



Certifying the
finest in HVACR

Commercial Refrigeration Service

KATE

Knowledge Areas of
Technician Expertise

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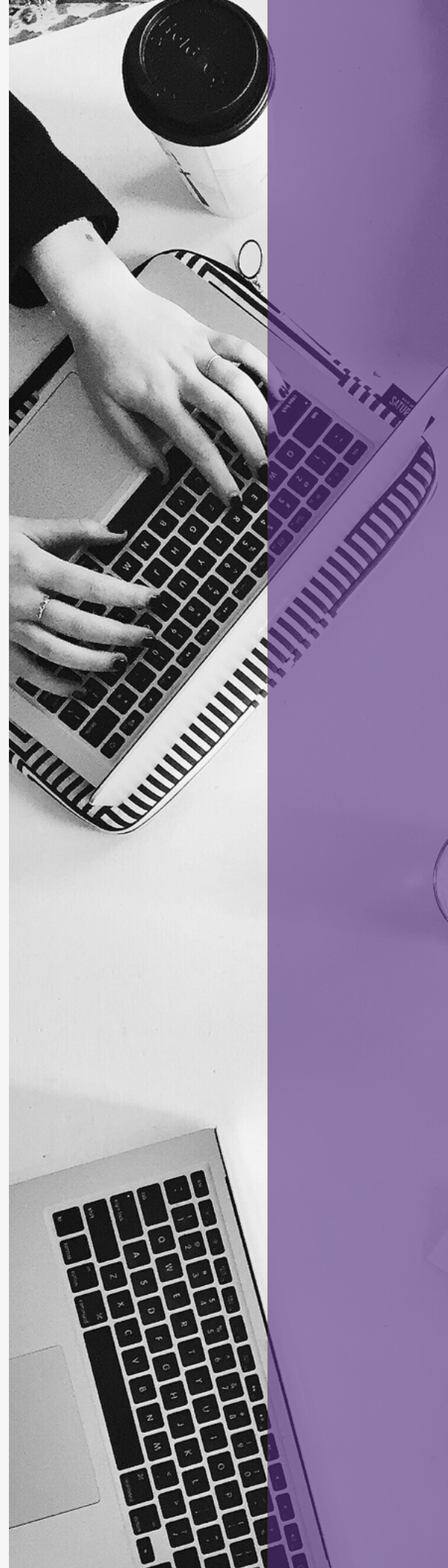
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Commercial Refrigeration - Service Specialty Exam

Exam Information & Qualifications



The Commercial Refrigeration - Service specialty exam tests a candidate's knowledge of the installation, service, maintenance, and repair of Commercial Refrigeration systems. System sizes are limited to 7.5 Horsepower to 80 Horsepower. The test is designed for the top level service technician. This test for certification is not intended for the refrigeration 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 Refrigeration Service candidates have an 80% likelihood of encountering at least once during the year on a national basis. Suggested experience is two years of field experience working on Refrigeration Systems as a service technician and technical training for theoretical knowledge.

Exam Copyrights

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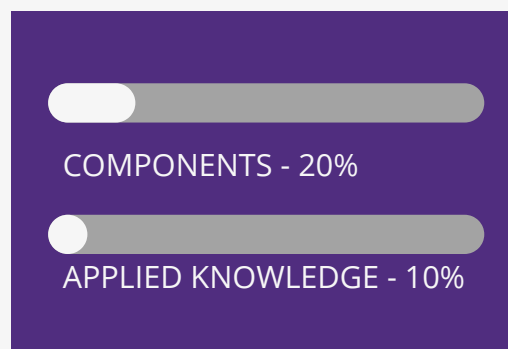
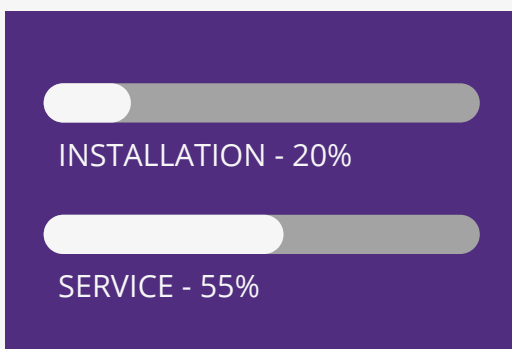
Passing Score Development Process



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.



- ASHRAE Fundamentals-Latest Edition
- ASHRAE Refrigeration-Latest Edition
- ASHRAE HVAC Applications-Latest Edition
- ASHRAE Standard-62.1-Latest Edition with Addendum
- ANSI/ASHRAE Standard-152-2004-Latest Edition with Addendum
- NSF/ANSI 7-2001-Commercial refrigerators and freezers-Requirements for Food Storage Refrigeration
- Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) Manuals
- American Society of Mechanical Engineers
- ASTM International

References continue on next page

Industry References (continued)

- International Energy Conservation Code-Latest Edition with Addendum
- International Plumbing Code- Latest Edition with Addendum
- International Mechanical Code-Latest Edition with Addendum
- Uniform Mechanical Code-Latest Edition with Addendum
- Uniform Plumbing Code- Latest Edition with Addendum
- NFPA 70-National Electrical 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 **Light Commercial Refrigeration - Service Exam** and should be used as reference material.

