



SPECIFIC REQUIREMENTS FOR QUALIFICATION AND MIBoC CERTIFICATION OF VIBRATION CONDITION MONITORING AND DIAGNOSTIC PERSONNEL

ED003 Version 5

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Introduction

The use of the Vibration Analysis method in condition monitoring and diagnosis of faults in machinery and structures has become a key activity in predictive maintenance programmes for many industries. The effectiveness of this technology depends on the capabilities of individuals who perform the measurements and analyse the data. This document follows on from document *ED002 - General Scheme Requirements*.

This document is designed to provide comprehensive information for users of the MIBoC Scheme. The complete list of externally published MIBoC documents is posted on the Mobius website at www.mobiuscertification.org, where all applicable documents are available for download free of charge.

It is intended, through publication of these documents, to provide industry, MIBoC candidates and certificate holders with all relevant information. However, if further information or advice is required on any certification matter, please contact the Certification Manager of the Mobius Institute Board of Certification on Tel +61 3 59797285, or email certification@mobiusinstitute.com

Scope

This document sets out the specific requirements for qualification and MIBoC certification of personnel engaged in Vibration Analysis Condition monitoring. In the event of a conflict between the requirements of *ED002 - General Scheme Requirements* and this document, the requirements specified in *ED002 - General Scheme Requirements* shall prevail.

Certification to this specification will provide evidence of the qualification and competence of individuals to perform vibration measurements and analysis using appropriate sensors and equipment.

Classification of Personnel

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.

Authority to work shall be limited or specified by the employer or 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 MIBoC body shall remain as it was at the time it was issued.

In 2.2 to 2.5, 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](#)

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.

Category I personnel shall be able to:

- 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:

- h. the choice of sensor, test method or technique or for any analysis or diagnosis to be conducted;
- i. the assessment of test results, other than identifying conditions against pre-established criteria,
- j. such as acceptance, alert, alarm, shutdown, etc.

Category II

Individuals 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 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.

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.

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.

Eligibility for Examination and Certification

General

Candidates shall have a combination of education, training and experience sufficient to ensure that they understand the principles and procedures consistent with clause 2 above and Annex A.

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

Training

1. To be eligible for MIBoC examination, candidates shall provide evidence of successful completion of approved training based on the requirements of [Annex A](#) or which is otherwise recognised by the MIBoC Technical Committee. A list of approved/recognised training courses can be found in (as listed in *ED009 – Approved Training Courses*). The minimum duration of training is shown in Table 1. Training should be in the form of lectures, demonstrations, trainer-specified practical exercises or controlled self study. Training time shall meet the minimum requirements given in Table 1 below, and shall include the topics identified in [Annex A](#). It is recommended that the training includes examinations or written assessment to ensure that the subject matter has been understood.

Table 1 – Minimum duration of cumulative training (hours)

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

- 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.

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 manager/supervisor. The minimum experience requirements are shown in Table 2 below.

Table 2 – Minimum duration of cumulative experience (months)

Category I	Category II	Category III	Category IV
6	18	36	60

Note: The months shown represent cumulative totals of months of experience for each category.

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.

Candidates who have a minimum of 60 months of experience may, at MIBoC's discretion, be eligible to apply for certification at category III as a mature candidate and bypass the requirement to hold previous certification at category II.

Examination

Examination content

For each category, the candidates shall be required to answer a fixed number of multiple choice questions in a specified time duration as indicated in Table 3. The questions, covering topics shown in Annex A, shall be selected from a database of questions existing at the time of the examination. These questions have been generated or approved by a technical committee.

Table 3 – Examination details

Category	Number of questions	Duration (hours)	Pass grade (%)
I	60	2	70
II	100	3	70
III	100	4	70
IV	60	5	70

1. MIBoC may, at its discretion, make accommodations to assist candidates who have a disability in accordance with *ED002 - General Scheme Requirements*, clause 9.3, or for whom the language of the examination is a second language.
2. Questions will be of a practical nature and test the candidate’s knowledge of the principles and procedures required to conduct machinery vibration testing and analysis.
3. Some questions may involve the interpretation of charts and plots. Simple mathematical calculations using a basic scientific calculator may be required.
4. The examination content shall be proportionate with the training syllabus contained in [Annex A](#).

Annex A

Training course requirements for personnel involved in vibration condition monitoring and diagnostics of machines

Table A.1 – Overview

SUBJECT	Hours of training			
	Category	Category	Category	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
12. Rotor /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.

