IVC Technologies
2021 Training

ASNT Corporate Partner

IVC TECHNOLOGIES

January						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

February						
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	1	2	3	4	5	6
7	8	9	VA 1T			PT
14	IR 1				19	20
21	22	23	24	25	26	27
28						

March						
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7	8	9	10	11	12	13
14	VA 1A					PT
21	22	23	24	25	26	27
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April						
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11	VA 2A					PT
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May						
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30	31					

June						
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July						
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August						
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15	IR 1				20	21
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29	30	31				

September						
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October						
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10	VA 2A					PT
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31						

November						
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December						
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19	20	21	22	23	24	25
26	27	28	29	30	31	

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

Training Rates (Lebanon Ohio Training Facility):	Days	Tuition	Certification
Vibration Analysis Level 1T (4 Person Min)	3	$ 985.00	$ 250.00
Vibration Analysis Level 1A (4 Person Min)	5	$ 1,650.00	$ 250.00
Vibration Analysis Level 2A (4 Person Min)	5	$ 1,875.00	$ 250.00
Infrared Level 1 (4 Person Min)	4	$ 1,350.00	$ 250.00
Infrared Level 2 (4 Person Min)	4	$ 1,650.00	$ 250.00
PdM Visual Inspection Level 2 (4 Person Min)	4	$ 1,150.00	$ 250.00
Custom Onsite Training (10 Person Max)	Call For Quote		
Hands-on Practical Testing, Extra Manuals, etc.	Call For Quote		

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.

Large classes may require practical testing after hours

www.IVCTechnologies.com (800) 525-1269 210 S. West St., Lebanon, OH 45036

IVC Technologies
2022 Training

ASNT Corporate Partner

IVC TECHNOLOGIES

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IVC Technologies Training Registration

Individual Registration & Payment Info:

Course Name:			
Scheduled Dates:		Alternate Dates:	

Name:		Title / Position:			
Company:		Dept:			
Address 1		E-Mail:			
Address 2		Phone + Ext			
City		State		Zip	
Desires Certification?	☐Y ☐N	Data collection experience:	☐Y ☐N		
Months Experience:		Analysis software experience:	☐Y ☐N		
Hardware Experience (Mfg):		Software Experience (Mfg):			

Bill To:

Name:		Title / Position:			
Company:		Dept:			
Address 1		E-Mail:			
Address 2		Phone + Ext			
City		State		Zip	
PO Number:		Expiration:			
Credit Card No:		Expiration:			
Name on Card:		***Master Card or Visa Only***			
Class Price:		Written Test (+250.00)	☐Y ☐N	Total Price:	

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

Comments / Special needs:

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

Industrial Vibration Consultants, Inc. dba IVC Technologies
210 S. West St. Lebanon, OH 45036
Phone: 513 932-4678
Fax: 513 932-4980
Toll Free: 800-525-1269

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

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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

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IVC Vibration Analysis Level 2A (Level 2 Analyst, Page 2 of 2)

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

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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

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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:

Review of IR Level 1
- History of infrared
- Nature of Heat and Energy
- Temperature units and conversions
- Infrared imaging devices
- Qualities of a good radiometric image

Heat Transfer Familiarization
- Heat Conduction
  - Fourier's Law of Heat Conduction
  - Conductivity & Heat Resistance
  - Thermal capacitance
- Heat Convection
  - Newton's Law of Cooling
  - Film coefficient basics
- Heat Radiation
  - ASTM 1862, 1897 & 1933
  - Stefan-Boltzmann Law
  - Planck's Law

Radiation - Physics
- Electromagnetic spectrum & IR Bands
- Atmospheric absorption
- Wien's Displacement Law
- Kirchhoff's Law
- Compensating for Transmissivity
- Compensating for Reflectivity
- Categories of IR Bodies
- Factors affecting Emissivity

Optics and Focal Plane Array
- Instantaneous Field of View (IFOV)
- Measurement IFOV
- Resolution and Zoom
- Impact of optical refraction
- Apparent vs. actual temperature

Inspection of Electrical Systems
- NFPA 70E, NFPA 70B, ASTM 1934

Inspection of Mechanical Systems
- ASTM 1934

Reporting and Documentation
- Camera and software operation
- Image fusion
- ASTM 1934
- Field exercises

Note: It is presumed that experience in the field includes knowledge of electrical components and their characteristics with respect to performing infrared inspections

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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

Bearings
- 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

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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

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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

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