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Neporušitveno preskušanje – Akustična emisija – Preverjanje kovinske tlačne opreme med preskušanjem – Območje namestitve senzorjev akustične emisije

Non destructive testing - Acoustic emission - Examination of metallic pressure equipment during proof testing - Zone location of AE sources

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Zerstörungsfreie Prüfung - Schallemissionsprüfung - Prüfung von metallischen Druckgeräten während der Abnahmeprüfung - Zonenortung von Schallemissionsquellen

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Contents

Page

Foreword 3

1 Scope 4

2 Normative references 4

3 Definitions 4

4 Personnel Qualifications 5

5 General 5
5.1 Application of load 5
5.2 Sensors 5
5.3 Zone location 6
5.4 Preliminary information 6
5.5 Written instruction requirements 6

6 Instrumentation 7

7 Testing 8
7.1 Pre-Test Measurements 8
7.1.1 Wave propagation 8
7.1.2 Determination of maximum allowed sensor spacing 8
7.2 Test steps 10
7.2.1 General Guidelines 10
7.2.2 In situ verification - 10
7.2.3 Background Noise 10
7.2.4 Equipment Pressurisation 10

8 Interpretation of results 11
8.1 Test stop criteria 11
8.1.1 Test stop during the initial proof loading 11
8.1.2 Test stop during subsequent loadings 11
8.2 AE zone grading criteria 12

9 Documentation 13

Foreword

This document (prEN 15495:2006) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

1 Scope

The purpose of this standard is to describe the methods for conducting acoustic emission (AE) examination of metallic pressure equipment during acceptance pressure testing using a zone location procedure. General principles of Acoustic Emissions are described in EN 13554.

The objectives of the AE testing are to provide 100% volumetric testing to define and grade zones of the structure which are acoustically active with burst type AE. The method should be regarded as supplementary to planar location. Planar location provides the source identification and characterisation. Zone location may also be applied in such cases where location of AE sources by planar location procedures according to EN 14584 is not possible.

The method identifies the need for further evaluation of follow-up by other NDT in localized zones.

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 its amendment or revision. For undated references the version valid at the time of publication of the standard containing the reference shall be used.

EN 1330-1, Non-destructive testing – Terminology – Part 1: General terms

EN 1330-2, 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 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 characteristics

EN 13554, Non-destructive testing - Acoustic emission - General principles

EN 14584, Non-destructive testing - Acoustic emission – Examination of metallic pressure equipment during proof testing – Planar location of AE sources….

EN 473, Non-destructive testing - Qualification and certification of NDT personnel - General principles

EN ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

3 Definitions

For the purpose of this European Standard, the terms and definitions given in EN 1330-1, EN 1330-2 and EN 1330-9 shall apply.

4 Personnel Qualifications

It is assumed that acoustic 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.

NOTE For pressure equipment see directive 97/23/EC, 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 General

The main target of the AE test is to identify and monitor zones of high acoustic emission activity and intensity caused by phenomena e.g. crack growth and yielding generated by the applied load to the equipment.

The properties and structural state of the material, the type and magnitude of the applied stress and stress rate are significant factors affecting the emission.

All zones showing significant activity shall be completely evaluated by other NDT methods. Evaluation according to EN 14584 may help to reduce the area to inspect.

5.1 Application of load

The application of the load to the equipment shall be made using internal pressure following the procedure specified in the relevant Product Standard. The rate of the application of pressure shall be established so as to avoid burst signal overlap. The pressurising system shall permit pressurisation at a steady controllable rate and shall allow the pressure to be held constant at the hold points. The pressurisation rate would not normally exceed 1% of test pressure per minute for pneumatic and 5% of the test pressure per minute for hydraulic test. The intermediate hold periods, if necessary according the AE activity or the pre-defined pressure schedule, will normally are 5 min to 10 min. The final hold period at the test pressure shall have a minimum duration of 15 min.

NOTE Intermediate hold periods are strongly recommended, especially if pressurisation rates exceed 0.5 % per minute for pneumatic or 2 % per minute for hydraulic tests.

Prior to starting the test, all the necessary actions shall be taken to identify and to reduce potential sources of extraneous noise.

Dependent upon the results of the initial loading, a reduction of the load to working pressure or lower, followed by re-pressurisation, may be required.

