



Certifying the  
finest in HVACR

# Air to Air Heat Pump Service

# KATE

Knowledge Areas of  
Technician Expertise

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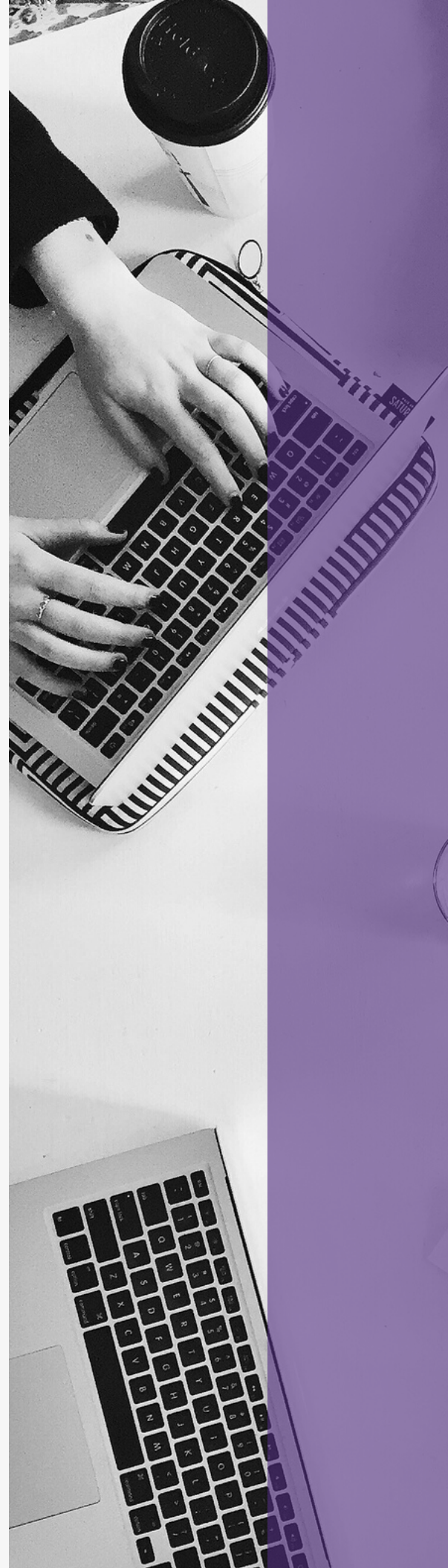
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KATES



# Air-to-Air Heat Pump- Service Specialty Exam



## Exam Information & Qualifications

The Air to Air Heat Pump - 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 Heat Pump 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 Heat Pump systems as a service technician and technical training for theoretical knowledge.

## Exam Copyrights

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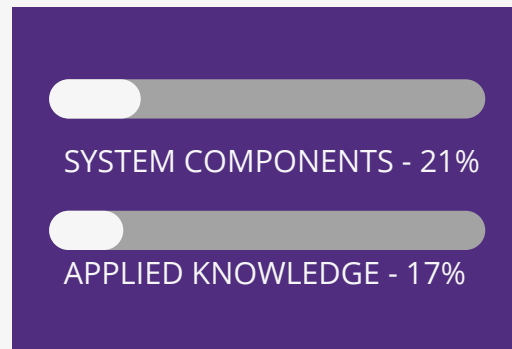
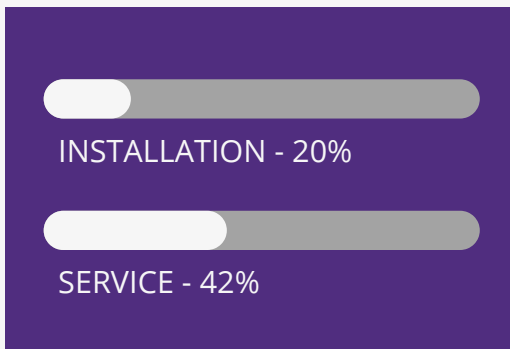
## Passing Score Development Process



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-to-Air Heat Pumps - Installation Exam** and should be used as reference material.

