


CERTIFICATION OF TESTING LABORATORIES – THE BASIS OF RELIABILITY AMONG RESEARCH VENDORS IN AVIATION

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Abstract

Material characterization and assessment is a crucial stage in most of aviation and aeronautical research and a basis for further design and testing of more complex aircraft elements and structures. Material test's reliability can only be guaranteed by conducting them at independent and reliable laboratories, operating based on a management system assessed by a third-party such as the accreditation according to the ISO/IEC 17025 or NADCAP or having the qualification of the second-party based on specific customer requirements. This paper introduces basic requirements for material testing laboratories according to accreditation systems and describes its responsibilities as qualified and reliable testing suppliers.

Keywords: certification, accreditation, NADCAP, ISO/IEC 17025, standardization, material test, standard, management system, quality, laboratory, validation, reliability

Article Category: Research Article

INTRODUCTION

A specific aviation market imposes very strict requirements according to quality performance and formal regulations. Depending on the scope of supplier's activity and services provided the requirements are regulated by the institutions like EASA (European Aviation Safety Agency) and additional management system certification programs according to ISO standards (ISO 9001, ISO/IEC 17025), AS 9100 or the NADCAP accreditation, which are mostly required by customers. Some producers developed their own qualification programs which include their extensive management and technical requirements. This paper focuses on requirements related to material testing laboratories, and in particular conducting special processes, based on general standards and according to requirements of a third-party. The examples used were based on certifications held by the material testing laboratory of the Łukasiewicz Research Network – Institute of Aviation and similar testing laboratories.



MATERIAL TESTS AND ITS STANDARDIZATION

Material tests of coupons is a basic and long-lasting level of physical tests in test pyramid. (Fig. 1). It is mostly important when working on verifying the appropriate material, especially by using a new alloy or designing a new type of aircraft parts. Tests carried out by competent personnel, in appropriate environmental conditions for a given method and according to technical requirements for measuring equipment, in circumstances that enable repeatability, are the requirements needed for the success of further research and tests.

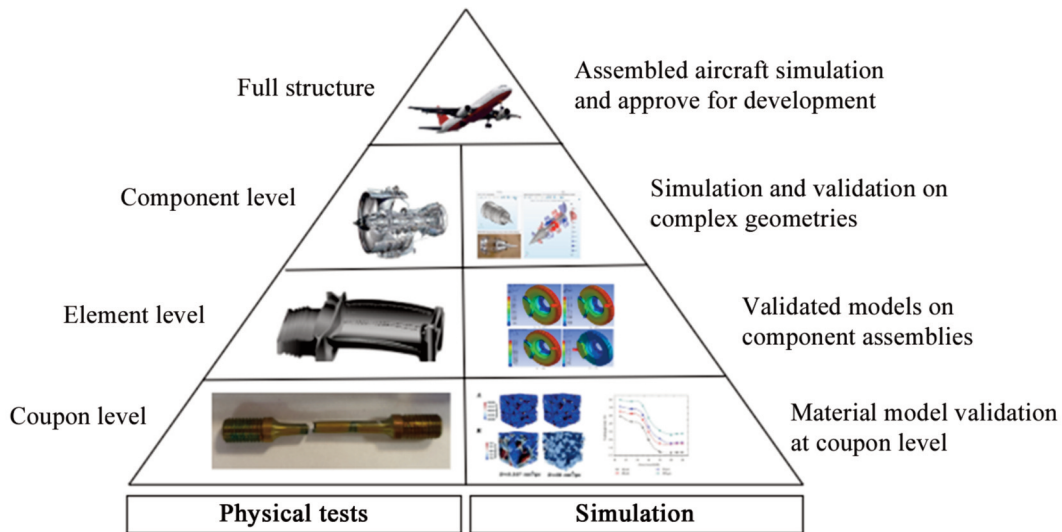


Figure 1. The pyramid of tests, divided in physical and virtual testing at each stage [1].

Each laboratory conducting materials tests and qualification works on specific standards, such as ISO and ASTM or has their own procedures or specifications with a detailed description of the research method. Standard laboratory documentation is crucial to describe testing methodology, environment conditions, requirements and capabilities for testing equipment and to ensure that tests carried out are repeatable and reproducible using the same conditions and parameters.

Test standards define the method of preparation, conduct and completion of tests. For instance, in static tests the requirements defined in technical standards (ASTM E21, E8E8M) includes:

- using machine calibrated in the appropriate force range, with an appropriate gripping system ensuring correct alignment of the entire measuring system
- using appropriate temperature measurement system, with certified and calibrated thermocouples,
- using appropriate extensometer standards and its proper attachments and use of the appropriate range of the extensometer ,
- types of testing specimens,
- measurement of test specimens dimensions,
- procedures for gauge length marking,
- executing required parameters, such as test speed, Yield Strength determination or offset method,

- calculation of tensile strength, elongation or reduction of area,
- defining minimum test report contents.

