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SELECTED ISSUES RELATED TO PRESENTING THE RESULTS OF THE LABORATORY TESTS OF THE AUTOMOTIVE PRODUCTS IN THE CONTEXT OF THEIR RELIABILITY TO THE CLIENT

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Abstract

The quality of the tests results is of paramount importance in the process of assessing conformity, conducted among the others, on the safety of the products use, their functionality or type approval. Ensuring the reliability of the results and their consistency should be an absolute priority in the operation of all appointed for this purpose metrology institutions and organizations, especially those units whose product offered to the customer are goods and services are based on measurements and their results. The essential criterion for assessing the quality of the results is their reliability to the user. One of the major issues that have a significant impact on the reliability of tests results is a form of reporting the results to the client.

This paper addresses the key issues related to the presentation of the tests results. Discussed are the risks associated with the presentation of test results. The qualities that the measurement result should have to be reliable to the customer, have been identified. The significance of the accreditation for the validity of the results has been presented. Normative documents containing the requirements for the presentation of research results have been recalled. The information to be contained in a report from an accredited testing laboratory provided to a customer has been specified. The principles of the identification of the document describing the test methods have been discussed. Attention was drawn to the need for placing, in the report, the information about the uncertainty of the measurements. The principles of placing in the test report and the assessment of conformity as well as the opinions and interpretations, have been discussed. The detailed requirements for use, by research laboratories, the accreditation symbols in test reports have been presented.

Keywords: *test result, the reliability of the results, research report*

1. Introduction

The modern world with globalization processes occurring in industrial production and services, aims to minimize technical barriers through international agreements, ensuring cohesion of national law and standardization. The basis and prerequisite to minimize technical barriers are reliable, trustworthy measurement and results in all areas of global society.

The reliability of the test results and their coherence, regardless of where the measurements were taken, and regardless of the technical and human factors associated with it, are the basis for the use of research results among the others in a uniform conformity assessment system, allowing free movement of goods and services in Europe and the throughout the world, wherever the conformity assessment systems have been in place and functioning based on the harmonized rules. Therefore, measurement and testing laboratories should carry out tests in accordance with applicable laws and regulations, normative documents and mutual agreements, on the basis of good professional practice, constantly maintaining established quality of research and the highest level of competence, in such a way as to fully satisfy the requirements of the client and other stakeholders.

The problem of the validity of the tests results is especially important in the automotive industry. Results of automotive products tests have a direct impact on the safety of all road users, and in the area of emissions, on the protection of the natural environment.

Analysis of the results of internal audits at the research laboratories performing tests for the type approval and / or certification of automotive products, as well as the results of assessments carried out by the accredited body indicate that the tests results communicated to the client do not always contain the information necessary for the proper and unambiguous interpretation of the results.

The purpose of this paper is to present, based on the analysis of normative documents and guidelines from the organizations providing acceptance, the most important issues concerning the content of the test report in terms of the reliability of the tests results, including automotive products.

2. The reliability of test results

The product tests are performed in order to obtain the test result on characteristics / properties of the product. The tests results provide a basis for assessing compliance with the applicable requirements, conducted within the following scope:

- user safety,
- functionality
- type approval.

The main purpose of any research laboratory is to provide the tests results of a specific, desired quality. The basic criterion for assessing the quality of tests results is their reliability to the client - the results user.

Result of the measurement / test is reliable when it has the following characteristics [6]:

- is reliable, which means that the actual value of the characteristic tested is with a certain probability, within the range: the measurement / test result ± uncertainty
- it is useful or allows the customer to solve his problem,
- is reliable, which means that the laboratory operates in accordance with a good professional practice.

Many factors affect the accuracy and reliability of measurements / tests obtained by the laboratory. The most important ones include:

- competences of personnel performing and supervising tests,
- facilities and environmental conditions in accordance with the requirements of the test method,
- the test method used, whose suitability for the intended application and the ability to be correctly implement in laboratory conditions, has been previously confirmed,
- measuring equipment used for tests which meets the specifications of the test method, provides a measure of the accuracy and supervised in such a way as to preserve the usefulness in a fixed period of time,
- metrological supervision over the measuring and test equipment ensuring measuring cohesion and thus comparability of the results,
- method of sampling and handling the test items.

The reliability of the tests results is significantly affected by the form to communicate the results to the customer ordering the tests or to other interested parties.

The way of presenting the results of tests involves a number of risks, in the form of:

- misinterpretation of test results,
- erroneous generalization of tests results
- misunderstanding customer expectations,
- incorrect client's decision,
- misuse and wrong use of the test result.