## Installation

### Fabricating Copper Tubing

- Refrigerant Line Installation
  - Locating, mounting, and routing
  - Understanding limitations of length and diameter
- Bending Copper Tubing
  - Making a proper bend
- Copper Tubing Preparation
  - Cutting, reaming, cleaning, and swaging copper tubing
- Brazing
  - Overview of brazing copper to copper
  - Use of purging gas when brazing
  - Overview of brazing copper to dissimilar metals
- Soldering
  - Overview of joining or repairing aluminum
- Flare Fittings
  - Making a flare fitting - single and double
  - Installing with flare fittings
- Brazing and 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
- Mechanical Press Fittings
  - Proper preparation and installation practices

### Installing Outdoor Units

- Installing and Connecting Outdoor Units
  - Locating, preparing site, and placing unit
  - Wiring outdoor units
  - Connecting refrigerant lines



# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### Installing Packaged Units

- Installing and Connecting Packaged Units
  - Locating equipment, preparing site, lifting unit
  - Sealing unit
  - Wiring

### Installing Indoor Equipment

- Installation of Indoor Air Handlers/Furnaces
  - Placing, handling, lifting, hanging and locating air handler/coil and furnace
  - Connecting ductwork
  - Connecting refrigerant lines
  - Connecting and trapping for primary and secondary condensate lines
  - Line voltage wiring
  - Low voltage wiring
  - Metering devices
  - Auxiliary heat

### Evacuation and Charging

- Safe Handling of Refrigerant Containers
  - Storage, secure transportation, and disposal of refrigerant containers
  - Signage and documentation for refrigerant
  - Proper container filling
- Evacuation
  - Evacuation tools and equipment
  - Single and triple evacuation procedures
- Leak Checking & Detection
  - Overview of leak checking with electronic leak detectors, soap solutions, leak detection methods (e.g., ultrasonic, ultraviolet)
  - Gas pressurization for leak checking
- Charging Method
  - Weigh in method
  - Superheat method and where used
  - Subcooling method and where used
  - Charging blended refrigerants



# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### 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 ducts
  - Hanging ductwork
  - Sealing metal duct
  - Insulation - internal and external
- Installing Flexible Duct
  - Assembly methods - appropriate length
  - Hanging flexible duct
  - Sealing flexible duct
- Installing Ductboard
  - Assembly methods for ductboard - supports
  - Hanging methods for ductboard
  - Sealing ductboard
- Installing Grilles, Registers, Diffusers, & Damper
  - Mounting and securing methods
  - Sealing methods
- Field Construction/Installation
  - Techniques for joining dissimilar duct
  - Duct of alternate materials - wood, aluminum, etc.
- Chases Used as Ducts
  - Vertical chases and floor joists as air ducts
- Reconnecting Duct When Replacing Equipment
  - Reconnecting metal duct
  - Reconnecting flexible duct
  - Reconnecting ductboard duct
- Installation of Plenums and Duct
  - Sizing plenums for physical fit
  - Types and styles of plenums selected
  - Insulation of plenums and ducts

# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### Installing Accessories

- Installing Thermostats
  - Locating and mounting
  - Wiring electronic and electromechanical thermostats
  - Setting anticipators or cycle rates when used
  - Installing air side low ambient control
- Installing Electronic Air Cleaners
  - Installing to a unit - sealing
  - Wiring and controlling electronic air cleaners
- Installing Humidifiers
  - Installing, wiring, and controlling humidifiers
- Installing Economizers
  - Installing, wiring, and controlling economizers

### Field Wiring

- Wiring Units and Control Wiring
  - Sizing and connecting electrical power to manufacturer's requirements
  - Connecting control circuits

# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### Start-Up and Checkout

- Pre-Start Procedures
  - Surveying installation
  - Inspect connections for tightness
  - Verification and setup of indoor blower for proper airflow for system capacity
  - 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.
  - Reversing valve checks
  - Capacity checks
- Leak Detection Tools
  - Soap solution
  - Electronic leak detectors
  - Ultrasonic leak detector
  - Use of dye leak detectors
  - Pressurization for leak detection
  - Meter calibration and maintenance

# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### Refrigerant Circuit Tools

- Manifold Gauge Set
  - How to read and connect manifold gauge set
  - Types and styles of gauge sets- analog/digital/app operated
  - Using the gauge set for diagnostics
  - Low loss fitting connections
  - Gauge calibration and maintenance
- Evacuation Tools
  - Vacuum pump
  - Valve opening tools - core removers, etc.
  - Micron gauge calibration, use, and maintenance
- Charging Tools
  - Charging scales - calibration, use, and maintenance

### Recovery/Recycling Machines

- Recovery Machines
  - Operation and maintenance of recovery machines
  - Recovery cylinders - use, inspection, and certification



# KATES Knowledge Areas of Technician Expertise

## Installation (continued)

### Airflow Measurements

- Airflow Velocity Measurements
  - Pitot tube and manometer in measuring static pressure
  - Discharge velocity equipment
  - Velometer - electronic and mechanical
  - Anemometer
  - Velocity measurement procedures
  - Gauge calibration
  - Introduction to airflow in Residential HVAC
  - Velocity
- Airflow Pressure Measurements
  - Overview of static pressure measurements
  - Electronic manometer / pressure measurement
  - Gauge / meter calibration
  - Absolute vs. Gauge Pressure
  - Static pressure
  - Air pressure measurement terminology
  - Velocity pressure
  - Total pressure
- Airflow Volume Measurements
  - Airflow hood
  - Formulae for determining CFM of air
  - Formulae for weight of air
  - Locations for air volume measurements
  - Airflow volume - CFM / SCFM (Static CFM)
- Airflow Checks and Design Tools
  - Using manufacturer's airflow charts and tables
  - Using a duct calculator and design charts

# KATES

Knowledge Areas of  
Technician Expertise

## Service

### Planned Maintenance

- Mechanical Planned Maintenance
  - Filters
  - Charge
  - Indoor and outdoor coil care
  - Roof seals - packaged
  - Ducts, Diffusers, grilles, and registers
  - Performance checks - temperature rise
- Electrical Planned Maintenance
  - Electric motor checks
  - General wiring checks - tightness of connections, aluminum wire, etc.
  - Sequence of operation checks
  - Compressor checks, voltage, current
  - Crankcase heater check

### Diagnostics

- Preliminary System Diagnostics
  - Outdoor unit checks
  - Indoor unit checks
  - Wiring checks
  - Refrigerant line checks
  - Thermostat checks
  - Condensate drain checks
  - Accessories
  - Attic ventilation
- Analyzing Reported Symptoms
  - No cooling
  - Low capacity
  - Humidity problems
  - Start problems
  - Noise problems
  - No heating
  - Drafty - cold air
  - Runs continuously
  - High utility bills
  - Air quality
  - Thermostat, droop
  - Steam/vapor from outdoor unit

# KATES Knowledge Areas of Technician Expertise

### Service (continued)

- System Air Side Diagnostics
  - Temperature checks - dry bulb, wet bulb, etc.
  - Airflow and static pressure checks- noise problems and drafts
  - Ductwork - supply and return checks
- Refrigerant System Diagnostics
  - Overview
  - Using superheat
  - Using subcooling
  - Analyzing overall refrigerant circuit performance
  - Analyzing effects of refrigerant circuits pressure difference on reversing valve operation
  - Locating problems based on refrigerant circuit temperatures and pressures
- Electrical Circuit Checks
  - Supply checks
  - Compressor circuits
  - Condenser fan circuits
  - Indoor blower circuits
  - Thermostat circuits
  - Transformer circuits
  - Indoor auxiliary heat circuits
  - Electronic controllers - input / output
  - Defrost control circuits
  - Reversing valve solenoid circuits
- Component Checks - Electrical
  - Compressor
  - Thermostat
  - Crankcase heaters
  - Low ambient controls fro cooling
  - Transformers
  - Overcurrent protection
  - Relays and contactors
  - Pressure controls
  - Condenser fans
  - Indoor blowers
  - Capacitors
  - Start relays
  - Solenoid valves coils
  - Defrost termination control
  - Defrost controls
  - Outdoor temperature sensors
  - Reversing valve coils

