VFD PROGRAMMING AND MOTOR CONTROL TROUBLESHOOTING

This customized 5 day training course will certify that your electrical workers are qualified to safely and effectively work on motor control circuits and VFD installations. It is 80% hands-on and will give your workers the knowledge and skills to troubleshoot motors and motor control systems and program a variety of VFD’s. Participants will test and diagnose over 30 three phase motors, a variety of motor control systems, program VFD’s from ABB, Allen-Bradley, Cutler-Hammer, Danfoss, Eaton, Mitsubishi, Sinamics and Telemecanique and analyze VFD’s from Delta, Hitachi, Honeywell, Omron, Teco-Westinghouse, Trane, Weg and Yaskawa. This broad exposure will give participants the ability and confidence to open the manual for any VFD and set the required parameters. Client systems will be integrated into this program at no extra cost to the client. It is common for participants to realize opportunities for improvements to their own systems during this training. This hands-on course is taught in Canada Training Group’s Lab 3.1, a full size highway trailer that has been customized for this training. Canada Training Group is ISO 9001 certified and authorized to provide 3.5 CEU’s for this training. Special attention is provided to the deadliness of VFD’s and how to troubleshoot them safely.
COURSE TOPICS:

TOPIC 1: VFD Hazards
TOPIC 2: VFD Applications
TOPIC 3: VFD Connections
TOPIC 4: VFD 1: Telemecanique Operation
TOPIC 5: VFD Braking
TOPIC 6: VFD’s 2-7 Motor Control Projects
TOPIC 7: VFD’s 8 & 9 Constant Torque and Variable Torque Loads
TOPIC 8: VFD Control Schemes
TOPIC 9: Review VFD’s 10 – 17
TOPIC 10: Medium Voltage Drives (In-house Option Only)
TOPIC 11: System Problems
TOPIC 12: VFD Maintenance
TOPIC 13: Motor and VFD System Failure Modes
TOPIC 14: Commissioning
TOPIC 15: Testing and Troubleshooting

LEARNING OBJECTIVES:

Given: Team and solitary work with three phase motors, control circuits, VFD’s and test equipment, manual, handouts, powerpoint presentation, illustrations, instruction, discussions, clarification, observations, interactions, analogies, interactive lessons, demonstrations, explicit and tacit examples, videos, accident case studies, question and answer opportunities, pretest, quizzes and final examination,

The successful technician will be able to:

The successful student will be able to test and diagnose failures in three phase motors, troubleshoot motor control circuits and program and troubleshoot variable frequency drives.

To the extent that they can:

Topic 1 Objective: Work safely around and with VFD’s to protect themselves, others and your facility.

Sub-Objective: Identify the human dangers inherent with VFD systems
Sub-Objective: Identify the damage that VFD’s can cause in a facility

Topic 2 Objective: Recognize applications where VFD’s or their improvement will benefit your facility.

Sub-Objective: Identify the energy saved by VFD’s
Sub-Objective: Identify VFD process control improvements
Sub-Objective: Review how VFD’s are used in your facility

Topic 3 Objective: Install a VFD

Sub-Objective: Describe the components of a VFD
Sub-Objective: Install and wire a VFD
Sub-Objective: Connect I/O signals to a VFD
Sub-Objective: Test line, load and I/O of a VFD
Topic 4 Objective:  Install and program a Telemecanique VFD

Sub-Objective:  Set Telemecanique functions and parameters
Sub-Objective:  Program a Telemecanique VFD for basic operation
Sub-Objective:  Program a Telemecanique VFD for advanced operation

Topic 5 Objective:  Provide braking to a VFD

Sub-Objective:  Dynamically brake a VFD
Sub-Objective:  Statically brake a VFD

Topic 6 Objective:  Install and program a variety of VFD’s

Sub-Objective:  Install and program a Sinamics VFD
Sub-Objective:  Install and program an Allen-Bradley VFD
Sub-Objective:  Install and program a Cutler Hammer VFD
Sub-Objective:  Install and program a Mitsubishi VFD
Sub-Objective:  Install and program an ABB VFD
Sub-Objective:  Install and program a Danfoss VFD

Topic 7 Objective:  Install and program VFDs to control constant and variable torque hydraulic loads

Sub-Objective:  Program an Eaton VFD to control a constant torque load
Sub-Objective:  Program another Allen-Bradley VFD to control a variable torque load

Topic 8 Objective:  Maintain and troubleshoot a variety of VFD control schemes

Sub-Objective:  Review how VFD’s create their output
Sub-Objective:  Identify how a VFD maintains its output
Sub-Objective:  Review common closed loop control systems
Sub-Objective:  Analyze VFD control schemes

