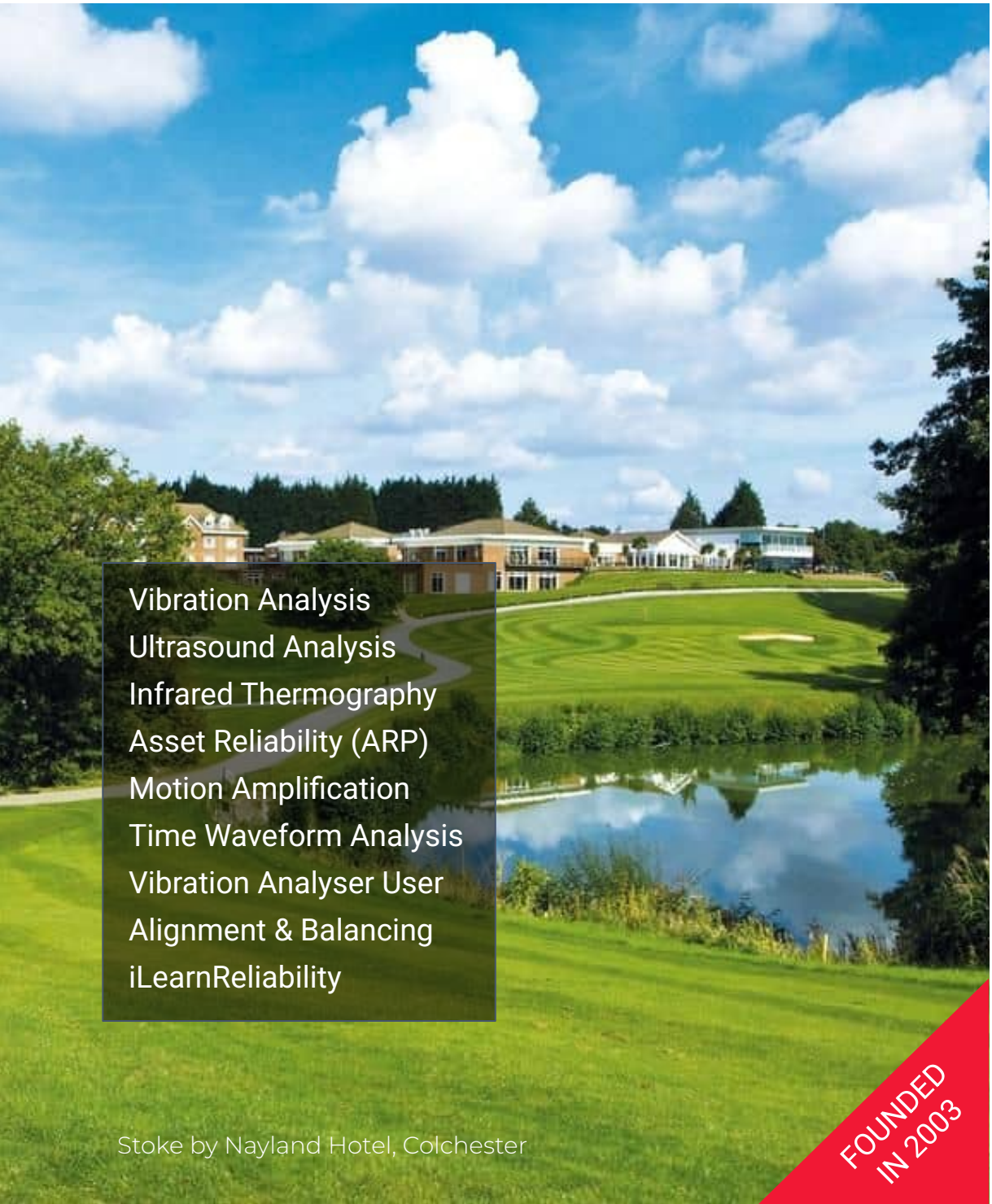
RMS
RELIABILITY TRAINING INSTITUTE

2026

# CM & Reliability Training Courses




rms-training.com

Reliability matters

RTC-V34 02-26

Easy navigation

# Table of Contents

Click the ▲ to return here. Best viewed in Adobe



REQUEST A QUOTATION

# Welcome to the RMS Reliability Training Institute

**Editable PDF Form**
* After completing the form in a web browser, be sure to select 'Print' to a PDF

* We recommend downloading PDFs to your computer.

* Press Shift & Mouse Click to open any link in a new tab.

Thank you for your interest, we hope you will find everything you need in the coming pages. If you do have any questions along the way feel free to reach out to the Training team.

RMS offer public, onsite, virtual and distance learning certified training courses across a range of CM and Reliability topics. The purpose of this document is to provide you with the information needed to register on an RMS Training Course.

Within the brochure you'll find the course topics, the public schedule, examination details, hotel locations, and the study options: public, onsite or online. To receive a custom quotation, complete the Website form or return the PDF variation.

REQUEST A QUOTATION

DOWNLOAD PDF FORM*

*CTRL+CLICK
Opens a new tab

*Passionately supporting practitioners to achieve their career goals since 1982*

Training

# Meet the Team

We believe that by listening carefully to customer needs, applying expert experience, implementing world class technology and certified training, we can solve complex reliability problems. We believe that by fostering a culture of service throughout the company and commitment to the needs and successes of others, we ensure that our relationships with customers are based on the same culture and values.

Dean Whittle

Training Manager

Andrew Loder

VA, MA Trainer

James Sylvester

VA Trainer

Micky Jackson

IRT Trainer

Tom Murphy

UA, ARP Trainer

Stuart Walker

Senior MA Trainer

Paul S-Hampson

Training Support


Wendy Whittle

Training Admin

*With both a local and global mindset we seek to serve and protect customers better and scale best-in-class service, product and training solutions effectively and affordably throughout the UK and beyond. Training Coordinator: Wendy Whittle.*

Innovation

# Why Choose RMS

The RMS Reliability Training Institute has teamed up with Mobius Institute, the "iLearn" company, and now offer a brand new way to help you become trained in vibration analysis. We believe that four days in a training room is not sufficient to provide you with the training and reference that you need to successfully master vibration analysis. So, instead of offering a four-day course, we offer a 6-month course! When you register for a Public course you will be given access to the world-renowned iLearnVibration training system (student version), via our student online 'learning zone'. Then you attend the course, with the best instructors, and the best training aids. When you go back to work, you can continue to utilise iLearnVibration (student edition) - because we all know that the hardest questions only come to mind when you are under pressure trying to analyse data, not when you are attending the course. Four days just is not enough to master the complexities of vibration analysis. Now you can take the instructor home with you and continue your education.

**Pre-study:** Step one is iLearnVibration Student Edition. When you register for one of our courses you will be sent an email containing details for logging on to the student on-line 'learning zone'. Here you can take iLearnVibration lessons via your Web browser. You don't have to look at the material before you attend the course, but you will gain so much more from the course if you do.

**Public or Onsite courses:** Our instructors have years of training and practical field experience. But what makes us unique is our professional slides, classroom activities, and our library of software simulators. The simulators revolutionise the training room. Instead of requiring endless discussion and diagrams to explain the range of complex concepts and procedures, the simulators (and 3D animations) make it all crystal clear in a fraction of the time.

And we should not forget the classroom activities. Rather than just listening to the instructor, you are able to participate in activities that help you learn more, and to assess how much you have learned. (cont.)

*It does not matter which equipment you use, or how hard you work, there is one dominant factor that makes successful analysts stand out – the quality and regularity of training and the ongoing support they receive.* - **Dean Whittle**

Promise

# Our Pledge

If you struggle with the activities then you can simply discuss the topics with your instructor - it is better to find out what you don't know while you are still in the classroom than you are back at work (or during the exam).

You'll be amazed what you will understand and remember as a result of attending one of our classes.

**The learning never ends:** Too many people have left training courses only to forget much of what they have learned. At best they have taken away a book of notes or technical papers (which is rarely used). If only you could take the instructor with you... Well, now you can! In addition to RMS's course book, vibration analysis pocket guide (forms parts of the recommended reading for BINDT ISO 18436-2 VA training) and charts, you retain access to your iLearnVibration student online 'learning zone' for either 4-months or choose a 1-Year Continued Education Upgrade. Whenever questions come to mind, jump into iLearnVibration portal and find the answers you need.

We also offer students additional training materials such as iLearn Reliability CM, iLearn Reliability (Professional), iLearn Reliability (Enterprise), Stress Wave Analysis Chart, although please note these additional items would be chargeable, POA.

**Our pledge:** When you attend the course you deserve the very best. You are giving up your time, giving up your training budget, and spending time away from your family, all in the hope that you will learn more so that you can do a better job and progress in life. Well, you are making an effort, and so are we. We make sure that your time in the class is optimised, with excellent slides, animations, simulators, interactive activities and challenges, and experienced instructors; and we make sure you gain the greatest benefit by sending you home with a reference manual, a very useful diagnostic reference guide, and the award winning iLearnVibration computer-based training system. Your time is very well spent in the classroom, and you can go on learning after you return to your place of work.

*Increasing competencies and skills through consistent training helps protect market share, delivers better customer experience and improves employee retention.* - **Dean Whittle**

# Table of Courses

Vibration, Ultrasound and IRT courses conform with ISO 18436 standards.

● Not available ● Available

| 2021 | Course Type | | | Certification | |
|---|---|---|---|---|---|
| **Course Title** | **Public (Hotel/ Virtual)** | **Private (Onsite/ Virtual)** | **Online Self-paced** | **BINDT** | **Mobius** |
| **Vibration Analysis**<br>CAT I<br>CAT II<br>CAT III<br>CAT IV (Part 1 & 2) | | | | | |
| **Asset Reliability (ARP)**<br>Introduction<br>Advocate<br>Engineer<br>Leader | | | | | |
| **Annual Licenses**<br>iLearnReliability (CM)<br>iLearnReliability (Prof.)<br>iLearnReliability (10 users) | | | | | |
| **Ultrasound**<br>CAT I<br>CAT II | | | | | |
| Motion Amplification | | | | | |
| Time Waveform Analysis | | | | | |
| VA Analyser System User | | | | | |
| Laser Alignment | | | | | |
| Dynamic Balancing | | | | | |
| IRT Thermography | | | | | |
| Condition Monitoring | | | | | |

**FOR AN ACCURATE QUOTATION PLEASE COMPLETE THE ONLINE COURSE FORM VIA THE LINKS ON THE LEFT**

- Online examination guidelines from Mobius Institute
- Motion Amplification certification is from RDI Technologies
- Exam pricing includes certification shipping fees
- Optional printed materials for Self-paced courses: ARP's (£160), VA's (£225)
- Printed materials include: Course manual, VA Wall Chart, Reference Guide, Mobius pen, Notebook, Key-fob, USB Stick.

CTRL + LINK-CLICK
Opens a new tab

# Public Schedule 2026

SBN: Stoke by Nayland Hotel
STL: Statham Lodge
GRH: Glenroyal Hotel (IE)
NOV-W: Novotel (Worsley)
Hybrid(H): Hotel or Virtual

## Vibration Analysis

| Course | Dates | Instructor | Location |
|---|---|---|---|
| VA CAT I | 2-5 Feb 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT II | 23-27 Mar 2026 | Dean Whittle | NOV-W - UK |
| VA CAT I | 20-23 April 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT III | 11-15 May 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT I | 15-18 Jun 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT I | 22-25 Jun 2026 | Dean Whittle | GRH - IE |
| VA CAT II | 6-10 Jul 2026 | Dean Whittle | NOV-W - UK |
| VA CAT I | 7-10 Sep 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT II | 5-9 Oct 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT IV (Part 2) | TBC Nov 2026(H) | João Pedro Pais | Denmark |
| VA CAT III | 9-13 Nov 2026 (H) | Dean Whittle | SBN - UK |
| VA CAT I | 30-3 Dec 2026 (H) | Dean Whittle | SBN - UK |

CTRL + LINK-CLICK
Opens a new tab

## Ultrasound Analysis

| | | | |
|---|---|---|---|
| U CAT I | 13-16 Apr 2026 | Tom Murphy | NOV-W - UK |
| U CAT I | 14-17 Sep 2026 | Tom Murphy | NOV-W - UK |

## Infrared Thermography

| | | | |
|---|---|---|---|
| IRT CAT I | TBC 2026 | Micky Jackson | NOV-W - UK |
| IRT CAT I | Self-paced | Micky Jackson | Online |

## Asset Reliability Practitioner

| | | | |
|---|---|---|---|
| ARP Advocate | Private onsite courses | Dean / Tom | Online/Virtual |
| ARP Engineer | Private onsite courses | Dean / Tom | Online/Virtual |
| ARP Leader | Private onsite courses | Dean / Tom | Online/Virtual |

Intro

# Vibration Analysis

The VA CAT-I is a 4 day course and is the ideal starting place for new vibration analysts, people collecting vibration data, and those who want a better understanding of vibration analysis and condition monitoring. The VA CAT-II is a 5 day course, and is intended for people who have mastered the basics, but who need to be able to take good data (and decide how the data collector should be set up); analyse a range of fault conditions; and understand balancing and alignment.

As a CAT-III/IV vibration analyst you are expected to be able to diagnose all of the common faults conditions with rolling element bearing machines; have a good understanding of fault conditions associated with sleeve bearing machines; utilise time waveforms, phase readings and enveloping/PeakVue readings to diagnose faults; and understand all condition monitoring technologies, how and when to apply them, and how to combine technologies to get the best results.

# CAT-I Vibration Analysis

## Good to know

**Summary:** the ISO 18436 VA CAT-I course is the ideal starting place for new vibration analysts, people collecting vibration data, and those who want a better understanding of vibration analysis and CM.
**Duration:** 4-day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (30 hours)
**Course Materials**: printed and/or online
**Examinations:** BINDT or MIBoC Certification examination; 60 questions, 2 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required for attending the training course or taking the examination, but 6 months of relevant experience is required for ISO certification.

## Student profile:

- You are relatively new to vibration analysis
- You are or will be collecting vibration data
- You are or will be analyzing vibration data
- You look forward to the opportunity to develop your skills in the field of machine condition & vibration analysis
- You are seeking to become certified to international standards (ISO-18436) by an accredited certification body

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of vibration analysis fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing vibration spectra.

- The benefits of performing condition monitoring and improving reliability
- The condition monitoring technologies: acoustic emission, infrared analysis (thermography), oil analysis, wear particle analysis, motor testing
- How machines work – via supplementary self-study using the “Equipment Knowledge” section
- How vibration measurements can tell you about the condition of the machine
- How to collect good, repeatable measurements
- What the F max, resolution, averaging and other analyzer settings mean
- How to analyze vibration spectra, and the basics of fault diagnosis: unbalance, misalignment, looseness, rolling element bearings faults, resonance, and other conditions
- An introduction to setting alarm limits

PUBLIC SCHEDULE

BINDT OUTLINE

MIBOC OUTLINE

REQUEST A QUOTATION

# CAT-II Vibration Analysis

## Good to know

**Summary:** the ISO 18436 VA CAT-II course is intended for people who have mastered the basics but who need to be able to take good data, and decide how the data collector should be set up, analyze a range of fault conditions, and understand balancing & alignment
**Duration:** 5 day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (38 hours)
**Course Materials**: printed and/or online
**Examinations:** BINDT or MIBoC Certification examination; 100 questions, 3 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** a valid CAT-I is not required for attending the training course or taking the examination, but 18 months of relevant experience is required for ISO certification.

## Student profile:

- You have a good understanding of the vibration fundamentals
- You want to be capable of confidently diagnosing a wide range of fault conditions, correcting certain conditions, and taking accurate measurements

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding about signal processing, time waveform and phase analysis, cross-channel testing, machine dynamics, and fault correction.

- How a well-designed program and a reliability centered maintenance approach improve the OEE
- The CM technologies: acoustic emission, infrared analysis (thermography), oil analysis, wear particle analysis, & motor testing
- How machines work; via supplementary self-study using the “Equipment Knowledge” section
- How to select the correct measurement location and axis, and collect good, repeatable measurements
- What the Fmax, resolution, averaging and other analyzer settings mean, and how to select the optimum settings for a wide variety of machine types
- How to analyze vibration spectra, time waveforms, envelope (demodulation), and phase measurements
- How to diagnose: unbalance, eccentricity, misalignment, bent shaft, cocked bearing, looseness, rolling element bearings faults, journal bearing faults, gearbox faults, resonance, and other conditions
- How to set alarm limits manually and with statistics
- How to balance and align a machine, and correct a resonance condition

PUBLIC SCHEDULE

BINDT OUTLINE

MIBOC OUTLINE

REQUEST A QUOTATION

# CAT-III Vibration Analysis

## Good to know

**Summary:** the ISO 18436 VA CAT-III course is for people who are confident with spectrum analysis but who wish to push on and learn more about signal processing, time waveform and phase analysis, cross-channel testing, machine dynamics, and fault correction
**Duration:** 5 day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (38 hours)
**Course Materials**: printed and/or online
**Examinations:** BINDT or MIBoC Certification examination; 100 questions, 4 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required to attend training, but certification requires 36 months experience and CAT-II certification, or a minimum of 60 months experience in lieu of CAT-II certification

## Student profile:

- Anyone with at least three years of vibration analysis experience who wants a complete understanding of vibration and phase analysis, dynamic balancing and shaft alignment, and a developing knowledge of machine dynamics and all condition monitoring technologies

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of vibration analysis fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing vibration spectra.

- How to select the correct measurement location and axis, and collect good, repeatable measurements
- What the Fmax, resolution, averaging and other single channel and cross-channel analyzer settings mean, and how to select the optimum settings
- How to analyze vibration spectra, time waveform, envelope, and phase measurements
- How to diagnose a wide range of fault conditions
- How mass, stiffness & damping affects the natural frequency of a structure
- How to use phase readings, bump tests, impact tests, negative averaging, peak-hold averaging, transient, ODS, modal analysis to determine natural frequencies and visualize machine movement
- How to balance and align a machine, correct a resonance conditions, and employ isolation

PUBLIC SCHEDULE

BINDT OUTLINE

MIBOC OUTLINE

REQUEST A QUOTATION

# CAT-IV Vibration Analysis

## Good to know

**Summary:** the ISO 18436 VA CAT-IV is comprised of two parts: self-paced and instructor led. It is intended for those already certified at CAT-III who wish to truly master vibration analysis, diagnosis and correction.
**Duration:** 2 x 4-days including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (64 hours)
**Course Materials**: Printed and/or online
**Examinations:** BINDT or MIBoC Certification examination; 100 questions, 4 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required to attend training, but certification requires 60 months experience and a valid CAT-III certification.

## Student profile:

- Anyone who has a valid CAT-III certification with at least five years of vibration analysis experience who wants to truly master vibration analysis, diagnosis and correction.

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of vibration analysis fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing vibration spectra.

- How to select the correct measurement location and axis, and collect good, repeatable measurements
- What the Fmax, resolution, averaging and other single-channel and cross-channel analyser settings mean, and how to select the optimum settings for a wide variety of machine types
- How to analyse vibration spectra, time waveforms, envelope (demodulation), and phase measurements
- How to diagnose a wide range of fault conditions: unbalance, eccentricity, misalignment, bent shaft, cocked bearing, looseness, rolling element bearings faults, journal bearing faults, gearbox faults, resonance, and other conditions
- How mass, stiffness and damping affects the natural frequency of a structure
- How to use phase readings, bump tests, impact tests, negative averaging, peakhold averaging, transient (run up and coast down), ODS, and modal analysis to determine natural frequencies and visualize machine movement

PUBLIC SCHEDULE

BINDT OUTLINE

MIBOC OUTLINE

REQUEST A QUOTATION

Intro

# Ultrasound Analysis

The Ultrasound CAT I-III certification training is an opportunity to work with and learn from some of the world's most experienced ultrasound trainers and inspectors. The courses are an essential mix of theoretical knowledge and practical experience. At CAT-I, students are exposed to basic sound theory and how it is applied to the inspection disciplines demanded by an effective ultrasound program.

CAT-II certified personnel are able to select the appropriate ultrasound measurement technique and understand its limitation as well as set up and verify equipment settings. CAT-III personnel are expected to have all the knowledge and capabilities of a Category I and II analyst and be able to apply ultrasound theory and techniques, including measurement and interpretation of survey results.

# CAT-I Ultrasound Analysis

## Good to know

**Summary:** the ISO 18436 UA CAT-I course is intended for the "practitioner" seeking to advance their knowledge in airborne/structure borne ultrasound inspection on rotating, static and electrical equipment.
**Duration:** 4-day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (32 hours)
**Course Materials**: Printed and/or online
**Examinations:** BINDT or MIBoC Certification examination; 2 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required for attending the training course or taking the examination, but 6 months of relevant experience is required for ISO certification; plus a hearing test.

## Student profile:

- Managers, engineers, analysts, supervisors, technicians and operators who wish to learn about ultrasound technology, monitoring and analysis in the areas of operations, maintenance, engineering, reliability and condition monitoring
- If you have ultrasound equipment but have never received trained

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of ultrasound analysis fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing ultrasound data.

- Practice the operation of the Ultraprobe
- Use software for analysis and trending
- Set up groups of points to test
- Upload points into the Ultraprobe
- Establish baseline readings on a "Pilot" group (Approx. 50 – 200 test points based on access and configuration)
- Download and organize the pilot group
- Record and store sound files in the pilot group
- Practice correct data acquisition techniques
- Use spectralyzer software
- View and import sound files
- Create a database, take baseline and subsequent readings, download
- information into software and generate a report

PUBLIC SCHEDULE

BINDT OUTLINE

MIBOC OUTLINE

REQUEST A QUOTATION

CAT I

Intro

# Thermography Infrared

The Mobius Institute Board of Certification™ has established an accredited certification program for ISO 18436-7 Category I. The Scheme Committee has developed the required policy documents, and the Technical Committee has developed an exam. According to ISO 18436-2, the training and certification requirements are: 32 hours, typically over four days

The examination is two hours long with 50 multiple choice questions and a passing grade of 75% Students must demonstrate 12-months of work, verified by an independent person. It is advised that all candidates have their colour perception tested by the Ishihare 24 plate test.

**Thermography courses planned for 2026.**

# CAT-I Thermography

## Good to know

**Summary:** the ISO 18436 Thermography CAT-I course is intended for those operating thermal imaging cameras under different conditions and for various purposes. You will be able to do IR inspections and reporting.
**Duration:** 4-day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (32 hours)
**Course Materials**: Printed and / or online
**Examinations:** BINDT or MIBoC Certification examination; 50 questions, 2 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required for attending the training course or taking the examination, but 6 months of relevant experience is required for ISO certification.

## Student profile:

- Plant Operator / Maintainers
- Reliability Engineers
- Plant Engineers
- Condition Monitoring Specialists
- Thermal camera operator / users

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of Thermography fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing IR data.

- An understanding of thermography and the history of the camera technology development
- An explanation of the camera operation and how it works
- An understanding of infrared theory and the scientific laws relating to conduction, convection, radiation, blackbodies, transmission emissivity, reflectivity and calibration. Practical demonstration with follow up theory
- An understanding of atmospheric and environmental considerations including distance, humidity, air temperature and reflected apparent temperature. How to measure them and setup the camera correctly
- An understanding of temperature definition and measurement, thermodynamics, heat and temperature, heat transfer, conduction, convection and radiation
- A look at cross hair measurement, area box /circle, colour alarms and specific dew point and insulation alarms
- Hands-on camera experience throughout the course; practice using portable simulated labs; integration of images with reporting software; creation of reports

PUBLIC SCHEDULE

BINDT OUTLINE

MIBOC OUTLINE

REQUEST A QUOTATION

CAT I - III

MOBIUS INSTITUTE

Intro

# Asset Reliability (ARP)

No reliability improvement initiative can be successful unless everyone is on the same page. Everyone needs to pull in the same direction. Everyone needs to share the same understanding of the issues, benefits, and remedies. And everyone must be inspired to contribute, support activities intended to improve reliability and performance, and look for opportunities to make improvements. This is the way to create the "culture of reliability".

The ARP course syllabus focuses on three levels: Advocate, Engineer and Leader. The ARP courses lend themselves well to public, onsite or online training. As ARP is an organisation wide effort, onsite training courses are a popular choice. In addition to the certified ARP courses, RMS also offer a 1-day 'Introduction to ARP' course that brings together a number of key people from each of the three levels. Contact the Training team for more details.

# ARP Reliability Advocate

## Good to know

**Summary:** whether your organization manufactures products (appliances, automobiles, etc.) or a commodity (mining, oil & gas, etc.); provides an essential service (e.g. water, sewage, power); relies on machinery/electrical equipment (facilities, shipping), this course details how to improve reliability and performance.
**Duration:** 4-day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (16 hours)
**Course Materials**: Printed and/or online
**Examinations:** MIBoC Certification examination; 60 questions, 2 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required for attending the training course or taking the examination, but 6 months of relevant experience is required for ISO certification.

MOBIUS INSTITUTE

## Student profile:

- The Asset Reliability Practitioner - Advocate [ARP-A] course is intended for everyone working within an organization, who in any way influences the management, design, engineering, procurement, maintenance, or operation of an organization that involves critical rotating machinery and electrical equipment.

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of Asset Reliability fundamentals including how reliability advocates support overall improvement.

- No reliability improvement initiative can be successful unless everyone is on the same page. Everyone needs to pull in the same direction. Everyone needs to share the same understanding of the issues, benefits, and remedies. And everyone must be inspired to contribute, support activities intended to improve reliability and performance, and look for opportunities to make improvements. This is the way to create the “culture of reliability”.
- The course achieves this goal by utilizing animations and animated simulations that make it understandable, memorable, and interesting. Delivered by passionate industry experts, this course, with the optional exam / certification, will make a difference to the future of your organization.

PUBLIC SCHEDULE

MIBOC OUTLINE

REQUEST A QUOTATION

# ARP Reliability Engineer

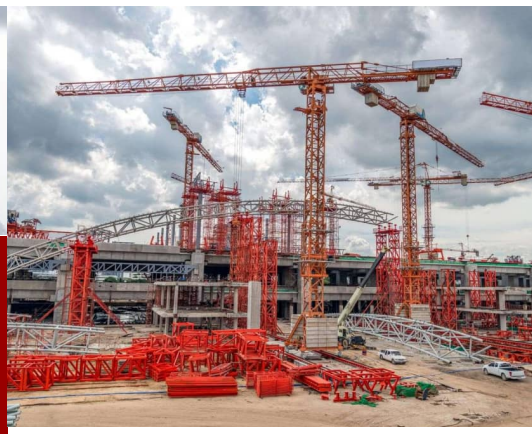
## Good to know

**Summary:** the reliability engineer has a critically important but challenging role. In most organizations there are almost infinite opportunities for improvement but understanding what to change and how to change it is difficult. Analysis is not enough. Action must be taken.
**Duration:** 5-day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (32 hours)
**Course Materials**: Printed and/or online
**Examinations:** MIBoC Certification examination; 100 questions, 3 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required for attending the training course or taking the examination, but 24 months of relevant experience is required for ISO certification.

## Student profile:

- The Asset Reliability Practitioner – Reliability Engineer [ARP-E] course is intended for industrial reliability engineers charged with helping the organization improve reliability and performance, and for anyone else in the organization who desires to have an in-depth knowledge of the reliability and performance improvement process.

★★★★★
CUSTOMER RATING



## Key learning

You will come away from this course with a very good understanding of Asset Reliability fundamentals including how reliability engineers support overall improvement.

- The course covers the A-Z of reliability improvement. While it is not possible for you to be an expert planner / scheduler, or condition monitoring analyst, or lubrication engineer, you will gain a very solid knowledge in all these areas. You will know how to justify and prioritize your activities and take all the necessary steps to engineer a successful reliability and performance improvement initiative; and avoid the obstacles that have derailed so many programs in the past.
- After a brief introduction into the strategy and the role of the reliability engineer, we will take a deep dive into reliability engineering data analysis, including statistical analysis, Pareto analysis, Weibull analysis, Crow-AMSAA, and other techniques including AI, machine learning, and predictive analytics.

PUBLIC SCHEDULE

MIBOC OUTLINE

REQUEST A QUOTATION

# ARP Reliability Leader

## Good to know

**Summary:** whether your organization manufactures products or a commodity; provides an essential service; relies on machinery/electrical equipment, this course will provide a memorable explanation of how and why to improve reliability and performance.
**Duration:** 5-day course including review and exam
**Instructors:** practitioners with 25+ years of CM training experience. More than 3000+ students trained.
**Format:** Public hotel-based / virtual; Online self-paced; Private onsite / virtual, Min. 6 Students. (32 hours)
**Course Materials**: Printed and/or online
**Examinations:** MIBoC Certification examination; 100 questions, 3 hours, 70% passing grade
**Public Course Pre-study:** access to the the Mobius Institute Learning Zone before the class and for 4-months after course completion.
**Online Learning:** access to the Mobius Institute LMS for 4-months with optional 1-Year Continued Education Upgrade. Students also gain access to RMS Learning Community for 6-months.
**Certification Prerequisite:** prior experience is not required for attending the training course or taking the examination, but 48 months of relevant experience is required for ISO certification.

## Student profile:

- The Asset Reliability Practitioner - Program Leader [ARP-L] course is intended for those who have taken the lead role in the reliability and performance improvement program. Great responsibility comes with this great opportunity, and the aim of this course is to set you up for success.

★★★★★
CUSTOMER RATING

## Key learning

You will come away from this course with a very good understanding of Asset Reliability fundamentals including how reliability advocates support overall improvement.

- While technical knowledge is an advantage in this role, it is essential that you can lead people, communicate frequently and clearly, and have strong budget and project management skills. You must have a crystal clear vision of how the program will benefit the business and its employees, and a detailed plan, with milestones on how to achieve those goals. You must also understand the nature of the challenges that you will face and have a proactive strategy for overcoming those challenges.
- This course is designed to prepare you for that role, and to strengthen your knowledge and skills if you already hold that position. It is based on 30+ years of experience seeing a relatively small number of companies truly succeed in their mission, and countless companies fail.

PUBLIC SCHEDULE

MIBOC OUTLINE

REQUEST A QUOTATION


RDI Certification

Intro

# Motion Amplification

Motion Amplification is a revolutionary video-processing product and software package that detects subtle motion and amplifies that motion to a level visible with the naked eye. Simply put, it's ODS within seconds! We offer the Level 1 (Basic) and Level 2 (Advanced) Motion Amplification Certification. The 3-day courses covers MA Theory, Photography, Software including Motion Explorer, MA acquisition and Motion Studio.

Training includes real world case studies and the practical use of the MA system. Students bring their own IRIS M system to train on some real world faults. At the end of Day-3 there is a short open book Level certificated exam. RMS Ltd are an approved RDI Technologies distributor and offer sales, support and training. Courses are available for organisations who have purchased an RDI Camera system. For scheduled dates, see the MA training schedule.

Public & Onsite Courses

# What's Included

## Traditional Courses

4 or 5 days hotel-based or onsite training course. Optional certification exam from BINDT or Mobius Institute. Access to the very latest training cloud-based software, material and learning aids (before, during and for 4 months after the course). Some pre-course study, including becoming familiar with some of the quizzes and, in particular, the student workbook, is highly recommended. Online pre-and-post course tutorials. Online training manual. Accredited printed training manual. VA Diagnostic Pocket Guide, VA Reference Guide, Diagnostic Mouse Mat, VA Diagnostic A1 sized Wall Chart. Access to RMS training PC's, real world case studies and materials throughout the course. We also provide 2-3 course lunches & morning and afternoon snacks/drinks.

Novotel

Statham Lodge

Glenroyal Hotel

Stoke by Nayland Hotel

* We continue to follow UK Government COVID 19 health-guidelines.

### Public schedule

To review the 2021 public course schedule for VA, ARP and MA, visit the Training page on the website.

### Onsite enquiries

If your organisation has six or more students and would prefer us to come to you, email info@rms-training.com.

### Online exams

Students can study VA CAT I-IV and ARP CAT I-III online. The Exam can be taken at a local center or online (See details).

Online & Virtual courses

# What's Included



| Self-paced Community Support with Personal Mentoring Options | | | |
|---|---|---|---|
| **Course + Exam** | **Bronze** | **Silver** | **Gold** |
| **Vibration & Ultrasound Analysis**<br>VCAT I<br>VCAT II<br>VCAT III<br>VCAT IV<br>UCAT I<br><br>**Asset Reliability**<br>Advocate<br>Engineer<br>Leader | · 4 months access, 1-Year Continued Education Upgrade to Mobius online learning portal<br>· 6 months RMS community access<br>· Regular Q&A virtual meetings<br>· Optional Mobius examination | Everything in the Bronze plus...<br><br>· 2x 30 minutes 1-1 personal mentoring<br>· 1x 30 minutes exam revision support | Everything in the Bronze plus...<br><br>· 4x 30 minutes 1-1 personal mentoring<br>· 2x 30 minutes exam revision support |
| Virtual Instructor-led Course | | | |
| **Vibration & Ultrasound Analysis**<br>VCAT I<br>VCAT II<br>VCAT III<br>UCAT I | · 4 days CAT I<br>· 5 days CAT II-III<br>· Delivered live on GoToWebinar.<br>· Community on Microsoft Teams | This learning option follows the same structure as public and onsite courses, albeit virtually. Pre-study starts two weeks before. Skip two pages for the study outline, or visit the course online. | |
| Elearning - iLearnReliability: Interactive Learning Knowledge Platform | | | |
| **iLearn** (Per user, p.a.)<br>iLearn (CM)<br>iLearn (Pro)<br>iLearn (Ent) (10+ users) | The iLearnReliability system provides both short and long interactive lessons on a wide range of reliability improvement, condition monitoring, and precision maintenance topics. The aim is to educate as many people as possible in your plant. | | |

## Community

The cost of the self-paced VA & ARP courses includes access to a Microsoft Teams community. Instructors answer questions and provide ongoing course support.

## 1-1 Support

Self-paced courses include an option to purchase 1-1 mentoring with the course instructor. Calls can be conducted using Microsoft Teams or telephone.

## Interactive Learning

If you want to have the entire organization speaking the same "reliability language", all contributing to the program, then iLearnReliability is exactly what you need.

Self-paced, Virtual & Hybrid

# What's Included

## Online Courses

### Self-paced with community support

Register on the Mobius Learning Portal. Login details are sent by email (3-5 working days). The portal gives access to full online course and materials. Choose 4-month access. Optional 1-Year Continued Education Upgrade. Printed course materials sent (optional). Join the Community on Microsoft Teams for support.

### Virtual Instructor-led & Hybrid

Mobius Institute, Learning Portal registration.
Login details are sent by email (three to five working days).
Learning Portal gives access to pre-study course materials.
Printed course materials sent two weeks before live dates.
Join the RMS i-Led Backchannel on Microsoft Teams.
Go-to-webinar invitation, 2 weeks before live dates.
Test-run one week before the live dates.
Attend all course dates as per the schedule, typically.
4 days for CAT-I, 5 Days for CAT-II and CAT-III.

#### Awarding bodies

BINDT students need to complete this Registration Form.
BINDT/MIBoC exams can be taken locally (Approved invigilator). MIBoC exams can also be taken Online.

.

#### Technology requirements

Individual computer with camera and audio available to Go-to-Webinar. Organisations with facilities, one Camera with focus on the whole classroom.

#### Daily program

The training starts at 9 am on day 1, 8:30 am on subsequent days. We aim to finish before 5 pm. Regular breaks are built-in, as one would expect on a public hotel-based courses.

## Examination and results

CAT I: 2 hrs (multi-choice. 60 Q's. Closed book. Pass: 70%).
CAT II: 3 hrs (multi-choice. 100 Q's. Closed book. Pass: 70%).
CAT III: 4 hrs (multi-choice. 100 Q's. Closed book. Pass: 70%)
Results/Certifications will be sent within 3-4 weeks.

## Online exams

BINDT or MIBoC for. VA & Ultrasound. MIBoC for ARP. The Exam can be taken at a local center or online (links aboves).

Certification

# Eligibility & Examination

## Student eligibility for certification

CAT-I: you'll need 6 months or more experience in VA. When completing the experience section on the online registration form please confirm you have sufficient experience. Note that when completing the official exam registration form you will be required to provide a witness who can verify your declared experience.

CAT-II: you'll need 18 months or more experience in VA. When completing the experience section on the registration form please confirm you have sufficient experience. Note that when completing the official exam registration form you will be required to provide suitable evidence.

CAT-III: you'll need 36 months or more experience in VA and have a valid CAT II certificate. When completing the experience section on the registration form please confirm you have sufficient experience. Note that when completing the official exam registration form you will be required to provide suitable evidence.

CAT-IV: 60 months experience. Contact the Training Team for more information.

## Certification process:

Those who successfully pass the course assessments (70% or greater pass mark required), will be eligible to sit an accredited exam at the end of the course (or at a later date if preferred).

We offer certification that follows ISO 18536-2 and ASNT standards for Mobius, as well as BINDT. It is our policy not to favour one certification institute over the other – use the links above to make your own assessment.

The BINDT certification exam price includes postage and packaging of the exam papers, and postage of your printed certificate.

Important: If you opt for the BINDT certification you must also complete their Admission Form. This editable form will be sent to students after course registration. Here you'll find the BINDT VA syllabus.

The MOBIUS certification exam price includes postage and packaging of the exam papers, and postage of your printed certificate.

The Mobius exam registration is completed by each student once they are logged into their Mobius online portal. This login also gives access to the online pre-study portal.

*"Thanks for a really good and interesting training course! I feel much more confident implementing changes now, and for once we had a trainer that actually was interested in the subject! Bravo!" -* ***Senior CBM Specialist. SKF, Sweden***

Terms & Conditions

# RMS Reliability Training Institute

REQUEST A QUOTATION

1. THE REGISTRATION FORM MUST BE COMPLETED AND RETURNED TO CONFIRM A PLACE ON THE COURSE.
2. A VALID EMAIL ADDRESS MUST BE SUPPLIED FOR EACH CANDIDATE.
3. BOOKINGS ARE TAKEN ON A FIRST COME, FIRST SERVED BASIS AND MUST BE RECEIVED PRIOR TO ATTENDING THE COURSE.
4. IF YOU ARE AN EXISTING CUSTOMER THEN A VALID PURCHASE ORDER MUST ACCOMPANY THE REGISTRATION FORM. PLEASE ADD THE PO NUMBER TO THE REGISTRATION FORM AND SEND THE PO TO WENDY@RMS-RELIABILITY.COM.
5. IF YOU ARE A NEW CUSTOMER THEN PAYMENT WILL NEED TO BE MADE ON RECEIPT OF THE INVOICE.
6. FOR CREDIT CARD PAYMENTS, ADD YOUR CARD DETAILS TO THE REGISTRATION FORM, OR IF YOU PREFER, CALL THE ACCOUNTS DEPARTMENT ON +44 (0)1206 791917. IN ACCORDANCE WITH UK LAW, THERE ARE NO PROCESSING FEES FOR USING PERSONAL CREDIT OR DEBIT CARDS. IF YOU ARE PAYING WITH A COMMERCIAL CREDIT OR DEBIT CARD THE PROCESSING FEE IS CURRENTLY 2.5%. AS OF MAY 2ND, 2023, ANY COMPLETE OR PARTIAL REFUNDS ISSUED WILL BE SUBJECT TO A DEDUCTION OF 2.5% FOR THE CARD PROCESSING FEES INCURRED.
7. ANY CANCELLATIONS WOULD NEED TO BE RECEIVED AT LEAST FOUR WEEKS BEFORE THE START OF THE COURSE, (SO WE HAVE ENOUGH TIME TO OFFER THE PLACE TO SOMEONE ELSE) OTHERWISE A CANCELLATION FEE OF HALF THE COURSE COSTS WOULD BE PAYABLE. CANCELLATIONS NEED TO BE CONFIRMED IN WRITING OR BY EMAIL.
8. NOTIFICATION OF A CHANGE OF CANDIDATE OR CHANGE OF COURSE WOULD NEED TO BE RECEIVED AT LEAST TWO WEEKS BEFORE THE START OF THE COURSE. AN ADMIN FEE OF £ 100.00 PER CANDIDATE WILL BE CHARGED. ANY CHANGES NEED TO BE NOTIFIED TO US IN WRITING OR BY EMAIL.
9. IF A CANDIDATE DOES NOT ATTEND THE COURSE AND WE HAVE NOT BEEN NOTIFIED IN ADVANCE OR WE ARE GIVEN LESS THAN 1 WEEKS NOTICE THEN THE FULL COURSE FEE WOULD BE PAYABLE.
10. STUDENTS ATTENDING HOTEL-BASED COURSES ARE RESPONSIBLE FOR BOOKING THEIR ACCOMODATION AND ALL HOTEL COSTS.

**Languages**

We would assume that as the course and exam are delivered in English, your level of spoken and written English is sufficient for you to be able to attend the course and take the exam. If English is not your first language we can apply for extra time in advance of the course. Please notify us as soon as possible if there is any other reason why you need extra time in the exam (eg. Dyslexia), so we can see if we can arrange extra time for you in the exam. The exam body will need to be contacted to arrange this.

**Pricing & VAT**

Prices quoted are exclusive of UK VAT, currently at 20%. This applies to all training courses conducted in the UK. Please contact the Training team on +44 (0)1206 791917 if you have any queries.

