Acoustic Emission Test Methods– SAE J1242 JUN83

SAE Information Report
First Revision June 1983

THIS IS A PREPRINT WHICH IS SUBJECT TO REVISIONS AND CORRECTIONS. THE FINAL VERSION WILL APPEAR IN THE 1984 EDITION OF THE SAE HANDBOOK.

SAE The Engineering Resource For Advancing Mobility

PREPRINT

ACOUSTIC EMISSION TEST METHODS—SAE J1242 JUN83

SAE Information Report

Report of the Iron and Steel Technical Committee, approved June 1978, first revision by ISTC Division 25 June 1983.

Purpose—The purpose of this report is to supply the user with sufficient information so that he may decide whether acoustic emission test methods apply to his particular inspection problem. Detailed technical information can be obtained by referring to the Bibliography at the end of this report.

General—Acoustic emission is defined as *a transient elastic wave generated by the rapid release of energy from a localized source or sources within a material.* The emission may be the result of any of several changes taking place in the material. A crack may be growing, the material may be undergoing permanent deformation, the internal structure may be changing due to heat treatment, or, in the case of composite materials, the fibers that strengthen the material may be breaking.

Some metals produce audible acoustic emission when they are bent. This is due to a deformation process called twinning. Tin, magnesium, ϕ and zinc show this effect. In tin this is known as "tin cry."

Acoustic emission technology is applicable to many nondestructive inspection problems. These include detection and growth monitoring of fatigue cracks and stress-corrosion cracking, in-process determination of ϕ weld quality, measurement of adhesive bond integrity, and in certain cases, the detection of loose parts in assembled components. Acoustic emission is particularly useful for monitoring the growth of a crack in order to ϕ give warning of impending failure, and to detect deformation. It is also useful for surveying very large volumes to locate emission sites. However, these sites often must be evaluated by supplementary methods.

There are several advantages of acoustic emission as a nondestructive test method when compared with more common methods such as radiography, ultrasonics, or magnetic particle techniques. Some of these are as follows:

ϕ 1. It is capable of continuously monitoring a complete structure in real time.

2. It is very sensitive to the presence of active flaws when compared to other nondestructive test methods, but usually requires these other methods to characterize the flaws.

3. It can detect discontinuities that may be inaccessible to other nondestructive test methods.

4. It is suitable for use during proof testing in those structures that will be stressed sufficiently to produce local plastic deformation during the test.

Limitations of acoustic emission testing include:

1. Inactive non-propagating flaws cannot be detected.

2. The significance of a detected source of emission cannot be assessed unambiguously.

3. As with many other nondestructive tests, acoustic emission tests are best used in conjunction with other nondestructive test methods, such as ultrasonics and radiography.

ϕ 4. The part or system under test must be stressed by an external stimulus.

Principle—There are two types of acoustic emission: *burst* and *continuous*. A single burst of emission lasts from a few microseconds to several milliseconds. Continuous emission consists of a series of closely spaced noise peaks of random amplitude that occur without interruption. Burst emissions usually have a larger amplitude than continuous emissions.

ϕ A specimen must be stressed to generate acoustic emission. For a material with no active sources, emission usually occurs while the stress is increasing. When the stress stops increasing, the emission stops. For many materials, excluding composites, when the force is reapplied it must exceed the previous stress level before the specimen will emit again.

Most of the acoustic emission signals that are useful in nondestructive testing are usually of low amplitude and have frequencies that are above the audible range. Ordinarily they are between 100 kHz and 1 MHz, depending upon the application. Low frequencies are filtered out in order to avoid interference from unwanted sources of noise such as machines or electrical equipment. The maximum distance that the signals will travel in a structure and still be detectable depends on the type of material and on the range of frequencies in the signal. In steel pressure vessels the acoustic emission caused by crack growth in welds can travel 10 m or more from the source of the emission to the transducer that is detecting it.

The location of a source of the emission is determined by triangulation methods. These are based on the differences in the times required for the signals to reach the various elements in an array of transducers.

Procedure—Specially designed transducers are used for detecting the acoustic emission in a test specimen or structure. These must be coupled to the test specimen with a suitable liquid or grease, or by means of an epoxy cement or other adhesive. The output of the transducer is amplified and the low frequencies filtered out. Processing of the signal is usually very desirable. The simplest method for monitoring an acoustic emission test is to electronically convert the high frequency acoustic emission signals to lower frequencies that can be heard with the human ear. The most common methods, however, use chart recorders or cathode ray oscilloscopes to display the test results. Magnetic tape is used for storing larger amounts of data for later processing or display. Specialized equipment for the detection and processing of acoustic emission signals is available from several manufacturers. Data processing as applied to acoustic emission tests is limited only by the creativity and sophistication of the user and the data processing facility.

BIBLIOGRAPHY

1. Metals Handbook, Eighth Edition, American Society for Metals, 1976, Vol. 11, "Nondestructive Inspection and Quality Control," pp. 234–243.

2. "Acoustic Emission," A Symposium presented December 7–8, 1971, at Bal Harbor, Florida. American Society for Testing and Materials, STP 505, (1972).

3. Monitoring Structural Integrity by Acoustic Emission, A Symposium presented at Fort Lauderdale, Florida, January 17–18, 1974. American Society for Testing and Materials, STP 571, (1975).

4. R. G. Liptai and D. O. Harris, "Acoustic Emission—An Introductory Review." Materials Research and Standards, Vol. 11, No. 3, March 1971, pp. 8–10.

5. C. R. Horak and A. F. Weyhreter, "Acoustic Emission System for Monitoring Components and Structures in a Severe Fatigue Noise Environment," Materials Evaluation, Vol. 35, No. 5, May 1977, pp. 59–63.

6. J. C. Spanner, "Acoustic Emission Techniques and Applications," Intex Publishing Co., 1974.

7. ASTM E 569, "Recommended Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation," American Society for Testing and Materials, Philadelphia, PA 19103. ϕ

8. ASTM E 610, "Definitions of Terms Relating to Acoustic Emission," American Society for Testing and Materials, Philadelphia, PA 19103. ϕ

The ϕ symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.