



Certifying the  
finest in HVACR

# Air Conditioning Service

# KATE

Knowledge Areas of  
Technician Expertise

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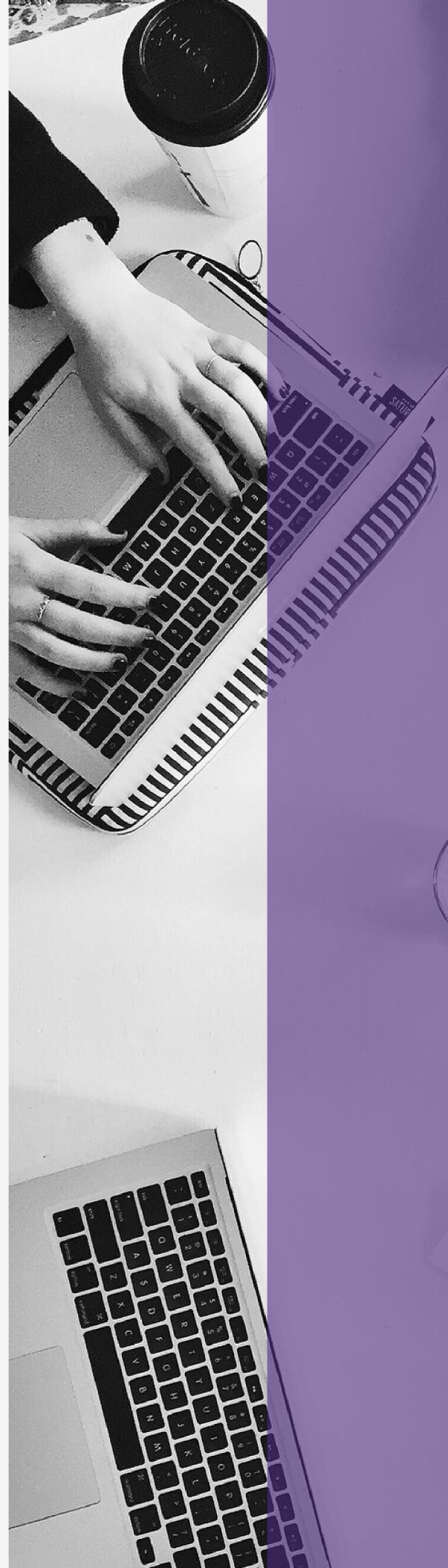
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# Air Conditioning - Service Specialty Exam



### Exam Information & Qualifications

The Air Conditioning - Service specialty exam tests a candidate's knowledge of the installation, service, maintenance, and repair of HVAC systems. System sizes are limited to 30 tons or less cooling capacity. This is a test and certification for technicians in the HVAC industry. The test is designed for top level service technicians. This test for certification is not intended for the HVAC system designer, sales force, or the engineering community.

To become NATE-certified, you must pass this specialty and the Core exam. This test will measure what 80% of the Air Conditioning candidates have an 80% likelihood of encountering at least once during the year on a national basis. Suggested requirement is one year of field experience working on Air Conditioning systems as a service technician and technical training for theoretical knowledge.

### Exam Copyrights

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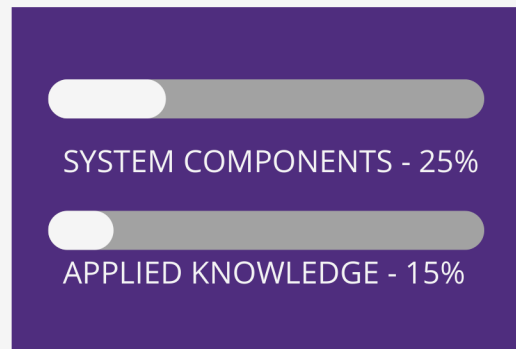
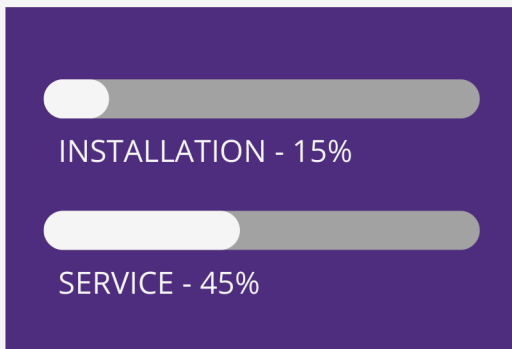
### Passing Score Development Process



The passing scores for the NATE tests were established using a systematic procedure (a Passing Score Study). This procedure employed the judgment of experienced HVAC professionals and educators representing various HVAC specialties and geographical areas. The passing scores were set using criteria defining competent performance. The passing score for different test forms may vary slightly due to the comparative difficulty of the test questions.

