Vibration Analyst Category II

(TCAT II)

Guidelines

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

Intended Participants:

For those who have engaged in vibration analysis for over a year and possess a solid grasp of its foundational principles, the TCAT II Vibration Analysis course presents the next level of advancement. This course is essential for individuals aiming to enhance their competence and confidence in diagnosing diverse fault conditions, rectifying specific issues, and achieving precision in measurement techniques.

- Minimum Required Experience: 18 months or 12 months under two options
  - Option 1: Minimum Required verifiable Experience in vibration related field: 36 months
  - Option 2: Minimum Experience/Education Combo: 12 months + 2-Year Tech Degree
- Minimum Training Hours: 38 hours
- Recommended Vibration Training for meeting the requirement: TCAT II Online course +internship (optional))

Quick Facts

Minimum Training Hours: 38 hours

Modes:
- On-site course
- Online course

Compliance: ISO 18436 Category II – Vibration Analyst

Exam:
- Three hours, Online
- 75% passing grade

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

Deliverables:
- 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 II Body of Knowledge/Training Course Topics:

Vibration Principles(2Hrs)

- 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(2Hrs)

- 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 (2Hrs)

- Vibration Severity
- Alarm Set-up (Narrow band, Envelope)
- Baseline Assessments, Trending Route/Task Planning
- Alternate
- Technologies (e.g., Oil Analysis, Wear Debris Analysis, Infrared Thermography, Motor Current Analysis, Acoustic Emission)
- Recognition of Baseline Variations
- Alarm and Trip Level Determination
- Integrated Health Analysis

Fault Analysis (6 Hrs)

- Basic Spectrum Analysis
- Spectral Harmonics and sidebands
- Time Waveform Analysis
- Phase Analysis
- Transient Analysis
- Orbital Analysis
- Shaft Centre-line Analysis
- Enveloping
- Mass Unbalance
- Misalignment
- Concentricity Errors
- Mechanical Looseness
- Rubs
- Instabilities
- Shaft Bow
- Bearing (Rolling Element, Journal) Defects
- Electric Motor Defects
- Gearbox Defects
- Resonance and
- Critical Speeds

Signal Processing(4Hrs)

- Analogue and Digital; Sampling
- FFT Application
- Windows (Uniform, Hanning, Flat-top)
- Filters (Low pass,High Pass, Band Pass,Tracking)
- Anti-aliasing
- Bandwidth, Resolution
- Noise Reduction
- Averaging (Linear, Synchronous Time, Exponential)
- Dynamic Range
- Run-out Compensation.

Corrective Action Recognition(2Hrs)

- Shaft Alignment
- Concentricity
- Balancing
- Basic Maintenance Action
- Lubrication

Acceptance Testing(2 Hrs)

- Test Procedures
- Specifications and Relevant Standards
- Acceptance Test Reporting

Reference Standards(1 Hrs)

- Relevant International (ISO, IEC), National and Regional Standards

Field Balancing (2Hrs)

- Single-plane
- Field Balancing: Two-plane

Equipment Testing and Diagnostics (1Hrs)

- Test Procedures
- Specifications and Relevant Standards
- Acceptance Test Reporting

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Reporting and Documentation (1Hrs)

- Vibration CM Reports
- Machine History Records
- Decision Making and Recommend Action

Fault Severity Determination (3Hrs)

- Levels (Overall, Narrow-band, Component)
- Spectrum Analysis
- Time Waveform and Orbit Analysis
- Severity Charts, Graphs, Formulae

Theoretical Rotor and Bearing Dynamics (1Hrs)

- Rotor Characteristics
- Bearing Characteristics

Category II Body of Knowledge/Training Course Topics:

Principles of vibration (3 Hrs: 8%)

- Basic motion: Understand superposition of sinusoidal vibrations; single degree of freedom.
- Period, frequency: Understand relationship of period to frequency, beat frequency.
- Amplitude: peak, peak-to peak, R.M.S.: Understand the relationship between peak, peak-to-peak, R.M.S
- Parameters: displacement, velocity, acceleration: Understand the application displacement, velocity, or acceleration
- Units, unit conversions: Understand conversion of units and integration.
- Time and frequency domains: Understand conversion of units and integration.
- Phase: Units; phase reference position
- Natural frequency, resonance, critical speeds: Fundamental natural mode; single degree of freedom. Recognise factors including frequency, stiffness, mass, damping, isolation.

Data acquisition (4 Hrs: 10.5%)

- Instrumentation: Dual channel on and offline acquisition, monitoring, and analysis systems including phase
- Transducers: Be familiar with proximity probes, velocity transducers, accelerometers, including those with in-built integration, Know requirements for transducer frequency ranges; runout compensation, need for calibration
- Sensor mounting, mounted natural frequency: 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.
- Fmax , acquisition time: Understand Fmax , zoom function; simple resolution calculations; relationship of Fmax to acquisition time Proximity sensor conventions: Recognise aspects such as: gap voltage, orthogonal radial fitment, and runout.
  Triggering: Be aware of use of phase detection: e.g. eddy- current probes, photocells, tracking filters
- Test planning: Be able to plan and schedule vibration monitoring (VM)
- Test procedures: 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.
- Data formats: Be aware of the common units and basic range of data presentation formats, e.g. trending, spectra, waterfall, time trace, phase
- Compute r database upload/download: Be aware of basic functions of host and data collector.

- Recognition of poor data: Mounting error; cable faults, tribo-electric, bias voltage and settling time.

Signal processing (4Hrs, 10.5%)

- FFT application: 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.
- 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
- Filters (low pass, high pass, band pass, tracking): Be aware of basic types of vibration filters; low pass; high pass; band pass.
- Anti-aliasing: Be aware of requirement for Anti-aliasing filter.
- Bandwidth, resolution: Bandwidth of bandpass filter; FFT resolution; signal duration; lines of resolution; analyser sample time; FFT collection time
- Noise reduction: Be aware of basic filtering and averaging methods used to reduce noise.
- Averaging: Linear, synchronous time, exponential: Be aware of FFT frequency averaging
- Dynamic range: Be aware of the term dynamic range.

Condition monitoring (4Hrs, 10.5%)

- Equipment evaluation and prioritisation: Be able to review sites and establish equipment VM requirements.
- Monitoring programme design: Be able to set up a VM programme using ISO 17359 and ISO 13373
- Baseline assessments, trending: Measuring baselines E.g., to ISO 10816, ISO 20816, ISO 14694, ISO 8528-9 or other requirements.
- Route planning: Be able to set up VM routes.
- Fault condition recognition: 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

Fault analysis (5Hrs, 13.16 %)

- Spectrum analysis harmonics and sidebands: Understand FFT harmonics, sidebands, and noise. Be aware of enveloping.
- Time waveform analysis: Understand the use of time waveform for basic analysis.
- Phase analysis: Understand the use of phase for basic analysis.
- Orbit analysis: Be aware of basic orbit analysis.
- Shaft centre-line analysis: Be aware of the shaft centre-line plot
- Enveloping: Understand the application of enveloping
- Mass unbalance: Understand static, couple and dynamic unbalance; residual unbalance, initial unbalance
- Misalignment: Be aware of alignment tolerances, recognise misalignment in FFT and time trace
- Mechanical looseness: Recognise looseness in FFT and time trace
- 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
- Electric motor defects: AC induction motor poles and line frequency; stator and rotor bar frequency analysis
- Gearbox analysis: Recognising gear mesh frequency and sidebands in FFT and modulation in time trace. Application of demodulation (enveloping)
- Resonance and critical speeds: Resonance; critical speed in rigid rotors; single degree of freedom
- 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

Corrective action (4Hrs, 10.5 %)

- Shaft alignment: Be aware of shaft alignment, tolerances.
- 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.
- Basic maintenance action: Be aware of range of responses to fault conditions, e.g. part replacement, lubrication, single plane balancing, alignment, and resonance control

Equipment knowledge (4Hrs, 10.5 %)

- Electric motors, generators and drives: 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.
- Pumps, fans: 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

- 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.
- 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
- Reciprocating machinery: Application of key International Standards e.g. ISO 18016-6 and ISO 8528-9.
- Rolling mills, paper machines, other process equipment: Be aware of components, faults, access
- Machine tools: Application of key International Standards e.g. ISO 10816-3 vibration standards, use of velocity and displacement
- Structures, piping: Resonances, natural frequencies
- Gearboxes: Pinion gear mesh and shaft speed calculations; effect of gear misalignment and backlash. Application of displacement, velocity and acceleration and enveloping.
- Rolling element bearings: Bearing defect frequencies, noise and impacts, crest factor
  Journal bearings: Proximity probe, runout; seismic velocity transducer, accelerometer integration, velometer; transducer frequency ranges
- Gearing: Pinion gear mesh and shaft speed calculations

Acceptance Testing: (2Hrs, 5.25%)

