... **1**

**2 Normative references** ... **1**

**3 Terms and definitions** ... **1**

**4 System and machine tool state description** ... **3**
4.1 General ... 3
4.2 Ambient conditions ... 3
4.3 Operating states and machine tool activity ... 3
4.4 Machine tool activity ... 4

**5 Test scenarios** ... **4**
5.1 General ... 4
5.2 Machine-based test scenario ... 4
5.2.1 General ... 4
5.2.2 Sample shift regime ... 4
5.2.3 Specific shift regime ... 6
5.3 Task-based test scenario ... 8

**6 System definition for measurement** ... **9**

**7 Measuring set up and methodology** ... **12**
7.1 Measuring points selection ... 12
7.2 Power measurement and calculation of energy supplied ... 12
7.3 Simultaneous measuring ... 13
7.4 Quasi-simultaneous measuring ... 13
7.5 Measuring equipment ... 13
7.5.1 General requirements ... 13
7.5.2 Equipment for electrical measurement ... 14
7.5.3 Equipment for measuring fluids ... 14
7.6 Measurement units ... 14
7.7 Measurement period ... 14
7.8 Conversion of measured values ... 14
7.9 Electrical energy equivalent ... 15
7.9.1 Standard conversion rates ... 15
7.9.2 Determination of electrical energy equivalent ... 15

**8 Measurement uncertainty** ... **17**

**9 Reporting of results** ... **17**
9.1 Reporting of individual measurement results ... 17
9.1.1 System description ... 17
9.1.2 Measurement setup description ... 17
9.1.3 Measurement result description ... 18
9.2 Mapping of measured values and interpretation ... 18
9.3 Measurement report ... 18

**Annex A** (informative) **Electrical energy equivalent** ... **19**

**Annex B** (informative) **Measuring of energy supplies (other than electrical)** ... **22**

**Annex C** (informative) **Measurement example** ... **33**

**Annex D** (informative) **Equations for the calculation of energy supplied and energy efficiency** ... **38**

**Annex E** (informative) **Examples of power measurement setup** ... **40**

**Bibliography** ... **51**

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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).

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This document was prepared by Technical Committee ISO/TC 39, *Machine tools*.

A list of all parts in the ISO 14955 series can be found on the ISO website.


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# Introduction

As environmental impact is a common challenge for all products and as natural resources become scarce, environmental performance criteria for machine tools need to be defined and the use of these criteria needs to be specified.

Machine tools are complex systems used by industry to manufacture “ready for use” products or semi-finished workpieces. Their environmental impact includes wasted raw material, use of auxiliary substances such as lubricants and other material flows, as well as conversion of electrical energy into heat, dissipation of heat to the ambient or heat exchange by fluids and possibly the use of other resources such as compressed air. Based on relevance considerations, the ISO 14955 series is focussed on environmental impacts related to the energy supplied to the machine tool during the use stage.

The performance of a machine tool as key data for investment is multi-dimensional regarding its economic value, its technical specification and its operating requirements which are influenced by the specific application. The energy supplied to the same machine tool can vary depending on the part which is being manufactured and the conditions under which the machine tool is operated. Therefore, the environmental evaluation of a machine tool cannot be done regardless of these aspects.

ISO 14955-1 describes a methodology for the environmental evaluation of machine tools and gives reasons for measuring energy supplied to the machine tool.

ISO 14955-3 to ISO 14955-5 describe the application of ISO 14955-1 and ISO 14955-2 to specific groups of machine tools.

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# Machine tools — Environmental evaluation of machine tools —

# Part 2: Methods for measuring energy supplied to machine tools and machine tool components

## 1 Scope

This document describes how measurements are made by providing measuring methods in order to produce reproducible data about the energy supplied to a machine tool under specified conditions. Furthermore, it provides methods to quantify the energy supplied to components in order to assign their share to generalized machine tool functions as described in ISO 14955-1.

It supports the energy-saving design methodology according to ISO 14955-1 by providing measuring methods for the energy supplied to machine tools. The assignment of the energy supplied to machine tool functions requires measurements at machine tool component level. These measurements need to be reproducible and independent of conditions other than those being recorded and documented.

The results of the measurements are intended to document improvements to the design, specifically under energy aspects, and/or to allow evaluating the energy involved in the manufacturing of a given part by a given machine tool. Any comparison requires identical conditions and ensures by specification and measurement that similar results are achieved.

## 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 1217, *Displacement compressors — Acceptance tests*

ISO 8778, *Pneumatic fluid power — Standard reference atmosphere*

ISO 14955-1:2017, *Environmental evaluation of machine tools — Part 1: Design methodology for energy-efficient machine tools*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14955-1 and the following 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/

**3.1**
**average electrical power**
average value of active electrical power for a given period in time

Note 1 to entry: Definitions for the measurement of electric power quantities under sinusoidal, non-sinusoidal, balanced, or unbalanced conditions are available in IEEE 1459-2010[13].

