International Standard

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Condition monitoring and diagnostics of machines — Vibration condition monitoring —

Part 9: Diagnostic techniques for electric motors

Surveillance et diagnostic d'état des machines — Surveillance des vibrations —

Partie 9: Techniques de diagnostic pour moteurs électriques

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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 document 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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This second edition cancels and replaces the first edition (ISO 13373-9:2017), which has been technically revised.

The main changes are as follows:

— unused terms have been deleted;

— Table A.2 has been added;

— Clause A.2 with descriptions of tests related to Table A.1 and Table A.2 has been added;

— references have been updated;

— document has been editorially revised.

A list of all parts in the ISO 13373 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document has been developed as a guideline for the procedures to be considered when carrying out vibration diagnostics of electric motors. It is intended to be used by vibration practitioners, engineers and technicians and provides them with useful diagnostic tools. These tools include the use of diagnostic flowcharts, process tables and fault tables. The material contained in this document presents the most basic, logical and intelligent steps that should be taken when diagnosing problems associated with these types of machines.

The ISO 10816 series and ISO 20816 series contain acceptable vibration levels and zones for various types and sizes of machines, ranging from new and well-running to those that are in danger of failing.

ISO 13373-1 presents the basic procedures for carrying out vibration narrow-band signal analysis. It includes the types of transducers used, their ranges and their recommended locations on various types of machines, online and periodic vibration monitoring systems and the detection of potential machine problems.

ISO 13373-2 includes descriptions of the signal conditioning equipment that is required, time and frequency domain techniques and the waveforms and signatures that represent the most common machines operating phenomena or machine faults that are encountered when performing vibration signature analysis.

ISO 13373-3 sets out some procedures to determine the causes of vibration problems common to all types of rotating machines. It includes systematic approaches to characterizing vibration effects, the diagnostic tools available, which tools are needed for particular applications, and recommendations on how the tools are to be applied to different types of machines and components. However, this does not preclude the use of other diagnostic techniques.

ISO 17359 indicates that diagnostics

a) can be started as a succeeding activity after the detection of an anomaly during machine monitoring, or

b) can be executed synchronous with monitoring from the beginning.

This document considers only a) in which diagnostics is performed after an anomaly has been detected. Moreover, this document focuses mainly on the use of flowcharts, process tables, fault and symptom tables as diagnostic tools, since it is felt that these are the tools that are most appropriate for use by practitioners, engineers and technicians in the field.

The flowchart and diagnostic process table methodology presents a structured procedure for a person in the field to diagnose a fault and find its cause. This step-by-step procedure guides the practitioner through the vibration diagnostics of the machine anomaly in order to reach its probable root cause.

The fault and symptom tables present a list of the most common faults in machines, as well as their manifestation in the vibration data. When used with the flowcharts, the tables assist with the identification of machine faults.

When approaching a machine problem that manifests itself as a high or erratic vibration signal, the diagnosis of the problem should be done in a well-thought-out systematic manner. This document, together with ISO 13373-3, achieve that by providing the analyst guidance on the selection of the proper measuring tools, the analysis tools and their use and the step-by-step recommended procedures to diagnose problems associated with various types of electric motors.

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Condition monitoring and diagnostics of machines — Vibration condition monitoring —

Part 9: Diagnostic techniques for electric motors

1 Scope

This document specifies the procedures to be considered when carrying out vibration diagnostics of various types of electric motors. The four motor types covered by this document are

a) squirrel-cage induction,

b) wound-rotor induction,

c) salient-pole, and

d) DC.

NOTE Motor types a) and b) are defined in ISO 20958.

This document is mostly applicable to motors with power above 15 kW.

This document is intended to be used by condition monitoring practitioners, engineers and technicians and provides a practical step-by-step vibration-based approach to fault diagnosis. In addition, it gives several examples for a range of machine and component types and their associated fault symptoms.

The procedures presented in this document can, in some cases, be applied to other types of electrical machines, such as generators, but there can be other specific techniques associated with such machines that are not included in this document.

The use of non-vibration quantities, such as voltage and current, to identify and analyse vibration-related faults in electric motors is outside the scope of this document.

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, *Condition monitoring and diagnostics of machines — Vocabulary*

ISO 13373-1, *Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 1: General procedures*

ISO 13373-2, *Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 2: Processing, analysis and presentation of vibration data*

ISO 20958, *Condition monitoring and diagnostics of machine systems — Electrical signature analysis of three-phase induction motors*

ISO 21940-2, *Mechanical vibration — Rotor balancing — Part 2: Vocabulary*

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IEC 60050, *International Electrotechnical Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041, ISO 13372, ISO 20958, ISO 21940-2, IEC 60050 and the following apply.

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

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
DC motor
motor including shaft with laminated, slotted core into which a two-layer winding is installed and connected to a commutator which is supplied with DC power via brushes

3.2
salient-pole rotor
shaft with solid or laminated poles having a winding on each pole

Note 1 to entry: The pole windings are connected together and to sliprings or a brushless exciter from which the required DC power supply is applied.

3.3
supply frequency
line frequency
frequency of the power supply connected to AC motors

3.4
slip frequency
<induction motors> difference between the synchronous rotational speed and rotor rotational speed frequencies

3.5
number of stator poles
integer which is defined by the following formula:

$$120\, f_{supp}/n_{syn}$$

where

n_{syn} is the synchronous rotational speed, in r/min;
f_{supp} is the supply frequency, in Hz.

Note 1 to entry: The number of pole pairs is the number of poles divided by 2.

3.6
stator slot pass frequency
number of stator slots times the rotor rotational speed

3.7
rotor slot pass frequency
number of rotor slots times the rotor rotational speed

3.8
rotor bar pass frequency
number of bars in a squirrel-cage rotor times the rotor rotational speed

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