



**SLOVENSKI STANDARD**  
**SIST EN 60654-4:1998**

**01-november-1998**

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**Operating conditions for industrial-process measurement and control equipment -  
Part 4: Corrosive and erosive influences (IEC 60654-4:1987)**

Operating conditions for industrial-process measurement and control equipment -- Part  
4: Corrosive and erosive influences

Einsatzbedingungen für Meß-, Steuer- und Regeleinrichtungen in der industriellen  
Prozeßtechnik -- Teil 4: Korrosive und erosive Einflüsse

Conditions de fonctionnement pour les matériels de mesure et commande dans les  
processus industriels -- Partie 4: Influences de la corrosion et de l'érosion

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**Ta slovenski standard je istoveten z: EN 60654-4:1997**

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**ICS:**

25.040.40	Merjenje in krmiljenje industrijskih postopkov	Industrial process measurement and control
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**SIST EN 60654-4:1998**

**en**

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EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 60654-4**

August 1997

ICS 25.040.40

Descriptors: Industrial process, measurement, control, operating conditions, corrosive and erosive influences

English version

**Operating conditions for industrial-process measurement and  
control equipment  
Part 4: Corrosive and erosive influences  
(IEC 60654-4:1987)**

Conditions de fonctionnement pour  
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(CEI 60654-4:1987)

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European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

### Foreword

The text of the International Standard IEC 60654-4:1987, prepared by SC 65A, System aspects, of IEC TC 65, Industrial-process measurement and control, was submitted to the formal vote and was approved by CENELEC as EN 60654-4 on 1997-07-01 without any modification.

The following dates were fixed:

- latest date by which the EN has to be implemented  
at national level by publication of an identical  
national standard or by endorsement (dop) 1998-06-01
- latest date by which the national standards conflicting  
with the EN have to be withdrawn (dow) 1998-06-01

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### Endorsement notice

The text of the International Standard IEC 60654-4:1987 was approved by CENELEC as a European Standard without any modification.

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**NORME  
INTERNATIONALE  
INTERNATIONAL  
STANDARD**

**CEI  
IEC**

**654-4**

Première édition  
First edition  
1987

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**Conditions de fonctionnement pour les matériels  
de mesure et commande dans les processus  
industriels**

**Quatrième partie:**

**Influences de la corrosion et de l'érosion  
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**Operating conditions for industrial-process  
measurement and control equipment**

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**Part 4:**

**Corrosive and erosive influences**

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Commission Electrotechnique Internationale  
International Electrotechnical Commission  
Международная Электротехническая Комиссия

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## CONTENTS

	Page
FOREWORD . . . . .	5
PREFACE . . . . .	5
Clause	
1. Scope . . . . .	7
2. Object . . . . .	7
3. General . . . . .	9
4. Non-solid substances . . . . .	9
4.1 Definitions . . . . .	11
5. Gases and vapours . . . . .	11
5.1 Contamination effects . . . . .	11
5.2 Inorganic chlorine compounds . . . . .	11
5.3 Explanation of contaminant severity levels . . . . .	13
6. Aerosols . . . . .	15
7. Liquids . . . . .	17
8. Solid substances . . . . .	17
8.1 Kind of industrial-process and location within that process . . . . .	17
8.2 Nature of solid substances in the environment which could affect the instruments . . . . .	17
8.3 In combination with . . . . .	19
8.4 Frequency of occurrence . . . . .	19
8.5 Size . . . . .	19
8.6 Concentration in mg/kg or g/kg of dry air . . . . .	19
8.7 Velocity in m/s . . . . .	19
8.8 Thermal conductivity . . . . .	21
8.9 Electrical conductivity . . . . .	21
8.10 Magnetic permeability . . . . .	21
8.11 Example given to demonstrate the use of the questionnaire . . . . .	21
9. Flora and fauna . . . . .	23
APPENDIX A — Industrial contaminants . . . . .	25
APPENDIX B — Methods of classification of reactive environments . . . . .	27

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OPERATING CONDITIONS FOR INDUSTRIAL-PROCESS  
MEASUREMENT AND CONTROL EQUIPMENT****Part 4: Corrosive and erosive influences**

## FOREWORD

- 1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
- 3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

## PREFACE

This standard has been prepared by IEC Technical Committee No. 65: Industrial-process measurement and control.

The text of this standard is based upon the following documents:

Six Months' Rule	Report on Voting
65(CO)38	65(CO)41

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Full information on the voting for the approval of this standard can be found in the Voting Report indicated in the above table.

