BS ISO 18436-2:2014

BSI Standards Publication

Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel

Part 2: Vibration condition monitoring and diagnostics

bsi.

...making excellence a habit.™

Document Sharing Hub

Full document details: BS ISO 18436-2:2014

National foreword

This British Standard is the UK implementation of ISO 18436-2:2014. It supersedes BS ISO 18436-2:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GME/21/7, Mechanical vibration, shock and condition monitoring - Condition monitoring.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2014. Published by BSI Standards Limited 2014

ISBN 978 0 580 66383 3

ICS 03.100.30; 17.160

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2014.

Amendments issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 18436-2:2014

INTERNATIONAL STANDARD

ISO 18436-2

Second edition
2014-05-01

Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel —

Part 2: Vibration condition monitoring and diagnostics

Surveillance et diagnostic d'état des machines — Exigences relatives à la qualification et à l'évaluation du personnel —

Partie 2: Surveillance des vibrations et diagnostic d'état des machines

Reference number
ISO 18436-2:2014(E)

Documents
Document Sharing Hub

© ISO 2014

Full document details: BS ISO 18436-2:2014

COPYRIGHT PROTECTED DOCUMENT

© ISO 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

© ISO 2014 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 18436-2:2014

Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Classification of personnel **1**
4.1 General 1
4.2 Category I 2
4.3 Category II 2
4.4 Category III 3
4.5 Category IV 4
5 Eligibility **4**
5.1 General 4
5.2 Education 4
5.3 Training 5
5.4 Experience 5
6 Examination **6**
6.1 Content 6
6.2 Examination conduct 6
Annex A (normative) **Training course requirements** **7**
Annex B (normative) **Applicable International Standards** **34**
Bibliography **36**

© ISO 2014 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 5, *Condition monitoring and diagnostics of machine systems*.

This second edition cancels and replaces the first edition (ISO 18436-2:2003), of which it is a minor revision.

ISO 18436 consists of the following parts, under the general title *Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel*:

— *Part 1: Requirements for assessment bodies and the assessment process*

— *Part 2: Vibration condition monitoring and diagnostics*

— *Part 3: Requirements for training bodies and the training process*

— *Part 4: Field lubricant analysis*

— *Part 5: Lubricant laboratory technician/analyst*

— *Part 6: Acoustic emission*

— *Part 7: Thermography*

— *Part 8: Ultrasound*

The following part is planned:

— *Part 9: Condition monitoring specialists*

© ISO 2014 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

Introduction

Non-intrusive technologies used in condition monitoring and fault diagnosis include vibration, infrared thermography, oil and wear debris analysis, acoustic and ultrasonic analysis, and electric signature analysis.

Those in manufacturing industry who have diligently and consistently applied these techniques have experienced a return on investment far exceeding their expectations. However, the effectiveness of these programmes depends on the capabilities of individuals who perform the measurements and analyse the data.

A programme, specified in this part of ISO 18436, has been developed to train and assess the competence of personnel whose duties require the appropriate theoretical and practical knowledge and relevant experience in VA for machinery condition monitoring and diagnostics.

This part of ISO 18436 defines the requirements against which personnel associated with vibration measurement and analysis for machinery condition monitoring and diagnostics are to be assessed, and the methods of assessing such personnel. Applicants should be aware that employers and customers are likely to have the greatest confidence in those vibration analysts certified by accredited bodies. Alternately, applicants can choose to seek recognition from other party assessment bodies which may provide the next lower level of confidence. Lastly, applicants may rely upon their own self-assessment and declaration of competence but in doing so they should be aware that employers and customers are likely to have the least confidence in this option.

© ISO 2014 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

Documents
Document Sharing Hub

INTERNATIONAL STANDARD ISO 18436-2:2014(E)

Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel —

Part 2: Vibration condition monitoring and diagnostics

1 Scope

This part of ISO 18436 specifies requirements for the training, relevant experience, and examination of personnel performing condition monitoring and diagnostics of machines using vibration analysis (VA).

A certificate or declaration of conformity to the requirements of this part of ISO 18436 in accordance with ISO 18436-1, provides recognition and evidence that individuals are able to perform vibration measurements and analysis for machinery condition monitoring and diagnostics using a range of vibration measurement equipment.

