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Variable Frequency Drive Basics

Contact us Today for a FREE quotation to deliver this course at your company's location.

<https://www.electricityforum.com/onsite-training-rfq>

Variable Frequency Drives are being installed more frequently today; however there are still several installations with VFD Issues being ignored or incorrectly being addressed. Examples of improper installations will be discussed to indicate potential problems that cause damaging consequences.

This presentation will provide an overview on the Distribution System from the Point of Common Coupling (Incoming Utility Power Connection Point) right down to the connection location of the motor(s). The student will be made aware of all the installation guidelines needed to ensure a successful installation of VFDs and associated Motors.

All issues related to Variable Frequency Drives and Motor installations will be presented with recommended solutions. We will work our way through a typical distribution system and discuss related issues or concerns at various points in the system. The course will be broken into the following six segments:

- Distribution System

- Motors
- VFDs
- Solutions for Upstream Issues
- Solutions for Downstream Issues
- Testing and Commissioning

Our Variable Frequency Drive Basics course instructor looks forward to discussing any questions or issues that the participant may have related to their Motor and VFD applications. The course will be completed with a thorough specification guideline specifying the solution for proper VFD and Motor installations.

This course is ideally suited for the individuals that specify, design, purchase, install or use variable speed drive systems. This presentation will be a good overview without a lot of theory. Each participant will receive a DVD with dozens of articles and papers on VFD and Motor Data as well as the full coloured slide presentation for printing as required.

Each Variable Frequency Drive Basics course Training student will receive a detailed VFD specification and Check list to use to ensure that all their VFD issues are addressed.

The student will also receive an electronic copy of the Basics of AC Drives and the Basics of AC Motors. These two books are more than 1,000 pages, providing valuable information for the student for future reference.

VFD TRAINING COURSE BENEFITS

- Learn the Fundamentals of Variable Frequency Drives
- Update Yourself on the Latest Advancements in VFDs
- Learn the Latest Improvements in Motor Efficiency
- Practical Approaches and Problem-Solving Solutions
- Learn How to Solve Common VFD Problems
- Learn Practical Troubleshooting Techniques
- Reduce Equipment Downtime and Operating Costs
- Reduce Reliance on Outside Service Companies

- Make Sure Your Equipment is Up and Running

STUDENTS RECEIVE

- **FREE** 130-Page Electric Motors and Drives Handbook Volume 5 (Value \$20)
- **\$100 Coupon** Toward any Future Electricity Forum Event (Restrictions Apply)
- 1.4 Continuing Education Unit (CEU) Credits
- **FREE** Magazine Subscription (Value \$50.00)
- Course Materials in Paper Format

Related Courses

[Electric Motor Training,](#)

[Electric Motor Testing Training,](#)

[Motor Control Training,](#)

[VFD Training,](#)

[Motors, Drives and Automation Systems](#)

COURSE OUTLINE

Instructor

Paul Wright, P.Eng, Motors and Drives Consultant, The Electricity Forum

DAY ONE

1. Typical Distribution System Overview

This seminar will discuss the Distribution components that make up a typical system and how they relate and impact the VFD and Motor selection.

1. Point of Common Coupling
2. Fault Capacity
3. Transformers
4. Capacitors
5. Switchgear
6. Low Voltage MCCs
7. VFDs
8. Motors
9. Other Loads

Benefits of Using Variable Frequency Drives: The many benefits of using Variable Speed Drives will be discussed for several different applications such as fans, pumps conveyors and process machines. Several common reasons for using VFDs from Energy Savings, Unlimited Starting and Reversing, Precise Process control, Extension of Equipment Life will be reviewed. Significant capital and operating costs reduction possibilities will be shown.

2. Understanding AC Motors

This presentation will provide discussion on motor theory as applied to fixed speed and variable speed operation. The presentation will discuss the different motors' performance and features available to the user: This presentation will start at the generation of a magnetic field and how to control this field to provide useful work. The following characteristics will be individually discussed to show their impact on the overall performance of the motor.

