



Vibration Analyst category I

(TCAT I)





Vibration Analyst category 1 guidelines (TCAT I)

Category I Vibration Analysts are qualified to perform a range of single channel machinery vibration condition monitoring and diagnostic activities including data acquisition on pre-determined routes, machine steady state testing to predefined procedures, and comparison of readings against pre-established

Intended Participants:

The CAT I Vibration Analysis course serves as an introductory point for individuals venturing into the realm of vibration analysis. If you possess less than a year's experience in vibration analysis or have been gathering vibration data Additionally, CAT I is curated for reliability engineers, PdM program managers, and maintenance personnel seeking a comprehensive understanding of condition monitoring, particularly centered around vibration analysis. This course also equips participants with the knowledge necessary for pursuing ISO or ASNT examinations

- Minimum Required Experience: **6 months**
- Minimum Training Hours: **30 hours**
- Recommended Vibration Training meeting requirement: TCAT I Online course + internship (optional).

Quick Facts

<ul style="list-style-type: none"> ⌚ Duration of the course: 30 hours ◆ Modes: <ul style="list-style-type: none"> ▪ On-site course ▪ Online course
<ul style="list-style-type: none"> ◆ Duration of the course: 30 hours
<ul style="list-style-type: none"> ◆ Compliance: <ul style="list-style-type: none"> ▪ ISO 18436 Category I – Vibration Analyst
<ul style="list-style-type: none"> ◆ Exam: <ul style="list-style-type: none"> ▪ Two hours, Online ▪ 75% passing grade
<ul style="list-style-type: none"> ◆ Certification requirements: <ul style="list-style-type: none"> ▪ Training course completed ▪ 6-Months of work experience, verified by an independent person ▪ Pass the exam ▪ Valid for 5 years
<ul style="list-style-type: none"> ◆ Deliverables: <ul style="list-style-type: none"> ▪ Printed course book ▪ Workbook ▪ Glossary/terminologies and charts, Formulae ▪ Usable data for certification exams (only for those writing exams) ▪ 6 months (3 months pre- and 3 months post-exam) ▪ Access to course video portal ▪ TOLearnVibe software

Category I Body of Knowledge/Training Course Topics:

Vibration Principles (6Hrs) <ul style="list-style-type: none"> ● Basic motion ● Period, Frequency ● Amplitude (Peak, Peak-to-Peak, RMS) ● Measurements (Displacement, Velocity, Acceleration) ● Time, Orbital and Frequency Domains ● Phase, Natural Frequency, Resonance, Critical Speeds ● Shaft and Casing Vibration 	Data Acquisition (6Hrs) <ul style="list-style-type: none"> ● Instrumentation (and acquire readings) ● Transducers ● Sensor Mounting, Mounted Natural Frequency ● Test Procedures ● Computer Database Upload/Download ● Recognition of Poor Data ● Vibration System Calibration
Condition Monitoring (2 Hrs) <ul style="list-style-type: none"> ● Vibration Severity ● Recognition of Baseline Variations 	Signal Processing (2Hrs) <ul style="list-style-type: none"> ● FFT Application
Fault Analysis <ul style="list-style-type: none"> ● Basic Spectrum Analysis ● Spectral Harmonics and Sidebands ● Basics of fault severity determination using Vibration levels 	Corrective action (2 Hrs) <ul style="list-style-type: none"> ● FFT Application
Equipment knowledge (6 Hrs) <ul style="list-style-type: none"> ● Process Safety 	Acceptance testing (2 Hrs) <ul style="list-style-type: none"> ● Process Safety

Detailed syllabus:

Principles of vibration (6 Hrs: 20%)

- **Basic motion:** Recognise vibration and understand the origin of the sine wave.
- **Period, frequency:** Recognise the following features of a vibration signal: time axis, period, frequency. Use of hertz or cycles per minute
- **Amplitude:** peak, peak-to peak, R.M.S.: Recognise the following features of a vibration signal: amplitude, peak, peak-to-peak, R.M.S
- **Parameters:** displacement, velocity, acceleration: Recognise the following parameters: displacement, velocity, and acceleration
- **Units, unit conversions:** Recognise that unit's conversion is possible.
- **Time and frequency domains:** Be aware of time and frequency domain.
- **Natural frequency, resonance, critical speeds:** Be aware resonance exists, and its effect on vibration.





Data acquisition (6 Hrs: 20%)

- **Instrumentation:** Recognising single channel hand-held route-based and on-line measurement and monitoring systems
- **Transducers:** Recognise displacement, velocity, and acceleration transducers. Be aware of powered and non-powered types.
- **Sensor mounting, mounted natural frequency:** Recognise broad effects of mounting on the frequency response, e.g., stud, magnet, or probe.
- **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.
- **Computer database upload/download:** Be aware of basic functions of host and data collector.
- **Recognition of poor data:** Recognise simple fault conditions, e.g., ski-ramp, no signal, cable fault.

