



## **THE EUROPEAN STANDARDISATION IN THE FIELD OF ACOUSTIC EMISSION TESTING (AT)**

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### **ABSTRACT**

Beside of the professional quality of the AT the standardisation of the testing methodology and training would be the most important step to the acceptance of a testing method. Because of a lack of AE standards on the national level it was necessary to establish a standardisation group on the European level, the Technical Committee (TC)138 (Non Destructive Testing; NDT) Working Group (WG) 7 (Acoustic Emission; AE).

In the last years the WG 7 produced on the European level the basic standards for the application of Acoustic Emission (terminology, AE-equipment and different testing methods) and co-operated on the development of standards and report for the training and certification of NDT personnel, in common and AT personnel in specific. Furthermore, based on Joint Working Groups with other product TCs and personnel membership in other product TCs, AT was implemented in several European product standards with minimum requirements for their application and data evaluation.

### **KEY WORDS**

European standardisation organisation (CEN) – Acoustic Emission standards – Terminology – Instrumentation – General principles - Product standards

### **INTRODUCTION**

Beside the professional and technical quality of a Non-Destructive Testing (NDT) methodology the standardisation of general principles and the training of the personnel are the most important steps for the acceptance of a method. Because in the most European countries such standards did not exist and the standards shall guarantee a common application of the technique all over Europe, it was a necessity to establish an European Working Group for this task. Many years after the establishment of the European Technical Committee CEN/TC 138 “Non-Destructive Testing” in the second part of the Nineties of the last century Acoustic Emission got the opportunity to establish a Working Group WG 7 “Acoustic Emission Testing (AT)” within this Technical Committee. Till to this stage some standards existed in France and Germany and few standards were produced from the “European Working Group



on Acoustic Emission (EWGAE)” on an European level. The deficit of the poor national standardisation gave us the opportunity to establish new and up to date standards without any troubles with national interests.

### **CEN – THE EUROPEAN STANDARDISATION ORGANISATION**

One of the most important difference between the national and European type of standardisation was, that within the CEN we distinguish between

- ✓ Basic (technology) standards and
- ✓ Product depended standards.

This bisection hinders extremely Acoustic Emission (AE), because AE is always be considered in conjunction with the test object. The separation between a product and technology standard is therefore flowing and discussions between the different experts are inherent. We, the members of CEN/TC138 WG7, learned to live with this fact and at the present stage we joined into different Joint Working Groups with colleagues from different product TCs.

Today we have more troubles with quack experts, which brings AT into discredit by their strange absolutely unscientific application of the technique.

#### **CEN/TC 138 “NON-DESTRUCTIVE TESTING (NDT)”**

The TC138, as Technical Committee shall establish basic standards for the NDT, like:

- ✓ Standardisation of the terminology (EN 1330 -1 and -2, common terms and such terms, which will be used for all NDT methods)
- ✓ Establish standards for the qualification and certification of NDT personnel (EN 473 with all technical reports for training syllabus, requirements for training- and certification centres)

The Committee is responsible for the valuation and acceptance of these technical standards, which were established from the different Working Groups.

<b>NDT method</b>	<b>Symbol</b>	<b>NDT method</b>	<b>Symbol</b>
Acoustic emission testing	AT	Penetrant testing	PT
Eddy current testing	ET	Radiographic testing	RT
Leak testing	LT	Ultrasonic testing	UT
Magnetic particle testing	MT	Visual testing	VT

Specific problems were dealt within “Ad-Hoc” Groups.

The essential standards for AT are the prEN 473:2007 “Non-destructive testing – Qualification and certification of NDT personnel – General principles” and the CEN ISO/TR 25107:2006 “Training syllabuses, which will be treated later on.



## CEN/TC138 WG7 “ACOUSTIC EMISSION TESTING”

The CEN/TC138 WG7 is the responsible Working Group for Acoustic Emission and has to establish the following basic standards:

- ✓ Standardisation of the specific AE terminology (EN 1330-9)
- ✓ Standardisation of the used AE-equipment and their control (EN 13477-1 and -2)
- ✓ Standardisation of the general principles of the different testing technologies.

