FINAL
DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 11844-1

ISO/TC **156**

Secretariat: SAC

Voting begins on:
2020-02-28

Voting terminates on:
2020-04-24

Corrosion of metals and alloys — Classification of low corrosivity of indoor atmospheres —

Part 1: Determination and estimation of indoor corrosivity

Corrosion des métaux et alliages — Classification de la corrosivité faible des atmosphères d'intérieur —

Partie 1: Détermination et estimation de la corrosivité des atmosphères d'intérieur

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Reference number
ISO/FDIS 11844-1:2020(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 11844-1:2006), which has been technically revised. The main changes compared with the previous edition are as follows:

— a reference to the ISO 16000 series in Clause 7 has been added;

— a model that estimates the indoor concentration and deposition of pollutants originating from outdoors has been added;

— lead has been included as a standard specimen with high sensitivity to vapour organic acids.

A list of all parts in the ISO 11844 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.

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Introduction

Metals, alloys and metallic coatings are subject to atmospheric corrosion under the impact of air humidity, especially when gaseous and solid substances of atmospheric pollution co-impact. Corrosivity data are of fundamental importance for derivation of suitable corrosion protection, or for evaluation of serviceability of metal elements of a product.

ISO 9223 classifies the atmospheric environment into six corrosivity categories.

Low corrosivity indoor atmospheres are indoor atmospheres with C 1 (very low) or C 2 (low) corrosivity categories in accordance with ISO 9223.

The classification in ISO 9223 is too broad for some purposes in low corrosivity indoor atmospheres, e.g. places where electronic devices, sophisticated technical products, or works of art and historical objects are stored.

For such purposes, it is necessary to subdivide the corrosivity categories C 1 (very low) and C 2 (low) into the indoor corrosivity categories given in this document.

The evaluation of low corrosivity indoor atmospheres can be accomplished by direct determination of corrosion attack of selected metals (see ISO 11844-2) or by measurement of environmental parameters (see ISO 11844-3) that can cause corrosion on metals and alloys.

This document describes general procedures for derivation and estimation of indoor corrosivity categories.

The aim of this document is to characterize indoor atmospheric environments of low corrosivity that can affect metals and metallic coatings during storage, transport, installation or operational use, to set a consistent way of indoor corrosivity classification, and to prescribe procedures for derivation and estimation of indoor corrosivity categories.

A general approach to the classification of corrosivity of indoor atmospheres is given in the scheme shown in Figure 1.

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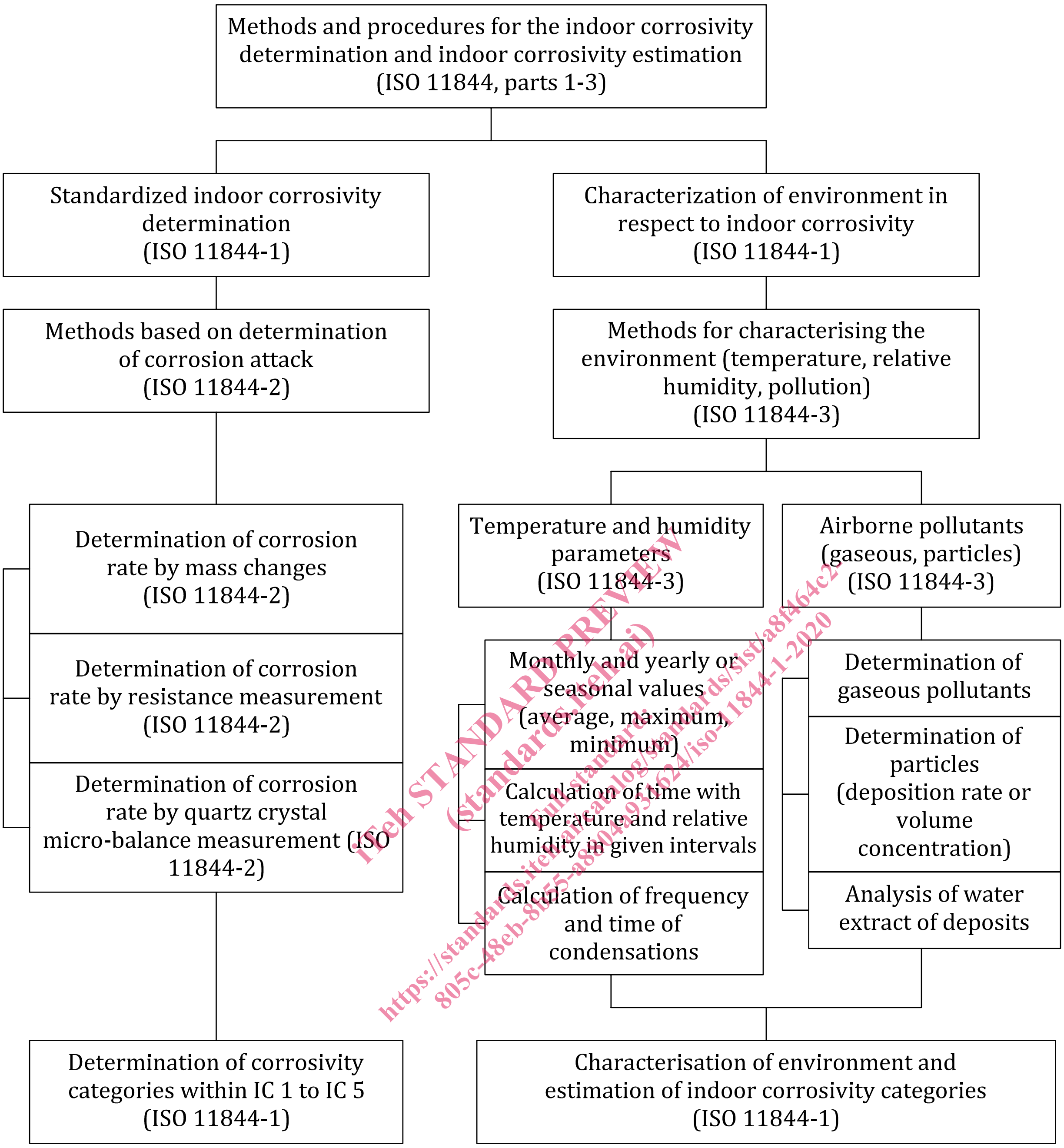