# Exam Subject Areas

Percentages of questions that will be in each section of the exam:



## Exam Specifications:



Passing Score: Pass/Fail



2.5 Hour Time Limit



Closed Book



100 Questions

# Industry References

The reference materials list below will be helpful in preparing for this exam. These materials may not contain all of the information necessary to be competent in this specialty or to pass the exam.



- American National Standards Institute (ANSI) / Air Conditioning Contractors of America (ACCA) Manuals – Latest Edition.
  - Manuals “D” “J” “QI” – Quality Installation, and “S”
- ACCA Manuals “T” and “RS” – Latest Editions
- ACCA Residential Duct Diagnostics and Repair – Latest Edition
- AHRI-Hydraulics Section – IBO/RAH – Latest Edition
- International Energy Conservation Code - Latest Edition with Addendum
- International Mechanical Code - Latest Edition with Addendum
- International Plumbing Code - Latest Edition with Addendum
- Uniform Mechanical Code - Latest Edition with Addendum
- Specification of Energy-Efficient Installation and Maintenance Practices for Residential HVAC Systems developed by Consortium for Energy Efficiency (CEE) - Latest Edition with Addendum

**References continue on next page**

# Industry References (continued)

- ASHRAE Standard-62.2 - Latest Edition with Addendum
- ANSI//ASHRAE Standard- 152-2004 – Latest Edition with Addendum
- ENGERY STAR™ Home Sealing Standards – Latest Edition with Addendum
- Duct Calculators – Sheet Metal, Ductboard, and Flexible Duct
- American National Standards Institute (ANSI)/Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) Manuals
  - HVAC Duct Construction Standards - Metal and Flexible
- Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) Manuals
  - Fibrous Glass Duct Construction Standards, Residential Comfort System Installation Standards Manual, and HVAC Air Duct Leakage Test Manual
- Air Diffusion Council Flexible Duct Performance & Installation Standards
- North American Insulation Manufacturers Association (NAIMA) Manuals
  - Fibrous Glass Duct Construction Standards and A Guide to Insulated Air Duct Systems
- International Fuel Gas Code – Latest Edition with Addendum
- National Fuel Gas Code – Latest Edition with Addendum



# KATES

## Knowledge Areas of Technician Expertise

All NATE exams are based on Knowledge Areas of Technician Expertise (KATES), statistically proven job task analysis from experts in the HVACR industry. This KATES outline covers all information tested in the **Air Conditioning - Service Exam** and should be used as reference material.

### Installation

#### LABRICATING COPPER TUBING

- REFRIGERANT LINE INSTALLATION
  - Locating, mounting, and routing
  - Understanding limitations of length and diameter
- BENDING COPPER TUBING
  - Making a proper bend with spring benders
  - Making a proper bend with cam type benders
- COPPER TUBING PREPARATION
  - Cutting copper tubing
  - Reaming copper tubing
  - Cleaning copper tubing
  - Swaging copper tubing
- BRAZING
  - Overview of brazing copper to copper
  - Oxyacetylene brazing
  - Using air / fuel to solder
  - Use of purging gas when brazing
  - Overview of brazing copper to brass Overview of brazing copper to steel
  - Selection of brazing materials
- FLARE FITTINGS
  - Making a flare fitting - single and double
  - Installing with flare fittings
- BRAZING & SOLDERING EQUIPMENT
  - Brazing products - rods, flux, etc.
  - Oxyacetylene brazing equipment
  - Gas purging equipment in field brazing
  - Air / Fuel systems - acetylene, propane, MAP, etc.
  - Soldering products - solder, flux, and torches
  - Tool maintenance and care

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Knowledge Areas of  
Technician Expertise

## Installation (continued)

### INSTALLING CONDENSING UNIT

- INSTALLING AND CONNECTING CONDENSING UNIT
  - Locating unit
  - Preparing site
  - Placing unit
  - Wiring outdoor units
  - Installing refrigerant lines
- INSTALLING PACKAGED UNITS
- INSTALLING AND CONNECTING
  - Locating equipment
  - Preparing site
  - Lifting unit Sealing unit
  - Wiring