# OPERATING CONDITIONS FOR INDUSTRIAL-PROCESS MEASUREMENT AND CONTROL EQUIPMENT

## Part 4: Corrosive and erosive influences

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### 1. Scope

Part 4 of the standard considers the corrosive and erosive industrial environment to which land-based and off-shore, industrial-process measurement and control systems or parts of systems may be exposed during operation, during periods when they are installed but inactive, during storage or transportation. Maintenance and repair conditions are excluded from this part.

The environmental influences considered in this part are limited to those which may directly affect performance of process-measurement and control systems or parts of such systems. Effects of the specific environmental conditions on personnel are not within the scope of this part. The appropriate values of the physical or chemical parameters listed here as well as the qualitative descriptions of the environment should be used to define local environments in which equipment is expected to operate, be transported and stored. Only conditions as such are considered; the resulting effects of these conditions on instrument performance are specifically excluded.

Many environmental conditions listed in this part are difficult to classify so that a qualitative description is used to characterize the environment.

### 2. Object

The object of Part 4 of the standard is to provide users and suppliers of industrial-process measurement and control systems and parts of such systems with a uniform listing and classification of corrosive and erosive environmental conditions to which equipment may be exposed in specified locations during operation, storage, handling and transportation. Conditions for transportation are for equipment in suitable packages to prevent damage.

The listed environmental conditions are intended to serve as a basis for comprehensive specifications.

One of the objects of this part is to minimize problems which might result from neglecting considerations of specific operating conditions affecting performance of systems and parts of systems.

An additional object of this part is to aid in the choice of specific limit values for use in the development of evaluation specifications for industrial-process measurement and control equipment.



### 3. General

Industrial-process measurement and control equipment is used all over the earth, thus being exposed to the characteristic environmental conditions of fauna and flora of tropical, temperate and arctic climates, as well as deserts, jungles, mountains and the sea.

Superimposed on these basic environmental influences and in addition to the general level of ambient pollution prevalent in industrialized areas where process control equipment and systems are heavily utilized, it should be recognized that higher levels of contamination do generally exist in the localized areas where the process control equipment is deployed, as contaminants are introduced into the environment by the very process that is being controlled. These higher levels of contamination can occur permanently or temporarily. In many cases the effects on measurement and control equipment are proportional to the concentration, temperature and the period of exposure, these effects being often increased by humidity. It is however very difficult to describe an environment by specifying the concentration of the contaminant against time. Therefore, the concept of the average value was used as a basis for quantitatively classifying the chemically active substances. But it is recognized that special damage may be caused by short-time high concentration (peak value) of corrosive contaminants, therefore the peak values as defined below have been incorporated in the classification.

In Appendix A is given a listing of industrial contaminants associated with various process plants. It is a guide to highlight the specific contaminants introduced by industrial processes.

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Atmospheric contamination to which systems and parts of systems may be exposed include gases, vapours, liquids and solids. The effects of these contaminants can be various, such as the corrosive effects from chemically active contaminants, erosive effects from sand blasting and clogging by dusts.

The different kinds of contaminants can also be present in combinations whereby more severe environmental conditions can arise such as high humidity combined with chlorine gas; therefore, the ambient temperature and relative humidity should be specified.

It is practically impossible to classify all the different environments, due to the unlimited number of possible combinations and associated large number of effects and severities.

It is recognized that the effects of gases, vapours and liquids are primarily corrosive while solid contaminants may cause adverse erosive, corrosive, thermal or electromagnetic effects.

Therefore, Clauses 4, 5, 6 and 7 classify the corrosive effects of non-solid chemically active substances. Clauses 8 and 9 are enumerations of other environmental effects on instrumentation in which solid active substances are listed and the effects of flora and fauna are briefly mentioned.

### 4. Non-solid substances

Non-solid substances are only chemically active. They are therefore classified according to the average and peak value of their concentration.

#### 4.1 Definitions

The following definitions are required to understand this part.

One-half hour mean value is defined as

$$\frac{1}{\frac{1}{2} \text{ h}} \int_0^{\frac{1}{2} \text{ h}} x \, dt$$

where  $x$  is the measured or expected contaminant concentration.

Peak value is the maximum measured or expected one-half hour mean value recognized over a year.

Mean value is the arithmetic mean of a statistically sufficient number of measured or expected one-half hour mean values.

*Note.* — A one hour mean value may be used where legal.

