SLOVENSKI STANDARD
SIST EN 14101:2004

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Space product assurance - Material selection for controlling stress-corrosion cracking

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Raumfahrtproduktsicherung - Kriterien für die Werkstoffwahl zur Vermeidung von Spannungsrisskorrosion

Assurance produit des projets spatiaux - Sélection des matériaux en vue d'éviter leur fissuration par corrosion sous contrainte

Ta slovenski standard je istoveten z: **EN 14101:2001**

ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

SIST EN 14101:2004 **en**

EUROPEAN STANDARD
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English version

Space product assurance - Material selection for controlling stress-corrosion cracking

Assurance produit des projets spatiaux - Sélection des matériaux en vue d'éviter leur fissuration par corrosion sous contrainte

This European Standard was approved by CEN on 28 September 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 14101:2001 E

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Foreword

This European Standard has been prepared by CMC.

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of an identical text or by endorsement, at the latest by April 2002, and conflicting national standards shall be withdrawn at the latest by April 2002.

It is based on a previous version[1] prepared by the ECSS Product Assurance Standards Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization (ECSS) is a cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this Standard takes into account the existing ISO 9000 family of documents.

Annex A is normative.

This standard includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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[1] ECSS-Q-70-36A.

1 Scope

This European Standard sets forth the criteria to be used in the selection of materials for spacecraft and associated equipment and facilities so that failure resulting from stress-corrosion is prevented.

Three categories of materials are listed in Tables 1, 2 and 3 of this Standard. They represent metal alloys with a high, moderate and low resistance to stress-corrosion cracking.

The stress-corrosion susceptibility of alloys included in this Standard was determined at ambient temperature

- by means of laboratory tests in which specimens were either sprayed with salt water or periodically immersed and withdrawn;
- by exposing specimens in sea coast or mild industrial environments;
- by subjecting fabricated hardware to service conditions.

Use of the criteria established herein should, therefore, be limited to designs for service involving similar exposure conditions.

Weldments present a special problem in designing for resistance to stress-corrosion cracking. In addition to the susceptibility of the parent metals, it is also necessary to consider the filler metal and the microstructural effects of heat introduced by the welding operations and subsequent heat treatments. Because of the additional variables that shall be considered, susceptibility data are not as extensive for weldments as for alloys in mill form. Design criteria for weldments in this Standard are limited to aluminium alloys, selected stainless steels in the 300 series and other specific alloys listed in Table 1.

This Standard is intended to provide general criteria to be used in designing for resistance to stress-corrosion cracking. Specific test data and other detailed information are not included.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 13701, *Space systems - Glossary of terms.*

ECSS-Q-70A, *Space product assurance - Materials, mechanical parts and processes.*

EN 14102, —[2], *Space product assurance - Determination of the susceptibility of metals to stress-corrosion cracking.*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13701, ECSS-Q-70 and the following term and definition apply.

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[2] To be published.

3.1.1

stress-corrosion

combined action of sustained tensile stress and corrosion that may lead to the premature failure of materials

3.2 Abbreviated terms

The following abbreviated terms are defined and used within this European Standard.

Abbreviation	Meaning
DML	declared materials list
ESA	European Space Agency
NASA	National Aeronautics & Space Administration
SCC	stress-corrosion cracking

4 Stress-corrosion

4.1 Definition

4.1.1 General

Stress-corrosion can be defined as the combined action of sustained tensile stress and corrosion that can lead to the premature failure of materials. Certain materials are more susceptible than others. If a susceptible material is placed in service in a corrosive environment under tension of sufficient magnitude, and the duration of service is sufficient to permit the initiation and growth of cracks, failure occurs at a stress lower than that which the material would normally be expected to withstand. The corrosive environment need not be severe in terms of general corrosive attack. Service failures due to stress-corrosion are frequently encountered in cases where the surfaces of the failed parts are not visibly corroded in a general sense. To avoid failures, the total tensile stress in service shall be maintained at a safe level. There is no absolute threshold stress for stress-corrosion, but comparative stress-corrosion thresholds can be determined for materials subjected to controlled conditions of test. Estimates of the stress-corrosion threshold for a specific application shall be determined for each alloy and heat treatment, using a test piece, stressing procedure and corrosive environment that are appropriate for the intended service.

4.1.2 Exclusions

Behaviour of the listed materials at elevated temperature and in specific chemical environments other than those mentioned above shall be ascertained by means of additional testing.

4.2 Grain orientation

Rolling, extrusion and forging are the most common processing operations employed in the production of standard forms of wrought metal. All of these produce a flow of metal in a predominant direction so that when viewed microscopically, is the metal neither isotropic nor homogeneous. As a result, the properties of the metal vary according to the direction in which they are measured. The extent of directional variation depends on the property of interest. For susceptibility to stress-corrosion cracking, the directional variation can be appreciable and shall be considered in the design of manufactured product.