### INSTALLING INDOOR EQUIPMENT

- INSTALLATION OF INDOOR AIR HANDLERS / FURNACES
  - Installing coil and air handler / furnace
  - Connecting ductwork
  - Connecting refrigerant lines Connecting condensate lines Wiring air handler / furnace
  - Wiring thermostats
  - Wiring electronic air cleaners
  - TEV's - installation
  - Installing fixed metering devices
  - Bulb location selection for TEV's
  - Auxiliary heat
  - Handling - lifting, hanging
  - Trapping for condensate lines
  - Service access and clearance considerations

### EVACUATION & CHARGING

- SAFE HANDLING OF REFRIGERANT CONTAINERS
  - Disposal
  - Securing refrigerants for transport
  - Signage and documentation for refrigerants
  - Proper storage
  - Proper container filling



# KATES Knowledge Areas of Technician Expertise

## Installation (continued)

- EVACUATION
  - Overview - use of a vacuum pump
  - Overview - use of a micron gauge
  - Use of a manifold gauge set in evacuation
  - Deep single evacuation process
  - Removing core of access valves
- LEAK CHECKING & DETECTION
  - Overview of leak checking and detection
  - Leak checking with electronic leak detectors
  - Leak checking with soap solutions
  - Gas pressurization for leak checking
  - Leak checking with ultrasonic leak detectors
- CHARGING METHOD
  - Weigh in method
  - Superheat method and where used
  - Subcooling method and where used
  - Charging blended refrigerants

## DUCT INSTALLATION

- DUCT FABRICATION EQUIPMENT
  - Ductboard tools - 90 V-groove, end cutoff, female shiplap, hole cutter, stapler, etc.
  - Flex tools - tensioning strap tools, knives, etc.
  - Metal tools - metal snips, sheers, benders, breaks, hand formers, calipers, rulers, stapler, etc.
- INSTALLING METAL DUCT
  - Assembly methods for rectangular duct
  - Assembly methods for round duct
  - Hanging ductwork
  - Sealing metal duct
  - Insulation - internal and external
- INSTALLING FLEXIBLE DUCT
  - Assembly methods - appropriate length
  - Hanging flexible duct
  - Sealing flexible duct
  - Installation technique
- INSTALLING DUCTBOARD
  - Assembly methods for ductboard - supports
  - Hanging methods for ductboard
  - Sealing ductboard
  - Installation technique

# KATES Knowledge Areas of Technician Expertise

## Installation (continued)

- INSTALLING GRILLES, REGISTERS, DIFFUSERS, & DAMPER
  - Mounting to ductwork
  - Securing methods
  - Sealing methods
- FIELD CONSTRUCTION / INSTALLATION
  - Techniques for joining dissimilar duct
  - Duct of alternate materials - wood, aluminum, etc.
- CHASES USED AS DUCTS
  - Floor joists as air ducts
  - Vertical chases

### INSTALLING ACCESSORIES

- INSTALLING THERMOSTATS
  - Locating and mounting
  - Wiring electromechanical thermostats
  - Wiring electronic thermostats
  - Setting anticipators when used
  - Installing air side low ambient control
  - Installing outdoor thermostat
  - Setting balance point on outdoor thermostat
- INSTALLING ELECTRONIC AIR CLEANERS
  - Installing to a unit - sealing
  - Wiring
  - Controlling electronic air cleaners
- INSTALLING ECONOMIZERS
  - Installing
  - Wiring
  - Controlling economizers

### FIELD WIRING

- WIRING UNITS & CONTROL WIRING
  - Connecting electrical power
  - Connecting control circuits
  - Meeting manufacturer sizing requirements - wire sizing (size and number)

# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### START-UP AND CHECKOUT

- PRE-START PROCEDURES
  - Surveying installation - checking equipment match
  - Inspect connections for tightness
  - Set dip switches / jumpers on ECM motors
  - Set speed taps on multi-speed motors
  - Set adjustable pulleys on belt driven blowers
  - Ensure clean filter is in place and accessible
  - Ensure condensate line is flowing
- START-UP PROCEDURES AND CHECKS
  - Surveying installation
  - Supply voltage checks
  - Motor checks
  - Checking sequences
  - Check fan rotation
  - Check scroll compressor rotation - high noise level, etc.
  - Start-up checklist and preparation
  - Metering device - refrigerant circuit checks
  - Airflow checks
  - Pressure checks
  - Temperature checks - dry bulb, wet bulb, etc.
- LEAK DETECTION TOOLS
  - Soap solution
  - Electronic leak detectors
  - Ultrasonic leak detector
  - Halide leak detector
  - Use of dye leak detectors
  - Pressurization for leak detection
  - Meter calibration and maintenance

