INTERNATIONAL STANDARD

ISO/IEC 28360

Second edition
2012-02-15

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

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

Reference number
ISO/IEC 28360:2012(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword v

Introduction vi

1 Scope 1

2 Conformance 1

3 Normative references 2

4 Terms and definitions 2

5 Symbols and abbreviated terms 5
5.1 Abbreviated terms 5
5.2 Symbols 6

6 Method overview 7

7 ETC requirements 9
7.1 Construction materials 9
7.2 Air tightness 9
7.3 Air mixing efficiency 9

8 Determination method 9
8.1 Test conditions 9
8.1.1 Operating temperature and relative humidity (rH) 9
8.1.2 Air exchange rate (n) 9
8.1.3 Air velocity 9
8.1.4 Sampled air flow 9
8.2 Handling of EUT and ETC 9
8.2.1 ETC purging 9
8.2.2 Background concentrations (C_{bg}) 10
8.2.3 EUT unpacking 10
8.2.4 Preparation of the EUT before testing 10
8.2.5 EUT installation 11
8.2.6 EUT operation during test 11
8.3 VOC, carbonyl compounds 12
8.3.1 Sorbents 13
8.3.2 Sample collection 13
8.3.3 Emission rate calculation 14
8.4 Ozone 15
8.4.1 Analyser and sampling line requirements 16
8.4.2 Monitoring 16
8.4.3 Emission rate calculation 16
8.5 Particulate matter 17
8.5.1 Weighing and Filter conditioning 17
8.5.2 Sampling 17
8.5.3 Emission rate calculation 18
8.6 Fine and Ultrafine Particles (FP and UFP) 18
8.6.1 General Requirements for Aerosol Measuring Systems 19
8.6.2 Measurement 21
8.6.3 Calculation 21

9 Test report 24

Annex A (normative) Print Patterns 27
A.1 Monochrome print pattern 5% coverage 27
A.2 Colour print pattern, 20% coverage 29

Annex B (normative) **Preparatory Aerosol Measuring System Test Procedures** **30**
B.1 Procedures for operational readiness of Aerosol Measuring System **30**
B.1.1 Particle size range measurements **30**
B.1.2 Particle number concentration range measurements **30**
B.2 Procedures for Operational readiness test of Fast Aerosol Measuring System **31**
B.2.1 Set up of instrument **31**
B.2.2 Zero Check **32**
B.2.3 Preparation for measurement **32**
B.3 Procedures for Operational readiness test of CPC **33**
B.3.1 Preparation **33**

Annex C (informative) **Emission rate model for EUT using consumables** **35**
C.1 Objective **35**
C.2 Approach **35**
C.3 General mass balance and concentration equations **35**
C.4 Background SER **35**
C.5 Emission during pre-operating phase **36**
C.6 Emission during operating phase **36**
C.7 Emission during post-operating phase **38**
C.8 Special cases **40**
C.9 Model for RAL-UZ 122 Option **40**

Annex D (informative) **Influence of EUT filtering on SER_{O3}** **43**

Bibliography **45**

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.

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

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national 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 and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 28360 was prepared by Ecma International (as ECMA-328) 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 second edition cancels and replaces the first edition (ISO/IEC 28360:2007), which has been technically revised. It also incorporates the Technical Corrigendum ISO/IEC 28360:2007/Cor.1:2008.

Introduction

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

Following the publications of the first edition of ECMA-328 and the “Test method for the determination of emissions from Hard Copy Devices” (RAL-UZ 122), experts from the German Federal Institute for Materials Research and Testing (BAM) and Ecma have collaborated to harmonise methods to determine the chemical emission rates from information and communication technology (ICT) and consumer electronics (CE) equipment in this second edition.

In addition to stricter test procedures, the second edition uses 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 (ETC).

The third edition of ECMA-328 was fully aligned with the first edition of ISO/IEC 28360, adopted under ISO/IEC JTC 1's fast-track procedure and published in September 2007.

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

Following the publications of the fourth edition of ECMA-328 and the “Test method for the determination of emissions from Hard Copy Devices” (RAL-UZ 122), experts from the BAM, the Wilhelm-Klauditz-Institut (WKI), the Japan Business Machine and Information System Industries Association (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 fifth edition.

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

1 Scope

This International Standard specifies methods to determine chemical emission rates of analyte from information and communication technology (ICT) and consumer electronics (CE) equipment during intended operation in an Emission Test Chamber (ETC).

