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Condition monitoring and diagnostics of machine systems — Prognostics —

Part 1: General guidelines and requirements

Surveillance et diagnostic des systèmes machines — Pronostic —
Partie 1: Lignes directrices générales et exigences

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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 5, *Condition monitoring and diagnostics of machine systems*.

This third edition cancels and replaces the second edition (ISO 13381-1:2015), which has been technically revised.

The main changes are as follows:

— update of definitions (for clarification purposes);

— revised data requirements;

— revised modelling types;

— revised failure modelling techniques (see Annex C);

— update of Bibliography.

A list of all parts in the ISO 13381 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

The complete process of machine condition monitoring consists of five distinct phases:

a) detection of problems (deviations from normal conditions);

b) diagnosis of the faults and their causes;

c) prognosis of future fault progression;

d) recommendation of actions;

e) post-mortems.

Machine health prognosis demands prediction of future machine integrity and deterioration so there can be no exactitude in the process. Instead, prognosis requires statistical or testimonial approaches to be adopted. Standardization in machine health prognosis therefore embodies guidelines, approaches, and concepts rather than strict procedures or standard methodologies.

Prognosis of future fault progressions requires foreknowledge of the probable failure modes, future duties to which the machine will or might be subjected, and a thorough understanding of the relationships between failure modes and operating conditions. This may require an understanding of the physics underlying the fault modes and demand the collection of previous duty and cumulative duty parameters, previous maintenance history, inspection results, run-to-failure data, trajectories and associated operational data, along with condition and performance parameters prior to extrapolations, projections and forecasts.

Prognosis processes need to be able to accommodate analytical damage models.

As computing power increases, and data storage decreases in cost, multiple-parameter analysis becomes more complex and modelling becomes more sophisticated. Thus, the ability to predict the progression of damage accumulation is achievable if the initiation criterion is known (expressed as a set of parameter values for a given mode) in addition to future behaviour for a given set of conditions.

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Condition monitoring and diagnostics of machine systems — Prognostics —

Part 1: General guidelines and requirements

1 Scope

This document provides guidance and requirements for the development and application of prognosis processes. It is intended to

a) allow developers, providers, users and manufacturers to share common concepts of prognostics,

b) enable users to determine the data, characteristics, processes and behaviours necessary for accurate prognosis,

c) outline appropriate approaches and processes to prognostics development, and

d) introduce prognostics concepts in order to facilitate future systems and training.

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

ISO 17359, *Condition monitoring and diagnostics of machines — 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.

3.1
prognosis
estimation of time to failure and risk for one or more incipient failure modes

[SOURCE: ISO 13372:2012, 10.2]

3.2
prognostics
analysis of the symptoms of faults to predict future condition and residual life within design parameters

[SOURCE: ISO 13372:2012, 1.15]

Note 1 to entry: Prognostics refers to the process of prediction whereas prognosis refers to the outcome.

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3.3
confidence level
figure of merit (e.g. percentage) that indicates the degree of certainty that the diagnosis and/or *prognosis* (3.1) is correct

Note 1 to entry: This figure essentially represents the cumulative effect of error sources on the final certainty or confidence in the accuracy of the outcome. Such a figure can be determined algorithmically or by a weighted assessment system.

3.4
root cause
set of conditions or actions that occur at the beginning of a sequence of events that result in the initiation of a failure mode

[SOURCE: ISO 13372:2012, 8.9]

3.5
failure modes and effects criticality analysis
FMECA
FMEA with a criticality classification process based on the severity of the faults

Note 1 to entry: This is in comparison with the criticality thresholds.

Note 2 to entry: A FMECA procedure is also outlined in IEC 60812[3].

[SOURCE: ISO 13372:2012, 8.3]

3.6
failure mode symptoms analysis
FMSA
process based on the FMECA that documents the symptoms produced by each failure mode and the most effective detection and monitoring techniques to be used to develop and optimize a monitoring programme

Note 1 to entry: This process shall be in accordance with ISO 13379-1.

3.7
estimated time to failure
ETTF
estimation of the period from the current point in time to the point in time where the monitored machine will fail

Note 1 to entry: Defined in Figure 2.

3.8
remaining useful life
RUL
remaining time before system health falls below a defined failure threshold

3.9
predictive horizon
threshold for the prediction of time to failure as desired by the user

4 Data requirements

4.1 The data requirements for condition monitoring shall be in accordance with ISO 17359 and shall form the basis for the prognostic process and its pre-requisites. Prognostics may also require the collection of documented data covering:

a) the original design specification and final design;

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