



BSI Standards Publication

Condition monitoring and diagnostics of wind turbines

Part 1: General guidelines

National foreword

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Condition monitoring and diagnostics of wind turbines —

Part 1: General guidelines

*Surveillance et diagnostic d'état des éoliennes de production
d'électricité —*

Partie 1: Lignes directrices générales





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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Overview of condition monitoring procedure implementation — Set-up and diagnostics requirements	4
5 FMECA: Identification of failure modes, their effects and criticality	6
5.1 Overview	6
5.2 Identification of wind turbine components criticality factor, f_{CR}	7
5.3 Identification of failure mode priority factor, f_{FMP}	8
5.4 Calculating the monitoring priority number, n_{MP}	10
Annex A (informative) P-F interval, ETTF and RUL	12
Annex B (informative) Example of FMECA analysis for a wind turbine drive train	14
Annex C (informative) List of wind turbine components and their failure modes	17
Annex D (informative) Brief introduction to the concept of FMECA analysis	20
Bibliography	22

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 5, *Condition monitoring and diagnostics of machine systems*.

A list of all parts in the ISO 16079 series can be found on the ISO website.

Introduction

General

This document is the first in a series of International Standards covering the application of condition monitoring to wind turbines. It is an application of the recommendations and best practices described in the generic standards developed under ISO/TC 108.

Background

Power production from wind turbines is growing exponentially on the global energy market. As a consequence, predictability of the production from wind power plants has become as crucial as predictability of power production from conventional power plants. As for conventional power plants, an efficient maintenance programme for wind power plants adds significant value to the reliability and predictability of the supply of energy. An efficient condition monitoring system is an important part of such a programme in order to achieve the following:

- a) obtain predictability in power production, thus avoiding penalties from grid authorities if the quoted amount of power is not delivered;
- b) maintain the confidence of investors by providing a stable power production, thus motivating future investments;
- c) lower turbine maintenance costs by
 - 1) avoiding development of failures to a serious state,
 - 2) avoiding consequential or subsequent failures, and
 - 3) being able to plan service months ahead;
- d) reduce the through life cost by
 - 1) avoiding loss of availability,
 - 2) allowing continued operations under fault conditions (perhaps with appropriate restrictions), and
 - 3) supporting failure investigations to prevent repetitive events.

Condition monitoring, in general, requires:

- Reliable alarms. An alarm is triggered only when the confidence level of the diagnosis and prognosis is high. Wind turbines are placed in remote locations and many wind turbines are located offshore where access is limited and costly.
- An estimated time to failure. This is for supporting efficient maintenance planning and utilization of cranes, staff, ordering of spare parts, etc.
- Reliable descriptor measurements. In addition to self-excited forces, a wind turbine is also subject to environmental occurrences. The compact structure can cause measurement readings from one machine part to be affected by other machine parts.
- Detection of faulty monitoring. A working data acquisition system is the basis of a reliable monitoring systems. Any equipment can fail. It is essential that faulty equipment is detected to ensure a reliable condition monitoring process.
- Complex IT landscape. A monitoring system is required to monitor thousands of wind turbines connected to a central server via complex worldwide data networks. (This requirement is outside the scope of this document.)

Condition monitoring of wind turbines presents some challenges compared to condition monitoring of other machinery.

- Access to the nacelle is difficult and potentially dangerous and in many countries is not allowed during operation, so online systems are likely to be required for measurements which have traditionally used hand-held methods.
- Wind turbine loading varies significantly with time and cannot be influenced; some extra measures need to be taken to ensure repeatability of measurements.
- Self-excitation of the structures, extremes of ambient temperature and the likelihood of lightning strikes present a severe test of the robustness of all systems.
- Since wind turbines are often in remote locations, the monitoring systems need to be able to function in the face of loss of network connectivity.