Installation

Fabricating Copper Tubing

- REFRIGERANT LINE INSTALLATION
 - Locating, mounting, and routing
 - Selecting tubing type
 - Sizing of refrigerant line
 - Sloping of refrigerant line
 - Understanding limitations of length and diameter
 - Installing line trap(s) in each line rise
 - Insulating refrigerant lines
 - Install adequate line/piping supports
- CONDENSATE DRAIN LINE INSTALLATION
 - Locating, mounting, and routing
 - Selecting tubing type
 - Sizing of line
 - Sloping of drain line
 - Understanding limitations of length and diameter
 - Installing drain line trap(s) for each room
 - Insulating condensate drain lines
- BENDING COPPER TUBING
 - Making a proper bend with gear benders
 - Making a proper bend with cam type benders
- COPPER TUBING PREPARATION
 - Cutting copper tubing
 - Reaming copper tubing
 - Cleaning copper tubing
 - Swaging copper tubing

KATES Knowledge Areas of Technician Expertise

Installation (continued)

- 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
 - The use of flux to limit oxidation
- FLARE FITTINGS
 - Selecting the correct type (angle) flare fitting
 - 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

INSTALLING PACKAGED REFRIGERATION UNIT

- INSTALLING AND CONNECTING PACKAGED UNITS
 - Locating equipment for proper placement
 - Preparing site - hole location, weight distribution
 - Lifting and placing unit(s)
 - Sealing unit and penetration through openings
 - Wiring unit to power source

KATES Knowledge Areas of Technician Expertise

Installation (continued)

INSTALLING SPLIT SYSTEMS (EXCLUDING EVAPORATOR)

- INSTALLING & CONNECTING
 - Locating split system components for proper placement
 - Preparing site(s)
 - Lifting and placing unit(s)
 - Connect water lines to condenser for water cooled unit
 - Wiring unit controls to power source
 - Wiring compressor unit to condenser
 - Wiring unit to evaporator unit(s)
 - Mount and pipe accessories (heat reclaim, etc.)
 - Installing refrigerant lines & supports
 - Understanding local codes (seismic, hurricane, etc.)
 - Sealing penetrations
 - Understanding the importance of proper ventilation

INSTALLING EVAPORATOR UNIT

- INSTALLATION AND CONNECTING EVAPORATOR UNIT
 - Locating evaporator unit for proper placement
 - Service access and clearance considerations
 - Handling - lifting, hanging, and placing unit
 - Mounting evaporator unit
 - Connecting refrigerant lines and supports
 - Connecting condensate, drain lines
 - Wiring evaporator fan motors
 - Wiring drain line heaters (for freezers)
 - Wiring electric defrost heaters & controls (when present)
 - Wiring room thermostats and liquid line solenoid valve Installing distribution nozzle Installing metering devices (TEV, EEV, etc.)
 - Bulb location selection for TEV's
 - Trapping & insulating condensate lines
 - Double suction line riser considerations
 - Trapping & insulating refrigeration line rises
 - Sealing penetrations through building structure

KATES Knowledge Areas of Technician Expertise

Installation (continued)

INEVACUATION & CHARGING SYSTEM

- SAFETY CONCERNS OF MISHANDLING REFRIGERANTS
 - Freezing
 - Breathing
 - Burning
- SAFE HANDLING OF REFRIGERANT CONTAINERS
 - Disposal
 - Securing refrigerants for transport
 - Signage and documentation for refrigerants
 - Proper storage
 - Proper container filling
- 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
 - Three pass blotter method of evacuation

LEAK CHECKING & DETECTION

- Overview of leak checking and detection
 - Leak checking with electronic leak detectors
 - Leak checking with bubble solutions Gas pressurization for leak checking
 - Leak checking with ultrasonic leak detectors Leak checking with ultraviolet leak detectors

CHARGING METHOD

- Weigh-in charge method
 - Percent of receiver method
 - Superheat method and where used
 - Subcooling method and where used
 - Charging blended refrigerants
 - Liquid charging
 - Floating head system considerations
 - Flooded condenser charging techniques
 - System charging techniques for specific compressors

KATES

Knowledge Areas of Technician Expertise

Installation (continued)

FABRIC DUCT INSTALLATION

- INSTALLING FABRIC DUCT
 - Routing and hanging duct support cable
 - Connecting duct to special fan guard adapter
 - Securing methods
 - Sealing duct to fan guard adapter
 - Installation technique