The client instructs the lab to perform the test in order to solve a specific problem and expects the results that are useful for him to solve this problem. Reliable result may not always be quantifiable to the customer. If it is presented in the improper form, without the additional

information required, it may be misinterpreted and therefore misused. Thus it will become completely useless to the customer.

Therefore, the result of each test should be submitted together with all information required by the customer and necessary for a correct interpretation of the results of the test, given precisely, clearly, unambiguously and objectively, and in accordance with any specific requirements, including legal requirements, and any considerations relating the possibility of using the test results.

The basis for confidence in the reliability of the tests results are competences of the research laboratory. The formal proof of competence to carry out specific tasks for conformity assessment is accreditation.

According to PN-EN ISO / IEC 17000:2006 standard [4] accreditation is a "validation by a third party relating to the conformity assessment body for the purpose of formal demonstration of its competence to carry out specific tasks in the field of conformity assessment". Accreditation is to be construed as a formal recognition, by the authorized national accreditation body, of the competences of an organization operating in the field of conformity assessment to perform certain actions, and continuously monitoring of these competences. Confirmation of this in practice translates into trust of customers and other parties to the reliability of the results of operations and mutual recognition.

Rules of accreditation are included in the PN-EN ISO / IEC 17011:2005 standard [5] and international guidelines. Unification of reference documents at the international level ensures high degree of objectivity and reliability of the accreditation granted by the bodies of various countries.

Research laboratories in the automotive industry are accredited with regard to the requirements of the international standard - ISO / IEC 17025 [6] This standard specifies general requirements for the competence of testing and calibration laboratories. It specifies requirements for the management system and technical competence of laboratories. One of the basic requirements of this standard is to confirm the competence of the laboratory to obtain reliable results.

As far as the accreditation is concerned, confirmation extends to the competences to carry out specific test method and its purpose. The standard defines the requirements found world-wide. The laboratories with an accreditation certificate for this standard testify that their technical competences have been assessed and can be internationally recognized. Certificate of accreditation provides confidence that the technical competences of the laboratory correspond to the recognized global standards in force in all countries of the world, and the risk associated with a poor outcome of the tests will be minimized.

If the national accreditation body is a member of international organizations active in the field of conformity assessment: EA (European co-operation for Accreditation) and / or ILAC (International Laboratory Accreditation Cooperation), a consequence of the membership in these organizations are agreements on mutual recognition of the MLA accreditations (Multilateral Agreement). To the research laboratories, this means that the test reports issued by accredited laboratories may be recognised by the interested parties in the countries where accreditation bodies are signatories of the aforementioned agreement.

3. Presentation of test results

In the section 5.10 – *Presenting the results* of the PN-EN ISO / IEC 17025 standard, it is defined precisely, that the test results should be presented in the test report. The standard also specifies what minimum information should the report include.

Additionally, other specific requirements relating to the content of the report may be included in the test method, and in the case of the regulated areas, in the relevant legislation.

In accordance with clause 5.10.8 of the standard, the laboratory should design the patterns of their reports tailored to each type of test performed. Developed patterns should minimize the possibility of misunderstanding or misuse of test results by the interested parties. The electronic

versions of the reports should include an approved electronic authorization method of the report. If the laboratory uses simplified versions of the report, the pattern should be designed in such a way so that the simplification did not in itself carried the risk of incorrect use or incorrect interpretation of test results. The data contained in the simplified report should enable the repetition and / or restoration of the test. All data and information, like for the complete report, should be kept and available in the laboratory.

What one ought to pay special attention to in the development of test report? First of all, to the clear identification of the test method used.

3.1. Identification of the test method

As the test result often depends on the test method used, the accurate identification of the method is essential for the reliability of the results. Marking a document describing the test method should include a full status of the document issued. If this is the standardised method – it should quote an ID number as indicated by the Polish Committee for Standardization or other standardization organization and the year of issue, as identified in the original document.

When using a method developed by the laboratory, one ought to give the identification of own test procedure with full status of its issue. When a document contains a number of test methods, one should identify the method, for example by indicating chapter, section or paragraph so there is no doubt that which method has been applied to the test.

If the document, e.g. indicated as identifying the method of testing, does not describe the implementation of the test method and refers to another document, which contains a test procedure, the report ought to cite a document referred to.

When a document containing a description of the implementation of the test method refers to other documents, which include requirements for, e.g. a specific test parameter, sample preparation, configuration of the measurement track channel, etc. without the knowledge of which the laboratory is unable to properly perform the test, the test report should recall the core document containing the description of the implementation of the test method.

Where a document referred to as a description of the test provides an overview of the test and does not present the test procedure, description of the course of test and does not refer to any other document, which contains a test procedure, the laboratory should establish its own test procedure.

