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Condition monitoring and diagnostics of machines — General guidelines on using performance parameters

Surveillance et diagnostic d'état des machines — Recommandations générales sur l'utilisation des paramètres de performance

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13380 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 5, *Condition monitoring and diagnostics of machines*.

Annexes A to D of this International Standard are for information only.

Introduction

This International Standard provides guidance for condition monitoring and diagnostics of machines using parameters such as temperatures, flow rates, contamination, power and speed, typically associated with performance, condition, safety and quality criteria. The evaluation of machine function and condition may be based on performance, condition, product quality or safety.

It is part of a series of standards developed under the general title *Condition monitoring and diagnostics of machines*.

Condition monitoring and diagnostics of machines — General guidelines on using performance parameters

1 Scope

This International Standard describes the general conditions and procedures for recording, assessment, evaluation and diagnostics of machine condition by measuring parameters related to machine performance, condition and safety, including thermal, electrical and hydraulic parameters where applicable.

The procedures relate to operational monitoring of machines, and include all components and sub-assemblies necessary to provide the functional operation of the machine.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1925, *Mechanical vibration — Balancing — Vocabulary*

ISO 2041, *Vibration and shock — Vocabulary*

ISO 13379, *Condition monitoring and diagnostics of machines — General guideleines on data interpretation and diagnostic techniques*

3 Terms and definitions

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

NOTE A terminology standard for condition monitoring and diagnostics of machines (ISO 13372) is in course of preparation.

3.1
fault
⟨in a machine⟩ condition of a machine when any of its components or their assembly is degraded or exhibits an abnormal behaviour

NOTE This may lead to failure of the machine.

3.2
failure
⟨of a machine⟩ condition of a machine when one or more of its principle functions are no longer available

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

3.3
performance
〈of a machine〉 capability of a machine defined by one or more characteristic quantities such as power, flow, efficiency or speed

NOTE Performance is derived by measurement and calculation of one or more parameters which singly or together provide information on the characteristic quantity. Performance characteristics are reference quantities or envelopes.

3.4
baseline
parameters or derived quantities made under specific equipment configurations and specified operating conditions

NOTE They can be stored or kept as reference values or characteristic profiles. These reference values are called baselines.

3.5
machine
device using or applying mechanical power

3.6
compressor
machine or component which increases the pressure of the working fluid

NOTE This can be a rotating or reciprocating machine with one or more stages.

3.7
turbine
component which produces power from the expansion of the working fluid

3.8
gas turbine
machine which converts thermal energy of a combustion gas into mechanical work

NOTE It consists of one or several rotating compressors, one or more thermal devices which heat the working fluid, one or more turbines, a control system and essential auxiliary equipment. Any heat exchangers (excluding waste heat recovery exchangers) in the main working fluid circuit are considered to be part of the gas turbine.

3.9
gas generator
assembly of gas turbine components which produces heated pressurized gas to a process or to a power turbine

NOTE It consists of one or more rotating compressors, one or more thermal devices heating the working fluid, one or more compressor-driven turbines, a control system and essential auxiliary equipment.

3.10
gas turbine power plant
gas turbine and all essential equipment necessary for the production of power in a useful form (e.g. electrical, mechanical or thermal)

3.11
steam turbine
machine which converts thermal energy of steam into mechanical work

NOTE It consists of one or more turbines, a control system and essential auxiliary equipment.

3.12
electric motor
machine which converts electrical energy into mechanical work

NOTE It consists of one or more rotors and stators, a starting and control system, and essential auxiliary equipment.

3.13
pump
component which increases the pressure of the working fluid

NOTE It consists of a mechanical work input coupling and one or more rotors.

3.14
RIC engine
reciprocating internal combustion engine
machine which converts chemical energy into rotational mechanical work

NOTE It consists of one or more pistons and cylinders arranged in Vee, in-line or horizontally opposed configurations connected to one or more crankshafts and an output coupling, a starting and control system and essential auxiliary equipment.

3.15
generator
rotating machine which converts mechanical work into electrical energy

NOTE It consists of a mechanical work input coupling, one or more rotors and stators, excitation equipment, a starting and control system and essential auxiliary equipment.

4 Monitored parameters

4.1 Type of parameters

A large range of performance parameters can be measured for the purposes of establishing performance criteria, both for acceptance testing and for through-life monitoring. The parameters to be considered are those which will indicate a fault condition either by an increase or decrease in overall measured value, or by some other change to a characteristic value, such as pump or compressor performance curves, reciprocating internal combustion engine pressure-volume curves or other performance curves.

4.2 Type of measurement

Measured parameters can be simple measurements of overall values, or values averaged over time. For certain parameters, such as current, voltage and vibration, simple measurements of overall values may not be sufficient to show the occurrence of a fault. Techniques such as spectral and phase measurement may be required to reveal changes caused by faults.

Examples of performance parameters useful to consider for a number of machine types are given in annex A. Examples of standards which may be useful to identify particular measurement methods and parameters for different machine types are included in the Bibliography.

4.3 Accuracy of monitored parameters

The accuracy required of performance parameters to be used for machine condition monitoring and diagnosis is not so absolute as the accuracy which may be required for performance measurement. Methods utilizing 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 ISO standard conditions of pressure and temperature, is not necessarily required for gas turbines for routine condition monitoring. Where this is required, advice is given in the appropriate acceptance testing standard; a list of some typical standards is included in the Bibliography.

4.4 Other causes of change to measured values

Measured values and baselines can change due to maintenance work, including component change, adjustment or duty change. In certain cases the baseline may need to be re-established following such changes.

It should be noted that changes in measured values can also be due to normal or controlled changes in the operating conditions, and do not necessarily indicate a fault condition.

5 Measurement procedure

5.1 Feasibility of measurement

Consideration should be given to the practicability of measuring the parameters, and whether surveillance or control systems exist which are already measuring parameters of interest. Examples of faults, and the parameters to be measured to detect them, are given by machine type in annex C. Although presented by machine type, it is recommended that the complete machine train be included in the decision and monitoring process.

5.2 Operating conditions during measurements

Measurements of different parameters should be taken wherever possible at the same time, or under the same operating conditions. For variable duty or variable speed machines, it may be possible to achieve similar measurement conditions by varying speed, load or some other control parameter.

Monitoring should be taken where possible 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.

5.3 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 and 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.

5.4 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.

5.5 Record of monitored parameters

Records of monitored parameters should include as a minimum the following information:

— essential data describing the machine;

— the measurement position;

— the measured quantity units and processing; and

— date and time information.

Other information useful to allow comparison include details of the measuring systems used, and the accuracy of each measuring system. It is recommended that details of machine configuration and any component changes are also included. Annex B gives typical information which should be recorded when monitoring. An example of a typical recording format is shown for information in annex D.

6 Fault diagnosis

6.1 Procedure for fault diagnosis

The possibility of carrying out fault diagnosis will depend on the machine type, configuration and operating conditions. A fault may be indicated by a change in one or more of the measured or derived parameters from the baseline values. For fault diagnosis procedures, see ISO 13379.

6.2 Criteria for fault diagnosis

The following methods may be used to perform fault diagnosis:

a) experience with similar machines, or by statistical analysis;

b) studies of deviations from required minimum or maximum values;

c) discussions between the manufacturer and customer.

For the machine types shown at annex A, examples of faults and their associated symptoms or measured parameters are given for each machine type considered in annex C. As and when circumstances permit, further examples of machine type and faults shown by performance parameter monitoring may be added to this International Standard. Until such time, fault parameter identification may be found using experience or the results of operation, and the interpretation should be agreed between the manufacturer and customer.