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

This International Standard includes specific methods for equipment using consumables, such as printers, and equipment not using consumables, such as monitors and PCs. Annex A specifies monochrome and colour print patterns for use in the operating phase of EUT using consumables (e.g. paper).

The following are examples of EUT that do not use consumables:

- monitors and TV sets (CRT, plasma, LCD, rear projector, beamer);
- video (VCR, DVD player/recorder, camcorder);
- SAT receiver (Set-Top Box);
- audio units (CD player/recorder, home theatre systems, audio home systems, micro-/mini-, midi-systems, amplifier, receiver);
- portable audio (CD player, MP 3 player, radio recorder, clock radio, etc.);
- computer (desktop, tower, server), portable computers (notebooks).

Emission rates from EUT using consumables may also be determined according to additional requirements identified by “RAL-UZ 122 Option”.

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 International Standard.

2 Conformance

Determinations of emission rates and total number of emitted particles conform to this International Standard 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 122 Option” herein conform to the RAL-UZ 122 Option [1].

3 Normative references

The following referenced documents are indispensable for the application 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 7779, *Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment* (ECMA-74)

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

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

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

ISO 16000-6, *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, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

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

EN 55013:2001, *Sound and television broadcast receivers and associated equipment — Radio disturbance characteristics — Limits and methods of measurement*

CIE 15:2004, *Colorimetry, 3rd edition*, Commission Internationale de l'Éclairage, ISBN: 9783901906336

4 Terms and definitions

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

4.1
aerosol
system of solid or liquid particles suspended in gas

[ISO 15900:2009]

4.2
Aerosol Measuring System
device for measuring the total number concentration of aerosol particles within a size range at a certain frequency

4.3
air exchange rate
n
ratio of the volume of clean air brought into the Emission Test Chamber (ETC) per hour [m^3/h] to the unloaded ETC volume [m^3]

4.4
air velocity
air speed [m/s] measured in the unloaded Emission Test Chamber (ETC)

4.5
analyte
volatile organic compounds (VOC), carbonyl compounds, ozone, particulate matter, fine particles (FP) and ultrafine particles (UFP)

4.6
averaged concentration time series
Simple Moving Average of total particle number concentration (Cp) over 31 ± 3 s

4.7
Condensation Particle Counter
CPC
instrument that measures the particle number concentration of an aerosol

NOTE 1 An Aerosol Measuring System consists of a flow meter, a particle counting device, a computer and suitable software. An Aerosol Measuring System may also be equipped with a particle size classifier.

NOTE 2 For the purposes of this International Standard, a CPC is used as a standalone instrument which measures the total particle number concentration within a device-dependent broad size range.

4.8
consumables
toner, ink, paper and ribbon

4.9
Emission Test Chamber
ETC
enclosure with controlled operational parameters for testing analyte mass emitted from Equipment Under Test (EUT)

4.10
Equipment Under Test
EUT
functional and complete information and communication technology (ICT) and consumer electronics (CE) equipment from which chemical emission rates are determined

4.11
Fast Aerosol Measuring System
Aerosol Measuring System with integrated particle size classifier

4.12
fine particles
FP
particles with particle size/diameter range between 0,1 µm and 2,5 µm

4.13
loading factor
ratio of the Equipment Under Test (EUT) volume to the volume of the unloaded Emission Test Chamber

4.14
Hard Copy Devices
class of Equipment Under Test (EUT) using consumables that includes printers, (photo)copiers and Multi Functional Devices (MFD)

4.15
maximum usage time before testing
MUT
<for EUT using consumables> ratio between the total number of prints carried out by the EUT and the printing speed of the EUT

NOTE 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.

4.16
operating phase
phase in which the Equipment Under Test (EUT) is performing its intended functions

4.17
particle
tiny piece of solid or liquid matter with defined physical boundaries suspended in a gas

4.18
Particle Emission Rate
PER
averaged emission rate, i.e. total number of particles in a specified particle size range emitted during the operating phase

4.19
Particle Emission Rate
PER(t)
time-dependent emission rate of particles in a specified particle size range after the start of the operating phase

4.20
particle loss-rate coefficient
β
coefficient that describes the loss of particles in a specified particle size range in an Emission Test Chamber (ETC)

4.21
particle size
particle diameter
measurement category to describe the physical dimension of a particle

NOTE 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. ultrafine particles, UFP).

4.22
particulate matter
PM
quantity of particles measured by gravimetric methods

4.23
pre-operating phase
phase in which the Equipment Under Test (EUT) is connected to an electrical supply before it is able to enter the operating phase

NOTE The pre-operating phase can include warming-up and energy saving modes.