### REFRIGERANT CIRCUIT TOOLS

- MANIFOLD GAUGE SET
  - Manifold gauge set
  - How to read the gauge set
  - How to connect the gauge set for different purposes
  - Types and styles of gauge sets
  - Using the gauge set for diagnostics
  - Low loss fitting connections
  - Gauge calibration and maintenance

# KATES

Knowledge Areas of  
Technician Expertise

### Installation (continued)

- EVACUATION TOOLS
  - Vacuum pump
  - Micron gauge
  - Valve opening tools - core removers, etc.
  - Gauge calibration and maintenance
- CHARGING TOOLS
  - Charging scales
  - Gauge calibration and maintenance

#### RETROFITTING

- EQUIPMENT COMPONENT RETROFITTING
  - Changing out an outdoor unit
  - Changing out an indoor unit
  - Modifying ductwork for replacement equipment

#### BASIC DUCT FABRICATION

- FABRICATION TECHNIQUES FOR METAL DUCT
  - Seam types - pittsburgh and snap lock
  - Joint types - drive slips, reinforced drive slips, "s" slip, and standing "s" slip
  - Use of strength breaks in rectangular duct
- FABRICATION TECHNIQUES FOR DUCTBOARD
  - Layout of duct fitting
  - Groove cutting - hand / machine
  - Use of joint tape

#### AIRFLOW MEASUREMENTS

- INTRODUCTION TO AIRFLOW MEASUREMENTS
  - Introduction to airflow
  - Static pressure
- AIRFLOW VELOCITY MEASUREMENTS
  - Introduction to airflow velocity
  - Velometer - electronic and mechanical
  - Anemometer
  - Velocity measurement procedures
  - Gauge calibration

# KATES Knowledge Areas of Technician Expertise

## Installation (continued)

- AIRFLOW PRESSURE MEASUREMENTS
  - Overview of static pressure measurements
  - Inclined manometer
  - Diaphragm type differential pressure gauge
  - U-tube manometer
  - Electronic manometer / pressure measurement
  - Gauge / meter calibration
  - Absolute vs. Gauge Pressure
- AIRFLOW VOLUME MEASUREMENTS
  - Introduction to volume
  - Airflow hood
  - Formulae for determining CFM of air
  - Formulae for weight of air
  - Locations for air volume measurements
- AIRFLOW CHECKS & DESIGN TOOLS
  - Using manufacturer's airflow charts and tables
  - Using a duct calculator and design charts

## Service

### DIAGNOSTICS

- PRELIMINARY SYSTEM DIAGNOSTICS
  - Outdoor unit checks
  - Indoor unit checks
  - Wiring checks
  - Refrigerant line checks
  - Thermostat checks
  - Condensate drain checks
  - Accessories
- ELECTRICAL CHECKS
  - Supply voltage checks
  - Compressor circuits
  - Condenser fan circuits
  - Indoor blower circuits
  - Wall thermostat circuits
  - Transformer circuits
  - Electronic controllers - input / output

# KATES

Knowledge Areas of  
Technician Expertise

### Service (continued)

- COMPONENT CHECKS - ELECTRICAL
  - Thermostat
  - Transformers
  - Overcurrent protection
  - Relays and contactors
  - Condenser fan motors
  - Indoor blower motors
  - Solenoid valves coils
- REPAIR
  - Refrigerant circuit on coils
  - Ductwork
  - Electrical wiring

#### INTRODUCTION TO ELECTRICAL TROUBLESHOOTING

- LOW VOLTAGE CIRCUITS
  - Voltage tests
  - Equipment continuity tests
  - Ground tests
- LINE VOLTAGE CIRCUITS
  - Voltage tests
  - Equipment continuity tests
  - Ground tests

### System Components

#### INTRODUCTION TO SYSTEMS

- HEAT TRANSFER PRINCIPLES
  - Heat transfer - evaporations and condensation
  - Basic refrigeration circuit - 7 components
  - Temperature and pressure in the refrigerant circuit.