Aims of the ISO 16079 series

This document and subsequent documents in the ISO 16079 series have the following aims:

- a) to allow manufacturers of wind turbines, operators of wind turbines and manufacturers of condition monitoring systems for wind turbines to share common concepts and terminology;
- b) to provide a methodology whereby users of this document can prioritize and select which components shall be monitored and which failure modes shall be detected, in order to obtain the most efficient condition monitoring system with regard to
 - 1) cost,
 - 2) detection capability,
 - 3) complexity of monitoring system and methods, and
 - 4) available resources and skill level of staff in the monitoring body.

It is NOT the intention of this document or subsequent documents in the ISO 16079 series to cover any aspects of safety monitoring systems.

Time-proven experience

The monitoring strategies presented in the ISO 16079 series are based on time-proven experience. Only conservative, well-proven methods and best practices are applied. This means that detection of certain failure modes may be left out if the behaviour of the failure modes and their related symptoms are not well-documented. As new monitoring techniques mature, this document will be updated accordingly.

Relation to the generic standards of ISO/TC 108

ISO 17359 is a parent standard of this document. It presents an overview of a generic procedure recommended to be used when implementing a condition monitoring programme and provides further details on the key steps to be followed. It introduces the concept of directing condition monitoring activities towards root cause failure modes and describes the generic approach to setting alarm criteria, carrying out diagnosis and prognosis and improving confidence in diagnosis and prognosis, which are developed further in other documents. Particular techniques of condition monitoring are introduced briefly.

The concept of condition monitoring itself and the measurement techniques involved are presented in other generalized condition monitoring guidelines such as ISO 13373 (all parts), ISO 13374 (all parts) and ISO 13379-1. Those guidelines are considered as foundations of this document. [Figure 1](#) illustrates how this machine-specific document is linked to other generic guidelines of condition monitoring and measurement techniques.

