INTERNATIONAL STANDARD

# ISO 9591

Second edition
2004-09-15

# Corrosion of aluminium alloys — Determination of resistance to stress corrosion cracking

*Corrosion des alliages d'aluminium — Détermination de la résistance à la corrosion fissurante sous contrainte*



Reference number
ISO 9591:2004(E)

**PDF disclaimer**

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.





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

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.

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

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

ISO 9591 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

This second edition cancels and replaces the first edition (ISO 9591:1992), which has been technically revised.



# Corrosion of aluminium alloys — Determination of resistance to stress corrosion cracking

## 1 Scope

**1.1** This International Standard specifies a method for the determination of resistance to stress corrosion cracking (SCC) of aluminium alloys.

**1.2** This International Standard covers the method of sampling, the types of specimens, the loading procedure, the type of environment and the interpretation of results.

**1.3** This International Standard is aimed at determining resistance to SCC as a function of the chemical composition, the method of manufacture and heat treatment of aluminium alloys.

**1.4** This International Standard applies to cast and wrought aluminium alloys in the form of castings, semi-finished products, parts and weldments.

**1.5** Since most natural and many artificial environments contain chlorides, this International Standard can be used to compare the performance of products employed under marine atmospheres and in environments containing chlorides, providing that the failure mechanism is not changed. However, the results of this test should not be considered as an absolute criterion for the quality of alloys.



## 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 7539-1:1987, *Corrosion of metals and alloys — Stress corrosion testing — Part 1: General guidance on testing procedures*

ISO 7539-2:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 2: Preparation and use of bent-beam specimens*

ISO 7539-3:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 3: Preparation and use of U-bend specimens*

ISO 7539-4:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 4: Preparation and use of uniaxially loaded tension specimens*

ISO 7539-5:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 5: Preparation and use of C-ring specimens*

ISO 7539-6:2003, *Corrosion of metals and alloys — Stress corrosion testing — Part 6: Preparation and use of pre-cracked specimens for tests under constant load or constant displacement*

ISO 7539-7, *Corrosion of metals and alloys — Stress corrosion testing — Part 7: Slow strain rate testing*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7539-1 apply.

## 4 Principle

**4.1** This International Standard specifies two methods of loading:

— under constant total strain;

— under constant load.

It does not cover slow strain rate test methods and determination of maximum admissible stress by the method of permanent deformation for aluminium alloys, although an effort is now being made to apply such methods to these alloys (see ISO 7539-7).

**4.2** This International Standard specifies two methods of immersion in the solution:

— alternate immersion;

— continuous immersion (subject to agreement between the interested parties).

NOTE 1 In alternate immersion experiments, the exposure of the wetted surface to the atmosphere and the subsequent drying out create an aggressive salt environment on the metal surface and enhanced transport of oxygen prior to subsequent immersion. The rate of drying will depend on the nature and thickness of the salts on the metal surface and may not be the same for different alloys.

NOTE 2 The wetting and drying cycle mimics, to some extent, the wetting and drying in marine atmospheres (although salts on the metal surface may redissolve on subsequent immersion in the laboratory tests).



**4.3** The evaluation criteria for corrosion cracking of alloys are:

— $\sigma_{SCC}$: the threshold stress, which is the maximum stress under which no failure of the samples occurs during the fixed period of the test;

— $\tau_{SCC}$: the time of failure, which is the moment of the appearance of the first visible crack (or under magnification up to $\times$ 30) for specimens under constant strain.

**4.4** The selection of the method of loading, the value of stresses, corrosive environment and criteria of evaluation can be the subject of an agreement between the interested parties and should be defined by the test programme.

## 5 Apparatus

### 5.1 Loading apparatus

Tensile stresses in the specimens are produced with yokes, stressing screws, springs, lever devices and special testing machines, e.g., testing devices for constant bending (Figure 1) and for constant load (Figure 2). The latter figure is an example of a device for multiple specimen testing which can be a considerable advantage.