And although standardization limits the errors or corrective actions, itself is not enough to eliminate it. There can be some areas and problematic issues in material testing laboratories like problems with measurement of specimens dimensions caused by inadequate or inaccurate measuring equipment, or determination of some test parameters, like test speed. The direction of rolling, the thickness of the bar and the place of sample collection also have a significant impact on the obtained strength properties. And that kind of errors are mostly eliminated by implementation of system solutions based on universal management systems and additional specific requirements.

MANAGEMENT SYSTEM AND ISO/IEC 17025 ACCREDITATION

A common objective of management systems, according to standards ISO 9001 or AS 9100 (a standard dedicated to organizations and suppliers – manufacturers and designers, in the area of aviation, space and defense), but also standards from the ISO 17000 family, is to define the requirements for organization, planning, operational activities and analysis of results and based on them further improvement, i.e. basing the activity on the Deming cycle (Plan – Do – Check – Act). The management system combines activities at all levels of the organization, involving both senior management and all employees. The guide to the system is often a document called Quality Manual as well as procedures and instructions defining the processes implemented in the organization, defining the roles of individual participants and the steps in the implementation of processes.

The basic areas required under the management system include activities related to:

- supervision over documentation and records,
- risks and opportunities analysis,
- corrective actions and improvements,
- internal audits,
- management reviews.

A system that imposes the use of additional requirements and a testing regime, by which the laboratory increases the ability to obtain reliable results, is a management system based on the ISO/IEC 17025 Standard “General requirements for the competence of testing and calibration laboratories”. [2] This quality management system refers to the competence to conduct tests (testing laboratories) or calibrations (calibration laboratories), in the scope of using standardized, non-standardized and own methods developed by the laboratory. These competences are confirmed by obtaining accreditation granted by the national accreditation body.

Accreditation according to ISO/IEC 17025 is a basic requirement for laboratories who supply testing services to aviation industry and gives rise to trust as a competent and impartial supplier [3]. The fact of having accreditation provides:

- applying a common standard of operation throughout the organization and meeting the technical requirements specified in Polish and international law,
- increasing the credibility and ensuring the repeatability of the conducted tests,

- streamlining and increasing the accuracy of the laboratory's operation,
- reduction of costs and better management of working time resulting from the elimination of errors and inconsistencies,
- ensuring good laboratory practice, carried out by professional employees at every stage of the research, enabling the taking of preventive measures before the emergence of problems,
- proving technical competences and their improvement by the personnel performing the tests.

Technical requirements contain in this standard refers to areas, which are crucial to ensure the above evidence of trust, especially:

- personnel and its competencies, well-educated and experienced, able to identify and correct error and interpret testing conditions and results,
- defining testing methods and its validation, according to the scope of laboratory capabilities,
- participation in proficiency tests and interlaboratory comparison programs,
- laboratory equipment, calibrated and aligned according to international standards,
- reference of measurements to standards of measurement units,
- sampling, handling of test/calibration items,
- presenting the results.

Laboratory personnel, based on evidence and records from activities such as cyclic verification of compliance with international standards of measurement, confirming the validity of the results by participating in proficiency tests and comparisons with other accredited laboratories or risk analysis, is able to diagnose the causes of disruptions in laboratory work and to take corrective and preventive actions on time, both for individual difficulties and errors as well as trends or gradual processes.

QUALIFICATION BY CUSTOMER

It often happens that suppliers have to go through additional assessments and audits carried out by a specific customer or a unit authorized by him, because customer requirements relating to specific services and products are strictly defined, based on specific requirements and norms as well as internal standards. A special procedure applies to special processes that change the original physical, chemical or metallurgical properties of the tested object, use unconventional methods, often using destructive processes, or are used to assess and control such as non-destructive testing. They require the documentation of skills and proficiency from the operator or equipment as well as special control and monitoring of conditions.

The methods of qualifying and assessing aviation test vendors usually look similar and follow a certain way of conduct. In the case of completely new suppliers, the qualification procedure is usually based on documenting individual scopes of requirements, usually confirmed by a positive audit. Many customers have their own checklists, verified during an auditor's visit to the supplier's premises. These requirements may have a very wide scope, but most of all, they relate to the procedures for ensuring appropriate test conditions, compliance with approved standards and good laboratory practice, and

procedures in the event of non-compliance. The key information and requirement is a confirmation of accreditation based on the requirements of ISO/IEC 17025 or a special NADCAP program. A frequent element of such an audit is also conducting tests on the spot, in the presence of an auditor, using the material provided by him, in order to use the obtained results to analyze the proficiency of a given laboratory and to assess compliance with relevant testing standards on the presented example.

