
**Mechanical vibration and shock —
Performance parameters for condition
monitoring of structures**

*Vibrations et chocs mécaniques — Paramètres de performance pour la
surveillance des structures*

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ISO 16587:2004

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Foreword

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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 16587 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*.

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Introduction

This International Standard provides general guidelines for the condition monitoring of structures, using parameters typically used to measure or monitor structure performance, such as displacement, strain, vibration, settlement, rotation, temperature, and foundation pore pressure.

It has been structured to be consistent with ISO 13380 and ISO 17359 in order to facilitate a consistent approach to the condition monitoring of systems.

The information provided in this International Standard will be supplemented by ISO 18431 which will be published in several parts.

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Mechanical vibration and shock — Performance parameters for condition monitoring of structures

1 Scope

This International Standard describes the performance parameters for assessing the condition of structures, including types of measurement, factors for setting acceptable performance limits, data acquisition parameters for constructing uniform databases, and internationally accepted measurement guidance (e.g. terminology, transducer calibration, transducer mounting and approved transfer function techniques).

The procedures relate to in-service monitoring of structures, and include all components and sub-assemblies necessary to provide the functioning of the structure as a complete entity. The monitoring is intended to be ongoing in nature through the lifecycle of the structure.

NOTE 1 Figure 1 is a flowchart showing how this International Standard takes the user from the initial client need for condition monitoring of structures through to the point where the corresponding performance parameters have been chosen. Subsequent standards will deal with how these parameters are measured and processed.

This International Standard presupposes that a “high level” need for condition monitoring of structures already exists.

NOTE 2 Some useful guidance on identifying this need by the use of asset identification and reliability/criticality audits, is contained in ISO 17359.

The target industries for this International Standard include

- construction,
- infrastructure,
- transportation,
- power generation,
- oil and gas, and
- leisure and entertainment.

This International Standard is applicable to stationary structures, such as

- buildings,
- bridges and tunnels,
- towers, masts and antennae,
- tanks and silos,
- retaining walls and dams,

- jetties and other shore-side structures,
- offshore platforms,
- pressure vessels, and
- pipelines.

Non-stationary structures (e.g. self-propelled ships) and mobile structures (e.g. offshore jack-up platforms) are excluded from this International Standard.

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 2041:1990, *Vibration and shock — Vocabulary*

3 Terms and definitions

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

3.1 defect
structural defect
event occurring when the condition of any of the components of a structure or their assembly is degraded or exhibits abnormal behaviour

NOTE This may lead to failure of the structure.

3.2 failure
structural failure
termination of the ability of a structure to perform its required function

NOTE This generally happens when one or more of the components of a structure are in a defective condition, either at a service or ultimate limit state. Also, failure is an event as distinguished from fault, which is a state.

3.3 performance parameter
structural performance parameter
one or more characteristic quantities such as displacement, strain, velocity, settlement, rotation and acceleration

NOTE Performance is derived by measurement and calculation of one or more parameters, which singly or together provide information on the characteristic quantity. Performance may be described in terms of static, quasi-static or dynamic parameters, depending on the type of loading being experienced.

3.4 baseline values
parameters or derived quantities, determined under specific loading configurations and specified environmental conditions, which may be stored or kept as reference values or characteristic profiles

NOTE Baseline values are normally strongly dependent on temperature.

3.5**structure****stationary structure**

stationary engineering artefact

EXAMPLES

- land-based structure, such as a building or bridge;
- coastal structure, such as a jetty;
- offshore structure, such as a fixed oil production platform and pipelines.

3.6**limit state**

boundary of a domain within which the structure is assumed to satisfy the design criteria

NOTE Limit states are classified into ultimate limit states and service limit states.

3.7**ultimate limit state**

state associated with collapse or with other forms of structural failure, which may endanger structural safety

NOTE The passage of an ultimate limit state is considered to cause failure.

3.8**service limit state**

state associated with specified service criteria for normal use

NOTE In the case of permanent damage or permanent unacceptable deformations, the first passage of a service limit state is irreversible and is considered to cause failure. In other cases (such as temporary damage, temporary deformations or vibrations), the passage of a service limit state may be reversible and then a passage of a limit state does not always cause failure.

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4 Monitored parameters and limits**4.1 Type of performance parameter**

A large range of performance parameters may 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 defect condition either by an increase or decrease in overall measured value, or by some other change to a characteristic value. The parameters may be either quasi-static (varying with time relatively slowly) or dynamic (varying with time relatively rapidly) in nature. The parameters may be identified with the assistance of reliability/criticality audits. Examples include displacement, strain, vibration, temperature, and stress waves.

Condition monitoring of structures will usually be carried out at the serviceability limit state. Any extrapolation to ultimate limit state performance requires careful consideration.

4.2 Type of measurement and diagnosis

Examples of performance parameters, and measurement transducers and systems, useful to consider for a number of structure types are given in Annex A. Measurement transducers and systems shall be appropriately calibrated (for example in accordance with the relevant part of ISO 5347 or ISO 16063), mounted (for example in accordance with ISO 5348) and experimentally determined (for example in accordance with ISO 7626). When monitoring structures, features must be extracted from the measured performance parameters. These may be overall values, or values averaged over time in simple cases. In most cases, these simple features or descriptors are not useful as symptoms for the occurrence of defects. Signal-processing techniques may be

required to reveal changes caused by emerging defects. These data-processing techniques, which are diagnostic in nature, include narrow-band vibration analysis, transfer-function analysis (e.g. mechanical mobility), broad-band vibration analysis, structural-damping analysis (both time domain and spatial domain), mechanical power-flow, complex wave number analysis, etc.

