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Condition monitoring and diagnostics of machines — General guidelines

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 17359 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 5, *Condition monitoring and diagnostics of machines*.

Introduction

This International Standard provides guidance for condition monitoring and diagnostics of machines. It is the parent document of a group of standards which cover the field of condition monitoring and diagnostics. It sets out general procedures to be considered when setting up a condition monitoring programme for all machines, and includes references to other International Standards and other documents required or useful in this process.

This International Standard presents an overview of a generic procedure recommended to be used when implementing a condition monitoring programme, and provides further detail 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 the confidence in diagnosis and prognosis, which are developed further in other International Standards.

Particular techniques of condition monitoring are only introduced briefly, and are covered in more detail in other International Standards referenced in the Bibliography.

Condition monitoring and diagnostics of machines — General guidelines

1 Scope

This International Standard sets out guidelines for the general procedures to be considered when setting up a condition monitoring programme for machines, and includes references to associated standards required in this process. It is applicable to all machines.

2 Normative references

The following referenced documents are indispensable for the application 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 1925, *Mechanical vibration — Balancing — Vocabulary*

ISO 2041, *Vibration and shock — Vocabulary*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1925, ISO 2041, ISO 13372 and the following apply.

3.1
equipment
machine or group of machines including all machine or process control components

3.2
fault
〈in a machine〉 condition occurring when any of the components of a machine or their assembly is degraded or exhibits abnormal behaviour

NOTE This may lead to failure of the machine.

3.3
failure
〈of a machine〉 condition occurring when one or more of the principle functions of a machine are no longer available

NOTE This generally happens when one or more of its components is in a fault condition.

4 Overview of condition monitoring procedure

A generic procedure which may be used when implementing a condition monitoring programme is described, and further details on the key steps to be followed is provided. Condition monitoring activities should be directed towards identifying and avoiding root cause failure modes.

Particular techniques of condition monitoring are only introduced briefly, and are covered in more detail in other International Standards referenced in the Bibliography.

A typical condition monitoring programme flowchart is shown in Figure 1. The sections of the flowchart are detailed in Clauses 5 to 10.

5 Equipment audit

5.1 Identification of equipment

List and clearly identify all equipment and associated power supplies, control and existing surveillance systems.

5.2 Identification of equipment function

Identify the following information.

— What is the equipment required to do?

— What are the operating conditions?

