

# AIR CONDITIONING AND VARIABLE FREQUENCY DRIVES WORKSHOP

Maintaining air conditioning and refrigeration systems is two fold. Troubleshooting and immediate action is required to repair issues as they occur. And proper preventive maintenance can lessen the frequency of the problems and lengthen equipment life. This course helps technicians with both scenarios in an environment that simulates maintenance issues that occur in the real world.

The course starts at a basic level and builds, avoiding the need for any technical prerequisite, other than the desire to increase your knowledge and understanding of variable speed drives. Learn proper design recommendations to ensure that your equipment is as energy efficient and safe as possible. Discover the best practices for frequency drives in HVAC, pumping, and facility applications. Whether in facility maintenance, chilled water systems, waste water systems or manufacturing, this course unlocks the secrets of VFDs to maintain your equipment.

## CLASS FORMAT:

Classroom

## STANDARD CLASS SIZE:

NTT recommends a class of no more than 35 participants to obtain the best results.

## NTT TO PROVIDE:

- Four-days (32 contact hours) of on-site instruction
- Day 1 & 2—Air Conditioning
- Day 3 & 4—Variable Frequency Drives
- Textbooks
- Classroom consumables
- Completion certificates
- Shipping and instructor travel logistics

## CLIENT PROVIDES:

- Classroom of 500 square feet or greater
- Projection screen, white board and/or flip chart(s)

## WHO SHOULD ATTEND:

- Technicians

### Those who work on or near:

- HVAC
- pumps
- chilled water systems
- waste water systems/manufacturing



# AIR CONDITIONING AND VARIABLE FREQUENCY DRIVES WORKSHOP

## COURSE AGENDA | DAY 1 & 2

### CONDITIONING & REFRIGERATION OVERVIEW

- Theory of refrigeration
- Compression refrigeration cycle

### TOOLS AND TEST EQUIPMENT

- Gauge manifold assembly
- Electronic leak detector
- Multimeter
- Clamp-on meter

### REFRIGERANTS & REFRIGERANT OILS

- Characteristics of refrigerants
- Importance of refrigeration rables
- Handling and storing refrigerants
- Section 608 of the Clean Air Act
- Regulatory requirements
- Recovery, recycling, and reclaiming

### COMPRESSORS

- Types of compressors
- Principles of operation

### EVAPORATORS

- Types of evaporators
- Operation of the evaporator in a refrigeration or air-conditioning system

### METERING DEVICES

- Effects of capillary tube length and size
- Thermostatic expansion valves

### CONDENSERS

- Types of condensers
- Operation of the condenser in a refrigeration or air-conditioning system

### PIPING AND ACCESSORIES

- Tubing
- Liquid receivers
- Sight glass
- Filter driers

### HEAT PUMP THEORY AND COMPONENTS

- Compressor
- Evaporator
- Condenser
- Reversing valve

## COURSE AGENDA | DAY 3 & 4

### INTRODUCTION

### MOTOR/DRIVE/CONTROL SYSTEM DESIGN AND OVERVIEW

- Advantages/disadvantages and effects of adjusting motor speed
- Identify and compare systems to adjust motor speed, torque and position control
  - Mechanical drives
  - Hydraulic drives
  - Eddy current
  - Rotating DC
  - Solid-state DC
  - Solid-state AC (VFD)
- Building blocks of a motor/drive system
- Advantages/disadvantages of three-phase AC motor/drive systems, DC motor/drive systems and single-phase AC motor systems
- Operating costs (maintenance, process, efficiency, space requirements)
- Technological capabilities (functionality, future expansion, communication, integration to other systems)

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- Operational reliability (impacts on existing equipment, code regulations, environmental conditions, replacement availability, power distribution reliability)
- Application characteristics (torque, speed, control, process requirements)

## POWER TRANSMISSION, RELATIONSHIP AND FORMULAS

- Efficiency
- Torque
- Inertia
- Horsepower/power factor
- Electrical demand

## COURSE AGENDA | DAY 3 & 4, CONTINUED

### MAINTENANCE RECOMMENDATIONS AND SPECIAL CONSIDERATIONS

- Power factor
- Line notching
- Harmonics
- Isolation transformer/reactors
- Operator interfaces
- Bypass systems

### AC INDUCTION MOTORS

- Motor construction
- Torque production
- Speed, pole, frequency relationship
- Types of AC motors

### OPERATING ON VARIABLE FREQUENCY

- Volts to hertz
- Constant voltage mode
- Sensorless vector
- Flux vector

### VARIABLE SPEED DRIVES

- Current Source Inverter (CSI)
- Variable Voltage Input Inverter (VVI)
- Pulse-Width Modulation (PWM/Transistor/IGBT)

### MOTOR SPECIFICATIONS: MATCHING MOTOR FOR VARIABLE SPEED DRIVE OPERATION—MGI

### OPERATION, SET UP AND MAINTENANCE OF VSD

- Typical faults
- Causes
- Fixes

### SELECTION AND APPLICATION FOR DRIVES

- Load matching
- Bypass considerations
- Motor nameplate information

### ENCLOSURE SIZING FOR HEAT DISSIPATION

- Heat calculations
- Energy saving opportunities
- Facility operating problems
- Variable torque operations
- Fans
- Pumps
- Payback/return on investment calculations