Table A.2 – Detailed list of topics and hours of instruction

Subject	CAT I	CAT II	CAT III	CAT IV
1. Principles of vibration	6	3	1	4
Basic motion	*	*	*	
Period, frequency	*	*	*	
Amplitude: peak, peak-to-peak, r.m.s.	*	*	*	
Parameters: displacement, velocity, acceleration	*	*	*	
Units, unit conversions	*	*	*	
Time and frequency domains	*	*	*	
Vectors, modulation			*	*
Phase		*	*	*
Natural frequency, resonance, critical speeds	*	*	*	*
Force, response, damping, stiffness			*	*
Instabilities, non-linear systems				*
2. Data acquisition	6	4	2	2
Instrumentation	*	*	*	*
Dynamic range, signal-to-noise ratio			*	*
Transducers	*	*	*	
Sensor mounting, mounted natural frequency	*	*	*	
f_{max} , acquisition time		*	*	
Proximity sensor conventions		*	*	
Triggering		*	*	
Test planning		*	*	*
Test procedures	*	*	*	*
Data formats		*	*	
Computer database upload/download	*			
Recognition of poor data	*	*	*	
3. Signal processing	2	4	3	8

R.m.s./peak detection				*
Analog/digital conversion				*
Analog sampling, digital sampling		*	*	*
FFT computation			*	*
FFT application	*	*		
Time windows: uniform, Hanning, flat-top		*	*	
Filters: low pass, high pass, band pass, tracking		*	*	*
Anti-aliasing		*	*	*
Bandwidth, resolution		*	*	*
Noise reduction		*	*	*
Averaging: linear, synchronous time, exponential		*	*	*
Dynamic range		*	*	*
Signal-to-noise ratio				*
Spectral maps			*	*
4. Condition monitoring	2	4	3	1
Computer data base set-up, computer database maintenance			*	
Equipment evaluation and prioritization		*		
Monitoring programme design		*	*	*
Alarms set-up: narrowband, envelope			*	
Baseline assessments, trending		*	*	
Route planning		*	*	
Alternative technologies: oil analysis, infrared thermography, motor current analysis and acoustic emission			*	*
Fault condition recognition	*	*		
5. Fault analysis	2	5	6	6
Spectrum analysis, harmonics, sidebands		*	*	*
Time waveform analysis		*	*	*
Phase analysis		*	*	*
Transient analysis			*	*

Orbit analysis			*	*
Shaft centreline analysis		*	*	*
Enveloping		*	*	*
Mass unbalance		*	*	
Misalignment		*	*	
Mechanical looseness		*	*	
Rubs, instabilities			*	*
Bearing defects: rolling element, journal		*	*	
Electric motor defects		*	*	*
Flow induced vibration, aerodynamics and liquids			*	*
Gearbox analysis		*	*	
Resonance and critical speeds		*	*	*
Turbomachinery			*	*
General fault recognition	*			
6. Corrective action	2	4	6	16
Shaft alignment		*	*	
Field balancing		*	*	*
Replacement of machine parts			*	
Flow control			*	*
Isolation and damping			*	*
Resonance control			*	*
Basic maintenance action	*	*	*	
7. Equipment knowledge	6	4	4	-
Electric motors, generators and drives	*	*	*	
Pumps, fans	*	*	*	
Steam turbines, gas turbines		*	*	
Compressors	*	*	*	
Reciprocating machinery		*	*	
Rolling mills, paper machines, other process equipment	*	*	*	
Machine tools	*	*	*	

Structures, piping	*	*	*	
Gearboxes	*	*	*	
Rolling element bearings		*	*	
Journal bearings		*	*	
Gearing		*	*	
Couplings, belts		*	*	
8. Acceptance testing	2	2	2	-
Test procedure	*	*		
Specifications and standards		*	*	
Reporting		*	*	
9. Equipment testing and diagnostics	-	2	4	4
Impact testing		*	*	*
Forced response testing		*	*	*
Transient analysis			*	*
Transfer functions			*	*
Damping evaluation				*
Cross channel phase, coherence			*	*
Operating deflection shapes			*	*
Modal analysis			*	*
Torsional vibration				*
10. Reference standards	-	2	2	2
ISO		*	*	*
IEC		*	*	*
Relevant national standards		*	*	*
11. Reporting and documentation	-	2	2	4
Condition monitoring reports		*	*	
Vibration diagnostics reports		*	*	*
12. Fault severity determination	-	2	2	3
Spectrum analysis		*	*	*
Time waveform analysis, orbit analysis		*	*	*

Levels: overall, narrowband, component		*	*	
Severity charts, graphs and formula		*	*	*
13. Rotor/bearing dynamics	-	-	-	14
Rotor characteristics				*
Bearing characteristics				*
Rotor balancing				*

Note 1: The symbol * indicates the subject is to be covered within the allotted time.

Note 2: Category II includes the knowledge of Category I;
 Category III includes the knowledge of Category I and II;
 Category IV includes the knowledge of Category I, II and III.