Training Coordinator
**Wendy Whittle**
wendy@rms-reliability.com

General Enquiries
**Training Team**
info@rms-training.com

*Updated 28.04.2023*

# COVID 19 Liability Waiver

## Updated 08/20

I acknowledge the contagious nature of the Coronavirus/COVID-19 and that the CDC and many other public health authorities still recommend practicing social distancing. I further acknowledge that the RMS Reliability Training Institute has put in place preventative measures to reduce the spread of the Coronavirus/COVID-19. I further acknowledge that RMS Reliability Training Institute can not guarantee that I will not become infected with the Coronavirus/Covid-19. I understand that the risk of becoming exposed to and/or infected by the Coronavirus/COVID-19 may result from the actions, omissions, or negligence of myself and others, including, but not limited to, training staff, and other training clients and their families. I voluntarily seek services provided by RMS Reliability Training Institute and acknowledge that I am increasing my risk to exposure to the Coronavirus/COVID-19. I acknowledge that I must comply with all set procedures to reduce the spread while attending my training course. I attest that: I am not experiencing any symptom of illness such as cough, shortness of breath or difficulty breathing, fever, chills, repeated shaking with chills, muscle pain, headache, sore throat, or new loss of taste or smell. I have not traveled internationally within the last 14 days. I have not traveled to a highly impacted area outside the UK in the last 14 days. I do not believe I have been exposed to someone with a suspected and/or confirmed case of the Coronavirus/COVID-19. I have not been diagnosed with Coronavirus/Covid-19 and not yet cleared as non contagious by state or local public health authorities. I am following all UK Government recommended guidelines as much as possible and limiting my exposure to the Coronavirus/COVID-19. I hereby release and agree to hold RMS Reliability Training Institute harmless from, and waive on behalf of myself, my heirs, and any personal representatives any and all causes of action, claims, demands, damages, costs, expenses and compensation for damage or loss to myself and/or property that may be caused by any act, or failure to act of the company, or that may otherwise arise in any way in connection with any services received from RMS Reliability Training Institute. I understand that by ‘placing a booking’ this release discharges RMS Reliability Training Institute from any liability or claim that I, my heirs, or any personal representatives may have against the company with respect to any bodily injury, illness, death, medical treatment, or property damage that may arise from, or in connection to, any services received from RMS Reliability Training Institute. This liability waiver and release extends to all owners, partners, and employees. **Making a booking confirms acceptance of the COVID 19 Liability Waiver.**

Venues

# Public Training Courses

Our public courses are hosted at a range of beautiful locations across the UK & Ireland. All our venues offer exceptional facilities, friendly staff and spectacular scenery. See the Training Schedule for which courses are available in each location.

## Manchester

**Novotel Manchester West**
Worsley Brow
Worsley, M28 2YA
https://all.accor.com/

## Dublin

**The Glenn Royal Hotel**
Straffan Rd, Maynooth,
Co. Kildare, W23 C2C9
https://www.glenroyal.ie/

## Lymm

**Stratham Lodge**
Warrington Road, Lymm,
Cheshire, WA13 9BP
https://stathamlodge.com

## Colchester

**Stoke by Nayland Hotel**
Keepers Lane, Leavenheath,
Colchester, Essex, CO6 4PZ
https://www.stokebynayland.com

Locations

# Onsite Training Courses

Over the past 20 years, our experienced team of trainers have conducted onsite training in countries all around the world. With many years engineering experience, our team works cross-sector for both UK & International blue-chip companies.

## UK & Ireland

Courses have been held in most counties across the UK over the past 20 years! We travel happily!

## Europe

Germany, France, Italy, Belgium, Luxembourg, Netherlands, Denmark, Sweden, Norway...

## Worldwide

USA, Mexico, Columbia, Malaysia, UAE & Middle East, Malaysia & SE Asia, South Africa, Australia.

Distance Learning

# Online Training Courses

Online, self-paced learning with Mobius Institute's award-winning learning portal. To meet the requirements for ISO Certification, every course lesson should be viewed thoroughly. Once completed, a Certificate of Completion from Mobius Institute can be requested.

## Vibration Analysis

VA CAT-I to IV online courses are available from Mobius Institute.

## Asset Reliability

ARP CAT-I to III online courses are available from Mobius Institute.

## iLearn Knowledge

iLearnReliability (CM)
iLearnReliability (Prof.)
iLearnReliability (Ent.)

Appendix

# Brochure Resources

## British Institute of Non-destructive Testing (BINDT)

Vibration

Analysis

Requirements for Certification

Training Syllabus

Ultrasound

Requirements for Certification

Training Syllabus

Thermography

Requirements for Certification

Training Syllabus

## Mobius Institute (MIBoC)

Vibration Analysis CAT-I, CAT-II, CAT-III, CAT-IV

Ultrasound Analysis CAT-I

Infrared Thermography CAT-I

ARP Advocate, Engineer, Leader

**Certification Services Division**
**Midsummer House, Riverside Way**
**Bedford Road, Northampton**
**NN1 5NX, United Kingdom**

Tel: +44 (0)1604 438300
E-mail: cm.admin@bindt.org

REQUEST A QUOTATION

# CM/GEN APPENDIX D Issue 9

## Issue dated: 1st July 2020
## Implementation date: 1st July 2020

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

CONTENTS

**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 is appended to CM/GEN (General requirements for qualification and certification of condition monitoring and diagnostic personnel). Other Appendices cover:

| | |
|---|---|
| Appendix A | Acoustic Emission |
| Appendix B | Infra-red Thermography |
| Appendix C | Lubrication Analysis |

These other non-intrusive technologies are used as complementary condition analysis tools. Those in the manufacturing industry who have diligently and consistently applied these technologies have experienced a return on investment far exceeding their expectations.

This series of documents is designed to provide comprehensive information for users of the PCN Scheme. The complete list of published PCN condition monitoring documents is detailed in publication reference PSL/8A-CM, which is posted on the Institute's web site at www.bindt.org, where all documents are available for download free of charge.

It is intended, through publication of these documents, to provide industry, PCN candidates and certificate holders with all relevant information. However, if further information or advice is required on any certification matter, contact the Certification Services Division of BINDT on telephone number +44 (0) 1604 438300, or email cm.admin@bindt.org

Organisations requiring at all times to be in possession of the most up to date PCN documents may register with the "PCN Update Scheme" which, for a small annual fee, guarantees that they automatically receive all new and revised PCN documents.

## 1. Scope

1.1. This appendix to PCN CM/GEN sets out the specific requirements for qualification and certification of personnel engaged in Vibration Analysis Condition Monitoring. In the event of a conflict between the requirements of PCN CM/GEN and this Appendix, the PCN CM/GEN requirements shall prevail.

1.2. This specification is in accordance with ISO 18436-2: Condition monitoring and diagnostics of machines-Requirements for qualification and assessment of personnel- Vibration Condition monitoring and diagnostics

1.3. Certification to this specification will provide evidence and recognition of the qualification and competence of individuals to perform machinery vibration measurements and analysis (hereafter referred to as Vibration Analysis in this specification) using portable and permanently installed sensors and equipment.

1.4. This part of CMGEN covers a four-Category certification programme that is based on the technical areas delineated herein.

1.5. The scope of this programme encompasses the normative references specified in ISO 18436-2 clause 2 and those found in Annex B of this document, and incorporates the terms and definitions found in ISO 18436-2 clause 3 and CMGEN, unless otherwise stated in this document.

1.6. BINDT, as a certification body accredited by UKAS in accordance with EN ISO/IEC 17024, manages this condition monitoring programme against these specifications which are derived from the relevant ISO 18436 parts, but wherever any minor regional or national modification to this adoption exists then it shall be identified as a ‘delta’ and signified by text enclosed in a box, in accordance with ISO/IEC Guide 21-1. At no point does any minor modification diminish the specifications in ISO 18436-2. Where appropriate, the structure and format of this specification shall reflect that of all BINDT PCN specification documents for document harmonization.

## 2. Classification of Personnel

### 2.1. General

1. Individuals certificated in accordance with this specification are classified in one of four Categories depending upon their qualifications and assessment, and have demonstrated the necessary competence and skills in the concepts of machinery vibration condition monitoring and diagnostics for their classification Category as indicated in the examination syllabus at Annex A, in the concepts of machine condition monitoring using VA.

2. The classification of individuals at all categories shall be subject to the scope and any limitations of the award issued by BINDT. 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.

3. 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.

4. 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 shall remain as it was at the time it was issued.

5. 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

| |
|---|
| 2.1.6. Personnel classified at a higher Category shall require the competence, knowledge and skills expected of personnel at all lower Categories |

### 2.2. Vibration Analysis Category 1

PCN certificated Vibration Analysis Category 1 personnel are qualified to perform a range of pre-defined, simple single channel machinery vibration condition monitoring and diagnostics of machines activities in accordance with established procedures. All activities shall be performed under direction. Personnel certified to Category 1 shall at least:

1. know of the basic principles of vibration and recognize the different units of measurement;

2. be able to collect reliable data ensuring appropriate standards of repeatability;

3. be able to identify errors in collected data;

4. 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;

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

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

7. report on visual observations of equipment condition. They

shall not be responsible for:

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

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

### 2.3. Vibration Analysis Category 2

PCN certificated Vibration Analysis Category 2 personnel are qualified to perform industrial machinery vibration measurements and basic vibration analysis using single-channel measurements, with or without phase trigger signals, according to established and recognised procedures. They require all the knowledge, experience and skills expected of Category 1, and in addition they shall at least:

1. be able to define the measurement activities to be undertaken by a category 1 individual in the course of routine data collection;

2. 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;

3. be able to perform basic (single channel) impact tests to determine natural frequencies;

4. be able to interpret and evaluate test results and acceptance tests in accordance with specifications and standards;

5. 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;

6. be able to provide technical guidance to and instruct category 1 personnel.

### 2.4. Vibration Analysis Category 3

PCN certificated Vibration Analysis Category 3 personnel require all the knowledge, experience and skills expected of personnel classified to categories 1 and 2, and in addition shall at least:

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

2. be able specify the appropriate vibration instrumentation hardware, software and processing for portable monitoring systems and permanently installed surveillance systems, and equipment protection systems;

3. 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 operating conditions, with or without a phase trigger;

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

5. be able to initiate and validate machinery corrective actions, including in situ two-plane rigid rotor balancing;

6. be able to recommend restrictions to machine operation;

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

2.4.8. be able to provide technical guidance to and instruct category 1 and 2 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.

2.4.9. be able to carry out, manage and supervise PCN CM qualification examinations on behalf of the BINDT, if so appointed.

It is the responsibility of the employer or client to ensure that category 3 personnel have the necessary competency in the required management skills, e.g. creating budgets, preparing cost justifications, and managing personnel development.

**2.5 Vibration Analysis Category 4**

PCN certificated Vibration Analysis Category 4 personnel require all the knowledge and skills expected of personnel certified to categories 1, 2 and 3, in addition, they shall be able to direct and audit condition monitoring strategies.

Employers should recognize that a category 4 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 4 shall at least:

1. 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;
2. be able to understand and perform signal analysis, including understanding of frequency and time domain processing, including orbits and their limitations;
3. be able to determine the natural frequencies, mode shapes and damping of systems, components and assemblies;
4. be able to determine the operating deflection shapes of machines and connected structures and recommend means for correction;
5. be able to use generally recognised advanced techniques for vibration analysis, parameter identification and fault diagnosis;
6. be able to apply basic principles of rotor-bearing dynamics to vibration diagnosis;
7. be able to recommend advanced two-plane influence coefficient or static and couple balancing theory;
8. be able to recommend corrective actions or design modifications, including component change or repair, isolation, damping, change of stiffness and change of mass;
9. be able to interpret and evaluate codes of practice and specification published in International Standards and other documents;
10. be able to recognise vibration caused by gas pulsation in machines such as reciprocating machines and screw compressors, and be able to measure the necessary parameters and recommend means for correction;
11. recommend corrective actions for resilient mounting and other holding-down and foundation problems;

2.5.12. carry out, manage and supervise PCN CM qualification examinations on behalf of the BINDT, if so appointed

## 3. Eligibility for Examination and Certification

3.1. General

3.1.1. In order to conform to the requirements of this document, and to ISO 18436-2, candidates shall have a combination of education, training and experience sufficient

to ensure that they understand the principles and procedures applicable to machinery vibration measurement and analysis consistent with Clause 2 and Annex A.

3.1.2. Candidates shall affirm adherence to the code of ethics contained in ISO18436-1 and BINDT document CP27- Code of Ethics.

3.2. Education

3.2.1. 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 3 and 4 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 certification to categories 3 and 4.

3.3. Training

3.3.1. To be eligible to apply for assessment to the requirements of this specification, candidates shall provide documentary evidence of successful completion of a BINDT accredited or recognised course of formal training based on the requirements of Annex A. The minimum duration of recommended training is shown in Table 1.

BINDT allows a maximum of 50% self-study or on-line training for topics consistent with Annex A and as specified by the approved trainer (CMGEN refers).

3.3.2 Training should take the form of formal lectures, demonstrations and trainer specified practical exercises or controlled self-study.

To achieve certification from BINDT the candidate must also provide evidence of required experience as specified below.

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 (hours)**

| Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|
| 30 | Category 1 + 38 | Category 2 + 38 | Category 3 + 64 |
| | | | |

2. 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. 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.

3. 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 half the duration as specified in 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.

3.4. Experience

3.4.1 To be eligible for assessment to the requirements to this specification, candidates shall provide evidence of experience in the field of machinery vibration condition monitoring and diagnostics. For category 4 candidates, validation may be acquired from another category 4 practitioner or their company manager.

3.4.2 Candidates must maintain a log of hours and nature of work on BINDT PCN document CP16-CM for all Categories.

The minimum experience requirements are shown in Table 2.

**Table 2 – Minimum Experience Requirements (months)**

| Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|
| 6 | 18 | 36 | 60 |
| NOTE The figures shown represent cumulative total months of experience to be held for each classification | | | |

Designation of a person as category 1 is not a prerequisite for certification as category 2. However, certification of a person as category 3 and category 4 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.

## 4 Certification Available

1. Category 1 (General – Vibration analysis condition monitoring)
2. Category 2 (General – Vibration analysis condition monitoring)
3. Category 3 (General –Vibration analysis condition monitoring)
4. Category 4 (General –Vibration analysis condition monitoring)

## 5 Qualification Examination

1. Application for qualification examinations

1. Application for qualification examinations is made on PCN form PSL/57-CM and supported with PSL30 and PSL33 where required.

5.2 Examination content (Theory and practical knowledge)

5.2.1 For each certification Category, the candidates shall be required to answer the number of questions indicated in Table 3. Category 3 examination papers are made up from both multiple choice and narrative questions. On each Category 3 paper there will be ten narrative questions offered, and only five need to be answered. Each narrative question will be worth ten marks, equivalent of ten multiple choice questions.

**Table 3 – Qualification examination content**

| **Categories** | **Number of Questions** | **Time (Hours)*** | **Passing Grade %** |
|---|---|---|---|
| Category 1 | 60 | 2.0 | 70 |
| Category 2 | 100 | 3.0 | 70 |
| Category 3 | 100 | 4.0 | 70 |
| Category 4 | 60 | 5.0 | 70 |

** Examination times may be extended by 25% to assist candidates with a disability or in the event that their first language is not English, in accordance with BINDT document CMGEN clause 9.3.*

2. Questions shall be of a practical nature, yet shall test the candidate regarding the concepts and principles required to conduct machinery vibration analysis 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.

3. Category 3 and 4 examinations may include both short answer (narrative) and multiple choice questions.

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

5.2.5 Detail of BINDT examination, re-examination and renewal procedure is given in BINDT documents CMGEN and PSL/65-CM-Marine.

5.3 Examination conduct

5.3.1 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 in BINDT documents CMGEN and PSL/65-CM-Marine.

## Annex A – Training Syllabus

**Table A.1 – Overview**

| Subject | | Category | | | |
|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** |
| 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 | 0 |
| 8. | Acceptance testing | 2 | 2 | 2 | 0 |
| 9. | Equipment testing and diagnostics | 0 | 2 | 4 | 4 |
| 10. | Reference standards | 0 | 2 | 2 | 2 |
| 11. | Reporting and documentation | 0 | 2 | 2 | 4 |
| 12. | Fault severity determination | 0 | 2 | 2 | 3 |
| 13. | Rotor/bearing dynamics | 0 | 0 | 0 | 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. | | | | | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **Principles of vibration** | 6 | 3 | 1 | 4 | | | | |
| **1.01** | Basic motion | • | • | • | | Recognise vibration, and understand the origin of the sine wave. | Understand superposition of sinusoidal vibrations; single degree of freedom. | Understand damped free vibration; self-excited, steady state and transient vibration; multiple degrees of freedom | |
| **1.02** | Period, frequency | • | • | • | | Recognise the following features of a vibration signal: time axis, period, frequency. Use of hertz or cycles per minute | Understand relationship of period to frequency, beat frequency | Understand requirements for selecting appropriate time period and frequency. Be aware of octave band analysis | |
| **1.03** | Amplitude: peak, peak-to-peak, r.m.s. | • | • | • | | Recognise the following features of a vibration signal: amplitude, peak, peak-to-peak, r.m.s | Understand the relationship between peak, peak-to-peak, r.m.s | Understand reasons for using peak, peak-to-peak or r.m.s. | |
| **1.04** | Parameters: displacement, velocity, acceleration | • | • | • | | Recognise the following parameters: displacement , velocity and acceleration | Understand the application displacement, velocity or acceleration | Understand the factors behind choosing displacement, velocity or acceleration | |
| **1.05** | Units, unit conversions | • | • | • | | Recognise that units conversion is possible | Understand conversion of units and integration | Be aware of integration, differentiatio n, effect on frequency distribution | |
| **1.06** | Time and frequency domains | • | • | • | | Be aware of time and frequency domain. | Be aware of enveloping, bandpass filters; demodulation ; crest factor | Be aware of orbit analysis, Lissajous figures, windowing | |
| **1.07** | Vectors, modulation | | | • | • | | | Understand vector definition, modulation | Acquisition for modal techniques |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **1.08** | Phase | | • | • | • | | Units; phase reference position | Phase detection methods | Cross-channel; coherence |
| **1.09** | Natural frequency, resonance, critical speeds | • | • | • | • | Be aware resonance exists, and its effect on vibration | Fundamental natural mode; single degree of freedom. Recognise factors including: frequency, stiffness, mass, damping, isolation | Critical speeds, two degrees of freedom, dynamic vibration absorber. Be aware of modal techniques and operational deflection shapes | *Q* Factor, multiple degrees of freedom systems, have a detailed understanding of modal techniques and operational deflection shapes |
| **1.10** | Force, response, damping, stiffness | | | • | • | | | Understand mobility, compliance | Apply mobility plot, stiffness, impedance, accelerance |
| **1.11** | Instabilities, non-linear systems | | | | • | | | | Non-elastic mounting systems |
| **2** | **Data acquisition** | **6** | **4** | **2** | **2** | | | | |
| **2.01** | Instrumentation | • | • | • | • | Recognising single channel hand-held route- based and on-line measurement and monitoring systems | Dual channel on and off-line acquisition, monitoring, and analysis systems including phase | Multi-channel on and off-line acquisition, monitoring, and analysis systems including phase | Multi-channel including modal analysis and troubleshooting |
| **2.02** | Dynamic range, signal-to-noise ratio | | | • | • | | | Be aware of requirements for dynamic range and signal-noise ratio. Auto-ranging, integration and system errors | Techniques for improving resolution and accuracy. Noise reduction and post- processing |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **2.03** | Transducers | • | • | • | | Recognise displacement, velocity and acceleration transducers. Be aware of powered and non- powered types | Be familiar with proximity probes, velocity transducers, accelerometers, including those with in-built integration, Be aware of requirements for transducer frequency ranges; runout compensation, need for calibration | Understand transducer selection requirements, including machine expected fault frequency, Understand typical runout compensation methods for proximity probes. Understand and be able to set calibration requirements | |
| **2.04** | Sensor mounting, mounted natural frequency | • | • | • | | Recognise broad effects of mounting on the frequency response, e.g. stud, magnet or probe | Understand accelerometer mounting methods and effects on frequency response; be familiar with a range of mounting methods. Be aware of transducer sensitive axis, tribo- electric effects | Understand International Standard measurement specifications; axial thrust bearing measurement requirements; mounting response and resonance; adhesive curing times | |
| **2.05** | $F_{max}$, acquisition time | | • | • | | | Understand $F_{max}$, zoom function; simple resolution calculations; relationship of $F_{max}$ to acquisition time | Understand basic aspects of fast Fourier transform (FFT) processing, samples, sampling rate, aliasing | |
| **2.06** | Proximity sensor conventions | | • | • | | | Recognise aspects such as: gap voltage, orthogonal radial fitment, and runout | Field calibration checks; proximity probes; axial thrust bearing measurement, runout compensation | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **2.07** | Triggering | | • | • | | | Be aware of use of phase detection: e.g. eddy- current probes, photocells, tracking filters | Understand synchronous time averaging and triggering. Be aware of use with dynamic balancing | |
| **2.08** | Test planning | | • | • | • | | Be able to plan and schedule vibration monitoring (VM) | Managing condition monitoring (CM) programmes | Creating specialised test procedures |
| **2.09** | Test procedures | • | • | • | • | Follow pre-set data acquisition procedures for on-line or route-based systems. Recognise measurement points for common machine types. Recognise some poor data and alarm conditions. Be aware calibration is a requirement | Be able to set up VM data collection system, e.g. select machines and measurement points, create appropriate acquisition and alarm settings, carry out and supervise measurement and basic reporting, and carry out calibration procedures | Manage VM programs, set up calibration procedures. Advanced CM reporting. Troubleshooting | Creating test and calibration procedures, Standards development |
| **2.10** | Data formats | | • | • | | | Be aware of the common units and basic range of data presentation formats, e.g. trending, spectra, waterfall, time trace, phase | Understand range of data presentation formats e.g. trending, spectra, waterfall, time trace, phase, Bode, Nyquist, Campbell plot etc. | |
| **2.11** | Computer database upload/download | • | | | | Be aware of basic functions of host and data collector | | | |
| **2.12** | Recognition of poor data | • | • | • | | Recognise simple fault conditions, e.g. ski-ramp, no signal, cable fault | Mounting error; cable faults, tribo-electric, bias voltage and settling time | Processing related errors, incorrect $F_{max}$, sampling time, integration etc | |
| **3** | **Signal processing** | **2** | **4** | **4** | **8** | | | | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **3.01** | r.m.s./peak detection | | | | • | | | | Understand r.m.s and peak detection features and benefits |
| **3.02** | Analogue/digital conversion | | | | • | | | | Understand requirements of analogue to digital conversion. Be aware of key stages in acquisition |
| **3.03** | Analogue sampling, digital sampling | | • | • | • | | Be aware of basic function of analogue to digital conversion, block diagram. Basic understanding of clipping, truncation and leakage | Understand FFT process; minimum multiples of frequency interest; synchronous sampling/key phasor; sampling rates | Understand requirements of analogue sampling and digital sampling. Be aware of key stages in acquisition |
| **3.04** | FFT computation | | | • | • | | | Be aware of FFT process block diagram. E.g. transducer, signal conditioning, anti-alias, analog-digital, windowing | Understand FFT process block diagram. E.g. transducer, filtering, signal conditioning, anti- alias, analogue-digital, windowing, cepstrum |
| **3.05** | FFT application | • | • | | | Be aware of the term FFT and recognise the following basic FFT terminology, e.g. number of lines, $F_{max}$ and time to sample | Matching FFT requirements to range of common fault profiles. Understand the requirements for number of lines (bins), $F_{max}$ sampling time, sampling rate. Basic understanding of other factors such as: anti-aliasing, windowing and averaging | | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **3.06** | Time windows (uniform, Hanning, flat-top) | | • | • | | | Be aware of Hanning window profile and its effect on sampling, e.g. reducing leakage, effect on amplitude and frequency | Be aware of other window functions: uniform, hamming, flat-top, and their effect on sampling, e.g. reducing leakage, effect on amplitude and frequency | |
| **3.07** | Filters (low pass, high pass, band pass, tracking) | | • | • | • | | Be aware of basic types of vibration filters; low pass; high pass; band pass | Recognise the following filter types; low pass; high pass; band pass. Be aware of pass-band and stop- band and tracking filters | Be aware of other filter types: E.g. Bessel, Butterworth, Chebyshev, Gaussian, elliptic. Be aware of basic filter design parameters, e.g. filter poles and response |
| **3.08** | Anti-aliasing | | • | • | • | | Be aware of requirement for Anti-aliasing filter | Understand requirements for aliasing and anti- aliasing filters and common methods | Be aware of instrument ation anti-aliasing design requiremen ts |
| **3.09** | Bandwidth, resolution | | • | • | • | | Bandwidth of bandpass filter; FFT resolution; signal duration; lines of resolution; analyser sample time; FFT collection time | Frequency resolution; distortion; calculations; frequency resolution | Noise and random vibration; response function |
| **3.10** | Noise reduction | | • | • | • | | Be aware of basic filtering and averaging methods used to reduce noise | Understanding requirements for noise reduction. Analogue and digital filtering | Understand and apply noise reduction techniques such as increased frequency resolution, time synchronous averaging, selection of low inherent |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | noise sensors and instrum ents, etc. |
| **3.11** | Averagi ng: Linear, synchr onous time, expone ntial | | • | • | • | | Be aware of FFT frequency averaging | Linear frequency and synchronous time domain averaging; overlapping averaging | Exponential frequency domain averaging |
| **3.12** | Dynamic range | | • | • | • | | Be aware of the term dynamic range | Understan d need for dynamic range. | Digital dynamic range calculations |
| **3.13** | Signal-to-noise ratio | | | | • | | | | Be aware of methods for testing and establishing signal-to-noise ratio |
| **3.14** | Spectral maps | | | • | • | | | Waterfall plots, recognising speed related and resonance frequencies | Cascade plots, Campbell diagrams, spectrogram |
| **4** | **Condition monitoring** | **2** | **4** | **3** | **1** | | | | |
| **4.01** | Computer data base set-up, computer database maintenance | | | • | | | | Procedures for setting measurement parameters locations and frequency. Database maintenance | |
| **4.02** | Equipment evaluation and prioritisation | | • | | | | Be able to review sites and establish equipment VM requirements | | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **4.03** | Monitoring programme design | | • | • | • | | Be able to set up a VM programme using ISO 17359 and ISO 13373 | Be familiar with applicable CM and VM Standards including ISO 17359 and ISO 13373, and to be able to carry out failure mode and effect analysis (FMEA) to establish program requirements. | Be familiar with all applicable CM and VM Standards, be able to set up and carry out FMEA to establish programme requirements |
| **4.04** | Alarms set-up: Narrowband, envelope | | | • | | | | Be able to specify vibration severity using appropriate ISO Standards and to set and apply frequency band and envelope alarms | |
| **4.05** | Baseline assessmen ts, trending | | • | • | | | Measuring baselines E.g. to ISO 10816, ISO 20816, ISO 14694, ISO 8528-9 or other requirements | Be able to set baseline requirements using all appropriate International Standards | |
| **4.06** | Route planning | | • | • | | | Be able to set up VM routes | Be able to optimise VM and CM routes | |
| **4.07** | Alternative technologies, e.g. infrared thermographic testing (TT); acoustic emission testing (AT); ultrasonic testing (UT), lubricant management (LM) – tribology and wear debris analysis; motor current analysis (MCA) | | | • | • | | | Be aware of TT; AT; UT, LM – tribology and wear debris analysis); MCA | Be aware of performance monitoring; causes of bearing wear |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **4.08** | Fault condition recognition | • | • | | | Recognising basic pre-set fault conditions, e.g. unbalance, looseness, misalignment, bearing noise and damage | Recognising more advanced range of fault conditions, e.g. unbalance, looseness, misalignment, bearing noise and damage, gear mesh faults, rotor bar and stator faults, drive belt faults, resonances etc | | |
| **5** | **Fault analysis** | **4** | **5** | **6** | **6** | | | | |
| **5.01** | Spectrum analysis harmonics and sidebands | | • | • | • | | Understand FFT harmonics, sidebands, and noise. Be aware of enveloping | Be familiar with FFT harmonics, sidebands, modulation and noise, octave bands | Understand cepstrum analysis, octave band analysis |
| **5.02** | Time waveform analysis | | • | • | • | | Understand the use of time waveform for basic analysis. | Be aware of requirements for time waveform sampling duration for different applications | Be able to conduct time waveform analysis on varied applications |
| **5.03** | Phase analysis | | • | • | • | | Understand the use of phase for basic analysis. | Understand basic time waveform analysis. Be able to use phase to confirm misalignment, static/couple unbalance, Bode and Nyquist Plots | Apply time waveform analysis to varied machine problems. Phase analysis of structural components, modal analysis and operational deflection shapes (ODS). System and structural response |
| **5.04** | Transient analysis | | | • | • | | | Coast down and run down time and phase plots, e.g. Bode plots | Understand swept frequency methods, time and phase run down analysis |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **5.05** | Orbit analysis | | | • | • | | Be aware of basic orbit analysis | Be aware of how the orbit shape indicates potential fault conditions. Explain the difference between filtered and un-filtered orbits. Explain why "glitch removal" is necessary. | Be familiar with orbit analysis, shaft resonance, Nyquist plots, oil whirl, etc |
| **5.06** | Shaft centre-line analysis | | • | • | • | | Be aware of the shaft centre-line plot. | Understand the data presented in a shaft centre-line plot. | Be able to interpret the data presented in the shaft centreline plot. |
| **5.07** | Enveloping | | • | • | • | | Understand the application of enveloping. | Understand the details of enveloping (and associated proprietary techniques) so that routine measurements can be set up correctly. | Understand de-modulation (enveloping) process and requirements |
| **5.08** | Mass unbalance | | • | • | | | Understand static, couple and dynamic unbalance; residual unbalance, initial unbalance | Be aware of sensitivity and susceptibility to unbalance; balance errors, sources of unbalance | |
| **5.09** | Misalignment | | • | • | | | Be aware of alignment tolerances, recognise misalignment in FFT and time trace | Understand sources of misalignment and methods of detection using FFT and time trace. Understand requirements and tolerances for alignment | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **5.10** | Mechanical looseness | | • | • | | | Recognise looseness in FFT and time trace | Understanding sources of misalignment and looseness and methods of detection using FFT and time trace | |
| **5.11** | Rubs, instabilities | | | • | • | | | Understandin g sources and effect of rubs and methods of detection using spectra and time waveform | Recognising sources of process instabilities |
| **5.12** | Bearing defects (rolling element, journal) | | • | • | | | Rolling element bearing defects, noise, impacts, damage, ball pass frequency of the outer race (BPFO), ball pass frequency of the inner race (BPFI), ball spin frequency (BSF), and fundamental train frequency (FTF). Time traces and enveloping data. Recognise the term: oil whirl. Recognise patterns of bearing defects in FFT and time traces | Journal bearing rub and sub-synchronous vibrations. Understand dynamics of oil whirl, and methods of avoiding or reducing effect of oil whirl | |
| **5.13** | Electric motor defects | | • | • | • | | AC induction motor poles and line frequency; stator and rotor bar frequency analysis | Variable speed drives, pulse width modulation. AC induction and synchronous motor drives | Thermal effects, DC motor drives |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **5.14** | Flow induced vibration, aerodynamics and liquids | | | • | • | | | Recognise and understand cavitation, recognise rotating stall | Understanding rotating stall, pulsation |
| **5.15** | Gearbox analysis | | • | • | | | Recognising gear mesh frequency and sidebands in FFT and modulation in time trace. Application of demodulation (enveloping) | Time domain averaging; sidebands and gear mesh frequency. Understanding of enveloping | |
| **5.16** | Resonance and critical speeds | | • | • | • | | Resonance; critical speed in rigid rotors; single degree of freedom | Resonance; critical speed in flexible rotors; two degrees of freedom | Resonance; critical speed in flexible rotors; multi degrees of freedom |
| **5.17** | Turbomachinery | | | • | • | | | Understanding oil whirl, rubs, misalignment, process influence | All faults associated with turbomachinery including oil whirl, oil whip, hogging, sagging, unbalance, misalignment, and intermittent rubs |
| **5.18** | General fault recognition | • | | | | Recognise fault frequencies for pre-set FFT and simple time waveforms for unbalance, looseness, misalignment, bearing noise and damage. Also recognise the terms: resonance and phase | | | |
| **6** | **Corrective action** | **2** | **4** | **6** | **16** | | | | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **6.01** | Shaft alignment | | • | • | | | Be aware of shaft alignment, tolerances | Understand shaft alignment tolerances e.g. relationship of turbine rotor speed to tolerances | |
| **6.02** | Field balancing | | • | • | • | | Understand single plane balancing of rigid rotors with and without phase. Be able to use balance quality and permissible residual unbalance. Be aware of test mass estimation | Understand two plane balancing of rigid rotors with phase. Be aware of static, couple and dynamic unbalance. offset balancing. balance errors. | Be aware of requirements for flexible rotor balancing, phase and modal techniques. Be aware of range of ISO balancing standards |
| **6.03** | Replacement of machine parts | | | • | | | | Be aware of requirements for replacement parts and factors such as balance and alignment tolerances | |
| **6.04** | Flow control | | | • | • | | | Understanding relationship of flow and pressure to avoid fluid cavitation | Be aware of influence of pipework or ductwork in fluid and aerodynamic flow |
| **6.05** | Isolation and damping | | | • | • | | | Be aware of requirements for specifying isolators | Understand requirements and calculations for specifying isolators |
| **6.06** | Resonance control | | | • | • | | | Be aware of methods of reducing/eliminating resonance: e.g. mass change, stiffness change, frequency change | Understand principles of dynamic vibration absorbers, application of damping and isolation |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | 2 | 3 | 4 | Recommended sub-topics<br>Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **6.07** | Basic maintenance action | • | • | • | | Be aware of simple maintenance actions to rectify or reduce faults, e.g. lubrication, alignment | Be aware of range of responses to fault conditions, e.g. part replacement, lubrication, single plane balancing, alignment, and resonance control | Be aware of range of methods to correct faults, e.g. replacement of parts, balancing, alignment, resonance control. e.g. recommending structural modifications etc. | |
| **7** | **Equipment knowledge** | **6** | **4** | **4** | **–** | | | | |
| **7.01** | Electric motors, generators and drives | • | • | • | | Recognise AC induction motor, and basic faults, e.g. bearing noise and damage, balance, looseness and misalignment | Application of key International Standards e.g. ISO10816-1 and Part 3 to AC induction motors and generators. Be aware of torque pulse, rotor and stator frequencies, variable speed drive harmonics, and slip frequency calculations | Be familiar with common types of AC and DC motor construction; wind turbine generator construction and components. Be familiar with applicable International Standards | |
| **7.02** | Pumps, fans | • | • | • | | Recognise basic pump and fan combinations, and basic faults, e.g. bearing noise and damage, balance, looseness and misalignment | Application of key International Standards e.g. ISO 10816-7 for pumps and ISO 14694 for fans. Leaks, cavitation, sub-synchronous frequencies; eccentric impellers; Pump flow conditions | Pump seals. Basic fan construction, installation, and operation; Recognise rotating stall, wind turbine rotor construction and components. Be familiar with applicable standards and specifications, e.g. ISO, Verein Deutscher Ingenieure [Association of German Engineers] (VDI) and American Petroleum Institute (API) | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **7.03** | Steam turbines, gas turbines | | • | • | | | Application of key International Standards e.g. ISO 10816 and ISO 20816 on vibration, basic fault set: balance, looseness, misalignment, oil whirl, rubs | Proximity probe set-up and calibration, Alarm level triggers (steam/gas turbines), stiffness and thermal dissymmetry. Affect of condenser vacuum, hogging, sagging, oil whirl, oil whip, rubs. Be familiar with applicable standards and specifications, e.g. ISO and API and other specifications. | |
| **7.04** | Compressors | • | • | • | | Recognise examples of centrifugal and screw compressors | Application of key International Standards e.g. ISO 10816 and ISO 20816 on vibration. Rotating compressor components, fault frequencies e.g. pumping frequency and rotor harmonics | Rotating and reciprocating compressor design and fault frequencies. Influence of process conditions. Be familiar with applicable standards, e.g. ISO and API | |
| **7.05** | Reciprocating machinery | | • | • | | | Application of key International Standards e.g. ISO 18016-6 and ISO 8528-9. | Reciprocating piston motion, primary and secondary balancing component standards, e.g. ISO and VDI | |
| **7.06** | Rolling mills, paper machines, other process equipment | • | • | • | | Recognise examples of these machines | Be aware of components, faults, access | Pulp refining machinery measurement s | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **7.07** | Machine tools | • | • | • | | Recognise examples of these machines | Application of key International Standards e.g. ISO 10816-3 vibration standards, use of velocity and displacement | Acoustic emissions; torque controlled machining | |
| **7.08** | Structures, piping | • | • | • | | Recognise the term: resonance | Resonance s, natural frequencie s | Vibration and fatigue of piping | |
| **7.09** | Gearboxes | • | • | • | | Recognise basic examples of simple gearboxes | Pinion gear mesh and shaft speed calculations; effect of gear misalignment and backlash. Application of displacement, velocity and acceleration and enveloping | Complex gearbox configurations and structures, planetary gears, multiple reduction gearboxes. Use of acceleration time and frequency and cepstrum and demodulation (enveloping) | |
| **7.10** | Rolling element bearings | | • | • | | | Bearing defect frequencies, noise and impacts, crest factor | De-modul ation, enveloping , kurtosis | |
| **7.11** | Journal bearings | | • | • | | | Proximity probe, runout; seismic velocity transducer, accelerometer integration, velomitor; transducer frequency ranges | Be familiar with oil whirl, oil whip, effect of lubrication flow and pressure. Runout compensation methods | |
| **7.12** | Gearing | | • | • | | | Pinion gear mesh and shaft speed calculations | Be familiar with a range of gear profiles and design. e.g. pinion, helical, double helical, bevel, epicyclic (planetary), etc. | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **7.07** | Machine tools | • | • | • | | Recognise examples of these machines | Application of key International Standards e.g. ISO 10816-3 vibration standards, use of velocity and displacement | Acoustic emissions; torque controlled machining | |
| **7.08** | Structures, piping | • | • | • | | Recognise the term: resonance | Resonance s, natural frequencie s | Vibration and fatigue of piping | |
| **7.09** | Gearboxes | • | • | • | | Recognise basic examples of simple gearboxes | Pinion gear mesh and shaft speed calculations; effect of gear misalignment and backlash. Application of displacement, velocity and acceleration and enveloping | Complex gearbox configurations and structures, planetary gears, multiple reduction gearboxes. Use of acceleration time and frequency and cepstrum and demodulation (enveloping) | |
| **7.10** | Rolling element bearings | | • | • | | | Bearing defect frequencies, noise and impacts, crest factor | De-modul ation, envelopin g, kurtosis | |
| **7.11** | Journal bearings | | • | • | | | Proximity probe, runout; seismic velocity transducer, accelerometer integration, velomitor; transducer frequency ranges | Be familiar with oil whirl, oil whip, effect of lubrication flow and pressure. Runout compensation methods | |
| **7.12** | Gearing | | • | • | | | Pinion gear mesh and shaft speed calculations | Be familiar with a range of gear profiles and design. e.g. pinion, helical, double helical, bevel, epicyclic (planetary), etc. | |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **9.03** | Transient analysis | | | • | • | | | Be able to carry out coast down and run down time and phase plots | Be able to set up and carry out coast down and run down time and phase plots |
| **9.04** | Transfer functions | | | • | • | | | Be aware of transfer functions, including coherence | Transfer function, input output (compressor loop), apply Nyquist plots. |
| **9.05** | Damping evaluation | | | | • | | | | Damping evaluation, isolation response testing |
| **9.06** | Cross channel phase, coherence | | | • | • | | | Be aware of cross-channel phase, coherence | Cross channel phase, coherence |
| **9.07** | Operating deflection shapes | | | • | • | | | Be aware of use of operating deflection shapes (ODS) | Understand modal analysis, structural response, operating deflection shapes (ODS) |
| **9.08** | Modal analysis | | | • | • | | | Be aware of modal analysis | Understand range of methods of modal analysis, establishing structural response |
| **9.09** | Torsional vibration | | | | • | | | | Be aware of ISO 22266-1 |
| **10** | **Reference standards** | – | **2** | **2** | **2** | | | | |
| **10.01** | ISO | | • | • | • | | Understand International Standards shown in Table B.1 for category 1 and category 2 | Be aware of International Standards shown in Table B.1 for category 3 | Be aware of International Standards shown in Table B.1 for category 4 |
| **10.02** | IEC | | • | • | • | | Be aware of IEC Standards referenced in ISO 17359 | Be aware of IEC Standards referenced in ISO 17359 | Be aware of IEC Standards referenced in ISO 17359 |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **10.03** | Relevant national standards | | • | • | • | | As required. e.g. API, VDI etc. | As required. e.g. API, VDI etc. | As required. e.g. API, VDI etc. |
| **11** | **Reporting and documentation** | – | **2** | **2** | **2** | | | | |
| **11.01** | Condition monitoring reports | | • | • | | | Be able to create vibration condition monitoring reports. Feedback to history | Manage and supervise vibration condition monitoring reports and requirements | |
| **11.02** | Vibration diagnostic reports | | • | • | • | | Review routine VM tours, rounds or readings, evaluate trends, spectra, time trace and produce advisory report. Feedback actions to history | Manage vibration diagnostic and prognostic reporting. Be able to carry out root cause analysis (RCA) failure investigations and prepare formal reports | Be able to carry out advanced vibration troubleshooting and prepare formal reports and formats. Be able to act as expert witness in all areas of VA |
| **12** | **Fault severity determination** | – | **2** | **2** | **3** | | | | |
| **12.01** | Spectrum analysis | | • | • | • | | Rotor and stator bar defects; gear mesh and sideband frequencies | Bode plots; rotor and stator bar defects; gear mesh and sideband frequencies | Rotating aerodynamic stall; sum and difference frequencies |
| **12.02** | Time waveform analysis, orbit analysis | | • | • | • | | Be familiar with time waveform analysis. Understand crest factor. | Be familiar with time waveform analysis. Understand crest factor. Be able to recognise basic orbit fault patterns E.g. Unbalance, looseness, misalignment, oil whirl and rubs | Apply more advanced orbit analysis e.g. Unbalance, looseness, misalignment, oil whirl and whip, resonance detection, critical speeds and phase response, rubs including Newkirk rub, thermal effects |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **12.03** | Levels: Overall, narrowband, component | | • | • | | | Be able to apply overall, narrowband or component alert levels | Understand requirements for overall, narrowband or component alert levels. Be able to source, set and apply alerts, alarms and trips | |
| **12.04** | Severity charts; graphs, formulae | | • | • | • | | Apply levels from ISO 10816, ISO 20816, ISO 8528-9, ISO 14694 etc. | Be familiar with relevant International Standard severity charts. Be able to carry out simple statistical review of alarms. | Apply all relevant International Standard severity charts and machine VM standards. Be able to review system and alarms, carry out advanced statistical review methods |
| **13** | **Rotor/bearing dynamics** | – | – | – | 14 | | | | |
| **13.01** | Rotor characteristics | | | | • | | | | Understand design and characteristics of steam and gas turbine rotors. Be aware of structural response, failure modes and effects, fault frequencies, performance, effect of lubricants etc. |

| Ref: | Subject<br>Syllabus topic | Category<br>1 | <br>2 | <br>3 | <br>4 | Recommended sub-topics<br>Category 1 | <br>Category 2 | <br>Category 3 | <br>Category 4 |
|---|---|---|---|---|---|---|---|---|---|
| **13.02** | Bearing characteristics | | | | • | | | | Understand design and characteristics of rolling element bearings, journal bearings and magnetic bearing. Be aware of failure modes and effects, geometry and fault frequencies, statistical life, performance, lubricants etc. |
| **13.03** | Rotor balancing | | | | • | | | | Understand methods and requirements for rigid and flexible rotor balancing, with and without phase, modal techniques. Be familiar with the range of International standards on balancing. |

NOTE 1 The symbol • indicates the subject is to be covered within the time allotted, or may be included within training on other topics.
NOTE 2 Category 2 includes the knowledge of Category 1; Category 3 includes the knowledge of Categories 1 and 2; Category 4 includes the knowledge of lower categories. 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 – Reading and International Standards References

**Table B.1 – Recommended reading includes:**

| Author, Title, Publisher, Pages, ISBN / Publ. No. | Category | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| MILLS S.R.W. *Vibration monitoring and analysis handbook.* Northampton: British Institute of Non-Destructive Testing, 2010, 326 p. ISBN 0903132397 | • | • | • | • |
| RMS Ltd, *Vibration Analysis Pocket Guide,* Northampton: British Institute of Non-Destructive Testing, ISBN 0-903132-36-2 | • | • | • | • |
| WALKER N., *Infrared Thermography- Theory & Practice,* Northampton: British Institute of Non-Destructive Testing, ISBN 0903132338 | | | • | • |
| HOLROYD T., *Acoustic emission and Ultrasonics,* Chipping Norton: Coxmoor, ISBN 1901892077 | | | • | • |
| ROYLANCE B. J. & HUNT T. M., *The wear debris analysis handbook,* Chipping Norton: Coxmoor, 1999, ISBN 1901892026 | | | • | • |
| EVANS and HUNT, *Oil Analysis,* Chipping Norton: Coxmoor, 2008, 180p, ISBN 1901892050 | | | • | • |
| Donald E Bently & Charles T. Hatch, Bob Grissom (Editor), Fundamentals of Rotating Machinery Diagnostics, 2002, Bently Pressurized Bearing Company, Minden, USA, ISBN 0-9714081-0-6 | | | • | • |

**Applicable International Standards** (material from which BINDT specified examination questions can be developed). Applicable International Standards for each Category are specified in Table B.2. The current published version of each standard applies.