5.2 Sensors

The frequency range shall be chosen so that the expected AE has sufficient energy in the chosen frequency range and the test result is unaffected by external noise sources. The most commonly used frequency range is 100 kHz to 300 kHz. Lower frequency monitoring allows detection at greater distances and high frequency monitoring provides improved rejection of external noise.

The equipment surface below the sensors shall be prepared to ensure the maximum coupling efficiency. The sensor couplant shall be as specified in the written test instruction. The sensors may be directly attached to the structure using magnetic devices or suitable adhesive.

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

5.3 Zone location

Zone location assigns each event producing at least one hit to the zone of the first-hit channel. Successive hits are assumed to belong to the same event as long as they arrive within the event definition time. The event definition time is a programmable time interval, which starts with the arrival of the first-hit of an event. It is essential for this type of location that all noise sources are well controlled.

5.4 Preliminary information

Prior to the test, the AE Test Organisation shall collect the following information:

a) relevant Product Standard

b) type of equipment or structure and material characteristics and specifications;

c) design- and test pressure;

d) working- and test temperature;

e) assembly and/or layout drawings with sufficient details of the structure;

f) material specifications, including heat treatment; if applicable

g) proposed pressure/stress application sequence;

h) potential acoustic noise interference sources and the isolating mechanism applied;

i) where possible, locations of known discontinuities and the general results of prior NDT.

5.5 Written instruction requirements

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

a) explicit 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 couplant used;

e) type of surface preparation;

f) type of AE equipment used with the main characteristics;

g) energy measurement method to be used

h) sensor location maps representing the structure or part of it;

i) description of equipment verification procedure;

j) description of the in-situ verification (see 7.2.2);

k) sequence of pressurisation;

l) recorded data and recording method;

m) available on-line presentation of data;

n) real time evaluation criteria

o) post analysis procedure with adopted filtering technique if used;

p) final report requirements;

q) qualification/certification of the personnel.

r) value of K_Z ,(for definition see figure 1) from the relevant Product Standard if available.

The written test instruction shall be prepared in accordance with EN 473.

6 Instrumentation

An AE system consists of sensors and equipment for signal conditioning and processing and for displaying and recording data according to EN 13447-1.

The AE instrument shall be capable of measuring at least the following parameters on all channels

a) AE burst count;

b) Burst signal peak amplitude;

c) Burst signal duration;

d) Burst signal rise time;

~~e)~~ Burst signal energy;

~~f)~~ arrival time;

and on external inputs pressure and/or other stress parameters.

To allow a real time control of the pressure equipment under test, the test instrumentation shall

— Store all the acquired AE data and the external parameter(s)

— Provide an on-line activity vs channel display

— Provide an on-line activity vs zone display

— Provide an on-line display of AE data and pressure

To assist the on-line evaluation it is recommended that the instrumentation provides real time noise indication by analysis of the AE data set. Online grading of zones is also recommended.

The AE system operating characteristics shall be verified according to EN 13477-2.

7 Testing

7.1 Pre-Test Measurements

The requirements listed in EN 14584 apply for a setup that uses both, planar and zone location. The following text is to be observed where planar location is not used.

7.1.1 Wave propagation

Attenuation measurements shall be performed on the structure in order to determine the maximum sensor spacing. The measurements shall be performed with the test fluid in the pressure equipment using the Hsu-Nielsen source. In the case that the Hsu-Nielsen source saturates the measurement chain, a lower energy artificial source shall be used up to the 20e distance. The obtained curve shall be adjusted to correspond with the original Hsu-Nielsen source.

The attenuation and wave velocity shall be measured using two sensors mounted in a region of the pressure equipment away from nozzles, manways, etc.

The shadowing effect of nozzles and ancillary attachments shall be quantified and transmission through the test fluid shall be taken into consideration.

7.1.2 Determination of maximum allowed sensor spacing

The maximum distance between adjacent sensors is 1,5 times the threshold distance d_{thr}.

The threshold distance is the distance where the amplitude of the Hsu-Nielsen source is equal to the evaluation threshold A_e.

The evaluation threshold A_e is defined as the amplitude of the Hsu-Nielsen source at the distance of 20 mm minus K_Z .

The detection threshold is x dB above the peak background noise, this must be less than evaluation threshold A_e.

Transmission must be through the steel.

The sensor spacing shall take into consideration variations in sensor sensitivity and coupling efficiency.