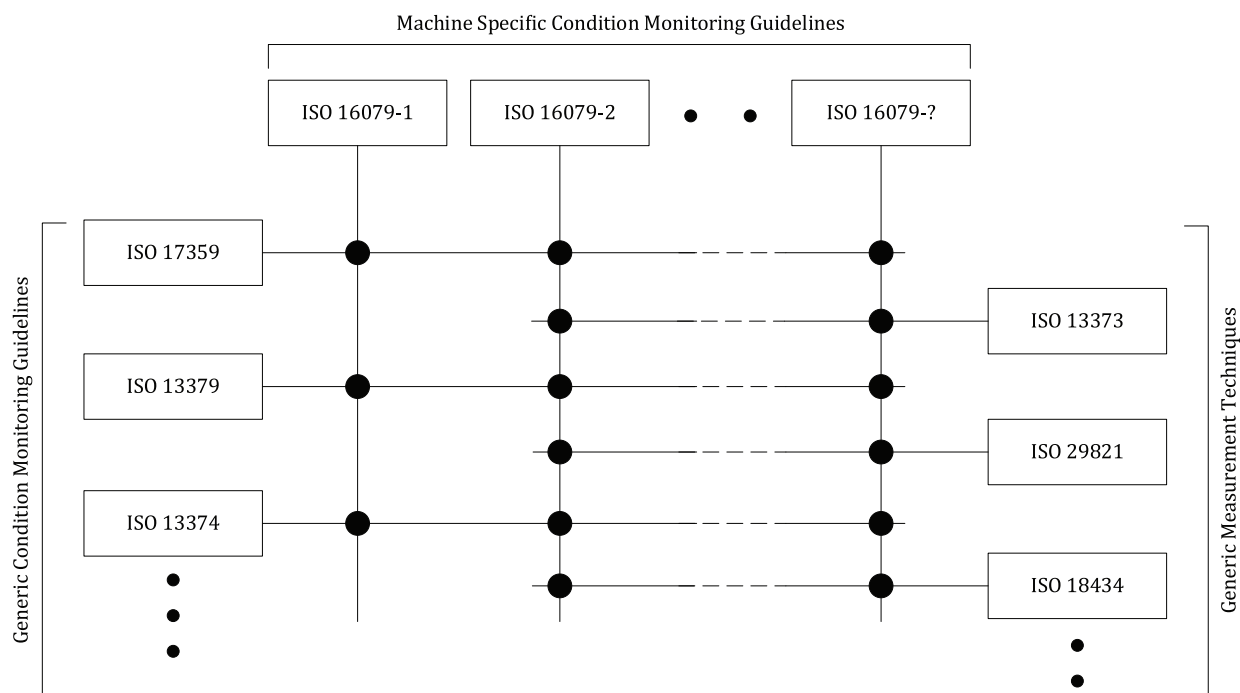


Figure 1 — Links between the machine-specific International Standards and the generic International Standards

Other documents and guidelines for wind turbines

The documents and guidelines listed here are not within the scope of this document. However, a brief introduction is relevant as they are often referenced.

- ISO 10816-21 [1] specifies broadband measurements to be applied for the evaluation of mechanical vibrations of wind turbine using zone boundaries. Examples of zone boundaries for onshore wind turbines below 3MW are provided in an annex. The aim of ISO 10816-21 is to standardize vibration measurements, to assist in their evaluation and to make possible a comparative evaluation of the vibration measured in wind turbines and their components. For long-term condition monitoring and diagnostics, more advanced techniques are required which are outside the scope of ISO 10816-21.
- IEC 61400-25-6 [10] in the IEC 61400-25 series specifies the information models related to condition monitoring for wind power plants and the information exchange of data values related to these models. The purpose of the ISO 16079 series is to define the descriptors for detection of various failure modes. IEC 61400-25-6 complements this document by specifying how to organize these descriptors in a data model.

A data model organizes data elements and standardizes how the data elements relate to one another. The data model allows a single computer program to retrieve wind turbine data from several different condition monitoring systems where the data model is implemented. IEC 61400-25-6 describes notation for identifying sensors and sensor locations, sensor types, operational states and proposes a systematic naming of descriptor types.

- The DNV·GL guideline [11] specifies requirements for the certification of condition monitoring systems for wind turbines and the associated monitoring bodies. The guideline specifies requirements to the documentation of the condition monitoring system and requirements to associated procedures which are applied by the staff of the monitoring body. The guideline specifies sensor location and required frequency ranges as well as requirements to the presence of certain analysis procedures. The guideline does not propose any requirements to which failure modes shall be detected, nor to the capability of measuring related descriptor types.

Relation to the ISO 55000 series

The requirement of the ISO 55000 series is straightforward and has a direct link to condition monitoring. An organization, a company, a wind power plant, etc. has a portfolio of assets. It has a corporate strategy that provides overall objectives for the entire organization. Those assets are intended to deliver part of those objectives. Effective control and governance of assets by organizations is essential to realize value through managing risk and opportunity, in order to achieve the desired balance of cost, risk and performance.

For a wind power plant, condition monitoring is a key risk-handling element of the asset management program by avoiding that wind turbines fail unexpectedly, keeping the cost of operation under control and ensuring a high performance.

Condition monitoring and diagnostics of wind turbines —

Part 1: General guidelines

1 Scope

This document gives guidelines which provide the basis for choosing condition monitoring methods used for failure mode detection, diagnostics and prognostics of wind power plant components.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 13372:2012, *Condition monitoring and diagnostics of machines — Vocabulary*

ISO 13379-1:2012, *Condition monitoring and diagnostics of machines — Data interpretation and diagnostics techniques — Part 1: General guidelines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041 and ISO 13372 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 alarm

operational signal or message designed to notify personnel when a selected *anomaly* (3.2) or a logical combination of anomalies, which requires a corrective action is encountered

[SOURCE: ISO 13372:2012, 4.2, modified — “requiring” has been replaced by “which requires”.]

3.2 anomaly

irregularity or abnormality in a system

[SOURCE: ISO 13372:2012, 4.4]