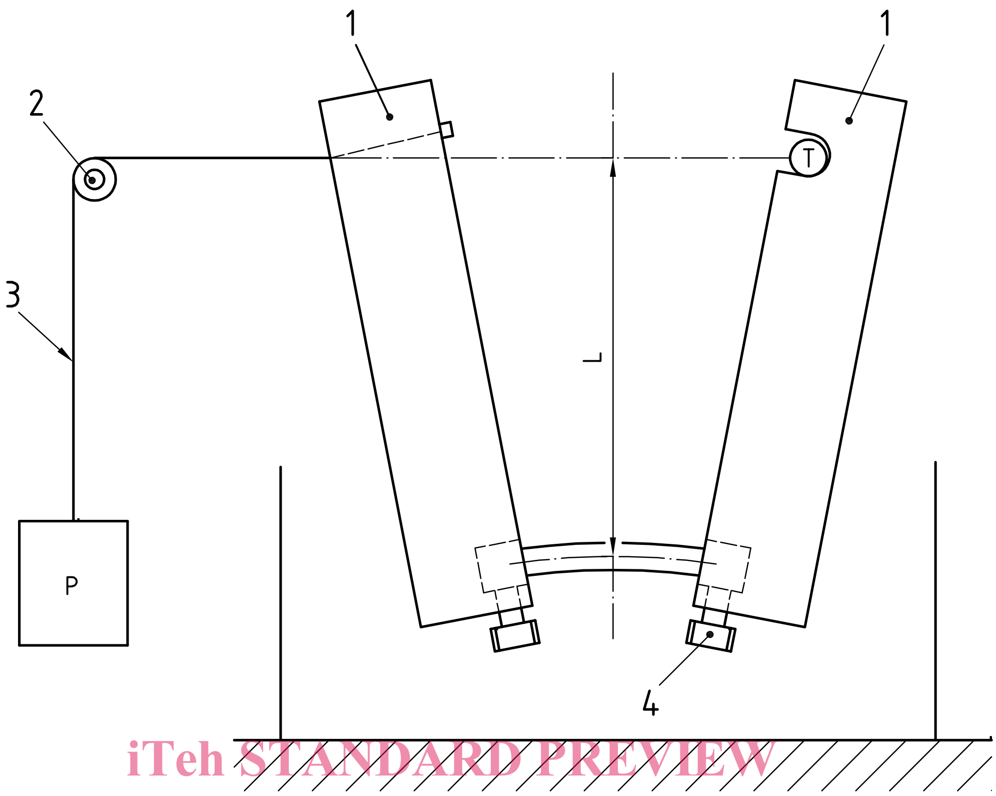
### 5.2 Construction materials

If in contact with the salt solution, the materials shall not be affected by the corrodent to such an extent that they can cause contamination of the solution and change its corrosiveness.

NOTE 1 Use of inert plastics or glass is recommended where feasible.

NOTE 2 Metallic components that are in contact with the solution should be made from corrosion resistant materials such as those recommended for marine environments. These materials should not be affected by the solution to the extent that they can cause contamination of the solution. In addition, metallic components may be protected by coating materials that do not cause contamination of the solution or change its corrosiveness.






**Key**

1 perspex

2 pulley

3 nylon cord

4 nylon bolt



**Figure 1 — Constant load bending device**

## 5.3 Specimen holders

The specimen holders shall be designed to electrically insulate the specimens from each other and from any bare metal parts. When this is not possible, as in the case of certain stressing bolts or jigs, the bare metal contacting the specimen shall be isolated from the corrodent by a suitable coating. Protective coatings shall be of a type that will not leach inhibiting or accelerating ions or protective oils or leave any residue, e.g. vapour, on the non-coated portions of the specimen. In particular, coatings containing chromates shall be avoided. It is recommended that all samples be degreased after coating.

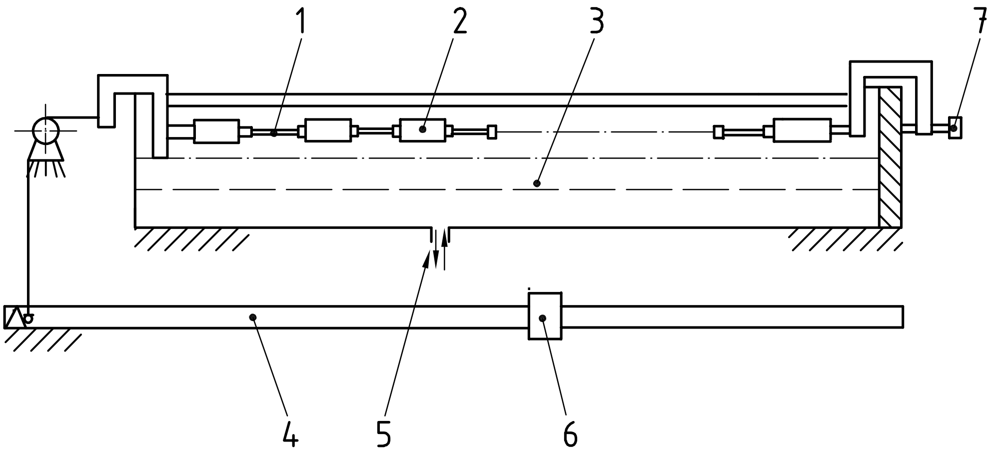
## 5.4 Apparatus for alternate immersion in solutions

**5.4.1** The temperature controller shall be capable of increasing the temperature of the surface of the specimen from 0 °C to 100 °C at a controlled rate. This is achieved by heating the solution. Above 10 °C, the average rate of temperature change of the specimen shall be controlled to within ± 30 % of the desired value, where the average is calculated over a temperature range of 10 °C. Guidelines for calculating the temperature of the specimen relative to the temperature of the solution are given in Clause 7.

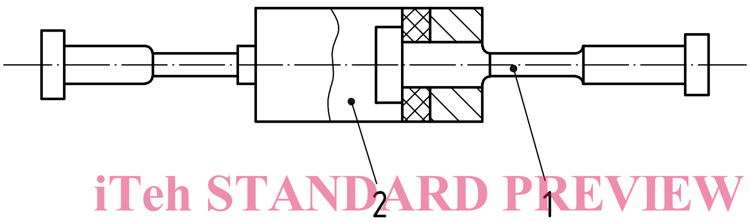
**5.4.2** Any suitable mechanism may be used to accomplish the immersion portion of the cycle provided that:

— it achieves the specified rate of immersion and removal;

— the apparatus is constructed of suitable inert materials.