Condition monitoring systems can take many forms. They can utilize permanently installed, semi-permanent or portable measuring instrumentation, or can involve methods for remote or local analysis.

4.3 Measurement uncertainty of monitored parameters

The measurement uncertainty (accuracy) required of monitored parameters to be used for structure condition monitoring and diagnosis is not so absolute as the accuracy that may be required for performance measurement. Methods utilizing trending of values can be effective when 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 routine condition monitoring. Where this is required, advice is given in the appropriate acceptance testing standard. It should be noted, however, that some parameters can be strongly dependent on temperature.

4.4 Sources of error and uncertainty

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

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

Examples of error and uncertainty include calibration uncertainties, uncertainty induced by transducer mounting, instrumentation measurement uncertainty, and uncertainty in calibration from environmental effects on measurement systems. Such errors and uncertainties can be minimized by the proper application of standards such as ISO 5347, ISO 5348, ISO 7626 and ISO 16063.

4.5 Factors affecting the setting of limits

As may be seen from Figure 1, the acceptable limits should be chosen by suitably experienced personnel, based on the following:

- design, construction, operation and maintenance codes, standards and criteria;
- type and magnitude of loading;
- service limit state and ultimate limit state characteristics;
- anticipated structural failure modes, either based on experience or on finite element models.

Many of the chosen limits may be preliminary, and may have to be improved iteratively after a period of monitoring (“trial and error”).

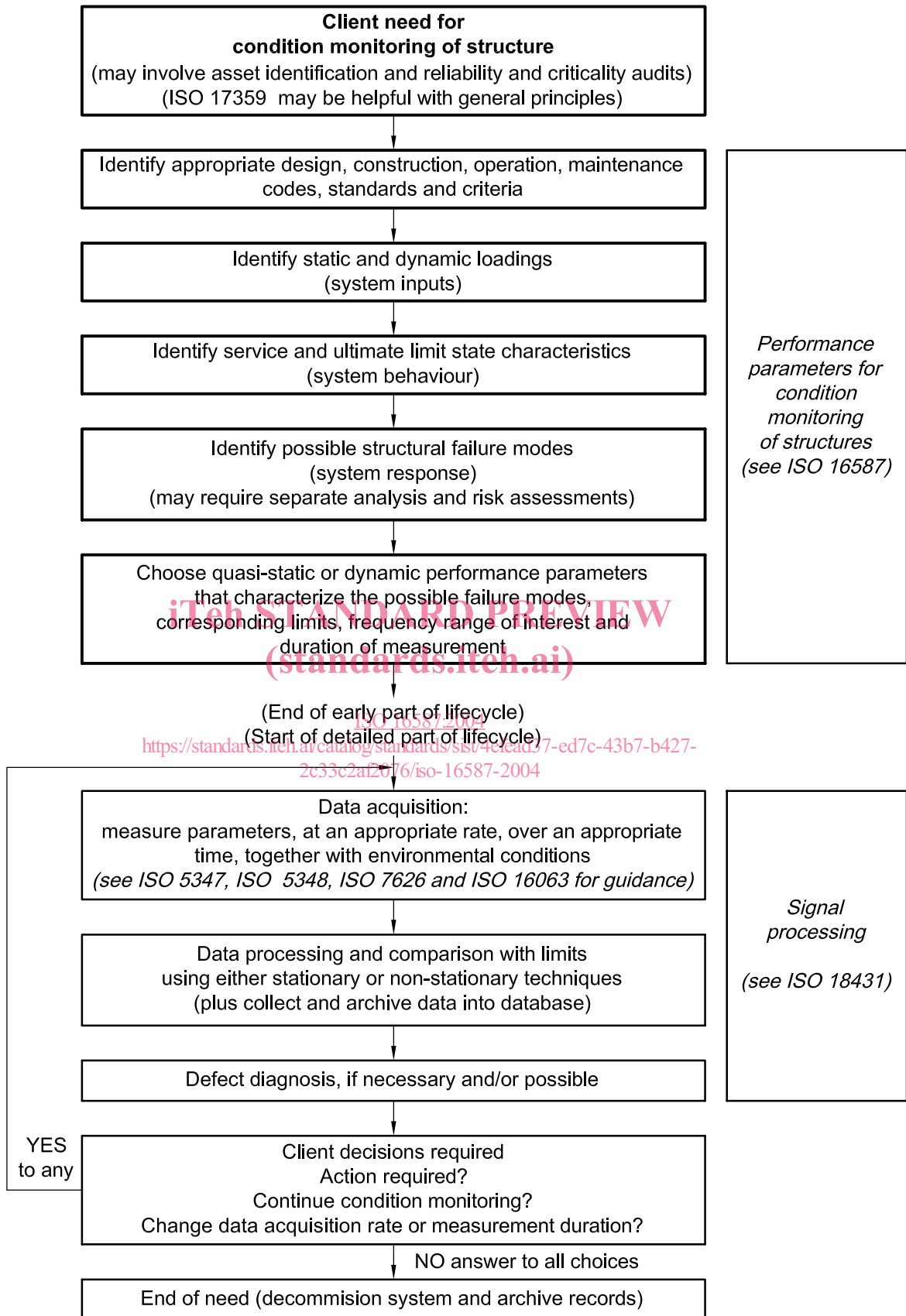


Figure 1 — Flowchart illustrating an idealized condition-monitoring lifecycle