INTERNATIONAL STANDARD

ISO/IEC 28360-1

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Information technology — Office equipment — Determination of chemical emission rates from electronic equipment —

Part 1: Using-consumables

Technologies de l'information — Équipement de bureau — Détermination des taux d'émission chimique d'un équipement électronique —

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC 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 www.iso.org/iso/foreword.html.

ISO/IEC 28360-1 was prepared by Ecma International (as ECMA-328 Part 1) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, Information technology, in parallel with its approval by national bodies of ISO and IEC.

This first edition of ISO/IEC 28360-1, together with ISO/IEC 28360-2, cancels and replaces ISO/IEC 28360: 2015, which has been technically revised. It also incorporates the Technical Corrigendum ISO/IEC 28360: 2015/Cor.1:2016. The main changes compared to the previous edition are as follows:

— This edition was divided into a part for electronic equipment using consumables and a part for electronic equipment not using consumables as follows:

  — Determination of Chemical Emission Rates from Electronic Equipment — Part 1 (using-consumables)

  — Determination of Chemical Emission Rates from Electronic Equipment — Part 2 (not using-consumables)

  The purpose of the split was to make the description of test procedures simpler (they included considerable differences between the two equipment categories) and to facilitate users' understanding.

— This edition is fully aligned with "Test method for the determination of emission from Hard Copy Devices" (RAL-UZ 205).

A list of all parts in the ISO 28360 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.

Introduction

Globally, governmental agencies, academic institutions, environmental organizations and manufacturers have started to develop methods to determine chemical emissions from electronic equipment. These attempts however, initially resulted in a range of tests from which the results were not necessarily comparable, either qualitatively or quantitatively.

Following the publications of the 1st edition of ECMA-328 in 2001 and the "Test method for the determination of emissions from Hard Copy Devices" (RAL-UZ 122), experts from the BAM and Ecma have collaborated to harmonise methods to determine the chemical emission rates from ICT & CE equipment in the 2nd edition.

In addition to stricter test procedures, the 2nd edition used generalised emission formulae, and their derivations developed in Annex C, to calculate emission rates from concentrations of analytes that are measured in Emission Test Chambers.

The 3rd edition was fully aligned with the 1st edition of ISO/IEC 28360:2007 adopted under ISO/IEC JTC 1 fast track procedure and published in September 2007.

In addition, the 4th edition fixed a number of errata on ISO/IEC 28360:2007 that JTC 1/SC 28 identified.

Following the publications of the 4th edition of ECMA-328 and the "Test method for the determination of emissions from Hard Copy Devices" (RAL-UZ 122), experts from the BAM, WKI, JBMIA and Ecma have collaborated to harmonise methods to determine the Fine Particle (FP) and Ultrafine Particle (UFP) emissions from hard copy devices in the 5th edition.

The 6th edition was aligned with the 2nd edition of ISO/IEC 28360:2012, and it added a new ozone calculation method. "Test method for the determination of emission from Hard Copy Devices" (RAL-UZ 122) has been replaced by "Test method for the determination of emission from Hard Copy Devices" (RAL-UZ 171) published in January 2013. Therefore, "RAL-UZ 122 option" is replaced with "RAL-UZ 171 option" in the 6th edition.

The 7th edition of ECMA-328 is fully aligned with ISO/IEC 28360:2015.

The 8th edition was divided into a part for electronic equipment using consumables and a part for electronic equipment not using consumables as follows:

— Determination of Chemical Emission Rates from Electronic Equipment — Part 1 (using-consumables)

— Determination of Chemical Emission Rates from Electronic Equipment — Part 2 (not using-consumables)

The purpose of the split was to make the description of test procedures simpler (they included considerable differences between the two equipment categories) and to facilitate users' understanding.

This 8th edition is fully aligned with "Test method for the determination of emission from Hard Copy Devices" (RAL-UZ 205).

This part of the Standard is Part 1.

Information technology — Office equipment — Determination of chemical emission rates from electronic equipment —

Part 1: Using-consumables

1 Scope

This document (all parts) specifies methods to determine chemical emission rates of analyte from ICT & CE equipment during intended operation in an Emission Test Chamber (ETC).

This document (all parts) includes specific methods for equipment using consumables, such as printers, and equipment not using consumables, such as monitors and PC's.

Part 1 specifies the methods to determine chemical emission rates of analyte from electronic equipment using consumables.

The methods comprise preparation, sampling (or monitoring) in a controlled ETC, storage and analysis, calculation and reporting of emission rates.