For the correct interpretation of the results, the necessary is information on specific test conditions as well as departures from it, anomalies of additions and limitations of the test method, at every stage of the test, including sampling, transport and handling of samples / test objects. The laboratory should agree with the client, while reviewing the contract, the test method and any anticipated departures from it.

The use of an appropriate test method is especially important if the client intends to use the results of tests in the regulated area. The use of other method of test than that indicated in the legislation, disqualifies the use of the results in the regulatory area. Such a result is not useful for conformity assessment bodies, and thus completely useless to the customer. The test report should include the information about the uselessness of the given results in the regulated area, even if the client has given his consent to using different test method. The inclusion in the test report the compliance assessment with the requirements of existing legislation / standards, issuing an opinion or interpretation in the regulated area, based on the useless results reduces confidence in the competence and integrity of laboratory activities.

3.2. Identification of test objects

No less important part of any test report is conclusive identification of the sample / test object and the handling of the samples. Laboratory tests a sample of the product, so identification should refer to the sample rather than the substance, material or product type. In addition, each test report

should include a statement that the results of the test refer only to the sample / object.

The correct interpretation of the results requires information on how the samples are taken. The research laboratory not taking samples, submits in the test report, the information on the procedures and plan of taking samples and the organization performing the sampling.

Laboratory that takes the samples presents in the test report the results of the sampling, in accordance with the par. 5.10.3.2 of PN-EN ISO / IEC 17025 standard.

3.3. Measurement uncertainty in the test report

The measurement result, even the most carefully obtained, does not provide direct information about measured values, due to the uncertainty accompanying this result. Measurement uncertainty is a parameter associated with the result of a measurement, that characterizes the dispersion of values, that can reasonably be attributed to the measurand. This parameter is an inherent feature of any measurement result. It can not be equated with the measurement error, which relates to a single measurement and is the difference between an individual result and the true value of the measurand. Uncertainty is the range in which, with the specified probability, there is the true value of the measurand. From the point of view of metrology, the result presented without the uncertainty assigned to it does not provide full information about the measured value. The criterion of the completeness of the measurement result will be fulfilled only when it is assigned the value of uncertainty. The knowledge of uncertainty of test results is fundamentally important to the laboratory, its customers and all institutions that use these results for comparisons.

The utility of the results obtained can be assessed only if the value of the uncertainty has been properly assessed.

In order to standardize the procedure for determining the uncertainty of the test results within EA, the document EA-04/16 was developed [2]. This document provides guidance and recommendations on establishing uncertainty of measurement and quantitative tests results.

In determining the uncertainty associated with the test result one should take into account, which is often overlooked, the component of the uncertainty coming from the stage of the examining the collected sample, i.e. the effect of sampling and sampling results on the final test result.

If the laboratory does not collect samples to be tested and / or does not take into account, in determining the uncertainty of measurement / test result, the component of the uncertainty associated with sampling, it is then required to provide the information in the report that the test result and the associated uncertainty are related to the sample tested.

If and when one ought to include in the report information on the uncertainty of test results?

Testing laboratories should develop principles of cooperation with the customer to ensure that the customer makes full use of laboratory services. Customers have the right to expect that the test report shown by the laboratory is factually correct, useful and comprehensive. Regardless of the purpose of the tests, the customer should be interested in the reliability of the results and a quantitative determination of this reliability by providing uncertainty. No less important is the level of confidence in the statement of compliance of the product tested, which may be a result of the finding of the study, together with the expanded uncertainty.

The section 5.10.3. of the PN-EN ISO / IEC 17025 standard states that in the test report uncertainty of the results must be given when:

- it is important to the reliability of the results and their application,
- it is required by the client,
- it is important for compliance with specified limits.

Almost always when test results are used for comparison purposes, especially when the test results are used to assess compliance, the test report should include information about the uncertainty of the test results.

3.4. Assessment of compliance

The test report, when it is necessary to interpret the results, should include a statement of compliance of the result presented with the requirements set out by standards, regulations or arrangements with the customer. It should be noted that the assessment of compliance concerns presented result of the characteristics tested, and not sample of the product and more still, the product. In accordance with the requirements of PN-EN ISO / IEC 17025 standard, the report can not contain certificates of classification or certification of the product.

In order to standardize the approach to the determination and reporting of compliance of the quantitative measurement results with the specification, the document ILAC-G8:03/2009 was developed [3]. This document provides testing laboratories and their clients guidance on decision-making and reporting of compliance or non-compliance with specified requirements.