# KATES Knowledge Areas of Technician Expertise

## System Components (continued)

- SPLIT SYSTEMS
  - Introduction to split system AC configurations and applications
  - Equipment locations and mounting
  - Duct designs for split systems air conditioners
  - Electrical layouts for split systems air conditioners
  - Refrigerant circuits for split systems air conditioners
  - Specifications for split system air conditioners
  - Attic / Crawlspace layouts for split systems air conditioners
  - Closet layouts for split systems air conditioners
  - Basement layouts for split systems air conditioners
  - Heat options with split system air conditioners
  - Ventilation options split systems air conditioners
  - Regional considerations in split system air conditioner designs
  - Special consideration of indoor coils above living space
- PACKAGED SYSTEMS
  - Introduction to package AC configurations
  - Equipment locations for package air conditioners
  - Basic duct designs for packaged equipment
  - Electrical layouts with packaged air conditioners
  - Packaged equipment in single story applications
  - Packaged equipment in multi story applications
  - Packaged equipment applied with crawlspace duct designs
  - Heat options with packaged air conditioners
  - Ventilation options for packaged air conditioners
  - Economizer options
  - Regional considerations in packaged equipment
  - Specifications for packaged equipment
- MULTI-CAPACITY SYSTEMS
  - Overview of multi-capacity systems
  - Sequencing of multi-capacity air conditioners
  - Refrigerant circuits of multi-capacity air conditioners

### DUCT SYSTEMS

- DUCT SYSTEMS
  - Duct system design
  - Duct configurations - extended plenum, reducing extended plenum, perimeter radial, perimeter loop,
  - overhead radial
  - Return configurations - ducted, central, etc.
  - Return grille locations - low sidewall, high sidewall, etc. Supply locations - floor, sidewall, ceiling, etc.

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Knowledge Areas of  
Technician Expertise

## System Components (continued)

### WIRING LAYOUTS

- POWER WIRING
  - Overview of power wiring
- LOW VOLTAGE
  - Overview of low voltage wiring

### COMPONENTS

- OUTDOOR COILS
  - Types - basic designs
  - Airflow characteristics
- COMPRESSORS
  - Fundamentals of compressor operations
  - Compressor types
- REFRIGERANTS
  - Refrigerants used in Res./Lt. Com air conditioners
  - Properties of refrigerants used in Res./Lt. Com air conditioners
  - Using temperature-pressure chart
  - Refrigerant conservation
- SERVICE VALVES
  - Front seating service valves
  - Back seating service valves
  - Gauge port
- REFRIGERANT CIRCUIT ACCESSORIES
  - Operation fundamentals - accumulators
  - Operation fundamentals - filter-driers
  - Operation fundamentals - sight glasses, moisture indicators, liquid indicators, etc.
  - Operation fundamentals - mufflers
- INDOOR COILS
  - Types - basic designs and operating characteristics of A-coil, slab, and slant indoor coils
  - Basics of selection
  - Condensate drains
- METERING DEVICES
  - Types
  - Selection



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Knowledge Areas of  
Technician Expertise

### System Components (continued)

- BLOWERS AND FANS
  - Role of indoor blowers
  - Role of outdoor fans
  - Blower and fan performance
- LINE SETS
  - Introduction to line sets
  - Application considerations when using line sets
- AIR SIDE COMPONENTS
  - Dampers
  - Ventilation fittings
  - Electronic air cleaners (EAC's)
  - Electrostatic filters - non-electric
  - Media type filters
  - Fixed outdoor air damper
  - Economizers
  - Insulating material
  - Flexible connectors
- GRILLES, REGISTERS, & DIFFUSERS
  - Types and uses
  - FASTENERS
    - Screws
    - Bolts
    - Nuts and washers
    - Lockpins
    - Rivets
- ELECTRICAL COMPONENTS
  - Overcurrent protection
  - Capacitors Solenoids
  - Crankcase heaters
  - Auxiliary strip heat
  - Transformers
- CONSTANT AIRFLOW MOTORS
  - Intro to variable speed motors - ECM, BPM, and VSIM
  - Motor mounting and installation requirements
  - Electronic interface and setting for airflow requirements

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### ELECTROMECHANICAL SENSING CONTROLS

- ELECTROMECHANICAL WALL THERMOSTATS
  - Basic thermostat types and operation
  - Thermostat terminals and wiring
  - Using electromechanical thermostats
- ELECTROMECHANICAL TEMPERATURE CONTROLS
  - Introduction to bimetal controls
  - Disc type temperature limit controls
  - Introduction to vapor charged controls
  - Overview of electric heat high limits
  - Motor overloads
- PRESSURE CONTROLS
  - Introduction to disc type pressure controls and hi/low controls
  - Operation of disc type pressure controls
- ELECTROMECHANICAL OUTDOOR THERMOSTATS
  - Overview of outdoor thermostats
  - Outdoor thermostat wiring
  - Low ambient cooling controls