Topic 9 Objective:  Determine how to program, test and troubleshoot any VFD

Sub-Objective:  Determine how to program, test and troubleshoot Delta VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Hitachi VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Honeywell VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Omron VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Teco-Westinghouse VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Trane VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Weg VFD’s
Sub-Objective:  Determine how to program, test and troubleshoot Yaskawa VFD’s

Topic 10 Objective:  Program, maintain and troubleshoot client MV VFD system problems

Sub-Objective:  Program, maintain and troubleshoot client MV VFD system problems

Topic 11 Objective:  Identify and troubleshoot VFD system problems

Sub-Objective:  Provide protection for a VFD
Sub-Objective:  Protect your system from your VFD’s
Sub-Objective:  Protect your motors from your VFD’s
Sub-Objective:  Install a drive properly
Topic 12 Objective: Perform predictive maintenance on VFD systems

Sub-Objective: Perform standard maintenance on your VFD’s
Sub-Objective: Perform advanced maintenance on your VFD’s
Sub-Objective: VFD 18 - Perform maintenance on your liquid cooled VFD’s

Topic 13 Objective: Identify the failure modes of motor and VFD systems

Sub-Objective: Describe VFD system faults
Sub-Objective: Describe the failure modes of three phase motors

Topic 14 Objective: Commission a VFD

Sub-Objective: Accept and commission a VFD

Topic 15 Objective: Test and troubleshoot motor and VFD systems

Sub-Objective: Test VFD’s and identify problems
Sub-Objective: Test three motors and identify problems
Sub-Objective: Troubleshoot motor control circuits and identify cause
**TOPIC 1: VFD Hazards**

Topic 1 Objective: Work safely around and with VFD’s to protect yourself, others and your facility.

**Subtopic 1: Human Dangers**
Sub-Objective: Identify the human dangers inherent with VFD systems
1. Physical Danger
2. Burns
3. Arc Flash
4. Electrocution
5. Anatomy of a VFD electrocution

Subtopic 2: System Dangers
Sub-Objective: Identify the damage that VFD’s can cause in a facility
1. Electrical Damage
2. Mechanical Damage
3. Process Damage

**TOPIC 2: VFD Applications**

Topic 2 Objective: Recognize applications where VFD’s will benefit your facility.

**Subtopic 1: Energy Savings**
Sub-Objective: Identify the energy saved by VFD’s
1. Affinity Laws
2. Case Studies

**Subtopic 2: Process Control**
Sub-Objective: Identify VFD process control improvements
1. Case Studies

**Subtopic 3: Client Systems**
Sub-Objective: Review how VFD’s are used in your facility
1. Examples
TOPIC 3: VFD Connections

Topic 3 Objective: Install a VFD

Subtopic 1: Drive Components
Sub-Objective: Describe the components of a VFD
1. 3 Phase 60 Hz Sine Wave
2. Rectifier
3. DC Bus
4. Electrolytic Capacitor Reforming
5. DC Bus Voltage Level
6. Inverter
7. PWM Waveform
8. Controls and Regulation

Subtopic 2: VFD Wiring
Sub-Objective: Install and wire a VFD
1. 3 Ph Line In
2. 1 Ph L-L Line In
3. 1 Ph L-N Line In
4. 3 Ph Load Out
5. Bypass
6. Practical Projects

Subtopic 3: VFD Reference Signals
Sub-Objective: Connect I/O signals to a VFD
1. Keypad
2. Pot
3. 4 - 20 mA signal
4. 0 - 10V signal
5. Network
6. PLC
7. Practical Projects

Subtopic 4: Test Points
Sub-Objective: Test line, load and I/O of a VFD
1. Safety Review
2. AC Input Lines
3. DC Bus
4. Reference Inputs
5. AC Output Lines
6. Practical Projects

TOPIC 4: VFD 1: Telemecanique Operation

Topic 4 Objective: Install and program a Telemecanique VFD

Subtopic 1: VFD Programming
Sub-Objective: Set Telemecanique functions and parameters
1. Display Functions
2. Parameter List
3. L1 Access
4. L2 Access
5. L3 Access
6. Practical Projects
Subtopic 2: Standard Operation
Sub-Objective: Program a Telemecanique VFD for basic operation
1. Start
2. Stop
3. Jog
4. Reversing
5. Speed Control
6. Practical Projects

Subtopic 3: Advanced Operation
Sub-Objective: Program a Telemecanique VFD for advanced operation
1. Acceleration Ramp
2. Deceleration Ramp
3. Motor Torque Control
4. Overload Protection
5. Motor Heating
6. Thermal Monitoring
7. Practical Projects

TOPIC 5: VFD Braking
Topic 5 Objective: Provide braking to a VFD

Subtopic 1: Standard Braking Method
Sub-Objective: Use standard method to brake a VFD
1. Coasting to Stop
2. Internal Braking Resistor
3. External Braking Resistor
4. Chopper Circuit
5. Practical Projects