This last point creates the troubles between the WG, TC and other TCs, because AT has its own peculiarity about the conjunction of the testing method with the tested structure. How it was mentioned before, in the last time it became better. Sometimes this was the reason for more “soft” standards, which hinders a little bit the further development of test method.

## EUROPEAN BASIC AE – STANDARDS

EN 473:2007                      Qualification and certification of NDT personnel

This standard influences AE only in the field of training and certification of the AE personnel. The new standard elongates the training time for AT1, which was in the intention of the trainer and the trainees. We have to take into account, that according EN 473 the level 1 is allowed to record and classify the results of the tests in terms of written criteria and shall furthermore report the results. In the field of AE this influences a lot the training level of AT1, how it has been in the former days.

To avoid any mistakes it has to be pointed out, that AT1 shall not be responsible neither for the choice of test method or technique to be used, nor for the assessment of the test results.

TR 25107:2006              Guidelines for NDT training syllabuses

This Technical Report defines the content of the training for all different NDT methods. For the first time the training content will be combined with necessary training time for the specific item, which gives a comparability between the training in the different European countries and even for different certification centres in the same country. We will see this in the next years, if this becomes successfully.

(pr)EN 1330 – 9              Terminology – part 9: Terms used in Acoustic Emission Testing

This standard is still under review. The classification into four parts is still the same:

- ✓ Terms relating to the physical phenomenon;
- ✓ Terms relating to the detection of acoustic emission;
- ✓ Terms relating to the measured characteristics of the signals(s);
- ✓ Terms relating to acoustic emission applications

During the review some terms were included into the standards or re-defined. The standards shall be accepted during the TC138 meeting in October this year.



EN 13477 -1/ -2:2002      Equipment characterisation

*Part 1: Equipment description*

This part describes the main components of an acoustic emission monitoring system, comprises

- ✓ detection,
- ✓ signal conditioning,
- ✓ signal measurement,
- ✓ analysis and output results.

This part of the standard is widely accepted and needs no review after 5 years.

*Part 2: Verification of operating characteristics*

This standard comprises some requirements, for which sometimes it is very difficult to fulfil it even for state-of-the art equipment. The verification procedure is very time consuming. These are the reasons, why this standard shall be reviewed in the following years.

EN 13554:2002      General principles

This standard shall specify the general principles required for the acoustic emission testing 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 describes the specific requirements for the application of the AE method.

Beside the principles of the acoustic emission method, the advantages and limitations were pointed out. The equipment and acquisition chain will be declared roughly. The core of the standards is the examination part, where it is divided into the 6 basic points

- ✓ preliminary information,
- ✓ preliminary preparation,
- ✓ site preparations
- ✓ data acquisition and on-line analysis,
- ✓ presentation of the results and
- ✓ subsequent operations.

The data analysis (source evaluation, grading and post examination analysis will be touched very common.

Because this standard was issued in 2000 and produced earlier, it is not surprising, that we need a review procedure. For the rapid development in the field of AT the year 2000 and especially before was the "AT - Stone Age".



EN 14584:2002 Examination of metallic equipment during proof testing – Planar location of AE sources

This standard provides to all AT customers and testing organisations clear and controllable guidelines for the application.

The main paragraphs are examination (§7) and specific classification criteria, which will also be used during the real time control (§8). The values have to be inserted according the experience of the test organisation. We hope, that this could be replaced in the future by different product standards. Very important are these values especially for pneumatic loading of the structure, which can lead to catastrophic failures without the pre-warning ability of AT.

The definition of the maximum sensor distance, the insertion of the factor K and recalculation of the peak amplitude to the position of the AE source together improve the quality of the tests and their results and lead to the “right” source severity classification.

