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

Version 2

Issued: 1 March 2019

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Introduction

Using ultrasound to monitor condition and diagnose faults in machinery is a key activity in predictive maintenance programmes for most industries. The effectiveness of these programmes depends on the capabilities of individuals who perform the measurements and analyse the data.

This document follows on from document *ED002 - General Scheme Requirements*, and is designed to provide comprehensive information for users of the MIBoC Scheme, specifically for the technology of ultrasound. 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.manager@mobiuscertification.org.

1. Scope

- 1.1. This document sets out the specific requirements for qualification and MIBoC certification of personnel who perform machinery condition monitoring and diagnostics using ultrasound. 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.
- 1.2. This document is based on *ISO 18436-8: Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Ultrasound*.
- 1.3. Certification to this specification will provide evidence of the qualification and competence of individuals to perform ultrasound measurements and analysis using ultrasound equipment. This procedure may not apply to specialised equipment or other specific situations.

Wherever there is a conflict between the requirements of standards concerning ultrasound personnel qualification and certification, the MIBoC scheme will comply with ISO 18436 criteria unless otherwise indicated by text placed within a frame similar to that in which this text is displayed, as authorised by invocation of ISO21-1.

2. Classification of Personnel

2.1. General

Individuals certified in accordance with this specification are classified in one of three categories depending on their qualification. They shall have demonstrated the necessary skills in ultrasound condition monitoring for their category as indicated in [Annex A](#).

Personnel classified as Category II need to have all the knowledge and skills expected of personnel classified as Category I, while personnel classified as Category III need to have all the knowledge and skills expected of personnel classified as Category II.

2.2. Category I

Individuals classified as Category I are qualified to perform ultrasound according to established and recognised procedures. Personnel classified as Category I shall be able to:

- 2.2.1. apply a specified ultrasound measurement technique, however, persons classified as Category I shall not be regarded as competent to choose the test method or technique to be used;
- 2.2.2. set up and operate the ultrasound equipment for safe ultrasound data collection;
- 2.2.3. verify the integrity of collected data and prevent or control poor data and error sources;
- 2.2.4. perform basic fault detection, severity assessment and diagnosis in accordance with established instructions;
- 2.2.5. record and categorise the results in terms of written criteria;
- 2.2.6. maintain a database of results and trends;
- 2.2.7. verify the sensitivity of ultrasound measurement instruments and systems;
- 2.2.8. evaluate and report test results in accordance with instructions and highlighting areas of concern; and
- 2.2.9. recognise and prevent or control factors that result in the acquisition of poor quality data.

2.3. Category II

Individuals classified as Category II are qualified to perform and/or direct ultrasound analysis according to established and recognised procedures, and are aware of the limitations of the ultrasound method. Personnel classified as Category II shall be able to:

- 2.3.1. select the appropriate ultrasound measurement technique and understand its limitations;
- 2.3.2. specify the appropriate hardware and software;
- 2.3.3. set up and verify equipment settings;
- 2.3.4. apply ultrasound theory and techniques where no procedures exist;
- 2.3.5. measure and perform diagnosis of ultrasound signals inclusive of amplitude, frequency and time domain analysis;
- 2.3.6. classify and evaluate the test results (including acceptance tests) in accordance with applicable codes, standards, specifications and procedures;
- 2.3.7. prepare reports on equipment condition fault diagnoses, recommend appropriate corrective actions and comment on effectiveness of repairs;
- 2.3.8. provide technical direction to ultrasound monitoring personnel at category I; and
- 2.3.9. be aware of the use of alternative or supplementary condition monitoring (CM) technologies.

2.4. Category III

Individuals classified as Category III are qualified to perform and/or direct all types of ultrasound measurements and analysis and shall be able to:

- 2.4.1. apply ultrasound theory and techniques, including measurement and interpretation of survey results such as amplitude, frequency and time domain processing;
- 2.4.2. understand and perform data analysis, including limitations;
- 2.4.3. determine the ultrasound data acquisition systems and component assemblies required;
- 2.4.4. use non-standard techniques for ultrasound monitoring and fault diagnosis;
- 2.4.5. interpret and evaluate standards, codes, specifications and procedures;
- 2.4.6. develop and establish ultrasound programmes, procedures and instructions including determination of the requirement for periodic/continuous monitoring, frequency of testing, etc.;
- 2.4.7. determine severity assessment acceptance criteria for new, in-service and faulty equipment;
- 2.4.8. measure and perform more advanced diagnosis and prognosis of ultrasound signal analysis with amplitude, frequency and time domain;
- 2.4.9. recommend the use of alternative or supplementary condition monitoring (CM) technologies; and
- 2.4.10. provide guidance to supervise and instruct category I and II personnel.

NOTE: It is the employer's responsibility to ensure that Category III personnel have the necessary competency in the required management skills, for example creating budgets preparing cost justifications and managing personnel development.

3. Eligibility for Examination and Certification

3.1. General

In order to be eligible for MIBoC certification, candidates should have a combination of education, training and experience to ensure that they understand the principles and procedures applicable to ultrasound measurement and analysis.