**Table B.2 – Applicable International Standards**

| International Standard Reference | Category | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| ISO 21940-2, Mechanical Vibration – Rotor balancing – Part 2 – *Vocabulary** | | • | • | • |
| ISO 21940-11, Mechanical Vibration – Rotor Balancing – Part 11: Procedures and tolerances for rotors with rigid behaviour | | • | • | • |
| ISO 2041, *Mechanical vibration and shock condition monitoring – Vocabulary.** | | • | • | • |
| ISO 20816-1, *Mechanical vibration – Measurement and evaluation of machine vibration – Part 1: General guidelines* | • | • | • | • |
| ISO 20816-2, *Mechanical vibration. Measurement and evaluation of machine vibration – Part 2: Land-based gas turbines, steam turbines and generators in excess of 40 MW, with fluid-film bearings and rated speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min and 3 600 r/min* | • | • | • | • |
| ISO 13372, *Condition monitoring and diagnostics of machines – Vocabulary** | • | • | • | • |
| ISO 13373-1, Condition monitoring and diagnostics of machines - *Vibration condition monitoring– Part 1:– General procedures* | • | • | • | • |
| ISO 13373-2, *Condition monitoring and diagnostics of machines – Vibration condition monitoring – Part 2: Processing, analysis and presentation of vibration data* | | • | • | • |
| ISO 13381-1, *Condition monitoring and diagnostics of machines – Prognostics – Part 1: General guidelines* | | • | • | • |
| ISO 14694, *Industrial fans – Specification for balance quality and vibration levels* | • | • | • | • |
| ISO 17359, *Condition monitoring and diagnostics of machines – General guidelines* | • | • | • | • |

*These are vocabulary standards and are available free of charge at www.iso.org/obp

The list of standards specified in Table B.3 and associated standards listed within ISO 18436-2 are noted for information only and not an auditable requirement.

**Table B.3 – Applicable International Standards**

| **BINDT specified additional standards** ***A comprehensive list of standards is available within the latest version of international standard ISO 18436-2*** | Category | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| ISO 281, *Rolling bearings – Dynamic load ratings and rating life* | | | | • |
| ISO 15, *Rolling bearings – Radial bearings – Boundary dimensions, general plan* | | | • | • |
| ISO 18436-2, *Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Part 2: Vibration condition monitoring and diagnostics* | • | • | • | • |
| ISO 22266-1, *Mechanical vibration – Torsional vibration of rotating machinery – Part 1: Land-based steam and gas turbine generator sets in excess of 50 MW* | | | | • |

**Summary of changes**

| Issue number | Issue date | Summary of changes |
|---|---|---|
| 8 | 1st July 2018 | • Reference to comprehensive list of standards<br>• Reference made to non-auditable standards<br>• Addition of standards 20816 parts 1 and 2 |
| 9 | 8th April 2020 | • Update to comprehensive list of standards<br>• Update to ISO reference in Annex A Table A.2 |

**Certification Services Department**
**Midsummer House, Riverside Way**
**Northampton, NN1 5NX**
**United Kingdom**

Tel: +44 (0)1604 438300
Fax: +44 (0)1604 438301
E-mail: cm.admin@bindt.org

# CM/GEN APPENDIX F Issue 1
# IMPLEMENTATION DATE 1st April 2022

# SPECIFIC REQUIREMENTS FOR QUALIFICATION AND PCN CERTIFICATION OF CONDITION MONITORING AND DIAGNOSTIC PERSONNEL FOR ULTRASOUND

## CONTENTS

## Introduction

The use of the Airborne and Structure-borne Ultrasound method in condition monitoring 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 is appended to CM/GEN (General requirements for qualification and PCN certification of condition monitoring and diagnostic personnel). Other Appendices cover:

| | |
|---|---|
| Appendix A | Acoustic Emission |
| Appendix B | Infra-red Thermography |
| Appendix C | Lubrication Analysis |
| Appendix D | Vibration Analysis |

This series of documents is designed to provide comprehensive information for users of the PCN Scheme. The complete list of published PCN condition monitoring documents is detailed in publication reference PSL/8A-CM, which is posted on the Institute's web site at www.bindt.org, where all documents are available for download free of charge.

It is intended, through publication of these documents, to provide industry, PCN candidates and certificate holders with all relevant information. However, if further information or advice is required on any certification matter, contact the Certification Services Division of BINDT on telephone number +44 (0) 1604 893811, or email pcn@bindt.org.

Organisations requiring to be in possession, at all times, of the most up to date PCN documents may register with the "PCN Update Scheme" which, for a small annual fee, guarantees that they automatically receive all new and revised PCN documents.

## 1. Scope

1.1. This appendix to PCN CM/GEN sets out the specific requirements for qualification and assessment of personnel engaged in **asset condition monitoring using Ultrasound equipment**. In the event of a conflict between the requirements of PCN CM/GEN and this Appendix, the PCN CM/GEN requirements shall prevail.

1.2. This specification is in accordance with ISO18436-8, *Condition monitoring and diagnostics of machines - Requirements for qualification and assessment of personnel Part 8: Ultrasound.*

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

## 2. Classification of Personnel

2.1. General

2.1.1. Individuals certified in accordance with this specification are classified in one of three categories and have demonstrated the necessary skills in using Ultrasound for condition monitoring to the category as indicated in the examination syllabus at Annex A.

2.1.2. Personnel classified as Category 2 require all the knowledge and skills expected of personnel classified as Category 1, and personnel classified as Category 3 require all the knowledge and skills expected of personnel classified as Category 2.

2.2. Ultrasound Category 1

PCN certificated Ultrasound Category 1 personnel are qualified to perform Ultrasound measurements according to established and recognised procedures and shall be able to:

2.2.1. apply a specified ultrasound measurement technique; however, persons classified as category 1 shall not be regarded as competent to choose the test method or technique 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 and trends;

2.2.6. maintain a database of results and trends;

2.2.7. evaluate and report test results in accordance with instructions highlighting areas of concern;

2.2.8. recognise and prevent or control factors that result in the acquisition of poor-quality data.

Category 1 certificated personnel shall not be regarded as competent to choose the test method or technique to be used nor to assess the test results.

2.3. Ultrasound Category 2

Individuals certificated as ultrasound Category 2 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. Category 2 personnel 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 1;

2.3.9. be aware of the use of alternative or supplementary condition monitoring (CM) technologies.

2.4. Ultrasound Category 3

Personnel certificated as category 3 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 procedure;

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;

2.4.10. provide guidance to supervise and instruct category 1 and 2 personnel.

Note: it is the employer's responsibility to ensure that category 3 personnel have the necessary competency in the required management skills, for example creating budgets, preparing cost justifications, and management personnel development.

## 3. Eligibility for Examination and Certification

### 3.1 General

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 utilising 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 examinations shall be administered by a licensed professional and a record of the test made available to the assessment body upon request.

*Note: BINDT holds the right to request proof a hearing examination has been carried out to the above specifications.*

### 3.2 Education

Candidates seeking certification do not need to provide evidence of formal education to establish eligibility. However, it is recommended that Category 1 and 2 candidates have at least a secondary school graduation diploma or its equivalent. Category 3 candidates shall be able to manipulate simple algebraic equations, use a basic scientific calculator (including logarithmic functions), and be familiar with the operation of personal computers. 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 certification to Category 3.

### 3.3 Training

3.3.1 To be eligible to apply for examination based on this Specification, the candidate shall provide documentary evidence of successful completion of a BINDT approved or recognised course of formal training, which will be based on the requirements of Annex A2. Sources of technical information are listed in Annex B. The minimum duration of training required shown in Table 1.

| |
|---|
| BINDT allows a maximum of 50% self-study or on-line training for topics consistent with Annex A2 and as specified by the approved trainer (CMGEN refers). |

3.3.2 Approved training should be in the form of lectures, demonstrations and practical exercises. The approved training shall include examinations to ensure

that the subject matter has been understood and that they have successfully completed the training.

Training may be modularised into two or more subject areas covering general scientific principles and application-specific knowledge in order to allow mutual recognition between non-destructive testing (NDT) and condition monitoring assessment bodies.

| TABLE 1. Minimum Duration of Training (hours) | | |
|---|---|---|
| Category 1 | Category 2 | Category 3 |
| 32 | 64 | 96 |
| The hours shown represent cumulative totals of training hours for each Category. | | |

3.4 Experience

3.4.1 To be eligible to apply for certification the candidate shall provide evidence of experience in the field of Ultrasound condition monitoring appropriate to the category sought. The minimum experience requirements are shown in Table 2.

3.4.2. Certification at Categories 2 and 3 requires previous certification at the lower categories

3.4.3. For the purposes of renewal, the candidates must maintain a log of hours and nature of work on PCN document CP16-CM for all categories.

| TABLE 2. Minimum Cumulative Experience Requirements (months) | | |
|---|---|---|
| Category 1 | Category 2 | Category 3 |
| 6 | 12 | 36 |

## 4. Certification Available

4.1 Category 1 (Airborne and Structure-borne Ultrasound Condition Monitoring)

4.2 Category 2 (Airborne and Structure-borne Ultrasound Condition Monitoring)

4.3 Category 3 (Airborne and Structure-borne Ultrasound Condition Monitoring)

## 5. Qualification Examination

5.1 Application for qualification examinations

5.1.1 Application for initial qualification examination is made on PCN form PSL/57-CM and supported with PSL/33-CM and PSL30-CM where required.

5.2 Examination content (Theory and practical knowledge)

5.2.1 For each certification Category, candidates will be required to answer the number of multiple choice questions indicated in Table 3.

5.2.2 A number of questions on the Category 3 examination paper may consist of narrative questions. Category 3 examinations may include fault diagnosis, prognosis and solution recommendation content.

**Table 3 – qualification examination content**

| Categories | Number of Questions | Time (Hours)* | Passing Grade % |
|---|---|---|---|
| Category 1 | 60 | 2.0 | 70 |
| Category 2 | 60 | 2.0 | 70 |
| Category 3 | 60 | 2.0 | 70 |

** 30 minutes additional time may be allowed to assist candidates with English as a second language or any disability.*

5.2.4 The content of the examination paper shall contain multiple-choice questions for each subject in Annex A2, and in the same weighting as indicated by the percentage of time spent on each subject indicated in Annex A2, together with the indicated narrative questions in the case of Category 3.

5.2.5 Questions will be of a practical nature and will test the candidate's knowledge of the principles and procedures required to conduct Airborne and Structure-borne Ultrasound condition testing and analysis.

5.2.6 Questions may include the interpretation of practical data and simple mathematical calculations using a basic scientific calculator may be required.

**Annex A1 Training Syllabus Heading**

| | Hours of training | | |
|---|---|---|---|
| Subject | Category 1 | Category 2 | Category 3 |
| 1 Principles of ultrasound | 3.00 | 2.00 | 1.00 |
| 2 Generic equipment knowledge | 1.50 | 1.00 | 1.00 |
| 3 Data acquisition in ultrasound | 2.50 | 1.00 | 1.00 |
| 4 Data storage and management | 1.00 | 2.00 | 2.00 |
| 5 Condition monitoring principles | 1.50 | 1.00 | 1.00 |
| 6 Applications to machine systems | 17.00 | 17.00 | 16.50 |
| 7 Severity determination | 2.00 | 4.00 | 4.00 |
| 8 Programme implementation | 0.50 | 0.50 | 1.00 |
| 9 Reporting and corrective action | 0.50 | 1.00 | 2.00 |
| 10 Personal safety | 0.50 | 0.50 | 0.50 |
| 11 Training examination | 2.00 | 2.00 | 2.00 |
| **Total hours for each category** | 32 | 32 | 32 |

**Annex A2 – Detailed list of topics and hours of Instruction**

| Ref | Subject | Durations in hours | | | Recommended Sub-Topics | | |
|---|---|---|---|---|---|---|---|
| | | Cat I | Cat II | Cat III | Category I sub-topics | Category II sub-topics | Category III sub-topics |
| **1** | **Principles of ultrasound** | **3.00** | **2.00** | **1.00** | | | |
| **1.01** | Basics of sound | • | — | — | Be aware of the basics of sound. Infrasound/Audible/Ultrasound. Relationship between Velocity, Frequency and Wavelength V=λf. Wavelength and barriers to transmission | | |
| **1.02** | Sound wave motion | • | — | — | Be aware of sound wave motion longitudinal vs. transverse motion. Non-continuous motion | | |
| **1.03** | Acoustic impedance | • | • | • | Be aware of acoustic impedance and its influence on Reflection and Transmission at a boundary between two different materials | Recognise acoustic impedance and its influence on propagation and attenuation Be aware of attenuation caused by material interfaces. Understand how material changes will affect measurements | Understand acoustic impedance and its influence on propagation and attenuation Be able to identify where material changes will cause measurement problems and develop improvements. Be able to identify and calculate attenuations caused by material interfaces and changes. |
| **1.04** | Inverse distance law | • | — | — | Be aware of the inverse distance law Conclude that an airborne measurement MUST have a distance associated with it | Understand how reflections may limit the losses from distance | |
| **1.05** | What produces ultrasound | • | • | • | Be aware of how friction, turbulence, and impacting produce ultrasound | Be familiar with how friction, turbulence, and impacting produce ultrasound and | Understand how friction, turbulence, and impacting produce ultrasound and |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | where they apply<br>Understand that multiple defects can occur together | where they apply<br>develop broader application range based upon the fundamentals |
| **1.06** | Properties of the decibel | • | • | — | Be aware of the properties of the decibel<br>Cannot multiply or divide decibels.<br>Decibels are comparative numbers and need a reference.<br>+6dB is a doubling in voltage amplitude | Understand the properties of the decibel<br>Be able to express a decibel as a ratio and vice versa.<br>Understand Crest Factor calculation with dBs | |
| **2** | **Generic equipment knowledge** | **1.50** | **1.00** | **1.00** | | | |
| **2.01** | Instrument operation and function | • | • | • | Be aware of instrument operation and function.<br>Sensors, signal conditioning, processing and perhaps storage | Be familiar with instrument operation and function<br>Be able to show CAT1 and lower users how to operate | Understand instrument operation and function<br>Understand and instruct on how settings can change measurements |
| **2.02** | Airborne sensors | • | • | • | Be aware of the different types of airborne sensors for use in different circumstances.<br>Be able to inspect sensors for signs of damage. | Be familiar with airborne sensors<br>Be able to select sensors and methods for appropriate application. | Understand airborne sensors<br>Inspect sensors for defects and instruct users on best usage practice |
| **2.03** | Structure-borne sensors | • | • | • | Be aware of the different types of contact sensors for use in different circumstances.<br>Be able to inspect sensors and cables for signs of damage. | Be familiar with structure-borne sensors.<br>Be able to select sensors and contact methods for appropriate application. | Understand structure-borne sensors<br>Inspect sensors for defects and instruct users on best usage practice |
| **2.04** | Heterodyne principle and application | • | • | • | Be aware of the use of heterodyning.<br>Making the inaudible, audible.<br>Varying the mixer frequency can change instrument sensitivity | Be familiar with the heterodyne principle and application<br>Understand that by changing the mixer frequency it is possible to allow sub-20kHz audio into the measurement | Understand the heterodyne principle and application<br>If your instruments have variable frequency, ensure that users always know which frequency to use |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **2.05** | Sensitivity validation | • | • | — | Be aware of sensitivity validation.<br>Be able to follow a sensor validation procedure | Be familiar with sensitivity validation<br>Be able to develop and document this procedure and to arrange OEM calibrations | |
| **3** | **Data acquisition in ultrasound** | **2.50** | **1.00** | **1.00** | | | |
| **3.01** | Principles of data acquisition | • | • | — | Be aware of principles of data acquisition.<br>Be aware of different types of measurement: RMS, Peak, Crest Factor, Time Signal, Spectrum | Be familiar with the principles of data acquisition<br>Are we measuring the right parameter?<br>Understand the influence of operating variables such as machine speed on measurements.<br>Understand different types of measurement: RMS, Peak, Crest Factor, Time Signal, Spectrum. | |
| **3.02** | Sensor positioning | • | • | — | Be aware of sensor positioning: Airborne sensors are directional, contact sensors need to be perpendicular to the surface | Understand sensor positioning. Be able to recommend various installation and measurement methods | |
| **3.03** | Competing ultrasound and shielding techniques | • | • | • | Be aware of competing ultrasound and shielding techniques.<br>Always listen to your data - is what you hear, what you expect to hear? | Be familiar with competing ultrasound and shielding techniques.<br>Be capable of developing corrective procedures | Understand competing ultrasound and shielding techniques<br>Identify likely sources and design barriers to ease problems |
| **3.04** | Measurement of ultrasound | • | • | • | Be aware of measurement of ultrasound - a measurement of RMS amplitude may not be enough | Be familiar with the measurement of ultrasound<br>Be able to explain RMS, Peak, Crest Factor. | Understand measurement of ultrasound<br>Understand how on-line systems can be helpful.<br>When and how to use them |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **3.05** | Capturing time domain and spectrum signals for analysis | • | • | • | Be aware of capturing time domain and spectrum signals for analysis.<br>Understand that the time signal should be what you are listening to, and the spectrum is derived from that. | Be familiar with capturing time domain and spectrum signals for analysis<br>Understand the significance of sample time to measurements | Understand capturing time domain and spectrum signals for analysis<br>Understand the benefits of oversampling to data capture |
| **4** | **Data storage and management** | **1.00** | **2.00** | **2.00** | | | |
| **4.01** | Developing and using a database | • | • | • | Be aware of databases.<br>Understand the need for consistency | Be able to develop and use a database.<br>Create a small database, move tree elements inside that database | Understand developing and using a database<br>Primary responsibility for database creation - understand the need to interrogate the database for Reliability data |
| **4.02** | Managing stored data | • | • | • | Be aware of managing stored data.<br>Understand the need for data to be representative of the operating conditions | Be familiar with managing stored data.<br>Know how to back up and to restore data | Understand managing stored data<br>Consider ways of pruning database tress for more efficient operation. Be able to remove old machines and unwanted data from the main databases |
| **4.03** | Detect and correct anomalies | — | • | • | Be aware of bad data.<br>bad data is a distractor - identify clipping | Be able to detect and correct data anomalies<br>know how to remove bad data from a database and organise replacement measurements | Understand detecting and correcting data anomalies<br>continue to train inspectors to improve measurement quality |
| **5** | **Condition monitoring principles** | **1.50** | **1.00** | **1.00** | | | |
| **5.01** | What is condition monitoring and why is it useful | • | — | — | Be aware of CM and why is it useful | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **5.02** | Other CM Technologies | • | • | • | Be aware other CM technologies exist | Be familiar with range of other CM Technologies: E.g., Vibration Analysis (VA), Infrared Thermography (IRT); Acoustic Emission (AE); Lubricant Management (LM) - tribology and wear debris | Be familiar with and be able to apply other CM Technologies: E.g., Vibration Analysis (VA), Infrared Thermography (IRT); Acoustic Emission (AE); Lubricant Management (LM) - tribology and wear debris |
| **5.03** | CM with ultrasound | • | — | — | Be aware of why and when ultrasound would be useful as a CM technique.<br>Come back to Friction, Impacting and Turbulence | | |
| **5.04** | Acceptance testing | • | • | • | Be aware of acceptance testing. New and newly repaired assets are very likely to fail | Be familiar with acceptance testing | Be able to develop acceptance testing procedures |
| **5.05** | Benchmarking | — | • | • | Be aware of benchmarking. Performance comparison can be very useful | Be familiar with benchmarking.<br>Understand the need for consistent measurements for comparison | Be able to develop benchmarking processes |
| **6** | **Applications to machine systems** | **17.00** | **17.00** | **16.50** | | | |
| **6.01** | General leak detection | • | • | • | Be aware of general leak detection: identifying faults including: turbulence and flow<br>What is a leak?<br>Energy losses and Reliability applications.<br>The importance of controlling distance, angle and sensor used.<br>What does a leak sound like? | Be familiar with general leak detection: identification of faults including; turbulence and flow, directionality, measurement precautions, pressurized gases and compressed air, vacuum<br>Running an air leak detection programme | Be familiar with leak detection: identification of faults including; turbulence and flow, directionality, pressurized gases and compressed air, vacuum, tightness testing using the ultrasonic tone method |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **6.02** | Valve Inspection | • | • | • | Be aware of valve inspection: the need for valve asset management.<br>Defect detection including: blockage, passing and cavitation<br>What are the practical detection limits?<br>Small overview of valve designs.<br>What the different defects sound like | Be familiar with valve inspection: defect detection including; blockage, passing, cavitation etc.<br>Running a valve inspection programme | Be able to develop valve inspection procedures: defect detection including; blockage, passing, cavitating etc. |
| **6.03** | Steam trap inspection | • | • | • | Be aware of steam trap inspection:<br>The importance of steam traps (e.g., condensate & gas removal, risk of water hammer) The need to manage them.<br>Small overview of trap designs.<br>identification of faults using ultrasound.<br>What the different defects sound like. | Be familiar with steam trap inspection: identification of faults using ultrasound, using ultrasound in combination with temperature, reporting techniques<br>Running a steam trap inspection programme. | Be able to apply steam trap inspection: identification of faults using ultrasound, using ultrasound in combination with temperature, developing reporting techniques. |
| **6.04** | Electrical inspection | • | • | • | Be aware of electrical inspection:<br>Understand that not all defects generate heat.<br>Be aware of faults including; Corona, tracking, arcing, partial discharge etc.<br>Overview of defect generation and severity.<br>Be aware what the different defects sound like. | Be familiar with electrical inspection.<br>Be able to identify faults including; Corona, tracking, arcing, partial discharge etc..<br>Working with LV, MV & HV<br>Running MV and HV inspection programmes. | Be able to apply electrical inspection: Identification of faults including; Corona, tracking, arcing, partial discharge etc.. Develop procedures for working with LV, MV & HV. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **6.05** | Hydraulic systems inspection | • | • | • | Be aware of hydraulic systems inspection:<br>How hydraulics works and how they generate Ultrasound.<br>detection of faults in; cylinders, valves, pipework, and pumps etc. | Be familiar with hydraulic systems inspection: Detection of faults in; Cylinders, valves, pipework, and pumps etc.<br>Running inspections on hydraulic cylinders | Understand hydraulic systems inspection: detection of faults in; cylinders, valves, pipework, and pumps etc. |
| **6.06** | On-condition bearing lubrication using ultrasonics | • | • | • | Be aware of on-condition bearing lubrication using ultrasonics, under and over-lubricated bearings<br>The relationship between friction, ultrasound, and lubrication condition. What under- and over-lubrication sound like - how to tell the difference. | Be familiar with on-condition bearing lubrication using ultrasonics, lubrication process considerations, under and over-lubricated bearings, trending values<br>Understand the needs when developing an on-condition lubrication programme | Understand on-condition bearing lubrication using ultrasonics, lubrication process considerations, under and over-lubricated bearings, trending values |
| **6.07** | Bearing Inspection | • | • | • | Be aware of bearing inspection: bearing defect detection including poor lubrication, mechanical faults, slow speed bearings etc.<br>Bearing failure progression, random impacts, repeating impacts.<br>How these change the measurement.<br>What these defects sound like | Be familiar with bearing Inspection: Bearing defect detection including poor lubrication, mechanical faults, slow speed bearings etc.<br>Understand the progression of failure.<br>Be able to identify and find bearing defect frequencies in a time signal and spectrum | Understand bearing inspection: bearing defect detection including poor lubrication, mechanical faults, slow speed bearings etc. |
| **6.08** | Gearbox Inspection | • | • | • | Be aware of gearbox inspection: detection of faults in gearing and gearboxes including poor lubrication, damaged gears, damaged teeth etc.<br>Where to place the sensors.<br>What the defects sound like | Be familiar with gearbox Inspection: Detection of faults in gearing and gearboxes including poor lubrication, friction, rubbing, damaged gears, damaged teeth etc.<br>Calculate a 1x and GMF and find them in a time signal and spectrum | Understand gearbox inspection: detection of faults in gearing and gearboxes including poor lubrication, friction, rubbing, damaged gears, damaged teeth etc. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **6.09** | Pump Inspection | • | • | • | Be aware of pump inspection: detection of faults including cavitation, turbulence, leakage, mechanical faults etc.<br>Basic source location - valve or pump? What the defects sound like | Be familiar with pump Inspection: Detection of faults including cavitation, turbulence, leakage, mechanical faults etc.<br>Where to place the sensors. | Understand pump inspection: detection of faults including cavitation, turbulence, leakage, mechanical faults etc. |
| **6.10** | Electric Motor Inspection | • | • | • | Be aware of electric motor inspection: detection of faults including. bearings and effect of variable speed drives etc.<br>Practical problems caused by VFDs<br>Application to couplings.<br>What the defects sound like | Be familiar with electric motor inspection: detection of faults including. bearings, stator, winding, arcing and effect of variable speed drives etc.<br>Where to place the sensors. | Understand electric motor inspection: detection of faults including. bearings, stator, winding, arcing and effect of variable speed drives etc. |
| **7** | **Severity determination** | **2.00** | **4.00** | **4.00** | | | |
| **7.01** | Setting up decibel alarms | — | • | • | | Be familiar with setting up decibel alarms<br>Understand that dB alarms are additive not multipliers | Be able to develop and set up decibel alarms |
| **7.02** | Trending decibels | • | • | • | Be aware of trending decibels and alarm levels. | Be familiar with trending decibels | Understand trending decibels |
| **7.03** | Statistical alarm creation | — | • | • | | Be aware of statistical alarm creation<br>Understand about distributions and standard deviations - what this means in terms of alarm significance | Be familiar with statistical alarm creation<br>Be able to export dB data, test the population and calculate statistical characteristics of the data in order to create alarm values |
| **7.04** | Time signal analysis | • | • | • | Be aware of time signal analysis. Look at examples such as friction vs. bearing defect.<br>Aware of amplitude and of clipping | Be familiar with time signal analysis<br>Know how to use cursors to find periodic signals | Understand time signal analysis |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **7.05** | Spectrum analysis | • | • | • | Be aware of spectrum analysis. | Be familiar with spectrum analysis (e.g., BPFI, BPFO, GMF etc.)<br>Know how to use cursors to find harmonic signals | Understand spectrum analysis (e.g., BPFI, BPFO, GMF etc.) |
| **7.06** | Case studies | • | • | • | Be aware of case studies. Show how we combine all of these learnt items into identifying problems | Be able to record case studies.<br>Be familiar with what information should be contained within a report. | Be able to develop and record case studies |
| **7.07** | Diagnosis and prognosis | — | • | • | | Be familiar with diagnosis and prognosis. | Be able to develop diagnosis and prognosis |
| **8** | **Program implementation** | **0.50** | **0.50** | **1.00** | | | |
| **8.01** | Routine CM inspection considerations | • | • | • | Be aware of routine CM inspection considerations | Be familiar with routine CM inspection considerations<br>Identify areas where sensors may need to be installed or guards modified | Be able to develop and implement routine CM inspection considerations<br>Devise routes based upon personnel and operating needs and conditions |
| **8.02** | Routine CM program management | • | • | • | Be aware of routine CM program management | Be familiar with routine CM program management | Be able to develop and implement routine CM program management.<br>Track missed measurements and devise strategies to identify why and then catch up |
| **8.03** | CM Report structuring | — | • | • | | Be familiar with CM report structuring<br>The key elements of a good report | Be able to develop and implement CM report structuring |
| **8.04** | Corrective action for alarm incidences | — | • | • | | Be familiar with corrective action for CM alarm incidences | Be able to develop and implement corrective action for CM alarm incidences |
| **9** | **Reporting and corrective action** | **0.50** | **1.00** | **2.00** | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **9.01** | Key information needed | • | • | • | Be aware of key report information needed | Be familiar with key CM reporting information needed | Be able to develop and implement key CM reporting information needed |
| **9.02** | Recommending corrective action | — | • | • | | Be familiar with recommending CM corrective action | Be able to develop and implement recommended corrective action |
| **9.03** | Tracking corrective action outcome | • | • | • | Be aware of tracking corrective action outcome | Be familiar with tracking corrective action outcome | Be able to develop and implement tracking processes for corrective action outcome |
| **10** | **Personal safety** | **0.50** | **0.50** | **0.50** | | | |
| | | • | • | • | Be able to apply basic pre-set ultrasonic CM inspections and monitoring methods and be aware of access and safety requirements.<br>Particularly stress the need to be able to still hear alarms when wearing ear defenders | Be able to apply all ultrasonic CM and inspection methods, and be familiar with access and safety requirements<br>Be aware of applications of Ultrasound which should be part of improved safety procedures | Be able to apply all ultrasonic and other CM methods, and be familiar with and able to develop safe access and safety requirements |
| **11** | **Training examination** | **2.00** | **2.00** | **2.00** | | | |
| | | • | • | • | Category I training examination | Category II training examination | Category III training examination |
| | **Total hours per category** | **32.00** | **32.00** | **32.00** | | | |
| | • Topics to be taught at each category<br>NOTE 1 Category II includes the knowledge of category I<br>NOTE 2 Category III includes the knowledge of category I and category II | | | | | | |

## Annex B – References

### Essential material

| Title | Author | Publisher | ISBN |
|---|---|---|---|
| *Have a listen to Ultrasound: The high frequency world of Reliability* | Murphy T.J. | N/A | 979-8412080727 |

### Recommended material

| Title | Author | Publisher | ISBN |
|---|---|---|---|
| *Have a listen to Ultrasound: The high frequency world of reliability* | Murphy T.J. | N/A | 9798412080727 |
| *Airborne/structure-borne ultrasound technology sourcebook.* | Nuclear Maintenance Applications Center. | Palo Alto, CA: Electric Power Research Institute, 2007. | |
| Acoustic leak testing. In: *Non-destructive testing handbook* | Moore P.O. | Columbus, OH: American Society for Nondestructive Testing, | 978-1-57117-421-5 |
| An Introduction to Condition Monitoring and Diagnostic Technologies | Editors: Prof A. Hope D. Whittle | BINDT | 978 0 903132 76 3 |

### Standards and Specifications

1. ISO 29821:2018 Condition monitoring and diagnostics of machines -- Ultrasound -- General guidelines, procedures and validation
2. ISO 17359 : 2018 Condition monitoring and diagnostics of machines – General guidelines

Certification Services Department
Midsummer House, Riverside Way
Bedford Road, Northampton
NN1 5NX, United Kingdom

Tel: +44 (0) 1604-438-300
Fax: +44 (0) 1604-438-301
E-mail: pcn@bindt.org

# CM/GEN APPENDIX B Issue 7
# IMPLEMENTATION DATE: 1st January 2022

# SPECIFIC REQUIREMENTS FOR QUALIFICATION AND PCN CERTIFICATION OF CONDITION MONITORING AND DIAGNOSTIC PERSONNEL FOR INFRARED THERMOGRAPHY

## CONTENTS

## Introduction

The use of Infrared Thermography (IRT) using measurements of surface temperature to monitor condition and diagnose faults in civil, mechanical and electrical systems has become 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 is appended to CM/GEN (General requirements for the qualification and PCN certification of condition monitoring personnel). Other Appendices cover:

| | |
|---|---|
| Appendix A | Acoustic Emission |
| Appendix C | Lubrication Analysis |
| Appendix D | Vibration Analysis |

This series of documents is designed to provide comprehensive information for users of the PCN Scheme. The complete list of published PCN condition monitoring documents is detailed in publication reference PSL/8A-CM, which is posted on the Institute's web site at www.bindt.org, where all documents are available for download free of charge.

It is intended, through publication of these documents, to provide industry, PCN candidates and certificate holders with all relevant information. However, if further information or advice is required on any certification matter, contact the Certification Services Division of BINDT on telephone number +44 (0) 1604 893811, or email cm.admin@bindt.org

Organisations requiring at all times to be in possession of the most up to date PCN documents may register with the "PCN Update Scheme" which, for a small annual fee, guarantees that they automatically receive all new and revised PCN documents.

## Definitions

**Civil:** The term 'Civil' when used in this document includes buildings, structures, roads and bridges.

**Mechanical:** The term 'Mechanical' when used in this document includes mechanical systems and associated processes.

**Electrical:** The term 'Electrical' when used in this document includes low and high voltage electrical systems, but does not include electronic systems.

**Supplementary examination:** The term supplementary examination when used in this document refers to an additional sector-specific examination available at Categories 2 and 3 only, and attempted either during, or after the first examination that consists of the general part and at least one other sector-specific part.

## 1. Scope

1.1. This appendix to PCN CM/GEN sets out the specific requirements for qualification and assessment of personnel engaged in Infrared Thermography Condition Monitoring. In the event of a conflict between the requirements of PCN CM/GEN and this Appendix, the PCN CM/GEN requirements shall prevail.

1.2. This specification is in accordance with ISO 18436 part 7: Condition monitoring and diagnostics of machines- Requirements for qualification and assessment of personnel- Thermography.

1.3. Certification to this specification will provide evidence of the qualification and assessment of individuals to perform Infrared Thermography measurements and analysis using appropriate sensors and equipment.

## Classification of Personnel

2.1. General

2.1.1. Individuals certificated in accordance with this specification are classified in one of three Categories and have demonstrated the necessary skills in the concepts of thermographic analysis and thermal condition monitoring for their classification Category as indicated in the examination syllabus at Annex A.

2.1.2. Personnel classified as Category 2 require all the knowledge and skills expected of personnel classified as Category 1, and personnel classified as Category 3 require all the knowledge and skills expected of personnel classified as Category 2.

2.1.3. Those personnel seeking to be classified as Category 2 or Category 3 can elect to qualify in any or all of three industry sectors, as specified at clause 5.

2.2. Infrared Thermography Category 1 (General)

PCN certificated Infrared Thermography Category 1 personnel are qualified to perform industrial infrared thermography measurements according to established and recognised procedures and shall be able to:

2.2.1. apply a specified thermographic measurement technique;

2.2.2. set up and operate equipment for safe thermographic data collection;

2.2.3. perform basic infrared thermography of plant and machinery, buildings and electrical systems;

2.2.4. Verify the calibration of the measurement systems and the integrity of collected data

2.2.5. Prevent, minimise or control poor data (sources of data error);

2.2.6. maintain a data base of results and trends;

2.2.7. perform basic fault detection severity assessment and diagnosis in accordance with established instructions;

2.2.8. Perform basic image post processing (measurement tools, emissivity adjustment, span and scale adjustment etc.);

2.2.9. verify the calibration of thermographic measurement systems;

2.2.10 evaluate and report test results in accordance with established instructions and highlight areas of concern.

Category 1 certificated personnel shall not be responsible for the choice of test method or technique to be used, nor for the assessment of test results.

2.3 Infrared Thermography Category 2.

In addition to the tasks undertaken by Category 1 personnel, Category 2 individuals are permitted to undertake the following additional tasks:

2.3.1. select the appropriate infrared thermography technique and understand its limitations;

2.3.2. specify the appropriate hardware and software for both portable and permanently installed systems;

2.3.3. Measure and analyse thermographic data;

2.3.4. perform advanced image post processing (trending, montage, image subtraction, statistical analysis etc.) and diagnosis;

2.3.5 Apply thermography theory and techniques, including measurement and interpretation of survey results;

2.3.6. Recommend appropriate corrective actions;

2.3.7. Prepare reports on condition, recommend corrective action and report on effectiveness of repairs in accordance with the type of certification held by the individual (Civil, Electrical or Mechanical);

2.3.8. provide technical direction for personnel at or below Category 2;

2.3.9. Supervise and instruct all Category 1 duties;

2.3.10. Establish infrared thermography programmes including determination of the requirement for periodic /continuous monitoring, frequency of testing, etc.

2.3.11. establish acceptance and severity criteria;

2.3.12. Establish programmes for acceptance for new and in-service systems;

2.3.13. Recommend the use of alternative CM technologies with an awareness of the principles of other CM technologies specified in CM/GEN, at least to Category 1.

2.4. Infrared Thermography Category 3

In addition to the tasks undertaken by Category 1 and Category 2 personnel, Category 3 individuals are permitted to undertake the following additional tasks:

2.4.1. Determine the thermographic signature of systems, components and assemblies (sector specific, where applicable);

2.4.2. Understand and perform data analysis;

2.4.3. Use advanced techniques of infrared thermography and fault diagnosis;

2.4.4. Recommend appropriate types of thermodynamic (radiation, convection, conduction based) corrective actions;

2.4.5. supervise trainees and Category 1 and 2 personnel;

2.4.6. Guide personnel below Category 3;

2.4.7. Interpret and evaluate Standards, Codes, specifications and procedures;

2.4.8. perform prognostics for fault conditions;

2.4.9. Direct the use of alternative CM technologies with an understanding of the principles of other CM technologies specified in CM/GEN, at least to Category 1.

2.4.10. Manage and supervise PCN CM qualification examinations on behalf of the British Institute of NDT, if so appointed.

## 3. Eligibility for Examination and Certification

3.1. General

Candidates shall have a combination of education, training and experience to ensure that they understand the principles and procedures applicable to thermographic measurement and analysis. Colour vision requirement in this scheme is specified in the following delta.

ISO 18436-7 recommends that candidates have colour perception tested to the criteria of the Ishihara test, where it may be required of employers to determine whether failure to meet the requirements of this test will affect the candidate's ability to perform analysis on IRT data using colour palettes. Failure to pass the Ishihara test may require the candidate to use a monochrome palette. This task-specific test, and any requirement to use a monochrome palette, is to be documented and the record of the test made available to the certifying body upon request. The PCN scheme will not enforce this recommendation as (1) recording of the candidates failure of the Ishihara test and limiting their work to monochrome palettes could potentially limit his/her employment and yet he/she may be capable of interpreting colour images if the degree of colour blindness is not severe, (2) the pass/fail criteria of the Ishihara test is not necessarily indicative of a person's ability to interpret colour differences on a thermogram.