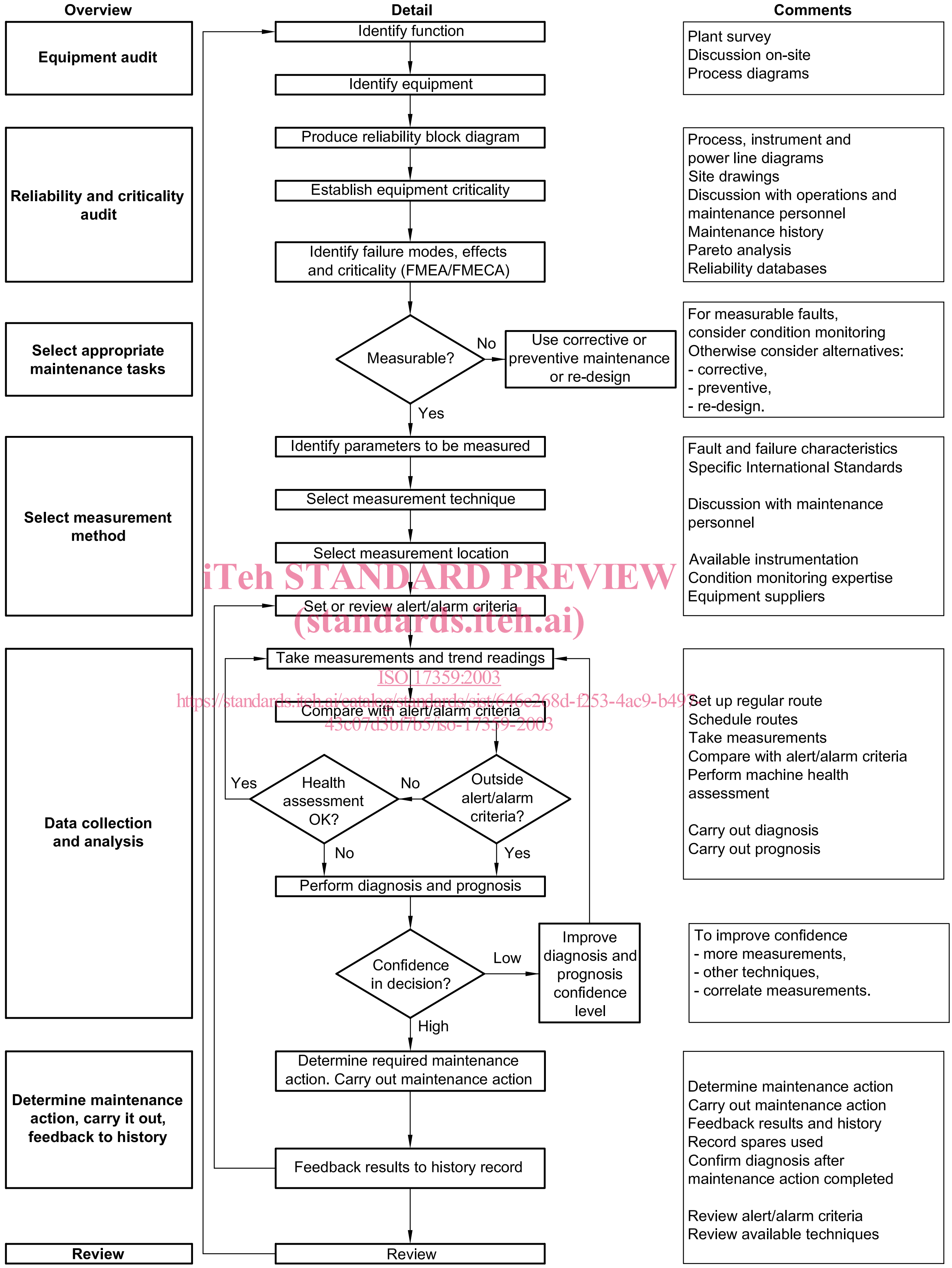

Figure 1 — Condition monitoring procedure flowchart

6 Reliability and criticality audit

6.1 Reliability block diagram

It can be useful to produce a simple high-level reliability block diagram, including whether the equipment has a series or parallel reliability effect. The use of reliability and availability factors is recommended to improve the targeting of the condition monitoring processes.

Detailed information on producing reliability block diagrams is contained in references in the Bibliography.

6.2 Equipment criticality

A criticality assessment of all machines is recommended in order to create a prioritized list of machines to be included (or not) in the condition monitoring programme. This may be a simple rating system based on factors such as

— cost of machine down-time or lost production costs,

— failure rates and mean time to repair,

— consequential or secondary damage,

— replacement cost of the machine,

— cost of maintenance or spares,

— life-cycle costs,

— cost of the monitoring system, and

— safety and environmental impact.

One or more of the above factors may be weighted and included in a formula to produce the prioritized list.

The results of this process may be used when selecting methods of monitoring (see 8.1).

6.3 Failure modes, effects and criticality analysis

It is recommended to perform a failure modes and effects analysis (FMEA) or failure mode effect and criticality analysis (FMECA) in order to identify expected faults, symptoms and potential parameters to be measured which indicate the presence or occurrence of faults.

The FMEA and FMECA audits will produce information on the range of parameters to be measured for particular failure modes. Parameters to be considered are generally those which will indicate a fault condition either by an increase or decrease in the overall measured value, or by some other change to a characteristic value such as pump or compressor curves, reciprocating internal combustion engine pressure-volume curves and other efficiency curves.

Examples of measured parameters which it may be useful to consider for a range of typical machine types are given in Annex A.

Annex B contains an example of a form (Table B.1) which can be completed for each machine type, linking each fault to one or more symptoms or measured parameters showing the occurrence of the fault. A completed example is also included in Table B.2.

References to more detailed methods of carrying out FMEA and FMECA are given in the Bibliography.

Guidance on the selection of performance parameters which may be useful to indicate faults for a range of machine types is contained in ISO 13380.

6.4 Alternative maintenance tasks

If the failure mode does not have a measurable symptom, alternative maintenance strategies may have to be applied. These include corrective maintenance, preventive maintenance or modification (design out).

7 Measurement method

7.1 Measurement technique

For the particular measurable parameter considered to be applicable following the previous selection process, one or more measurement techniques may be appropriate. Annex A shows a range of parameters measurable using appropriate measurement techniques.

Condition monitoring systems can take many forms. They may utilize permanently installed, semi-permanent, or portable measuring instrumentation, or may involve methods such as sampling fluids or other materials for local or remote analysis.

7.2 Accuracy of monitored parameters

In most cases, the accuracy required of the measured parameters to be used for machine condition monitoring and diagnosis is not necessarily as absolute as the accuracy which may be required for other measurements such as performance testing. Methods using trending of values can be effective where repeatability of measurement is more important than absolute accuracy of measurement. Correction of measured parameters, for example to standard conditions of pressure and temperature, is not necessarily required for routine condition monitoring.

7.3 Feasibility of measurement

Consideration should be given to the feasibility of acquiring the measurement, including ease of access, complexity of required data acquisition system, level of required data processing, safety requirements, cost, and whether surveillance or control systems exist which are already measuring parameters of interest. It is recommended that the complete machine system be included in the decision and monitoring process.

7.4 Operating conditions during measurements

If possible, monitoring should be carried out when the machine has reached a predetermined set of operating conditions (e.g. normal operating temperature) or, for transients, a predetermined start and finish condition and operating profile (e.g. coast down). These are also conditions which may be used for a specific machine configuration to establish baselines. Subsequent measurements are compared to the baseline values to detect changes. The trending of measurements is useful in highlighting the development of faults.

7.5 Measurement interval

Consideration should be given to the interval between measurements, and whether continuous or periodic sampling is required. The measurement interval primarily depends on the type of fault, its rate of progression (and thus the rate of change of the relevant parameters). However, the measurement interval is also influenced by factors such as duty cycles, cost and criticality.

7.6 Data acquisition rate

For steady-state conditions, the data acquisition rate should be fast enough to capture a complete set of data before conditions change. During transients, high-speed data acquisition may be necessary.

