



# IVC Technologies 2018 Training



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						
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			

March						
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

April						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	Vibration 2A				PT	
22	23	24	25	26	27	28
29	30					

May						
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		

June						
S	M	T	W	T	F	S
					1	2
3	4	5	Visual 2			9
10	Vibration 1T		PT	15	16	
17	18	19	20	21	22	23
24	25	26	27	28	29	30

July						
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				

August						
S	M	T	W	T	F	S
			1	2	3	4
5	6	PT Services		10	11	
12	13	IR 1			18	
19	AMRRI - MLA 1			24	25	
26	27	28	29	30	31	

September						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	Vibration 1A				PT	
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

October						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	Vibration 2A				PT	
21	22	23	24	25	26	27
28	29	30	31			

November						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	Infrared 2			17	
18	19	20	21	22	23	24
25	26	27	28	29	30	

December						
S	M	T	W	T	F	S
						1
2	3	Visual 2		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					

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 (6 Person Min)	3	\$ 950.00	\$ 250.00
Vibration Analysis Level 1A (6 Person Min)	5	\$ 1,550.00	\$ 250.00
Vibration Analysis Level 2A (6 Person Min)	5	\$ 1,770.00	\$ 250.00
Infrared Level 1 (6 Person Min)	4	\$ 1,290.00	\$ 250.00
Infrared Level 2 (6 Person Min)	4	\$ 1,550.00	\$ 250.00
PdM Visual Inspection Level 2 (6 Person Min)	3	\$ 950.00	\$ 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  
 RBM Workshop: Database refinement for Sr. Analysts



# IVC Technologies 2019 Training



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13	14	Visual 2			18	19
20	21	22	23	24	25	26
27	28	29	30	31		

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3	4	5	Vibration 1T		PT	
10	Infrared 1				15	16
17	18	19	20	21	22	23
24	25	26	27	28		

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12	Infrared 2				17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

June						
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						1
2	3	Visual 2			7	8
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23	24	25	26	27	28	29
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 Visual 2: PdM Visual Inspection Level 2  
 PdM: PdM Awareness  
 RBM Workshop: Database refinement for Sr. Analysts



## *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?	<input type="checkbox"/> Y <input type="checkbox"/> N	Data collection experience:	<input type="checkbox"/> Y <input type="checkbox"/> N
Months Experience:		Analysis software experience:	<input type="checkbox"/> Y <input type="checkbox"/> 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:		<i>Master Card or Visa Only</i>	
Class Price:		Written Test (+250.00)	<input type="checkbox"/> Y <input type="checkbox"/> N
		Total Price:	

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

### *Comments / Special needs:*



ISO 9001:2015

**Lebanon Training Registration**

2017-10

E-mail completed forms to:  
[training@ivctechnologies.com](mailto:training@ivctechnologies.com)  
 Fax completed forms to:  
 513.932.4980



## **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



## **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



## **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:

### **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*



## **IVC PdM Visual Inspection Level 2**

2.5 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 afternoon of the third 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



## **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  $\sqrt{\quad}$ 
    - 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