4.24
post-operating phase
phase following the operating phase

NOTE The post-operating phase can include energy saving modes.

4.25
total number of emitted particles
TP
calculated total number of particles emitted in a specified particle size range

4.26
total particle number concentration
C_p
particle number concentration in a specified particle size range

4.27
total volatile organic compounds
TVOC
sum of the concentrations of identified VOC and the concentrations of the converted areas of unidentified peaks using the toluene response factor

4.28
ultrafine particles
UFP
particles with particle diameter less than or equal 0,1 µm

4.29
unit specific emission rate
SER
mass, in micrograms, of a specific analyte emitted per hour

NOTE If more than one Equipment Under Test (EUT) is placed in the Emission Test Chamber, the determined SER is divided by the number of EUTs to obtain the unit specific emission rate SERu.

4.30
Volatile Organic Compounds
VOC
compounds that elute between n-hexane and n-hexadecane on an unpolar GC-column

5 Symbols and abbreviated terms

5.1 Abbreviated terms

CE	Consumer Electronics
CPC	Condensation Particle Counter
DNPH	2,4-Dinitrophenylhydrazine
ETC	Emission Test Chamber
EUT	Equipment Under Test
FP	Fine Particles
FID	Flame Ionisation Detector
GC/MS	Gas chromatography/Mass spectrometry
ICT	Information and Communication Technology
MFD	Multi Functional Device
PTFE	Polytetrafluoroethene
PVC	Polyvinylchloride
rH	Relative humidity

SER	Unit Specific Emission Rate
PER	averaged Particle Emission Rate
PER(t)	time-dependent Particle Emission Rate
TVOC	Total Volatile Organic Compounds
UFP	Ultrafine Particles
VOC	Volatile Organic Compounds

5.2 Symbols

α	factor in the exponential particle decay function [cm^{-3}]
β	particle loss-rate coefficient [h^{-1}]
C_s	average mass concentration [µg m^{-3}]
C_{bg}	background mass concentration [µg m^{-3}]
C_{max}	maximum ozone mass concentration [µg m^{-3}]
C_0	initial mass concentration [µg 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}]
$Cp_{,BG}$	background particle number concentration [cm^{-3}]
d	equivalent particle diameter [nm]
H’	ozone half-life [min]: the period of time for the ozone concentration to drop from C_{max} to C_{max} /2
k	ozone decay constant, without ventilation [min^{-1}]
k’	ozone decay constant with ventilation (k’ = k + n/60) [min^{-1}]
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]
PER	Particle Emission Rate [h^{-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}]
SER_u	SER per unit [µg h^{-1} u^{-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 operating phase
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]
u	number of EUT units
V	ETC volume [m^3]
V_s	sampled air volume [m^3]
V_{bg}	sampled air volume [m^3] for determination of C_{bg}
V_{pre}	sampled air volume [m^3] in pre-operating phase
V_{ope}	sampled air volume [m^3] in operating and optionally post-operating phase

