



SLOVENSKI STANDARD
SIST-TS CEN/TS 13445-501:2019
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Nekurjene tlačne posode - 501. del: Akustična emisija za tlačne posode

Unfired pressure vessels - Acoustic emission for pressure vessels

Unbefeuerte Druckbehälter - Teil 501: Schallemissionen bei Druckbehältern

Réipients sous pression non soumis à la flame - Émission acoustique

Ta slovenski standard je istoveten z: CEN/TS 13445-501:2018

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ICS:

23.020.32 Tlačne posode Pressure vessels

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Unfired pressure vessels - Part 501: Acoustic emission for pressure vessels

Réceptifs sous pression non soumis à la flamme -
Partie 501 : Émission acoustique

Unbefeuerte Druckbehälter - Teil 501:
Schallemissionen bei Druckbehältern

This Technical Specification (CEN/TS) was approved by CEN on 3 September 2018 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

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

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European foreword

This document (CEN/TS 13445-501:2018) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

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CEN/TS 13445-501:2018 (E)

1 Scope

This document is intended for the application of AT on metallic pressure equipment during controlled loading.

Therefore the overall aims of this document are:

- to detect, locate and grade areas with evolving imperfections;
- to provide the manufacturer the possibility to compare results of the first test with those of subsequent periodic inspections;
- to determine the possibilities and limits of AE testing (AT) for pressure equipment;
- to establish common basis for procedures to perform AT, taking into account the specific characteristics of the equipment under test;
- to define the criteria, features and grades essential for evaluation of test results;
- to suggest follow-ups to the test.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 13445-5:2014, *Unfired pressure vessels - Part 5: Inspection and testing*

EN 1330-1:2014, *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, *Non-destructive testing - Terminology - Part 9: Terms used in acoustic emission testing*

EN 14584:2013, *Non-destructive testing - Acoustic emission testing - Examination of metallic pressure equipment during proof testing - Planar location of AE sources*

EN 13477-1, *Non-destructive testing - Acoustic emission - Equipment characterisation - Part 1: Equipment description*

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

EN ISO 9712:2012, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012)*

EN ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2017)*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Personnel qualification

AT personnel shall be qualified and certified in accordance with EN ISO 9712 level 2 at minimum. Personnel shall hold an appropriate certificate of competence (operating authorization according to EN ISO 9712), e.g. personnel certification on AT level 2 or 3 as appropriate (see EN 13445-5:2014, 6.6.3.7).

NOTE For pressure equipment, see Directive 2014/68/EU, Annex 3.1.3: “For pressure equipment in categories III and IV, the personnel must be approved by a third party organization recognized by a Member State”.

5 Basis of AT on pressure equipment

The AE methodology is described in EN 13554.

The main target of the AT of pressure equipment is to detect acoustic emission sources caused by phenomena generated by the applied load to the equipment:

- local plastic deformation;
- crack initiation; <https://standards.iteh.ai/catalog/standards/sist/143be5d8-5aa2-4794-971e-a7c0179765ac/sist-ts-cen-ts-13445-501-2019>
- subcritical crack growth;
- surface rubbing in existing cracks;
- corrosion;
- leakage;
- etc.

AT can monitor evolution of AE sources respective to the equipment loading. In general, the detection of AE sources is not restricted by the size of the evolving imperfection.

The properties and structural state of the material, the magnitude of the applied pressure, pressure sequence and pressure rate are significant factors affecting the generation of AE.

After determination of wave propagation conditions, maximum allowed sensor spacing for location of AE sources shall be determined according to EN 14584.

The influence of test fluid inside the pressure equipment on the different parameters of wave propagation (e.g. wave attenuation, wave velocity, wave paths) shall be considered.

Grading of located AE sources is based on the evolution of their AE activity, AE intensity and other parameters according to EN 14584:2013, Clause 8.

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6 Instrumentation

6.1 Generality

The AE instrumentation shall be in line with EN 13477-1 and EN 13477-2.

6.2 Sensors

The most commonly used sensors are resonant in-frequency range from 100 kHz to 300 kHz. Lower frequency monitoring allows detection at greater distances and high frequency monitoring provides improved rejection of external noise. Selection of frequency range may optimize location accuracy.

The equipment surface below the sensors shall be cleaned to ensure the maximum coupling efficiency. The sensor coupling shall be as specified in the written test instruction. The sensors may be mainly directly attached to the structure using magnetic devices or an adhesive, or by using wave guides (e.g. high/low temperature, mounded equipment).

The effectiveness and reliability of the acoustic coupling shall be verified. The characteristics of the type of the acoustic coupling agent used shall not affect the structure adversely.

In case of specific requirement (hazardous zones), intrinsically safe sensors and instrumentation shall be used.

If the results of the shop test have to be a reference for subsequent tests, this has to be taken into account for the sensor arrangement (e.g. for mounded equipment where wave guides will be used, the shop test shall also be done with wave guides).

6.3 Preamplifiers

The preamplifier ensures both signal amplification and impedance matching. It may be integrated into the sensor or connected to the sensor through a cable. For high sensitivity, the cable shall be as short as possible (see EN 13477-1).

6.4 Filters

Analogue or digital frequency filtering is used at the measurement instrumentation to increase the signal to noise ratio and to remove unwanted high or low frequency signals for measurement purposes.

6.5 AE Signal conditioning and processing

The AE signal processor provides analogue to digital conversion, threshold controlled feature extraction (e.g. peak amplitude, rise time, duration, energy, counts) and time driven measurements (e.g. RMS) in real time.

The AE signal processor can record the waveform. The AE signal processor normally provides the power supply for the preamplifier and a method for using AE sensors as a mechanical pulse generator (e.g. for the automatic sensor coupling test).

6.6 Localization of AE sources

The localization of AE sources is performed using delta t measurement.

The localization accuracy is normally within $\pm 5\%$ of the maximum used sensor spacing and shall be measured and verified using an artificial source (see EN 14584:2013, 5.4).

For difficult geometry (e.g. nozzles, manholes) reference measurements shall be made.

For the on line evaluation of located AE sources, it is necessary to apply the real time distance peak amplitude correction (see EN 14584:2013, Clause 6 and Annex A).

7 Testing

7.1 Preliminary information

Prior to the test (proof test or periodic in service inspection), the AE test organization shall collect the following information, as relevant:

- a) type of equipment or structure;
- b) assembly and/or layout drawings with sufficient details of the structure;
- c) material characteristics and specifications, including heat treatment, if applicable;
- d) history of the equipment (maximum pressure, temperature, etc.);
- e) proposed pressure application sequence;
- f) potential acoustic noise interference sources and the isolating mechanism applied;
- g) where possible, locations of known imperfections and the general results of prior NDT.

7.2 Written test instruction requirements

The AE test organization shall provide a written test instruction, which shall include but not necessarily be restricted to the following:

- a) indication of the purpose of the test and limitations, if any;
- b) sensor type, frequency and manufacturer;
- c) method of sensor attachment;
- d) type of acoustic coupling used;
- e) type of surface preparation;
- f) type of AE instrumentation used with its main characteristics;
- g) energy measurement method to be used;
- h) value of K (see EN 13445-5:2014, Annex E), if available, or determined by the AE test organization during lab tests;
- i) sensor location maps representing the structure or part of it;
- j) description of periodic AE instrumentation verification procedure;
- k) description of the *in situ* verification;
- l) pre-defined pressure schedule;
- m) recorded data and recording method;
- n) available online presentation of data;
- o) real-time evaluation criteria;
- p) post analysis procedure with adopted filtering technique, if used;