Journal of Polish CIMAC
Gdansk University of Technology
The Faculty of Ocean Engineering and Ship Technology

ELABORATION OF THE WIND TURBINE CONSTANT DIAGNOSTIC SYSTEM AS A TESTING PROCEDURE IN AN ACCREDITED LABORATORY – THE PROCESS APPROACH TO WRITING THE DRAFT DOCUMENT

Marek Szczutkowski

University of Technology and Life Sciences in Bydgoszcz
ul. Prof. Kaliskiego 7 85-789 Bydgoszcz, Poland
phone: +48 52 340 82 55, fax: +48 52 340 82 55
e-mail: m.szczutkowski@utp.edu.pl

Abstract

The paper deals with the problem of writing a test procedure as a document of an accredited testing laboratory in accordance with ISO/IEC 17025 standard. The test procedure is a key document presenting a test method of the laboratory while the test is no performed in accordance with a specific standard (i.e. standards on strength of materials and constructional elements). There is presented the process approach on the example of the wind turbine constant diagnostic system. Individual stages of works are presented as well as an example of modern methodology achievements in the range of testing methods on wind turbine diagnostics as an element of input data for the procedure. Reference materials are named and stated as basic sources to define criteria for evaluation of wind turbine conditions. The whole is summarized with general remarks on the process approach in reference to both organizational and technical aspect of the quality management system of the laboratory.

Keywords: *quality, laboratory, accreditation, testing methods, wind turbines.*

1. Introduction

Renewable energy sources like wind energy are copiously available without any limitation. Wind turbines are used to tap the potential of wind energy, which is available in millions of MW. Reliability of wind turbine is critical to extract this maximum amount of energy from the wind [8] Wind energy is undergoing expansion, and it is bound to grow to a commercial/consumer level in the decades to come. This growth has materialized in the form of large-scale wind farms, wind energy cooperatives, wind turbines owned by individual investors, and multinational exploration of remote sites and offshore locations. Despite the increasing rated capacity of wind turbines, operation and maintenance (O&M) costs remain high due to failures of wind turbine components such as gearboxes and blades. To make matters worse, in spite of several drawbacks associated with current/traditional maintenance practices, almost all industries are still following them. Thus, there is a great need to educate managers of such firms about the economic justification of performance monitoring in the wind industry, which is currently characterized by high maintenance costs [17].

Taking into consideration the above there are more and more companies that try to develop and offer new diagnostic services in the area of wind turbines. Usually, from the point of view of

competiveness, there are at least several problems i.e. time issues, price, reliability of test results. In order to compete more efficiently and to reach a customer's satisfaction in laboratory services the implementation of requirements included in ISO/IEC 17025 standard [2] is an option for the testing service provider . Gaining an accreditation certificate in accordance with the standard confirms testing competencies of the laboratory. The standard widens requirements of ISO 9000 standards with technical competencies referring to essential activities of individual laboratories [10].

The aim of the paper is to present the process approach to writing the draft procedure on the wind turbine constant diagnostic system. As the requirement of ISO/IEC 17025 standard such a procedure can be a base, from the point of view of technical requirements, to create the quality management system and in the future to undergo the process of accreditation. As it was mentioned such a solution increases the competiveness of the testing unit.

2. Testing method as a process

The procedure is a document, in the range of the laboratory management system that describes in details the methodology of a test. In this case: wind turbine diagnostic system. If the test is performed in accordance with a standard there is no need of a special documentation describing the methodology. For instance if the laboratory deals with strength of the weld line in the metal layer and bonding between layers by use of a cone for multilayer M pipes in plastic piping systems its tests can be based on ISO/TR 18124:2006 standard [3] that specifies the method. However if the laboratory is able to reach goals set by the standard ; in a different way than it is described in the document [3] the procedure has to be developed and implemented.