# KATES

Knowledge Areas of  
Technician Expertise

### Service (continued)

- Repair
  - Refrigerant circuit on coils
  - Ductwork
  - Electrical wiring
- Replacements
  - Outdoor units
  - Compressors
  - Outdoor fans
  - Indoor coils
  - Thermostatic Expansion Valves (TEVs) and fixed orifice metering devices
  - Transformers, relays and contractors, capacitors
  - Liquid line bi-flow filter-driers and suction line filter-driers
  - Indoor blowers
  - Defrost controls
  - Reversing valves
- System Cleanup After Compressor Electrical Failure
  - Compressor
  - Thermostatic Expansion Valves (TEVs), reversing valves, and check valves
  - Acid test
- Component Checks - Refrigeration
  - Compressor
  - Thermostatic Expansion Valves (TEVs), fixed orifice metering devices/  
piston, solenoid valves, check valves, and reversing valves
  - Filter-drier
  - Suction line - oil traps, risers, etc.
  - Liquid line - vertical height, static pressure loss, etc.
  - Condensate drains
  - Indoor and outdoor coils

### Overview of Electrical Troubleshooting

- Low Voltage Circuits
  - Voltage tests
  - Control string analysis
  - Troubleshooting equipment with electronic testing devices
  - Troubleshooting with or without schematics
  - Equipment continuity tests
  - Current tests
  - Component continuity tests



# KATES

Knowledge Areas of  
Technician Expertise

### Service (continued)

- Line Voltage Circuits
  - Voltage tests
  - Current tests
  - Component tests
  - Circuit tracing line voltages
  - Troubleshooting with or without schematics
  - Component continuity tests
  - Ground tests

### Retrofitting

- Equipment Component Retrofitting
  - Changing out an indoor or outdoor unit
  - Matching split system components - efficiency and capacity
  - Modifying ductwork for replacement equipment

### Air Balancing

- Gathering Design Information
  - Interpreting air distribution system design, specifications, and equipment information
  - Interpreting control data
  - Modifying air distribution system design
- Preparation of System for Air Tests
  - Locating registers, grilles, equipment, controls, and dampers in building walkthrough
  - Setting dampers for tests
  - Setting thermostat for tests
  - Checking for proper fan operation and rotation
  - Checking for proper static pressure and temperature
- Procedures for Conducting Air Tests
  - Measurements of each supply outlet and return inlet- total readings
  - Adjust airflow to verify required total airflow
  - Adjust dampers to obtain design airflow and verify that it is within +/- 10%

# KATES

Knowledge Areas of  
Technician Expertise

### Service (continued)

- Final Test
  - Comparing manufacturer's equipment information with test results
  - Record sheave, pulley, and belt sizes data
  - Test and record voltage and full load motor amperes
  - Test and record motor and fan RPM
  - Test and record supply and return static pressures
  - Test and record supply and return air temperatures - heat and cool temperature difference
- Completion of Appropriate Forms
  - HVAC system reports, system diagrams, duct traverse or data pulley forms
  - Instrument list - including calibration dates

### Basic HVAC System Analysis

- Noise Problems
  - Interpreting supply / return air volume
  - Interpreting supply / return air velocity
  - Noise problems
  - Blower cavitation
  - Oil canning
  - Motor/belt noise
  - Vibration
- High Utility Bills and Comfort Conditions
  - Interpreting supply / return air temperature and air volume
  - Evaluating duct leakage
  - Evaluating duct insulation
  - Envelope infiltration
  - Thermostat location and setting
- Indoor Air Quality
  - Number of air changes per hour
  - Contaminants