**a) Multiple test assembly**






**b) Chains of specimens connected by loading links**



**Key**

1 specimen
2 loading link
3 environment
4 lever system
5 connexions for solution sleeve
6 mobile load
7 loading screw

**Figure 2 — Illustrations of the multiple specimen testing device for the constant uniaxial stress corrosion cracking test**

The usual methods of alternate immersion are:

a) specimens are placed on a movable rack that is periodically lowered into a stationary tank containing the solution;

b) specimens are placed on a corrosion wheel arrangement which rotates every 10 min through 60° and thereby passes the specimens through a stationary tank of solution;

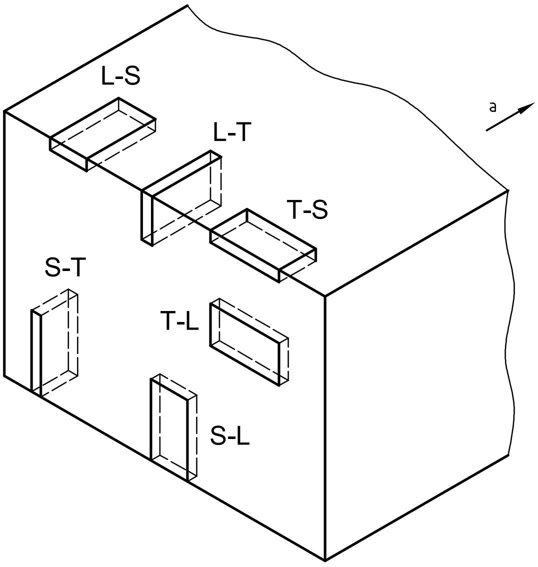
c) specimens are placed in a stationary tray open to the atmosphere and the solution is moved by air pressure, by a non-metallic pump, or by gravity drain from the reservoir to the tray.

**5.4.3** The rate of immersion and removal of the specimens from the solution should be as rapid as possible without jarring them. For the purposes of standardization, an arbitrary limit shall be adopted such that no more than 2 min elapse for the time to achieve full immersion or emersion from the solution.

## 6 Sampling

**6.1** In general, this International Standard specifies three specimen orientations for thick products and two for thin products. The orientation diagram is given in Figure 3. In Figure 3 a), the first direction refers to the specimen axis and the second direction refers to the direction of crack growth.



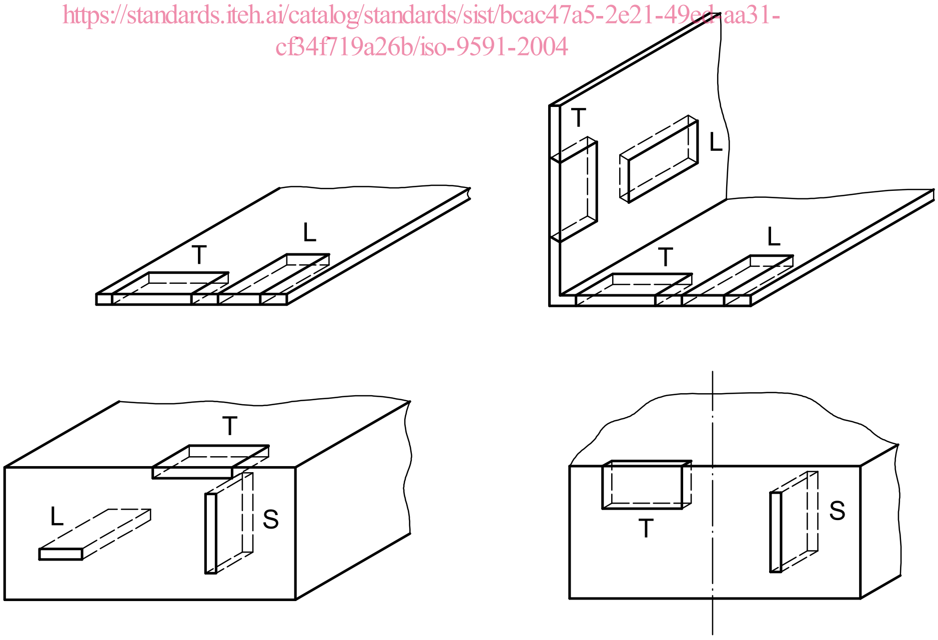

**Key**

a Working direction
L—T = longitudinal-long transverse direction
L—S = longitudinal-short transverse direction
T—L = long transverse-longitudinal direction
T—S = long transverse-short transverse direction
S—L = short transverse-longitudinal direction
S—T = short transverse-long transverse direction



**a) General procedure**






**b) Recommended procedure**

**Key**

L = longitudinal direction
T = long transverse direction
S = short transverse direction

**Figure 3 — Specimen orientation**