# SVENSK STANDARD
# SS-EN ISO 9224:2012

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SWEDISH STANDARDS INSTITUTE

## Korrosion hos metaller och legeringar – Atmosfärers korrosivitet – Riktvärden för korrosivitetskategorierna (ISO 9224:2012)

## Corrosion of metals and alloys – Corrosivity of atmospheres – Guiding values for the corrosivity categories (ISO 9224:2012)

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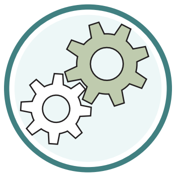

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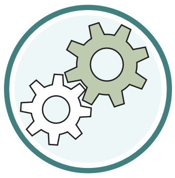

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Europastandarden EN ISO 9224:2012 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN ISO 9224:2012.

Denna standard ersätter SS-EN 12500, utgåva 1 och SS-ISO 9224, utgåva 1.

The European Standard EN ISO 9224:2012 has the status of a Swedish Standard. This document contains the official version of EN ISO 9224:2012.

This standard supersedes the Swedish Standard SS-EN 12500, edition 1 and SS-ISO 9224, edition 1.

**Nationell kommentar/National comment**

Det är fel i dokumentet från CEN.
Denna standard ska inte ersätta SS-EN 12500, utgåva 1.

The document from CEN is not correct.
This standard does not supersede SS-EN 12500, edition 1.



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Denna standard är framtagen av kommittén för Korrosion i atmosfär inklusive klassificering och provning, SIS/TK 146/AG 2665.

Har du synpunkter på innehållet i den här standarden, vill du delta i ett kommande revideringsarbete eller vara med och ta fram andra standarder inom området? Gå in på www.sis.se - där hittar du mer information.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN ISO 9224

February 2012

ICS 77.060

Supersedes EN 12500:2000

English Version

# Corrosion of metals and alloys - Corrosivity of atmospheres - Guiding values for the corrosivity categories (ISO 9224:2012)

Corrosion des métaux et alliages - Corrosivité des atmosphères - Valeurs de référence relatives aux classes de corrosivité (ISO 9224:2012)

Korrosion von Metallen und Legierungen - Korrosivität von Atmospären - Anhaltswerte für die Korrosivitätskategorien (ISO 9224:2012)

This European Standard was approved by CEN on 22 January 2012.

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**Management Centre: Avenue Marnix 17, B-1000 Brussels**



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## Contents

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# Foreword

This document (EN ISO 9224:2012) has been prepared by Technical Committee ISO/TC 156 "Corrosion of metals and alloys" in collaboration with Technical Committee CEN/TC 262 “Metallic and other inorganic coatings” the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2012, and conflicting national standards shall be withdrawn at the latest by August 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12500:2000.

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**Endorsement notice**

The text of ISO 9224:2012 has been approved by CEN as a EN ISO 9224:2012 without any modification.

## Introduction

The “corrosivity category” established in ISO 9223 is a general term suitable for engineering purposes, which describes the corrosion properties of atmospheres based on current knowledge of atmospheric corrosion.

Guiding values of corrosion attack can be used to predict the extent of corrosion attack in long-term exposures based on measurements of corrosion attack in the first-year exposure to the outdoor atmosphere in question. These values can also be used to determine conservative estimates of corrosion attack based on environmental information or corrosivity category estimates as shown in ISO 9223.

Corrosion attack estimates obtained by using the methods in this International Standard can be used to predict the useful life of metallic components and, in some cases, of metallic coatings exposed to outdoor atmospheres covered by ISO 9223. The corrosion attack results can also be used to determine whether or not protective measures, such as coatings, are required to achieve desired product lives. Other uses include the selection of construction materials for outdoor atmospheric service.

Guiding values of corrosion can be used as information for the selection of a protection method against atmospheric corrosion according to ISO 11303.

The guiding values in this International Standard are based on a large number of exposures in many locations throughout the world. However, the procedure used in this International Standard cannot possibly cover all the situations in natural environments and service conditions which can occur. In particular, situations that result in significant changes in the environment can cause major increases or decreases in corrosion rates. Users of this International Standard are cautioned to consult with qualified experts in the field of outdoor atmospheric corrosion in cases where localized corrosion can be more important than general attack. The specific issues of galvanic (bi-metallic) corrosion, pitting corrosion, crevice corrosion, environmental cracking and corrosion product wedging are not addressed in this International Standard.

# Corrosion of metals and alloys — Corrosivity of atmospheres — Guiding values for the corrosivity categories

## 1 Scope

This International Standard specifies guiding values of corrosion attack for metals and alloys exposed to natural outdoor atmospheres for exposures greater than one year. This International Standard is intended to be used in conjunction with ISO 9223.

Guiding corrosion values for standard structural materials can be used for engineering calculations. The guiding corrosion values specify the technical content of each of the individual corrosivity categories for these standard metals.

Annex A provides examples of calculated maximum corrosion attack after extended exposure (up to 20 years) for six standardized corrosivity categories.

Annex B provides presumed average initial and steady-state corrosion rates of standard metals in intervals relative to six standardized corrosivity categories.

Annex C provides the calculation procedure for corrosion attack of steels in regard to their composition.