3.2. Training

3.2.1 At Category 1 the written examination shall contain practical application questions that cover quality data acquisition, the recognition, prevention and control of error sources and basic fault diagnosis. At Category 2 it will cover diagnostics and image interpretation for condition monitoring of machines, electrical or civil systems and image interpretation. At Category 3 it will include all topics for Categories 1 and 2 and include solution design and verification.

3.2.2 The image interpretation questions should be based on case histories requiring fault identification, solution recommendation and a solution verification process.

| TABLE 1. Minimum Cumulative Duration of Training (hours) | | |
|---|---|---|
| Category 1 | Category 2 | Category 3 |
| 33 | Category 1 + 32 | Category 2 + 32 |

3.2.3 Training may be modularised into two or more subject areas covering general scientific principles and application-specific knowledge in order to allow for mutual recognition between non-destructive testing (e.g.: ISO9712, SNT-TC-1A) and other condition monitoring assessment bodies (2nd or 3rd party).

3.2.4 In addition to the training hours in Table 1 and formal education specified in CM/GEN, Category 2 candidates only, should have completed formal or on-the-job training on mechanical, electrical or civil engineering, with either a training examination certificate or verifiable records (PSL30-CM), including the relevant systems and components, of at least a similar duration to that in Table 1, which covers the sector specific certification sought. This training should cover design, manufacture, installation, operation and maintenance principles relevant to the sector (civil, mechanical or electrical systems), and include failure mechanisms associated with each principle and the typical thermodynamic signatures associated with each mechanism.

3.3. Experience

3.3.1. To be eligible to apply for certification the candidate shall provide evidence of experience in the field of machinery, electrical or civil infrared thermography condition monitoring, appropriate to the Category and sector sought. The minimum experience requirements are shown in Table 2.

3.3.2. Certification at category 3 requires previous certification at the lower categories.

3.3.3. Candidates must maintain verifiable documentary evidence and log of hours and nature of work (see ISO18436-7 clause 5.4), especially scanning (practical) times, on PCN document CP16-CM for all categories.

| TABLE 2. Minimum Cumulative Experience Requirements (months) | | |
|---|---|---|
| Category 1 | Category 2 | Category 3 |
| 12* | 24* | 48* |

*The experience hours are based on 16 hours minimum per month of thermography-based machinery condition monitoring experience in accordance with Clauses 2 & 3.

## 4. Certification Available

4.1 Category 1 (IRT-General)

4.2 Category 2 (IRT- Civil, IRT-Mechanical, IRT-Electrical)

4.3 Category 3 (IRT- Civil, IRT-Mechanical, IRT-Electrical)

Category 2 and 3 candidates may attempt any or all modules in one sitting.

## 5. Qualification Examinations

5.1 Application for qualification examinations

5.1.1 Application for qualification examination is made on PCN form PSL/57-CM and supported with PSL/30-CM and PSL/33-CM where required.

5.2 Initial examination

5.2.1 Category 1 candidates are required to be successful in a multiple choice examination paper covering the basic principles and practical knowledge of the CM technology in terms of civil, mechanical and electrical engineering and basic thermography theory. The examination will also test for quality data acquisition and error source recognition, prevention and control.

5.2.2 Category 2 and 3 candidates for Infrared Thermography are required to be successful in a multiple choice examination comprising at least two modules covering:

5.2.2.1 the basic principles and practical knowledge of Infrared Thermography;

5.2.2.2 at least one practical applications module paper on the specific application of Infrared Thermography in the civil, mechanical or electrical engineering sector, as selected by the candidate. At Category 2 the practical applications sector paper will cover diagnostics and image interpretation. At Category 3 the sector paper will cover diagnostics, prognostics, image interpretation, solution design and solution verification. The practical sector specific module pertains to subjects 6, 7 or 8 in Annex A2, but must also include material derived from subjects 9, 10, 11, 12 and 13 for the respective sector.

5.2.2.3 the basic principles of alternative condition monitoring technologies as defined in Table A2.

5.2.2.4 Category 3 examination papers have a narrative component (see below).

5.3 Supplementary practical applications examination

5.3.1 Supplementary modular practical examinations are only available to existing PCN Infrared Thermography Category 2 or 3 certificate holders. This examination comprises separate supplementary modules covering civil, mechanical or electrical engineering, as selected by the candidate.

5.3.2 Supplementary examination modules will be graded separately, so that a candidate electing to attempt two modules at the same examination sitting may be awarded certification for a module in which success was achieved, even if the other module was failed.

5.3.3 Supplementary examination candidates must have satisfactorily completed a course of training covering the syllabus to be examined, and provide documentary evidence of the training.

5.4 Examination content (Theory and practical knowledge)

5.4.1 For each certification category, the candidates shall be required to answer the fixed number of multiple choice questions in the two-part written paper, within specified time duration as indicated in Table 3. Part A covers general theory and Part B is the sector specific practical application module paper. At Category 3, 10% of each part of the examination paper will consist of narrative questions. In a 30 question paper module four narrative questions will be offered but only three need to be answered.

5.4.2 Each narrative question will be worth 5 points.

5.4.3 The examination will cover the training syllabus at Annex A2.

5.4.4 Questions will test the candidate's knowledge of the principles and procedures required to conduct infrared thermography condition testing and analysis in the sector (machinery, electrical or civil) that the examination pertains.

5.4.5 Questions are of a practical nature and include the interpretation of practical data and thermal images and simple mathematical calculations using a basic scientific calculator may be required.

5.4.6 The Category 1 examination paper will comprise 60 questions covering the general topics listed in Annex A2. The Category 2 and 3 examination papers will comprise general (30 questions) and practical application specific (30

questions) parts. Modules will be graded separately. Examinations for additional sector specific modules will comprise 30 questions per module, as noted in Table 3.

**Table 3 – qualification examination content**

| Categories | Number of Questions | Time (Hours)* | Passing Grade % |
|---|---|---|---|
| Category 1 | 60 | 2.0 | 75 |
| Category 2 (General + 1st sector module) | 60 (30 + 30) | 2.0 | 75 |
| Category 2 (Supplementary module) | 30 | 1.0 | 75 |
| Category 3 (General + 1st sector module) | 60 (30 + 30) | 3.0 | 75 |
| Category 3 (Supplementary module) | 30 | 1.0 | 75 |

*Examination times may be extended by 25% to assist candidates with a disability or in the event that their first language is not English, in accordance with BINDT document CMGEN clause 9.3.

**Annex A1 Training Syllabus**

| Subject | Hours of training | | |
|---|---|---|---|
| | Category 1 | Category 2 [Only 1 module from subjects 6] | Category 3 [Only 1 module from subjects 6] |
| 0. Introduction | 0.5 | - | - |
| 1. Principles of IRT | 6 | 7 | 6 |
| 2. Equipment and data acquisition | 5 | 3 | 1 |
| 3. Image Processing | 6 | 2 | 1 |
| 4. Condition Monitoring | 4.5 | 0 | 0 |
| 5. Diagnostics and prognostics | 1 | 2 | 2 |
| 6. Condition Monitoring applications | 4 | 10.5 | 7 |
| a) Electrical applications | | | |
| b) Mechanical applications | | | |
| c) Civil applications | | | |
| 7. Reporting and documentation (ISO International Standards) | 1 | 3 | 6 |
| 8. Condition Monitoring programme design | 0.5 | 0.5 | 0.5 |
| 9. Condition Monitoring programme implementation | 1 | 0.5 | 3.5 |
| 10. Condition Monitoring programme management | 0.5 | 1 | 1 |
| 11. Training examination | 1 | 0.5 | 2 |
| 12. Practical skills evaluation | 2 | 2 | 2 |
| Total hours for each Category | 33 | 32 | 32 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **0** | **Introduction** | | | | **0.5** | 0 | 0 |
| **1** | **Principles of IRT** | | | | **6** | **7 6.5** | **6** |
| **1.01** | Heat and heat transfer basics | • | • | | Distinguish between various temperature scales, e.g., Centigrade (°C), Kelvin (K).<br>Define 'Energy' and 'Heat'.<br>Understand the basic principles of the following:<br>Radiosity; transient & steady state heat flow; principles of thermal capacity; phase change & latent heat; system response time. | In addition to C1 topics, understand the principles of the following:<br>System mass transfer of thermal energy; thermal diffusivity; basics of saturated and superheated steam.<br>. | |
| **1.02** | Laws of thermodynamics & other laws | • | | | Distinguish between the definitions of the following Thermodynamic Laws:<br>1st & 2nd Law<br>Combined Gas Law | | |
| **1.03** | Conduction fundamentals | • | • | • | Understand the principles of conduction fundamentals. | Understanding of the following: Fourier's Law; conduction through matter; heat transfer between objects in contact. | Comprehensive understanding of the principle of heat transfer through complex structures. |
| **1.04** | Conductivity / resistance | • | | | Understand the basic principles of: thermal conductivity of materials; thermal conductivity of composite structures (buildings or composite refractory linings). | | |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **1.05** | Convection fundamentals | • | • | • | Understand the basic principles of heat convection. | Understand: Thermal convection; Newton's Law of cooling; heat transfer through gasses and liquids; boundary layer; thermal conductivity of gases & liquids. | Critically analyse: heat convection; Newton's Law of cooling; heat transfer through gasses and liquids; boundary layer; thermal conductivity of gases and liquids. |
| **1.06** | Radiation fundamentals & Radiation Laws | • | • | | Understand the basic principles of the following: propagation through vacuum; Stefan Boltzmann Law; Planck's Law; Wien's Law (Planckian Curves); radiation properties – Lambertian; radiation properties of dielectrics and other materials. | Detailed study of all Radiation Laws<br><br>Surface radiosity emissivity curves and characteristics for different materials. | |
| **1.07** | Electromagnetic spectrum | • | | • | Understand the basic principles of the following: electromagnetic spectrum; relationship between Frequency/Wavelength/Speed of light. | | Analysis of the 'Electromagnetic Spectrum' and highlight any areas which may be relevant to other NDT techniques (UV, X ray, etc.). |
| **1.08** | Spectral band used by IR cameras | • | | | Understand the basic principles of the spectral band and why the following bands are used for IR cameras: (IR band is considered to be 0.7 to 1000 µm).<br>SW band 1 to 3 µm.<br>MW band 2 to 6 µm.<br>LW band 8 to 14 µm. | | |
| **1.09** | Atmospheric transmission | • | • | | Understand the basic principles of atmospheric transmission and the fundamentals of effects on atmospheric transmission: distance; Carbon Dioxide ($CO_2$); Moisture ($H_2O$); solid particles; transmission vs. wavelength characteristics. | Fully understand how transmission vs. distance is influenced by the following: atmospheric moisture ($H_2O$); atmospheric Carbon Dioxide ($CO_2$); solids in atmosphere. | |
| **1.10** | Distance (atmospheric) correction | • | • | | Understand the effect of atmospheric transmission on temperature measurement accuracy and the reason for compensation within the IR camera. The relationship between atmospheric attenuation and wavelength. | Understand the effect of solid particles on the spectral atmospheric transmission of gases (How IR cameras compensate for atmospheric attenuation) | |
| **1.11** | IR lens materials and types of lenses | • | | | Lens types and why different lens materials are used.<br>Why a range of lenses is required for some applications. | | |
| **1.12** | IR windows | • | • | | Understand the currently available range of IR windows. | Fully understand the currently available range of IR windows and analyse their specifications and safety standards. | |
| **1.13** | Radiation reference sources | | • | • | | Extrapolate relevant information from the 'Recommended reading material' listed in Annex B | Extrapolate relevant information from the 'Recommended reading material' listed in Annex B and any other relevant reference document. |

| Ref: | Subject Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **1.14** | Emissivity | • | • | • | Definition of emissivity and basic difference between the emissivity of a Blackbody, Graybody and Non-graybody (Dielectrics). | Definition of emissivity and fully understand difference between the emissivity of a Blackbody, Graybody and Non-graybody (Dielectrics).Detailed evaluation of emissivity determination factors. | Definition of emissivity and critical analysis of the difference between the emissivity of a Blackbody, Graybody and Non-graybody (Dielectrics). |
| **1.15** | Emissivity determination | • | • | | Conduct the following emissivity calibration method: using a calibrated temperature probe; using high emissivity adhesive tape (at low temperatures); using high emissivity paint (at high temperatures). | Critical analysis of the following emissivity calibration method: using a calibrated temperature probe; using high emissivity adhesive tape (at low temperatures); using high emissivity paint (at high temperatures). | |
| **1.16** | Factors affecting emissivity | • | • | • | Differentiate between reflectance from 'Spectral' and 'Diffused' surfaces. Material types, surface condition, viewing angle, temperature, etc. | Analyse differences between reflectance from 'Spectral' and 'Diffused' surfaces. Material types, surface condition, viewing angle, temperature, etc. | Critically analyse differences between reflectance from 'Spectral' and 'Diffused' surfaces. Material types, surface condition, viewing angle, temperature, etc. |
| **1.17** | Emittance, reflectance and transmittance | • | • | | Awareness of: transmittance / absorptance of various materials; fundamentals of radiative heat flow; radiation impinging on a target surface; radiation exchange at the target surface; radiation leaving a target. | Study of opaque material properties, e.g., glass plastic films and meshes. Practical approach to the determination of window transmissivity and target temperature measurement through IR windows. | |
| **1.18** | Active Thermography | | • | • | | 'Passive' and 'active' thermography and principle properties of various active thermography excitation techniques. | 'Passive' and 'active' thermography and critically analyse the key properties of various active thermography excitation techniques. |
| **2** | **Equipment & data acquisition** | | | | 5 | 3 | 1 |
| **2.01** | How your infrared camera works | • | | | Operate Focal Plane Array (FPA) IR imagers. Also, understanding basics of: infrared radiation thermometers; line scanners; various other thermal scanners. | | |
| **2.02** | Infrared camera selection criteria & other radiant energy measuring instruments | | • | • | | Evaluate various features, such as resolution and functions of FPA thermal imagers, including selection of: temperature range requirements; detector pixels matric size; lens angle requirements (IFOV). Instruments. such as flux meters | Evaluate requirements of IR cameras and associated equipment which may be applicable to other IR application, such as: Acoustic emissions (AE); Lubrication analysis (LA); Vibration analysis (VA). |
| **2.03** | Waveband selection criteria | • | • | • | Basic knowledge of currently available wavebands for various IR applications and correctly selecting the applicable waveband. | Extended knowledge of currently available wavebands for various IR applications and correct selection of applicable waveband. | Critically evaluate the currently available wavebands for IR applications, including selection of a correct waveband range for specific CM & NDT applications. |
| **2.04** | IR system specifications | • | • | | Basic functions of currently available IR systems and their choice for specific applications. | Critically evaluate all functions of currently available IR systems and their choice for specific applications. | |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **2.05** | Typical IR camera controls and temperature measurement tools | • | | | Apply and understand their effect on the appearance of a thermogram:<br>Camera controls<br>Temperature Range/span/level settings; emissivity settings; ambient temperatures (atmospheric and reflected); compensation; temperature functions (spot, circle, square); distance; electronic zoom vs lens selection; palette selection.<br>Temperature measurement<br>Spot; circle: Max/Av/Min; square / rectangle: Max/Av/Min; temperature profile; Isotherms (temperature line or band). | | |
| **2.06** | Operation of equipment | • | • | | Control and measurement features of a standard (FPA) IR cameras. | Apply all control and measurement features of the following IR instruments: FPA, 'Scanner type', line scanners and special IR cameras. | |
| **2.07** | Temperature measurement range/considerations | • | | | Importance of settings on the accuracy of temperature measurement: (Temperature range, span and level). | | |
| **2.08** | Thermal sensitivity (NETD) | | • | | | Understand thermal sensitivity; NETD (Noise Equivalent Temperature Difference); MRTD (Minimum Resolvable temperature Difference); SRF (Slit Response Function); Dynamic Range. | |
| **2.09** | Lens & IR filter selection | • | • | | Lens selection importance for certain applications. | Optical and physical properties of currently available lens materials and determining lens selection for application. | |
| **2.10** | Optical resolution | • | • | | Differentiate between the optical (different lenses) and electronic zoom. | Differentiate between the optical (different lenses) and electronic zoom and the effect each has on the appearance on a thermogram. | |
| **2.11** | Getting a good image | • | | | Producing a good image, considering the following IR instrument settings: temperature Range/Span/Level; ambient temperatures (atmospheric and reflected); emissivity; distance (field of view); Minimum target size (estimation from lens angle or detector pixels). Focus. | | |
| **2.12** | Image composition | • | • | • | Ensuring correct adjustment of composition to clearly show the anomalies and accurate temperature measurements. | Ensuring correct adjustment of composition to clearly show the anomalies and accurate temperature measurements. | Revision of Category 2 |
| **2.13** | Image clarity (optical focus) | • | | | Understand correct optical focus prior to image procuring. (Clarity and temperature measurement accuracy). | | |

| Ref: | Subject Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **2. 14** | Thermal tuning (range, level and span) | • | | | Understand importance of correct temperature range setting. | | |
| **2.15** | Temperature measurement | • | • | | Understand importance of collation of data for accurate non-contact temperature measurement with FPA IR cameras. | Specify data collation requirements for accurate non-contact temperature measurement with various IR cameras. | |
| **2.16** | Comparative quantitative thermography | • | • | | Understand measurement of ΔT between 'good' components and anomaly temperatures. | Full knowledge of ΔT between 'good' components and anomaly temperatures. | |
| **2.17** | Comparative qualitative thermography | • | • | | Understand measurement of ambient and anomaly temperatures. | Comprehensive understanding of measurement of ambient and anomaly temperatures. | |
| **2.18** | Environmental influences | • | • | | Recognise the effect on the temperature measurement accuracy of the following: variations in atmospheric temperature; solar radiation/cloud cover; wind speed and direction; moisture (effect of surface moisture, fog, rain, solid particles, etc.); effect of reflections from nearby hot or cold objects. | Understand of the effect on the temperature measurement accuracy of the following: variations in atmospheric temperature; solar radiation/cloud cover; wind speed and direction; moisture (effect of surface moisture, fog, rain, solid particles, etc.); effect of reflections from nearby hot or cold objects, effects of any obstructions, e.g., insulation | |
| **2.19** | Error source recognition, prevention or control | • | • | | Recognise the effect on the temperature measurement accuracy from the following error sources: reflected apparent temperature measurement – direct method; reflected apparent temperature measurement – reflector method; importance of initial instrument settings - focus and temperature range. | Recognise and fully correct the effect of error sources on the temperature measurement accuracy. (Reflected apparent temperature measurement – direct method; reflected apparent temperature measurement – reflector method; importance of initial instrument settings - focus and temperature range). | |
| **2.20** | Recognising and dealing with radiation (reflections, reflected apparent temperature, angle of incidence) | • | • | • | Recognise the existence of error sources and their influence on the final result. (Solar or clear sky reflection; reflections from nearby hot or cold objects; methods for estimating a reflective temperature, angle of incidence). | Existence of error sources and their influence on the final result. (Solar or clear sky reflection; reflections from nearby hot or cold objects; methods for estimating a reflective temperature, angle of incidence). | Critical analysis of error sources and their influence on the final result: solar or clear sky reflection; reflections from nearby hot or cold objects; methods for estimating a reflective temperature, angle of incidence. |
| **2.21** | Recognising and dealing with convection | • | • | • | Recognise sources of convection and their influence on the final result. (Thermal Boundary Layer; wind effect on structure surface temperatures; mass heat/energy transport. | Understand sources and their influence on the final result: Thermal Boundary Layer. Wind effect on surfaces of a structure temperatures. Mass heat/energy transport. | Critically analyse sources and their influence on the final result: Thermal Boundary Layer. Wind effect on surfaces of a structure temperatures. Mass heat/energy transport. |
| **2.22** | Recognising and dealing with conduction | • | • | • | Recognise sources and their influence on the final result e.g., Nearby objects contributing to conduction, e.g., h ot fan near a bearing housing. | Understand sources and explain their influence on the final result by giving examples e.g., Nearby objects contributing to conduction, e.g., hot fan near a bearing housing. | Critically analyse sources and explain their influence on the final result by giving examples e.g., Nearby objects contributing to conduction, e.g., hot fan near a bearing housing. |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **2.23** | Effects of incorrect emissivity | • | • | | Importance of emissivity settings on temperature measurement accuracy:<br>Correct emissivity - accurate temperature.<br>Emissivity higher – lower temperatures.<br>Emissivity lower – higher temperatures (more difficult to measure accurately). | Importance of emissivity settings on temperature measurement accuracy:<br>Correct emissivity - accurate temperature.<br>Emissivity higher – lower temperatures.<br>Emissivity lower – higher temperatures (more difficult to measure accurately). | |
| **2.24** | Environmental and operation conditions | • | • | | Basic principles of atmospheric or environmental conditions and the influence they may have on temperature measurement, e.g., moisture, rain, wind, solar or reflections from nearby objects, etc. | Principles of atmospheric or environmental conditions and the influence they may have on temperature measurement, e.g., moisture, rain, wind, solar or reflections from camera internal surfaces or nearby objects, etc. | |
| **2.25** | Camera calibration | • | • | | Carry out quick calibration procedures and understand the basic procedure for full calibration test:<br>Quick calibration check using melting ice (about 0°C).<br>• Take a thin sheet of ice and place it on a high emissivity surface. When nearly melted, take spot reading at the interface of ice and water.<br>Quick calibration check using boiling water (about 100°C)<br>• Boil water in a pan, filled nearly to the top (not a kettle). View at slight angle to avoid interference from steam and take a spot reading near the edge of the pan.<br>• Take into consideration boiling temperature of water vs. pressure for various altitudes.<br>Quick calibration check using human tear duct at room temperature (about 36°C).<br>Check against a calibrated temperature probe. A full check on a calibration test rig. | Specify procedures for calibration of IR cameras and basic procedure for full calibration test:<br>Quick calibration check using melting ice (about 0°C).<br>• Take a thin sheet of ice and place it on a high emissivity surface. When nearly melted, take spot reading at the interface of ice and water.<br>Quick calibration check using boiling water (about 100°C)<br>• Boil water in a pan, filled nearly to the top (not a kettle). View at slight angle to avoid interference from steam and take a spot reading near the edge of the pan.<br>• Take into consideration boiling temperature of water vs. pressure for various altitudes.<br>Quick calibration check using human tear duct at room temperature (about 36°C).<br>Check against a calibrated temperature probe. A full check on a calibration test rig. | |
| **2.26** | Safe data acquisition | • | • | | Importance of some IR camera settings on date relevant to the thermogram, e.g.,:<br>Is the image in focus?<br>Is the temperature Range/Span/Level correctly set?<br>Is the target below minimum spot size?<br>Are all instrument settings correct?<br>Are there any other 'external anomalies' that may corrupt the genuine result? | Specify checks should be applied before recording and analysing a thermogram, e.g.,:<br>Is the image in focus?<br>Is the temperature Range/Span/Level correctly set?<br>Is the target below minimum spot size?<br>Are all instrument settings correct?<br>Are there any reflections from nearby objects or the sky present? | |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| | | | | | | Genuine or false anomalies. | |
| **2.27** | Data and image storage | • | | | Storing data in its original format. | | |
| **2.28** | Accessories | • | • | | Basic requirement for accessories:<br>Photographic equipment (if not fitted to infrared camera). Spare batteries.<br>High emissivity PVC tape. Lens brush. | Requirement of accessories:<br>Mechanical:<br>Corrugated reflector for reflected temperature measurement.<br>Electrical:<br>Current clamp ammeter.<br>Civil:<br>Air flow meters.<br>Borescopes.<br>Contact and immersion thermometers.<br>Heat flow meters.<br>Hydrometers.<br>Moisture meters.<br>Blower doors.<br>Building fan systems.<br>Specification for above instruments. | |
| **3** | **Image processing** | | | | **6** | **2** | **1** |
| **3.01** | ISO 18434-1 | • | • | • | Basic requirements of the standard. | Complete understanding of the standard. | Complete understanding and application of the standard. |
| **3.02** | General guidelines for establishing thermal severity assessment criteria (ISO 18434-1: engineering codes and other standards) | | • | • | | Basic guidelines listed in the standards, CM/GEN Appendix B and other literature, including: General severity criteria topics (absolute, delta, statistical). Severity criteria applied to individual components or like groups. Factors affecting severity assessment criteria. Temperature difference criteria (ΔT or qualitative). Maximum permissible temperature criteria (quantitative). Profile assessment criteria. | Guidelines listed in the standard, CM/GEN Appendix B and other literature, including: General severity criteria topics (absolute, delta, statistical). Severity criteria applied to individual components or like groups. Factors affecting severity assessment criteria. Temperature difference criteria (ΔT or qualitative). Maximum permissible temperature criteria (quantitative). Profile assessment criteria. |
| **3.03** | Level and span adjustment | • | | | Understand settings for widest temperature, level and span, in the area of the anomaly and reference temperatures. | | |
| **3.04** | Statistical analysis | | • | | | Evaluate existing software packages and recommend a basic package suitable for the instrument and application being considered. | |
| **3.05** | Image subtraction | | • | • | | Evaluate existing software packages and recommend an advanced package suitable for the instrument and application being considered. | Evaluate existing software packages and specify one suitable for the instrument and application being considered. |

| Ref: | Subject Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **3.06** | Image montage | • | • | • | Basic requirement for image montage. | Image montage procedures to achieve the best image quality. | Specify the procedure for achieving image montage quality. |
| **3.07** | Temperature trending | • | • | • | Understand how to use the software and be able to demonstrate the basic principles of temperature trending. | Evaluate existing software packages and recommend one suitable for the instrument and application being considered. | Evaluate existing software packages and specify one suitable for the instrument and application being considered. |
| **3.08** | General image interpretation guidelines | • | • | • | Ensure recorded thermogram is a true representation of an anomaly, e.g.,:<br>Is the image in focus? Is the temperature Range/Span/Level correctly set?<br>Is the target below minimum spot size?<br>Are all instrument settings correct?<br>Are there any other 'external anomalies' that may corrupt the genuine result? | Record and evaluate the thermogram as a true representation of an anomaly, e.g., Is the image in focus? Is the temperature Range/Span/Level correctly set? Is the target below minimum spot size? Are all instrument settings correct? Are there any reflections from nearby objects or the sky present? Genuine or false anomalies. | Revision of Category2 |
| **4** | **Condition monitoring** | | | | **4.5** | **0 0.5?** | **0** |
| **4.01** | Discussion on general industrial applications | • | • | | Basic application of thermography in the following fields:<br>Mechanical & Process.<br>Electrical.<br>Building & Civil examples. | Include and discuss some simple examples and thermograms for application in modules not included in the selected certification module & mention any applicable standards | |
| **4.02** | Active and passive thermography | • | • | • | Basic difference between the two techniques. | Fully understand the difference between the two techniques. | Extensive knowledge of the difference between the two techniques and various excitation sources. |
| **5** | **Diagnostics and prognostics** | | | | **1** | **2** | **2** |
| **5.01** | Basic principles of diagnostics (ISO 17359 & 13379-1) | • | • | • | Basic understanding of the standards. | Complete understanding of the standards, concentrating on the application of diagnostic techniques. | Complete understanding of the standards and be able to critically evaluate sections relating to diagnostic techniques. |
| **5.02** | Basic principles of prognostics (ISO 13381-1) | | • | • | | Complete understanding of the standard, concentrating on the application of prognostics techniques. | Complete understanding of the standard and critically evaluate sections relating to prognostics techniques. |
| **6** | **Condition monitoring applications** | | | | **4** | **10.5** | **7** |
| **6.01** | Plant & equipment engineering principles.<br>Component failure modes and associated thermal signatures related to the target size.<br>Choice of camera/lens combination or software features. | • | • | • | Knowledge of the basic principles of ISO 13379-1, 17359, and BSEN 60812 relating to failure modes of systems and associated thermal signatures. | Knowledge and understanding of the principles of ISO 13379-1, 17359, and BSEN 60812 relating to failure modes and associated thermal signatures of basic electrical, mechanical (such as rotating and sliding theory) and building construction systems. | Knowledge and understanding of ISO 13379-1, 17359, and BSEN 60812 including failure modes and associated thermal signatures of the complex electrical, mechanical (such as rotating and sliding theory) and building construction systems.<br>Also, including the basic principles of the following CM activities:<br>Acoustic emissions (AE).<br>Lubrication analysis (LA). |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| | Exothermic/Endothermic applications | | | | | | Vibration analysis (VA). |
| **6.02** | Severity assessment and acceptance criteria (engineering codes and standards) | • | • | • | Aware of currently recommended data | Implement data currently recommended | Implement data currently recommended and where necessary recommend guidelines |
| **6.03** | Safety issues | • | | | Basic principles of national or local safety procedure specified by the National standards, 'Client' or C2/C3 Thermographer. | | |
| **6.04** | Fault analysis | • | | | Basic principles of fault analysis. | | |
| **6.a)** | **Electrical applications** | | | | | | |
| **6.a.01** | Electrical engineering (components & construction) | | • | • | | Basic construction of typical electrical component and systems, areas where heat is likely to be generated and possible anomalies arise:<br>Extra-Low Voltage (E-LV).<br>Low Voltage (LV).<br>High Voltage (HV). | Construction of typical electrical component and systems, highlighting the areas where heat is likely to be generated and possibly anomalies arise:<br>Extra-Low Voltage (E-LV).<br>Low Voltage (LV).<br>High Voltage (HV). |
| **6.a.02** | IR theory to electrical applications and thermal signatures including recommended maximum component operating temperatures & target size | | • | • | | Basic electrical theory, including:<br>Relationship between current, voltage and resistance. Relationship between power, current and resistance. Harmonics (particularly 3rd order/zero sequence).<br>Effect of eddy currents on thermal patterns.<br>Danger of circulation currents. Thermal theory. | Extensive electrical theory, including:<br>Relationship between current, voltage and resistance. Relationship between power, current and resistance. Harmonics (particularly 3rd order/zero sequence).<br>Effect of eddy currents on thermal patterns.<br>Danger of circulation currents. Thermal theory. |
| **6.a.03** | Applications examples with anomaly analysis | | • | • | | Basic principles of electrical distribution systems and present thermograms of various electrical anomalies, with full analysis, for examples listed below: | Principles of electrical systems and present thermograms of complex electrical anomalies, with full analysis, for examples listed below: |
| | e) Electrical distribution | | | | | E-LV, LV and HV. | E-LV, LV and HV. |
| | f) Electrical panels | | | | | E-LV, LV and HV. | E-LV, LV and HV. |
| | g) Electrical components | | | | | Conductor types.<br>Termination types.<br>Fuse types.<br>Contactor types.<br>Main isolator types.<br>Overload types.<br>Other components. | Revision of Category 2 |
| | h) Electrical motors | | | | | Cage and motor windings. | Revision of Category 2 |

| Ref: | Subject Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| | | | | | | Terminal box.<br>Bearings.<br>AC/DC motors. | |
| **6.a.04** | Anomaly analysis with recommended corrective action | | • | • | | Evaluate anomalies and recommend corrective action in the following:<br>Low voltage examples - open and closed panels.<br>Motors.<br>Busbars.<br>High voltage systems.<br>Transformers.<br>Power lines.<br>Measuring temperatures through safety grills and windows. | Critically evaluate anomalies and recommend corrective action in the following:<br>Low voltage examples - open and closed panels.<br>Motors.<br>Busbars.<br>High voltage systems.<br>Transformers.<br>Power lines.<br>Measuring temperatures through safety grills and windows. |
| **6.a.05** | Safety issues | | • | • | | National and local electrical standards and knowledge of the following:<br>Risk Assessment and Method Statement example. Safe approach boundary. Working near live equipment at very close range. Removal of panels on live electrical equipment. Maintenance of electrical joints. Working at height. Prepare a basic Risk Assessment and Method Statement document. | Revision of Category 2 and also:<br>Provide C1 or C2 thermographers with Risk Assessment and Method Statement documents. |
| **6.b)** | **Mechanical applications** | | | | | | |
| **6.b.01** | Mechanical engineering (components and construction) | | • | • | | Basic principles of design and operation of the following: Bearing design – ball, taper, roller and other types. Motor types – externally cooled, enclosed, AC, DC. Pump types – centrifugal, piston, screw. Fan types – centrifugal, piston, screw. Compressor types – piston, screw. Valve types and basic design: Shut off and check valves and Safety valves Gearboxes – gear, worm, bevel. Drive types – direct coupled, belt gear drives. Steam trap types – thermostatic & thermodynamic including basic design and principle of operation. Heat exchangers – finned tube, external flow, internal flow. | Design and operation of the following: Bearing design – ball, taper, roller and other types. Motor types – externally cooled, enclosed, AC, DC. Pump types – centrifugal, piston, screw. Fan types – centrifugal, piston, screw. Compressor types – piston, screw. Valve types and basic design: Shut off and check valves and Safety valves. Gearboxes – gear, worm, bevel. Drive types – direct coupled, belt gear drives. Steam trap types – thermostatic & thermodynamic including basic design and principle of operation. Heat exchangers – finned tube, external flow, internal flow. |
| **6.b.02** | IR theory to mechanical applications and thermal signatures including | | • | • | | Dealing with highly reflective surfaces<br>Dealing with grills,<br>Basic knowledge of the following: Drives. | Advanced knowledge of the following: Drives. Steam theory: Boiling temperature vs. pressure. Phase change – ice–water-steam. Steam tables. Wet steam and |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| | recommended maximum operating temperatures | | | | | Steam theory: Closed steam systems. - Temperature vs. pressure. Phase change – ice–water-steam. Steam tables. Wet steam and superheated steam. Energy loss calculations:<br>Example - heat transfer through a furnace wall. Example – heat loss from a furnace wall. | superheated steam. Energy loss calculations:<br>Example - heat transfer through a furnace wall. Example – heat loss from a furnace wall. |
| **6.b.03** | Applications examples with anomaly analysis | | • | • | | Basic principles of mechanical systems and present thermograms of various mechanical anomalies, with full analysis: Process Industry: Food, paper, petrochemical etc. Mechanical applications: Conveyors, etc. Active Thermography, e.g., wind turbine blades. | Principles of mechanical systems and present thermograms of various mechanical anomalies, with full analysis: Process Industry: Food, paper, petrochemical etc. Mechanical applications: Conveyors, etc. Active Thermography, e.g., wind turbine blades. |
| | c) Rotating & sliding equipment | | | | | Defective bearings, shafts, couplings, misalignment, friction, etc. | Revision of Category 2 |
| | d) Fluid flow & processes | | | | | Blocked pipes or heat exchangers. Deposit in pipes or leaking valves. | Revision of Category 2 |
| | e) Power transmission | | | | | Overheating gearboxes, belt slip. Defective couplings | Revision of Category 2 |
| | f) Furnaces | | | | | Refractory lined or external insulation defects. | Revision of Category 2 |
| | g) Pipes, tanks & insulation | | | | | Deposit level in tanks. Trace heating defects, etc. | Revision of Category 2 |
| **6.b.04** | Anomaly analysis with recommended corrective action | | • | • | | Evaluate basic anomalies and recommend corrective action in the following: Rotating equipment, preload, alignment, etc. Conveyor belts problems. Paper machines, mechanical & process. Fluid flow problems. Heat exchangers blockage. Furnace refractories and tubes. Effect of wind on tall structures. Tank deposits and insulation. Active Thermography, e.g., a wind turbine blade. | Evaluate complex anomalies and recommend corrective action in the following: Rotating equipment, preload, alignment, etc. Conveyor belts problems. Paper machines, mechanical & process. Fluid flow problems. Heat exchangers blockage. Furnace refractories and tubes. Effect of wind on tall structures. Tank deposits and insulation. Active Thermography, e.g., a wind turbine blade. |
| **6.b.05** | Safety issues | | • | • | | Know about national and local mechanical standards and demonstrate knowledge of the following:<br>Risk Assessment and Method Statement example.<br>In the absence of a C3 thermographer, be able to prepare a basic Risk Assessment and Method Statement document. | Revision of Category 2 and also:<br>Provide C1 or C2 thermographers with Risk Assessment and Method Statement documents. |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **6.c)** | **Civil applications** | | | | | | |
| **6.c.01** | Civil Engineering (components & construction) | | • | • | | Basic knowledge of the following:<br>Overview of building envelope types | Complex knowledge of the following:<br>Overview of building envelope types |
| | b) Construction types | | | | | Building Technology:<br>• Historic buildings.<br>• Domestic buildings before approximately 1940.<br>• Domestic buildings built after 1940.<br>• Commercial buildings.<br>• Industrial buildings.<br>• Sick-building syndrome.<br>• Wooden frame construction. | Revision of Category 2 |
| | b) Material types | | | | | Steel fabrications.<br>Concrete structures - plain or reinforced.<br>Various types of brick – building or fire bricks.<br>Stone types.<br>Glass.<br>Plastics.<br>Wood, etc., | Revision of Category 2 |
| **6.c.02** | IR theory to civil applications, thermal signatures, thermal energy transient/steady state transfer.<br>Energy storage.<br>Survey procedures, min/max environmental & equipment recommendations.<br>Recommended equipment & test conditions.<br>Any current standards or guidelines? | | • | • | | Typical thermal signatures in civil applications as well as: | Complex thermal signatures in civil applications as well as: |
| | b) Properties of materials | | | | | IR characteristics of building materials.<br>Physical & mechanical properties of building materials.<br>Thermal properties of building & other materials. | Revision of Category 2 |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| | c) Environmental conditions & their effect on thermal patterns B | | | | | Radiant heat transfer caused by the solar radiation or cloudless night sky<br>Effect of ambient temperature variations.<br>Effect of reflected temperature.<br>Wind effect (convection).<br>Effect of rain (moisture).<br>Phase change (evaporation). | Revision of Category 2 |
| **6.c.03** | Building applications examples with anomaly analysis | | • | • | | Basic knowledge of the following types of constructions.<br>Domestic buildings.<br>Commercial buildings.<br>Industrial buildings. | Extensive knowledge of the following:<br>Domestic buildings.<br>Commercial buildings.<br>Industrial buildings. |
| | b) Insulation | | | | | Types of insulation. Thermal resistance of insulating materials. | Revision of Category 2 |
| | c) Moisture | | | | | Theoretical and practical methods for dew point estimates. Dampness, transport mechanism and thermal signature.<br>Condensation, transport mechanism and thermal signature. | Revision of Category 2 |
| | d) Air leakage/air tightness | | | | | External measurement of thermal patterns - building increased pressure and examples.<br>Internal measurement of thermal patterns – building reduced pressure and examples.<br>Leak detection using smoke IR equipment.<br>Equipment for controlling building pressure.<br>Test procedure. | Revision of Category 2 |
| **6.c.04** | Other structures | | • | • | | Basic knowledge of other structures:<br>Rendered buildings.<br>Concrete tarmac surfaces.<br>Tunnels & bridges, etc. | Knowledge of other structures:<br>Rendered buildings.<br>Concrete tarmac surfaces.<br>Tunnels & bridges, etc. |
| | b) Structural details and defects | | | | | Delamination in concrete structures.<br>Corrosion of Concrete.<br>Other Defects.<br>Industrial refractory lined furnaces. | Revision of Category 2 |
| | c) Structural finishes | | | | | Brick or concrete.<br>Rendering.<br>Paint.<br>Glass.<br>Plastics.<br>Metals. | Revision of Category 2 |
| **6.c.05** | Anomaly & thermal patterns analysis with recommended corrective action | | • | • | | Evaluate basic anomalies and recommend corrective action for the following:<br>Roofs and Ceiling.<br>Walls.<br>Glass windows. | Revision of Category 2 |

| Ref: | Subject Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| | | | | | | Air tightness.<br>Delamination (Spalling).<br>Cold bridging.<br>Underfloor heating systems.<br>District heating systems.<br>Asphalt roads.<br>Refractory lined industrial furnaces & stacks.<br>Pollution control.<br>Active Thermography example. | |
| **6.c.06** | Safety issues | | • | • | | National and local mechanical standards and demonstrate knowledge of the following: Risk Assessment and Method Statement example. Prepare a basic Risk Assessment and Method Statement document. | Revision of Category 2 and also:<br>Provide C1 or C2 thermographers with Risk Assessment and Method Statement documents |
| **7** | **Reporting and documentation (ISO international standards)** | | | | **1** | **0.5** | **0.5** |
| **7.01** | Report writing | • | • | • | Produce reports, based on instructions from a C2 thermographer, on the survey findings that include requirements from ISO 18434-1. | Produce extensive reports based on the survey findings in compliance to ISO 18434-1. Analyse reports produced by C1 thermographers. | Produce comprehensive reports based on the survey findings in compliance with ISO 18434-1. Analyse reports produced by C1 & C2 thermographers. Specify the required format and content. |
| **7.02** | Thermographers' and end-users' responsibilities | • | • | • | Produce reports that satisfy all requirements of ISO 18434-1 and the 'Client'. | Produce reports that satisfy all requirements of ISO 18434-1 and the 'Client'. Analyse reports produced by C1 thermographers. | Produce reports that satisfy all requirements of ISO 18434-1 the 'Client '. Specify report format, analyse reports produced by C1 & C2 thermographers. |
| **8** | **Condition monitoring programme design** | | | | **0.5** | **0.5** | **3.5** |
| **8.01** | General principles | • | • | • | Basic principles as described in: CM/GEN Appendix B, ISO 17359, 18434, 13374, 13379-1 and 13381. | Analyse information from the following documents: CM/GEN Appendix B, ISO 17359, 18434, 18436, 13379-1 and 13381,or other relevant standards | Critically analyse and design appropriate programme based on requirements: CM/GEN Appendix B, ISO 17359, 18434, 18436,13379-1 and 13381,or other relevant standards |
| **8.02** | Technique selection | | • | • | | Consider survey technique appropriate to application, e.g., selection of IR instrument and additional equipment. | Specify survey technique appropriate to application or write new procedures. |
| **8.03** | Measurement intervals | | • | • | | Implement inspection interval requirements in compliance with supplier recommendations and historic anomaly records. | Specify inspection interval requirements based on supplier recommendations and historic anomaly records. |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **8.04** | Reference temperatures | • | • | • | Principles of reference temperatures | Evaluate data presented in existing literature or specifications. Provide instructions to C1 thermographers. | Critically evaluate data in existing literature or specifications or create data specific to application. |
| **8.05** | Plant & equipment baseline temperatures | • | • | • | Principles for baseline temperatures. | Evaluate established baseline temperatures data based on:<br>• New equipment (or building) at operating loads<br>• Recommendations by manufacturers or (designers)<br>• Experience<br>Issue instructions to C1 thermographers on the values to be used. | Establish baseline temperatures data as well as specify new values based on:<br>• New equipment (or building) at operating loads<br>• Recommendations by manufacturers or (designers)<br>• Experience<br>Issue instructions to thermographers. |
| **8.06** | CM management procedure and process development | | • | • | | Evaluate existing data and recommend corrective procedures based on severity, safety, cost, etc. Instruct C1 thermographers. Maintain up to date records. | Evaluate existing data and recommend corrective procedures based on the anomaly severity, safety, cost, etc.<br>Write instructions for thermographers.<br>Implement procedures. |
| **8.07** | Alarm values | | • | • | | Understand severity of the anomalies and establish alarm values | Evaluate severity of the anomalies and set alarm values. |
| **9** | **Condition monitoring programme implementation** | | | | **1** | **1** | **1** |
| **9.01** | Overview | • | | | Basic principles behind the documents: ISO 17359, 13381-1, 18434-1 and their effect on IR surveys. | | |
| **9.02** | Safe system of work | • | • | • | Follow basic regulations in ISO 18434-1 and specific national and local site regulations related to thermography. | Implement the basic regulations in ISO 18434-1 and specific national and local site regulations related to thermography.<br>Also analyse topics raised in sections 6.a) 6.b) 5 and 6.c). | Ensure compliance with regulations in ISO 18434-1 and specific national and local site regulations related to thermography.<br>Also, analyse topics raised in sections 6.a), 6.b) and 6.c). |
| **9.03** | Roles and responsibilities | | • | • | | Roles of the 'Client' and the thermographer:<br>• Implement procedures approved by a qualified person.<br>Customer<br>• Specify what is to be inspected.<br>• Provide a guide qualified for the purpose.<br>• Provide site induction course. | Roles of the 'Client' and thermographer:<br>• Write procedures<br>Customer<br>• Specify what is to be inspected.<br>• Provide a guide qualified for the purpose.<br>• Provide site induction course. |
| **9.04** | Training and accreditation | | • | • | PCN requirements to obtain the C1 certificate. | PCN requirements to obtain the C2 certificate. | PCN requirements to obtain the C3 certificate. |
| **10** | **Condition monitoring programme management** | | | | **0.5** | **0.5** | **2** |

| Ref: | Subject<br>Syllabus topic | Category | | | Category sub-topics | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Category 1 | Category 2 | Category 3 |
| **10.01** | Safety management | • | • | • | Interpret and apply safety requirements specified by the 'Client' and/or qualified C2 or C3 certified supervisor. | Interpret and apply safety requirements specified by any national laws or regulations, e.g., as applicable in UK:<br>Health and Safety at Work Act (HSWA)<br>Electricity at Work regulations (EAW)<br>Construction (Design and Management) Regulations (CDM)<br>Provision and Use of Work Equipment Regulations (PUWER)<br>By the 'Client' and/or the qualified supervisor with C3 certificate. | Write and implement safety requirements agreed by the 'Client'<br><br>Have full understanding of the Acts and Regulations applicable in the area of operation. |
| **10.02** | Equipment management | • | • | • | Follow equipment management procedure and make certain that the IR instrument to be used is 'certified' and functioning correctly. | Implement equipment management procedure and ensure the equipment to be used is 'certified' and functioning correctly. | Write and implement equipment management procedure; ensure full compliance. |
| **10.03** | Procedure management | | • | • | | Thermography procedure management and ensure it is fully implemented by all site Thermographers. | Thermography (and other CM) procedure management system and ensure it is fully implemented by all staff. Write new procedures. |
| **10.04** | Skills and competence management | | • | • | | Collate the following records:<br>Thermographer skills; Thermographer valid certification. | Collate and manage records:<br>Thermographer skills: Thermographer valid certification; Write new procedures. |
| **10.05** | Database management | • | • | • | Follow procedure for thermography database management | Follow procedure for thermography database management and ensure it is followed by C1 thermographers. | Write the procedure for thermography database management ensuring it is followed by all thermographers. |
| **10.06** | Managing corrective action implementation | | • | • | | Collate and in conjunction with the 'Client', recommend corrective action to be taken. Whenever possible, making certain that the database is kept up to date on the action actually taken and ensure that this procedure is followed by all C1 thermographers. | Collate and in conjunction with the 'Client', recommend corrective action to be taken. Whenever possible, making certain that the database is kept up to date on the action actually taken and ensure that this procedure is followed by all thermographers. |
| **11** | **Training examination** | | | | **1** | **2** | **2** |
| **12** | **Practical skills evaluation** | | | | **2** | **0** | **0** |
| | **Total Hours** | | | | **33** | **32** | **32** |

Notes:

1. Category 2 includes the knowledge of Category 1; Category 3 includes the knowledge of Category 1 and Category 2.

2. At Categories 2 and 3, the times allocation are indicative only, indicating the bias towards application topics, and the actual time spent for each topic is flexible, provided an advised minimum of approximately 24hours is allocated per field of application.