INSTALLING COMPONENTS & ACCESSORIES

- INSTALLING REFRIGERANT METERING DEVICE (TEV)
 - Purpose
 - Locating, mounting, and placement
 - Installing distributor nozzle and selecting
 - Protecting from overheating
 - Brazing to distributor
 - Connecting to liquid refrigerant line
 - Insulating refrigerant lines
- INSTALLING THERMOSTAT
 - Purpose
 - Locating, mounting, and placement
 - Wiring electromechanical thermostats
 - Wiring electronic thermostats
 - Setting differential of thermostat
 - Calibrating display setting of thermostat

KATES Knowledge Areas of Technician Expertise

Installation (continued)

- INSTALLING REFRIGERANT LINE SOLENOID VALVE
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - Wiring to room thermostats
 - Wiring interconnection to condensing unit
 - Selecting proper solenoid for application
- INSTALLING SUCTION LINE ACCUMULATORS & FILTERS
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - Selecting suction filter for application
- INSTALLING LIQUID LINE COMPONENTS
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant liquid lines
 - Selecting drier for application
- INSTALLING LIQUID TO SUCTION HEAT EXCHANGER
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - When and when NOT to use
- INSTALLING SUCTION LINE PRESSURE REGULATING VALVES
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
- INSTALLING HEAD PRESSURE REGULATING VALVES
 - Purpose
 - Locating, mounting, and placement - 1 & 2 valve setup
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - Verify receiver capacity

KATES Knowledge Areas of Technician Expertise

Installation (continued)

- INSTALLING OIL SEPARATORS
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - When and when NOT to use
- INSTALLING LIQUID REFRIGERANT RECEIVERS
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - When to heat and insulate
 - Check valve usage considerations
- INSTALLING HOT GAS BYPASS
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - Design considerations
- INSTALLING LIQUID INJECTION SOLENOID
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Wiring & controlling
- INSTALLING WATER REGULATING VALVES
 - Purpose
 - Locating, mounting, and placement
 - Connect water lines and supports
 - Wiring & controlling & adjusting
- INSTALLING DEFROST CONTROLS
 - Purpose
 - Locating, mounting, and placement of time clocks
 - Locating, mounting, and placement of hold-out relays
 - Locating, mounting, and placement of lock-out relays
 - Locating, mounting, and placement of defrost termination (adjustable and non-adjustable)
 - Locating, mounting, and placement of fan delay
 - Wiring with and without fan contactor(s)
 - Wiring with and without heater contractor(s)
 - Settings for air defrost / off cycle defrost operation
 - Settings for electric defrost operation
 - Settings for hot gas defrost operation

KATES

Knowledge Areas of Technician Expertise

Installation (continued)

- INSTALLING EVAPORATIVE CONDENSERS
 - Purpose
 - Locating, mounting, and placement
 - Connect refrigerant lines and supports
 - Insulating refrigerant lines
 - Wiring interconnection to compressor unit(s)
 - Wiring sump heater for low ambient operation
 - Connect water lines and supports
- INSTALLING COOLING TOWERS
 - Purpose
 - Locating, mounting, and placement
 - Connect water lines/ accessories and supports
 - Wiring interconnection to compressor unit(s)
 - Wiring sump heater for low ambient operation

FIELD WIRING

- WIRING UNITS & CONTROL WIRING
 - Equipment isolation
 - Connecting electrical power
 - Connecting control circuits
 - Meeting manufacturer sizing requirements - wire sizing (size and number)
 - NEC and local inspector's requirements

KATES Knowledge Areas of Technician Expertise

Installation (continued)

START-UP AND CHECKOUT

- PRE-START PROCEDURES
 - Surveying installation
 - Visual connections – wiring and piping
 - Check piping traps in refrigerant and drain lines
 - Set dip switches / jumpers on ECM motors
 - Set dip switches on electronic system controller
 - Set wiring taps on multi-speed/voltage motors
 - Check fan blade alignment
 - Check for obstructions to operation
 - Ensure condensate line is flowing
 - Check pressure control and thermostat settings
 - Check oil level in compressor
 - Check compressor mounting
 - Run crankcase heater 24 hrs. before startup
 - Check seals of all penetrations (wiring, piping, drains)
 - Check all hand valve adjustments/settings
 - Check TEV sensing bulb mounting
 - Check defrost time clock settings