The anisotropy of grain orientation, produced by rolling and extruding, is illustrated in Figure 1. Taking the rolled plate as an example, it is conventional to describe the direction of rolling as the longitudinal direction, the direction perpendicular to the longitudinal axis and in the plane of the plate as the long transverse direction, and the direction through the thickness of the plate as the short transverse direction.

For certain shapes, it is not possible to distinguish both a long and a short transverse direction on the basis of the simple rules for identifying those directions in a plate. As an example, consider the thick tee illustrated in Figure 2, where a region with both long and short transverse orientations has been identified on the basis of experience with that particular shape and a knowledge of the forming method.

Forgings also require special consideration when identifying the short transverse direction. In a forging operation, the flow of metal is influenced and constrained by the shape of the die cavity. For complex shapes, there can be several regions where a short transverse direction exists. The direction perpendicular to the parting plane of the dies is always short transverse, as illustrated in Figure 3.

The resistance of metals, particularly alloys of aluminium, to stress-corrosion cracking is always less when tension is applied in a transverse direction. It is least for the short transverse direction. Figures 2 and 3 were drawn to illustrate undesirable situations in which tensile stresses due to assembly have been applied in the short transverse direction. For optimum resistance to stress-corrosion cracking, similar situations shall be avoided in structural design.

4.3 Stress considerations

In designing for stress-corrosion resistance, it is important to realize that stresses are additive and that threshold stresses for susceptibility are often low. There have been a number of stress-corrosion failures for which design stresses were intermittent and of short duration, and only of minor significance in contributing to failure. Stress-corrosion cracking in those cases occurred because of a combination of residual and assembly stresses not even anticipated in design. All possible sources of stress shall be considered to ensure that threshold stresses are not exceeded. Unfortunately, for most service environments, accurate threshold stresses are difficult to assess. In addition to stresses resulting from operational, transportation and storage loads that are anticipated during design, assembly and residual stresses also contribute to stress-corrosion, and in many cases are the major contributors to stress-corrosion failure.

Assembly stresses result from improper tolerances during fit-up (Figures 2 and 3), overtorquing, press fits, high-interference fasteners and welding. Residual stresses are present in components of fabricated structures as a result of machining, forming and heat-treating operations. Some typical residual-stress distributions through plate and rod are illustrated in Figure 4 to provide an indication of the magnitudes of stress which can be developed as the result of conventional heat treating and forming operations.