3.5 Opinions and interpretations

When it is appropriate and necessary for the interpretation of the test results, the laboratory may place in the test report the opinions and interpretations. As opinions and interpretations one should understand expressing the view, explanation, clarification, commenting tests results by competent personnel with appropriate knowledge, training and experience in a particular field of tests. The assessment of compliance with the requirements can be a part of opinion and interpretation. Opinions and interpretations, require wider technical knowledge, expertise among the others on the application of the object / product, effects resulting from non-compliance with the requirements by the product / object, etc. Opinions and interpretations should be formulated in such a way that they are not confused with the inspection and certification of products. The accreditation highlighted in the scope of accreditation is the confirmation of staff competence in this area.

Laboratory can not formulate opinions / interpretations of the product based on testing the sample, without its sampling by the laboratory, unless the legislation states otherwise.

4. Citing the accreditation in the test report

The reference to accreditation in the test report is information that the laboratory is recognized as competent to carry out the activities covered by the accreditation, and the results obtained by laboratory in the accredited field are reliable and recognized by organizations that use the conformity assessment process. Therefore, the way to cite an accreditation in the reports should provide unambiguous identification of accredited and non-accredited results and actions taken based on the decisions concerning conformity.

Accredited laboratories can provide in their test reports the results of accredited activities and results / information from non-accredited activities. The reference to accreditation held may take place by the use of accreditation symbol or appropriate quote in the text. This applies to both reports, in printed form, simplified ones and electronic version. Laboratories in their management systems should determine how they will quote their accreditation and unequivocal identify the results of non-accredited tests, as opposed to accredited ones and identify the test results obtained from subcontractors with accreditation for the test methods.

Detailed requirements for quoting the accreditation held in the test reports are contained in the document of the Polish Centre for Accreditation DA-02 [1]. This document is based on international guidelines and the requirements contained in it are consistent with the requirements of other national accreditation bodies.

In the case of placing in the report the results of the own accredited and non-accredited tests the accreditation symbol can be placed on a report that contains at least one test result as part of

accreditation. The laboratory should ensure that interested parties can distinguish between the accredited results of from those that are not accredited. In this situation, the assessment of compliance with the specification should include clear information that has been formulated with regard to non-accredited test results. Assessment of conformance of the result of the product test sample characteristics is considered as an activity within the scope of accreditation while the assessment of conformance with the requirements of a product sample submitted for tests, as the activity not within the scope of accreditation.

If the test report contains at least the result of one own test conducted within the scope of accreditation as well as the test results obtained from accredited subcontractors in relation to subcontracting, when these tests have been accepted for implementation by the laboratory as part of the order, the laboratory should ensure a clear distinction between the results of their own results and those obtained from an accredited subcontractors, together with the number of accredited contractor.

When a test subcontractor has been specified by the customer, the laboratory should additionally include information on subcontractor and unequivocally declare that it is not responsible for the results contained in the test report obtained from subcontractor. Conformity assessment should include additional information that the decision was taken on the basis of the results for which the laboratory is not responsible.

Accredited laboratory can not issue test reports bearing the accreditation symbol, that include an assessment of compliance with the requirements or opinions and / or interpretations that could be mistaken for the inspection and certification of products. If the opinions and / or interpretations are not covered by the scope of accreditation or are based on non-accredited tests results, the test report ought to contain an appropriate statement.

A necessary condition for the possibility of including on the test report a symbol of accreditation is an authorization of the test report by the competent staff mentioned in the laboratory management system, whose competence has been certified by the accreditation body. An authorizing person takes full responsibility for the factual content of the test report.

5. Summary

The reliability of test results conveyed to the customer should be the primary goal of any research laboratory operating in the automotive industry. For the client, it is not enough to have numeric values of the product characteristics, even if they are credible and reliable. The test report is expected to have objective and comprehensive information allowing to unequivocal interpretation of the numerical values of the characteristic tested and the area of use of the results. Guarantee of the reliability of the test results to the client is represented by laboratory competences confirmed in the accreditation process. One of the points in this evaluation process, is the contents of the test report handed over to the client, in the context of the purpose of the test and the intended use of the results.

Work conducted within the analysis of the requirements in this scope, as well as pointing towards the most important issues affecting the proper interpretation of results, can be used, by eliminating potential causes of discrepancies in the area of the presentation of test results, for the improvement of the laboratory management system.

Demonstration of competence in practice translates into trust of customers and other parties to the quantifiability of tests results and their mutual recognition. Automotive product, once tested in an accredited laboratory and having a test report does not require testing in another country where it is to be used.

References

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[4] PN-EN ISO/IEC 17000:2006, *Ocena zgodności-Terminologia i zasady ogólne*.
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