- START-UP PROCEDURES AND CHECKS
 - Surveying installation - checking equipment match
 - Supply voltage checks
 - Check refrigerant match (compressor, TEV, nozzle, etc.) Motor/compressor checks - amps, voltage, phase, etc.
 - Checking sequences of operation
 - Check all fan rotations
 - Check scroll compressor rotation - high noise level, etc.
 - Start-up checklist and preparation documentation
 - Metering device - refrigerant circuit checks
 - Airflow and condensate/frost patterns checks
 - Pressure checks - high side and low side
 - Temperature checks - dry bulb, wet bulb, etc.
 - Check superheat at compressor inlet
 - Check safety and operational control settings (hi/low, oil, fan cycling, head pressure, etc.)
 - Capacity checks - system balance
 - Check sight glass - charge and moisture indicator
 - Observe oil level in compressor through cycles
 - Check drain pan for proper drainage
 - Check drain line heaters Jumper freezer motor fan delay for start up
 - Check defrost heater operation
 - Check liquid injection solenoid operation
 - Do not leave system unattended before operating conditions met)
 - Time schedule for pull down of low temp rooms

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Knowledge Areas of Technician Expertise

Installation (continued)

- Leak Detection Tools
 - Bubble 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
 - Scale calibration and maintenance
- EVACUATION TOOLS
 - Vacuum pump
 - Micron gauge
 - Valve opening tools - core removers/ etc.
 - Gauge calibration and maintenance
- CHARGING TOOLS
 - Charging scales
 - Gauge calibration and maintenance
- TEMPERATURE TOOLS
 - Electrical
 - Mechanical

KATES Knowledge Areas of Technician Expertise

Installation (continued)

RECOVERY / RECYCLING MACHINES

- RECOVERY MACHINES
 - Why recover
 - 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
 - Recycling machine maintenance and cylinder maintenance

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 commercial refrigeration
 - Velocity (FPM)
- 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
 - Static pressure
 - Air pressure measurement terminology
 - Velocity pressure
 - Total pressure

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Knowledge Areas of Technician Expertise

Installation (continued)

- AIR VOLUME MEASUREMENTS
 - Formulae for determining CFM of air
 - Formulae for weight of air
 - Use of psychrometric chart
 - Locations for air volume measurements
 - Airflow volume - CFM / SCFM (Static CFM)

SERVICE

PLANNED MAINTENANCE

- MECHANICAL PLANNED MAINTENANCE
 - Filters (liquid and suction)
 - Charge
 - Lubrication
 - Condenser coil care
 - Evaporator coil care
 - Condensate pans and drains
 - Shell & tube vessels (condensers & chiller barrels)
 - Packaged unit cabinet care
 - Fan guards
 - Fan blades
 - Entering air coil surface
 - Performance checks - temperature rise
- ELECTRICAL PLANNED MAINTENANCE
 - Electric motor and contactor checks
 - General wiring checks - tightness of connections/ aluminum wire/ etc.
 - Sequence of operation checks
 - Compressor checks/ voltage/ current
 - Crankcase heater check
 - Electric heater - fit into coil

KATES Knowledge Areas of Technician Expertise

Service (continued)

DIAGNOSTICS

- PRELIMINARY SYSTEM DIAGNOSTICS
 - Condenser / condensing unit checks
 - Evaporator unit checks
 - Wiring checks
 - Refrigerant line checks
 - Thermostat checks & calibration
 - Condensate drain checks
 - Accessories
- ANALYZING REPORTED SYMPTOMS
 - No cooling
 - Low capacity
 - Humidity problems
 - Compressorstart problems
 - Noise problems
 - Not defrosting
 - System runs continuously
 - High utility bills
 - Ice or water on ceiling & floor
 - Snow on product
 - Wide swings in space temperatures
 - Safety control trips
 - Frequent loss of motors
 - Frequent loss of compressors
 - Compressor running hot
- SYSTEM AIR SIDE DIAGNOSTICS
 - Temperature checks - dry bulb, wet bulb, etc.
 - Airflow checks
 - Noise problems
 - Vibration problems
 - Water 'blow-off' problems
 - Evaporator fan blades
 - Condenser fan blades
- REFRIGERANTSYSTEM DIAGNOSTICS
 - Overview
 - Using superheat
 - Using subcooling
 - Using compressor circuiting split A
 - nalyzing overall refrigerant circuit performance
 - Locating problems based on refrigerant circuit temperatures and pressures

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Knowledge Areas of Technician Expertise

Service (continued)

- ELECTRICAL CHECKS
 - Supply voltage checks
 - Compressor circuits
 - Condenser fan circuits
 - Evaporator fan circuits
 - Wall thermostat and solenoid circuits
 - Transformer circuits
 - Defrost heater & timer circuits
 - Electronic controllers - input / output
- COMPONENT CHECKS - ELECTRICAL
 - Compressor
 - Thermostat
 - Crankcase heaters
 - Low ambient controls for cooling
 - Transformers
 - Fuses and breakers
 - Relays and contactors
 - Hi-Lo Pressure controls
 - Condenser fan motors
 - Evaporator fan motors
 - Capacitors
 - Start relays
 - Solenoid valves
 - Defrost heaters
 - Defrost time clocks
 - Programmable electronic system controller
 - Phase loss monitors
 - Compressor modules
 - Discharge line thermostats
 - Oil pressure safety switches
 - Drain line heaters
 - Demand cooling modules
 - Defrost termination controls
 - Evaporator fan motor fan delays
 - Low pressure switch time delays
 - Fan cycling controls
 - Double suction risers – varying capacity units