Note 3: If the symbol * appears in more than one category for a subject item, it should be understood that at Category X deeper knowledge of the subject is required than at Category X-1.

Annex B

Applicable International Standards

ISO Reference	Category			
	I	II	III	IV
ISO 1925, <i>Mechanical vibration — Balancing — Vocabulary</i>		*	*	*
ISO 1940-1, <i>Mechanical vibration — Balance quality requirements of rigid rotors — Part 1: Specification and verification of balance tolerances</i>		*	*	*
ISO 2017-1, <i>Mechanical vibration and shock — Resilient mounting systems — Part 1: Application of source and receiver isolation</i>				*
ISO 2041, <i>Vibration and shock — Vocabulary</i>		*	*	*
ISO 2954, <i>Mechanical vibration of rotating and reciprocating machinery — Requirements for instruments for measuring vibration severity</i>				*
ISO 5348, <i>Mechanical vibration and shock — Mechanical mounting of accelerometers</i>		*	*	*
ISO 7919-1, <i>Mechanical vibration of non-reciprocating machines — Measurement on rotating shafts and evaluation criteria — Part 1: General guidelines</i>	*	*	*	*
ISO 7919-2, <i>Mechanical vibration — Evaluation of machine vibration by measurements on rotating shafts — Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min and 3 600 r/min</i>		*	*	*
ISO 7919-3, <i>Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 3: Coupled industrial machines</i>		*	*	*
ISO 7919-4, <i>Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 4: Gas turbine sets</i>		*	*	*
ISO 7919-5, <i>Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 5: Machine sets in hydraulic power generating and pumping plants</i>		*	*	*
ISO 8528-9, <i>Reciprocating internal combustion engine driven alternating current generating sets — Part 9: Measurement and evaluation of mechanical vibrations</i>		*	*	*

ISO 10816-1, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 1: General guidelines</i>	*	*	*	*
ISO 10816-2, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min and 3 600 r/min</i>		*	*	*
ISO 10816-3, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured in situ</i>		*	*	*
ISO 10816-4, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 4: Gas turbine driven sets excluding aircraft derivatives</i>		*	*	*
ISO 10816-5, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 5: Machine sets in hydraulic power generating and pumping plants</i>		*	*	*
ISO 10816-6, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 6: Reciprocating machines with power ratings above 100kW</i>		*	*	*
ISO 10816-7, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts</i>		*	*	*
ISO 10816-8, <i>Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 8: Reciprocating compressor systems</i>		*		
ISO 11342, <i>Mechanical vibration — Methods and criteria for the mechanical balancing of flexible rotors</i>				*
ISO 13372, <i>Condition monitoring and diagnostics of machines — Vocabulary</i>	*	*	*	*
ISO 13373-1, <i>Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 1: General procedures</i>	*	*	*	*
ISO 13373-2, <i>Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 2: Processing, analysis and presentation of vibration data</i>		*	*	*
ISO 13374-1, <i>Condition monitoring and diagnostics of machines - Data processing, communication and presentation - Part 1: General guidelines</i>		*	*	*

ISO 13379-1, <i>Condition monitoring and diagnostics of machines — Data Interpretation and diagnostic techniques - Part 1: General guidelines</i>			*	*
ISO 13381-1, <i>Condition monitoring and diagnostics of machines — Prognostics - Part 1: General guidelines</i>		*	*	*
ISO 14694, <i>Industrial fans — Specifications for balance quality and vibration levels</i>	*	*	*	*
ISO 14695, <i>Industrial fans — Method of measurement of fan vibration</i>			*	*
ISO 17359, <i>Condition monitoring and diagnostics of machines — General guidelines</i>	*	*	*	*
ISO 18431-1, <i>Mechanical vibration and shock - Signal processing - Part 1: General introduction</i>		*	*	*
ISO 18431-2, <i>Mechanical vibration and shock - Signal processing - Part 2: Time domain windows for Fourier Transform analysis</i>		*	*	*
ISO 18436-1, <i>Condition monitoring and diagnostics of machines — Requirements for training and certification of personnel — Part 1: Requirements for certifying bodies and the certification process</i>				*
ISO 18436-3, <i>Condition monitoring and diagnostics of machines — Requirements for training and certification of personnel — Part 3: Requirements for training bodies and the training process</i>				*
ISO 19499, <i>Mechanical vibration - Balancing - Guidance on the use and application of balancing standards</i>				*
ISO 21940-13, <i>Mechanical vibration - Rotor balancing - Part 13: Criteria and safeguards for the in-situ balancing of medium and large rotors</i>				*
ISO 21940-14, <i>Mechanical vibration - Rotor balancing - Part 14: Procedures for assessing balance errors</i>			*	*

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