This part of ISO 18436 specifies a four-category classification programme that is based on the technical areas delineated herein.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *Mechanical vibration, shock and condition monitoring — Vocabulary*

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

ISO 18436-1, *Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel — Part 1: Requirements for assessment bodies and the assessment process*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1925, ISO 2041, ISO 13372, , and ISO 18436-1 apply.

4 Classification of personnel

4.1 General

Depending upon their competence in VA, individuals meeting the requirements of this part of ISO 18436 shall be classified in one of four categories (4.2 to 4.5). They shall have demonstrated competence appropriate to their classification category as indicated in Annex A, in the concepts of machine condition monitoring using VA.

The classification of individuals at all categories shall be subject to the scope and any limitations of the award issued by the assessing body. Authority to work shall be limited or specified by the employer, or

© ISO 2014 – All rights reserved

AVA Documents Document Sharing Hub

Full document details: BS ISO 18436-2:2014

client. Individuals shall provide recommendations based on the limits of their training and experience. This declaration shall not allow a practitioner to make recommendations or give advice that may affect plant design, safety or operation without discussion with, and approval from, the appropriate plant specialist, manager or operator. The limits of the practitioner are specified in this clause whereas the limits of liability shall be agreed between the practitioner and their employer or client.

The classification category of the practitioner and any requirements for additional knowledge to work with specific equipment shall be subject to agreement between the customer and service supplier. This qualification shall provide the practitioner with sufficient knowledge to be able to make measurements and interpret data as appropriate for their category. In addition, the applicability of the qualification to a particular specialized machine type or types should be verified by the client through reference to the previous experience and training of the practitioner. It is recognized that different industrial applications require knowledge of varying aspects of VA. Using supporting documented evidence, the supplier of the VA service shall be able to demonstrate to the employer or client, that staff carrying out work has the appropriate machine knowledge and experience.

Where an individual has specialized knowledge in a particular concept of VA or in specific types of machinery, they may be capable, when approved by the client or employer, of working beyond their qualification classification category. Their certificate or declaration of conformity from the assessment body shall remain as it was at the time it was issued.

In 4.2 to 4.5, an outline is given of the typical competencies and skills required in each category. Detailed recommended topics and sub-topics are shown in Tables A.1 and A.2

4.2 Category I

Personnel classified to category I are able to perform a range of pre-defined, generally simple single-channel, machinery vibration condition monitoring activities in accordance with established procedures. All activities shall be performed under direction.

Personnel classified to category I shall at least:

a) know of the basic principles of vibration and recognize the different units of measurement;

b) be able to collect reliable data ensuring appropriate standards of repeatability;

c) be able to identify errors in collected data;

d) be able to retrieve pre-defined measurement settings for use with VA equipment and transfer data from an analysis system to a computer-based system;

e) be able to compare overall or single-value vibration measurements against pre-established alert settings;

f) be able to identify deviations from the norm for single-value vibration values and trends;

g) report on visual observations of equipment condition.

They shall not be responsible for:

— the choice of sensor, test method or technique or for any analysis or diagnosis to be conducted;

— the assessment of test results, other than identifying conditions against pre-established criteria, such as acceptance, alert, alarm, shutdown, etc.

4.3 Category II

Personnel classified to category II are able to perform industrial machinery vibration measurements and basic VA using single-channel measurements, with or without phase trigger signals, according to

© ISO 2014 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

established and recognized procedures. They require all the knowledge, experience and skills expected of category I, and in addition they shall at least:

a) be able to define the measurement activities to be undertaken by a category I individual in the course of routine data collection;

b) be aware of and capable of using the basic principles of signal analysis and, as such, can define acquisition and analysis settings to collect data appropriate to the machine(s) monitored;

c) be able to perform basic (single-channel) impact tests to determine natural frequencies;

d) be able to interpret and evaluate test results from routine analysis and acceptance tests in accordance with specifications and standards;

e) be able to diagnose common fault indications and recommend basic corrective actions commensurate with their area of machinery experience including carrying out single-plane balancing of rigid rotors with or without phase;

f) be able to provide technical guidance to and instruct category I personnel.