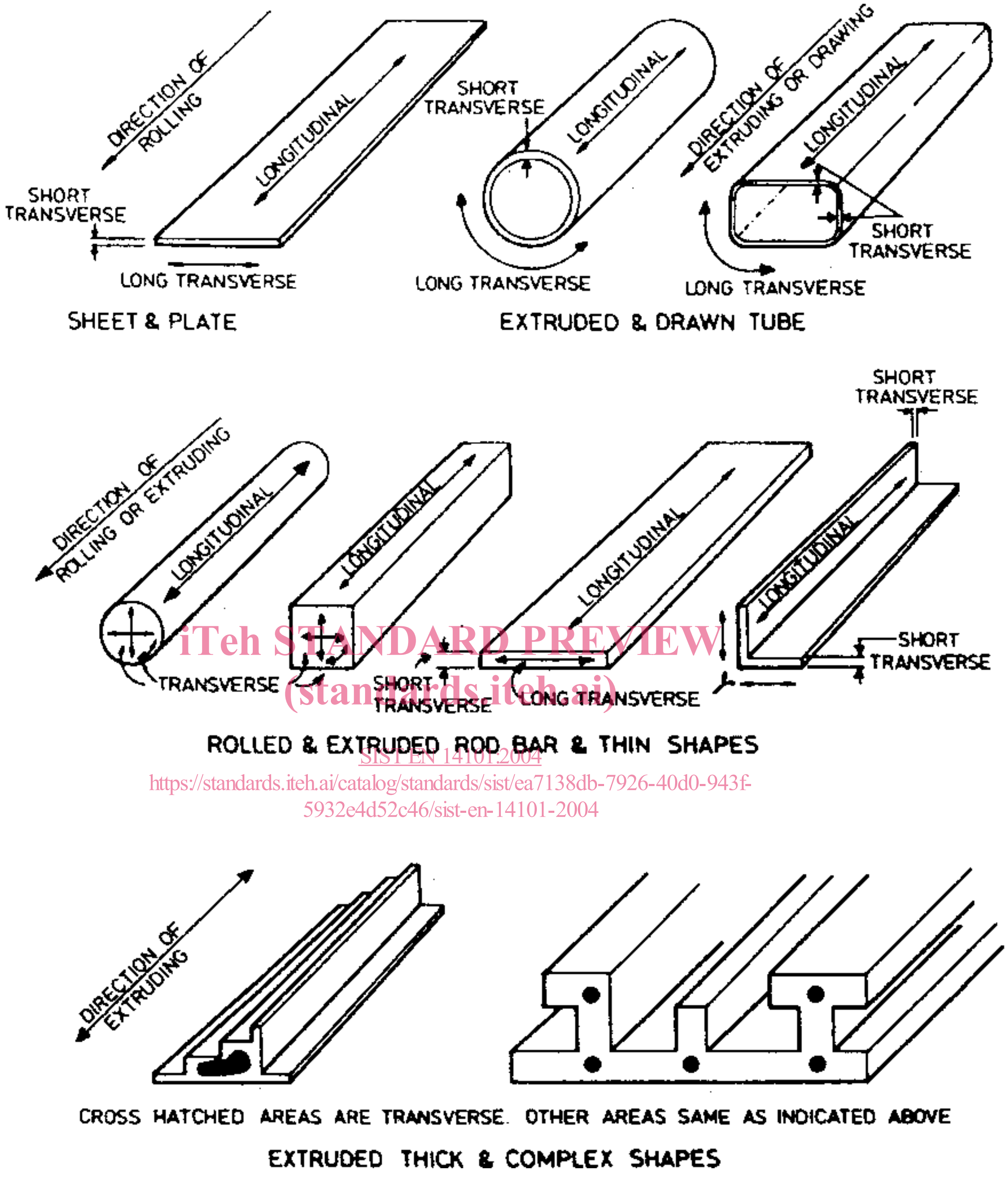
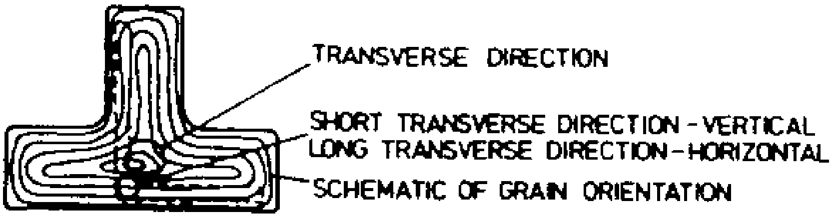
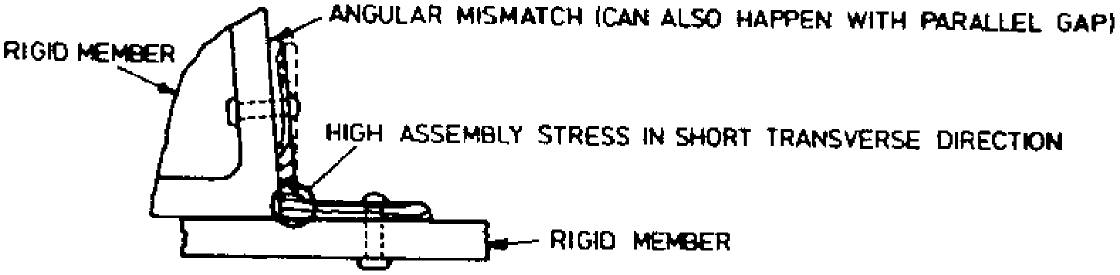


Figure 1 — Grain orientations in standard wrought forms

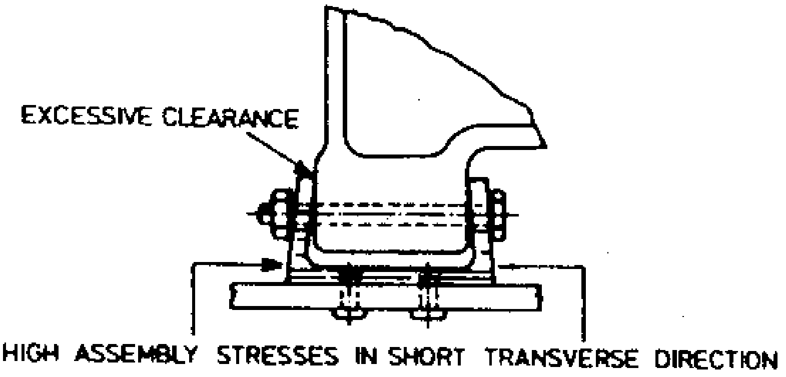


LOCATION OF MACHINED ANGLE WITH RESPECT TO TRANSVERSE GRAIN FLOW IN THICK TEE



ASSEMBLY STRESS RESULTING FROM MISMATCH

LOCATION OF MACHINED CHANNEL IN PLATE OR BAR



ASSEMBLY STRESS RESULTING FROM EXCESSIVE CLEARANCE

Figure 2 — Examples of tensile stresses in short transverse direction applied during assembly