Considering the topic of the wind turbine constant diagnostic system first of all, a goal for the procedure has to be set. As an assumed to create such a system that gives reliable test results minimizing time needed for essential operations. Minimization means to limit time for the direct work at the wind turbine. Time has to be limited to data gathering and data processing has to be performed at the laboratory of the service provider. Gaining the reliability of test results in the future is possible by elaboration of the own testing method in the for of procedure and undergoing the process of accreditation in order to confirm that laboratory fulfills the requirements of the standard [2]. Such an approach, apart from the mentioned competitiveness issues, results also as a organizational innovativeness source in the company that forces other technical activities influencing reliability of test results.

Another step, after actions described above, may be creation of the own computer support system for the defined testing process. The elaboration of a specific process and than its formalization as a testing procedure can be an input data to elaborate an algorithm of a special application software. The aim of the software would be to gather data at limited parameters – measurement is going to be performed only if a limit is crossed.

Moreover assuming that above mentioned issues the plan of works can be based on the scheme presented in fig. 1 [13]. The figure gives general approach and having in mind the aim of the paper the „processing” element should be completed with tests and materials and tools to fulfill the main goal defined in input data.

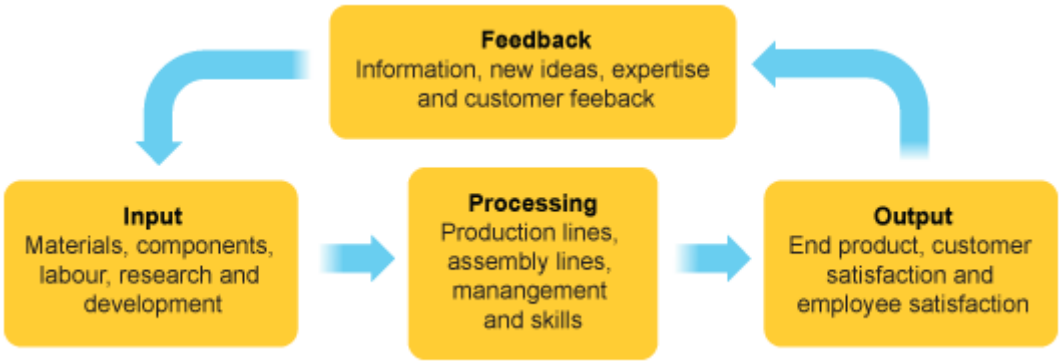

Fig. 1. Production/ service system with feed back [13]

In accordance to the above the following stages of works for the procedure writing were assumed:

a) identification of input data for the process as the analysis of:
   - personnel qualifications,
   - needs of customers in the discussed area,
   - competitors in the market,
   - testing tools and methods in accordance with the modern achievements and requirements,

   (Input data can be identified among others by literature review, gathering of data from the testing market, discussions with customers as well as the analysis of up-to-date experiences. The gathered information has to be elaborated and concluded before its transformation into the testing procedure.),
b) definition of precise requirements on tools and facilities (i.e. testing and measurement equipment) along with referring metrological requirements,
c) design of the test system in the form of own testing procedure,
d) summary connected with the cost analysis on the base of activities from a) to c),
e) initial validation of test service/ procedure in cooperation with former customers that requires direct contacts and consultations,
f) preparation of a report with an essential attachment in the form of the testing procedure.

3. Modern methodology achievements in the range of testing methods on wind turbine diagnostics as an element of input data for the procedure

In reference to the presented plan (stages of works) suitable technical and organizational assumptions have to be considered in the process of design of the testing procedure on the wind turbine diagnostic system. Obviously knowledge gathered from own experience, references, trainings or expert discussion is essential. As we cannot compare and classify experience, trainings or expert discussion one can say that the access to references nowadays is almost unlimited. In the era of Internet limitations may consider linguistic issues or the price of an individual file.