### REFRIGERANT CIRCUIT CONTROLS

- PRESSURE CONTROLS
  - High pressure limit controls
  - Low pressure limit controls
- NON-SENSING CONTROLS
- RELAYS AND CONTACTORS
  - Introduction to relays and contactors
  - Basics of relay and contactor operation - inrush and holding
  - Selecting relays and contactors
  - Application considerations for relays and contactors
- ELECTRIC HEAT CONTROLS
  - Sequencers
- ELECTRONIC CONTROLS
- ELECTRONIC THERMOSTATS
  - Fundamentals of electronic thermostats
  - Overview of electronic thermostat operation
- ZONE CONTROLS
  - Fundamentals of zone controls
  - Typical zone control logic

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Knowledge Areas of  
Technician Expertise

## System Components (continued)

- ELECTRONIC COMPRESSOR CONTROLS
  - Fundamentals of compressor controls
- ELECTRONIC TIMERS
  - Introduction to blower delay timers
  - Introduction to compressor delay timers

## Applied Knowledge: Regulations, Codes and Design

### AIR QUALITY REGULATIONS

- INDOOR AIR QUALITY
  - Fresh air supplies

### ELECTRICAL CODE

- REQUIREMENTS
  - Overview of electrical code
  - Circuit breaker and fuse requirements
  - General wiring practices
  - Class I wire sizing Class II wire sizing
  - Conduit sizing
  - Definitions

### STATE AND LOCAL REGULATIONS AND CODES

- STATE AND LOCAL REGULATIONS
  - State requirements for technicians
- CODES
  - Plumbing
  - Municipalities
  - HVAC for Lt. Commercial

### FIRE PROTECTION REGULATIONS AND CODES

- REQUIRED COMPONENTS
  - Return air sensors
  - Fire dampers
- FIRE PREVENTION
  - Overview

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Knowledge Areas of  
Technician Expertise

## Applied Knowledge (continued)

### DESIGN CONSIDERATIONS - COMFORT

- TEMPERATURE
  - Designing for capacity
- HUMIDITY
  - Role of humidity in comfort
- INDOOR AIR QUALITY
  - Ventilation - comfort
  - Air cleaning for comfort
  - Outside air
- SOUND LEVEL
  - Equipment location considerations
  - Isolation, mounting pad, duct, and structure
  - Duct systems

### DESIGN CONSIDERATIONS - EQUIPMENT

- SPLIT SYSTEMS
  - System designs - closets, basements, etc.
  - Refrigerant piping
  - Equipment location
  - Electrical layouts
  - Duct design / balancing
  - Condensate drains
  - Ventilation - fresh air
  - Regional design considerations
  - Ventilation - equipment
  - Secondary condensate drains / pans
  - Mounting of equipment

# KATES

Knowledge Areas of  
Technician Expertise

### Applied Knowledge (continued)

- PACKAGED SYSTEMS
  - Package system configurations and design
  - Equipment locations design
  - Applications for packaged systems
  - Basic duct designs for packaged equipment
  - Condensate drain piping design
  - Electrical layouts with packaged air conditioners
  - Packaged equipment in single story applications
  - Packaged equipment in multi story applications
  - Packaged equipment in crawlspace applications
  - Heat options with packaged systems
  - Ventilation options
  - Regional considerations in packaged equipment

#### DESIGN CONSIDERATIONS - COMPONENTS

- DIFFUSERS, REGISTERS, AND GRILLES
  - Selecting diffusers, grilles, and registers
  - Modifying locations
- ACCESSORIES
  - Start components
  - Filter-driers - When to use? and How to select?
  - Filtering - EAC, media, HEPA, electrostatic

#### RECOVERY / RECYCLING MACHINES

- RECOVERY MACHINES
  - Introduction to recovery machines
  - Types and styles of recovery machines
  - Typical recovery procedures
  - Recovery machine maintenance and cylinder maintenance
- RECYCLING MACHINES
  - Introduction to recycling machines
  - Types and styles of recycling machines
  - Typical recycling procedures
  - Recovery machine maintenance and cylinder maintenance

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Knowledge Areas of  
Technician Expertise

## Applied Knowledge (continued)

### MECHANICAL CODE

- EQUIPMENT ACCESS
  - Minimum clearance
  - Electrical disconnects
  - Fire dampers
- REFRIGERANT LINE ROUTING
  - Support requirements
  - Inspection requirements
- CONDENSATE DRAINS
  - Materials
  - Sizing