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Non-destructive testing — Acoustic emission inspection — Vocabulary

Essais non destructifs — Contrôle par émission acoustique — Vocabulaire

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Foreword

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International Standard ISO 12716 was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 3, *Acoustical methods*.

Introduction

This International Standard is a compilation of terms to provide a precise understanding or interpretation of acoustic emission inspection. These terms serve to secure the foundation of acoustic emission technology growth within the academic and industrial communities.

Non-destructive testing — Acoustic emission inspection — Vocabulary

1 Scope

This International Standard defines the terminology that is used in acoustic emission inspection and forms a common basis for standards and general use.

2 Terms and definitions

2.1
acoustic emission
AE
class of phenomena whereby transient elastic waves are generated by the rapid release of energy from localized sources within a material, or the transient waves so generated

NOTE Acoustic emission is the recommended term for general use. Other terms that have been used in AE literature include:

a) stress wave emission;

b) microseismic activity;

c) emission or acoustic emission with other qualifying modifiers.

2.2
acousto-ultrasonics
AU
nondestructive examination method that uses induced stress waves to detect and assess diffuse defect states, damage conditions and variations of mechanical properties of a test structure combining aspects of acoustic emission (AE) signal analysis with ultrasonic materials characterization techniques

2.3
AE signal duration
time interval between AE signal start and AE signal end

2.4
AE signal end
recognized termination of an AE signal, usually defined as the last crossing of the threshold by that signal

2.5
AE signal generator
device which can repeatedly induce a specified transient signal into an AE instrument

2.6
AE signal rise time
time interval between AE signal start and the peak amplitude of that AE signal

2.7
AE signal start
beginning of an AE signal as recognized by the system processor, usually defined by an amplitude excursion exceeding threshold

2.8
array
group of two or more AE sensors positioned on a structure for the purposes of detecting and locating sources that would normally be within the array

2.9
attenuation
decrease in AE amplitude per unit distance, normally expressed in dB per unit length

2.10
average signal level
rectified, time-averaged AE logarithmic signal, measured on the AE amplitude logarithmic scale and reported in dB_{AE} units (where 0 dB_{AE} refers to 1 μV at the preamplifier input)

2.11
channel, acoustic emission
acoustic emission channel
assembly of a sensor, preamplifier or impedance matching transformer, filters, secondary amplifier or other instrumentation as needed, connecting cables, and detector or processor

NOTE A channel for examining fiberglass reinforced plastic (FRP) may utilize more than one sensor with associated electronics. Channels may be processed independently or in predetermined groups having similar sensitivity and frequency characteristics.

2.12
count, acoustic emission
acoustic emission count
count, ring-down
ring-down count
emission count
N
number of times the acoustic emission signal exceeds a preset threshold during any selected portion of a test

2.13
count, event
event count
N_e
number obtained by counting each discerned acoustic emission event once

2.14
count rate, acoustic emission
acoustic emission count rate
emission rate
count rate
$\dot{N}$
time rate at which emission counts occur

2.15
couplant
material used at the structure-to-sensor interface to improve the transmission of acoustic energy across the interface during acoustic emission monitoring

2.16
dB_{AE}
logarithmic measure of acoustic emission signal amplitude, referenced to 1 µV

Signal peak amplitude (dB_{AE}) = 20 $\log_{10}(A_1/A_0)$

where

A_0 is equal to 1 µV at the sensor output (before amplification);

A_1 is the peak voltage of the measured acoustic emission signal.

Acoustic emission reference scale:

dB_{AE} value	Voltage at sensor output
0	1 µV
20	10 µV
40	100 µV
60	1 mV
80	10 mV
100	100 mV

2.17
dead time
instrumentation dead time
any interval during data acquisition when the instrument or system is unable to accept new data for any reason

2.18
distribution, amplitude, cumulative (acoustic emission)
cumulative (acoustic emission) amplitude distribution
$F(V)$
number of acoustic emission events with signals that exceed an arbitrary amplitude as a function of amplitude V

2.19
distribution, threshold crossing, cumulative (acoustic emission)
$F_t(V)$
cumulative (acoustic emission) threshold crossing distribution
number of times the acoustic emission signal exceeds an arbitrary threshold as a function of the threshold voltage V

2.20
distribution, differential (acoustic emission) amplitude
differential (acoustic emission) amplitude distribution
$f(V)$
number of acoustic emission events with signal amplitudes between amplitudes of V and $V + \Delta V$ as a function of the amplitude V where $f(V)$ is the absolute value of the derivative of the cumulative amplitude distribution $F(V)$

2.21
distribution, differential (acoustic emission) threshold crossing
differential (acoustic emission) threshold crossing distribution
$f_t(V)$

number of times the acoustic emission signal waveform has a peak between thresholds V and $V + \Delta V$ as a function of the threshold V where $f_t(V)$ is the absolute value of the derivative of the cumulative threshold crossing distribution $F_t(V)$

2.22
distribution, logarithmic (acoustic emission) amplitude
logarithmic (acoustic emission) amplitude distribution
$g(V)$
number of acoustic emission events with signal amplitudes between V and αV (where α is a constant multiplier) as a function of the amplitude

NOTE This is a variant of the differential amplitude distribution, appropriate for logarithmically windowed data.