It is advised that all candidates utilizing instrumentation with headphones should be given hearing examinations to ensure natural or corrected hearing acuity exists in at least one ear. A record of the results should be retained and presented to the assessment body upon request. The individual should be capable of hearing a standard pure tone audiometry with results of an average of 25 dB hearing level or lower. This examination should be administered upon initial certification and upon recertification. The examination shall be administered by a licensed professional and a record of the test made available to the assessment body using document *ED160 - Hearing Test Declaration*.

Candidates who do not provide a record of passing the hearing test will receive conditional certification under which it becomes the responsibility of their employer to assess the candidate's hearing acuity and their suitability to perform ultrasound data collection and/or analysis. This condition of certification will be noted on the candidate's certificate as well as MIBoC's website list of certified analysts.

3.2. Education

Candidates seeking classification do not need to provide evidence of formal education to establish eligibility. However, it is recommended that candidates for Category I and Category II have at least a secondary school graduate qualification or its equivalent. Category II and III candidates shall be able to manipulate simple algebraic equations, use a basic scientific calculator (including trigonometric and logarithmic functions), and be familiar with the operation of personal computers. Successful completion of two or more years of an engineering skills or technology programme at an accredited college, university, or technical school is highly recommended for candidates seeking classification to Category III.

3.3. Training

3.3.1. Introduction

To be eligible for the MIBoC ultrasound certification examination, candidates shall provide evidence of successful completion of approved training based on the requirements of [Annex A](#) and which follows the requirements of ISO 18436-3, or which is otherwise recognised by the MIBoC Ultrasound Technical Committee. A list of approved/recognised training courses can be found in (as listed in *ED146 – Approved US Training Courses*). The minimum duration of cumulative training is shown in Table 1. Training should be in the form of lectures, demonstrations, practical exercises or formal training courses. Training time devoted to each subject shall be in accordance with Annex A.2 and Table 1.

Table 1 – Minimum duration of cumulative training (hours)

Category I	Category II	Category III
32	64 (CAT I + 32)	96 (CAT I + CAT II + 32)

3.3.2. Additional training on machine knowledge

In addition to the training hours shown in Table 1, it is recommended for candidates to attend formal or on-the-job machinery and component training of at least a similar as shown in Table 1.

Such training should be in addition to any formal education compliant with 3.2, inclusive of any college or university education. If undertaken, the additional training shall cover the design, implementation, operation and maintenance principles of machines and components, and the failure modes and mechanisms associated with each principle.

3.3.3. Mature candidate entry

Mature candidate entry may be allowed at MIBoC's discretion.

Such candidates may apply for direct entry to Category II, without the need to have previously held classification at Category I, providing they can produce verifiable documentary evidence of training and experience that satisfies the requirements for both Category I and Category II qualifications.

Candidates shall have at least five years of documented experience without significant interruption in ultrasound-based condition monitoring of machines for Category II. Candidates shall provide evidence of completion of an equivalent course of training in accordance with Annex A. Such candidates should apply to the assessment body under the mature candidate route. If a significant interruption exists, the candidate may be required to undertake further training as determined by the assessment body.

3.4. Experience

- 3.4.1. To be eligible to apply for MIBoC Ultrasound certification the candidate shall provide evidence of experience in the field of ultrasound condition monitoring in accordance with Table 2.
- 3.4.2. Classification to Category II and Category III requires previous classification at the lower category, except for mature candidates (as per 3.3.3 above).
- 3.4.3. Candidates shall keep verifiable documentary evidence of experience, and have it validated by a person certified to at least Category II or higher (for a Category I or II candidate) or Category III (for a Category III candidate), or in the absence of such persons, by the candidate's technical supervisor.

Table 2 – Minimum cumulative experience requirements (months)

Category I	Category II	Category III
6	12	36

3.5. Recognition of prior learning

- 3.5.1. MIBoC will take into account prior learning in signal analysis and diagnostic methods on machines.
- 3.5.2. For candidates who have achieved certification as Vibration Analyst Category III or IV or Acoustic Emission Category II or III through a MIBoC approved certification body, the required cumulative experience shall be 1/3 of that stated in Table 2.
- 3.5.3. For candidates who have achieved certification as Vibration Analyst Category I or II or Acoustic Emission Category I through a MIBoC approved certification body, the required cumulative experience shall be 1/2 of that stated in Table 2.

4. Examination

4.1. Examination content

- 4.1.1. For each category, candidates shall be required to answer a minimum fixed number of multiple choice questions in a specified time duration as indicated in Table 3.

4.1.2. Table 3 – Examination details

Category	Number of questions	Time (hours)	Passing grade (%)
Category I	60	2	70
Category II	60	2	70
Category III	60	2	70

- 4.1.3. 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.
- 4.1.4. The content of the examination paper shall contain questions for each subject in Annex A.2 and in the same weighting as indicated by the percentage of time spent in each subject indicated in Table A.2.
- 4.1.5. Questions will be of a practical nature and test the candidate's knowledge of the principles and procedures required to conduct ultrasound condition monitoring, analysis and evaluations.
- 4.1.6. Some questions will include the interpretation of data and simple mathematical calculations using a basic scientific calculator may be required.