One of the most developed examples of the quality supervision policy towards suppliers is a program lead by General Electric Aviation, aimed at both independent and embedded testing suppliers. The extensive research and development potential and the wide chain of suppliers of one of the biggest American aircraft producers allow for the ongoing development of new technologies and the development of models that meet the ever-growing quality requirements and constitute strong competition on the aviation services market.

The basis of GE Aviation's supply quality management system (GE-A) is the document "S-1000. General Electric Aircraft Engines Quality System Requirements for Suppliers" which sets out minimum requirements for all types of suppliers offering products or services to GE Aviation. The detailed requirements relating to suppliers of special processes are specified in the document "S-400. Certified Materials Test Laboratories (CMTL)".

The purpose of the S-400 qualification assessment is to verify the technical resources and testing quality control system and to confirm compliance with the GE Aviation requirements. All process is completed by issuing "Special Process Certification" (GT-193) certificate, with specified scope and codes for types of certified tests.

NADCAP ACCREDITATION

Accreditation of laboratories according to the ISO/IEC 17025 standard is a universal way to confirm the competence of testing provider, however it only applies to testing and calibration laboratories, excluding the issues of products and special processing of materials, which are a key issues in aviation. Therefore, among aviation manufacturers, it was decided that it is necessary to find a method of assessing suppliers, based on the accreditation method and leaded by an independent, authorized unit who can verify the competences of the supplier to carry out specific activities.

For this purpose, world aviation leaders associated in the Society of Automotive Engineers (SAE) created in 1990 The National Aerospace and Defense Contracts Accreditation Program (Nadcap) – an accreditation program. It is an international program based on impartial and independent assessment, aimed at improving management, production and cooperation at optimal costs by means of quality assurance in the area of production for aviation and defense [4].

Nadcap uses the expertise of industry and government experts. The largest producers, suppliers and government representatives are working together on the development of accreditation requirements, supplier qualification criteria and assumptions for the evaluation of operational programs. The independent unit Performance Review Institute (PRI), established in 1990 by SAE, is responsible for the entire accreditation process and administration of the Nadcap program.

The Nadcap accreditation system was created for various, specified areas of activity of companies from the aviation industry. Among the elements covered by the Nadcap program, we distinguish both special processes as well as systems and products. The group of special processes includes: non-destructive testing (NDT), material testing (MTL), heat treatment (HT) or welding (WLD).

Nadcap program participants can be divided into two groups. The main participants are companies that receive products manufactured using special methods, which include mainly program leaders and members. The second group consists of suppliers who, using special processes, manufacture and deliver products to main recipients. They have the opportunity to participate in the processes created by Nadcap by participating in working groups while retaining the right to vote (except for issues related to accreditation).

There are many reasons for participating in the Nadcap program. Customers use to treat Nadcap accreditation as one of the requirements for cooperation. It is because Nadcap specifications and requirements are based on best practices and its implementation increases the quality of products and services, operational reliability and customer satisfaction. A very general quality system, especially based only on ISO 9000 family standards, is not sufficient to meet the requirements of processes such as heat treatment, welding, material testing or machining. The Nadcap system goes much further, guaranteeing quality in these specific areas and based on a detailed methodology.

SUMMARY

A laboratory that conducts material tests, especially identified as special processes, plays an important role in the entire research and development cycle of industries such as aviation and astronautics. Accreditation systems, such as ISO/IEC 17025 and Nadcap and additional certification requirements, gives the acknowledgements of competences and best practices of such laboratory and guarantee valid and reliable results. It is also important that in case of damage or accident of designed construction, companies and producers have a clear path and opportunities to investigate all the circumstances during design and development process, including testing results. That is why one of the most important objectives of these systems are constant identification and traceability of all testing objects and actions.

An accredited and certified laboratory by participating in numerous proficiency tests and comparisons is able not only to improve its competences regarding the performance of tests, but also puts great emphasis on the activities preceding the tests and the selection of the appropriate material for the production of samples. This is especially important in relation with 3D printing development. It should be remembered that with this type of materials, treatments should be applied to unify the structure of the material and direction of printing also has a great influence on the strength parameters. That is why the constant improvement of research suppliers, increasing their competences and the level of applied methods is so important in the success of many projects and the development of new aviation technologies.

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