4.4 Category III

Personnel classified to category III require all the knowledge, experience and skills expected of personnel classified to categories I and II, and in addition shall at least:

a) be able to design, direct and establish routine condition monitoring programmes and non-routine investigations for the purpose of fault diagnosis;

b) be able to specify the appropriate vibration instrumentation hardware, software, and processing for portable monitoring systems, permanently installed surveillance systems, and equipment protection systems

c) have an in-depth knowledge of the principles and techniques of machinery VA and be able to make initial diagnoses of suspected faults beyond the range of commonly encountered issues. This should include, but not be limited to, the use of frequency spectra, time waveforms and orbits, transfer functions, basic operating deflection shapes, and acceleration enveloping under both steady state and transient conditions with or without a phase trigger;

d) be able to manage such condition-monitoring programmes, evaluate the alarm sets, write working procedures and specify vibration acceptance testing procedures;

e) be able to initiate and validate machinery corrective actions including in situ two-plane rigid rotor balancing;

f) be able to recommend restrictions to machine operation;

g) be able to understand and direct, when necessary, alternative condition monitoring technologies to verify or investigate issues raised through routine data collection;

h) be able to provide technical guidance to and instruct category I and II personnel, and, subject to agreement with the employer or client, deem them competent to carry out certain duties which would normally be outside the scope of those competencies.

It is the responsibility of the employer or client to ensure that category III personnel have the necessary competency in the required management skills, e.g. creating budgets, preparing cost justifications, and managing personnel development.

© ISO 2014 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

4.5 Category IV

Personnel classified to category IV require all the knowledge and skills expected of category I, category II and category III personnel. In addition, they shall be able to direct and audit condition monitoring strategies.

Employers should recognize that a category IV individual is likely to have a broad technical knowledge and experience of a range of machine situations and techniques, and an in-depth knowledge of a selection of them.

In addition, personnel classified to category IV shall at least:

a) be able to apply vibration theory and techniques, including measurement and interpretation of multi-channel spectral results such as frequency response functions, phase and coherence;

b) be able to understand and perform signal analysis, including understanding of frequency and time domain processing, including orbits and their limitations;

c) be able to determine the natural frequencies, mode shapes and damping of systems, components and assemblies;

d) be able to determine and assess the operating deflection shapes of machines and connected structures and recommend means for correction;

e) be able to use generally recognized advanced techniques for VA, parameter identification, and fault diagnosis;

f) be able to apply the basic principles of rotor-bearing dynamics to vibration diagnosis;

g) understand and apply advanced two-plane influence coefficient or static and couple balancing theory;

h) be able to recommend corrective actions or design modifications, including component change or repair, isolation, damping, change of stiffness and change of mass;

i) be able to interpret and evaluate codes of practice and specifications published in International Standards and other documents;

j) be able to recognize vibration caused by gas pulsation in machines, such as reciprocating machines and screw compressors, be able to measure the necessary parameters, and recommend means for correction;

k) be able to recommend corrective actions for resilient mounting and other holding-down and foundation problems.

5 Eligibility

5.1 General

In order to conform to the requirements of this part of ISO 18436, candidates shall have a combination of education, training and experience sufficient to ensure that they understand the principles and procedures consistent with Clause 4 and Annex A.

5.2 Education

Candidates seeking classification do not need to provide evidence of formal education to establish eligibility. All candidates shall be able to use a basic scientific calculator and be familiar with the operation of personal computers. Category III and IV candidates shall require familiarity with current VA technology. Successful completion of two or more years of mechanical technology or mechanical

© ISO 2014 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

engineering at an accredited college, university or technical school is highly recommended for candidates seeking classification to categories III and IV.

5.3 Training

5.3.1 Basic training

To be eligible to apply for assessment to the requirements of this part of ISO 18436, candidates shall provide documentary evidence of successful completion of formal training based on the requirements of Annex A. Training should take the form of formal lectures, demonstrations, trainer-specified practical exercises or controlled self-study. Training should be assessed by the trainer for evidence of adequate knowledge acquisition. Training time shall meet the minimum requirements given in Table 1 shall include the topics identified in Annex A.