The examination content shall be proportionate with the training syllabus contained in [Annex A](#).

4.2. Conduct of Examinations

All examinations shall be conducted in accordance with *ED002 - General Scheme Requirements* Clause 11.

Annex A (normative)

Training course requirements for ultrasound condition monitoring and diagnostics of machines

Table A.1 – Training Syllabus

SUBJECT	Hours of training		
	Category I	Category II	Category III
1. Principles of ultrasound	3	2	1
2. General equipment knowledge	1.5	1	1
3. Data acquisition in ultrasound	2.5	1	1
4. Data storage and management	1	2	2
5. Condition monitoring principles	1.5	1	1
6. Applications to machines	17	17	16.5
7. Severity determination	2	4	4
8. Programme implementation	0.5	0.5	1
9. Reporting and corrective action	0.5	1	2
10. Personal safety	0.5	0.5	0.5
11. Training examination	2	2	2
Total hours for each category	32	32	32

Table A.2 – Detailed training course requirements

Subject	Topics	CAT I	CAT II	CAT III
1. Principles of ultrasound		3	2	1
1.a)	Basics of sound	*		
1.b)	Sound wave motion	*		
1.c)	Acoustic Impedance and its influence on propagation and attenuation	*	*	*
1.d)	Inverse distance law	*		
1.e)	How friction, turbulence and impacting produce ultrasound and where they apply	*	*	*
1.f)	Understanding the properties of the decibel	*	*	
2. General equipment knowledge		1.5	1	1
2.a)	Instrument operation and function	*	*	*
2.b)	Airborne sensors	*	*	*
2.c)	Structure-borne sensors	*	*	*
2.d)	Heterodyne principle and application	*	*	*
2.e)	Sensitivity validation	*	*	
3. Data acquisition in ultrasound		2.5	1	1
3.a)	Principles of data acquisition	*	*	
3.b)	Sensor positioning	*	*	
3.c)	Competing ultrasound and shielding techniques	*	*	*
3.d)	Measurement of ultrasound	*	*	*
3.e)	Capturing time domain and spectrum signals for analysis	*	*	*
4. Data storage and management		1	2	2
4.a)	Developing and using a database	*	*	*
4.b)	Managing stored data	*	*	*
4.c)	Disposition of anomalies		*	*
5. Condition monitoring principles		1.5	1	1
5.a)	What is condition monitoring	*		
5.b)	Why is it useful?	*		
5.c)	What other technologies are there?	*	*	*
5.d)	Why and when would ultrasound be useful?	*		
5.e)	Acceptance testing	*	*	*
5.f)	Benchmarking		*	*

Subject	Topics	CAT I	CAT II	CAT III
6. Applications to machine systems		17	17	16.5
6.a)	Leak detection i. Turbulence and flow ii. Directionality iii. Measurement precautions iv. Pressurised gases and compressed air v. Vacuum vi. Tightness testing using the ultrasonic tone method	* (all)	* (all)	* (all)
6.b)	Valve inspection to identify: i. Blocked ii. Passing iii. Cavitating			
6.c)	Steam traps i. Using ultrasound ii. Combination with temperature iii. Reporting techniques			
6.d)	Electrical inspection i. Corona, tracking and arcing ii. Internal partial discharge iii. Safety concerns			
6.e)	Hydraulic systems inspection i. Cylinders, valves and pumps			
6.f)	On-condition bearing lubrication i. Trending values ii. Ultrasonic lubrication process considerations iii. Under and over-lubricated bearings			
6.g)	Bearing defect detection			
6.h)	Slow speed bearing inspection			
6.i)	Gearing inspection			
6.j)	Pump inspection-cavitation			
6.k)	Motor inspection and the effect of variable speed drives			
7. Severity Determination		2	4	4
7.a)	Setting up decibel alarms		*	*
7.b)	Trending decibels	*	*	*
7.c)	Statistical alarm creation		*	*
7.d)	Time signal analysis	*	*	*
7.e)	Spectrum analysis	*	*	*
7.f)	Case studies	*	*	*
7.g)	Diagnosis and Prognosis		*	*

8. Programme implementation		0.5	0.5	1
8.a)	Routine inspection considerations	*	*	*
8.b)	Routine management	*	*	*
8.c)	Report structuring		*	*
8.d)	Corrective action for alarm incidences		*	*
9. Reporting and corrective action		0.5	1	2
9.a)	Key information needed	*	*	*
9.b)	Recommending corrective action		*	*
9.c)	Tracking corrective action outcome	*	*	*
10. Personal safety		0.5	0.5	0.5
11. Training examination		2	2	2
TOTAL HOURS		32	32	32
<p>Note 1: Category II includes the knowledge of Category I Note 2: Category III includes the knowledge of Category I and II. Note 3: * indicates topics to be taught at indicated category.</p>				