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Knowledge Areas of Technician Expertise

Service (continued)

- REPAIR
 - Refrigerant circuit on coils
 - Refrigerant leaks
 - Electrical wiring
 - Leaking seals through building structure
 - Damaged piping insulation
 - Broken drain line
 - Cleanable liquid screens
 - Rebuildable control valves - solenoids, pressure control, heat reclaim, etc.
 - Metering device
- REPLACEMENTS
 - Condenser / condensing units
 - Compressors
 - Condenser fans (motors, blades, and mounts)
 - Condenser coils
 - Evaporator fans(motors/blades/mounts)
 - Evaporator coils
 - Evaporator defrost heaters
 - Metering devices
 - Transformers
 - Liquid line filter-driers
 - Suction line filters
 - Suction accumulators
 - Receivers (vessels & relief)
 - Relays and contactors
 - Capacitors
 - Compressor safety controls
 - Drain line heaters
 - Distributor nozzles
 - Evaporator drain pans
 - Head pressure controls F
 - an cycling controls
- SYSTEM CLEANUP AFTER COMPRESSOR ELECTRICAL FAILURE
 - Compressor
 - Metering device
 - Oil / acid test
 - Oil changing procedures
 - Changing compressor start components
 - Cleanup filters - suction
 - Cleanup driers - acid and moisture
 - Suction accumulator - change or clean out

KATES Knowledge Areas of Technician Expertise

Service (continued)

- COMPONENT CHECKS - REFRIGERATION
 - Compressor
 - Metering device
 - Filter-drier
 - Suction line - oil traps, risers, etc.
 - Liquid line - vertical height, static pressure loss, etc.
 - Solenoid valves
 - Condensate drains
 - Check valves
 - Evaporator and condenser coils
 - Flow control valves - pressure control, heat reclaim, etc
 - Suction pressure
 - Discharge pressure
- PARALLEL PIPE REFRIGERATION
 - Rack systems
 - Basic operation
 - Oil management
 - Piping
 - Controls operation

OVERVIEW OF ELECTRICAL TROUBLESHOOTING

- LOW VOLTAGE CIRCUITS
 - Definition
 - Microprocessors
 - Voltage tests
 - Control string analysis
 - Understanding the logic of low voltage troubleshooting
 - Troubleshooting equipment with electronic devices
 - Troubleshooting with schematics
 - Troubleshooting without schematics
 - Current tests
 - Equipment continuity tests
 - Ground tests
- LINE VOLTAGE CIRCUITS
 - Definition
 - Voltage tests
 - Current tests
 - Component tests
 - Circuit tracing line voltages
 - Troubleshooting with schematics
 - Troubleshooting without schematics
 - Equipment continuity tests
 - Ground tests – Wye and Delta

KATES Knowledge Areas of Technician Expertise

Service (continued)

- MOTOR WINDING WIRING
 - Single phase
 - Three phase
 - Part winding start
 - Permanent split capacitor

RETROFITTING EQUIPMENT

- COMPONENT RETROFITTING
 - Changing out condenser / condensing unit
 - Understanding design temperature difference (TD)
 - Matching to evaporator for proper system balance
 - Changing out an evaporator
 - Matching proper metering device, nozzle, and drier selections
 - Modifying unit placement and any piping/electrical changes
 - Match evaporators to condensing unit and application
- COMPLETION OF APPROPRIATE FORMS
 - Start up form
 - System diagrams
 - Understanding readings from forms
 - Analyzing system performance
 - Instrument list, including calibration dates

BASIC REFRIGERATION SYSTEM ANALYSIS

- NOISE PROBLEMS
 - Interpreting supply / return air volume Interpreting supply / return air velocity
 - Noise problems
 - Motor / belt noise
 - Vibration
 - Metering device noises
 - Solenoid chattering
 - Contactor chattering
 - Defrost heater creeping
 - Compressor noise

KATES Knowledge Areas of Technician Expertise

Service (continued)

- HIGH UTILITY BILLS
 - Interpreting supply / return air temperature
 - Interpreting supply / return air volume
 - Evaluating room air leakage
 - Evaluating damaged doors or panels - gaskets, door closers, etc.
 - Room envelope infiltration
 - Thermostat air sensing/ placement/ calibration
 - Compressor performance
 - System performance
 - Control settings
 - Frosting/icing of evaporator
 - Refrigerant charge
 - Fan motor operation (evaporator & condenser)
 - Drain line air leakage and icing of evaporator
- WIDE TEMPERATURE SWINGS
 - Interpreting supply / return air temperature
 - Interpreting supply / return air volume
 - Evaluating compressor performance
 - Evaluating system performance
 - Room envelope infiltration
 - Thermostat air sensing/ solenoid
 - Thermostat coil sensing placement/ calibration
 - Product location
 - Control settings
 - Check product loading patterns
 - Check product temperature when loaded
 - Check air patterns around refrigerator
 - Check worker door discipline
 - Check for fluctuating power conditions
 - Check system TD
 - Check TEV operation
 - Check system filter-driers for high pressure drop
 - Checking current & voltage with name plate data