**Certification Services Department**
**Midsummer House, Riverside Way**
**Bedford Road, Northampton**
**NN1 5NX, United Kingdom**

Tel: +44 (0) 1604-438-300
Fax: +44 (0) 1604-438-301
E-mail: pcn@bindt.org

BINDT
THE BRITISH INSTITUTE OF NON-DESTRUCTIVE TESTING

## Annex B – Reading references

**Essential Reading** (material from which examination questions can be developed)

| Categories | Title | Author(s) | Publisher | Reference |
|---|---|---|---|---|
| 1, 2, 3 | ASNT Level 3 Study Guide- Infrared and Thermal Testing Method | H Kaplen | American Society of Non Destructive Testing, 2001 | ISBN 1571170154 |
| 2, 3 | Safe Thermal Imaging of Electrical Systems | C. Pearson | UK Thermography Association, 1997 | Application Guide AG/97 |
| 2, 3 | Thermal Imaging of Building Fabric | C. Pearson | BSRIA | ISBN 086022-590-9 |
| 1, 2, 3 | Common sense approach to thermal imaging | G C Holst | Society of Photo-Optical Instrumentation Engineers, 2000 | ISBN 0819437220 |
| 1, 2, 3 | Infrared Thermography- Applications | A Nowicki | BINDT | 090313232X |
| 2, 3 | Measurement in Thermography | C. Ohman | FLIR Systems AB | 1557498 Rev A |
| 3 | Condition-based Maintenance using Non-Destructive Testing: Application Guide AG 1/2003 | C Pearson<br>A Seaman | BSRIA | ISBN 860226115 |
| 1, 2, 3 | Infrared Thermography- Theory & Practice | N Walker | BINDT | 0903132338 |
| 3 | Acoustic emission and ultrasonics | T Holroyd | Coxmoor | 1901892077 |
| 3 | Vibration monitoring handbook | C W Reeve | Coxmoor, 1998 | 190189200X |
| 3 | The wear debris analysis handbook | B J Roylance & T M Hunt | Coxmoor, 1999 | 1901892026 |
| 3 | Oil Analysis | Evans and Hunt | Coxmoor | 1901892050 |
| 3 | Defects in Buildings, symptoms, investigation, diagnosis and cure', | M Billington; 2001 | Carillion Services | ISBN 0117024368 |
| 2,3 | Measuring Air Permeability of Building Envelopes –Technical Standard 1. | ATTMA | ATTMA; 2006 | NA |
| 2,3 | Airtightness testing- The essential guide to Part 2 of the 2006 Building Regulations (UK)- BG4/2006 | David Pickavance and Tom Jones | BSRIA, 2006 | 086022662X |

UKAS PERSONNEL CERTIFICATION 0030



PCN

| | | | | |
|---|---|---|---|---|
| 2,3 | Airtightness testing for new Dwellings; A practical guide for builders and testers (UK); BG11/2004 | Nigel Potter and Chris Knights | BSRIA, 2004 | 0860226484 |
| 1,2 | An Introduction to Condition Monitoring and Diagnostic Technologies | Professor A. Hope & Mr D Whittle (Editors) | BINDT | 978 0 903132 76 3 |

**Standards, codes and specifications** (Material from which examination questions can be developed)

1. ISO 13374. Part 1. Condition monitoring and diagnostics of machines- Data processing, communication and presentation: Part 1. general Guidelines
2. ISO 13372, Condition monitoring and diagnostics of machines- vocabulary
3. ISO 17359, Condition monitoring and diagnostics of machines- general guidelines
4. ISO 13379-1, Condition monitoring and diagnostics of machines. Data interpretation and diagnostics techniques. General guidelines
5. CMGEN, General requirements for qualification and PCN certification of condition monitoring and diagnostic personnel
6. ISO 13381-1, Condition monitoring and diagnostic of machines; prognostics: Part 1 general Guidelines
7. ISO 18436-1, Condition monitoring and diagnostics of machines; requirements for qualification and assessment of personnel. Part 1, Requirements for certifying bodies and the certification process
8. ISO 18436-7, Condition monitoring and diagnostics of machines; requirements for qualification and assessment of personnel. Part 7, Thermography
9. ISO 18434-1. Condition monitoring and diagnostics of machines. Thermography. Part 1: General procedures.
10. -BS EN 60812, Analysis techniques for system reliability. Procedure for failure mode and effects analysis (FMEA)
11. BS EN 61025, Fault tree analysis (FTA)
12. ISO 9869-2 Thermal insulation – Building elements – In-situ measurement of thermal resistance and thermal transmittance – Part 2: Infrared method for frame structure dwelling
13. ISO 13187. Thermal performance of buildings- Qualitative detection of thermal irregularities in building envelopes- Infrared method

**Recommended reading** (Informative) (material that contains helpful information on a related subject)

| Category | Title | Author(s) | Publisher | ISBN/Publ No |
|---|---|---|---|---|
| 1, 2 | Product Technology Classroom Training Handbook | | BINDT | NA |
| 2, 3 | Practical Applications of Infrared Thermal Sensing and Imaging Equipment | H Kaplen | Society of Photo-Optical Instrumentation Engineers, 1999, 2nd Edition | 0819431389 |

| | | | | |
|---|---|---|---|---|
| 2,3 | NFPA 70E Standard for electrical safety in the workplace | NFPA | NFPA (USA), 2004 Edition | NA |
| 3 | Business-focussed Maintenance- A BSRIA Guide | J Harris, P Hastings | BSRIA, 2004 BG/3/2004 | 0860226042 |
| 3 | NFPA 70B Recommended practice for electrical equipment maintenance | NFPA | NFPA (USA), 2002 Edition | NA |

# ISO 18436-2 Category I-IV

## JUNIOR I - INTERMEDIATE II - SENIOR III - EXPERT IV

VIBRATION ANALYST TRAINING & CERTIFICATION

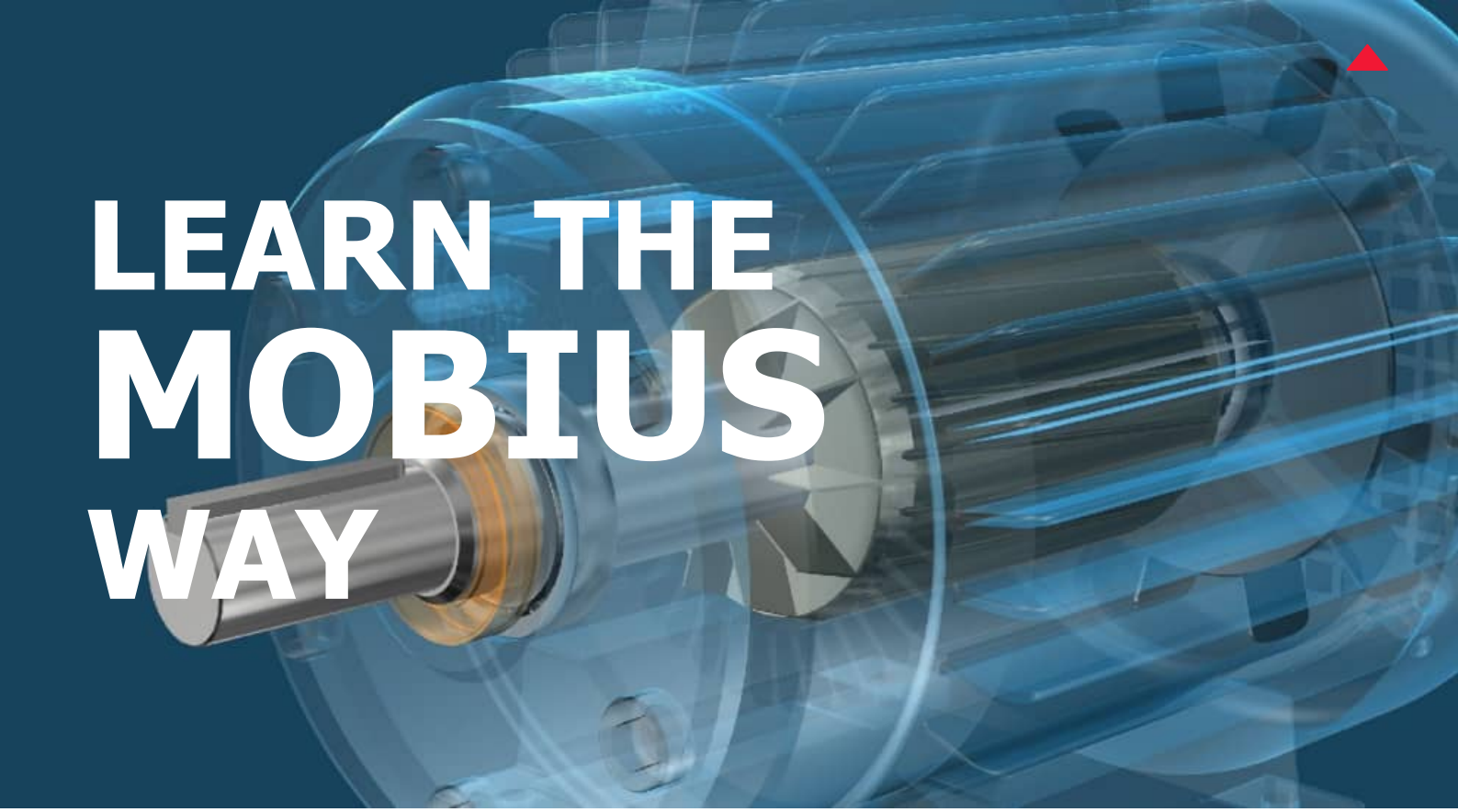
REQUEST A QUOTATION

RMS RELIABILITY TRAINING INSTITUTE

rms-training.com

MOBIUS INSTITUTE

www.mobiusinstitute.com



# LEARN THE MOBIUS WAY

## WHY LEARN WITH MOBIUS INSTITUTE™?

There are three major reasons why over 5,000 students choose Mobius Institute every year:

- We make complex topics simple with amazing 3D animations and simulations that make you say, *"Ah, now I get it!"*
- We give you access to the entire course before the class begins so you are better prepared, and for four months after the course, or you can choose a 1-Year Continued Education Upgrade.
- We use anonymous, stress-free polling throughout the course, so you know if you truly understand each topic, and the instructor knows not to move on to the next topic - *no student is left behind.*

There are many other reasons why vibration analysts, and their managers, choose Mobius Institute.

www.mobiusinstitute.com

# WITH MOBIUS INSTITUTE™, YOU CAN *LEARN YOUR WAY.*

We offer the ultimate flexibility. See the course details for more information.

CLASSROOM INSTRUCTOR-LED COURSES

We have training partners in 60 countries, offering 23 languages.

VIRTUAL INSTRUCTOR-LED COURSES

Attend a virtual course - just like a live course, but you learn via GoToMeeting.

PRIVATE ON-SITE INSTRUCTOR-LED COURSES

Have the instructor come to your site to save your precious time and money (and health).

ONLINE VIDEO COURSES

Traditional eLearning courses and iLearnReliability Learning Management System (LMS) courses

## WHY BECOME CERTIFIED BY THE MOBIUS INSTITUTE BOARD OF CERTIFICATION™?

There are so many benefits to becoming certified:

- You should be recognized for your achievements; not everyone is up to the challenge of understanding vibration analysis, let alone successfully collecting data and utilizing it
- Being certified by an accredited certification organization is a major step up from simply passing a test. Yes, the process is a little more complicated and stricter, but that is for very good reasons
- The educational process is extremely valuable, but being certified tells an employer (or a consulting client) that you are capable of doing an important job

Mobius Institute has certified more vibration analysts than any other organization, and we have only been offering certification since 2005. Almost 40,000 vibration analysts around the world, just like you, chose Mobius Institute.

You will receive a digitally encrypted certificate, an ID card, and a personalized logo that you should use in email signatures and elsewhere that you want people to know about your achievements.

# VCAT-I Junior Vibration Analyst

## ISO 18436-2 Category I

Learn to be an effective vibration technician—capable of collecting quality data, and performing basic analysis and data validation—with advanced 3D animations and interactive simulations that make everything easy to understand.

Welcome to the beginning of the vibration analysis journey. The good news is you are in the right place. Our VCAT-I ISO Category I course will set you up for success.

Once you complete the training, you can take the exam with confidence, and become certified to ISO 18436-2 Category I via the internationally respected Mobius Institute Board of Certification [MIBoC]. The MIBoC certification is accredited to ISO/IEC 17024 - there is no higher standard. You will join thousands of other Mobius Institute certified analysts around the world.

### VCAT-I CANDIDATE PROFILE

This course is intended for the vibration analyst who will:

- Collect vibration data
- Validate that the data is good
- Begin to perform basic analysis
- Use the training and certification as the start of a new and rewarding career as a vibration analyst

## WHAT WILL YOU GAIN FROM TAKING THIS COURSE?

There are so many benefits to taking this course. You will learn…

- About condition monitoring, including a summary of the most common technologies
- About reliability improvement
- How vibration analysis plays a key role in reliability improvement
- About how machines work via the supplementary self-study "equipment knowledge" section of the manual
- About the fundamentals of vibration: waveforms, spectra, and simple metrics (overall levels, RMS, peak, peak to peak, and crest factor)
- How to take dependable, repeatable, high-quality vibration readings
- About vibration sensors, and how and where to mount them
- The basics of the analysis process, primarily with vibration spectra
- The basics of the key analyzer settings: fmax, resolution, and averaging
- The basics of setting alarm limits
- About the common "failure modes" of machines and how to detect them, including rolling element bearing faults, unbalance, misalignment, looseness, and resonance

## VCAT I FAST FACTS

**Duration:**
30 hours, typically over four days

**Format:**
- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

**Compliance:**
- Training and certification: ISO 18436-2
- Certification: ISO 18436-1, ISO/IEC 17024
- Training: ISO 18436-3

**Exam:**
- Two hours
- 60 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

**Certification requirements:**
- Training course completed
- 6-months of work experience, verified by an independent person
- Pass the exam
- Valid for 5 years

**Pre-study:**
- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

**Post-study:**
- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

# VCAT-II Intermediate Vibration Analyst

## ISO 18436-2 Category II

Learn to be an effective vibration analyst - capable of diagnosing a wide range of faults, conducting special tests, and performing precision aligning and balancing machinery - with advanced 3D animations and interactive simulations that make everything easy to understand.

So, you are ready to take the next step in your vibration analysis career. The good news is you are in the right place. Our VCAT-II ISO Category II course teaches you what you need to know to be a successful, confident, and competent vibration analyst.

We will teach you how to diagnose a wide range of fault conditions. We will teach you how to collect the right data with the correct vibration analyzer settings. And we will teach you some useful tips and tricks so that you may validate the diagnoses that you make. In addition, we will teach you about shaft alignment and balancing so that you can improve the reliability of the equipment.

Once you complete the training, you can take the exam with confidence, and become certified to ISO 18436-2 Category II via the internationally respected Mobius Institute Board of Certification [MIBoC]. The MIBoC certification is accredited to ISO/IEC 17024 - there is no higher standard. You will join thousands of other Mobius certified analysts around the world.

### VCAT-II CANDIDATE PROFILE

This course is intended for the vibration analyst who will:

- Collect vibration data
- Validate that the data is good
- Set up the analyzer for routine data collection and special tests
- Diagnose most of the common fault conditions
- Perform special tests to validate unbalance, misalignment, resonance, looseness, and other conditions
- Know how to perform precision shaft alignment and balancing
- Use the training and certification as the next step in a rewarding career as a vibration analyst

# VCAT-II Intermediate Vibration Analyst ISO 18436-2 Category II

## WHAT WILL YOU GAIN FROM TAKING THIS COURSE?

There is a great deal to learn, but it will help you to perform your role with confidence. In this course you will:

- Increase your knowledge on maintenance practices, condition monitoring, and the common condition monitoring technologies
- Increase your knowledge about data collection, testing techniques, sensor types, and so on
- Learn a great deal about signal processing and the settings of your vibration analyzer
- Increase your knowledge of spectrum analysis, time waveform analysis, and phase analysis
- Understand why phase analysis and time waveform analysis are both critical tools used by the vibration analyst
- Learn about common failure modes and how to detect them, including unbalance, misalignment, looseness, resonance, pump/fan/compressor vane, and flow issues, cavitation, turbulence, gearbox failures, rolling element bearing failure, and more
- Learn about high-frequency bearing and gear fault detection techniques: demodulation, enveloping, SPM HD, shock pulse, PeakVue, Spike Energy, and others
- Be able to use spectra, phase readings, time waveforms, bump and impact tests, to test for looseness, resonance, and other conditions
- Learn about precision shaft alignment and soft foot correction
- Learn about single and two-plane balancing
- Learn the basics of setting alarm limits: band alarms, and mask/envelope alarms

The key is that with the VCAT-II course, you will transition from being a person who is primarily capable of collecting data to a person who can diagnose faults on the critical machinery, and in some cases, prevent or correct them.

## VCAT II FAST FACTS

**Duration:**
38 hours, typically over five days

**Format:**
- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

**Compliance:**
- Training and certification: ISO 18436-2
- Certification: ISO 18436-1, ISO/IEC 17024
- Training: ISO 18436-3

**Exam:**
- Three hours
- 100 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

**Certification requirements:**
- Training course completed
- 18-months of vibration analysis experience, verified by an independent person
- Pass the exam
- Valid for 5 years

**Pre-study:**
- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

**Post-study:**
- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

# VCAT-III Senior Vibration Analyst

## ISO 18436-2 Category III

Learn to be an effective vibration leader and master analyst - capable of managing the condition monitoring program, diagnosing the widest range of fault conditions, verifying and correcting resonance problems, performing complex balancing machinery - with advanced 3D animations and interactive simulations that make everything easy to understand.

If you are ready to be the senior vibration analyst, with the capability of handling all the common fault conditions and leading the Category I and II analysts, then this is the course for you.

The Category III course is intended for people who are confident with spectrum analysis but who wish to push on and learn more about signal processing, time waveform and phase analysis, cross-channel testing, machine dynamics, and fault correction. If you wish to truly advance in vibration analysis and be able to run a successful condition monitoring team, then you are ready for this course.

- You will learn to diagnose all of the common fault conditions with rolling element and sleeve bearing machines, utilizing spectra, high-frequency detection techniques, time waveforms, phase readings, and other techniques to diagnose faults.
- You will also learn machine dynamics (natural frequencies, resonance, etc.), how to perform resonance testing, and how to correct resonance problems. The course also covers single and cross-channel measurement capabilities of your analyzer.
- And after completing the CAT-III course, you will be able to set up and run a successful vibration program and mentor the junior analysts.

Once you complete the training, you can take the exam with confidence, and become certified to ISO 18436-2 Category III via the internationally respected Mobius Institute Board of Certification [MIBoC]. The MIBoC certification is accredited to ISO/IEC 17024 - there is no higher standard. You will join thousands of other Mobius certified analysts around the world.

### VCAT-III CANDIDATE PROFILE

This course is intended for the vibration analyst who will:

- Have a minimum of 3 years of experience
- Have a senior role in the condition monitoring team
- Have others report to them to verify diagnoses
- Be responsible for the most complex fault conditions (with the possible exception of sleeve bearing, flexible rotor machines)
- Need to perform complex tests to validate fault conditions (e.g., resonance) and find a solution
- Want to be a leader of the vibration team or take a leading role in diagnosing faults and making repair recommendations
- Want to understand all data collector options, special test capabilities, all analysis tools and understand the widest range of fault conditions
- Seek to become certified to international standards (ISO-18436) by an accredited certification body
- Want to understand all condition monitoring technologies, how and when to apply them
- Want to understand machine dynamics (natural frequencies, resonance, ODS), how to perform resonance testing and how to correct resonance problems
- Use the training and certification as the next step in a rewarding career as a vibration analyst

# VCAT-III Senior Vibration Analyst ISO 18436-2 Category III

## WHAT WILL YOU GAIN FROM TAKING THIS COURSE?

There is a great deal to learn, but it will help you to perform your role with confidence. The topics covered in this course include:

- Review of condition monitoring technologies and the ISO standards
- Signal processing and data acquisition
- Time waveform analysis
- Phase analysis
- Dynamics (natural frequencies and resonance)
- Testing for natural frequencies
- Operating Deflection Shape (ODS) analysis
- Modal analysis and intro to FEA
- Correcting resonances
- Rolling element bearing fault detection
- Journal bearing fault detection
- Electric motor testing
- Pumps, fans, and compressors
- Gearbox fault detection
- Corrective action
- Running a successful condition monitoring program
- Acceptance testing
- Review of ISO standards

The key is that with the VCAT-III course, you will transition from being a vibration analyst who should be supervised to a person who is capable of running the program, being a senior consultant, solving difficult problems, and taking a leadership role.

## VCAT III FAST FACTS

**Duration:**
38 hours, typically over five days

**Format:**
- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

**Compliance:**
- Training and certification: ISO 18436-2
- Certification: ISO 18436-1, ISO/IEC 17024
- Training: ISO 18436-3

**Exam:**
- Four hours
- 100 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

**Certification requirements:**
- Training course completed
- 36-months of vibration analysis experience, verified by an independent person
- Have previsouly been certifed to VCAT-II by a MIBoC approved certification body
- Pass the exam
- Valid for 5 years

**Pre-study:**
- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

**Post-study:**
- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

# VCAT-IV Expert Vibration Analyst

## ISO 18436-2 Category IV

Achieve the highest status as a vibration analysis professional – capable of handling any condition that may be presented, capable of performing any test, fully understanding flexible rotor machinery - with advanced 3D animations and interactive simulations that make everything easy to understand.

Congratulations on being ready to tackle the Mount Everest of vibration analysis. The good news is you are in the right place. We have developed an amazing set of 3D animations and simulations that even make the Category IV topics relatively easy to understand. Topics that were once only suitable for Ph.D's and math geniuses are now accessible to practical vibration analysts—*as it should be.*

There is a lot to learn. You are required to take 64 hours of training according to ISO 18436-2, but we provide over 80 hours with combined online learning and 5-day in person learning (including Day 5 optional certification exam).

When you are ready, you must attend the face-to-face course where the instructor will review the topics and take you through a series of "worked examples" until you feel ready for the exam.

This training process will ensure you understand the topics so that you can apply the techniques in your role as the expert vibration analysts.

This training process will also help you achieve the pinnacle of the vibration world – the ISO Category IV Vibration Analyst.

### Like two courses in one

The topics are roughly broken into two groups:

1. There is an entire course that could be called "Category III on steroids." Many of the topics you covered on Category III are covered again, but we go into more detail. Those topics include signal processing, dynamics, ODS, modal analysis, and so on.
2. And then the course goes into overdrive. Now you get into the topics that are unique to Category IV. You will learn about fluid film bearings and flexible rotors, including measurements with proximity probes, diagnosing a variety of fault conditions, and even balancing flexible rotors.

### Mobius Institute™ animations and simulations to the rescue

Category IV does cover a lot of practical content, but there is a good dose of theory as well. It is the theory and the calculations that can intimidate many vibration analysts. But we have done our best to make it all understandable and achievable. We provide you with a long list of worked examples with clear explanations on how to perform the calculations. But we also have animations and simulations that let you understand exactly what is going on. Rather than abstract concepts that only Ph.D's feel comfortable with, you will be able to connect theory with reality because you will see it right there on the screen.

Once you complete the training, you can take the exam with confidence, and become certified to ISO 18436-2 Category IV via the internationally respected Mobius Institute Board of Certification [MIBoC]. The MIBoC certification is accredited to ISO/IEC 17024 - there is no higher standard. You will join thousands of other Mobius certified analysts around the world.

# VCAT-IV Expert Vibration Analyst ISO 18436-2 Category IV

## VCAT-IV CANDIDATE PROFILE

This course is intended for the vibration analyst who will:

- Have a minimum of 5 years of experience
- Have a senior role in the condition monitoring team, but you want to go beyond and truly reach the peak of the vibration world
- Be able to understand the measurements associated with critical turbomachinery and other fluid-film bearing machines
- Be able to do everything the Category III can do – only better!

## WHAT WILL YOU GAIN FROM TAKING THIS COURSE?

There is a great deal to learn, but it will help you to perform your role with confidence. The topics covered in this course include:

- Advanced signal processing
- Cross channel measurements
- Dynamics (mass/stiffness/damping, natural frequencies, modes)
- Resonance testing (run-up/coast down tests, impact tests, ODS, modal analysis)
- Corrective action (flow control, resonance correction, isolation, and damping)
- Proximity probe and casing measurements
- Orbit and centerline plot analysis
- Rotor dynamics (natural frequencies, modeling)
- Journal bearings (design, fluid film instabilities)
- Flexible rotor balancing
- Torsional vibration

The key is that with the VCAT-IV course, you will transition from being a very good vibration analyst to a vibration super-hero!

## VCAT IV FAST FACTS

### Duration:

82 hours: Everything on video, then a 5-day course with exam

### Format:

Expert Vibration Analyst (VCAT-lV) is a two part course. Part one is a distance learning online course. Part two is a public classroom instructor-led course.

### Compliance:

- Training and certification: ISO 18436-2
- Certification: ISO 18436-1, ISO/IEC 17024
- Training: ISO 18436-3

### Exam:

- Five hours
- 60 multiple-choice questions, with calculations required
- 70% passing grade
- Can be taken online or in-person at the course

### Certification requirements:

- Training course completed
- 60-months of vibration analysis experience, verified by an independent person
- Have previsouly been certifed to VCAT-III by a MIBoC approved certification body
- Pass the exam
- Valid for 5 years

### Pre-study:

You will have access to 52.5 hours of videos and materials

### Post-study:

- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

*Mobius Institute Board of Certification is an accredited certification body per ISO/IEC 17024 and ISO 18436-1 authorized to provide certification in accordance with ISO 18436-1 and 18436-2.*

*Mobius Institute Board of Certification (MIBoC) is an impartial and independent entity that is directed by scheme and technical committees to ensure that its certification meets or exceeds the requirements defined by the applicable International Organization for Standardization, ISO 18436 standards.*

*MOBIUS INSTITUTE is a worldwide provider of Reliability Improvement, Condition Monitoring and Precision Maintenance education to industrial plant managers, reliability engineers, and condition monitoring technicians, allowing plants to be successful in implementing Reliability Improvement programs through delivery of more easily understandable and comprehensive training of Reliability and Vibration Analysis via public, in-plant and online education programs.*

For more information about additional training courses, software tools, industry terminology and definitions, accredited certification, and specific course details, visit the Mobius Institute website.

www.mobiusinstitute.com

North America: +1 (239) 600 - 6828 | Australia: (+61) (0)3-5977-4606

learn@mobiusinstitute.com

RMS RELIABILITY TRAINING INSTITUTE

rms-training.com

Join thousands of other industry professionals by creating your free custom profile today at https://www.mobiusconnect.com/

**DOWNLOAD THE MOBILE APP**

MOBIUS CONNECT
SOLVING · LEARNING · SHARING

**The maintenance and reliability industry's professional network.**

**TOPICS COVERED – JUNIOR ANALYST CATEGORY I**

- Maintenance practices
  - Reactive, preventive, condition-based, proactive
  - How to decide between them
- Condition monitoring
  - Why it works
  - Ultrasound, infrared, oil analysis, wear particle analysis, and electric motor testing
- Principles of vibration
  - Waveforms
  - Metrics: overall levels, RMS, Pk, Pk-to-Peak, and crest factor
- Introduction to vibration measurement
  - Vibration sensors: displacement, velocity, acceleration
  - Vibration units
  - Mounting: where and how
  - Naming conventions
  - Repeatability and quality
  - Vibration axes: V, H, A, R, and T
  - What are “routes” and how do you create them?
  - Detecting and avoiding poor data
- An introduction to the time waveform
- An introduction to the spectrum
  - An introduction to forcing frequencies
- A brief introduction to phase
- Signal processing (just the absolute basics)
  - A quick tour of your analyzer settings
  - Fmax
  - Resolution
  - Spectral averaging
- Vibration analysis
  - The spectrum analysis process
- What is resonance – a quick introduction
- Diagnosing common fault conditions
  - Unbalance
  - Misalignment
  - Rolling element bearing failure
  - Looseness
  - Resonance
- Setting alarm limits

**TOPICS COVERED – INTERMEDIATE ANALYST CATEGORY II**

- Review of maintenance practices
- Review of condition monitoring technologies
- Principles of vibration
  - Complete review of basics
  - Waveform, spectrum (FFT), phase and orbits
  - Understanding signals: modulation, beating, sum/difference
- Data acquisition
  - Transducer types: Non-contact displacement
- Proximity probes, velocity sensors, and accelerometers
  - Transducer selection
  - Transducer mounting and natural frequency
  - Measurement point selection
  - Following routes, and test planning
  - Common measurement errors
- Signal processing
  - Filters: Low pass, band pass, high pass, band stop
  - Sampling, aliasing, dynamic range
  - Resolution, Fmax, data collection time
  - Averaging: linear, overlap, peak hold, time synchronous
  - Windowing and leakage
- Vibration analysis
  - Spectrum analysis
  - Time waveform analysis (introduction)
  - Orbit analysis (introduction)
  - Phase analysis: bubble diagrams and ODS
  - Enveloping (demodulation), shock pulse, spike energy, PeakVue
- Fault analysis
  - Natural frequencies and resonances
  - Imbalance, eccentricity and bent shaft
  - Misalignment, cocked bearing and soft foot
  - Mechanical looseness
  - Rolling element bearing analysis
  - Analysis of induction motors
  - Analysis of gears
  - Analysis of belt-driven machines
  - Analysis of pumps, compressors, and fans
- Equipment testing and diagnostics
  - Impact testing and bump tests
  - Phase analysis
- Corrective action
  - General maintenance repair activities
  - Review of the balancing process
  - Review of shaft alignment procedures

CONTINUED NEXT PAGE…

**TOPICS COVERED – INTERMEDIATE ANALYST CATEGORY II**

(continued)

- Running a successful condition monitoring program
  - Setting baselines
  - Setting alarms: band, envelope/mask, statistical
  - Setting goals and expectations (avoiding common problems)
  - Report generation
  - Reporting success stories
- Acceptance testing
- Review of ISO standards

**TOPICS COVERED – SENIOR ANALYST CATEGORY III**

## Signal processing

- Filters: Low pass, band pass, high pass, band stop
- Sampling, aliasing, dynamic range
- Signal-to-noise ratio
- Resolution, Fmax, data collection time
- Averaging: linear, overlap, peak hold, time synchronous
- Windowing and leakage
- Order tracking
- Cross-channel measurements
- Correlation and coherence

## Time waveform analysis

- Collecting data – ensuring you have the correct setup
- When should you use time waveform analysis?
- Diagnosing unbalance, misalignment, bent shaft, eccentricity, cocked bearing, resonance, looseness, and other conditions

## Phase analysis

- Collecting data
- Bubble diagrams
- Diagnosing unbalance, misalignment, bent shaft, eccentricity, cocked bearing, resonance, looseness, and other conditions

## Dynamics (natural frequencies and resonance)

- Natural frequencies and resonances
- Mass, stiffness, and damping
- SDOF and MDOF

## Testing for natural frequencies

- Run-up coast down tests
- Bode plots and Nyquist (polar) plots
- Impact and bump tests

## Operating Deflection Shape (ODS) analysis

- Can we prove the existence of a natural frequency?
- Visualizing vibration
- Setting up the job
- Collecting phase readings correctly
- Interpreting the deflection shape
- Using Motion Amplification

## Modal analysis and intro to FEA

- How does modal analysis differ from ODS?
- How does Finite Element Analysis (FEA) differ from modal analysis
- A quick review of the modal testing process

## Correcting resonances

- The effect of mass and stiffness
- Beware of nodal points
- Adding damping
- A ‘trial and error’ approach
- A ‘scientific’ approach
- Isolation
- Tuned absorbers and tuned mass dampers

CONTINUED NEXT PAGE…

**TOPICS COVERED – SENIOR ANALYST CATEGORY III**

(continued)

- Rolling element bearing fault detection
  - Why do bearings fail?
  - Cocked bearing, sliding on the shaft or inside the housing, looseness
  - EDM and DC motors and VFDs
  - Bearing frequencies and what to do when you don't have all the details
  - The four stages of bearing degradation
  - Ultrasound
  - High-frequency detection techniques
  - Shock Pulse, Spike Energy, Peak Vue, and other techniques
  - Demodulation/enveloping
  - Selecting the correct filter settings
  - Spectrum analysis
  - Time waveform analysis
  - Low-speed bearings
- Journal bearing fault detection
  - What are journal bearings?
  - Measuring displacement
  - Introduction to orbit plots
  - Using your analyzer to acquire orbit plots
  - Introduction to centerline diagrams
  - Eccentricity ratio
  - Glitch removal
  - How the orbit changes with pre-load, unbalance, misalignment, instabilities, oil whir and whip
- Electric motor testing
  - How do motors work?
  - Diagnosing a range of fault conditions: eccentric rotor, eccentric stator, soft foot, phasing, broken rotor bars, rotor bar, and stator slot pass frequencies
  - Motor current analysis
- Pumps, fans, and compressors
  - Unique fault conditions
  - Flow turbulence, recirculation, cavitation
- Gearbox fault detection
  - Spectrum analysis versus time waveform analysis
  - Wear particle analysis
  - Gearmesh, gear assembly phase frequency (and common factors)
  - Tooth load, broken teeth, gear eccentricity and misalignment, backlash and more
- Corrective action
  - General maintenance repair activities
  - Review of the balancing process and ISO balance grades
  - Review of shaft alignment procedures
- Running a successful condition monitoring program
  - Defining the program
  - Setting baselines
  - Setting alarms: band, envelope/mask, statistical
  - Setting goals and expectations (avoiding common problems)
  - Report generation
  - Reporting success stories
- Acceptance testing
- Review of ISO standards

**TOPICS COVERED – EXPERT ANALYST CATEGORY IV**

## Principles of vibration

- Vectors, modulation
- Phase
- Natural frequency, resonance, critical speeds
- Force, response, damping, stiffness
- Instabilities, non-linear systems
- Torsional vibration
- Instrumentation
- Proximity probe operation, conventions, glitch removal
- Shaft and casing measurements

## Signal processing

- RMS / peak detection
- Analog/digital conversion
- Analog sampling, digital sampling
- FFT computation
- 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

## Fault analysis

- Spectrum analysis, harmonics, sidebands
- Time waveform analysis
- Orbit analysis
- Shaft centerline analysis
- Transient analysis
- Unbalance, bent shaft, cracked shaft, eccentricity, rubs, instabilities

## Fault analysis (continued)

- Resonance and critical speeds
- Turbomachinery

## Phase analysis

- Transient analysis
- Enveloping
- Electric motor defects
- Flow-induced vibration, aerodynamics, and liquids
- General fault recognition

## Rotor/bearing dynamics

- Rotor/bearing dynamics
- Rotor characteristics
- Rotor modeling (rotor, wheels, bearings, aerodynamic effects)
- Bearing characteristics (fluid film bearings, housing, and supports, seals, couplings)

## Corrective action

- Flow control
- Isolation and damping
- Resonance control
- Low and high-speed shop balancing
- Field balancing (single plane, two plane, static/couple, flexible rotor)

CONTINUED NEXT PAGE…

**TOPICS COVERED – EXPERT ANALYST CATEGORY IV**

(Continued)

- Equipment testing and diagnostics
  - Impact testing
  - Forced response testing
  - Transient analysis
  - Transfer functions
  - Damping evaluation
  - Cross channel phase, coherence
  - Operating deflection shapes
  - Modal analysis
- Fault severity determination
  - Spectrum analysis
  - Time waveform analysis, orbit analysis
  - Severity charts, graphs and formula
- Reference standards
  - ISO
  - IEC
  - Relevant national standards

WILL I RECEIVE PRE-COURSE STUDY MATERIALS?