(pr)EN 15495:2007 Examination of metallic equipment during proof testing – Zone location of AE sources

The method should be regarded as supplementary to planar location and may be applied in such cases, where the location of AE sources by planar location is not possible. Even under these restrictions the weakest point of the method is, that the results can only rely on activity criteria. For the intensity criteria you have no information, where the source is within the zone, which results in big differences according the amplitude and consequently the criticality of the defect.

The only fact for the application of the zone location is, if you have to decide between “AT using the cheap (less sensors, less evaluation) zone location or loading without AT”.

The possibility for its application, where planar location is not possible, is often an aid not to perform the more expensive but also more sophisticated application of planar location with all its uncertainties.

TC138 WI 00138140 General principles of AE testing for the detection of corrosion within metallic surrounding filled with liquid

This standard created the biggest difficulties between TC and WG. The first time, when the WG7 tried to include this standard, which is necessary for the corrosion testing of the flat bottoms of bulk liquid storage tanks, into the working programme of the TC138 was 2000 in Rome. The biggest problem was, that we have to standardise the AT principles for testing a specific product, which is normal for AT.

From the technical point of view this standard gives us a tool to combine and validate the application procedure and results of different test providers. After a discussion during the fall 2007 meeting the WI shall be send as quick as possible to the TC for translation and enquiry.



TC138 WG7 NWI 607      General principles for testing of fibre-reinforced plastics – Methodology and general evaluation criteria

This is a very broad employed project dealing with the general principles for testing fibre-reinforced plastics, which in the future will become more and more important in the industrial application. During the work this project raises unfortunately a lot of questions, which have to be solved before an adequate standard can be delivered to the TC.

### **PRODUCT STANDARDS WITH REFERENCE TO ACOUSTIC EMISSION**

EN 13445 – 5                      Unfired pressure vessels – Part 5: Testing and Inspection

Within the informative Annex E Acoustic Emission will be used as a safety method during the pneumatic loading of pressure equipments. Because this is a product standard we were able to define values for the K – factor for the most common steels for pressure equipments.

Within this annex some peculiarities for AE monitoring of gas pressure tests will be discussed. We shall allude to the fact, that AT is able not only to detect active sources but also to validate the criticality of the source. All other so-called safety precautions for gas pressure tests have any access to the answer of the structure to the applied stress.

EN 12817/18 Annex C      Minimum requirements for the performance of an acoustic emission test on LPG vessels up to a volume of 13 m<sup>3</sup>

The normative Annex was produced by a Joint Working Group of the TC138 WG7 and the TC286 WG7 (product TC for LPG pressure equipments) and will be included into the LPG standards, which are responsible for maintenance and periodic inspection of LPG vessels.

The Annex relies on Basics coming from the AT standards and shall prevent, that testing organisations (footboard driver) with improper technology and data material perform virtual tests. The difficulties with the restricted access to the structure will be solved by a sophisticated factor and subsequently requirements for the real time control and stop criteria will be implemented.

EN 14334 Annex X      Minimum requirements for acoustic emission testing of road tankers

In cooperation with TC 286 WG5 an Annex for the AT of road tankers were developed to replace during the periodic inspection the hydrotest and the inside inspection. The test method is based on the EN 14584 with some special problems for the specific structure.

A problem for these tests is based in the ADR, which have to accept the test method also for the inside inspection, especially for those countries, where the road tankers cross often the borders.



## **CONCLUSION**

The standardisation is an important point for the acceptance of a testing method. AT has done a very important step towards this acceptance in the last years. For a wide variety of AT application we have now general requirements for the application.

The separation into technology- and product standards within the European standardisation leads to the fact, that today the most standards define the technology and its application, but we have no quantitative values for the evaluation and classification of AE sources. Therefore it is very important, that we get in touch with the respective product TCs to include together with them quantitative values for the AT in product standards. This would also improve the comparability between the different test providers.

When we reach this stage, AT will become more and more an accepted and well used NDT method, with a wide variety of advantages, which cannot be provided by any other NDT method.



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