Emission rates from EUT may also be determined according to additional requirements identified by "RAL-UZ 205 Option".

Annex A specifies monochrome and colour print patterns for use in the operating phase of EUT using consumables.

The operational readiness of AMS is confirmed according to Annex B.

Calculations use the generalised model and approximations thereof as developed in Annex C.

The emission rates determined with this method may be used to compare equipment in the same class.

Predictions of "real indoor" *concentrations* from the determined *emission rates* are outside the scope of this document.

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 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 16000-3:2011, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method*

ISO 16000-6:2011, *Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID*

ISO 16000-9:2006, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

ISO 16017-1:2000, *Indoor, ambient and workplace air — Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography — Part 1: Pumped sampling*

CIE 15:2004, *Commission Internationale de l'Eclairage — Colorimetry, 3rd edition*

3 Terms and definitions

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

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

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

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

3.1
averaged concentration time series
simple moving average of total particle number concentration (C_p) over 31 ± 3 seconds

3.2
averaged ozone concentration time series
simple moving average of ozone concentration (Co_3) over 80 ± 5 seconds

3.3
aerosol
suspension of fine solid particles and/or liquid droplets in a gas

3.4
aerosol measuring system
AMS
device category for measuring the total particle number concentration of an aerosol within a size range at a certain frequency

Note 1 to entry: CPC (4.8) and fast AMS (4.12) belong to AMS.

3.5
air exchange rate
n
ratio (n) of the volume of clean air brought into the ETC per hour [m^3/h] to the unloaded ETC volume [m^3]

3.6
air velocity
air speed [m/s] measured in the unloaded ETC

3.7
analyte
volatile organic compounds (VOC), carbonyl compounds, ozone, particulate matter, fine particles (FP) and ultrafine particles (UFP)

3.8
condensation particle counter
CPC
instrument that measures the particle number concentration of an aerosol

Note 1 to entry: For the purpose of this document a CPC is used as a standalone instrument which measures the total particle number concentration within a device dependent size range.

3.9
consumables
toner, ink, paper and ribbon

3.10
emission test chamber
ETC
enclosure with controlled operational parameters for testing analyte mass emitted from EUT

3.11
equipment under test
EUT
electronic equipment from which chemical emission rates are determined

3.12
fast AMS
instrument with rapid time resolution and particle size classification

3.13
fine particles
FP
particles with particle size / diameter range between 0,1 µm and 2,5 µm

3.14
hard copy devices
class of EUT using Consumables that includes printers, (Photo)copiers and Multi Functional Devices (MFD)

3.15
loading factor
ratio of the EUT volume to the volume of the unloaded ETC

3.16
maximum usage time before testing
MUT
ratio between the total number of prints carried out by the EUT and the printing speed of the EUT

Note 1 to entry: Maximum usage time is the maximum permitted time of operation before testing in order to consider the EUT as newly manufactured equipment for testing purposes.

3.17
operating phase
phase in which the EUT is performing its intended functions

3.18
particle
solid or liquid matter with defined physical boundaries suspended in a gas

3.19
particle emission rate
PER
averaged emission rate, i.e. total number of particles in a specified particle size range emitted during the operating phase

3.20
particle emission rate
PER(t)
time dependent emission rate of particles in a specified particle size range after the start of the operating phase

3.21
particle loss coefficient
β
coefficient describes the loss of particles in a specified particle size range in an ETC

3.22
particle size/particle diameter
measurement category to describe the physical dimension of a particle

Note 1 to entry: The term particle size is often used as a synonym for particle diameter. The particle diameter is used to assign a particle to a particle size class (e.g. UFP).

3.23
particulate matter
PM
quantity of particles measured by gravimetric methods

3.24
post-operating phase
phase following the operating phase

Note 1 to entry: The post-operating can include energy saving modes.

3.25
pre-operating phase
phase in which the EUT is connected to an electrical supply before the EUT is able to enter the operating phase

Note 1 to entry: The pre-operating phase can include warming-up and energy saving modes.

3.26
standard particle emission rate
PER_{10} calculated number of particles emitted during a 10-minute operating phase in a specified particle size range

3.27
total number of emitted particles
TP
calculated total number of particles emitted in a specified particle size range

3.28
total particle number concentration
C_p
particle number concentration in a specified particle size range

3.29
total volatile organic compounds
TVOC
the sum of the concentrations of identified VOC and the concentrations of the converted areas of unidentified peaks using the toluene response factor

Note 1 to entry: This definition of "total volatile organic compounds" differs from the definition in ISO 16000-6:2011.

