

BS ISO 17093:2015



BSI Standards Publication

Corrosion of metals and alloys — Guidelines for corrosion test by electrochemical noise measurements

bsi.

...making excellence a habit.
AVA Documents™
Document Sharing Hub

National foreword

This British Standard is the UK implementation of ISO 17093:2015.

The UK participation in its preparation was entrusted to Technical Committee ISE/NFE/8, Corrosion of metals and alloys.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2015.
Published by BSI Standards Limited 2015

ISBN 978 0 580 75558 3

ICS 77.060

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2015.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

Corrosion of metals and alloys — Guidelines for corrosion test by electrochemical noise measurements

*Corrosion des métaux et alliages — Lignes directrices pour essais de
corrosion par mesures de bruit électrochimique*





COPYRIGHT PROTECTED DOCUMENT

© ISO 2015, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principles	2
5 Apparatus and measurement methods	3
6 Test cell	5
7 Measurement procedure	5
8 Evaluation of instrument noise	6
9 Test report	8
Annex A (informative) Analysis of data	9
Annex B (informative) Example of simultaneous current and potential noise measurement on pitting corrosion of aluminium	12
Annex C (informative) Example of simultaneous current and potential measurement on organically coated carbon steel	15
Bibliography	19

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 ISO documents 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 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 156, *Corrosion of metals and alloys*, in cooperation with the ECG-COMON (European Cooperative Group on Corrosion Monitoring of Nuclear Materials, <http://www.ecg-comon.org>).

Corrosion of metals and alloys — Guidelines for corrosion test by electrochemical noise measurements

1 Scope

This International Standard is intended to assist in corrosion testing by electrochemical noise measurement. It covers test procedures and analysis methods for reliable measurement of electrochemical noise for both uncoated and organically coated metal.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 17475, *Corrosion of metals and alloys — Electrochemical test methods — Guidelines for conducting potentiostatic and potentiodynamic polarization measurements*

3 Terms and definitions

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

3.1 electrochemical noise

EN

fluctuation typically at low frequencies (≤ 1 Hz) and low amplitude in current and potential generated by electrochemical reactions and other processes on the surface, for example, bubble evolution

3.2 electrochemical potential noise

fluctuation in potential (typically in the range of μV to mV) of an electrode relative to a reference electrode or fluctuation in potential between two similar electrodes

3.3 electrochemical current noise

fluctuation in current (typically in the range of nA to μA) of one electrode or between two electrodes

3.4 electrochemical noise resistance

resistance obtained by dividing the standard deviation of potential noise by the standard deviation of current noise from the time record

3.5 power spectral density of potential

PSD_E

power present in the potential noise as a function of frequency

3.6 power spectral density of current

PSD_I

power present in the current noise as a function of frequency

3.7 electrochemical noise impedance

Z_n
impedance determined as $Z_n = \sqrt{PSD_E / PSD_I}$ where all terms are a function of frequency

Note 1 to entry: The noise impedance is real and positive.

3.8 working electrode

electronic conductor in contact with the electrolyte, made out of the investigated material

Note 1 to entry: This definition differs from that of the same term given in ISO 8044:2015, 6.1.46, "test electrode in an electrochemical cell designed for polarization tests".

3.9 auxiliary electrode

electrode commonly used in applied polarization to balance the current passing to the working electrode

Note 1 to entry: It is usually made from a non-corroding material.

3.10 Nyquist frequency

frequency equal to one half of the sampling frequency ($f_s/2$); maximum frequency about which information can be obtained from the sampled data

3.11 thermal noise

noise resulting from thermal vibrations of electrons and charge carriers

Note 1 to entry: Thermal noise is the absolute minimum of the noise that can be expected; also called Johnson noise.

3.12 shot noise

noise due to the quantized nature of the charge carriers that move in very short times causing current peaks

3.13 dummy cell

non-electrochemical cell with a well-defined noise level that usually does not deliberately generate noise above normal thermal noise levels

4 Principles

4.1 The source of EN in corrosion might result from partial faradaic currents, adsorption/desorption processes, surface coverage, and, in the case of localized corrosion, the initiation of pits, crevice corrosion, and mechanical effects from cracking and several other processes. Special care has to be taken as a variety of other sources not related to corrosion might cause fluctuations in current and potential.

4.2 Electrochemical noise can be measured potentiostatically, galvanostatically, or at the free corrosion potential (the various methods are described in [Clause 5](#)). Examples of two simple tests with EN measurements on aluminium during pitting corrosion and on organically coated carbon steel can be found in [Annexes B and C](#).

4.3 Electrochemical noise data can be analysed in the time and/or frequency domains. Details of data analysis are described in [Annex A](#).

5 Apparatus and measurement methods

5.1 Instrumentation

5.1.1 Accurate measurement of potential and current requires instruments that have appropriate input impedance (much higher than the system being measured in the case of potential and much lower in the case of current) and sensitivity (sufficient to minimize quantization noise). Suggestions are given in the following Clauses but these will not be sufficient for some systems.

5.1.2 Potential measuring instruments

The instrument should have an input impedance of at least 10^9 ohm for bare metal and 10^{11} ohm for coated metal to minimize current drawn from the system during measurement. The higher input impedance might be necessary for very high impedance systems (e.g. for EN measurements with coated metals). The sensitivity and accuracy of the instrument should be sufficient to detect a change of $10\text{ }\mu\text{V}$ or lower for the typical range of 1 V.

5.1.3 Current measuring instruments

The instrument should be capable of measuring current to a resolution of 10^{-9} A or better with a voltage burden (the voltage between the terminals, also known as a voltage drop or burden voltage) of less than 1 mV (the low voltage burden is only required when the current measurement is made between two corroding working electrodes). A low voltage burden ammeter is often termed a zero resistance ammeter (ZRA) in corrosion literature.

5.1.4 Potentiostat

Some measurement configurations use a potentiostat to control the potential of an electrode. The potentiostat shall have low noise characteristics, which should be tested by using a dummy cell with comparable properties to the system under investigation (see [Clause 8](#) or Reference [1]).

5.1.5 Galvanostat

Some measurement configurations use a galvanostat to apply a current to an electrode. The galvanostat shall have low noise characteristics, which should be tested by using a dummy cell with comparable properties to the system under investigation (see [Clause 8](#) or Reference [1]).

5.1.6 Grounding, shielding, and isolation

It is very important to ensure correct grounding and shielding of the measurement system. In particular, there should be a single well-defined connection to ground in order to avoid ground loops and to minimize induced interference. Isolated or differential measuring devices will commonly be required to avoid short-circuit connections to ground and ground loops, especially in plant monitoring conditions.