As it was mentioned there are various reference materials that can be useful in the process. Among different ones one can mention as interesting and worth reading such as [5, 6, 7, 9, 11, 12, 14, 15, 16, 17] The own analysis of reference materials enabled to define two base documents as well as two basic criteria for final works in the range of preparation of the testing procedure on the wind turbine diagnostic system. Base documents were recognized as following:

a) VDI 3834 Part 1 - Measurement and evaluation of the mechanical vibration of wind energy turbines and their components - Onshore wind energy turbines with gears,
b) ISO 10816-1:1995 - Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - Part 1: General guidelines.

VDI 3834 Part 1 gives practical advice on the measurement and evaluation of the mechanical vibrations of wind energy plants whereas ISO 10816 establishes the general conditions and procedures for the measurement and evaluation of vibration, using measurements made on the non-rotating parts of machines. The general evaluation criteria relate to both operational monitoring and acceptance testing and have been established primarily with regard to securing reliable long-term operation of the machine [1, 4].

The analysis of references led to define two basic criteria for evaluation:

a) machine component criterion – the wind turbine is defined by following components (fig. 2 presents the first criterion in accordance with [4]):

- gearbox,
- nacelle,
- tower,
- generator,

b) the values of the characteristics measured at these components:

- velocity,
- acceleration.