# KATES

Knowledge Areas of  
Technician Expertise

## Service (continued)

### Analyzing Reported Symptoms in Cooling

- Poor Cooling
  - Interpreting supply / return air temperature, volume, and velocity
  - Determining and interpreting the sensible heat ratio
  - Evaluating duct leakage
  - Using temperature drop across evaporator coil
- Humidity Problems
  - Interpreting wet bulb and dry bulb temperatures
  - Interpreting supply / return air volume
  - Determining and interpreting the sensible heat ratio and selected equipment capacity
  - Evaluating duct leakage
- Drafty
  - Interpreting supply / return air temperature, volume, and velocity

### Analyzing Reported Symptoms in Heating

- Poor Heating
  - Interpreting supply / return air temperature, volume, and velocity
  - Evaluating duct leakage
  - Using temperature change across indoor and outdoor coil
  - Inadequate supplemental heat
- Humidity Problems
  - Interpreting wet bulb and dry bulb temperatures
  - Determining the need for additional humidity
  - Evaluating duct leakage
- Drafty
  - Interpreting supply / return air temperature, volume, and velocity

# KATES

Knowledge Areas of  
Technician Expertise

## System Components

### Introduction to Systems

- Heat Transfer and the Basic Cooling Cycle
  - Heat transfer and cooling
  - Basic refrigeration circuit - components
  - Analysis of temperatures and pressure in the refrigerant circuit
  - Psychrometrics
  - Subcooling and superheat
- Split Systems
  - Introduction to split system heat pump configurations and applications
  - Equipment locations and mounting
  - Duct designs
  - Electrical layouts
  - Refrigerant circuits
  - Specifications
  - Locations (e.g., Attic/ crawlspace, closet, basement)
  - Auxiliary heat options
  - Ventilation options
  - Regional considerations
  - Special consideration of indoor coils above living space
  - Introduction to refrigerant pipe layout
- Packaged Systems
  - Introduction to package heat pump configurations
  - Equipment locations
  - Basic duct designs
  - Electrical layouts
  - Locations (e.g., single story, multistory, crawlspace)
  - Heat options
  - Ventilation/Economizer options
  - Regional considerations, specifications, and applications
- Multi-Capacity Systems
  - Overview and staging of multi-capacity systems
  - Refrigerant circuits



# KATES

Knowledge Areas of  
Technician Expertise

### System Components (continued)

- Basic Heat Pump Refrigerant Circuit
  - Basic circuit layout for a heat pump
  - Role of compressor, evaporator, condenser, metering device
  - Role of high-pressure vapor line, low pressure vapor line, role of reversing valves
- The Heat Pump Refrigeration Cycle Operating Modes
  - Heat pump circuit operation in the cooling mode, heating mode, and defrost mode

### Duct Systems

- Duct Systems
  - Duct system design and configurations - extended plenum, reducing extended plenum, perimeter radial, perimeter loop, overhead radial
  - Supply and return grille locations - low sidewall, high sidewall, etc.

### Wiring Layouts

- Power Wiring
  - Overview of single and three-phase wiring
- Low Voltage
  - Overview of low voltage wiring
- Control Sequence
  - Overview of control sequence used in split systems, packaged systems

# KATES Knowledge Areas of Technician Expertise

## System Components (continued)

### Components

- Outdoor Coils
  - Types - basic designs microchannel and fin and tube
  - Airflow characteristics - horizontal and vertical
- Compressors
  - Fundamentals of compressor operations
  - Compressor types
  - Introduction and selecting start components
  - Hard and soft start kits - potential relay and start capacitor
- Refrigerants
  - Refrigerants used in Res./Lt. Com heat pumps
  - Using temperature-pressure chart and characteristics of blends, temperature glide, and fractionation
- Service/Check Valves
  - Front and back seating service valves
  - Gauge port (e.g., king valve, 2 or 3 position service valve)
  - Check valves
- Refrigerant Circuit Accessories
  - Operation fundamentals - receivers, accumulators, filter-driers, sight glasses, moisture indicators/ liquid indicators, mufflers, etc
- Indoor Coils
  - Types - basic selection, design and operation of coils (e.g., A-coil, slab, slant indoor coils, etc.)
  - Condensate drains
- Metering Devices
  - Types and basics of operation (e.g., TEV, electronic, fixed restrictor, captubes)
  - Selection
- Blowers And Fans
  - Introduction to indoor blowers - types and selection
  - Introduction to outdoor fans - types and selection
  - Blower and fan performance

