SLOVENSKI STANDARD
SIST EN 13554:2011

01-april-2011

Nadomešča:
SIST EN 13554:2004
SIST EN 13554:2004/A1:2004

Neporušitveno preskušanje - Akustična emisija - Splošna načela

Non destructive testing - Acoustic emission - General principles

Zertörungsfreie Prüfung - Schallemission - Allgemeine Grundsätze

Essais non destructifs - Émission acoustique - Principes généraux

Ta slovenski standard je istoveten z: **EN 13554:2011**

ICS:

19.100 Neporušitveno preskušanje Non-destructive testing

SIST EN 13554:2011 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13554

January 2011

ICS 19.100

Supersedes EN 13554:2002

English Version

Non-destructive testing - Acoustic emission testing - General principles

Essais non destructifs - Émission acoustique - Principes généraux

Zerstörungsfreie Prüfung - Schallemissionsprüfung - Allgemeine Grundsätze

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Ref. No. EN 13554:2011: E

Contents

Foreword

This document (EN 13554:2011) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by July 2011, and conflicting national standards shall be withdrawn at the latest by July 2011.

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 13554:2002.

The following summary of changes intends to identify the most significant changes made to the standard during the revision process. It does not necessarily contain all changes, and it is recalled that, while efforts have been made to highlight the relevance of the list, the user of this standard is responsible for recognizing any differences between this and the present edition.

— 6: Further applications were introduced;

— 7.3: Adoption on the new EN 13477-2 (signal processor);

— 7.5: New paragraph on external parameters input;

— 8: Examination was replaced by testing;

— 9: Clause divided in on-line and post test analysis;

— 9.3.3: Source severity grading was changed;

— 10: Examination procedure was replaced by test instruction;

— 11: Examination report was replaced by test documentation and test report and re-written.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the general principles required for the acoustic emission testing (AT) of industrial structures, components, and different materials under stress and for harsh environment, in order to provide a defined and repeatable performance. It includes guidelines for the preparation of application documents, which describe the specific requirements for the application of the AE method.

Unless otherwise specified in the referencing documents, the minimum requirements of this European Standard are applicable.

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.

EN 1330-1:1998, *Non destructive testing — Terminology — Part 1: List of general terms*

EN 1330-2:1998, *Non destructive testing — Terminology — Part 2: Terms common to the non-destructive testing methods*

EN 1330-9:2009, *Non-destructive testing — Terminology — Part 9: Terms used in acoustic emission testing*

EN 13477-2, *Non-destructive testing — Acoustic emission — Equipment characterisation — Part 2: Verification of operating characteristic*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1330-1:1998, EN 1330-2:1998 and EN 1330-9:2009 apply.

4 Personnel qualification

It is assumed that emission testing is performed by qualified and capable personnel. In order to prove this qualification, it is recommended to certify the personnel in accordance with EN 473 or equivalent.

Note that for pressure equipment in categories III and IV according to Directive 97/23/EC, Annex I, 3.1.3: the personnel shall be approved by a third-party organization recognized by a Member State.

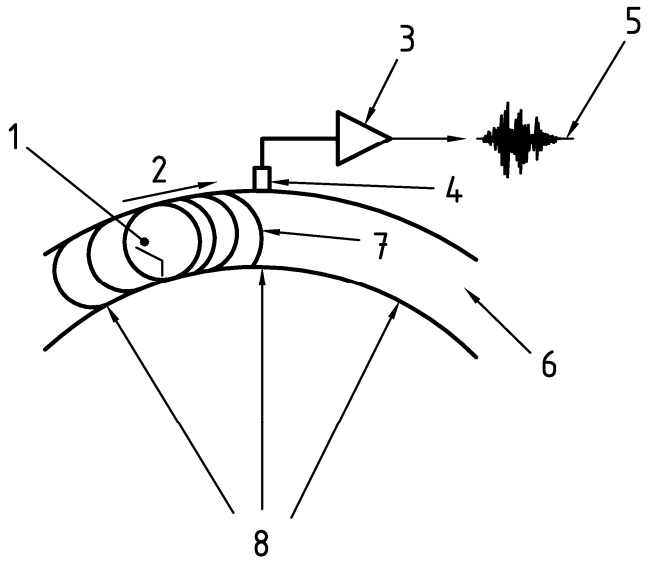
5 Principle of the acoustic emission method

5.1 Acoustic emission (AE) phenomenon

Acoustic emission is a physical phenomenon whereby transient elastic waves are generated within a material or by a process.