Every registered student will receive an instructional email to finalize their course registration. They will also receive a link to their personal Learning Zone account. The account provides a digital version of the coursebook and also a series of folders containing movies. These movies are actual course videos, recorded in a studio, and contain the same content taught in the Instructor-led course the student is registered in. The Learning Zone account may be used for pre-course study materials, review during the course week, reference after the course, or used to re-take the course and re-sit your certification exam. The account is activated at the time the student registers for the course and expires 4 months after the close date of the course they will be attending, or a student chooses a 1-Year Continued Education Upgrade.

MAY I TAKE ONE OF YOUR COURSES IF I AM NOT INTERESTED IN BECOMING CERTIFIED OR IF I HAVE INSUFFICIENT EXPERIENCE FOR CERTIFICATION?

Yes, our courses are open to the public, regardless of experience. If you are involved in vibration analysis or rotating machinery in any capacity, such as sales, marketing, engineering, design, or reliability, you will come away with a far better understanding of how machines are monitored, how faults develop, and what can be done to determine what faults actually exist in a machine. All attendees receive certificates of completion.
Candidates without sufficient experience will still receive a certificate if they pass the exam, but it will note that their experience was insufficient for ISO certification at the time.

AFTER I ATTEND YOUR COURSE AND TAKE THE EXAM, WHEN WILL I RECEIVE NOTIFICATIONS AS TO WHETHER I PASSED, AND WHEN WILL I RECEIVE MY CERTIFICATE?

You will receive notification of your results 5-10 days after the exam has been received at our Australian office. If you have passed the exam and met all certification requirements, you will receive your Digital Certificate 10-15 days after your exam results notification email.

HOW LONG IS THE CERTIFICATION VALID?

Vibration analysis certification is valid for five (5) years.

HOW DO I RENEW MY CERTIFICATION?

We will endeavor to contact you before your certification expires, therefore it is important that you keep your TMS records up to date (TMS is the training management system you will use to register for the course and for certification). If you change roles, it is essential that you update your records. We also invite you to set a reminder in your calendar for five years hence to contact us.

### HOW DO I QUALIFY FOR RENEWAL?

As per the standard, we do not require you to attend our conferences or take our courses, however, we hope you will take advantage of www.mobiusconnect.com and the sites linked to Mobius CONNECT so that your knowledge remains current. These sites are free of charge. When it is time to renew your certification, we will ask you to nominate an independent person who can verify that you are still active as a vibration analyst. There will be a small fee to renew your digital certificate and to renew your certification status with the accreditation body.

### WHAT ARE THE EXPERIENCE REQUIREMENTS FOR VCAT I?

You must have six months of experience generally associated with maintenance, reliability, and vibration data collection. You will be asked to nominate an independent person who can verify that you have that experience.

### WHAT ARE THE EXPERIENCE REQUIREMENTS FOR VCAT II?

You must have 18 months of experience in vibration data collection and analysis. You will be asked to nominate an independent person who can verify that you have that experience.

### WHAT ARE THE EXPERIENCE REQUIREMENTS FOR VCAT III?

You must have 36 months of experience in vibration data collection and analysis. You will be asked to nominate an independent person who can verify that you have that experience. Certification to VCAT III also requires previous certification to VCAT II by a MIBoC approved certification body.

### WHAT ARE THE EXPERIENCE REQUIREMENTS FOR VCAT IV?

You must have 60 months of experience in vibration data collection and analysis. You will be asked to nominate an independent person who can verify that you have that experience. Certification to VCAT IV also requires previous certification to VCAT III by a MIBoC approved certification body.

# UCAT-I ISO Category I

ULTRASOUND ANALYSIS TRAINING & CERTIFICATION

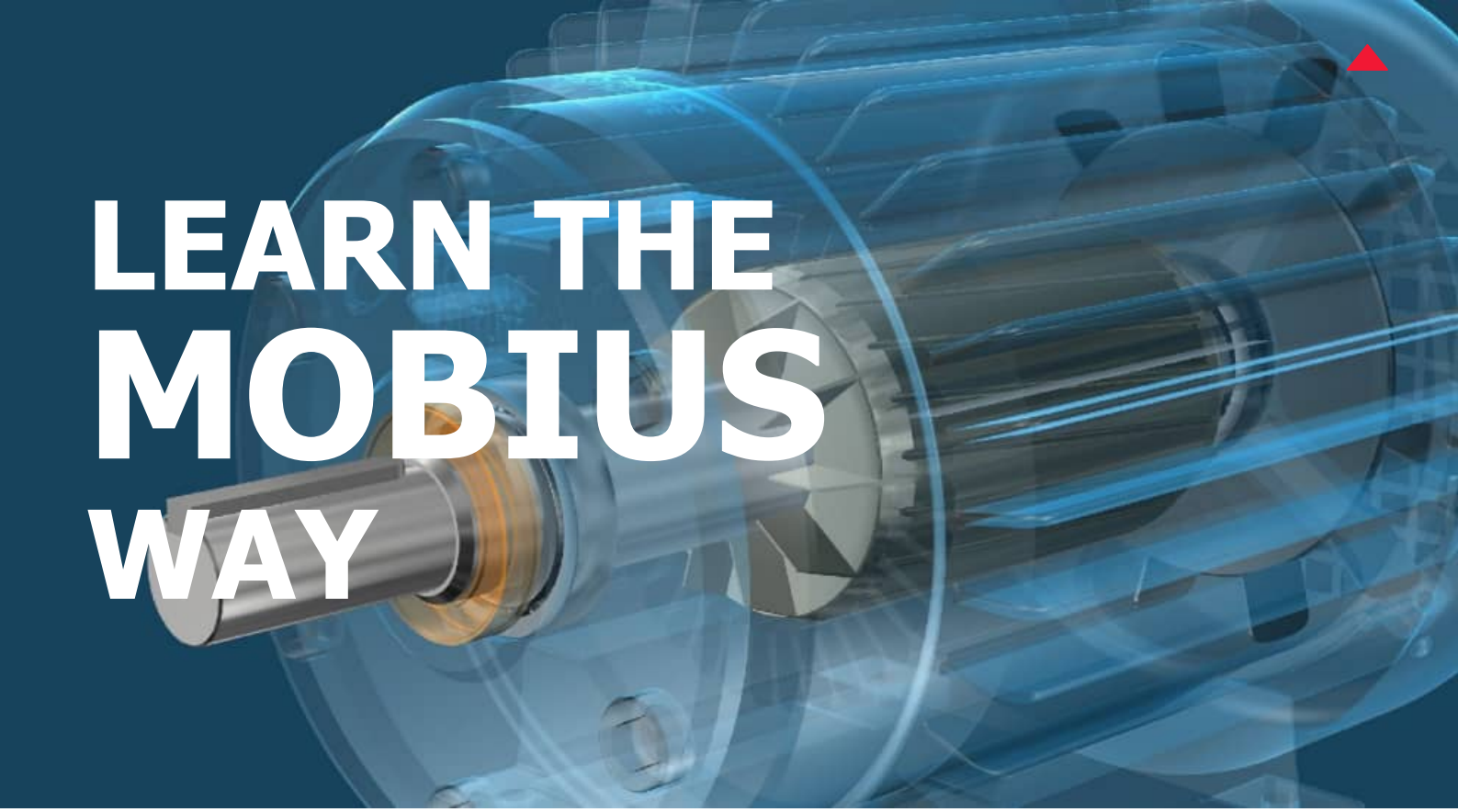
REQUEST A QUOTATION

RMS RELIABILITY TRAINING INSTITUTE

rms-training.com

MOBIUS INSTITUTE

www.mobiusinstitute.com



# LEARN THE MOBIUS WAY

## WHY LEARN WITH MOBIUS INSTITUTE™?

There are three major reasons why over 5,000 students choose Mobius Institute every year, and why you should, therefore, choose Mobius Institute for your ultrasound training and certification.

- We make complex topics simple with amazing 3D animations and simulations that make you say, *"Ah, now I get it!"*
- We give you access to the entire course before the class begins so you are better prepared, and for four months after the course, or you can choose a 1-Year Continued Education Upgrade.
- We use anonymous, stress-free polling throughout the course, so you know if you truly understand each topic, and the instructor knows not to move on to the next topic - *no student is left behind.*

MOBIUS INSTITUTE BOARD of CERTIFICATION

MOBIUS INSTITUTE

www.mobiusinstitute.com

# WITH MOBIUS INSTITUTE™, YOU CAN *LEARN YOUR WAY.*

We offer the ultimate flexibility. See the course details for more information.

CLASSROOM INSTRUCTOR-LED COURSES

We have training partners in 60 countries, offering 23 languages.

VIRTUAL INSTRUCTOR-LED COURSES

Attend a virtual course - just like a live course, but you learn via GoToMeeting.

PRIVATE ON-SITE INSTRUCTOR-LED COURSES

Have the instructor come to your site to save your precious time and money (and health).

ONLINE VIDEO COURSES

Traditional eLearning courses and iLearnReliability Learning Management System (LMS) courses

## WHY BECOME CERTIFIED BY THE MOBIUS INSTITUTE BOARD OF CERTIFICATION™?

There are so many benefits to becoming certified:

- You should be recognized for your achievements; not everyone is up to the challenge of understanding ultrasound analysis, let alone successfully collecting data and utilizing it
- Being certified by an accredited certification organization is a major step up from simply passing a test. Yes, the process is a little more complicated and stricter, but that is for very good reasons
- The educational process is extremely valuable, but being certified tells an employer (or a consulting client) that you are capable of doing an important job

Almost 40,000 students around the world, just like you, chose Mobius Institute for a good reason.

You will receive a digitally encrypted certificate, an ID card, and a personalized logo that you should use in email signatures and elsewhere that you want people to know about your achievements.

# UCAT-I Ultrasound Analysis

## ISO 18436-8 Category I

Learn to be a confident and effective ultrasound technician - capable of diagnosing faults, detecting costly steam and air leaks, and precision lubricating bearings - with advanced 3D animations and interactive simulations that make everything easy to understand.

Congratulations on the decision to become an ultrasound specialist. Ultrasound is incredibly powerful and versatile, so there is a lot to learn. The good news is you are in the right place. Our UCAT-I ISO Category I course will set you up for success.

We will help you understand why ultrasound analysis is important. You will gain a solid understanding of the fundamentals of ultrasound, lubrication, and leak detection. You will learn how to take quality, dependable measurements, and you will begin the process of understanding how to diagnose common faults.

Once you complete the training, you can take the exam with confidence, and become certified to ISO 18436-8 Category I via the internationally respected Mobius Institute Board of Certification [MIBoC]. The MIBoC certification is accredited to ISO/IEC 17024.

### UCAT-I CANDIDATE PROFILE

This course is intended for the ultrasound analyst and technician analyst who will:

- Collect ultrasound data to detect fault conditions in rotating machinery, electrical equipment, and a host of other equipment including valves, hydraulics, steam traps, and more
- Detect leaks in compressed air and steam systems
- Grease lubricate bearings with precision
- Use the training and certification as the start of a new and rewarding career as an ultrasound technician

# UCAT-I Ultrasound Analysis ISO 18436-8
Category I

## WHAT WILL YOU GAIN FROM TAKING THIS COURSE?

There are so many benefits to taking this course. You will learn…

- About condition monitoring, including a summary of the most common technologies
- About reliability improvement
- How ultrasound testing and ultrasound-assisted lubrication plays a key role in reliability improvement
- About the fundamentals of sound: frequency, amplitude, wavelength, pitch, and period
- How it is measured and quantified: dB, RMS, peak, kurtosis, and crest factor
- How sound behaves: speed of sound, reflection, refraction, and transmission
- How ultrasound is detected in industrial settings
- How to take dependable, repeatable, high-quality readings
- About listening to ultrasound, and capturing and interpreting waveforms and spectra
- About how to set up software systems, including the naming of assets
- About impacts, friction, turbulence, cavitation, arcing, tracking, corona, and partial discharge
- How it can be used to detect faults in bearings, electrical systems, steam traps, valves, hydraulic equipment, pumps, compressors, and other equipment
- About how hydraulics, electrical systems, steam systems, compressors, bearings, pumps, valves, steam traps, and other components work – all with vivid, realistic 3D animations
- How to correctly lubricate bearings: not too much, not too little
- How to collect data and perform tests safely
- How to generate reports that will provide people with the information they really need

## UCAT I FAST FACTS

### Duration:
32 hours, typically over four days

### Format:
- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

### Compliance:
- Training and certification: ISO 18436-8
- Certification: ISO 18436-1, ISO/IEC 17024
- Training: ISO 18436-3

### Exam:
- Two hours
- 60 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

### Certification requirements:
- Training course completed
- 6-months of work experience, verified by an independent person
- Pass a hearing test
- Valid for 5 years

### Pre-study
- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

### Post-study
- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

*Mobius Institute Board of Certification is an accredited certification body per ISO/IEC 17024 and ISO 18436-1 authorized to provide certification in accordance with ISO 18436-1 and 18436-2.*

*Mobius Institute Board of Certification (MIBoC) is an impartial and independent entity that is directed by scheme and technical committees to ensure that its certification meets or exceeds the requirements defined by the applicable International Organization for Standardization, ISO 18436 standards.*

*MOBIUS INSTITUTE is a worldwide provider of Reliability Improvement, Condition Monitoring and Precision Maintenance education to industrial plant managers, reliability engineers, and condition monitoring technicians, allowing plants to be successful in implementing Reliability Improvement programs through delivery of more easily understandable and comprehensive training of Reliability and Vibration Analysis via public, in-plant and online education programs.*

For more information about additional training courses, software tools, industry terminology and definitions, accredited certification, and specific course details, visit the Mobius Institute website.

## www.mobiusinstitute.com

North America: +1 (239) 600 - 6828 | Australia: (+61) (0)3-5977-4606

learn@mobiusinstitute.com

RMS RELIABILITY TRAINING INSTITUTE

## rms-training.com

Join thousands of other industry professionals by creating your free custom profile today at **https://www.mobiusconnect.com/**

**DOWNLOAD THE MOBILE APP**

MOBIUS CONNECT
SOLVING · LEARNING · SHARING

**The maintenance and reliability industry's professional network.**

- Maintenance practices
  - Reactive, preventive, condition-based, proactive
  - How to decide between them
- Condition monitoring
  - Why it works
  - Vibration, infrared, oil analysis, wear particle analysis, and electric motor testing
  - Detecting faults, root causes, and quality control
  - Acceptance testing
- Principles of sound
  - What is sound, sound waves, and sine waves
  - Frequency, pitch, period, wavelength
  - Acoustic impedance, reflection, and transmission with different media (materials)
  - The inverse distance rule
- The application of ultrasound
  - Friction, turbulence, impacting, arcing, tracking, corona
- Ultrasound measurement
  - Heterodyning
  - The decibel dB scale
  - Metrics: RMS, Peak, crest factor, and Kurtosis
  - Listening versus measuring
  - Severity determination
- Collecting test data
  - Safety precautions
  - Sensor types: contact vs non-contact, magnets, horns, parabolic dishes
  - Collecting good data
  - Sensitivity validation
  - Repeatability
  - Sensor positioning
  - Shielding and competing ultrasound sources
  - Waveforms and spectra
- Data storage and management
  - Setting up a good database
  - ISO 14224 as a guide
- Leak detection
  - Steam systems
  - Compressed air systems and gas
  - Pressurized systems and systems under vacuum
  - Leak detection
  - Tightness testing
- Electrical testing
  - Safety precautions
  - Corona, arcing, tracking
  - Partial discharge
- Lubrication
  - Concerns with traditional methods
  - On-condition lubrication
  - Avoiding over-greasing or under-greasing

- Testing different assets types
  - Valves, steam traps, bearings (low speed and high speed), compressors, pumps, hydraulic systems
  - A detailed explanation of all the above equipment and their failure modes
- Report generation
  - Providing actionable information
- Case studies - Many case studies are presented throughout the course

## CAN I SKIP THE CATEGORY I COURSE AND CERTIFICATION?

No, it is a requirement to be UCAT-I trained and certified before you move to UCAT-II.

## WILL I RECEIVE PRE-COURSE STUDY MATERIALS?

Every registered student will receive an instructional email to finalize their course registration. They will also receive a link to their personal Learning Zone account. The account provides a digital version of the coursebook and also a series of folders containing movies. These movies are actual course videos, recorded in a studio, and contain the same content taught in the Instructor-led course the student is registered in. The Learning Zone account may be used for pre-course study materials, review during the course week, reference after the course, or used to re-take the course and re-sit your certification exam. The account is activated at the time the student registers for the course and expires 4 months after the close date of the course they will be attending, or the students choose a 1-Year Continued Education Upgrade.

## CAN I BUY THE LEARNING ZONE ACCOUNT AND USE IT TO STUDY FOR THE CERTIFICATION EXAM?

No, but we do offer Category I Distance Learning (DL) courses which are the online equivalent to our Public courses. The training material content is fully ISO 18436 compliant and you will be qualified to take the certification exam once you have completed the DL course.

You will find the distance learning courses on our shopping cart.

## DO YOU OFFER ON-SITE INSTRUCTOR LED COURSES?

Yes, we offer a range of courses that can be conducted onsite, including our Category I ultrasound courses, Asset Reliability Practitioner® ARP, vibration analysis, balancing, alignment, and others. If you are in North America, please email learn@mobiusinstitute.com for a quotation. Outside North America, contact your local training partner.

## MAY I TAKE ONE OF YOUR COURSES IF I AM NOT INTERESTED IN BECOMING CERTIFIED OR IF I HAVE INSUFFICIENT EXPERIENCE FOR CERTIFICATION?

Yes, our courses are open to the public, regardless of experience. If you are involved in ultrasound measurement and analysis in any capacity, such as sales, marketing, engineering, design, or reliability, you will come away with a far better understanding of how machines are monitored, how faults develop, and what can be done to determine what faults actually exist in a machine. All attendees receive certificates of completion. Candidates without sufficient experience will still receive a certificate if they pass the exam, but it will note that their experience was insufficient for ISO certification at the time.

## AFTER I ATTEND YOUR COURSE AND TAKE THE EXAM, WHEN WILL I RECEIVE NOTIFICATIONS AS TO WHETHER I PASSED, AND WHEN WILL I RECEIVE MY CERTIFICATE?

You will receive notification of your results 5-10 days after the exam has been received at our Australian office. If you have passed the exam and met all certification requirements, you will receive your Digital Certificate 10-15 days after your exam results notification email.

## HOW LONG IS THE CERTIFICATION VALID?

Certification is valid for five (5) years.

## HOW DO I RENEW MY CERTIFICATION?

We will endeavor to contact you before your certification expires, therefore it is important that you keep your TMS records up to date (TMS is the training management system you will use to register for the course and for certification). If you change roles, it is essential that you update your records. We also invite you to set a reminder in your calendar for five years hence to contact us.

## HOW DO I QUALIFY FOR RENEWAL?

As per the standard, we do not require you to attend our conferences or take our courses, however, we hope you will take advantage of www.mobiusconnect.com and the sites linked to Mobius CONNECT® so that your knowledge remains current. These sites are free of charge. When it is time to renew your certification, we will ask you to nominate an independent person who can provide evidence of continued work experience in the field of ultrasound condition monitoring for the previous five years without significant interruption. You will also be required to submit evidence of passing a hearing test at the time of renewal. There will be a small fee to renew your digital certificate and to renew your certification status with the accreditation body.

## WHAT ARE THE EXPERIENCE REQUIREMENTS FOR UCAT I?

You must have six months of experience generally associated with maintenance, reliability, and ultrasound testing. You will be asked to nominate an independent person who can verify that you have that experience.

## WHAT IS THE HEARING TEST?

As per the requirements of ISO 18436-8, candidates 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 MIBoC upon request. The individual should be capable of hearing a standard pure tone in an audiometry exam with results of an average of 25 dB hearing level or lower. This examination should be administered upon initial certification and upon renewal, be administered by a licensed professional, and a record of the test made available to MIBoC upon request.

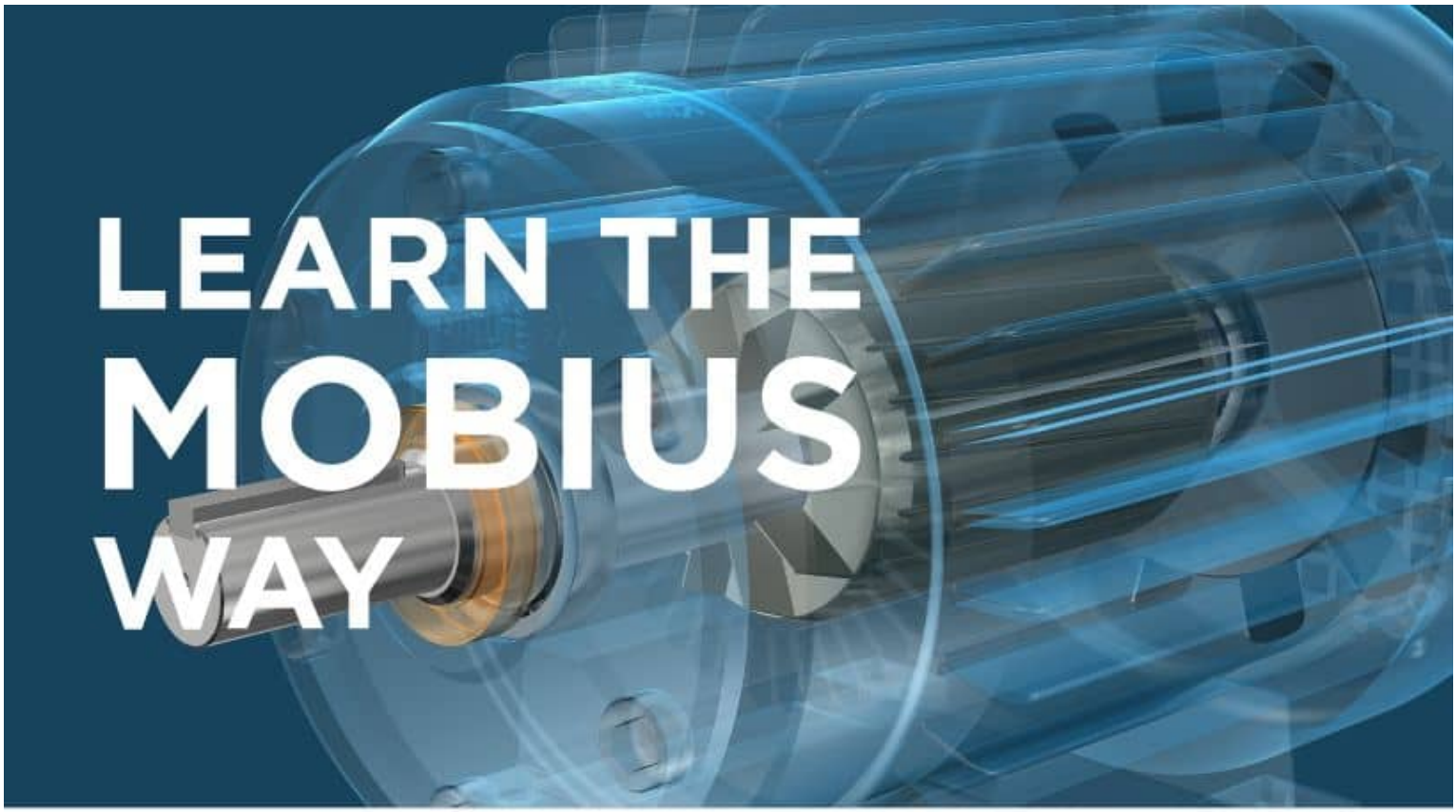
Candidates who do not provide a record of passing the hearing test will receive conditional certification under which it becomes the responsibility of their employer to assess the candidate's hearing acuity and their suitability to perform ultrasound data collection and/or analysis. This condition of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

# IRTCAT-I ISO Category I

INFRARED THERMOGRAPHY TRAINING
& CERTIFICATION

MOBIUS INSTITUTE

www.mobiusinstitute.com




## WHY LEARN WITH MOBIUS INSTITUTE™?

**There are three major reasons why over 5,000 students choose Mobius Institute every year, and why you should, therefore, choose Mobius Institute for your Infrared Thermography training and certification.**

- We make complex topics simple with amazing 3D animations and simulations that make you say, *"Ah, now I get it!"*
- We give you access to the entire course before the class begins so you are better prepared, and for 4 months after the course, just in case you still have questions.
- We use anonymous, stress-free polling throughout the course, so you know if you truly understand each topic, and the instructor knows not to move on to the next topic - *no student is left behind.*

MOBIUS INSTITUTE BOARD of CERTIFICATION

MOBIUS INSTITUTE

**www.mobiusinstitute.com**

# WITH MOBIUS INSTITUTE™, YOU CAN *LEARN YOUR WAY.*

We offer the ultimate flexibility. See the course details for more information.

### CLASSROOM INSTRUCTOR-LED COURSES

We have training partners in 60 countries, offering 23 languages.

### VIRTUAL INSTRUCTOR-LED COURSES

Attend a virtual course - just like a live course, but you learn via GoToMeeting.

### PRIVATE ON-SITE INSTRUCTOR-LED COURSES

Have the instructor come to your site to save your precious time and money (and health).

### ONLINE VIDEO COURSES

Traditional eLearning courses and iLearnReliability Learning Management System (LMS) courses

# WHY BECOME CERTIFIED BY THE MOBIUS INSTITUTE BOARD OF CERTIFICATION™?

**There are so many benefits to becoming certified:**

- You should be recognized for your achievements; not everyone is up to the challenge of understanding Infrared Thermography, let alone successfully collecting data and utilizing it
- Being certified by an accredited certification organization is a major step up from simply passing a test. Our certification is recognized internationally, setting you apart from others in the industry.
- The educational process is extremely valuable, but being certified tells an employer (or a consulting client) that you are capable of doing an important job

Almost 55,000 students around the world, just like you, chose Mobius Institute for a good reason.

You will receive a digitally encrypted certificate, an ID card, and a personalized logo. Update your email signatures, resume, and social media to reflect your certification achievement.

# IRTCAT-I INFRARED THERMOGRAPHY

## ISO 18436-7 Category I

**This course will prepare you for life as an Infrared Thermographer. You will learn the fundamentals of infrared energy and the camera, and you will learn about the most common applications.**

With the assistance of the Mobius Institute interactive simulations, 3D animations, and case studies, you will not require a great memory to learn all the facts and concepts. As a result, you will understand the 'science' of infrared thermography. You will understand how the camera functions and learn about plant equipment's mechanical and electrical failure modes so that you can accurately and confidently detect and diagnose a wide range of fault conditions. You will come away from the course with the knowledge and confidence to be successful as an infrared thermographer.

Once you complete the training you will be eligible to take the exam to become certified by the internationally renowned Mobius Institute Board of Certification [MIBoC] to ISO 18436-7 Category I. To be certified, you will need to achieve a minimum score of 75% of the 50 questions and complete the Ishihara color perception test. The MIBoC certification is one of the only international programs accredited to ISO/IEC 17024 – there is no higher standard in condition monitoring certification.

### IRTCAT-I CANDIDATE PROFILE

—

**This course is intended for the infrared thermographer who will:**

- Set up and operate the thermal imaging equipment for safe thermographic data collection
- Verify the calibration of thermographic measurement systems
- Identify, prevent minimize and control poor data acquisition and error sources
- Apply a specified thermographic measurement technique
- Evaluate and report test results and highlight areas of concern

# IRTCAT-I Infrared Thermography

## ISO 18436-7 Category I

## WHAT WILL YOU GAIN FROM TAKING THIS COURSE?

**There are so many benefits to taking this course. You will learn...**

- Why we perform condition monitoring
- How to decide between reactive, preventive, condition-based, and proactive maintenance
- Vibration Analysis, Ultrasound Analysis, Oil Analysis, Wear Particle Analysis, and Electric Motor Testing
- All about heat vs. temperature and temperature scales
- The laws of thermodynamics
- How thermal conductivity occurs in different materials
- The difference between thermal conductivity and specific heat capacity
- Real-life examples of conductive heat transfer
- Convective heat transfer
- How wind will affect the results you achieve
- Radiant heat transfer
- How your infrared camera works and the functionality to perform inspections
- How to acquire data and process images
- "Thermal tuning."
- How to determine emissivity
- How to identify and deal with reflections
- How to acquire data and store images
- The basic principles of diagnostics and prognostics
- The relationship between CBM, diagnostics, and prognostics
- The different thermal signatures of heat generation
- The concept of "comparative temperature measurements."
- How to distinguish between active and passive thermography

## IRTCAT I FAST FACTS

### Duration:

32 hours, typically over four days

### Format:

- Live public course
- On-site course
- Virtual online course
- Video distance learning online courses and Life Long Learning (LLL) access

### Compliance:

- Training and certification: ISO 18436-7
- Certification: ISO 18436-1, ISO/IEC 17024
- Training: ISO 18436-3

### Exam:

- Two hours
- 50 multiple-choice questions
- 75% passing grade
- Can be taken online or in-person at the course

### Certification requirements:

- Training course completed
- 12-months of work experience, verified by an independent person
- Pass the Ishihara color perception test
- Valid for 5 years

### Pre-study:

- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

### Post-study:

- Continue to access the Learning Zone for 4-months after the course
- Continue learning, without charge, on MOBIUS CONNECT™ via WWW.MOBIUSCONNECT.COM

*Mobius Institute Board of Certification is an accredited certification body per ISO/IEC 17024 and ISO 18436-1 authorized to provide certification in accordance with ISO 18436-1 and 18436-2.*

*Mobius Institute Board of Certification (MIBoC) is an impartial and independent entity that is directed by scheme and technical committees to ensure that its certification meets or exceeds the requirements defined by the applicable International Organization for Standardization, ISO 18436 standards.*

*MOBIUS INSTITUTE is a worldwide provider of Reliability Improvement, Condition Monitoring and Precision Maintenance education to industrial plant managers, reliability engineers, and condition monitoring technicians. Our programs allow plants to be successful in implementing Reliability Improvement programs through delivery of more easily understandable and comprehensive training of Reliability and Vibration Analysis via public, in-plant and online education programs.*

For more information about additional training courses, software tools, industry terminology and definitions, accredited certification, and specific course details, visit:

**www.mobiusinstitute.com**

North America: +1 (239) 600 - 6828 | Australia: (+61) (0)3-5977-4606

**learn@mobiusinstitute.com**

Join thousands of other industry professionals by creating your free custom profile today at **https://www.mobiusconnect.com/**

**DOWNLOAD THE MOBILE APP**

MOBIUS CONNECT®
SOLVING • LEARNING • SHARING

**MOBIUS CONNECT** is your gateway to reliability and CBM videos, webinars, articles, tips, and a live feed and forum. You will connect with people, just like you, all over the world.

**At MOBIUS CONNECT,** you can solve problems, continue learning, and share your experience - all for free!

**You must never stop learning.**

- Maintenance practices
  - Reactive, preventive, condition-based, proactive
  - How to decide between them
- Condition monitoring
  - Why it works
  - Vibration, ultrasound, oil analysis, wear particle analysis, and electric motor testing
  - Detecting faults, root causes, and quality control
- Principles of infrared thermography
  - Understanding the difference between heat energy and temperature
  - The laws of thermodynamics
  - Heat transfer modes – conduction, convection and radiation
  - The thermal capacity of different materials
- Thermal conduction
  - The fundamentals of conduction
  - Conductive heat transfer rate
  - Thermal conductivity of different materials
- Thermal convection
  - The fundamentals of convection
  - Compensating for the "wind cooling effect"
- Thermal radiation
  - The fundamentals of radiation
  - Emitted, reflected and transmitted radiation
  - Radiation wavelengths and the electromagnetic spectrum
  - Emissivity and the Stefan-Boltzmann Law
  - Incident and exitant radiation
- Equipment and data acquisition
  - Understanding the infrared camera
  - Lenses and lens materials
  - Capturing and controlling the image with temperature range, level and span
  - Color palette selection
  - Error source recognition, prevention and control
  - Calibrating the thermal camera
  - Environmental and operational conditions
  - Image storage and management
- Safety rules and guidelines
  - Hazard awareness
  - Standards and guides
  - Personal Protective Equipment (PPE)
- Thermographic applications
  - The basic principles of diagnostics (ISO 13379) and prognostics (ISO 13381)
  - Machinery engineering principles
  - Electrical application – fuses, transformers, switchgear, transmission lines etc
  - Mechanical application – pipes, tanks, refractories, heat exchangers etc
  - Civil applications – windows, air leaks, construction integrity etc
  - Process applications – steam traps
- General image interpretation guidelines
  - Image processing
  - Fault classification
- Report generation
  - Providing actionable information

## WHAT IS THE DIFFERENCE BETWEEN MOBIUS INSTITUTE INFRARED THERMOGRAPHY TRAINING/CERTIFICATION AND THE OTHER OPTIONS AVAILABLE?

In short, we have invested heavily in highly informative animations, 3D illustrations, and interactive simulators that make all the complex topics far easier to understand. Plus, our certification not only follows international standards per ISO 18436-7, but the examination process administered by Mobius Institute Board of Certification [MIBoC] is accredited to ISO/IEC 17024. There is no higher standard of certification.

## WHY IS ACCREDITED CERTIFICATION IMPORTANT?

Accredited certification is worldwide recognised certification that is respected within the industry. The exams are not necessarily harder, but the process is far more 'robust'. If you want to be able to hold your head high knowing that you meet the highest international standards that every employer instantly recognizes, then you must be certified by the Mobius Institute Board of Certification [MIBoC].

The accreditation process, administered by Government appointed agencies such as ANSI, UKAS, and JASANZ, includes regular audits to ensure the certification process is fair and independent. The audits are given to check that the certification body continues to meet the international standards: ISO 18436-7, ISO 18436-1, ISO 18436-3, and ISO/IEC 17024. They check that we continually follow these processes and that an effective quality control process is in place to ensure that we continue to adhere to the standards governed by ISO.

If you are going to go to the effort and expense to be trained and certified, then why not shoot for the highest standard of certification?

## DO I NEED TO BE TRAINED IN THE FIELD OF INFRARED THERMOGRAPHY?

On the face of it, infrared thermography looks 'easy'. Point the camera, look for hot spots, and order the maintenance. But nothing could be further from the truth. It is a classic case that many people don't know what they don't know. The science behind infrared thermography, the failure modes you are attempting to detect, and the cameras themselves are all very complex. If you do not master all three areas your program will not only lose all credibility (missed faults and unnecessary work orders), but you will put your own safety, and the safety of your co-workers and the viability of the plant at risk.

You have three choices. Receive basic training on the camera and face all the risks described. Take 'conventional' training and be forced to attempt to remember all the testing techniques, failure modes, and more, (and suffer the consequences if your memory is not perfect). Or you can take our training, with powerful new 3D animations and simulations that will embed the knowledge in your brain, so that you understand it. You will look at the application with a new set of eyes. It will all make sense. You will avoid all the testing traps and you will get the diagnosis right the first time because you mastered the technique, not just relied on memory.

## CAN I SKIP THE TRAINING COURSE AND GO DIRECTLY TO THE EXAM?

No, you must complete training to meet the certification requirements. Training must be from a MIBoC approved IRT training provider.

## WILL I RECEIVE PRE-COURSE STUDY MATERIALS?

Every registered student will receive an instructional email to finalize their course registration. They will also receive a link to their personal Learning Zone account. The account provides a digital version of the coursebook and also a series of movies. These movies are actual course videos, recorded in a studio, and contain the same content taught in the Instructor-led course the student is registered in. The Learning Zone account may be used for pre-course study materials, review during the course, reference after the course, or used to re-take the course and re-sit your certification exam. The account is activated at the time the student registers for the course and expires 4 months after the closing date of the course they will be attending.

## DO YOU OFFER ON-SITE INSTRUCTOR LED COURSES?

Yes, we offer a range of courses that can be conducted onsite, including our Infrared Thermography course, Ultrasound, Asset Reliability Practitioner® ARP, Vibration Analysis, Balancing, Alignment and others. If you are in North America, please email learn@mobiusinstitute.com for a quotation. Outside North America, contact your local training partner.

## MAY I TAKE ONE OF YOUR COURSES IF I AM NOT INTERESTED IN BECOMING CERTIFIED OR IF I HAVE INSUFFICIENT EXPERIENCE FOR CERTIFICATION?

Yes, our courses are open to anyone that wishes to improve their knowledge. If you are involved in Infrared Thermography in any capacity, such as sales, marketing, engineering, design, or reliability, you will come away with a far better understanding of how machines are monitored, how faults develop, and what can be done to determine what faults actually exist in a machine. All attendees receive certificates of training completion.

## AFTER I ATTEND YOUR COURSE AND TAKE THE EXAM, WHEN WILL I RECEIVE NOTIFICATION AS TO WHETHER I PASSED, AND WHEN WILL I RECEIVE MY CERTIFICATE?

You will receive notification of your results 5-10 days after the exam has been received at our Australian office. If you have passed the exam and met all certification requirements, you will receive your digital certificate 10-15 days after your exam results notification email.

## HOW LONG IS THE CERTIFICATION VALID?

Certification is valid for five (5) years.

### HOW DO I RENEW MY CERTIFICATION?

We will endeavor to contact you before your certification expires, therefore it is important that you keep your student profile in our TMS system up to date (TMS is the training management system you will use to register for the course and for certification). We recommend a best practice of utilizing a personal email address for certification communications, in case of a job change.

### HOW DO I QUALIFY FOR RENEWAL?

When it is time to renew your certification, you are required to provide evidence of continued work experience in the field of infrared thermography for the previous five years without significant interruption since certification. This evidence is to be added to your student profile under your experience. We will ask you to nominate an independent person/manager or supervisor who can verify your work experience. You will also be required to submit evidence of passing an Ishihara perception color test at the time of renewal. There is a fee to renew your certification.

### WHAT ARE THE EXPERIENCE REQUIREMENTS FOR IRTCAT-I?

You must have 12-months of hands on work experience with Thermography and associated condition monitoring tasks. You will be asked to nominate an independent supervisor or manager who can verify that you have the required experience.

### WHAT IS THE COLOR PERCEPTION TEST?

MIBoC uses the Ishihara color perception test, also known as the color vision test, to measure a person's ability to tell the difference between colors. Ishihara test checks for red-green color blindness.

In an Ishihara test, a person looks at a series of circles (known as Ishihara plates) with dots of different colors and sizes. A person who has trouble seeing red and green will find the shapes and numbers hard to see, or may not see them at all.

# ASSET RELIABILITY PRACTITIONER® [ARP]

## TRAINING AND CERTIFICATION

[ARP-A] RELIABILITY ADVOCATE
[ARP-E] RELIABILITY ENGINEER
[ARP-L] RELIABILITY PROGRAM LEADER

REQUEST A QUOTATION

RMS RELIABILITY TRAINING INSTITUTE

rms-training.com

MOBIUS INSTITUTE

www.mobiusinstitute.com

# ASSET RELIABILITY PRACTITIONER® [ARP] TRAINING AND CERTIFICATION

A growth path for Asset Reliability Leaders and Practitioners. The only way to gain a first-class education and achieve recognition for knowledge and experience.

## A growth path for Asset Reliability Leaders and Practitioners

The only way to enjoy success in a reliability improvement initiative is to appreciate what it takes to achieve culture change and the process improvements necessary to change the current practices into those that ensure equipment is maintained and operated in a manner that achieves peak performance. Mobius Institute™ has developed a series of training courses that provide the breadth and depth of knowledge necessary to achieve success.

Everyone needs to play their role in the initiative, and we offer training, and in some cases accredited certification, on the growth path from technician to leader:

- Precision maintenance skills: alignment, balancing, fastening, and lubrication
- Condition monitoring program establishment and technology expertise: vibration, ultrasound, oil analysis, infrared, and motor current analysis
- Reliability engineering with the technical skills to implement the technical elements
- Reliability leadership with the leadership skills to make the business case, build a strategy, and develop a motivated culture
- Asset reliability strategy: the plan to ensure the initiative delivers sustained business value

## A foundation built on mechanical skills

If the machine is not precision aligned and balanced, if it is not lubricated correctly, and if the fasteners are too tight or loose, the machine is destined for a short and disappointing life. It will be another asset that does not deliver its true value, it will interrupt operations, add to your maintenance costs, at worst, result in injury or environmental harm.

You can solve that problem with specific skills training, and you will learn all about it in the Asset Reliability Practitioner [ARP] courses.

## See the future with condition monitoring

Condition monitoring is a key ingredient in any successful reliability improvement initiative, but while it can drastically reduce costs and improve plant reliability and dependability, it does not necessarily contribute to improved equipment reliability.

You can take specific training on the technologies according to ISO standards, or you can learn how to design and lead the condition monitoring program in the Asset Reliability Practitioner [ARP] courses.

## Asset Reliability Practitioner [ARP] training and certification

To enjoy a truly successful reliability improvement initiative, you need both depth and breadth of knowledge.

The leader of the initiative must have a clear view of the entire scope of the initiative, with a detailed understanding of the business proposition, the culture change process, and the individual steps required to implement the strategy. The reliability engineer must have a depth of knowledge in reliability analysis, maintenance strategy, and best practice, plus condition monitoring (and other topics). And they both must be surrounded by a workforce of people who are engaged and enthusiastic about the initiative.