# KATES

Knowledge Areas of  
Technician Expertise

### System Components (continued)

- Line Sets
  - Introduction to and selection of line sets
  - Application considerations when using or reusing line sets
- Air Side Components
  - Outdoor air dampers, ventilation fillings, economizers
  - Electronic air cleaners (EAC's) Electrostatic filters - non-electric, Media type filters
  - Insulating material
  - Flexible duct materials
  - Ductboard
  - Metal duct components
- Grilles, Registers, & Diffusers
  - Types and uses
  - Selecting diffusers, grilles, and registers
- Fasteners
  - Screws, bolts, nuts, washers, lockpins, rivets, etc.
- Electrical Components
  - Overcurrent protection, capacitors, solenoids, crankcase heaters, transformers, etc.
  - Auxiliary heat
- Lubricants
  - System compatibility of mineral oil, Alkylbenzenes (AB), Polyolesters (POE), PAGS
  - Disposal of lubricants
- Reversing Valves
  - Basics of operation and components
- Constant Airflow Motors
  - Motor mounting and installation requirements
  - Electronic interface and setting for airflow requirements

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Temperature and Pressure Sensors

- Wall Thermostats
  - Thermostat types and operation
  - Thermostat terminals and wiring
- Temperature Controls
  - Disc type temperature limit controls
  - Introduction to vapor charged controls
  - Overview of high limits
  - Motor overloads
  - Thermal links
  - Outdoor temperature controls

### Refrigerant Circuit Controls

- Pressure Controls
  - High pressure limit controls
  - Low pressure limit controls

### Non-Sensing Controls

- Relays and Contactors
  - Introduction to, and basics of, relays and contactors
  - Application considerations and selecting relays and contactors
- Electronic Heat Controls
  - Sequencers

### Electronic Controls

- Zone Controls
  - Fundamentals, selection, and control logic of zone controls
- Electronic Timers
  - Fan delay timers, blower delay timers, compressor delay timers
- Electronic Compressor Controls
  - Compressor staging controls and time delays
- Electronic Defrost Controllers
  - Fundamentals of electronic defrost controls

# KATES

Knowledge Areas of  
Technician Expertise

## Applied Knowledge: Regs, 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 Mechanical codes

### Fire Protection Regulations and Codes

- Fire Prevention
  - Overview

### Design Considerations - Comfort

- Temperature
  - Designing for capacity
  - Using industry standards
- Indoor Air Quality
  - Outside air
  - Industry standards for air quality

# KATES

Knowledge Areas of  
Technician Expertise

### Applied Knowledge (continued)

- Sound Level
  - 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
  - Auxiliary heat options
  - Specifying equipment
- 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 heat pumps
  - 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
  - Specifications for packaged equipment

# KATES

Knowledge Areas of  
Technician Expertise

## Applied Knowledge (continued)

### Design Considerations - Components

- Diffusers, Registers, And Grilles
  - Locations
  - Selecting diffusers, grilles, and registers (for capacity, throw, spread, pressure drop, and reduced sound)
- Accessories
  - Start components
  - Filter-driers - When to use? and How to select?
  - Filtering - EAC, media, HEPA, electrostatic
  - Outdoor thermostats - lockout auxiliary heat
  - Wall thermostat options
  - Humidifier sizing
  - Time delays
  - Crankcase heaters
  - Low ambient cooling controls

### Mechanical Code

- Equipment Access
  - Minimum clearance
  - Electrical disconnects
  - Fire dampers
- Refrigerant Line Routing
  - Support requirements
  - Inspection requirements
- Condensate Drains
  - Materials
  - Sizing

### Industry Standards

- Equipment and System Standards
  - Introduction to industry standards