### 5. Gases and vapours

The classes in Table I recognize that average concentrations and peak values shall both be considered to properly classify an environment. Peak values have been integrated on a ½ hour basis. Chemical agents (e.g. SO<sub>2</sub> or HF) may vary greatly in their reactivity rate over a ½ h period. Therefore, the relationship of peak value to average value may vary with each contaminant. The classification of environment by category should be determined by the highest class if average and peak values are not in the same category. An alternate method of classification based on copper reactivity rates is shown in Appendix B.

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#### 5.1 Contamination effects

Each site may have different combinations and concentration levels of corrosive gaseous contaminants. Performance degradation can occur rapidly or over many years, depending on the particular concentration levels and combinations present at a site. The following paragraphs describe how various contaminants contribute to equipment performance degradation.

#### 5.2 Inorganic chlorine compounds (expressed as Cl<sub>2</sub> in Table I)

This group contains both strong oxidants (chlorine, chlorine dioxide) and compounds such as hydrogen chloride, so reactivity will depend upon the specific gas composition. In the presence of moisture, these gases generate chloride ions which react readily with copper, tin, silver and iron alloys. These reactions are significant even when the gases are present at low levels. These reactions are attenuated in dry atmospheres. At higher concentrations, many elastomers and some plastics are oxidized by exposure to chlorinated gases. Particular care shall be given to equipment which is exposed to atmospheres which contain chlorinated contaminants. Sources of chloride ions, such as cleaning compounds and cooling tower vapours, etc., should be considered when classifying.

### 5.2.1 *Active sulphurs* (expressed as H<sub>2</sub>S in Table I)

This group includes hydrogen sulphide, elemental sulphur and organic sulphur compounds such as the mercaptans. When present at low levels, they rapidly attack copper, silver and iron alloys. The presence of moisture and small amounts of inorganic chlorine compounds greatly accelerates sulphide corrosion. Note, however, that attack still occurs in low relative humidity environments. Active sulphurs rank alongside inorganic chlorides as the predominant cause of atmospheric corrosion in the process industries.

### 5.2.2 *Sulphur oxides* (expressed as SO<sub>2</sub> in Table I)

Oxidized forms of sulphur (SO<sub>2</sub>, SO<sub>3</sub>) are generated as combustion products of sulphur-bearing fossil fuels. Low levels of sulphur oxides can passivate reactive metals and thus retard corrosion. At higher levels they attack certain types of metals, elastomers and plastics. The reactions with metals normally occur when these gases dissolve in water to form sulphurous and sulphuric acid.

### 5.2.3 *Nitrogen oxides* (expressed as NO<sub>x</sub> in Table I)

NO<sub>x</sub> compounds (NO, NO<sub>2</sub>, N<sub>2</sub>O<sub>4</sub>) are formed as combustion products of fossil fuels and have a critical role in the formation of ozone in the atmosphere. They are also believed to have a catalytic effect on corrosion of base metals by chlorides and sulphides. In the presence of moisture, these gases form nitric acid which, in turn, attacks most common metals.

### 5.2.4 *Hydrogen fluoride* (expressed as HF in Table I)

This compound is a member of the halogen family and reacts like inorganic chloride compounds.

### 5.2.5 *Ammonia and derivatives* (expressed as NH<sub>3</sub> in Table I)

Reduced forms of nitrogen (ammonia, amines, ammonium ions) occur mainly in fertilizer plants, agricultural applications, and chemical plants. Copper and copper alloys are particularly susceptible to corrosion in ammonia environments.

### 5.2.6 *Photochemical species* (expressed as O<sub>3</sub> in Table I)

The atmosphere contains a wide variety of unstable, reactive species which are formed by the reaction of sunlight with moisture and other atmospheric constituents. Some have lifetimes measured in fractions of a second as they participate in rapid chain reactions. In addition to ozone, a list of examples would include the hydroxyl radical as well as radicals of hydrocarbons, oxygenated hydrocarbons, nitrogen oxides, sulphur oxides and water. Because of the transient nature of most of these species, their primary effect is on outdoor installations and enclosures. In general, plastics and elastomers are more susceptible to photochemical effects than metals.

*Note.* — Electrostatic precipitators in air-conditioning systems to buildings can generate ozone.

## 5.3 *Explanation of contaminant severity levels*

There is a broad distribution of contaminant concentrations and reactivity levels existing within industries using process measurement and control equipment. Some environments are severely corrosive while others are mildly corrosive.