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Knowledge Areas of Technician Expertise

Service (continued)

ANALYZING REPORTED SYMPTOMS IN COOLING

- POOR COOLING
 - Interpreting supply / return air flow
 - Determining TD – Room temperature & SST
 - Interpreting system refrigerant charge
 - Interpreting compressor performance
 - Interpreting system performance
 - Interpreting control settings
 - Interpreting product location and loading patterns
 - Calculating frost loading on evaporator
 - 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 Evaluating frosting on evaporator
 - Evaluating door management
 - Determining seal damage through building structure
 - Evaluating air infiltration
 - Evaluating system balance and humidity relationship
 - Flowers and meat cutting rooms
 -

KATES Knowledge Areas of Technician Expertise

System Components

INTRODUCTION TO SYSTEMS

- Heat transfer
 - Heat transfer
 - Basic refrigeration circuit
 - Dynamic analysis of temperatures and pressure in the refrigerant circuit
 - Understanding seasonal effects
 - Psychrometrics
 - Subcooling
 - Superheat
- SPLIT SYSTEMS
 - Introduction to split system configurations and applications
 - Equipment locations and mounting
 - Basic pipe sizing
 - Electrical layouts for split systems
 - Refrigerant circuits for split systems
 - Specifications for split systems
 - Regional considerations in split system designs
 - Refrigerant circuits for multiple evaporator systems
 - Specifications for ultra-low ambient designs
 - Specifications for high humidity designs
 - Specifications for low humidity designs
 - Specifications for high ambient designs
 - Specifications for hanging evaporators
 - Specifications for special local code compliances
 - Introduction to refrigerant pipe layout in split systems
- PACKAGED REFRIGERATION SYSTEMS
 - Introduction to package configurations
 - Equipment locations for package units
 - Basic placement designs for packaged equipment
 - Electrical layouts with packaged units
 - Packaged equipment in “drop through” applications
 - Packaged equipment in “side mount” applications
 - Packaged equipment for indoor applications
 - Packaged equipment for outdoor applications
 - Controls & settings for packaged cooler equipment
 - Controls & settings for packaged freezer equipment
 - Regional considerations in packaged equipment
 - Specifications for packaged equipment
 - Applications for packaged systems
-

KATES Knowledge Areas of Technician Expertise

System Components (continued)

- MULTI-CAPACITY SYSTEMS
 - Overview of multi-capacity systems
 - Sequencing of multi-capacity refrigeration systems Refrigerant circuits of multi-capacity systems
 - Hot gas by-pass usage Cylinder unloading Frequency drive usage VFD
 - Piping considerations
 - Oil management considerations

WIRING LAYOUTS

- POWER WIRING
 - Definition
 - Overview of power wiring
- LOW VOLTAGE
 - Definition
 - Overview of low voltage wiring
- CONTROL SEQUENCE
 - Overview of control sequence used in split systems
 - Overview of control sequence used in packaged systems

COMPONENTS

- CONDENSERS
 - Types - basic designs (air/ water/ evaporative) Head pressure controls
 - Fan cycling controls
 - Multiple circuited basic designs Multiple circuited seasonal designs Subcooling circuits
 - Heat reclaim systems
- RECIPROCATING COMPRESSORS
 - Fundamentals of reciprocating compressor operations Design considerations of compressors
 - Compressor components
 - Compressor efficiency check
- SCROLL COMPRESSORS
 - Fundamentals of scroll compressors
 - Scroll compressor components
 - Design considerations of scroll compressors advanced features
 - Compressor efficiency check
- SCREW COMPRESSORS
 - Fundamentals of screw compressors
 - Screw compressor components
 - Design considerations of screw compressors advanced features
 - Compressor efficiency check

KATES Knowledge Areas of Technician Expertise

System Components (continued)