Table 1 — Minimum training durations

Durations in hours

Category I	Category II	Category III	Category IV
30	Category I + 38	Category II + 38	Category III + 64

Training may be separated into subject areas, but shall comply with the requirements of Annex A. Additional sources of technical information may be found in Annex B and the Bibliography. It is recommended that the training includes examinations or written assessment to ensure that the subject matter has been understood and to provide the required documentary evidence.

5.3.2 Additional training on machine knowledge

In addition to the training hours shown in Table 1 and detailed in Annex A, it is recommended that candidates attend machinery and component training, or equivalent on-the-job training of at least one-half the duration as specified in Table 1. Such training may be inclusive of any college or university education, or provided as additional courses or on-the-job training by an employer to specific requirements. If undertaken, the additional training should cover the design, manufacturing, installation, operation, and maintenance principles of machines and components, the failure modes and mechanisms associated with each principle, and the typical vibratory behaviours associated with each mechanism. Such training shall be validated by verifiable records.

5.4 Experience

To be eligible for assessment to the requirements of this part of ISO 18436, candidates shall provide evidence to the assessment body of experience in the field of machinery vibration condition monitoring and diagnostics. For category IV candidates, validation may be acquired from another category IV practitioner or their company manager.

The minimum experience requirements are shown in Table 2.

Table 2 — Minimum experience

Durations in months

Category I	Category II	Category III	Category IV
6	18	36	60
NOTE The figures shown represent the cumulative total months of experience to be held for each classification.			

© ISO 2014 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

Designation of a person as category I is not a prerequisite for certification as category II. However, certification of a person as category III and category IV requires previous certification at the lower category. At each higher classification category, the breadth and depth of experience is expected to be greater than at the previous lower category.

6 Examination

6.1 Content

For all categories, it is recommended that the candidate should answer a number of questions within a specified duration similar to the examples shown in Table 3. The questions, covering the topics shown in Annex A, should have been selected from a database of questions existing at the time of the examination. These questions should be generated or approved by a technical committee or an appropriate assessment body.

Table 3 — Example of examination content, duration and pass grade

Category	Number of questions	Examination duration	Pass grade
		h	%
I	60	2	70
II	100	3	70
III	100	4	70
IV	60	5	70

Questions shall be of a practical nature, yet shall test the candidate regarding the concepts and principles required to conduct machinery VA for condition monitoring of machines.

Some questions may involve the interpretation of charts and plots. Simple mathematical calculations using a basic scientific calculator may be required. At the discretion of the assessment body, a summary of common formulae may be provided with the examination questions.

Category III and IV examinations may include both short answer (narrative) and multiple choice questions.

The examination content shall be consistent with the training syllabus contained in Annex A.

Assessment bodies may, at their discretion, make accommodation for candidates with conditions that may require some form of compensation (e.g. dyslexia).

6.2 Examination conduct

In order to maintain confidentiality and integrity, all examinations shall be conducted in accordance with the requirements of ISO 18436-1 and the procedures specified by the assessment body.

© ISO 2014 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014

Annex A
(normative)

Training course requirements

Table A.1 — Overview

Durations in hours

Subject		Category			
		I	II	III	IV
1.	Principles of vibration	6	3	1	4
2.	Data acquisition	6	4	2	2
3.	Signal processing	2	4	4	8
4.	Condition monitoring	2	4	3	1
5.	Fault analysis	4	5	6	6
6.	Corrective action	2	4	6	16
7.	Equipment knowledge	6	4	4	—
8.	Acceptance testing	2	2	2	—
9.	Equipment testing and diagnostics	—	2	4	4
10.	Reference standards	—	2	2	2
11.	Reporting and documentation	—	2	2	4
12.	Fault severity determination	—	2	2	3
13.	Rotor and bearing dynamics	—	—	—	14
Total hours per category of training		30	38	38	64

NOTE The hours per subject are approximations to allow training bodies and assessment bodies to assess the relative importance of subjects, and it is recognized that subject contents may overlap.

© ISO 2014 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 18436-2:2014