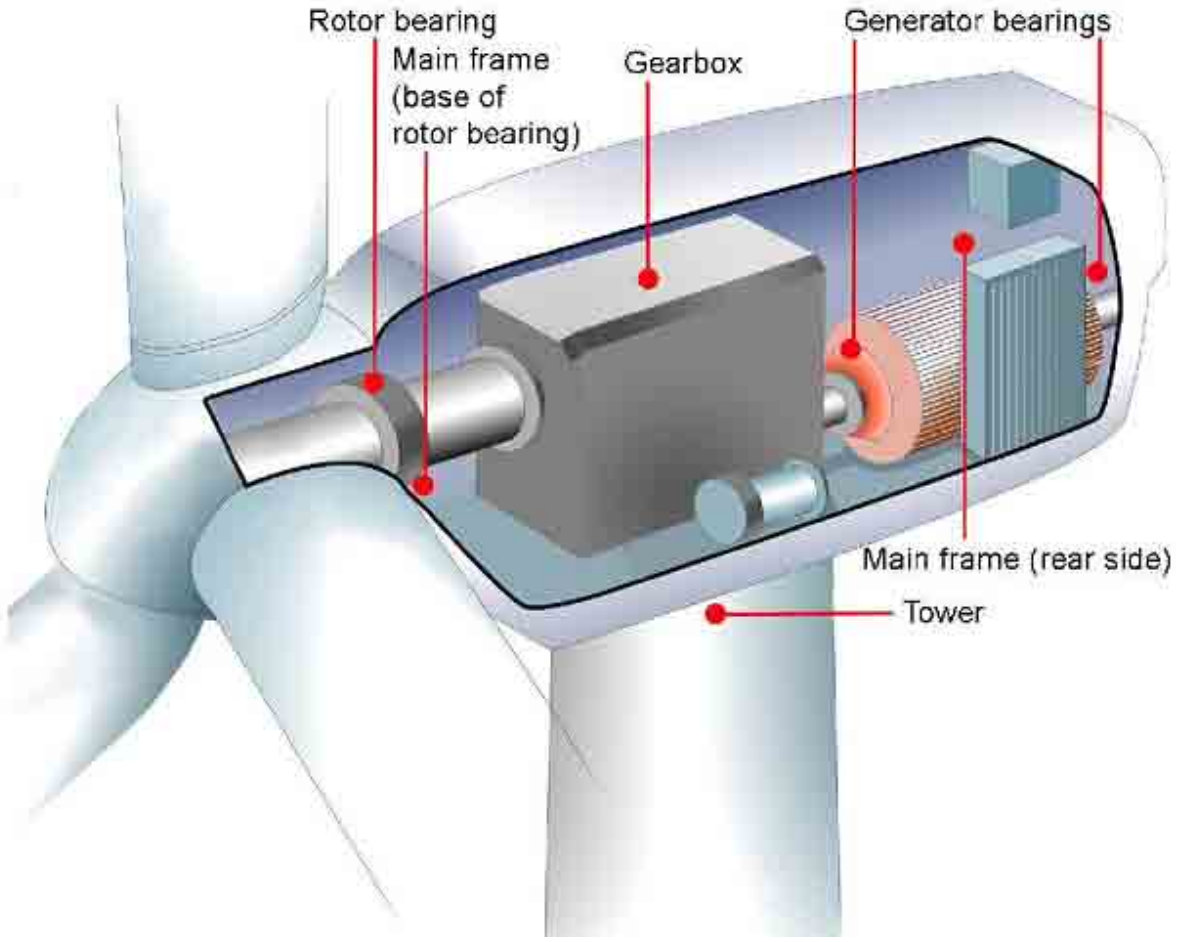

Fig. 2 Components and measuring points to VDI 3834 part 1 [4, 14]

4. Summary

The goal of each company is to earn money as a result of its activity. Laboratories are units that offer unique services in comparison to other companies but economical laws and organizational problems are also their everyday reality. In order to improve their efficiency, develop management system, organizational skills they can implement the requirements of ISO/IEC 17025 standard. The tool is considered to be also efficient from the point of view of competitiveness.

Quality management systems generally base on the process approach. On this assumption in the paper there was presented the process approach to writing the draft testing procedure on the example of the wind turbine constant diagnostic system. Individual stages were discussed and followed by the example of modern methodology achievements in the range of testing methods on wind turbine diagnostics as an element of input data for the procedure.

Such a systematical approach enables to organize works more efficiently and reach reliability of test results in the process of elaboration of the testing procedure. Precise definition of input and output data is essential to design the correct transformation process. In such a case feedback information seems to be more clear and useful and in the range of corrective and preventive actions it is easier to define the sources of nonconformities.

References

[1] ISO 10816-1:1995 - Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - Part 1: General guidelines.

[2] ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories.

[3] ISO/TR 18124:2006 - Plastics piping systems - Multilayer M (metal) pipes - Test method for strength of the weld line in the metal layer and bonding between layers by use of a cone

[4] VDI 3834 Part 1 - Measurement and evaluation of the mechanical vibration of wind energy turbines and their components - Onshore wind energy turbines with gears.

[5] Barszcz T., *Application of diagnostic algorithms for wind turbines*, Diagnostyka 2 (50), 2009.

[6] Cotton, I. ,*Lightning protection for wind turbine blades and bearings*, Wind Energy, 2001.

[7] European Commission / DG TREN, *Advanced maintenance and repair for offshore wind farms using fault prediction and condition monitoring techniques*, Final Report, NNE5/2001/710, FP5 Contract, 2005.

[8] Hameed, Z., *Condition monitoring and fault detection of wind turbines and related algorithms: A review*, Renew Sustain Energy Rev, 2007.

[9] Kusiak, A., Wenyan, L., *The prediction and diagnosis of wind turbine fault*, Renewable Energy 36, 201.

[10] Szczutkowski, M., *Walidacja metod badawczych w laboratorium akredytowanym. Część I. Podstawowe zagadnienia*, Inżynieria i Aparatura Chemiczna nr 2, 2009.

[11] Yan, Y., Osadciw, L.A., Benson, G., White, E., *Inverse data transformation for change detection in wind turbine diagnostics*, Proceedings of 22nd IEEE Canadian Conference on Electrical and Computer Engineering, Delta St. Johns, Newfoundland and Labrador, Canada, May 2009.

[12] Ye, X., Veeramachaneni, K., Yan, Y., Osadciw L.A., *Unsupervised learning and fusion for failure detection in wind turbines*, Proceedings of 12th International Conference on Information Fusion, Seattle,Washington, USA, July 2009.

[13] http://www.bbc.co.uk, 06/2012.

[14] http://www.mmf.de, 06/2012.

[15] http://www.newagepublishers.com, 09/2011.

[16] http://projekter.aau.dk, 09/2011.
[17] http://www.windsystemsmag.com, 09/2011.