- REFRIGERANTS
 - P/E chart
 - Refrigerants used in commercial refrigeration
 - Properties of refrigerants used commercial refrigeration
 - Using temperature-pressure chart/tables
 - Refrigerant conservation
 - Characteristics of blends/ temperature glide/ and fractionation
- SERVICE VALVES
 - Schrader valves
 - One way (front seating) service valves
 - Two-way (back seating) service valves
 - Gauge port
- REFRIGERANT CIRCUIT ACCESSORIES
 - Receivers & reliefs
 - Accumulators
 - Filter- driers
 - Sight glasses, moisture indicators, liquid indicators, etc.
 - Mufflers / muffler plates
 - Oil safety controls
 - Head pressure controls
 - Oil separators
 - EPR/ CPR/ hot gas bypass
 - Flow control valves - heat reclaim, etc
 - Condenser fan cycling
 - Condenser fan dampers
 - Condenser split circuits
- EVAPORATOR COILS
 - Basic designs and operating characteristics
 - Selection basics
 - Types of defrosts components and controls
 - Condensate drains and traps
- REFRIGERANT METERING DEVICES - VARIABLE
 - Metering devices- types and operation, with check valves, bi-directional
 - Role of distributors in variable metering devices
 - Externally equalized
 - Thermostatic charges
 - Off cycle pressure equalization
 - Selection of TEV's - Superheat setting, charge
 - Electric & electronic valves

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Knowledge Areas of Technician Expertise

System Components (continued)

- REFRIGERANT METERING DEVICES - FIXED
 - Basics of operation - capillary tubes
 - Basics of operation - expansion valves
 - Orifice
 - Role of distributor in metering device performance
 - Adjustments for required superheat
- ELECTRICAL COMPONENTS
 - Fuses and breakers
 - Capacitors
 - Solenoids
 - Crankcase heaters
 - Drain line heaters
 - Transformers
 - Fan cycling controls
 - Time delays
 - Phase loss monitors
 - Contactors & relays
 - Current sensing relay
 - Defrost heaters (drain pan and coil)
 - Fan delays
 - Defrost terminators
 - Defrost time clocks
 - Damper actuators
 - Compressor modules
 - Demand cooling modules
 - Auxiliary contacts
 - Room temperature thermostat
 - Heater limit switches
 - Pump down switches
 - Thermal overloads
 - Discharge line thermostat
 - Electric disconnects
 - Electronic system controller
- Fans
 - Introduction to indoor fans
 - Introduction to outdoor fans
 - Indoor fans - types and selection
 - Outdoor fans - types and selection
 - Fan performance
 - Cycling methods
 - Basic control characteristics

KATES Knowledge Areas of Technician Expertise

System Components (continued)

- AIR SIDE COMPONENTS
 - Dampers & baffles Fan filters
 - Fan Guards(wire & plastic)
 - Fabric duct
 - Air stack
- LINE SETS
 - Introduction to line sets
 - Selecting line sets
 - Application considerations when using line sets
- LUBRICANTS
 - Mineral oil-basedrefrigerants and properties
 - Alkylbenzenes (AB)
 - Polyol Esters (POE)
 - Lubricant / system compatibility
 - Evaluating lubricants after removal from system
 - Disposal of lubricants
 - High tem breakdown
- CONSTANT AIRFLOW MOTORS
 - Intro to variable speed motors - ECM, BPM, and VSIM
 - Motor mounting and installation requirements
 - Electronic interface and setting for airflow requirements

ELECTROMECHANICAL SENSING CONTROLS

- ELECTROMECHANICAL SPACE THERMOSTATS
 - Basic thermostat types and operation
 - Thermostat terminals and wiring
 - Using electromechanical space thermostats
 - Selecting space thermostats
- ELECTROMECHANICAL TEMPERATURE CONTROLS
 - Introduction to bimetal controls
 - Disc type temperature limit controls
 - Introduction to vapor charged controls
 - Overview of electricheater high limit controls
 - Motor overloads
 - Fuses and fuse links
 - Fan delay control
 - Defrosttermination control

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Knowledge Areas of Technician Expertise

System Components (continued)

- PRESSURE CONTROLS
 - Introduction to disc type pressure controls and hi/low controls
 - Selection of disc type pressure controls
 - Using disc type pressure controls

REFRIGERANT CIRCUIT CONTROLS

- PRESSURE CONTROLS
 - High pressure controls
 - Low pressure controls
 - Oil failure safety controls
 - Head pressure control
 - Fan cycling
 - Loss of charge
 - Dual pressure controls

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
- DEFROST TIME CLOCKS
 - Introduction to defrost timers
 - Basic wiring for off-cycle operation
 - Basic wiring for electric/hot gas defrosting
 - Basic wiring for reverse cycle air defrost operation
 - Basic wiring for water defrost operation
 - Basic settings

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Knowledge Areas of Technician Expertise

System Components (continued)

ELECTRONIC CONTROLS

- ELECTRONIC THERMOSTATS
 - Fundamentals of electronic thermostats
 - Selecting electronic thermostats
 - Overview of electronic thermostat operation
- ELECTRONIC COMPRESSOR CONTROLS
 - Solid-state pressure transducer
 - Compressor staging controls
 - Compressor time delays
- ELECTRONIC DEFROST TIMERS
 - Introduction to defrost timers
 - Basic wiring for off-cycle operation
 - Basic wiring for electric/hot gas defrosting
 - Basic settings
- OVERVIEW OF ELECTRONIC CONTROLLERS
 - Communication
 - Input / output operations
 - Logic
- ELECTRONIC PRESSURE CONTROLS
 - High pressure controls
 - Low pressure controls
 - Dual pressure controls
 - Fan cycling controls
 - Differential controls
 - Modulating controls