## 2 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 8044, *Corrosion of metals and alloys — Basic terms and definitions*

ISO 9223, *Corrosion of metals and alloys — Corrosivity of atmospheres — Classification, determination and estimation*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8044 and the following apply.

**3.1**
**guiding corrosion value**
corrosion rates, mass loss, penetration or other corrosion characteristics expressing the expected corrosive action of the atmospheric environment of a given corrosivity category towards standard metals

**3.2**
**corrosion rate after extended exposure**
corrosion rate after exposures longer than one year

**3.3**
**average corrosion rate**
$r_{av}$
yearly corrosion rate calculated as an average value for the first 10 years of atmospheric exposure of a metal

**3.4**
**steady-state corrosion rate**
$r_{lin}$
yearly corrosion rate derived from a long-term atmospheric exposure of a metal, not including the initial period

NOTE For the purposes of this International Standard, the corrosion rate after 10 years of exposure is considered constant.

## 4 Principle

The corrosion rate of metals and alloys exposed to natural outdoor atmospheres is not constant with exposure time. For most metals and alloys, it decreases with exposure time because of the accumulation of corrosion products on the surface of the metal exposed. The progress of attack on engineering metals and alloys is usually observed to be linear when the total damage is plotted against exposure time on logarithmic coordinates. This relationship indicates that the total attack, $D$, expressed either as mass loss per unit area or penetration depth, may be given as:

$$D = r_{corr} \, t^b \tag{1}$$

where

$t$ is the exposure time, expressed in years;

$r_{corr}$ is the corrosion rate experienced in the first year, expressed in grams per square metre per year [g/(m$^2$·a)] or micrometres per year (µm/a), in accordance with ISO 9223;

$b$ is the metal-environment-specific time exponent, usually less than 1.

## 5 Prediction of corrosion attack after extended exposure

This procedure should be used in cases where the extent of corrosion attack in the first year is available or can be estimated by the procedures in ISO 9223, and the desire is to predict the extent of attack after an extended exposure.

The attack prediction is calculated by substituting the values in Equation (1).

An appropriate $b$ value is selected or calculated according to Clause 7. In cases where long-term metal loss data are available, use the $b$ value from this data. In cases where the detailed composition of the metal is not known, select the B1 value from Table 2 for the metal or alloy in question. This is the $b$ value to be used in Equation (1).

The B1 values were taken as the average time exponents from regression analyses of the flat panel long-term results of the ISO CORRAG atmospheric exposure programme[1].

NOTE It is necessary to distinguish between metal-environment-specific time exponent, $b$, in Equation (1), estimated from exposure data, and B1 and B2 values assumed or calculated from the ISO CORRAG programme as generalized $b$ values.

Table 3 contains values of the function $t^b$ for time values up to 100 years with the B1 exponents to simplify the calculations. However, it is possible for Equation (1) not to apply to exposures beyond 20 years (see Clause 7 below for a discussion of long-term exposures).

In cases where it is important to estimate a conservative upper limit of corrosion attack after an extended exposure, the $b$ value used in Equation (1) should be increased to account for uncertainties in the data. One way to do this is to add two standard deviations to the average value to obtain a value at the upper 95 % confidence level. For the four metals shown in Table 2, the standard deviations of the $b$ values[1] are:

— Carbon steel: 0,026 0

— Zinc: 0,030 0

— Copper: 0,029 5

— Aluminium: 0,039 5

NOTE Estimation of a conservative upper limit of corrosion attack after an extended exposure is based on uncertainties in $b$. This estimation does not take into account uncertainties in $r_{corr}$, which are defined in ISO 9223.

The B2 values in Table 2 include the two standard deviation additions and may be used where an upper limit of corrosion attack is desired when using the flat panel data from the ISO CORRAG programme. Table 3 also provides calculated values for the function, $t^b$, up to 100 years using B2 values for $b$ (see Clause 7 for exposures beyond 20 years).

Annex A provides maximum corrosion attack for the standard metals covered in ISO 9223 for exposures up to 20 years for the six corrosion categories. These calculations are made using the time exponents given in Table 2.

## 6 Specific criteria for calculation of corrosion rates of structural metals

### 6.1 Steels

The protectiveness of rust layers on steels in atmospheric exposures is very strongly affected by the alloying elements in the steel. Weathering steels, in particular, have specific alloying additions to promote the formation of a protective rust layer that develops during the exposure. Other carbon and low-alloy steels vary significantly in their performance in atmospheric exposures depending on their specific alloy content. The calculation procedure for corrosion rates of steels in regard to their composition is given in Annex C.

The B1 and B2 values in Table 2 are estimated for carbon steel with the composition mentioned in Table 1[2].

**Table 1 — Composition of steel for which the B1 and B2 values are estimated**

| Element | **Composition** mass fraction % |
|---|---|
| Carbon | 0,056 |
| Silicon | 0,060 |
| Sulfur | 0,012 |
| Phosphorus | 0,013 |
| Chromium | 0,02 |
| Molybdenum | 0,01 |
| Nickel | 0,04 |
| Copper | 0,03 |
| Niobium | 0,01 |
| Titanium | 0,01 |
| Vanadium | 0,01 |
| Aluminium | 0,02 |
| Tin | 0,005 |
| Nitrogen | 0,004 |
| Manganese | 0,39 |