Condition monitoring (2Hrs, 6.5%)

- **Fault condition recognition:** Recognising basic pre-set fault conditions, e.g., unbalance, looseness, misalignment, bearing noise and damage.

Signal processing (2Hrs, 6.5%)

- **FFT application:** Be aware of the term FFT and recognise the following basic FFT terminology, e.g. number of lines, Fmax and time to sample.

Fault analysis (4Hrs, 13 %)

- **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.
- Basics of fault severity determination using Vibration levels.

Corrective action (2Hrs, 7 %)

- Basic maintenance action: Be aware of simple maintenance actions to rectify or reduce faults, e.g., lubrication, alignment.

Equipment knowledge (6 Hrs: 20%)

- **Electric motors, generators, and drives:** Recognise AC induction motor, and basic faults, e.g., bearing noise and damage, balance, looseness, and misalignment.
- **Pumps, fans:** Recognise basic pump and fan combinations, and basic faults, e.g., bearing noise and damage, balance, looseness, and misalignment.
- **Compressors:** Recognise examples of centrifugal and screw compressors
Rolling mills, paper machines, other process equipment: Recognise examples of these machines.
- **Machine tools:** Recognise examples of these machines.

- **Structures, piping:** Recognise the term: resonance.
- **Gearboxes:** Recognise basic examples of simple gearboxes

Acceptance Testing: (2Hrs, 7 %)

- **Test Procedures:** Basic procedures.

The Process and norms:

- Meet the work experience requirement of **6 Months (Verifiable)**
- Meet the minimum vibration training requirement of **30Hrs.**
- Register for the TCAT 1 training course @ <https://learn.tieraonline.in/courses/>
- Register for the exam after completing the training and submitting the course completion certificate to vacertifications@tieraonline.in
- Complete your certification application by uploading the experience details and immediate mentor for verifying the same via email.
- Register for exams after only getting confirmation from vacertifications@tieraonline.in
- **Format:** Online learning/audit/certification.
- The course site includes workbooks that candidates must complete after studying each section through graded quizzes for internal marks. Additionally, PDF study guides and downloadable formula sheets and notes are available on the site. Registered students are given access to the online version of the course via the TIERA's online learning portal for six months.
- **Compliance:** ISO 18436 Category I – Vibration Analyst
- **Educational requirements:** There is no formal education requirement for sitting for any certification exam per ISO 18436-2, however, candidates are expected to be able to manipulate simple algebraic equations, use a basic scientific calculator, and be computer literate. It is recommended that candidates for Category I and Category II have at least a 10+2 education in India or high school abroad. Diploma/BTech is preferable but not mandatory.
- **Certification examination:** The certification examination is a proctored online test lasting 2 hours (with 65+ questions), with a passing grade requirement of 75% (online requirement, 70% for offline exam). It follows ISO 18436-3 guidelines and is a closed book exam. Formula sheets are allowed as instructed. Exams will be practical in nature consisting of MCQ and short answer questions. An invigilator will monitor the exam via webcam to ensure proper conduct, and candidates must keep their webcams on throughout the exam, with the session recorded for future verification. Students can use their own scientific calculator or a basic non-programmable calculator available at the exam site, but smartphones and internet browsing are strictly prohibited during the examination. **Refer the TBoC handbook of online certification for more details.**





- **Cheating and forgery:** Those found cheating, colluding, forging certificates, or violating the Code of Ethics will face immediate exam disqualification, certification revocation, and a minimum 48-month reapplication waiting period.
üResults: Upon completion, TIERA will provide a score and a written summary of the results based on the categories to candidate registered email within 21 business days.
- **Re-Examination:** A candidate who fail to attain the passing grade in the examination can wait a minimum of 30 days before re-examination. Separate registration and fee are applicable for every retest.
- **Additional training:** As per ISO 18436-2 guidelines, allows candidates to attend optional on-job training or internships in the vibration analysis-related field. The training should have a minimum duration of 15 hours (half the category training requirement) and can be part of academic programs, research, or job experiences. TIERA highly recommends and offers free internship for students/researchers/technicians in the field of vibration analysis.
- **Online credential Management:** TIERA maintains its list of certified vibration analysts in its private portal <https://certificates.tieraonline.in/>. One can verify the credentials by entering email or certificate number.
- **Recertification:** CAT 1 certification is valid for 5 years, after which it expires. To recertify, individuals must pay the recertification fee. However, those applying for TIERA's higher category exams are exempt from recertification.
- **Certification Prerequisite:** Prior experience is not required for attending the training course, but 6 months of experience is required for certification.
- **Outcome:** Upon completion of the course, you will acquire a strong comprehension of:
 - The advantages associated with conducting condition monitoring and enhancing reliability.
 - Various condition monitoring technologies, including acoustic emission, infrared analysis (thermography), oil analysis, wear particle analysis, and motor testing.
 - Enhanced insight into machinery functionality through supplementary self-study in the "Equipment Knowledge" segment.
 - The correlation between vibration measurements and machine condition.
 - Proficiency in obtaining accurate and consistent measurements.
 - Understanding of terms such as Fmax, resolution, averaging, and other settings on the analyser.
 - Proficient analysis of vibration spectra and foundational fault diagnosis, covering aspects like unbalance, misalignment, looseness, rolling element bearing faults, resonance, and other anomalies.