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Knowledge Areas of Technician Expertise

Applied Knowledge: Regs, Codes, and Design

EPA Regulations

- EPA EMISSIONS
 - Fresh air supplies
- EPA REFRIGERANT REGULATIONS
 - Applicable leakage rates

Electrical Code

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

Regulations and Codes

- STATE AND LOCAL REGULATIONS
 - State requirements for technicians
- CODES
 - Plumbing
 - Municipalities
 - Emissions or reliefs
 - Health and sanitation
 - Fire (NEC, UL, local)

Fire Protection Regulations and Codes

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

KATES Knowledge Areas of Technician Expertise

Applied Knowledge (continued)

Design Considerations - General

- Temperature
 - Designing for capacity
 - Using ASHRAE standards
- Humidity
 - Using the evaporator TD to control humidity
 - Role of humidity in quality of products
 - Using ASHRAE standards
- Sound Level
 - Equipment location considerations
 - Isolation, mounting pad, duct, and structure
 - Sound attenuation insulation techniques
- REGIONAL REGULATIONS
 - Seismic constraints
 - Tornado or hurricane proof
 - Refrigerant relief/ purge ventilation
 - Wiring protection
 - Wiring/power interlocks
 - Access safety measures

Design Considerations - Components

- ACCESSORIES
 - Start components
 - Filter-driers - When to use? and How to select? (replaceable core vs. welded construction)
 - Flare vs. sweat connections
 - E.P.R. and C.P.R. valves
 - Room thermostat options
 - Accumulators - When to use? and How to select?
 - Defrost time clocks options
 - Time delays
 - Crankcase heaters
 - Low ambient controls
 - Oil separators
 - Heated & insulated receivers
 - Lock-out relays
 - Hold-out relays
 - Current sensing relays
 - Lead-lag options
 - Receivers
 - Head pressure controls
 - Capacity control options
 - Liquid-to-suction heat exchangers

KATES Knowledge Areas of Technician Expertise

Applied Knowledge (continued)

Design Considerations - Commercial

- PACKAGED SYSTEMS
 - Package system configurations and design
 - Equipment locations design
 - Applications for packaged systems
 - Condensate drain piping design
 - Electrical layouts with packaged systems
 - Packaged equipment “drop in” applications
 - Packaged equipment “sidemount” applications
 - Packaged equipment outdoor applications
 - Packaged equipment indoor applications
 - Regional considerations in packaged equipment
 - Specifications for packaged equipment
- SPLIT SYSTEMS
 - System designs- pad / roof mounting
 - Refrigerant piping
 - Equipment location
 - Electrical layouts
 - Accumulators
 - Condensate drains and traps
 - Defrost options
 - Regional design considerations
 - Oil separators
 - Secondary condensate drains / pans
 - Mounting of equipment
 - Piping insulation
 - Specifying equipment
- REMOTE SYSTEMS
 - System designs- basement, attic, etc.
 - Refrigerant piping
 - Equipment location
 - Electrical layouts
 - Accumulators
 - Condensate drains and traps
 - Defrost options
 - Regional design considerations
 - Oil separators
 - Secondary condensate drains / pans
 - Mounting of equipment
 - Piping insulation
 - Specifying equipment
 - Fresh/ supply air consideration for condenser

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Knowledge Areas of Technician Expertise

Applied Knowledge (continued)

Mechanical Code

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

Industry Standards

- EQUIPMENT STANDARDS
 - Introduction to industry standards
 - ARI standards for ratings
- SYSTEM STANDARDS
 - Introduction to industry standards
 - ASHRAE standards

KATES Knowledge Areas of Technician Expertise

Applied Knowledge (continued)

Bids and Proposals

- SYSTEM SIZING
 - Survey of requirements
 - Selecting equipment
 - Sizing components - high / low side
 - Adding accessories
- ESTIMATING INSTALLATION
 - Design/build
 - Installation price
 - Understanding proposal forms
 - Understanding bid forms - bid to specs and flat rate pricing
 - Legal implications of a bid
- SIZING REFRIGERANT LINES
 - Capacities of refrigerant lines
 - Effects of improper sizing or trapping
 - Effects of fittings, pressure drop, and insulation on system performance
 - Understanding special system designs
- CONDENSATE LINES
 - Effects of improper trapping
 - Effects of improper heating & insulating
- ELECTRICAL
 - Effects of electrical power on system devices
 - Electrical analysis - power