The Asset Reliability Practitioner [ARP] training and accredited certification program provides the knowledge, qualifications, and growth path to enable a program to be run successfully.


# ARP-A RELIABILITY ADVOCATE

Everyone must start somewhere. Whether you are new to reliability improvement and need a way to get up to speed, or if you wish to understand the complete holistic view of reliability and performance improvement because you are considering beginning a program, the ARP-A "Reliability Advocate" course is the perfect place to start.


# ARP-E RELIABILITY ENGINEER

This course is perfect for the technical reliability engineer. If you are the person who needs to understand how to implement the technical elements of reliability improvement and perform the analysis that will drive the key decisions, this is the ideal course for you.


# ARP-L RELIABILITY PROGRAM LEADER

If the responsibility for running a successful reliability and performance improvement initiative rests on your shoulders (or you wish it did), this is the course for you. The emphasis on this course is how to generate business value, develop and implement a strategy, and create the right culture, although we do summarize the technical elements.

# ASSET RELIABILITY TRANSFORMATION® [ART]:

## THE PRACTICAL AND DETAILED STRATEGY

### One of the keys to success: a practical, detailed strategy

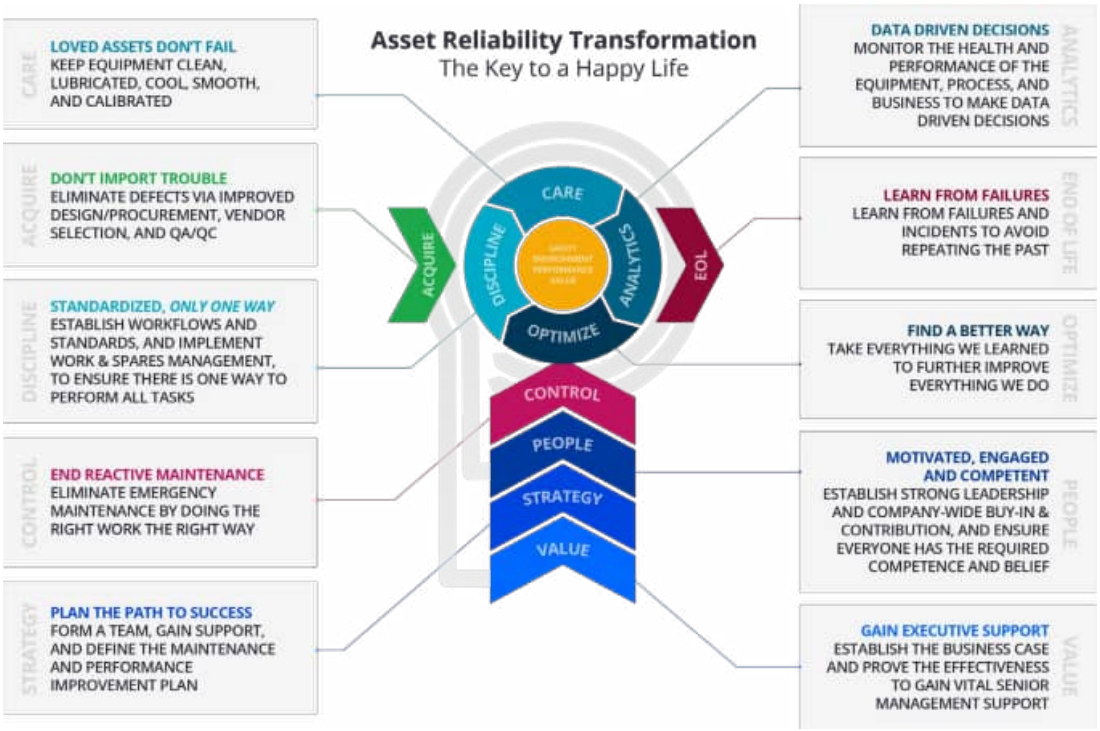
You must have a strategy to be successful. Improving reliability and achieving target levels of performance is not easy. Many have tried and many have failed. The most common reason for failure is a lack of strategy: a plan that avoids the bear traps and keeps everyone motivated and aligned.

We have built the Asset Reliability Transformation [ART] process that will guide you, step-by-step through the initiative:

- 10 phases, 64 steps, and 365 documented recommended practices – no stone left unturned
- We help you ask the right questions at the right time so you make the right moves
- VALUE, PEOPLE, and STRATEGY: Build a solid foundation
- CONTROL: Overcome reactive maintenance
- ACQUIRE, DISCIPLINE, CARE, ANALYTICS, EOL, and OPTIMIZE: Don't create problems, make data-driven decisions, and continually improve

Regardless of your starting point, regardless of your industry, ART will enable you to run a successful reliability and performance improvement initiative.

# LEARN THE MOBIUS WAY




## WHY LEARN WITH MOBIUS INSTITUTE™?

There are three major reasons why over 5,000 students choose Mobius Institute every year:

- We make complex topics simple with amazing 3D animations and simulations that make you say, *"Ah, now I get it!"*
- We give you access to the entire course before the class begins so you are better prepared, and for six months after the course, or you can choose a 1-Year Continued Education Upgrade.
- We use anonymous, stress-free polling throughout the course, so you know if you truly understand each topic, and the instructor knows not to move on to the next topic - *no student is left behind.*

There are many other reasons why asset reliability practitioners, and their managers, choose Mobius Institute.

MOBIUS INSTITUTE BOARD of CERTIFICATION

MOBIUS INSTITUTE

www.mobiusinstitute.com

# WITH MOBIUS INSTITUTE™, YOU CAN *LEARN YOUR WAY.*

We offer the ultimate flexibility. See the course details for more information.

CLASSROOM INSTRUCTOR-LED COURSES

We have training partners in 60 countries, offering 23 languages.

VIRTUAL INSTRUCTOR-LED COURSES

Attend a virtual course - just like a live course, but you learn via GoToMeeting.

PRIVATE ON-SITE INSTRUCTOR-LED COURSES

Have the instructor come to your site to save your precious time and money (and health).

ONLINE VIDEO COURSES

Traditional eLearning courses and iLearnReliability Learning Management System (LMS) courses

# ACCREDITED CERTIFICATION

## Respected, accredited certification

Everyone should be recognized for their knowledge and experience, and that is certainly true for the champions of reliability improvement. There is so much to know across such a broad range of topics, that it takes a special person to be successful. The Asset Reliability Practitioner® certification program recognizes people in two ways: for their knowledge and for their experience.

Recognition for your knowledge

Following the guidelines established by international standards (IEC and ISO) and adhering to the highest standard of ISO/IEC 17024, the Asset Reliability Practitioner ARP-A "Reliability Advocate", ARP-E "Reliability Engineer", and ARP-L "Reliability Program Leader" recognizes your knowledge and general experience.

If you are educated, pass the examination, and can verify your experience, you will join the ranks of the international fraternity of Mobius Institute™ certified practitioners.

This is a legitimate certification.

# ASSET RELIABILITY PRACTITIONER®
# [ARP-A] Reliability Advocate

Whether you are new to reliability improvement, or you are a manager thinking of starting an initiative, ARP-A is the best way to begin the reliability journey.

Where are you on the journey to reliability improvement? If you are new to the program, or you are interested in learning more so that you can begin a new program at your plant, then the Asset Reliability Practitioner [ARP-A] "Reliability Advocate" course is precisely what you need.

Improving the reliability of physical assets takes far more than just monitoring their condition, improving lubrication practices, and making some improvements to the maintenance department. To have a truly successful program you must understand how to add value to the organization and thus gain senior management support. You must have the support of the entire organization, not just a small group of evangelistic condition monitoring and reliability experts. You must have a coordinated effort between maintenance, operations/ production, engineering, finance, and the reliability group – no more silos. And you must follow a strategy that will enable you to build the program, layer upon layer, to achieve milestones and build on success.

Yes, we could simply talk about the common reliability acronyms of RCM, PMO, RCA, and literally dozens of others, but knowing what they mean does not help you implement a successful program.

The ARP-A Reliability Advocate program will provide a holistic view of how to improve reliability and plant performance. It will explain the implementation process and all the essential elements necessary to have a truly successful program.

## THE ARP-A RELIABILITY ADVOCATE CERTIFICATION PROCESS

There are just four requirements to become certified:

1. You must attend this Mobius Institute course, or any other recognized training course that covers the same topics.
2. You must achieve a 70% score, or better, on the two-hour, 60-question, multiple-choice exam. The exam is intended to test whether you understand the core concepts and principles – it is not a challenging exam on reliability engineering topics, remembering what the acronyms stand for, condition monitoring technology details, or anything else that is covered in the more difficult ARP-E and ARP-L exams.
3. You must have a minimum of six months of experience in the industry involved in some way with maintenance, operations, or reliability in a role where you have experienced the challenges associated with poor reliability.
4. Your experience must be verified by an independent person.

## ARP-A FAST FACTS

**Duration:**
16 hours minimum: Typically delivered over 3 days

**Format:**

- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

**Compliance:**

- Training: modeled on 18436-2 and ISO 18436-3, but there is no ISO standard for reliability personnel certification.
- Certification: according to ISO/IEC 17024 and modeled on ISO 18436-1
- Training: ISO 18436-3

**Exam:**

- Two hours
- 60 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

**Certification requirements:**

- Training course completed
- 6-months of work experience, verified by an independent person
- Pass the exam
- Valid for 3 years

**Pre-study:**

- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

**Post-study:**

- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

## HOW MUCH DETAIL WILL WE COVER?

We only have three days together, and that includes plenty of time for discussions and case studies, so it is not possible to get into the details of every topic. The goal
is to explain what it takes to be successful and how to avoid all the traps that have caused so many programs to fail. Public courses are conducted around the world, but to gain the greatest value, we recommend you invite the instructor to visit your facility and gather the entire team together.

The course follows the Asset Reliability Transformation® [ART] implementation process; however, it is totally up to you whether you follow our recommended practices.
After three days, you'll have a clear understanding of why you should improve reliability and how to implement the successful program. You will also have a much clearer understanding of all the jargon, acronyms, and common elements that make up a reliability or asset management program. Plus, you will be ready to take the exam so
that you may be recognized for your knowledge under the Mobius Institute Board of Certification™ [MIBoC] accredited program.

## WHAT WILL I BE CAPABLE OF ONCE I COMPLETE THE COURSE?

*In short, you will have a solid understanding of the "big picture" of the reliability improvement process.*
As a manager thinking of starting a new initiative (or reviving an existing one)

- You will understand the key ingredients of running a successful program:
  - Defining value
  - Gaining senior management support
  - Having a detailed strategy
  - Developing a motivated reliability culture
  - You will see how all the pieces of the puzzle fit together
  - How the technical elements support the overall business goal

As a person who is new to "reliability improvement" you will gain

- A detailed understanding of the business case
- A detailed understanding of the "big picture" of reliability and performance improvement
- A solid understanding of the technical aspects, along with all the reliability, maintenance, and CBM technologies, techniques, and jargon
- The ability to contribute to an existing program
- Motivation to get involved and play your role

## MAXIMIZING THE VALUE OF THE TRAINING: DON'T STOP WITH ARP-A

Here is something to think about. The ARP-A Reliability Advocate course is an excellent way to get up to speed about reliability, especially when starting a new program.
Many organizations have found it beneficial to have it delivered on-site so that a range of personnel can
attend from the maintenance department, operations/ production, finance, safety/health/environment, engineering, and even other departments – including the plant manager. The course gets everyone up to speed and on the same wavelength.

But the big question you must ask is; what happens next?
The course is beneficial, but if no one else is educated/ trained, if there is not a strategy to move forward that everyone understands and believes in, if people don't know how they can contribute to the initiative, then unfortunately, you may not gain the greatest benefit from the course.

- First, we have the ARP-L "Reliability Program Leader" course for the person/people who will lead the initiative, and the ARP-E "Reliability Engineer" course for the people who will engineer the technical aspects of the initiative. The ARP-A course is great, but it is just the start of the journey.

- Second, we have developed the Asset Reliability Transformation [ART] process with a roadmap that explains how to implement the strategy to achieve the best results. It is filled with the phases, steps, and recommended practices to guide you through the implementation process. It includes a training plan that gets everyone up to speed, pulling in the
same direction, and skilled/qualified to play their role. iLearnReliability™ will help you with the plant-wide educational process.

- And if you need help with the roll-out, and/or the training component, we have Partners around the world who can help you with whatever you need.

# ASSET RELIABILITY PRACTITIONER®
# [ARP-E] Reliability Engineer

This course is the best way to master reliability engineering. You will learn a broad range of essential topics.

**The reliability engineer must be tremendously versatile.**

They must understand a broad range of technical subjects and be capable of applying them all. If you are up for the challenge, the Asset Reliability Practitioner [ARP-E] "Reliability Engineer" course is just what you need.

You will have 5 days to master everything from defect elimination, asset strategy development with RCM, PMO, and FMEA, planning and scheduling, spares and materials management, condition monitoring, precision maintenance practices, reliability data analysis, criticality and Pareto analysis, root cause analysis and FRACAS, lubrication and asset care, and other topics.

There is a lot to learn, but to be a successful reliability engineer, you must learn it all. Fortunately, the Mobius Institute™ training techniques will ensure that you will not just survive the course, you will enjoy it, understand all the topics, and feel confident in the role of a reliability engineer.

## THE ARP-E RELIABILITY ENGINEER CERTIFICATION PROCESS

There are just four requirements to become certified:

1. You must attend this Mobius Institute course, or any other recognized training course that covers the same topics.
2. You must achieve a 70% score, or better, on the three-hour, 100-question, multiple-choice exam.
3. You must have a minimum of 24 months of experience in the industry involved in some way with reliability improvement.
4. Your experience must be verified by an independent person.

## ARP-E FAST FACTS

**Duration:**
32 hours minimum: Typically delivered over 5 days

**Format:**

- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

**Compliance:**

- Training: modeled on 18436-2 and ISO 18436-3, but there is no ISO standard for reliability personnel certification.
- Certification: according to ISO/IEC 17024 and modeled on ISO 18436-1
- Training: ISO 18436-3

**Exam:**

- Three hours
- 100 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

**Certification requirements:**

- Training course completed
- 24-months of work experience, verified by an independent person
- Pass the exam
- Valid for 3 years

**Pre-study:**

- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

**Post-study:**

- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

## WHAT WILL I BE CAPABLE OF ONCE I COMPLETE THE COURSE?

The role of "Reliability Engineer" does not have a clear-cut definition. And different organizations utilize reliability engineers differently. However, after our course, you will have a solid understanding of a wide range of topics that will enable you to perform the tasks that are commonly performed by reliability engineers, and provide advice to people in the maintenance, engineering, and operations/ production departments.

Reliability data analysis

You will have a good understanding of statistics, asset criticality ranking, Pareto analysis, Weibull analysis, and Crow-AMSAA. You will also learn about Reliability Block Diagrams (RBD) and the Monte Carlo method – and a few other topics. You will know whether you need to utilize those techniques: their benefits, the tools you will need, how you can utilize what you learned, etc.

With this information:

1. You will be able to work with other stakeholders to develop a thorough, robust criticality ranking. And with that, you can prioritize and justify a wide range of tasks
2. You will able to extract data and perform Pareto analysis to identify your bad actors and thus prioritize your improvement activities.
3. You will understand Weibull analysis, Crow-AMSAA, reliability block diagrams, and Monte Carlo analysis so that, if you had the tools to perform that analysis, they would make perfect sense. Additional training would be required to master those techniques.

Asset strategy development: FTA, RCM, PMO, FMECA

You must follow a structured process to ensure your asset strategy (maintenance plan) manages your risks and makes the best use of available resources. We spend a lot of time on these subjects so that you understand:

1. Why it is so important to develop a maintenance plan with a clear understanding of asset criticality, the function (and context) of the asset, and the failure modes.
2. How to avoid the common traps experienced with the use/implementation of these techniques.

Now, you *can* attend week-long courses on RCM, PMO, and FMECA, so there *is* more you can learn. Having said that, many of those courses also cover topics that are covered separately on our course, for example, condition monitoring, failure patterns, precision maintenance, etc. And on those courses, you will spend time with basic exercises putting what you have learned into practice with exercises, etc.

Therefore, the ARP-E course cannot make you an expert in every area of reliability, maintenance, design, and operations but you will have a very clear picture of how to utilize these techniques, you will be able to assess whether the techniques you used to develop your maintenance plan was adequate, you will be able to assess consultants who may help you in your implementation – and it will be a foundation to learn much more.

Condition Monitoring

You will understand how a "condition-based maintenance" program should work; how to prioritize the implementation, how to select the technologies, how to select the measurement periods, and so on. You will also learn about the technologies.

With this information, you will be able to assess your existing program, or how to select contractors, and how to improve what you are already doing.

But please remember, there is a LOT to know about each technology and how to successfully run the program. You will require additional training if you want to communicate with condition monitoring experts at a technical level. The training will, however, enable you to know what "good" looks like.

We do offer additional condition monitoring training if you are interested.

Lubrication management

One of the key topics for people with rotating machinery is how to manage lubricants and hydraulic fluids.

Once again, you can spend a week learning about this subject, and there are additional courses to gain true expertise. But with the ARP-E course, you will have a very clear understanding of the importance of selecting the right lubricants and how to avoid contamination.
You will feel very comfortable with this subject. You will be able to take that knowledge to improve your current practices.

Precision maintenance

Precision maintenance is certainly one of the keys to improved reliability. You will learn enough about precision fastening (electrical and mechanical), shaft and belt alignment, and rotor balancing to identify whether your current practices meet the required high standards. You will be familiar with all the key terms so that you can engage with the craftspeople, contractors, and vendors of the equipment.

We do offer additional alignment and balancing training if you are interested.

Work and spares management

Work management (planning and scheduling) is another core component of a successful reliability program: it affects the quality of work, the efficiency of the work, the safe execution of the work, and the costs of executing the work. Spares management works hand-in-hand with work management – you can't have one without the other. Spares management reduces costs, improves work efficiency, and can dramatically reduce maintenance costs.

In this course, you will learn enough to know what "good" looks like. Normally the reliability engineer does not have responsibility for work and spares management, but you will understand that it plays a very important role in reliability improvement, and you will be able to assess whether what your organization is doing is "world-class" or whether there are "opportunities for improvement". You can then advise (with tact) the maintenance manager about changes that could be made.

Root cause failure analysis

There are lengthy courses you can take to master the various techniques (5-Why, Ishikawa, fault/causal tree, etc.), to utilize software, and more, but what you will learn on our course will set you up for success. You will understand:

3. What the techniques are and basically how to use them (5-Why, Ishikawa, KT, FTA, and others)
4. How to manage the projects
5. The human error factors
6. The human psychology side of solving problems and implementing solutions
7. How to manage the project (A3, 8D, 16J) to ensure the process has the desired outcome

But the truth is, we only get to spend approximately half- a-day on this important topic, so there is more to learn. But you will know what you know, and you will know what you need to learn so that you feel confident to perform root cause failure analysis.

# ASSET RELIABILITY PRACTITIONER®
# [ARP-L] Reliability Program Leader

Success in reliability leadership comes from understanding the value of the program (and communicating that value), having a detailed strategy, and engaging with the entire organization so everyone is pulling in the same direction. Those topics are the main focus of this training course.

### For the true leader of the reliability improvement initiative

What a great opportunity you have. Improving reliability will make the plant safer and more competitive. Your fellow workers will have greater job security and they will enjoy a greater sense of job satisfaction.

*But that's only if you are successful with the program…*
You, therefore, have a great weight on your shoulders. Not every reliability improvement initiative is successful; sadly, far from it.

We have defined this course to help you to be successful with your program. We don't know of any other training course like it. Success in reliability leadership comes from understanding the value of the program (and communicating that value), having a detailed strategy, and engaging with the entire organization so everyone is pulling in the same direction. Those topics are the main focus of this training course.

### Leadership versus program management

It is all too common for people to view reliability improvement as a technical challenge, and therefore the role of the manager of the program simply to facilitate the technical solution.

*And that is one of the major reasons why so many programs fail.*

This training course is not about managing a technical program. It is about leading a successful, sustained initiative that achieves the highest levels of performance via improved reliability and reduced waste.

The leader must deliver value to the organization, and therefore they must understand what that means for their organization. The leader must change the culture and sustain the enthusiasm and engagement of all employees.

The leader must establish a strategy that steers around the quicksand and continually add value. *This course will explain how to do just that.*

## THE ARP-L RELIABILITY PROGRAM LEADER CERTIFICATION PROCESS

There are just four requirements to become certified:

1. You must attend this Mobius Institute course, or any other recognized training course that covers the same topics.
2. You must achieve a 70% score, or better, on the three-hour, 100-question, multiple-choice exam.
3. You must have a minimum of 48 months of experience in the industry involved in some way with reliability improvement.
4. Your experience must be verified by an independent person.

If you do not meet all of the requirements (for example, you do not have enough experience), then you can take the course, take the exam, and when you do have the required months of experience, you will be officially certified.

# Asset Reliability Practitioner®
# [ARP-L] Reliability Program Leader

## ARP-L FAST FACTS

**Duration:**
32 hours minimum: Typically delivered over 5 days

**Format:**
- Live public course
- On-site course
- Virtual online course
- Video distance learning online course

**Compliance:**
- Training: modeled on 18436-2 and ISO 18436-3, but there is no ISO standard for reliability personnel certification.
- Certification: according to ISO/IEC 17024 and modeled on ISO 18436-1
- Training: ISO 18436-3

**Exam:**
- Three hours
- 100 multiple-choice questions
- 70% passing grade
- Can be taken online or in-person at the course

**Certification requirements:**
- Training course completed
- 48-months of work experience, verified by an independent person
- Pass the exam
- Valid for 3 years

**Pre-study:**
- Access to the "Learning Zone" upon registration and payment
- Complete set of videos covering every topic
- An excellent way to be prepared and get the most from the course

**Post-study:**
- Continue to access the Learning Zone for 6-months after the course
- Continue learning, without charge, on MOBIUS CONNECT® via mobiusconnect.com

## WHAT WILL I BE CAPABLE OF ONCE I COMPLETE THE COURSE?

*In short, you will be capable of successfully leading a reliability improvement program.*

You will understand:
- How to develop the economic justification,
- How to develop and implement a strategy,
- How to build a culture of reliability and performance improvement,
- How to ensure that everyone is trained, motivated, and qualified to play their role,
- How to break out of reactive maintenance, and
- How to lead a team that will establish discipline in everything it does, which includes:
  - Caring for the equipment so their life is maximized,
  - Learning from a range of data so the best decisions can be made, and
  - Continuously improving everything that is done.

Let's take a closer look.

The economics of reliability

Economics drives business decisions. You must be able to translate the "common-sense advantages" of reliability and performance improvement into the language and financial benefits that senior management understands. We will start the course with a detailed module that explains the language of finance, and then we will explore how you can assess how the program will add value to your business, assess your current state, develop a business case, establish pilot programs that will prove your credibility, and finally, gain support from the senior executive.

You will be able to do all of that, on your own, if this is a brand-new program. You will be able to lead this process if you need to circle back and prove the value of your existing program.

Develop the reliability improvement strategy

The Asset Reliability Transformation process provides a blueprint that will guide you through the entire process. You are therefore welcome to learn from this blueprint or adopt the blueprint. Either way, it is essential that you follow a strategy.

This course will provide sufficient detail so that you understand the core elements of a successful reliability improvement initiative and the order in which you should implement those elements. It is fair to say that there is considerable detail underlying the ART process. Not all of that detail (i.e. all of the details of the recommended practices that make up the steps that make up the phases) will be revealed during the course – we only have time to provide detailed summaries – additional training is available if you are interested.

But again, there is no doubt that you will be able to return to your facility after this course and understand what you must do to implement a successful program.

Develop the reliability culture

The most common reason why programs fail is that the reliability group attempts to control all aspects of reliability improvement with little involvement or support from others in the plant. You will learn why this will be fatal for your program. You will learn how to engage with everyone in the organization to ensure that you have complete support and that you gain their contribution.

This part of the program is supported by a module on the "Psychology of reliability", a module called "Human error and human error management", and a module on "Culture change". Those modules, and the detailed module on the PEOPLE phase, will enable you to successfully gain the support of the entire organization.

Break out of the "reactive maintenance cycle of doom"

Although it is a dramatic name, the reactive maintenance cycle of doom is a major roadblock that many reliability improvement programs are unable to pass. This course will set you up with the knowledge and strategy to lead your organization, with the assistance of the maintenance manager and the management of operations/production, out of the costly and dangerous cycle where every attempt to improve reliability is thwarted by the next breakdown.

Lead the journey to "world-class" reliability improvement

While it can be difficult to define "world-class", you will be provided with the knowledge and strategy that will enable your organization to achieve the highest level of performance thanks to improved reliability, less waste, reduced maintenance costs, and optimization of production output (or the provision of the service your organization provides).

You will know what good looks like. You will know how to achieve the highest standards in maintenance, performance, project management, procurement, and other key areas.

*Mobius Institute Board of Certification is an accredited certification body per ISO/IEC 17024 and ISO 18436-1 authorized to provide certification in accordance with ISO 18436-1 and 18436-2.*

*Mobius Institute Board of Certification (MIBoC) is an impartial and independent entity that is directed by scheme and technical committees to ensure that its certification meets or exceeds the requirements defined by the applicable International Organization for Standardization, ISO 18436 standards.*

*MOBIUS INSTITUTE is a worldwide provider of Reliability Improvement, Condition Monitoring and Precision Maintenance education to industrial plant managers, reliability engineers, and condition monitoring technicians, allowing plants to be successful in implementing Reliability Improvement programs through delivery of more easily understandable and comprehensive training of Reliability and Vibration Analysis via public, in-plant and online education programs.*

For more information about additional training courses, software tools, industry terminology and definitions, accredited certification, and specific course details, visit the Mobius Institute website.

www.mobiusinstitute.com

North America: +1 (239) 600 - 6828 | Australia: (+61) (0)3-5977-4606

learn@mobiusinstitute.com

RMS RELIABILITY TRAINING INSTITUTE

rms-training.com

Join thousands of other industry professionals by creating your free custom profile today at **https://www.mobiusconnect.com/**

**DOWNLOAD THE MOBILE APP**

MOBIUS CONNECT
SOLVING · LEARNING · SHARING

**The maintenance and reliability industry's professional network.**

**TOPICS COVERED – ADVOCATE [ARP-A]**

- Getting started
  - What is a reliable plant?
- What are the benefits?
- Introduction to implementation
  - Process overview
  - Comparison of strategies
  - The Asset Reliability Transformation [ART] process
  - Asset management and ISO 55000
- Assessing the value
  - Why improve reliability
  - Current performance and cost
  - Measuring progress
- Selling senior management
  - Selling the benefits
  - Pilot projects
- Strategy
  - Planning, mission, support, mission establishing the team
  - The Asset Reliability Transformation® [ART] process
- Plantwide engagement
  - Human error and psychology
  - Culture change
  - Employee feedback
  - The brown-paper engagement process
- Getting maintenance under control
  - Breaking out of the reactive maintenance cycle of doom
- Defect elimination
  - Design for reliability
  - Value-driven procurement
  - Reliability-focused transport
  - Acceptance testing
- Understanding failure
  - What is failure?
- Asset strategy
  - Condition Based Maintenance (CBM), Run to failure (RTF)
  - Getting organized (Master Asset List, Bill of Material)
  - Developing a strategy
  - Analyzing reliability data
  - Asset criticality ranking
  - Preventative Maintenance Optimization (PMO)
  - Reliability Centered Maintenance (RCM)
  - Failure Modes Effects Analysis (FMEA)
  - Root Cause Failure Analysis (RCFA)

Continued…

**TOPICS COVERED – ADVOCATE [ARP-A]**
***continued***

- Work management
  - Work management flow
  - Strategy based work and work requests
  - Establishing a priority system
  - Processing requests
  - Job planning, scheduling, and execution
  - Commissioning
  - Closeout and feedback
- Spares management
  - Databases
  - Access control
  - Selection process
  - Caring for spares
- Precision work
  - Precision installation, alignment, balancing, fastening
  - Resonance elimination
  - 5S in the workshop
- Proactive asset care
  - Precision lubrication
  - Operations
  - 5s and the visual workplace
- Condition monitoring
  - Vibration analysis
  - Ultrasound
  - Electric motor diagnostic testing
  - Oil analysis
  - Wear particle analysis
  - Infrared analysis
  - Visual inspections
  - Performance monitoring
  - Non-destructive testing (NDT)
- Continuous improvement
  - Key Performance Indicators (KPIs)
  - Review program strategy
  - Continual education

**TOPICS COVERED – ENGINEER [ARP-E]**

- Introduction
  - The reliability engineer and the reliability program leader
  - Overview of the Asset Reliability Transformation® process
  - The benefits of reliability
  - How does reliability improvement compare to other programs?
- Culture change
  - Culture change and you
  - Getting suggestions
  - The brown-paper process
  - Motivation
- Training and skills assessment
  - Why do people need to be trained?
  - Skills assessment
  - Training and certification
- Risks and consequences
  - Assessing the risks
  - Developing the consequence ranking system
- Likelihood and detectability
  - How likely is failure?
  - Will we see the failure coming?
- Reliability data analysis
  - The importance and value of data
  - The foundation of reliability engineering
  - Statistical techniques
  - Data and Weibull distribution
  - Duane model and Crow-AMSSA
  - Reliability block diagrams (RBDs)
  - Using reliability data for decision making
  - Data quality
- Asset criticality ranking
  - How should the asset criticality ranking be defined?
  - Asset criticality ranking step by step
- Pareto analysis
  - What is Pareto analysis?
  - Pareto analysis example
- Defect elimination
  - What is defect elimination?
  - Defect elimination strategy
- Minimize life cycle cost
  - Life cycle cost minimization
  - Design for reliability
  - Value-driven procurement
  - Acceptance testing

Continued
…

**TOPICS COVERED – ENGINEER [ARP-E]**
***continued***

- Operations and reliability
  - Operator-driven reliability (ODR)
  - Standard operating procedures (SOP)
  - Overall equipment effectiveness (OEE)
- Asset strategy development
  - What is an asset strategy?
  - How to develop an asset strategy
  - Typical outcomes of an asset strategy
- Master asset list and bill of materials
  - How to develop an accurate Master Asset List (MAL)
  - How to create a Bill Of Materials (BOM)
  - Change management
- Fault tree analysis (FTA)
  - What is FTA?
  - The steps of FTA
  - Example of FTA
- Failure modes, effects, and criticality analysis (FMECA)
  - What is FMECA?
  - The steps of FMECA
  - Example of FMECA
- Reliability centered maintenance (RCM)
  - What is RCM?
  - The steps of RCM
  - Example of RCM
- Preventive maintenance optimization (PMO)
  - What is PMO?
  - Prerequisites for performing PMO
  - Getting started
- Root cause (failure) analysis (RCA)
  - Why and when to perform RCA?
  - People and RCA
  - RCA techniques
  - Condition Monitoring data and RCA
- Work management
  - Goals of work management
  - Roles and responsibilities
  - Work management flow
  - Job scheduling and execution
  - Closeout and feedback
- Spares and material management
  - The importance of spares management
  - Spares database
  - The selection process and purchasing requirements
  - Caring for spares
  - The storeroom
- Precision lubrication and contamination control
  - The importance of lubrication
  - How lubrication works
  - Contamination
  - Filtration
  - Storage and dispensing
- Precision shaft alignment
  - Introduction to shaft alignment
  - What is misalignment?
  - Types of misalignment
  - Determine the alignment state

Continued
…

**TOPICS COVERED – ENGINEER [ARP-E]**
***continued***

- Rotor balancing
  - What is unbalance?
  - Causes of unbalance
  - Diagnosing unbalance
  - Why balance?
  - Balancing the rotor
- Mechanical and electrical fastening
  - Precision fastening
  - Bolt torquing (tensioning)
  - Electrical connections
  - 5S and the visual workplace
  - 5S: Lean: Six Sigma Reliability improvement
- Vibration analysis
  - Introduction to vibration analysis
  - Vibration sensors
  - Overall level readings
  - Vibration spectra, time waveform, and phase analysis
  - Rolling element bearing fault detection
  - Fluid-film bearing and rotor fault detection
  - The future of vibration analysis
  - Case studies
- Ultrasound
  - Introduction to ultrasound
  - Mechanical and electrical applications
- Oil analysis
  - New and used oil analysis
  - Analysis technologies
  - Measuring and reporting oil cleanliness
  - Wear particle analysis
- Infrared thermography
  - Introduction to infrared analysis
  - Mechanical and electrical applications
- Inspections performance and NDT
  - Visual inspections
  - Non-destructive testing (NDT) methods
- Electrical equipment
  - Power quality
  - Electrical testing
  - Partial discharge
  - Induction motor testing
  - Motor current signature analysis (MCSA)
  - Electrical signature analysis (ESA)
  - Motor circuit analysis (MCA)
- The future of condition monitoring
  - Technologies and analytics in the future
- Breaking out of reactive maintenance
  - How to break out of the reactive maintenance cycle of doom
- Continuous improvement (Kaizen)
  - Key performance indicators (KPIs)
  - Maintenance metrics
  - CM and reliability performance
  - Review program strategy

**TOPICS COVERED – RELIABILITY PROGRAM LEADER [ARP-L]**

- Getting started
  - The goals of "reliability improvement"
- Implementation
  - Why do programs fail?
  - The Asset Reliability Transformation (ART) process
- The economics of reliability
  - Speaking the language of "finance"
  - Basic financial analysis techniques
- Phase One: Value
  - Performance
    - Safety incident reductions, improving quality, profit maximization etc
  - Constraints
    - Capital, regulation, raw material availability etc
  - Risk
    - Pareto analysis
    - Asset Criticality Ranking
  - Opportunities
    - Achieving peak business performance
    - Total Effective Equipment Performance (TEEP) and Overall Equipment Effectiveness (OEE)
  - Winning the support of management
- Phase Two: Strategy
  - Implementation strategy
  - Asset strategy
- The psychology of reliability
  - How do people make decisions?
  - Changing behavior
- Human error and human performance management
  - What causes human error
  - Managing human error
- Culture change
  - Why do we need to change the culture?
  - How do you change the culture?
- Phase Three: People
  - Leadership – a key ingredient to success
  - Buying in to reliability improvement
  - Training and certification
- Phase Four: Control
  - Breaking out of the "reactive maintenance cycle of doom"
- Phase Five: Acquire
  - Project management
  - Designing for reliability
  - Acceptance testing

Continued
…

**TOPICS COVERED – LEADER [ARP-L]** ***continued***

- Phase Six: Discipline
  - The CMMS/EAM
  - Documenting procedures
  - Shutdowns, turnarounds and outages
  - 5S and the visual workplace
- Phase seven: Care
  - Basic care – lubrication and cleanliness
  - Operator-driven reliability
- Phase Eight: Analytics
  - Review and improve financial performance
  - Monitor KPIs
  - Condition-Based Maintenance
  - Predictive analytics
- Phase Nine: End of life (EOL)
  - Root Cause Failure Analysis
  - Recording failure data
- Phase Ten: Optimize
  - Continuous improvement
  - Re-assess the risks, goals, constraints and opportunities

## IS THE ARP CERTIFICATION ACCREDITED TO ISO/IEC 17024?

As of this writing, the ARP certification scheme has passed the final audit but has not been formally accredited by the government-appointed body. The auditing body has also stated that everyone who has already been certified will automatically be enrolled in the accredited program. Therefore, for all intents and purposes, the program is accredited.

## WHAT IS THE DIFFERENCE BETWEEN ARP CATEGORY I, II, AND III AND ARP A, E, AND L?

When the Mobius Institute Board of Certification™ [MIBoC] Scheme Committee initially established the Asset Reliability Practitioner certification scheme, it was decided that it should follow the same naming process as the condition monitoring ISO 18436 certification program. Therefore, it was decided that each level should be Category I, II, and III.

The problem was, it caused confusion because whereas there is a definite growth path from Category I to II and III in vibration analysis, for example, and the fact that you needed to be Category II before you could apply for Category III, the same rules did not apply for ARP.

The Scheme Committee decided that a person should be able to transition directly to the highest certification level of the ARP without being required to be certified at lower levels. The reason why is described in separate FAQ questions.

The same is true for the second-highest level. The scheme committee determined that a person should be able to go directly to Category II.

To avoid confusion, the certification levels were renamed as follows:

- Category I became ARP-A “Reliability Advocate”
- Category II became ARP-E “Reliability Engineer”
- Category III became ARP-L “Reliability Program Leader”

## WHY DOES ARP HAVE THREE LEVELS?

Certain people in the industry, and the practitioners who formed the Mobius Institute Board of Certification Scheme Committee and Technical Committee believed that there should be more than one level of certification in recognition of the challenging task involved with improving reliability, maintenance, operational performance, and asset health monitoring. Thus, the three-level system was devised:

- ARP-A: For engineers, managers, and practitioners who need to understand the entire picture of reliability and performance improvement without getting bogged down in any of the details in any one area
- ARP-E: For reliability engineers who are focused on the technical aspects of reliability, maintenance, and asset health monitoring – the requirements go well beyond CMRP or any other certification program

- ARP L: For the reliability program leaders who must primarily understand the business case, the requirements to change the culture, the strategy, and the leadership skills necessary to make such an initiative successful – the requirements, once again, go well beyond CMRP or any other certification program

## WHY DO YOU NOT REQUIRE PEOPLE TO BE CERTIFIED ARP-E BEFORE THEY CAN BE CERTIFIED ARP-L?

Generally speaking, there are two types of people in the role of a Reliability Program Leader.

There are people who have come up through the ranks, potentially beginning in a condition monitoring role, then working in reliability engineering, and finally being promoted into a role where they lead the reliability program. That person will have the technical skills and experience but will have to develop the knowledge necessary to create the business case, change the culture, develop the strategy, and implement a successful program. And that is what ARP-L is for.

However, there are also people who come into the role because they have already demonstrated leadership skills. They understand the business case, and they know how to lead people. They are organized project managers, and therefore have the skills to implement a successful program. In many cases, those people do not wish to delve deeply into the technical side of reliability engineering. Instead, they make sure that they have competent Reliability Engineers reporting to them who are able to make the right technical decisions and provide accurate information.

Although this second group of people would benefit from having a deeper knowledge of reliability engineering, it was decided that they should not be forced to gain that knowledge. Instead, the ARP-L training provides a solid overview of the technical aspects so that they understand the terminology and main issues.

## WHAT IS THE DIFFERENCE BETWEEN ARP AND CMRP?

The SMRP CMRP certification has been around for a long time and it is generally respected in the industry. The SMRP CMRP certification program is accredited to ISO/IEC 17024 so it is fair, independent, and legitimate – just like ARP.

Certain people in the industry and the practitioners who formed the Mobius Institute Board of Certification Scheme Committee and Technical Committee believed that there should be more than one level of certification in recognition of the challenging task involved with improving reliability, maintenance, operational performance, and asset health monitoring. Thus the three-level system was devised.

The Scheme Committee and Technical Committee also believed there should be a structured training program to support the certification program and that people should be encouraged to take the training. Many people are only given the opportunity to take training if it is associated with the certification program. Unfortunately, SMRP actively discourages organizations from offering training that prepares a person for the CMRP certification, instead requesting people to read a variety of books.

While certification is important, the education gained in achieving that certification is arguably more important.

## WHAT IS THE DIFFERENCE BETWEEN ARP AND CRL?

The structure, independence, discipline, and fairness behind the Asset Reliability Practitioner training and certification are very different from those that exist for CRL. While the training associated with CRL is closely related to that covered on the ARP-A course, that is where the similarities end.

## WHAT IS THE DIFFERENCE BETWEEN ARP AND CRE?

CRE certification is highly respected in the industry. CRE is focused on reliability engineering, however, the vast majority of CRE certified personnel are focused on product reliability; ensuring that your television does not fail, and determining warranty requirements, for example.

ARP-E "Reliability Engineer" is focused on the role performed by personnel working with industrial equipment (rotating machinery, electrical equipment, mobile assets, etc.) with the goal of ensuring that equipment is available to be used when called upon, and to minimize the maintenance costs associated with those assets.

## DO I NEED TO BE ARP-A CERTIFIED IN ORDER TO TAKE THE ARP-E COURSE AND EXAM?

No. While the ARP-A course will provide a useful introduction which will make it far easier to understand the topics covered in ARP-E, the ARP-E course does not assume prior knowledge.

## DO I NEED TO BE ARP-A OR ARP-E CERTIFIED IN ORDER TO TAKE THE ARP-L COURSE AND EXAM?

No. While the ARP-A and ARP-E courses provide a useful introduction which will make it far easier to understand the topics covered in ARP-L, and while ARP-E will be tremendously valuable to the Reliability Program Leader, the ARP-L course does not assume prior knowledge.

## WHAT DO I RECEIVE WHEN I AM CERTIFIED?

You will be issued a digital certificate, personalized logo, and certification card. The certificate will acknowledge that the recipient has completed training, passed the exam, and if they have sufficient practical work experience relevant to the technology to be fully certified. This will be available to share online as needed by the candidate. Your name will also appear on the Mobius Institute website (unless you would prefer to remain anonymous).

## WHAT ARE THE EXPERIENCE REQUIREMENTS FOR ARP A, E, AND L?

(From the MIBoC guide ED161-2) The requirements are:

- ARP-A – 6 months
- ARP-E – 24 months
- ARP-L – 48 months

## WHAT TYPE OF EXPERIENCE IS REQUIRED FOR ARP-A, E, AND L?

The experience requirements exist simply to ensure that you have experienced the issues related to poor reliability: downtime, lower than desired production output, frustration with breakdowns, etc. In the case of ARP-E and ARP-L, the experience requirements also exist to ensure that you have some experience improving reliability. It is not expected that you have been a full-time reliability engineer or program leader, but it is expected that you may have been involved with some of the common activities, such as condition monitoring, the acquisition of laser alignment or other precision maintenance tools, root cause failure analysis, and so on.