Subtopic 2: Alternative Braking Methods
Sub-Objective: Brake a VFD using alternative methods
1. DC Braking
2. DC Hold
3. Regenerative Braking
4. Electromechanical Brake
5. Practical Projects

TOPIC 6: VFD’s 2-7 Motor Control Projects
Topic 6 Objective: Install and program a variety of VFD’s

Subtopic 1: VFD 2: Sinamics
Sub-Objective: Install and program a Sinamics VFD
1. Tune a Sinamics VFD to a motor
2. Set the parameters on a Sinamics VFD
3. Adjust speed and direction

Subtopic 2: VFD 3: Allen-Bradley
Sub-Objective: Install and program an Allen-Bradley VFD
1. Tune an Allen-Bradley VFD to a motor
2. Set the parameters on an Allen-Bradley VFD
3. Adjust speed and direction
Subtopic 3: VFD 4: Cutler Hammer  
Sub-Objective: Install and program a Cutler Hammer VFD  
1. Tune a Cutler Hammer VFD to a motor  
2. Set the parameters on a Cutler Hammer VFD  
3. Adjust speed and direction

Subtopic 4: VFD 5: Mitsubishi  
Sub-Objective: Install and program a Mitsubishi VFD  
1. Tune a Mitsubishi VFD to a motor  
2. Set the parameters on a Mitsubishi VFD  
3. Adjust speed and direction

Subtopic 5: VFD 6: ABB  
Sub-Objective: Install and program an ABB VFD  
1. Tune an ABB VFD to a motor  
2. Set the parameters on an ABB VFD  
3. Adjust speed and direction

Subtopic 6: VFD 7: Danfoss  
Sub-Objective: Install and program a Danfoss VFD  
1. Tune a Danfoss VFD to a motor  
2. Set the parameters on a Danfoss VFD  
3. Adjust speed and direction

TOPIC 7: VFD’s 8 & 9 Constant Torque and Variable Torque Loads  
Topic 7 Objective: Install and program VFDs to control constant and variable torque loads

Subtopic 1: Application Curves  
Sub-Objective: Relate torque curves to different loads  
1. Constant Torque  
2. Variable Torque  
3. Constant Power

Subtopic 2: Constant Torque Practical Projects  
Sub-Objective: Program VFD’s to control a constant torque load  
1. VFD 8: Program an Eaton VFD to control a Constant Torque load  
2. VFD 9: Program an Allen-Bradley VFD to control a Constant Torque load
Subtopic 3: Variable Torque Practical Projects
Sub-Objective: Program VFD’s to control a variable torque load
1. VFD 8: Program an Eaton VFD to control a Variable Torque load
2. VFD 9: Program an Allen-Bradley VFD to control a Variable Torque load

TOPIC 8: VFD Control Schemes
Topic 8 Objective: Maintain and troubleshoot a variety of VFD control schemes

Subtopic 1: Control Modes
Sub-Objective: Review how VFD’s create their output
1. Volts/Hz
2. Voltage Vector
3. Voltage Vector Plus
4. Flux Vector
5. Servo

Subtopic 2: Feedback Loops
Sub-Objective: Identify how a VFD maintains its output
1. Open Loop
2. Closed Loop

Subtopic 3: Closed Loop and PID
Sub-Objective: Review common closed loop control systems
1. Control Action
2. Setpoint
3. Offset/Error
4. Proportional Gain
5. Integral Gain
6. Derivative/Differential
7. External PID Control
8. Internal PID Control
Subtopic 4: VFD Control Schemes
Sub-Objective: Analyze VFD control schemes
1. Multi-Motor Control
2. Cascade
   1. Fixed Stages
   2. Variable Stages
3. Leader/Follower Control

TOPIC 9: Review VFD’s 10 - 17
Topic 9 Objective: Determine how to program, test and troubleshoot any VFD

Subtopic 1: VFD 10 - Delta
Sub-Objective: Determine how to program, test and troubleshoot Delta VFD’s
1. Parameters
2. Troubleshooting
3. Testing

Subtopic 2: VFD 11 - Hitachi
Sub-Objective: Determine how to program, test and troubleshoot Hitachi VFD’s
1. Parameters
2. Troubleshooting
3. Testing

Subtopic 3: VFD 12 - Honeywell
Sub-Objective: Determine how to program, test and troubleshoot Honeywell VFD’s
1. Parameters
2. Troubleshooting
3. Testing

Subtopic 4: VFD 13 - Omron
Sub-Objective: Determine how to program, test and troubleshoot Omron VFD’s
1. Parameters
2. Troubleshooting
3. Testing

Subtopic 5: VFD 14 - Teco-Westinghouse
Sub-Objective: Determine how to program, test and troubleshoot Teco-Westinghouse VFD’s
1. Parameters
2. Troubleshooting
3. Testing