Figure 1 — Scheme for classification of low corrosivity of indoor atmospheres

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Corrosion of metals and alloys — Classification of low corrosivity of indoor atmospheres —

Part 1: Determination and estimation of indoor corrosivity

1 Scope

This document establishes a classification of low corrosivity of indoor atmospheres.

It specifies the reference metals for which a corrosion attack after a defined exposure period is used for determining corrosivity categories of indoor atmospheres of low corrosivity.

It defines corrosivity categories of indoor atmospheres according to corrosion attack on standard specimens.

It indicates important parameters of indoor atmospheres that can serve as a basis for an estimation of indoor corrosivity.

The selection of a method for the determination of corrosion attack, description of standard specimens, exposure conditions and evaluation are given in ISO 11844-2. The measurement of environmental parameters affecting indoor corrosivity is given in ISO 11844-3.

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2 Normative references

There are no normative references in this document.

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:

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

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

3.1
climate
statistics of temperature, humidity, atmospheric pressure, wind, rainfall, and other meteorological elements in a given location over a long period of time

[SOURCE: EN 15759-1:2011, 3.1]

3.2
atmosphere
mixture of gases, aerosols and particles that surrounds a given material, object or structure

3.3
indoor atmosphere
environment [combined effect of *climate* (3.1) and *atmosphere* (3.2)] inside a box, a room or a building

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3.4
microclimate
climate (3.1) of a small area, specific rooms, part of building, etc., which may be different from that in the general region

3.5
temperature-humidity complex
combined effect of temperature and relative humidity on the *corrosivity of the atmosphere* (3.10)

[SOURCE: ISO 9223:2012, 3.4]

3.6
time of wetness
period when a metallic surface is covered by adsorptive and/or liquid films of electrolyte to be capable of causing atmospheric corrosion

[SOURCE: ISO 9223:2012, 3.5]

3.7
atmospheric pollution
specific corrosion-active substances, gases or suspended particles in the air (both natural and the result of human activity)

3.8
corrosion system
system consisting of one or more metals and those parts of the environment that influence corrosion

[SOURCE: ISO 8044:2020, 3.4, modified — Note 1 to entry has been deleted.]

3.9
corrosivity
ability of an environment to cause corrosion of a metal in a given *corrosion system* (3.9)

[SOURCE: ISO 8044:2020, 3.14]

3.10
corrosivity of atmosphere
ability of the atmosphere to cause corrosion in a given *corrosion system* (3.9)

EXAMPLE Atmospheric corrosion of a given metal or alloy.

[SOURCE: ISO 9223:2012, 3.1, modified — An example has been added.]

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4 Symbols and abbreviated terms

IC indoor corrosivity

r_{corr} corrosion rate derived from mass-loss measurement after an exposure of one year

r_{mi} rate of mass increase after an exposure of one year

5 Classification of corrosivity

5.1 General

The corrosivity of indoor atmospheres can be classified either by a determination of the corrosion attack on standard specimens of selected standard metals as given in Clause 6 or, where this is not possible, by an estimation of corrosivity based on the knowledge of humidity, temperature and pollution conditions as described in Clause 7 and Annexes B, C and D.

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Estimation of corrosivity as described in 7.2 and Annexes C and D can lead to wrong conclusions. Therefore, the determination of corrosivity by the measurement of the corrosion attack on standard specimens is strongly recommended.

5.2 Categories of indoor corrosivity

For the purpose of this document, indoor atmospheres are classified into five corrosivity categories denoted IC 1 to IC 5. The classification is given in Table 1.