6 Method overview

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

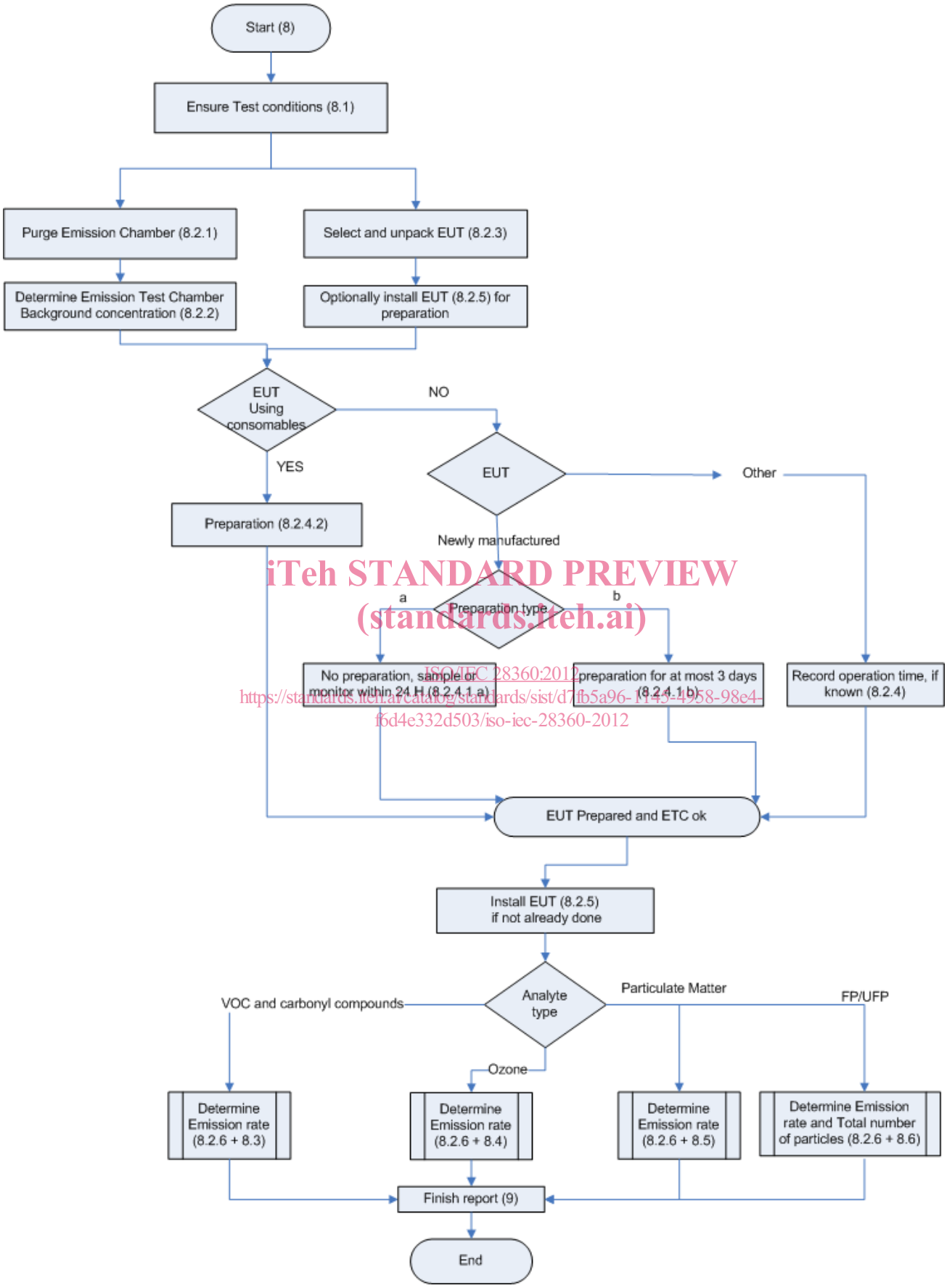

Figure 1 — Determination method overview

7 ETC requirements

7.1 Construction materials

ETC construction materials shall comply with ISO 16000-9.

7.2 Air tightness

The ETC air tightness shall be as specified in ISO 16000-9.

7.3 Air mixing efficiency

The air mixing efficiency in the ETC shall be as specified in ISO 16000-9.

8 Determination method

For the RAL-UZ 122 Option, tests should be executed within 10 working days after delivery of the EUT.

8.1 Test conditions

To meet the operational requirements specified herein, ETC parameters such as temperature, relative humidity and supply airflow shall be controlled and measured at regular intervals and recorded in accordance with ISO 16000-9 and shall be reported as specified in Clause 9.

8.1.1 Operating temperature and relative humidity (rH)

Tests shall be executed at (23 ± 2) °C and (50 ± 5)% rH according to ISO 554. For EUT used in alternative climatic conditions, higher operating temperature and humidity conditions may be used as specified in ISO 554.

Consult 8.2.6.2 for special requirements on rH for EUT using consumables.

8.1.2 Air exchange rate (n)

For unloaded ETCs with a volume larger than 5 m^3, n shall be in the range from 0,5 to 2,0. For unloaded ETC's with a volume of 5 m^3 or smaller, n shall be in the range from 0,5 to 5,0.

8.1.3 Air velocity

The air velocity in the unloaded ETC shall be in the range from 0,1 to 0,3 m/s.

8.1.4 Sampled air flow

The sum of sampled airflow shall be less than 80% of the inlet airflow into the ETC.

8.2 Handling of EUT and ETC

EUT shall be selected from normal manufactured batches or shall be a prototype that is representative for EUT from such batches. For determinations using the RAL-UZ 122 Option, EUT shall be stored in an air-conditioned room (23 °C, 50% rH) in its original packaging.

To ensure detection of a minimum emission within a practicable time, the ETC with capabilities as specified in 7 shall be selected such that the loading factor is in the range of 1:4 to 1:100.

8.2.1 ETC purging

The selected ETC shall be unloaded and its interior walls shall be cleaned as described in ISO 16000-9.