Subtopic 6: VFD 15 - Trane
Sub-Objective: Determine how to program, test and troubleshoot Trane VFD’s
1. Parameters
2. Troubleshooting
3. Testing
Subtopic 7: VFD 16 - Weg
Sub-Objective: Determine how to program, test and troubleshoot Weg VFD’s
   1. Parameters
   2. Troubleshooting
   3. Testing

Subtopic 8: VFD 16 - Yaskawa
Sub-Objective: Determine how to program, test and troubleshoot Yaskawa VFD’s
   1. Parameters
   2. Troubleshooting
   3. Testing

TOPIC 10: Medium Voltage Drives (Inhouse Option Only)
Topic 10 Objective: Program, maintain and troubleshoot client MV VFD system problems

Subtopic 1: Client Drive
Sub-Objective: Program, maintain and troubleshoot client MV VFD system problems
   1. Components
   2. Applications
   3. Parameters
   4. Maintenance
   5. Troubleshooting
   6. Safety
TOPIC 11: System Problems
Topic 11 Objective: Identify and troubleshoot VFD system problems

Subtopic 1: Drive Protection
Sub-Objective: Provide protection for a VFD
1. Drive Sizing
2. Heat Dissipation
3. VFD Duty Cycle
4. Overload
5. High Overload
6. Breakaway Torque
7. Over Torque
8. Over Voltage
9. Short Circuit
10. Surges
11. Sags
12. Transients/Spikes
13. Phase Imbalance
14. Single Phasing

Subtopic 2: System Protection
Sub-Objective: Protect your system from your VFD’s
1. RFI
2. Harmonics
3. Managing Harmonic Distortion

Subtopic 3: Motor Protection
Sub-Objective: Protect your motors from your VFD’s
1. Turn Down Ratio
2. Insulation Systems
3. Rotor
4. Bearings

Subtopic 4: Installation
Sub-Objective: Install a drive properly
1. Heat Dissipation
2. Induction
3. Wiring
4. Grounding
5. Frequency Lockout

TOPIC 12: VFD Maintenance
Topic 12 Objective: Perform predictive maintenance on VFD systems

Subtopic 1: Standard Maintenance
Sub-Objective: Perform standard maintenance on your VFD’s
1. Clean
2. Dry
3. Tight
4. Cool
Subtopic 2: Advanced Maintenance
Sub-Objective: Perform advanced maintenance on your VFD’s
1 Enclosure
2 Components
3 Auxiliaries
4 Accessories
5 Alarm History

Subtopic 3: VFD 18 Liquid Cooled VFD’s
Sub-Objective: VFD 18 - Perform maintenance on your liquid cooled VFD’s
1 Enclosure
2 Components
3 Problems
4 Maintenance

**TOPIC 13: Motor and VFD System Failure Modes**
Topic 13 Objective: Identify the failure modes of motor and VFD systems

Subtopic 1: System Troubleshooting
Sub-Objective: Describe VFD system faults
1 Faults
2 Causes
3 Remedies

Subtopic 2: Three Phase Motor Construction
Sub-Objective: Describe the failure modes of three phase motors
1 Bearing Systems
2 Motor Winding Systems
3 Motor Insulation Systems
4 Large Winding Dangers
5 Failure Modes
**TOPIC 14: Commissioning**  
Topic 14 Objective: Commission a VFD

Subtopic 1: Acceptance Testing  
Sub-Objective: Accept and commission a VFD  
1. Factory Acceptance Testing  
2. Delivery Acceptance Testing  
3. Installation Acceptance Testing  
4. Functional Performance Testing  
5. Criteria for Acceptance

**TOPIC 15: Testing and Troubleshooting**  
Topic 15 Objective: Test and troubleshoot motor and VFD systems

Subtopic 1: Test Variable Frequency Drives  
Sub-Objective: Test VFD’s and identify problems  
1. Safety Review  
2. Test Equipment  
3. Rectifier  
4. DC Bus  
5. Inverter  
6. Practical Projects
Subtopic 2: Three Phase Motor Testing  
Sub-Objective: Test three motors and identify problems  

1. Safety Review  
2. Six Electrical Areas of a Motor  
3. Current Draw  
4. Winding Resistance Test  
5. Insulation Test  
6. DAR Test  
7. PI Test  
8. DC Hipot  
9. Tan Delta  
10. VLF Hipot  
11. Surge Test  
12. IR Thermal Scan  
13. Stethoscope  
14. Pump Cavitation  
15. Impedance Tester  
16. Current Signature Analysis  
17. Practical Projects
Subtopic 3    Troubleshoot Motor Control Circuits
Sub-Objective: Troubleshoot motor control circuits and identify cause

1    Troubleshooting Dangers
2    Manual Motor Control
3    Magnetic Motor Control
4    Reversing Motor Control
5    Client Systems
6    Practical Projects