Some of these characteristics will differ with changes in line voltages, line frequencies or both.

1. Power Factor
2. Rated RPM (synchronous RPM)
3. Rated Voltage
4. Rated Frequency
5. Rated Current
6. Equivalent Circuit Parameters
7. Slip
8. Starting, Pull-up and Breakdown Torques
9. Service Factor
10. Design Frames
11. Insulation Ratings
12. Temperature rise design

3. Understanding VFDs

This presentation will discuss the topology of today's low voltage VFDs. The function of the Rectifier, Pre Charge Circuit, DC Bus Capacitors, Chopper Circuit and Inverter section will be discussed. Discuss when to select PWM Control (V/Hz) or Vector Control operating modes. Discuss the selection of the voltage and current ratings of the VFD and the individual components that make up the complete system to show how the reliability of the VFD is improved.

1. VFD Overview
2. Enclosures Types
3. Voltage rating and Tolerance
4. Current Capacity and Overload Capability
5. VFD System Components
6. Disconnect Switch or Circuit Breaker

7. Line Filtering
8. Surge Protection
9. Fused Control Power
10. 120Vac and 24VDC control
11. Isolating Contactor
12. Bypass Control Schemes
13. Motor Filters
14. Analog isolators
15. Enclosure Heating and Cooling Requirements
16. Dedicated Customer Field Connection Terminal Blocks
17. Motor control performance comparison on Fixed Speed and Reduced Voltage Starting will be compared to VFD Operation.
18. Starting
19. Stopping
20. Braking
21. Reversing
22. Over and Under nominal Line Voltage

This presentation will also provide a short digital tour a motor plant to show the different manufacturing steps to the assembly of an Above NEMA Squirrel cage Motor.

Daily Summary and Seminar wrap up

DAY TWO

4. Motor Performance

The operation performance of AC Motors on fixed speed starters, reduced voltage solid state starters and on VFDs will be reviewed. This presentation will outline the significant

differences in overall performance that the motor produces while starting, stopping, braking and reversing direction for the different control methods. Several new torque and current speed motor curves will be presented to highlight changes and their effect into the distribution system. Discussion of welding of contacts in motor starters and fuse failure or Circuit Breaker tripping when starting high inrush motors.

The torque and current versus speed curve characteristics will be discussed.

1. Torque Characteristics
2. Locked Rotor Torque (LRT)
3. Pull-up Torque (PUT)
4. Breakdown Torque (BDT)
5. Full Load Torque
6. Current Characteristics
7. Locked Rotor amperes (LRA)
8. Peak Asymmetrical Current
9. Full Load current

5. NEMA Motor specification Part 30 and Part 31 differences

This presentation will discuss the differences between the Standard for Part 30 designed Motors and the Standard for Part 31 designed Motors.

1. Nameplate Information
2. Cooling methods
3. Stator wiring
4. Speed Range
5. dv/dt and Voltage Stress design

We will also review the motor technical ratings for typical NEMA motors built to NEMA Part 30 and 31 designs including: HP, RPM, FL RPM, NL AMPS, FL EFF., FL TORQUE and the equivalent circuit impedances. Understanding how the Voltage and Frequency affect Motor Performance: We will show the relationship of changing of the voltage and frequency will impact the development of torque and the speed of the motor. We will also discuss the differences in the Torque/Current versus Speed curve for motor on a fixed speed application versus that for a VFD operation.

Temperature, Service Factor & Insulation Class: The above electrical design criteria is necessary to ensure the motor can provide a suitable operating life in a given application. Each of the above criteria can have significant detrimental impact on the motors' life. An increase of 10 degree Celsius temperature rise in the motor will cause a 50% reduction in the motors' insulation life.