- A preliminary introduction to establishing alarm thresholds.

- **Deliverables:** printed course book, workbook, glossary/terminologies and charts, formulae and usable data for certification exams (only for those writing exams), 6 months (**3 months pre- and 3 months post-exam**) access to course video portal and TOLearnVibe software lite.

A preliminary introduction to establishing alarm thresholds.

TCAT I Sample questions

1. What are the units of vibration displacement?
 - a. meters
 - b. inches/mm
 - c. centimeters
 - d. feet
2. The period of vibration is typically measured in
 - a. seconds
 - b. milliseconds
 - c. minutes
 - d. hours
3. A vibration transducer used to evaluate pump faults and condition should be mounted
 - a. on the floor.
 - b. on the piping.
 - c. close to the machine bearings.
 - d. on the ceiling.
4. In vibration testing, the Fast Fourier Transform is used to
 - a. obtains the amount of vibration at machine frequencies.
 - b. transform machine vibration into heat.
 - c. generates a vibration waveform.
 - d. analyzes machine temperature.
5. Baseline vibration measurements are made to
 - a. evaluates the life of equipment.
 - b. generates new design information.
 - c. provides a basis for future comparisons of data.
 - d. monitor power consumption.
6. A gearbox can be used in a machine train to
 - a. increase speed.
 - b. lower speed.
 - c. both a & b.
 - d. decrease heat losses.





7. A 60 Hz two-pole induction motor operates
 - a. at slightly less than 3,600 RPM underload.
 - b. at 1600RPM.
 - c. with no slip.
 - d. at 7,200 RPM.

8. The principal function of acceptance testing is to obtain
 - a. equipment that meets a specification.
 - b. baseline data.
 - c. a fault analysis.
 - d. a maintenance plan.

9. The vibration level at running speed on a fan increased from 0.1 inch per second to 0.2 inch per second over the period of 3 months. What is the possible cause of the increase in vibration?
 - a. loss of a blade material due to wear or dirt accumulation
 - b. small rolling element bearing defect.
 - c. change in the weather
 - d. change in operational conditions

10. Operation of a machine at its critical speed
 - a. may cause decreased vibration levels.
 - b. may not change the vibration levels.
 - c. may increase vibration levels.
 - d. will increase its efficiency.

11. What unit is used to measure ISO 10816 based limits?
 - a. decibels
 - b. hertz
 - c. watts
 - d. mm/s (inch/s)

12. The natural frequency of a vibrating system depends on its
 - a. mass
 - b. Force
 - c. amplitude
 - d. power

13. A common method to detect imbalance in rotating machinery is by using
 - a. ultrasonic testing
 - b. thermography
 - c. vibration analysis
 - d. radiography

14. Which type of bearing is known for its ability to support both radial and axial loads?
 - a. roller bearing
 - b. thrust bearing.
 - c. ball bearing
 - d. sleeve bearing

15. Vibration analysis is an essential and popular tool for monitoring the condition of
 - a. electrical circuits
 - b. heating systems
 - c. rotating machinery
 - d. medical condition

16. Fill in the blanks:

- I. Vibration velocity is typically measured in _____.
- II. FFT stands for _____.

17. Short answer (1 line):

- I. What is the principal function of acceptance testing?

1. b (inches/mm)
2. a (seconds)
3. c (close to the machine bearings)
4. a (obtain the amount of vibration at machine frequencies)
5. c (provide a basis for future comparisons of data)
6. c (both a & b.)
7. a (at slightly less than 3,600 RPM under load.)
8. a (equipment that meets a specification)
9. a (loss of a blade material due to wear or dirt accumulation)
10. c (may increase vibration levels)
11. d (mm/s (inch/s))
12. a (mass)
13. c (vibration analysis)
14. a (roller bearing)
15. c (rotating machinery)
16. Fill in the blanks:
I. inches per second or mm/s or velocity units
II. Fast Fourier Transform
17. Short answer (1 line):
I. To test and assure that equipment meets desired specification without defects.

Answers:

