# 2020 Training

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All scheduled classes are tentative based on a minimum of four (4) attendees.

<table>
<thead>
<tr>
<th>Training Rates (Lebanon Ohio Training Facility):</th>
<th>Days</th>
<th>Tuition</th>
<th>Certification</th>
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<td>Vibration Analysis Level 1T (6 Person Min)</td>
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<tr>
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<tr>
<td>Hands-on Practical Testing, Extra Manuals, etc.</td>
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</table>

Vibration 1T: Vibration Analysis equivalent to ISO Category I
Vibration 1A: Vibration Analysis equivalent to ISO Category II
Vibration 2A: Vibration Analysis equivalent to ISO Category III
*** PT: Vibration Analysis Practical Testing
Infrared 1: PdM Infrared Level 1
Infrared 2: PdM Infrared Level 2
Visual 2: PdM Visual Inspection Level 2
PdM: PdM Awareness
Mentoring: Balancing, Database Development, Transient, etc.

www.IVCTechnologies.com  (800) 525-1269  210 S. West St., Lebanon, OH 45036
### IVC Technologies
#### 2021 Training

**Training Rates (Lebanon Ohio Training Facility):**

<table>
<thead>
<tr>
<th>Training Level</th>
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*All scheduled classes are tentative based on a minimum of four (4) attendees.*

Vibration 1T: Vibration Analysis equivalent to ISO Category I
Vibration 1A: Vibration Analysis equivalent to ISO Category II
Vibration 2A: Vibration Analysis equivalent to ISO Category III

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### July

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**July Training Rates:**

- **Vibration Analysis Level 1T (6 Person Min)**: $1,875.00
- **Vibration Analysis Level 1A (6 Person Min)**: $1,650.00
- **Infrared Level 1 (6 Person Min)**: $1,350.00
- **Infrared Level 2 (6 Person Min)**: $1,650.00
- **PdM Visual Inspection Level 2 (6 Person Min)**: $1,150.00
- **Custom Onsite Training (10 Person Max)**: Call For Quote
- **Hands-on Practical Testing, Extra Manuals, etc.**: Call For Quote

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### September

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### IVC Technologies Training Registration

#### Individual Registration & Payment Info:

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<td>Address 2</td>
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| Class Price: | Written Test (+250.00) | □ Y □ N | Total Price: |

*** Billing type must be completed for registration to be accepted ***

#### Comments / Special needs:

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Lebanon Training Registration
2017-10

E-mail completed forms to: training@ivctechnologies.com
Fax completed forms to: 513.932.4980

ISO 9001:2015
**IVC Vibration Analysis Level 1T (Level 1 Technician)**

2.5 day course which focuses on providing the fundamentals of vibration, collection of quality vibration data on pre-defined Predictive Maintenance routes, and validation of the data during data collection. A closed book test will be available on the afternoon of the third day.

Recommended experience:
3 months PdM experience (210 hours vibration experience) in the field performing or observing data collection under the direct guidance of certified individuals.

Topics:

**Vibration Fundamentals**
- Definitions
- Components of a Spring Mass system
- Terms used to describe vibration
- Displacement, Velocity & Acceleration
- Frequency and Period
- Vibration amplitude and alarming
- Data Presentation

**Transducers**
- Definitions
- Accelerometers
- Mounting
- Limitations

**Vibration Instruments**
- Overall meter, Real Time Analyzer, FFT Analyzer
- Limitations
- FFT Process
- Complex time-waveform
- Spectral display
- Time-waveform display
- Sample time
- Spectral resolution
- Averaging methods
- Overlapping
- Integration modes

**Machine Setup and Data Collection**
- Transmission path
- Measurement location
- Measurement planes
- Route
- Route based data collection procedure
- Pattern recognition
- Causes of “bad” data

**Machine Types and Components**
- Overview of general industrial machinery
- Review of expected signature
- Review of data collection locations

**Safety**
- Industrial safety concerns
- Work around rotating machinery
IVC Vibration Analysis Level 1A (Level 1 Analyst)
4.5 day course which focuses on providing the fundamentals of vibration, standard industrial machine configurations and expected vibration signatures, and intermediate vibration analysis. A closed book test will be available on the afternoon of the fifth day.

Recommended experience:
6 months PdM experience (420 hours vibration experience) in the field collecting data and observing data analysis under the guidance of certified individuals.

Topics:

**Vibration Fundamentals**
- Definitions
- Components of a Spring Mass system
- Terms used to describe vibration
- Frequency, Amplitude & Phase
- Displacement, Velocity & Acceleration
- Frequency and Period
- Unit conversions
- Data Presentation

**Transducers**
- Definitions
- Transducers (Displacement, Velocity, Acceleration & others)
- Mounting
- Advantages & Limitations

**Vibration Instruments**
- Overall meter, Real Time Analyzer, FFT Analyzer
- Limitations
- FFT Process; Complex time-waveform
- Spectral display & Spectral resolution
- Effect of non-sinusoidal data on spectrum
- Time-waveform display
- Aliasing & Signal processing
- Sample rate and sample time
- Windows; Averaging methods
- Overlapping; Integration modes

**Machine Setup and Data Collection**
- Transmission path
- Measurement location & planes
- Route based data collection
- Pattern recognition
- Time-waveform characteristics
- Causes of “bad” data

**Machine Types and Components**
- Overview of general industrial machinery
- Review of expected signature
- Review of data collection locations

**Synchronous Vibration**
- Imbalance; Misalignment; Looseness
- Journal bearings; Coupling wear
- Blades / Vanes; Gear wear
- Motors – Rotor bars; Rolls

**Sub-Synchronous Vibration**
- Belts; Oil whirl / whip; Rubs
- Looseness; Anti-friction bearing wear
- Pump / Fan surging

**Non-Synchronous Vibration**
- Anti-friction bearing wear; Flow related
- Resonance; Electrical (AC & DC)

**Machine / Component Review**
- Review of common problems as associated by machinery type

**Safety**
- Industrial safety concerns
- Work around rotating machinery
**IVC Vibration Analysis Level 2A (Level 2 Analyst, Page 1 of 2)**

4.5 day course which focuses on providing the fundamentals of vibration, standard industrial machine configurations and expected vibration signatures, and advanced vibration analysis. A closed book test will be available on the afternoon of the fifth day.

Recommended experience:
24 months PdM experience (840 hours vibration experience) in the field collecting/analyzing vibration data and experience with database configuration.

Topics:

**Review**
Reliability Based Maintenance
- Definitions
- Components of a Spring Mass system
- Frequency, Amplitude & Phase
- Displacement, Velocity & Acceleration
- Transducers
- Unit conversions
- Limitations

**Review of Machine Types and Components**
- Overview of general industrial machinery
- Review of expected signature
- Review of data collection locations

**Signal Processing**
- FFT; Nyquist frequency; Aliasing
- Sampling frequency; Block size
- Spectral results from non sinusoidal time data
- Spectral resolution; Leakage and windowing
- Averaging; Overlapping; Dynamic range
- Analog vs Digital integration and overall calculations

**Time-Waveform Analysis**
- Frequency and Period
- Waveform characteristics: Impacting (Pulses)
- Sinusoidal
- Modulation
- Truncation & Symmetry
- Crest Factor
- Circular format vs linear format

**Orbits**
- Definition
- Measurement methods
- Characteristics and analysis

**Phase**
- Definition
- Measurement methods
- Benefits in analysis

**Anti-Friction Bearings**
- Common failures
- Vibration characteristics
- Interaction of components
- Bearing life calculations
- Failure stages
- Bearing identification

**Resonance**
- Definition
- Mass, Stiffness & Damping
- Excitation
- Characteristics
- Impact testing
- Critical speed

Critical speed testing
- Bode & Nyquist plots
- Methods for correcting resonance
### Analysis
- Spectral, Time-waveform and Phase indications for:
  - Imbalance and balance standards
  - Balancing methods
- Misalignment
- Couplings
- Eccentricity & Bent Shaft
- Looseness
- Shaft rub
- Journal bearings
- Flow related (Vane Pass, Cavitation, Starvation, etc.)
- Gears
- Electrical (Stator & Rotor related, AC & DC)
- Belts

### Data Presentation
- Narrow band spectral alarming
- Waterfall display
- Frequency units
- Amplitude units
- Trending
- Parameter profile
- Parameter correlation
- Long time capture (beyond FFT time-block)
- Peak vs Phase vs Transfer function

### Alarming
- Establishing effective band alarms
- Use of Envelope alarms
- Statistical alarm values

### Reporting
- Pre-screening data prior to analysis
- Program management
- Measurement deviation
- Field note codes
- Documenting analysis

### Safety
- Industrial safety concerns
- Work around rotating machinery
**IVC Infrared Testing Level 1**

4 day course which focuses on providing the fundamentals of thermal / infrared testing, standard industrial machine configurations, basics of industrial electrical components, expected thermal characteristics, basic qualitative analysis and actual report images. A closed book test will be available on the afternoon of the fourth day.

Recommended experience:
3 months PdM experience (210 hours infrared experience) in the field collecting data and observing data analysis under the guidance of certified individuals.

Topics:

- **Overview / History of Infrared Testing**
  - Introduction to Thermography
  - Infrared imager types & limitations
  - Qualities of a good radiometric image

- **Heat Energy - The nature of Heat**
  - Definitions
  - Scales and conversions
  - Instrumentation

- **Heat Transfer Familiarization**
  - Heat Conduction
    - Fourier’s Law of Heat Conduction
    - Conductivity & Heat Resistance
  - Heat Convection
    - Newton’s Law of Cooling
    - Film coefficient basics
  - Heat Radiation
    - Stefan-Boltzmann Law
    - Planck’s Law
    - Kirchhoff’s Law

- **Basic Industrial Electrical Components**
  - AC Distribution
  - Switchgear
  - Motor Control Centers
  - Bus Ducts, Bus Plugs & Disconnects

- **Inspection of Electrical Systems**
  - How failures occur
  - Knowledge of components and functions
  - Testing procedure
  - Direct and Indirect measurements
  - Evaluation of findings
  - Safety

- **Inspection of Mechanical Systems**
  - Knowledge of components and functions:
    - Motors, Couplings, Bearings & Belts
    - Heat exchangers, Piping & Ovens
  - Testing procedure
  - Direct and Indirect measurements
  - Evaluation of findings
  - Safety

- **Camera Operation**

- **Software Operation**
**IVC Infrared Testing Level 2**

4 day course which focuses on providing the fundamentals of thermal / infrared testing, standard industrial machine configurations, basics of industrial electrical components, expected thermal characteristics, basic qualitative analysis and actual report images.

A closed book test will be available on the afternoon of the fourth day.

Recommended experience:

6 months PdM experience (420 hours infrared experience) in the field collecting data and observing data analysis under the guidance of certified individuals.

Topics:

<table>
<thead>
<tr>
<th>Review of IR Level 1</th>
<th>Compensating for Transmissivity</th>
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<tr>
<td>History of infrared</td>
<td>Compensating for Reflectivity</td>
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<tr>
<td>Nature of Heat and Energy</td>
<td>Categories of IR Bodies</td>
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<td>Temperature units and conversions</td>
<td>Factors affecting Emissivity</td>
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<td>Infrared imaging devices</td>
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<td>Qualities of a good radiometric image</td>
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<td>Heat Conduction</td>
<td>Instantaneous Field of View (IFOV)</td>
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<tr>
<td>Fourier’s Law of Heat Conduction</td>
<td>Measurement IFOV</td>
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<tr>
<td>Conductivity &amp; Heat Resistance</td>
<td>Resolution and Zoom</td>
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<tr>
<td>Thermal capacitance</td>
<td>Impact of optical refraction</td>
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<tr>
<td>Heat Convection</td>
<td>Apparent vs. actual temperature</td>
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<tr>
<td>Newton’s Law of Cooling</td>
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<tr>
<td>Film coefficient basics</td>
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<tr>
<td>Heat Radiation</td>
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<tr>
<td>ASTM 1862, 1897 &amp; 1933</td>
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<tr>
<td>Stefan-Boltzmann Law</td>
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<td>Planck’s Law</td>
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<tr>
<th>Radiation - Physics</th>
<th>Inspection of Electrical Systems</th>
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<tr>
<td>Electromagnetic spectrum &amp; IR Bands</td>
<td>NFPA 70E, NFPA 70B, ASTM 1934</td>
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<td>Atmospheric absorption</td>
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<tr>
<td>Wien’s Displacement Law</td>
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<td>Kirchhoff’s Law</td>
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<tr>
<th>Inspection of Mechanical Systems</th>
<th>Reporting and Documentation</th>
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<tr>
<td>ASTM 1934</td>
<td>Camera and software operation</td>
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<td></td>
<td>Image fusion</td>
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<td></td>
<td>ASTM 1934</td>
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<td>Field exercises</td>
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**Note:** It is presumed that experience in the field includes knowledge of electrical components and their characteristics with respect to performing infrared inspections.
**IVC PdM Visual Inspection Level 2**

3 day course which focuses on the fundamentals of visual testing, knowledge of visual inspection tools, understanding the construction and principle of operation for standard industrial machinery, component discussions to include bearings, belts and lubrication, as well as blue print reading.

A closed book test will be available on the morning of the fourth day.

Recommended experience:
6 months PdM experience (420 hours visual testing experience) in the field performing or observing inspections under the direct guidance of certified individuals.

Topics:

**Overview of the Eye**
Factors which affect perceived condition

**Condition Based Monitoring Inspections**
Why is Visual Testing necessary?

**Blue Print Reading**
Types & tolerancing
Metric vs. Imperial

**Rotating Electrical Equipment**
AC Motors
DC Motors

**Pump Inspections**
Centrifugal
Positive displacement

**Gear Box Inspections**
Gear types and failure modes

**Fan Inspections**
Fan types and failure modes

**Couplings**
Belts and chain drives
Flexible couplings

**Bearing**
Bearing types and applications
Failure modes

**Hydraulic Systems Inspections**
System components
Probable failure sites

**Lubrication**
Lubrication theory and methods

**Piping**
System components

**Welding**
Welding methods
Discontinuities

**Fasteners & Bolt Recognition**
Bolt grades
Torque & limitations

**Safety**
Work around rotating machinery
Site Specific Predictive Maintenance Awareness Training (1 Day)

This course focuses on developing technical understanding of the predictive techniques and their application. Upon completion of this course, you will be able to identify appropriate predictive strategies for various machinery configurations.

**PdM Program Overview – 1 hour**
- Reactive Maintenance, Preventive Maintenance, & Predictive Maintenance
- History of Predictive Maintenance (PdM)
- Benefits of a PdM Program

**Visual Inspections – ½ hour**
- Identifying Visual Inspection Points
- Documenting Inspection Routes
- Common Visual Inspections

**Vibration Analysis – 1 ½ Hr**
- Basic Theory
- Common Terms: Amplitude Units, Frequency Units, Time Waveform, Spectrum
- Vibration Monitoring vs. Vibration Analysis
- Typical Fault Types: Misalignment, Imbalance, Bearings, Gears, Electrical

**Infrared Thermography – 1 Hr**
- Basic Theory
- Common Terms: Emissivity, Reflected, Transmitted & Emitted, Delta T
- Common Applications for Infrared: Electrical, and Mechanical

**Ultrasonic Emissions (UE) – ½ Hr**
- Basic Theory
- Mechanical
- Electrical
- Airborne Emissions (Leak Detection)

**Oil Analysis – 1 Hr**
- Basic Theory
- Internal Testing/External Analysis Lab
- Common Tests Performed: Chemistry Control, Contamination Control, Oil Condition
- Ferrographic Analysis
- Spectrographic Analysis
- The Importance of Drawing Proper Oil Samples

**Motor Circuit Analysis – ½ Hr**
- Basic Theory
- Motor Shop Testing
- Online/Offline Testing
- Common Tests Performed
- Insulation Resistance
- Phase to Phase Measurements
- Rotor-Influence Check

**Non Destructive Testing – ¼ Hr**
- Basic Theory & Tests Performed
- Common Tests Performed: Magnetic Particle Testing, Dye Penetrant Testing, Ultrasonic Sub-Surface Defect Detection, Eddy Current Testing

**PdM Program Management – ¾ Hr**
- In-House Analysis vs. PdM Service Vendors
- Communication of Testing Results
- Key Performance Indicators for Managing a PdM Program
- Performance Auditing/Predictive Tests
- Periodic Program Reviews
IVC Technologies Training Information:

- Class begins each day at 8 AM, and will end at approximately 4:30 PM.
- Homework and/or reading assignments may be given each day. Students should be prepared to study 1-2 hours each evening in preparation for the next day.
- Minimum experience is recommended for each class so that the candidate is well prepared for the entire training experience. Some knowledge regarding the desired certification is expected to be obtained during this time, and is testable.
- A printed manual will be provided for class.
- After hours assistance is available upon request. No candidate should feel as if every opportunity to learn the material was not provided.

- Class and Closed-Book Examinations require the use of a calculator. **Only** non-programmable calculators are permitted during testing (example: Ti-30Xa).
  - A scientific calculator, with the following functions is recommended: Pi, 1/x, x^2 , and √
    - Vibration Analysis Level 2A candidates should be familiar with the statistics functions of their calculators used during discussion of statistical alarming.
  - All testing materials with the exception of a calculator will be provided by IVC during the written examination.
- Practical Testing:
  - Visual and Infrared practical exams require the use of a digital camera (and infrared camera for IR), and appropriate software. Candidates need to generate a report, consistent with their facility requirements and concepts taught during class.
  - Vibration Analysis Practical Testing will be conducted on Saturday morning following training.
    - Level 1T and 1A candidates should ensure they have 3 hours for completion.
    - Level 2A candidates should ensure they have 6 hours completion, and should be **thoroughly** familiar with the steps needed to create a database without assistance.
  - All materials normally available during the performance of the job will be permitted during the practical, including course manual, reference books, procedures, etc.

- Travel arrangements:
  - Affordable lodging is available in Cincinnati, Kings Island, Middletown, Monroe, Springboro, and West Chester.
  - Return travel arrangements should take into consideration testing on the day of departure.

- Facility Information:
  - Training areas, ATG offices and Common areas are “tobacco free”, including smokeless tobacco.
  - Snacks and lunch will be provided by IVC. Individuals with particular dietary needs should contact IVC Technologies prior to arrival for training.

- Grading Information:
  - In accordance with IVC’s Written Practice, the minimum passing score for any portion of the exam is 75%.
  - Closed-book examinations will be graded within 5 business days following all scheduled training.
  - Every attempt to grade the Practical examinations in the same 5 business days will be made. However, grading of the Vibration Analysis Level 2A Practical is much more involved and may require additional time (up to 10 business days).
  - Candidates will be notified via e-mail regarding their results, and certificates will be mailed to the address on record. Certificates will be one of the following:
    - Attendance – For those personnel who do not take the exam, or failed to pass a section of the exam.
    - Achievement – For those personnel who passed the closed-book exam, but did not take the practical.
    - Certification – For those personnel who passed all 3 portions of the exam, and whose company has contracted IVC as their Certifying Authority.

ISO 9001:2015

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Toll Free: 800-525-1269

[ISO 9001:2015 logo]