6. Understanding VFDs

This presentation will discuss the topology of today's low voltage VFDs used with PWM or Vector Control schemes. The function of the Rectifier, Pre Charge Circuit, DC Bus Capacitors, Chopper Circuit and Inverter section will be discussed. Discuss when to select PWM Control (V/Hz) or Vector Control operating modes. Discuss the selection of the voltage and current ratings of the VFD and the individual components that make up the complete system to show how the reliability of the VFD is improved. The student will learn how to select the VFD models from various Manufacturers that will be more reliable and have longer Mean Time Between Failures (MTBF).

1. VFD Overview
2. Enclosures Types
3. Voltage rating and Tolerance
4. Current Capacity and Overload Capability
5. VFD System Components
6. Disconnect Switch or Circuit Breaker
7. Line Filtering

8. Surge Protection
9. Fused Control Power
10. 120Vac and 24VDC control
11. Isolating Contactor
12. Bypass Control Schemes
13. Motor Filters
14. Analog isolators
15. Enclosure Heating and Cooling Requirements
16. Dedicated Customer Field Connection Terminal Blocks

7. Power Quality and Up Stream Issues

This presentation will look at the line side issues that a VFD may have on the power system. All the following issues will be discussed along with the recommended solution(s) for each issue:

1. Fault Capacity
2. Harmonic Limitations (Voltage and Current Distortion)
3. Power Quality
4. Power Factor
5. Voltage and Tolerance
6. Transients and Surges
7. Short term and Long term Power Loss

8. Motor and Cable Down-Stream Issues

This presentation will look at the load side issues that a VFD may have in the motor circuit. All the following issues will be discussed along with the recommended solution(s) for each issue:

Bearing Currents:

The effect of current flowing through the bearings and bearing housing will cause the inner and outer raceways to pit. Over time the pitting will continue to increase the depth of the grooves and the bearing will eventually be damaged. The causes and remedies for bearing current issues will be discussed.

VFD Cables:

Why shielded VFD cables are recommended by the VFD manufacturers.

Radio Frequency and Electro Magnetic interference:

How they are produced and steps to mitigate the transmission of these unwanted noise signals. These high frequencies exhibit special characteristics that may cause undesirable effects in the industrial distribution and communication systems.

VFD and Motor Selection Examples:

This part of the presentation will look at a few applications where the operating performance characteristics for continuous and intermittent speed and torque ranges are provided. The student will be able to select the best combination of motor and VFD based on meeting or exceeding the specified criteria. The student will see the cost impact of their selection for the Motor and VFD to the cost of other possible acceptable selections.

Programming and Testing:

The most common 50-70 VFD setting parameters will be presented. We will provide a parameter list for several different VFD manufacturers. The testing of the VFD packaged

system is a very important procedure that makes the whole System complete. This verifies the controls and power wiring function as specified. A good testing program enables the VFD to be installed and commissioned on site without any issues. The proposed testing and commissioning procedures will be discussed.

1. Routine Testing
2. Certified Full Load Testing
3. Heat Run Testing in 40oC ambient

Review of VFD Specification:

A generic non manufacturer biased VFD specification is provided to specify the minimum systems components to provide a for a reliable VFD package.

Daily Summary and Seminar wrap up

All students attending this presentation will receive electronic copy of the 9 Presentations plus several papers and booklets discussing the course and related material. A detailed VFD specification and Data Sheets will also be included to ensure future drive purchases provide reliable trouble free installations.

SPECIAL NOTE: Along with the above seminar material:

Each student will receive a detailed VFD specification and Check list to use to ensure that all the above issues are addressed.

The student will also receive an electronic copy of the Basics of AC Drives and the Basics of AC Motors. These two books are more than 100 pages, providing valuable information for the student for future reference.

COURSE TIMETABLE

Both days:

Start: 8:00 a.m.

Coffee Break: 10:00 a.m.

Lunch: 12:00 noon

Restart: 1:15 p.m.

Finish: 4:30 p.m.

Contact us Today for a FREE quotation to deliver this course at your company's location.

<https://www.electricityforum.com/onsite-training-rfq>