3.30
ultrafine particles
UFP
particles with particle diameter less or equal 0,1 µm

3.31
unit specific emission rate
SER
mass, in micrograms, of a specific analyte emitted per hour

3.32
volatile organic compounds
VOC
compounds that elute between n-hexane and n-hexadecane on a nonpolar GC-column

4 Symbols and abbreviated terms

4.1 Abbreviated terms

AMS	Aerosol Measuring System
CPC	Condensation Particle Counter
DNPH	2,4-Dinitrophenylhydrazine
ETC	Emission Test Chamber
EUT	Equipment Under Test
FID	Flame Ionisation Detector
FP	Fine Particles
GC/MS	Gas Chromatography/Mass Spectrometry
MFD	Multi Functional Device
PER	Averaged Particle Emission Rate
PER(t)	Time-dependent Particle Emission Rate
PER_{10}	Standard Particle Emission Rate
PTFE	Polytetrafluoroethene (Polytetrafluoroethylene)
PVC	Polyvinylchloride
RH	Relative Humidity
SER	Unit Specific Emission Rate
TVOC	Total Volatile Organic Compounds
UFP	Ultrafine Particles
VOC	Volatile Organic Compounds

4.2 Symbols

α	Factor in the exponential particle decay function [cm^{-3}]
β	Particle loss coefficient [h^{-1}]
C_s	Average mass concentration [$\mu g\ m^{-3}$]
C_{bg}	Background mass concentration [$\mu g\ m^{-3}$]
C_0	Initial mass concentration [$\mu g\ m^{-3}$]

C_{pre}	Average mass concentration during pre-operating phase [µg m^{-3}]
C_{ope}	Average mass concentration during operating phase and optionally during post-operating phase [µg m^{-3}]
C_p	Total particle number concentration [cm^{-3}]
C_{pbg}	Background particle number concentration [cm^{-3}]
Co_3	Ozone concentration [mg/m^3]
d	Equivalent Particle Diameter [nm]
m_{after}	Sample filter mass [µg] after sampling
m_{before}	Sample filter mass [µg] before sampling
m_{bg}	Sampled mass for chamber background [µg]
m_{pm}	Mass of particulate matter [µg] deposited on the filter
$m_{ref\text{-}after}$	Reference filter mass [µg] after sampling
$m_{ref\text{-}before}$	Reference filter mass [µg] before sampling
m_s	Sampled mass [µg]
m_{pre}	Sampled mass [µg] during pre-operating phase
m_{ope}	Sampled mass [µg] during operating and optionally post-operating phase
n	Air exchange rate [h^{-1}]
p	Atmospheric pressure [Pa]
R	Gas constant [PaK-1], (for ozone: 339.8 [PaK-1])
SER_{bg}	Background SER [µg h^{-1}]
SER_{ope}	SER during operating and optionally post-operating phase [µg h^{-1}]
SER_{O3}	SER for ozone [µg min^{-1}]
SER_{pm}	SER for particulate matter [µg h^{-1}]
SER_{pre}	SER during pre-operating [µg h^{-1}]
T	Ambient temperature [K]
TP	Total Number of Emitted Particles
t_{ope}	Operating phase duration [h]
t_G	Sampling time during operating and optionally post-operating phase [h]
t_{start}	Point in time marking the start of particle emission
t_{stop}	Point in time marking the end of particle emission
t_{pre}	Pre-operating phase duration [h]
Δt	Time-resolution of the UFP measurement [s]

V	ETC volume [m3]
V_s	Sampled air volume [m3]
V_{bg}	Sampled air volume [m3] for determination of C_{bg}
V_{pre}	Sampled air volume [m3] in pre-operating phase
V_{ope}	Sampled air volume [m3] in operating and optionally post-operating phase

5 Conformance

Determinations of emission rates and total number of emitted particles conform to this document (Part 1) when:

1. Executed using a Quality Assurance Project Plan, Quality Assurance and Quality Control as specified in ISO 16000-9;
2. Tested in a controlled ETC as specified in Clause 7;
3. Sampled/monitored and calculated as specified in Clause 8 and Annex B;
4. Reported as specified in Clause 9.

For EUT using consumables, determinations according to additional requirements identified by "RAL-UZ 205 Option" herein conform to the RAL-UZ 205 Option.

6 Method overview

The flowchart in Figure 1 illustrates the method; clause numbers are indicated in brackets.