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**3.2**
**electrical energy**
active electrical power integrated over a given period of time

**3.3**
**electrical energy equivalent**
*electrical energy* (3.2) necessary to provide any other form of energy supplied to the *machine tool* (3.4)

**3.4**
**machine tool**
mechanical device which is fixed (i.e. not mobile) and powered (typically by electricity and compressed air), typically used to process workpieces by selective removal/addition of material or mechanical deformation

Note 1 to entry: Machine tools operation can be mechanical, controlled by humans or by computers. Machine tools may have also a number of peripherals used for machine tool cooling/heating, process conditioning, workpiece and tool handling (workpiece feeding excluded), recyclables and waste handling and other tasks connected to their main activities.

[SOURCE: ISO 14955-1:2017, 3.16]

**3.5**
**machine tool component**
mechanical, electrical, hydraulic, or pneumatic device of a *machine tool* (3.4), or a combination thereof

[SOURCE: ISO 14955-1:2017, 3.13]

**3.6**
**machine tool function**
*machine tool* (3.4) operation (machining process, motion and control), process conditioning, workpiece handling, tool handling or die change, recyclables and waste handling, machine tool cooling/heating

Note 1 to entry: Any machine tool function may be realized by one *machine tool component* (3.5) or by a combination of machine tool components. Some machine tool components may realize more than one machine tool function.

Note 2 to entry: Machine tool functions may be used for identifying machine tool components relevant for energy supplied to the machine tool.

[SOURCE: ISO 14955-1:2017, 3.12, modified — The Note 2 to entry has been deleted and the Note 3 to entry has become Note 2 to entry.]

**3.7**
**evaluation period**
continuous time interval in which the energy supplied and the result obtained are quantified

**3.8**
**operating state**
combination of ON, HOLD and OFF etc., settings of mains, peripheral units, *machine tool* (3.4) control, machine tool processing unit and machine tool motion units including relevant machine tool activities

Note 1 to entry: Peripheral units are, for example, units for machine tool cooling/heating, process conditioning, workpiece and tool handling, recyclables, and waste handling.

Note 2 to entry: Machine tool processing units are, for example, main spindle of a turning machine, tool spindle of a machining centre, generator for electro-discharge machine, slide of a press, draw cushions of a press.

Note 3 to entry: Machine tool motion units are, for example, linear axes of a turning machine, linear and rotary axes of a machining centre, linear axes of a wire electro-discharge machine.

Note 4 to entry: Reference to operating states (e.g. OFF, STANDBY, EXTENDED STANDBY, WARM UP, READY FOR PROCESSING, PROCESSING and CYCLING) requires definition of these states. An example for such a definition for a metal-cutting machine tool is given in ISO 14955-1:2017, Annex C.


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Note 5 to entry: Examples of machine tool activities are tool loading, workpiece loading, axes movements, waiting, machining or cycling, or complete test cycles.

Note 6 to entry: Depending on the operating state and the machine tool activities, a mode of operation is selected as defined by relevant safety standards of machine tools.

[SOURCE: ISO 14955-1:2017, 3.7, modified — The reference in Note 4 to entry has been updated.]

**3.9**
**pneumatic energy**
energy supplied by a flux of compressed air

**3.10**
**shift regime**
set of operating states and their time shares within an evaluation period

**3.11**
**machine tool activity**
set of operations of a *machine tool* (3.4) in operating states other than OFF

Note 1 to entry: Machine tool activities are caused by a defined control input to the machine tool by the user such as setting of a parameter or starting a program.

Note 2 to entry: Examples for machine tool activities are tool loading, workpiece loading, axes movement at specified speed and acceleration, machining or cycling, or complete test cycles (with relevant parameters specified).

# 4 System and machine tool state description

## 4.1 General

To perform the energy assessment, the system and the state of the machine tool shall be described. The description of the system is suggested in Clause 6. The machine tool state is the result of three distinct but not necessarily independent types of influences:

— ambient conditions;

— operating states;

— machine tool activity.

A complete statement shall comprise the system description and the state of the machine tool, characterized by ambient conditions, operating state and machine tool activity. Measurements shall be documented accordingly.

## 4.2 Ambient conditions

Measurements should be made at a stable ambient temperature, preferably at 20 °C. Ambient temperature and its fluctuations shall be monitored and reported in terms of average value and its variation (e.g. standard deviation or minimum/maximum values). Other ambient conditions, if relevant, shall be reported (e.g. humidity, direct sunlight, heat transfer).

## 4.3 Operating states and machine tool activity

Operating states result from the selection of a mode of operation and, eventually, from the introduction of further parameters by the operator, putting the machine tool in a desired state. The machine tool may include provisions to switch automatically to a particular operating state when default conditions, such as changing to STANDBY some time after finishing a part cycle and being unattended, are reached.

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