Table 1 — Corrosivity categories of indoor atmospheres

Indoor corrosivity category	
IC 1	Very low indoor corrosivity
IC 2	Low indoor corrosivity
IC 3	Medium indoor corrosivity
IC 4	High indoor corrosivity
IC 5	Very high indoor corrosivity

6 Determination of indoor atmospheric corrosivity

The determination of corrosivity of indoor atmospheres is based on measurements of corrosion attack on standard specimens of five reference metals after an exposure for one year in accordance with ISO 11844-2. From the mass loss or mass increase, the indoor corrosivity category for each metal is determined from Table 2.

In indoor environments when the all conditions (temperature, humidity, air pollutions) vary only in range of ±5 % from average value, the exposure period should be shorter, e.g. one month only. Preferably, this month should represent the most corrosive period of the year.

Metals complement each other in the classification of indoor corrosivity for a given environment.

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7 Characterization of indoor atmospheres with respect to indoor corrosivity

7.1 General

Environmental characteristics are informative and allow assessment of specific corrosion effects with regard to individual metals and metallic coatings.

The ISO 16000 series deals with indoor air measurements describing the sampling strategy, including the conditions to be observed for particular substances or groups of substances, such as the dependence of indoor air pollution concentrations on atmospheric humidity or temperature or other effects. ISO 16000-1:2004, Table A.1, summarizes the most important types of indoor environment and gives examples of the sources that can be encountered in them. The list is not, of course, fully comprehensive because of the large number of possibilities. ISO 16000-1:2004, Table B.1, shows the sources of indoor air pollutants and the most important substances emitted. ISO 16000-1:2004, Table C.1, lists substances frequently detected and their possible sources. The ISO 16000 series does not cover all indoor air pollutants significant for indoor atmospheric corrosivity.

Methods for the characterization and measurement of environmental parameters of indoor atmospheres are given in ISO 11844-3.

This method of corrosivity estimation is, in many cases, oversimplified and can give misleading results.

An estimation of corrosivity is based on:

— climatic influences (outdoor situation including pollution);

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— indoor microclimate influences;

— indoor gaseous and particle pollution.

The corrosivity of an indoor atmosphere increases with higher humidity and depends on the type and level of pollution.

Important characteristics are frequency of variation of relative humidity (RH) and temperature (T) in intervals, and frequency and time of condensation.

An indoor environment is rarely static, since the concentration of any substance can be constantly altered by the strength of the source, human activity, ventilation rate, external or internal climatic conditions, chemical reactions and possible sinks (e.g. sorption by surfaces and furnishings). In addition, the composition of indoor air can vary within and between rooms, and be less homogeneous than the outdoor air surrounding the building.

Indoor atmospheres are polluted by the components from external and internal sources. Typical pollutants are SO_2, NO_2, O_3, H_2S, Cl_2, NH_3, HCl, HNO_3, Cl^-, NH_4^+, organic acids, aldehydes and particles (see Annex B). Due to the permanent exchange between indoor and outdoor air caused by infiltration and ventilation processes, it may be important to supplement indoor air measurements with a simultaneous measurement of the outdoor air [if possible, at the same level (floor) of the building]. The outdoor air samples should be taken in the vicinity of the building but not closer than 1 m. In making such measurements, it should be remembered that vertical concentration gradients can occur, e.g. for the components of vehicle exhaust gases in street canyons.

The air exchange of a building, whether it is due to mechanical ventilation, natural ventilation or infiltration, can have a significant influence on the indoor atmosphere. The model estimates the indoor concentration and deposition of pollutants originating from outdoors was derived for the steady-state indoor/outdoor (I/O) relation of various gaseous pollutions in buildings, as shown by Formula (1):

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$$\mathrm{I/O} = \frac{C_i}{C_o} = \frac{n}{n + v_d \left(\frac{A}{V} \right)} \tag{1}$$

where

C_i is the indoor concentration of pollutant (in µg.m^{-3});

C_o is the outdoor concentration of pollutant (in µg.m^{-3});

n is the air exchange rate (in h^{-1});

v_d is the deposition velocity (in m.h^{-1});

A is the inside surface area of room (in m^2);

V is the volume of room (in m^3).

The typical I/O ratio of sulfur dioxide is approximately 0,50. The typical I/O ratio of nitrogen dioxide is in the range of 0,60 to 0,80. There are exceptions: at sites with a low air exchange rate, or with chemical air-filtration, the I/O ratio can be less than 0,10. The matching I/O concentration ratios for ozone show the same trend, with the typical I/O ratio below 0,7, and half of these I/O ratios even below 0,20.

For indoor conditions, volatile organic acids such as formic acid (HCOOH), acetic acid (CH_3COOH) and propionic acid (CH_3CH_2COOH) can have a significant influence on indoor corrosivity. Carboxylic acids in the atmosphere can exist as anthropogenic and/or biogenic air pollution, from automotive exhaust, biomass combustion for domestic and industrial heating, vegetation, organic coatings or emanating from the oceans. Other sources can be the photochemical oxidation of organic species in air or water.

Corrosion for many of the metals is significantly influenced by the synergistic effects of different pollutants.

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