2.23
dynamic range
difference, in decibels, between the overload level and the minimum signal level (usually fixed by one or more of the noise levels, low-level distortion, interference or resolution level) in a system or sensor

2.24
effective velocity
velocity calculated on the basis of arrival times and propagation distances determined by artificial AE generation and used for computed location

2.25
emission, burst
burst emission
qualitative description of the discrete signal related to an individual emission event occurring within the material

NOTE Use of the term “burst emission” is recommended only for describing the qualitative appearance of emission signals. Figure 1 shows an oscilloscope trace of burst emission at two different sweep rates.

2.26
emission, continuous
continuous emission
qualitative description of the sustained signal level produced by rapidly occurring acoustic emission events

NOTE Use of the term “continuous emission” is recommended only for describing the qualitative appearance of emission signals. Figure 2 shows oscilloscope traces of a continuous emission signal at two different sweep rates.

2.27
energy, acoustic emission event
acoustic emission event energy
total elastic energy released by an emission event

2.28
evaluation threshold
threshold value used for analysis of the examination data

NOTE Data may be recorded with a system examination threshold lower than the evaluation threshold. For analysis purposes, dependence of measured data on the system examination threshold must be taken into consideration.

2.29
event, acoustic emission (emission event)
acoustic emission event
local material change giving rise to acoustic emission

2.30
examination area
that portion of a structure being monitored using acoustic emission

2.31
examination region
that portion of the test article evaluated using acoustic emission technology

2.32
Felicity effect
presence of detectable acoustic emission at a fixed predetermined sensitivity level at stress levels below those previously applied

2.33
Felicity ratio
ratio of the stress at which the Felicity effect occurs to the previously applied maximum stress

NOTE The fixed sensitivity level will usually be the same as was used for the previous loading or test.

2.34
floating threshold
any threshold with amplitude established by a time average measure of the input signal

2.35
hit
any signal that exceeds the threshold and causes a system channel to accumulate data

2.36
interval, arrival time
arrival time interval
Δt_{ij}
time interval between the detected arrivals of an acoustic emission wave at the ith and jth sensors of a sensor array

2.37
Kaiser effect
absence of detectable acoustic emission at a fixed sensitivity level, until previously applied stress levels are exceeded

2.38
location, cluster
location method based upon a specified amount of AE activity located within a specified length or area, e.g. 5 events within 12 linear units (e.g. cm) or 12 square units (e.g. cm^2)

2.39
location, computed
adaptive location
source location method based on algorithmic analysis of the difference in arrival times among sensors

NOTE Several approaches to computed location are used, including linear location, planar location, three dimensional location and adaptive location.

2.39.1
linear location
one-dimensional source location requiring two or more channels

2.39.2
planar location
two-dimensional source location requiring three or more channels

2.39.3
3-D location
three-dimensional source location requiring five or more channels

2.39.4
adaptive location
source location by iterative use of simulated sources in combination with computed location

2.40
location, continuous AE signal
method of location based on continuous AE signals, as opposed to hit or difference in arrival time location methods

NOTE This type of location is commonly used in leak location due to the presence of continuous emission. Some common types of continuous signal location methods include signal attenuation and correlation analysis methods.

2.40.1
signal attenuation-based source location
source location method that relies on the attenuation versus distance phenomenon of AE signals; by monitoring the AE signal magnitudes of the continuous signal at various points along the object, the source is determined based on the highest magnitude or by interpolation or extrapolation of multiple readings

2.40.2
correlation-based source location
source location method that compares the changing AE signal levels (usually waveform based amplitude analysis) at two or more points surrounding the source and determines the time displacement of these signals, this time displacement data being used with conventional hit-based location techniques to arrive at a solution for the source site

2.41
location, source
any of several methods of evaluating AE data to determine the position on the structure from which it originated

NOTE Several approaches to source location are used, including zone location, computed location, and continuous location.