- Test Procedures: Basic procedures.
- Specifications and Relevant Standards: Basic specifications.
- Acceptance Test Reporting: Basic reporting

Equipment testing and diagnostics (2 Hrs, 5.25%)

- Impact Testing: Awareness of bump testing
- Forced response testing: Awareness.
- Modal analysis: awareness of modal analysis

Reference standards (2Hrs, 5.25%)

- ISO: Understand International Standards
- IEC: Be aware of IEC Standards referenced in ISO 17359
- Relevant national standards: As required. e.g. API, VDI

Reporting and documentation (2 Hrs, 5.25%)

- Condition monitoring reports: Be able to create vibration condition monitoring reports. Feedback to history
- Vibration diagnostic reports: Review routine VM tours, rounds or readings, evaluate trends, spectra, time trace and produce advisory report. Feedback actions to history

Fault severity determination (2 Hrs, 5.25%)

- Spectrum analysis: Rotor and stator bar defects; gear mesh and sideband frequencies
- Time waveform analysis, orbit analysis: Be familiar with time waveform analysis. Understand crest factor.
- Levels: Overall, narrowband, component: Be able to apply overall, narrowband or component alert levels
- Severity charts; graphs, formulae: Apply levels from ISO 10816, ISO 20816, ISO 8528-9, ISO 14694 etc.

The Process and norms:

- Meet the work experience requirement of 18 Months (Verifiable) or options.
- Meet the minimum vibration training requirement of 38Hrs
- Register for the TCAT 2 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 info@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 II – 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 3 hours (105+ questions), with a passing grade requirement of 75% (70% for offline test). 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.

- **Results:** 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 19 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:** The validity of CAT 2 certification extends for a period of 5 years, after which it becomes invalid. To renew the certification, individuals are required to submit the recertification fee (reach out to vacertifications@tieraonline.in) within a maximum of 1 year from the expiration date. Notably, candidates pursuing TIERA's advanced category exams are excluded from the recertification requirement

- **Certification Prerequisite:** Prior experience is not required for attending the training course, but 18 months of experience (or options) is required for certification

- **Outcome:** 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 analysing vibration spectra

    - Identify measurement activities for routine data collection.
    - Understand and apply basic principles of signal analysis for data acquisition and analysis settings.
    - Perform basic single-channel impact tests to determine natural frequencies.
    - Interpret and evaluate test results in line with specifications and standards.
    - Diagnose common faults and recommend basic corrective actions based on machinery experience.
    - Provide technical guidance and instruction to category I personnel.

- **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

Visit our website and preview the TCAT 2 courseware, certification exam sample, certificate sample, credential management system sample, guidelines etc.

About the Instructor

Dr. Akash Rajan
Founder & CEO, TIERA Pvt. Ltd.

Expert in Vibration Analysis and Structural Dynamics

Dr. Akash Rajan is a leading authority in the field of vibration and structural dynamics, widely recognized for his contributions to vibration measurement, condition monitoring, and training in India. As the Founder and CEO of TIERA Pvt. Ltd., he has been instrumental in developing indigenous vibration analysis systems and capacity-building programs that empower engineers and industries across sectors.

Professional Journey

Dr. Akash holds advanced degrees in Mechanical Engineering, with a PhD focused on vibration and fluid–structure interaction modeling. His early career included a tenure with ISRO's Cryogenic Engine Division, where he worked on complex structural dynamics challenges. Transitioning from research to entrepreneurship, he co-founded TIERA in 2016 with the mission of making high-end vibration measurement and analysis tools accessible and affordable for Indian industries and academic institutions.

Leadership at TIERA
Under his leadership, TIERA has emerged as a pioneer in indigenous vibration analysis technology — designing and manufacturing multi-channel vibration analyzers, calibration systems, and diagnostic software. Beyond product innovation, Dr. Rajan has championed training and knowledge dissemination, bridging the gap between theory and real-world condition monitoring applications.

Expertise and Contributions
- Lead Instructor for ISO 18436 Category I & II Vibration Analyst training programs.
- Extensive experience in modal analysis, signal processing, and fault diagnostics.
- Published research in vibration control and structural dynamics.
- Advocate for Made-in-India engineering solutions and self-reliance in measurement technology.
- Actively engaged with industries across manufacturing, power, aerospace, and defense.

Training Philosophy
Dr. Rajan's approach combines strong theoretical grounding with deep practical insight gained from real-world projects. His sessions are known for their clarity, structured content, and relevance to modern reliability and maintenance practices.

"Our goal is to equip engineers with the right tools and understanding — not just to detect faults, but to prevent them."