## HOW LONG ARE THE EXAMS?

(From the MIBoC guide ED161-2) The requirements are:

- ARP-A: 60 questions, duration 2 hours, 70% passing grade
- ARP-E: 100 questions, duration 3 hours, 70% passing grade
- ARP-L: 100 questions, duration 3 hours, 70% passing grade

## HOW ARE THE EXAM QUESTIONS DEVELOPED?

The Mobius Institute Board of Certification (MIBoC) has established an independent Technical Committee (TC) and questions have been submitted for approval from industry experts. Questions are proposed, audited, and reviewed by the TC. MIBoC has developed a process that utilizes software developed for the task so that the exam questions are protected, and so that all changes are tracked. The TC is made up of industry experts and experienced people who work in the field from around the world.

Once a question has been used in an exam, special statistical processes, called psychometrics, are used to check if any questions are too easy, too hard, or too confusing. Those questions are then reviewed by the TC and either improved or rejected.

## IS THE ASSET RELIABILITY PRACTITIONER CERTIFICATION SCHEME BASED ON AN ISO STANDARD?

Yes and no. Unfortunately, there is not an ISO standard for the certification of reliability practitioners or anything close to it.

However, the Mobius Institute Board of Certification [MIBoC] ED-161 scheme is modeled on the ISO 18436 standards; the topics are mapped to the ISO 55000 standards; the scheme follows ISO/IEC 17024, and the core knowledge and vocabulary/terminology is based on definitions developed in a variety of ISO standards (and other international standards). The topics themselves, and the requirements, were developed over a long time by the MIBoC Scheme Committee and Technical Committee. SC and TC are made up of industry experts and experienced people who work in the field from around the world.

### IF MOBIUS CERTIFIES ME AT ARP A, E, OR L, DOES THAT MEAN THAT I AM QUALIFIED TO DO MY JOB AND THUS DO NOT REQUIRE ANY SUPERVISION?

No. Certification at ARP A, E, and L demonstrates that you have some experience in an industrial setting and that you understand certain facts, concepts, and principles, but it does not mean that an employer should not take responsibility for the tasks that you are assigned to perform.

Having said that, a person who has passed ARP-E should have the knowledge necessary to become an effective reliability engineer, and a person who passes ARP-L should be able to manage and lead a reliability improvement initiative.

### IF I HAVE ALREADY RECEIVED EQUIVALENT TRAINING, CAN I TAKE THE EXAM?

Yes. We will need to see some evidence that you have taken the training, that the training covered the required topics, but it is not necessary to retake any training.

### WHAT IS THE RELATIONSHIP BETWEEN MOBIUS INSTITUTE AND THE MOBIUS INSTITUTE BOARD OF CERTIFICATION (MIBOC)?

Mobius Institute is a private training, conference, and media organization. Some of the training offered by Mobius Institute has been approved by the Mobius Institute Board of Certification. At the time of this writing, there were approximately 130 organizations in 60 countries that have been approved to teach the Mobius Institute courses in 23 languages.

Mobius Institute Board of Certification (MIBoC) is a private organization, however it operates in the same way as a not-for-profit organization (except that, due to Australian taxation law, we do not have not-for-profit status because we service organizations outside Australia, therefore we pay tax on all revenue received, unlike other not-for-profit organizations.) MIBoC is governed by the MIBoC Governing Body, and all of its procedures are defined by independent Scheme Committees. All technical matters are defined by independent Technical Committees.

### IS THE TRAINING AND EXAM SPECIFIC TO MOBIUS INSTITUTE THEORY?

No. For many years there has been a body of knowledge associated with reliability and performance improvement, including best practices in maintenance, condition monitoring, asset strategy development, reliability engineering, and other related topics. While a Mobius Institute course may have a unique way of presenting the material, Mobius Institute courses simply teach well documented best practices.

### CAN I TAKE A MOBIUS INSTITUTE COURSE, AND THEN TAKE THE CMRP OR CMRT EXAM?

Yes. The topics covered in the Mobius Institute courses will prepare you for the SMRP certification exams. You will simply have to make arrangements with the organization providing that training, and SMRP, to ensure that you can take an exam after you have been trained.

### IF I HAVE TAKEN THE CRL COURSE CAN I TAKE THE ARP-A EXAM?

Yes. If you have evidence that you took the course, then you are welcome to take the ARP-A exam so that you are certified by an accredited certification body.

### CAN THE ARP EXAMS BE TAKEN ONLINE?

Yes. It will be necessary to coordinate with the Mobius Institute Board of Certification (MIBoC) as there are certain procedures that must be followed.

### IS IT POSSIBLE TO TAKE THE ARP EXAMS AT THE MOBIUS CONNECT TRAINING CONFERENCES?

Yes, many people take the ARP (and other) exams at our training conferences. Please contact the certification manager to organize the exam.

### WHAT IS THE RELATIONSHIP BETWEEN THE ASSET RELIABILITY PRACTITIONER CERTIFICATIONS AND THE SMRP CMRP CERTIFICATION?

If you have knowledge and experience in the field of reliability and performance improvement, then the ARP-A course may aid you in the preparation for the CMRP exam. However, given that the main aim of the ARP-A course is to create detailed awareness rather than detailed knowledge, you are best advised to take the longer ARP-E course to fully understand Reliability Engineering.

It should be stated that the SMRP certification scheme has been developed with the highest standards, and the CMRP scheme is accredited to ISO/IEC 17024. The Mobius Institute Board of Certification [MIBoC] processes mirror the SMRP processes, and MIBoC is accredited to the same standard.

### CAN I HAVE THE TRAINING COURSE I HAVE DEVELOPED RECOGNIZED BY THE MOBIUS INSTITUTE BOARD OF CERTIFICATION AND THEN ORGANIZE FOR PEOPLE TO TAKE THE ARP EXAM AFTERWARDS?

Yes. Your training material will need to be approved by the independent Technical Committee established by MIBoC, and the Technical Committee members to review your course are chosen to ensure there is no conflict of interest.

### CAN I BE APPROVED TO TEACH THE MOBIUS INSTITUTE COURSES AND THEN OFFER THE MOBIUS INSTITUTE BOARD OF CERTIFICATION EXAM?

Yes. We have a simple but proven method to become an Approved Training Center. We have been working with companies in 60 countries around the world to teach other Mobius Institute courses, and we would certainly like the opportunity to work with you as well. As you can imagine, we need to ensure that you are qualified in the subject areas, that you have experience teaching courses, and you have a business capable of supporting these activities. And once you are approved, you will take additional training to ensure you are confident and competent in teaching the Mobius Institute courses.

## WHY DOES MOBIUS INSTITUTE USE THE PHRASE "RELIABILITY AND PERFORMANCE IMPROVEMENT" RATHER THAN SIMPLY "RELIABILITY IMPROVEMENT" OR "MAINTENANCE AND RELIABILITY IMPROVEMENT"?

The reason that most organizations seek to improve reliability is to improve the performance of the organization.

Ultimately most organizations wish to improve financial performance; whether that's increased profits, or reduced expenses in the case of a government organization, for example. Organizations must also seek to improve their safety and environmental performance. In order to achieve the company's goals, the organization must perform better in many departments of the company, including maintenance, operations/production, procurement, materials and work management, and engineering.

While we seek to improve reliability, we are not improving reliability for reliability's sake; we are making improvements that add value to the organization, ultimately by improving performance.

## CAN THE ARP COURSES BE DELIVERED AT OUR SITE?

Yes. The ARP-A "Reliability Advocate" course would be perfect for an on-site course, and it has been delivered on-site many times. We can either "simply" teach the course or we can work with you to expand the course so that you can relate the topics of the course, and the issues raised during the course, to the reality in your plant. In that case, we could team up with someone within your organization who can ask the ideal questions at the ideal time.

There are actually two versions of the ARP-A course. The standard course which is taught during conferences and public training sessions, and a course that we call the ARP-A "PLANT-WIDE AWARENESS" course. This course was developed for people who will not actually work in the role of which the primary goal is to improve reliability, who therefore need to understand how to implement the program, the challenges of culture change, the business case, and other issues. The "PLANT-WIDE AWARENESS" is perfect for people who work in the plant and simply need to know why reliability should be improved, how they will benefit, how they can contribute to the program, and to demystify all of the technologies and terminology.

It is an excellent course if you want to ensure that everyone is on the same page, pulling in the same direction.

# iLearnReliability™

Condition Monitoring
Professional Development
Enterprise Edition

RMS RELIABILITY TRAINING INSTITUTE
Approved Training Partner

**iLearnReliability is a series of training structured for Managers, Program Management, Condition Monitoring specialists and the plant floor craftspeople and operators. Each series has a number of training modules that range from briefings to detailed training covering the topic areas of Management, Condition Monitoring and Precision Maintenance.**

### Essential Elements [EE]

The Essential Elements [EE] modules provide initial orientation of all of the reliability improvement topics covered in each respective version of iLearnReliability and can be used later for refresher training.

### Manager Briefings [MB]

All Manager Briefings [MB] are short and focused. They are written for upper level managers who may not have the time to explore the intricacies of condition based maintenance, reliability improvement, and all the other topics, but do need a basic understanding of the issues, and most importantly, need to understand the financial benefits associated with the CBM program and reliability improvement initiative.

### Program Management Training [MT]

The Program Management Training [MT] modules are intended for reliability engineers, PdM program managers, and other people who are charged with implementing the reliability improvement and PdM (CBM) program. These people generally do not need the same level of knowledge as the people who will actually use the condition monitoring tools and software, or the people who will work on machines (alignment, balancing, lubrication, etc.) but they do need to have a good working knowledge of those topics, and they certainly need to know how to run a successful program.

### Skills Training [ST]

All Skills Training [ST] modules are very detailed and intended (primarily) for the person who is actually involved with the condition monitoring technique or craft (alignment, balancing, etc.). Of course, anyone can take the lessons in order to better understand the topic, but the detail provided is primarily intended for the practitioner.

### Toolbox Talks [TT]

All Toolbox Talks [TT] are short and focused. They are primarily written for plant floor personnel or anyone who would like a quick introduction to a condition monitoring technology or precision maintenance activity without getting into too much detail. Toolbox Talks are intended to demystify condition based maintenance (and the associated technologies), the importance of reliability, and the techniques that can be used to improve reliability.

# Essential Elements [EE]

iLearnReliability includes a series of brief modules called "Essential Elements" [EE] that provide a quick introduction to key reliability topics and can be used as a handy reference or refresher.

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| EE-RR | **Roadmap to Reliability**<br>This module provides a quick introduction to the Roadmap to Reliability; the core strategy behind iLearnReliability. Roadmap to Reliability provides a strategy for defect elimination which includes condition monitoring, reliability centered maintenance, precision skills and guidance which are used alongside these tools to develop the reliability culture. | Essential Elements | ** | 54 | | ✔ | ✔ |
| EE-DE | **Defect Elimination**<br>Your fundamental goal as a reliability professional should be to identify the root cause of the defects and proactively eliminate them. Taking proactive steps to eliminate the root causes of equipment failure is also known as, Defect Elimination. This module covers some common sources of defects, defect justification and how to use condition monitoring for QA/QC. | Essential Elements | ** | 67 | | ✔ | ✔ |
| EE-ACR | **Asset Criticality Ranking**<br>Beginning to understand criticality analysis and the asset criticality ranking are the main goals of this module. Developing an asset criticality ranking is an essential step in the reliability improvement process, it enables work to be prioritized and investments justified. This module discusses the likelihood of failure, Risk Priority Numbers (RPN) and the detectability of the warning signs that must also be taken into consideration. | Essential Elements | ** | 55 | | ✔ | ✔ |
| EE-RCM | **Reliability Centered Maintenance (RCM)**<br>The classic Reliability Centered Maintenance (RCM) strategy ensures the function of an asset is preserved without compromising safety or the environment. The main outcome is to determine the proactive tasks that can be performed to meet that goal. In this module, we will review the roles of maintenance, as well as the reliability centered maintenance process which covers operating context, failure modes, task intervals and more. | Essential Elements | ** | 62 | | ✔ | ✔ |
| EE-MP | **Maintenance Practices**<br>This module focuses on several different types of maintenance practices; from reactive, proactive and preventive maintenance to planned, precision and run-to-failure maintenance. Some of these terms, and your understanding, are often broadly used, but in this module, we will begin to clarify each of their differences. | Essential Elements | ** | 57 | | ✔ | ✔ |
| EE-FMEA | **Failure Mode Effects Analysis (FMEA)**<br>The FMEA (Failure Mode and Effects Analysis) process is the examination of failure modes, the effects and consequences of failures and the focus on determining how to deal with those failure modes. This in-depth module begins to explain the purpose and benefits of using the FMEA process versus the Root Cause Failure Analysis (RCFA) method. | Essential Elements | ** | 47 | | ✔ | ✔ |
| EE-PMO | **Planned Maintenance Optimization (PMO)**<br>The Preventive Maintenance Optimization (PMO) process should reduce maintenance costs, increase availability and identify interval-based maintenance tasks that were not previously being performed. In this module, we will discover where preventive maintenance tasks come from and why these tasks are necessary. | Essential Elements | ** | 27 | | ✔ | ✔ |
| EE-CBM | **Condition Based Maintenance (CBM)**<br>Just because condition monitoring test are being performed on your equipment does not mean that you are properly improving reliability of that equipment. The condition based maintenance technologies discussed in this module can be used to detect the root cause of failure and we'll cover how those technologies can be used in QA/QC function; checking installations, performing acceptance testing, etc. | Essential Elements | ** | 50 | ✔ | ✔ | ✔ |
| EE-VIB | **Vibration Analysis**<br>This module provides an overview of vibration analysis; a vital tool in seeing "inside" the machine. This module covers how to measure vibration to determine the health of rotating machinery by utilizing overall-level readings, time waveform and spectrum analysis. You will learn why vibration analysis is so vitally important in any condition monitoring and defect elimination program. | Essential Elements | ** | 72 | ✔ | ✔ | ✔ |
| EE-UT | **Ultrasound Testing**<br>This module introduces you to ultrasound analysis and how to use it to detect mechanical, electrical and process faults so that you can reduce failure rates and energy consumption. Leak detection, mechanical and electrical applications, as well as stream traps are a few of the topics that are covered in this module. | Essential Elements | ** | 56 | ✔ | ✔ | ✔ |

# Essential Elements [EE] (Cont.)

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| EE-IR | **Infrared Thermal Imaging**<br>Infrared thermal imaging, also known as Infrared thermography, is a powerful tool that can be used to detect faults in mechanical and electrical equipment. In this module, we discuss theory as well as the electrical, mechanical and other industrial applications that benefit from this type of condition monitoring tool. | Essential Elements | ** | 46 | ✔ | ✔ | ✔ |
| EE-ALIGN | **Precision Shaft Alignment**<br>Precision shaft alignment is essential if you value equipment reliability. This module is an introduction to machine shaft alignment with dial indicators and laser alignment systems. We will discuss pre-alignment checks, straightedge and dial indicator alignment as well as proper methods to correct misalignment. | Essential Elements | ** | 50 | ✔ | ✔ | ✔ |
| EE-BAL | **Precision Balancing**<br>The module on precision balancing is an introduction to correcting machine rotor unbalance. Bearings, shafts, seals and foundations will all last longer in precision balanced machines, that's why it needs to be a key element in your plan for reliably improvement. | Essential Elements | ** | 49 | ✔ | ✔ | ✔ |
| EE-CC | **Lubrication Contamination Control**<br>This module focuses on how you can extend the life of all rotating machinery and the lubricants themselves by controlling lubrication contamination. We will discuss why contamination is so harmful, how to minimize contamination, contaminants that affect the surface and the importance of precision lubrication. | Essential Elements | ** | 54 | ✔ | ✔ | ✔ |
| EE-PM | **Preventive Maintenance**<br>Preventive maintenance (PM), which is also known as interval-based maintenance, should be a part of a broader maintenance strategy that includes condition-based maintenance and run-to-failure maintenance. This module explores when you should use preventive maintenance, the goals you should have to preserve function and how to develop a preventive maintenance strategy. | Essential Elements | ** | 57 | | ✔ | ✔ |
| EE-ODR | **Operator Driven Reliability**<br>This module covers the benefits of using operator driven reliability to performing simple condition monitoring tasks and inspections, adjustments and perform elementary maintenance tasks. By utilizing operator driven reliability as part of your reliability initiative, you will free up dedicated maintenance and condition monitoring personnel so that they can be more productive and effective. | Essential Elements | ** | 33 | | ✔ | ✔ |

# Manager Briefings [MB]

Manager Briefings on MANAGEMENT topics [MB-M]

The majority of the Manager Briefings [MB] are written on Management [M] topics. These modules are focused on strategy and financial benefits, but they also explain the philosophy of the different maintenance practices that can be taken.

Manager Briefings on CONDITION MONITORING topics [MB-CM]

These Manager Briefings [MB] are written on Condition Monitoring [CM] topics. The aim is to provide the upper level manager with a working knowledge of how the condition of rotating machinery and other assets can be determined using vibration analysis, infrared thermography and other technologies. The aim is to demystify the topics.

Manager Briefings on PRECISION MAINTENANCE topics [MB-PM]

These Manager Briefings [MB] are written on Precision Maintenance [PM] topics. The aim is to provide the upper level manager with a working knowledge of how the reliability of rotating machinery and other assets can be improved by performing precision alignment and balancing, resonance elimination, precision lubrication, optimal operation, correct fastening, and other reliability improvement areas, as well as acceptance testing and root cause failure analysis. The aim is to demystify the topics.

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| MB-M-1 | **Roadmap to Reliability (A Summary)** This Manager Briefing provides a summary of the PERI program, explaining how you can use iLearnReliability to transform your plant from reactive to reliable. | Management Briefs | * | 30 | | | ✔ |
| MB-M-2 | **Condition Based Maintenance vs. Preventive Maintenance** This Manager Briefing provides a quick overview of the philosophy of preventive maintenance and uses the results of numerous studies to demonstrate why it is flawed when applied to rotating machinery. It goes on to discuss why condition based maintenance makes more sense. | Management Briefs | * | 15 | | | ✔ |
| MB-M-3 | **The Benefits of Reliability & Condition Based Maintenance** This Manager Briefing explains the benefits of the precision maintenance/reliability improvement strategy. It provides a number of examples of organizations that reduced costs, increased production and improved their stock price. It also discussed the benefits in relation to improved safety, improved quality, and improved asset utilization. | Management Briefs | * | 30 | | | ✔ |
| MB-M-4 | **What is Classical Reliability Centered Maintenance (RCM)?** This Manager Briefing provides an introduction to classical RCM and its relationship to the PERI approach and the iLearnReliability content. It provides a basic understanding of RCM, and also shows the relationship between it and FMECA. | Management Briefs | * | 30 | | | ✔ |
| MB-M-7 | **Why Condition Monitoring does not Improve Reliability** This Manager Briefing presents a "story" that illustrates the difference between condition based maintenance and reliability improvement. We use car maintenance as a way to demonstrate that condition monitoring (while very important), does not improve failure, it simply provides a warning about potential catastrophic failures (that could have been avoided). | Management Briefs | * | 20 | | | ✔ |

# Program Management Training [MT]

Program Management on MANAGEMENT topics [MT-M]

These Program Management Training [MT] modules are focused on Management [M] topics. These modules are intended to ensure that a) the benefits of condition based management and reliability improvement are fully understood, b) the steps required to successful start and maintain a successful program are understood, and most importantly c) the steps required to gain buy-in from upper-management through to the "plant-floor" staff are fully understood.

Program Management on CONDITION MONITORING topics [MT-CM]

These Program Manager Management [MT] modules are focused on Condition Monitoring [CM] technology topics. These modules will provide a very strong base of knowledge on all of the condition monitoring technologies so that it is possible to speak with confidence to a sales person selling the systems, and carry on a sensible conversation with the condition monitoring specialist, whether he or she is a consult or an in-house employee.

Program Management on PRECISION MAINTENANCE topics [MT-PM]

These Program Management Training [MT] modules are focused on Precision Maintenance [PM] topics. These modules will provide a very strong base of knowledge on all of the precision maintenance techniques such as precision alignment and balancing, resonance elimination, precision lubrication, optimal operation, correct fastening, and other reliability improvement areas. It is assumed that the person taking these modules does not require the knowledge to perform these tasks but does need to fully understand how they are done so that purchase decisions can be made, work practices can be established, and correct practice is recognized.

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| MT-M-1 | **The Roadmap to Reliability Improvement**<br>This Management Training [MT] module is the key training module in the iLearnReliability series. This learning module takes you by the hand and explains how to achieve the transformation from reactive to reliable at your plant using iLearnReliability. It presents the decisions you will have to make, and it will help you to determine where you are along the path. It makes recommendations regarding who should receive training and recommends which training modules should be used – however, you are free to use any lesson modules for any people. | Manager Training | *** | 240 | | ✔ | ✔ |
| MT-M-2 | **Understanding Maintenance Practices**<br>This Management Training [MT] module provides a detailed overview of maintenance practices. After discussing perils of working in a plant that only practices reactive maintenance, the module moves on to a discussion breakdown maintenance (pros and cons) and preventive maintenance (and why the strategy can be flawed for rotating machinery). Next the module introduces condition based maintenance strategy. We explain the benefits of basing maintenance on condition, and provide an overview of each condition monitoring technique. And finally, we discuss how the greatest reductions in maintenance costs, energy consumption, inventory costs and production losses are gained through reliability improvement. We provide an introduction to RCM but then explain how most plants can make huge gains by focusing on precision alignment and balancing, proper lubrication and fastening/torqueing, resonance elimination, and other techniques. | Manager Training | *** | 200 | | ✔ | ✔ |
| MT-M-3 | **KPIs, Benchmarking, And Continuous Improvement**<br>This Management Training [MT] module explains the importance of developing a vision statement, a plan, and a set of targets. The vision statement, and leadership from the top, is essential to the success of this program. If you don't have goals, and you don't have a plan, then it is impossible to measure your progress. Identifying and addressing the gaps are an important part of the continuous improvement program. In addition to providing a set of leading and lagging KPIs, with guidance on how to acquire the data, we provide a helpful benchmarking tool so that you can compare yourself to best practice in your industry. | Manager Training | *** | 50 | | ✔ | ✔ |

# Program Management Training [MT] (Cont.)

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| MT-M-4 | **Leadership And Culture Change**<br>This Management Training [MT] module is aimed at helping you understand the psychology of your fellow human beings, and navigate the change process. The best plan and vision in the world will fail unless you address the human factors. The culture in your plant will need to change, and the human-error issues will need to be addressed. Your only tools are communication and training; you need to manage both correctly. | Manager Training | *** | 70 | | ✔ | ✔ |
| MT-M-5 | **Building a Master Asset List**<br>This Management Training [MT] module explains the need for a Master Asset List; a list that documents all of the assets that relate to the reliability of the plant, tagged with information documenting the location and function of the asset. This module explains why you need such a list and how to develop the list even if you don't already have a Computerized Maintenance Management System (CMMS). If you already have a functioning CMMS, then it will be unnecessary to go through this module (unless you want to check that your CMMS contains the required information). | Manager Training | *** | 40 | | ✔ | ✔ |
| MT-M-6 | **Establishing the Asset Criticality Ranking**<br>This Management Training [MT] module provides guidance on how to assign the criticality to each asset and function. It is impossible to proceed with the reliability improvement program without an accurate assessment of criticality. Without it, it is impossible to justify which maintenance strategy should be applied to each asset. This module describes how you can involve different stakeholders from the maintenance, production, quality control, engineering, and health and safety departments to build a Master Asset List ordered by criticality. | Manager Training | *** | 115 | | ✔ | ✔ |
| MT-M-7 | **Determining your Asset Maintenance Strategy**<br>This Management Training [MT] module explains the importance of understanding the criticality of your assets and then, starting from the most critical asset and working down, determining the failure modes of your assets, the probability of failure, and the effects of the failure. The aim is to determine which assets should be part of the condition based maintenance program (and which technologies/monitoring methodologies should be applied), which assets should be part of a preventive maintenance program, and which assets should receive precision maintenance (and which techniques should be applied). All of these decisions have a technical and financial basis. | Manager Training | *** | 105 | | ✔ | ✔ |
| MT-M-9 | **Establishing a New Vibration Monitoring Program**<br>This Management Training [MT] series of lessons is intended for the person who intends to start a condition monitoring program, the person who has started a condition monitoring program but wants to check that it is set up correctly, and the person who wants to better understand the vibration program in their plant. The module presents a structure plan and then goes through all the key steps: selecting the machines to monitor, determining the best measurement strategy, selecting the measurement types, choosing the best measurement locations, options for mounting the sensor, specifying and controlling test conditions, selecting the optimal measurement settings, building the database, establishing baseline data, and setting alarms. The focus is clearly on vibration analysis, but many of its messages are equally valid for other technologies. | Manager Training | *** | 250 | ✔ | ✔ | ✔ |
| MT-M-10 | **Supercharging an Existing Vibration Monitoring Program**<br>This Management Training [MT] is intended for the person managing the vibration monitoring program, or anyone interested in establishing a successful program or improving an existing program. This module goes through eight major areas that should be optimized in any vibration program in order to extract the maximum benefit from the skills of the vibration analyst: acceptance testing, the detection phase, the analysis phase, the diagnostic phase, the reporting phase, the correction phase, the improvement phase, and the verification phase. | Manager Training | *** | 150 | ✔ | ✔ | ✔ |

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| MT-CM-1 | **An Introduction to Condition Monitoring Technologies**<br>This Program Management Training [MT] module provides an overview of each of the condition monitoring technologies: vibration analysis, ultrasound, oil analysis, wear particle analysis, thermography, electric motor testing, performance monitoring and inspections. This module is simply intended to provide an introduction for the person who does not require the more detailed training provided in the other remaining MT-CM modules. | Manager Training | *** | 75 | ✔ | ✔ | ✔ |
| MT-CM-2 | **Vibration Analysis and Bearing Fault Detection**<br>This Program Management Training [MT] module provides a detailed introduction to vibration analysis, describing the different types of readings that can be taken, a little about how those readings can be interpreted, and how the data is typically collected (i.e. different monitoring systems). Topics include: overall levels, spectra, waveforms, phase and orbits, plus the monitoring systems: walk- around, periodic monitoring, and protection systems. The module also covers the unique high frequency techniques designed to detect rolling element bearing defects. | Manager Training | *** | 95 | ✔ | ✔ | ✔ |
| MT-CM-3 | **Airborne And Structure-Borne Ultrasound**<br>This Program Management Training [MT] module provides a detailed introduction to the use of airborne and structure-borne ultrasound for condition monitoring. Topics include: understanding ultrasound, airborne measurements, structure-borne measurements, mechanical applications (bearings, lubrication, and other rotating machine faults), electrical faults (arching, corona, etc.), and process applications (detecting leaks and steam trap issues). | Manager Training | *** | 50 | ✔ | ✔ | ✔ |
| MT-CM-4 | **Oil Analysis and Wear Particle Analysis**<br>This Program Management Training [MT] module provides a detailed introduction to oil analysis and wear particle analysis. The module starts with an introduction to the importance of lubrication and the field of oil analysis; determining if the lubricant is fit for purpose, assess the properties, detecting particles, and detecting contamination. It then discusses wear particle analysis; detecting contaminants and look for particles that indicate that wear is occurring. A range of test methods are introduced. | Manager Training | *** | 70 | ✔ | ✔ | ✔ |
| MT-CM-5 | **On-line and Off-line Electric Motor Testing**<br>This Program Management Training [MT] module provides a detailed introduction to motor current signature analysis (to primarily detect broken rotor bars), electrical signature analysis (using voltage and current) to detect mechanical and power supply problems; and motor circuit analysis to detect mechanical, electrical and insulation problems. The module begins with a description of how induction motors work. | Manager Training | *** | 50 | ✔ | ✔ | ✔ |
| MT-CM-6 | **Infrared Thermography**<br>This Program Management Training [MT] module provides an overview of the application of infrared (IR) thermography to the condition monitoring of rotating machinery, electrical apparatus, and plant process application. Infrared energy is briefly introduced and spot radiometers and infrared cameras are described. The module does not go into a lot of theory, but important issues such as emissivity, test conditions and optical issues are explained. | Manager Training | *** | 55 | ✔ | ✔ | ✔ |
| MT-PM-1 | **An Introduction to Shaft Alignment**<br>This Management Training [MT] module provides a detailed introduction to shaft alignment. Topics include: why is misalignment so destructive, pre-alignment checks, soft-foot testing and correction, dial indicator techniques, laser alignment techniques, thermal growth, and moving the machine. | Manager Training | *** | 100 | ✔ | ✔ | ✔ |
| MT-PM-2 | **An Introduction to Precision Balancing**<br>This Management Training [MT] module provides a detailed introduction to field balancing. Topics include: why is unbalance so destructive, the basics of unbalance, determining if a machine is out of balance, single plane balancing, and overview of two plane balancing, tolerances and the importance of precision balancing. | Manager Training | *** | 65 | ✔ | ✔ | ✔ |
| MT-PM-3 | **Precision Lubrication and Contamination Control**<br>This Management Training [MT] module provides a detailed introduction to the key role lubrication plays in the reliability improvement process. It provides a number of demonstrations of the financial benefits of precision lubrication and then explains how the wrong lubricant and contaminated lubricant can affect bearings, gears and hydraulic systems. It also explains how a lack of grease or excessive grease can harm a bearing. | Manager Training | *** | 55 | ✔ | ✔ | ✔ |

# Skills Training [ST]

Skills Training on CONDITION MONITORING topics [ST-CM]

These Skills Training [ST] modules are written on Condition Monitoring [CM] topics. The aim is to provide the person collecting vibration readings and/or analyzing the data to know how to perform the job with confidence. Note that additional training will be required in order to meet the certification requirements per ISO 18436-2. These modules are also excellent reference modules.

Skills Training on PRECISION MAINTENANCE topics [ST-PM]

These Skills Training [ST] modules are written on Precision Maintenance [PM] topics. The aim is to provide the person who will actually balance or align the machine with the know- how to perform these tasks correctly.

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| ST-CM-1 | **Vibration Fundamentals** This Skills Training [ST] module provides a detailed introduction to the fundamentals of vibration. The focus is on frequency and amplitude, the time waveform, and the spectrum (FFT). This module is ideal for the manager who would like a more detailed understanding of vibration analysis, and the person collecting vibration readings who is just moving into vibration analysis. | Skills Training | ** | 110 | ✔ | | ✔ |
| ST-CM-2 | **Accurate and Repeatable Data Collection** This Skills Training [ST] module provides a detailed introduction to the collection of vibration readings. It provides information on eight key steps: Safety, selecting measurement settings, selecting the measurement location, naming conventions, mounting the sensor, controlling the test conditions, recording observations, and recognizing bad data. Although some people who collect data may not have to make some of the measurement and analyzer setup choices covered in this module, it is believed that the information presented is important and useful. | Skills Training | ** | 175 | ✔ | | ✔ |
| ST-CM-3 | **Diagnosing Common Faults with Spectrum Analysis** This Skills Training [ST] module provides a detailed introduction to the spectrum and how five common fault conditions (unbalance, misalignment, looseness, resonance and rolling element bearing faults) can be detected via the spectrum. The module outlines a systematic approach that should be followed, and also provides an overview of common vibration analysis terms. This module is ideal for the manager who would like a more detailed understanding of vibration analysis, and the person who is relatively new to vibration analysis. | Skills Training | ** | 100 | ✔ | | ✔ |
| ST-CM-4 | **Vibration Analysis** This Skills Training [ST] module provides a great deal of training on vibration analysis, from the most basic topics through to diagnosing faults. This series of lessons is intended to be used by the vibration analyst; it provides all the information necessary to collect, analyze and diagnose machine faults. Formerly called iLearnVibration, this module has been used as a training tool and a handy reference system for thousands of people around the world. | Skills Training | **** | 2000 | ✔ | | ✔ |
| ST-PM-1 | **Precision Shaft Alignment** This Skills Training [ST] module provides a great deal of training on precision shaft alignment. After a detailed overview of the entire process it covers the following topics: Determining if misalignment exists, pre-alignment checks, soft foot correction, dial indicators, alignment using the reverse dial and rim-and-face methods, laser alignment, dealing with thermal growth, and moving the machine. Regardless of how simple you may believe it is to use the modern laser alignment systems, every person who performs shaft alignment should complete this training. These lessons are from iLearnAlignment product. | Skills Training | **** | 950 | ✔ | | ✔ |
| ST-PM-2 | **Field Balancing** This Skills Training [ST] module provides a great deal of training on precision field balancing. The training covers a large number of topics: understanding unbalance, causes of unbalance, understanding phase and vectors, balance theory, diagnosing unbalance, preparing for the balance job, singe plane balancing, two plane balancing, static-couple balancing, trial weight selection, slitting weights, tolerances and quality (ISO, API, Navy), and more. Regardless of how simple you may believe it is to use the balancing programs in modern vibration analyzers, every person who performs field balancing should complete this training. These lessons are from iLearnBalancing product. | Skills Training | **** | 600 | ✔ | | ✔ |

# Toolbox Talks [TT]

Toolbox Talks on CONDITION MONITORING topics [TT-CM]

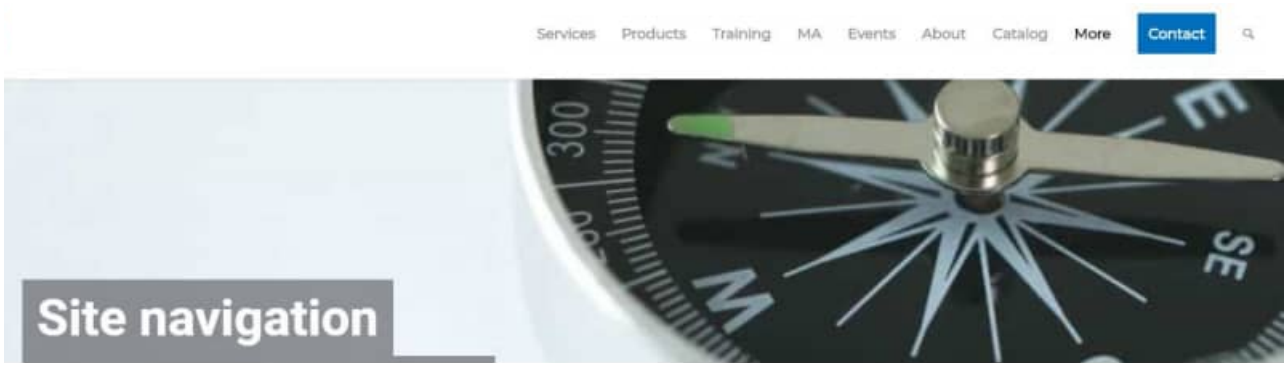
These Toolbox Talks [TT] are written on Condition Monitoring [CM] topics. The aim is to provide people with a working knowledge of how the condition of rotating machinery and other assets can be determined using vibration analysis, infrared thermography and other technologies. The aim is to demystify the topics.

Toolbox Talks on PRECISION MAINTENANCE topics [TT-PM]

These Toolbox Talks [TT] are written on Precision Maintenance [PM] topics. The aim is to provide people with a working knowledge of how the reliability of rotating machinery and other assets can be improved by performing precision alignment and balancing, resonance elimination, precision lubrication, optimal operation, correct fastening, and other reliability improvement areas, as well as acceptance testing and root cause failure analysis. The aim is to demystify the topics.

| ID | Topic | iLearnReliability Series | Topic Depth | Slides | Condition Monitoring | Professional Development | Enterprise Edition |
|---|---|---|---|---|---|---|---|
| TT-CM-1 | **Condition Monitoring and Reliability** This Toolbox Talk [TT] provides a quick introduction to the field of condition monitoring and reliability improvement. It paints the big picture in a brief presentation. | Toolbox Talks | * | 25 | ✔ | | ✔ |
| TT-CM-2 | **Vibration Analysis** This Toolbox Talk [TT] provides a quick introduction to vibration analysis. Using lots of animations and machine sounds, this presentation demystifies why we perform vibration and basically how it works. | Toolbox Talks | * | 25 | ✔ | | ✔ |
| TT-CM-3 | **Ultrasound** This Toolbox Talk [TT] provides a quick introduction to the use of ultrasound tools for condition monitoring. The aim is to demonstrate how high frequency sounds are emitted when machines are in distress, when leaks occur, and in other situations. The aim of the presentation is to demystify the application. | Toolbox Talks | * | 25 | ✔ | | ✔ |
| TT-CM-4 | **Thermography** This Toolbox Talk [TT] begins by relating high temperature to changing condition in mechanical and electrical applications, and explains how spot radiometers and infrared cameras can be used to detect the higher-than-normal temperature. | Toolbox Talks | * | 30 | ✔ | | ✔ |
| TT-CM-5 | **Oil Analysis and Wear Particle Analysis** This Toolbox Talk [TT] introduces the topic of lubrication and explains how important it is that the lubricant maintains its essential properties and remains contaminant free. It goes on to explain how tests can be performed to analyze the lubricant and check for contaminants, and how additional tests can detect wear particles that indicate that a fault condition exists. | Toolbox Talks | * | 15 | ✔ | | ✔ |
| TT-CM-6 | **Electric Motor Testing** This Toolbox Talk [TT] provides and introduction to the field of electric motor testing using on-line tests (voltage and/or current) and static/off-line tests. This presentation demystifies the testing techniques and reveals how important it is to detect mechanical, electrical and insulation faults before failure occurs. | Toolbox Talks | * | 35 | ✔ | | ✔ |
| TT-PM-1 | **The Need for Precision Maintenance** This Toolbox Talk [TT] provides an overview to the benefits of precision maintenance, explaining that it is better to fix the machine once correctly (and operate the machine correctly), rather than having to incur unplanned downtime and risk failure that could result in injury or environmental harm. | Toolbox Talks | * | 35 | ✔ | | ✔ |
| TT-PM-3 | **An Introduction to Precision Shaft Alignment** This Toolbox Talk [TT] delivers a very brief introduction to precision shaft alignment using dial indicators and laser alignment systems. After explaining what misalignment is, and why it is destructive, the lesson uses animations to demonstrate how the alignment is performed. | Toolbox Talks | * | 55 | ✔ | | ✔ |
| TT-PM-6 | **An Introduction to Precision Balancing** This Toolbox Talk [TT] delivers a brief introduction to the destructive forces associated with unbalance, and the techniques that can be used in the field (using vibration analyzers) and with balance machines to precision balance a rotor. | Toolbox Talks | * | 35 | ✔ | | ✔ |
| TT-PM-7 | **Precision Lubrication (and Contamination Control)** This Toolbox Talk [TT] explains how important lubrication is, and highlights critical it is that the lubricant is in a fit state with the correct viscosity and other properties and free of contaminants. The focus is rolling element bearing lubrication, and the 3D animations make it clear that contaminants damage the bearing surface and too much or too little lubrication will greatly reduce the life of the bearing. | Toolbox Talks | * | 19 | ✔ | | ✔ |

# Useful Links




- Moblus Institute Online Examinations
- Motion Amplification
- Motion Amplification Showcase Events
- My Account
- Privacy
- Products
- Services
- Sitemap
- Subscribe
- Terms of Service
- Thank you for your enquiry
- Training

## Product tags

- Advocate
- Analysis
- Animation
- ARP
- Bearing
- BINDT
- Cables
- Are you inspecting bearing defects to identify root cause?
- Category: Vibration
  - The Vibration Analyst Checklist – Do You Pass?

## Authors

- Steve Whittle
- Stuart Walker
- Support

## Forums

- Training & Certification
- Wireless & Sensors
- Oil Analysis
- Infrared & Thermography
- Asset Health & Care
- Criticality Analysis
- Motor Analysis
- Ultrasound & Ultrasonics
- Balancing & Alignment
- Asset Reliability

## Products

- Motion Amplification Showcase - Antwerp
- Motion Amplification Showcase - Rotterdam
- BINDT UK CM2020 (London)
- Plant and Asset management 2020 (NEC)
- Maintenance 2020 (Antwerp Expo)
- Vibration Analysis Training Cat III (Nov)
- Vibration Analysis Training Cat II (Oct)
- Vibration Analysis Training Cat II (Jun)
- Vibration Analysis Training Cat I (Sep)
- Vibration Analysis Training Cat I (Dec)
- Vibration Analysis Training Cat II (Jan)
- Motion Amplification Course (Nov)
- Motion Amplification Course (Sep)
- Motion Amplification Course (Jul)
- Motion Amplification Course (May)
- Motion Amplification Course (Mar)
- Motion Amplification Course (Feb)
- Vibration Analysis Training Cat III (Jul)
- Vibration Analysis Training Cat I (Jun)
- Motion Amplification Camera - Iris CM™
- PCH 1-Channel Vibration Monitor
- PCH 4-Channel Vibration Monitor

VIEW ONLINE | CALL BACK | REGISTER*

*CTRL + LINK-CLICK
Opens a new tab

RMS
RELIABILITY TRAINING INSTITUTE

# 2026


RMS Ltd
**Reliability Training Institute**

No.42 Goldcrest Close
Longridge Park
Colchester
Essex CO4 3FN

Company Reg No. 03808313
VAT No. GB 741737428

Tel/Fax: +44 (0)1206 791917
info@rms-training.com

rms-training.com