The application of load or harsh environment in a material produces internal structural modifications such as local plastic deformation, crack growth, corrosion, erosion and phase transformations. AE sources also arise from impact, leakage (turbulent flow), cavitation, electric discharge and friction. All these mechanisms and processes are generally accompanied by the generation of elastic waves that propagate in materials or into ambient liquids. The waves therefore contain information on the internal behaviour of the material and/or structure.

The waves are detected by the use of sensors that convert the particle motion at the surface of the material into electric signals. These signals can be of a burst or continuous nature and are processed by appropriate instrumentation to detect, characterize and locate the AE sources. Figure 1 shows the schematic principle of AE.



Key

1 growing discontinuity
2 surface waves
3 preamplifier
4 AE sensor
5 signal out
6 section view of the component material
7 wave packet
8 applied load inducing stress

Figure 1 — Schematic principle of Acoustic Emission and its detection

5.2 Advantages and features of AE

The AE method has the following features:

a) it is a passive detection method that monitors the dynamic response of the material to the applied load or environment;

b) it allows detection of sources, depending on the materials properties, up to several meters distance;

c) it allows a 100 % volumetric monitoring of the test object;

d) it is sensitive to growth of discontinuities and changes in the material structure rather than to the presence of static discontinuities;

e) it is non invasive;

f) it offers a dynamic real time monitoring of any discontinuity that grows under the applied stress;

g) it can be applied to monitor the structures during operation;

h) it can be used to detect the effects of the application of load in order to prevent catastrophic failure of structures;

i) it is capable of locating a growing discontinuity in the structure under test by the use of a sufficient number of sensors;

j) its measurement frequency range extends from about 20 kHz to 2 MHz depending on the application.

The AE method can be applied only if the materials in the structures or components are adequately stressed.

The difference between AE and most NDT methods stems from the above features. It is the material itself that releases the energy in consequence of structural degradation due to different source mechanisms. This is different to detecting existing geometrical discontinuities in a static condition.

AE is a method which points out the presence and location of an evolving degradation process under a given stimulus.

5.3 Limitations of AE

Limitations of the AE method are:

a) non growing discontinuities may not generate AE;

b) subsequent application of load to the previously applied maximum stress level will only identify discontinuities which are still active;

c) it is sensitive to in-service or other extraneous noise.

Prior to performing an acoustic emission testing (AT), it is very important to check for the presence of potential noise sources. Noise sources should be removed or action taken to insure they do not reduce the effectiveness of the AT.

6 Applications of the acoustic emission method

AE is applied at the different phases of product life:

— materials and design optimisation;

— manufacturing (quality assurance);

— acceptance test;

— initial proof test;

— requalification tests;

— in-service condition / health monitoring;

— leak detection.

Furthermore, it is applicable to detection of:

— cavitation erosion;

— electric discharge;

— crack activity of rocks and concrete;

— etc.

It is applied to:

— pressure equipment;

— pipe systems;

— atmospheric storage tanks;

— machinery;

— civil constructions (e.g. bridges, dams);

— power transformers;

— mines (e.g. rock salt mines for hazardous waste disposal);

— etc.

These examples concern metallic materials, polymer composites, ceramics, concrete, rock, etc.

7 Instrumentation

7.1 General

The AE instrumentation shall fulfil the requirements of EN 13477-2 and the performance shall be checked periodically in accordance with this European Standard.

7.2 AE sensors

7.2.1 General

Detection is the most important part of an AE measurement chain because any problem here (poor acoustical coupling, incorrect installation, incorrect frequency selection, cable mismatching, etc.) affects the rest of the measurements and hence the results.

7.2.2 AE sensor selection

The sensors are normally of the resonant type, i.e. one frequency dominates the response; sensors with different resonant frequencies are available.

The choice of the sensor and the operating frequency depends upon:

— the purpose of testing;

— the requirements of the referencing standard or specification;

— type and shape of structure or component;

— operating temperature and surface condition of the structure or component (insulation, painting, coating, surface corrosion, etc.);

— environment;

— material properties;

— background noise;

— wave attenuation;

— material thickness.

The signal waveform from the sensor is affected by multiple path propagation and multiple waves modes that are generated in the material. An example of a typical AE burst signal is shown in Figure 2.