**Class:** Variable Frequency Drives

**Description:**

 This course provides a solid foundation for those needing to understand Variable Frequency Drives. It enables students to service their own VFDs from top to bottom. It is practically designed around common applications involving HVAC, pumps, fans, conveyors and other specific applications including those that require constant torque operation. It covers AC motors, VFD configuration, component layout, control methods, installation requirements, operation, setup, programming, preventive maintenance, power quality and harmonics issues and more.

**Presentation:** Classroom - lecture and hands-on exercises

**Anticipated size:** Maximum 20 students

**Attendance Verification:**

 All students must sign in both days, provide their ID card, and note their state license number on the sign-in sheet to apply for Continuing Education Units in their state. The rosters are kept on file for three years at TPC Trainco headquarters and will be submitted in accordance with the state’s requirements.

**Participant Evaluation:**

 Every student that attends the full training session will receive a three star certificate of completion at the end of the course, as well as complete a training evaluation form. A proctored exam is not required to complete this class, although the option of an online or paper mail-in exam is available at the student’s request after successful completion. If they choose to take the exam, they will receive an additional four or five star certificate after passing the exam; four if they choose to take it online and five if they choose to get it proctored.

**Fees:** $990 for 2 days, all materials included

**Material/Visual Aids:** IPVF 101 1015 ATMT Variable Frequency Drives PPT Presentation

WBVF 101 1215 ATMT Variable Frequency Drives Workbook REET 101 1115 ATMT Electrical Troubleshooting Reference Guide

 Standard A/V equipment, whiteboard

Training Outcomes

At the completion of the course, students will learn:

* Where and how VFDs are used in the workplace
* How VFDs can improve efficiency, safety and cost savings in a variety of applications
* How to read and understand electrical drawings in the design or troubleshooting of a VFD application
* How the VFD relates to the motor to accomplish a desired objective
* Types of VFDs and their various options and capabilities
* Application of VFD technology to your specific needs
* How to install a VFD
* VFD setup and programming
* Hard wiring and grounding of VFDs
* VFD control for constant torque or variable torque applications
* How to get optimum performance from your VFD
* The importance of monitoring your VFD
* Maintenance considerations for a VFD
* Identifying and isolating a VFD problem from a motor problem
* VFD Troubleshooting tricks and techniques
* How to find and fix the most common VFD problems
* Other VFD best-practices

Course Outline

**VFD Safety Review**

* Electrical Hazards
* LOTO (Lockout – Tagout)
* Personal Protective Equipment & Insulated Tools

**Electrical Basics Review**

* Mulitmeter, Clamp-On, Megohmmeter
* Single Phase and Three Phase Motors
* Motor Troubleshooting and Replacement
* Basic Control Circuits & Troubleshooting

**What VFDs Do**

* Motion Control / Motor Speed
* Air Flow / Liquid Flow / Pressure Control
* Eliminates the need for:

◦ Variable Transmission or Sheave

◦ Variable Vanes or Dampers on Fans

◦ Variable Valves on Pumps

**Benefits of Using a VFD**

* Energy Savings
* Easier Maintenance
* Enhanced System Monitoring

**Load Types**

* Constant Torque – Conveyors, Positive Displacement Pumps, Superchargers
* Variable Torque - Centrifugal Fans or Pumps, Saws, Routers, Planers

**VFD Options**

* Bypass - Two or Three Contactor Style, Disconnect Switch Style, Soft Starter
* Fusing - VFD or Bypass Protection
* Input / Output Reactors
* Motor Overload Device
* Transient Protection
* Auxiliary Relays
* Power Line Phase Reversal Detection

**Installation of a VFD**

* Environmental Concerns
* Clearances
* Conduit Entry

**Customer Connections**

* Safety Circuit
* Start / Stop
* Jog
* Status Indication
* Fault Indication
* Remote Speed Reference
* Monitoring of Motor Parameters

**Wiring & Grounding VFDs**

* Induced Signals
* Inductive, Capacitative
* Incoming Power (line) Wiring
* Motor (load) Wiring
* Control Wiring
* Proper Grounding Methods

**Controlling a VFD**

* Keypad Controls
* Terminal Strip Control – Automatic, Manual
* Bus Communication Control
* Open Loop Control
* Manual Operation
* Automatic Operation
* Sensorless Flux Vector
* Closed Loop Control
* PI Loop Configuration
* Sensor or Transducer Feedback
* Motor Shaft Encoder Feedback

**VFD Setup, Programming, & Troubleshooting**

* Language & Display
* Control Modes
* Open Loop, Closed Loop
* Motor Data
* Power (kW) and RPM
* Voltage, FLA Current
* Service Factor, Power Factor
* References & Limits
* Motor Speeds – Min, Max and Preset
* Ramp Times, Speed Reference, Skip Frequencies
* Limits for Alarms or Faults
* Inputs / Outputs – Analog, Digital, and Relay
* Application Functions
* Reset
* Flying Start
* Sleep Mode
* Switching Frequency
* No Load
* Phase Loss
* Closed Loop Functions
* Normal / Inverse
* Anti Windup
* Start-up Frequency
* Integral Time / Differential Time
* Proportional Gain / Differential Gain
* Lowpass Filter

Course Outline

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| **DAY ONE** |
| **Start Time** | **End Time** | **Hours** | **Topic** |
| 7:30 | 8:00 | .5 | Registration |
| 8:00 | 9:30 | 1.5 | **VFD Safety Review** |
| 9:30 | 9:45 | .25 | Break |
| 9:45 | 11:30 | 1.75 | **Electrical Basics Review** |
| 11:30 | 12:30 | 1 | Lunch |
| 12:30 | 2:45 | 2.25 | **What VFDs Do** |
| 2:45 | 3:00 | .25 | Break |
| 3:00 | 3:45 | 1 | **Benefits of Using a VFD** |
| 3:45 | 4:30 | .75 | **Load Types** |
| **DAY TWO** |
| **Start Time** | **End Time** | **Hours** | **Topic** |
| 7:30 | 8:00 | .5 | Registration |
| 8:00 | 9:00 | 1.25 | **VFD Options** |
| 9:00 | 10:00 | .75 | **Installation of VFD** |
| 10:00 | 10:15 | .25 | Break |
| 10:15 | 11:15 | 1 | **Customer Connections** |
| 11:15 | 12:15 | 1 | **Wiring & Grounding VFDs** |
| 12:15 | 1:15 | 1 | Lunch |
| 1:15 | 2:30 | 1.25 | **Controlling a VFD** |
| 2:30 | 2:45 | .25 | Break |
| 2:45 | 4:30 | 1.75 | **VFD Setup, Programming, & Troubleshooting** |