2.42
location, zone
first-hit location
any of several techniques for determining the general region of an acoustic emission source, e.g. total AE counts, energy, hits, etc.

NOTE Several approaches to zone location are used, including independent channel zone location, first-hit zone location and arrival sequence zone location.

2.42.1
independent channel zone location
zone location technique that compares the gross amount of activity from each channel

2.42.2
first-hit zone location
zone location technique that compares only activity from the first-hit channel among a group of channels

2.42.3
arrival sequence zone location
zone location technique that compares the order of arrival among sensors

2.43
location accuracy
comparison of the actual position of an AE source (or simulated AE source) to the computed location

2.44
overload recovery time
interval of nonlinear operation of an instrument caused by a signal with amplitude in excess of the instrument's linear operating range

2.45
processing capacity
number of hits that can be processed at the processing speed before the system must interrupt data collection to clear buffers or otherwise prepare for accepting additional data

2.46
processing speed
sustained rate in hits per second, as a function of the parameter set and number of active channels, at which AE signals can be continuously processed by a system without interruption for data transport

2.47
rate, event count
event count rate

$\dot{N}_e$

time rate of the event count

2.48
sensor, acoustic emission
acoustic emission transducer
acoustic emission sensor
detection device, generally piezoelectric, that transforms the particle motion produced by an elastic wave into an electrical signal

2.49
signal, acoustic emission
acoustic emission signal
emission signal
electrical signal obtained by detection of one or more acoustic emission events

2.50
signal amplitude, acoustic emission
acoustic emission signal amplitude
peak voltage of the largest excursion attained by the signal waveform from an emission event

2.51
signal overload level
that level above which operation ceases to be satisfactory as a result of signal distortion, overheating or damage

2.52
signal overload point
maximum input signal amplitude at which the ratio of output to input is observed to remain within a prescribed linear operating range

2.53
signature, acoustic emission
acoustic emission signature
signature
characteristic set of reproducible attributes of acoustic emission signals associated with a specific test article as observed with a particular instrumentation system under specified test conditions

2.54
stimulation
application of a stimulus such as force, pressure, heat, etc., to a test article to cause activation of acoustic emission sources

2.55
system examination threshold
electronic instrument threshold (see **evaluation threshold**) at which data will be detected

2.56
transducers, acoustic emission
active element in an acoustic emission sensor, usually piezoelectric

2.57
voltage threshold
voltage level on an electronic comparator above which signals will be recognized

NOTE The voltage threshold may be user-adjustable, fixed or automatic floating.

2.58
waveguide, acoustic emission
acoustic emission waveguide
device that couples elastic energy from a structure or other test object to a remotely mounted sensor during AE monitoring

NOTE An example of an acoustic emission waveguide would be a solid wire or rod that is coupled at one end to a monitored structure, and to a sensor at the other end.

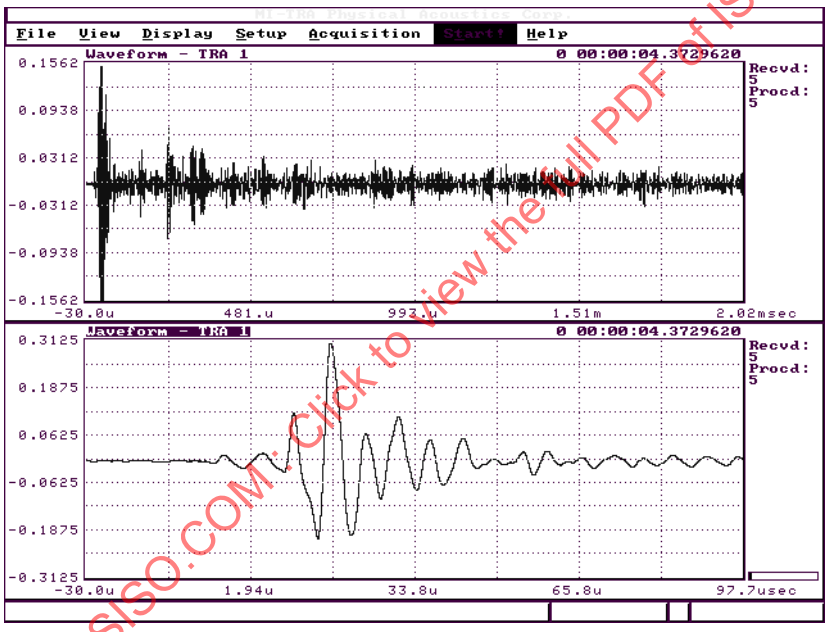

Figure 1 — Same burst emission signal at two different sweep rates