Certifying the finest in HVACR

Air to Air Heat Pump Installation KATE

Knowledge Areas of Technician Expertise

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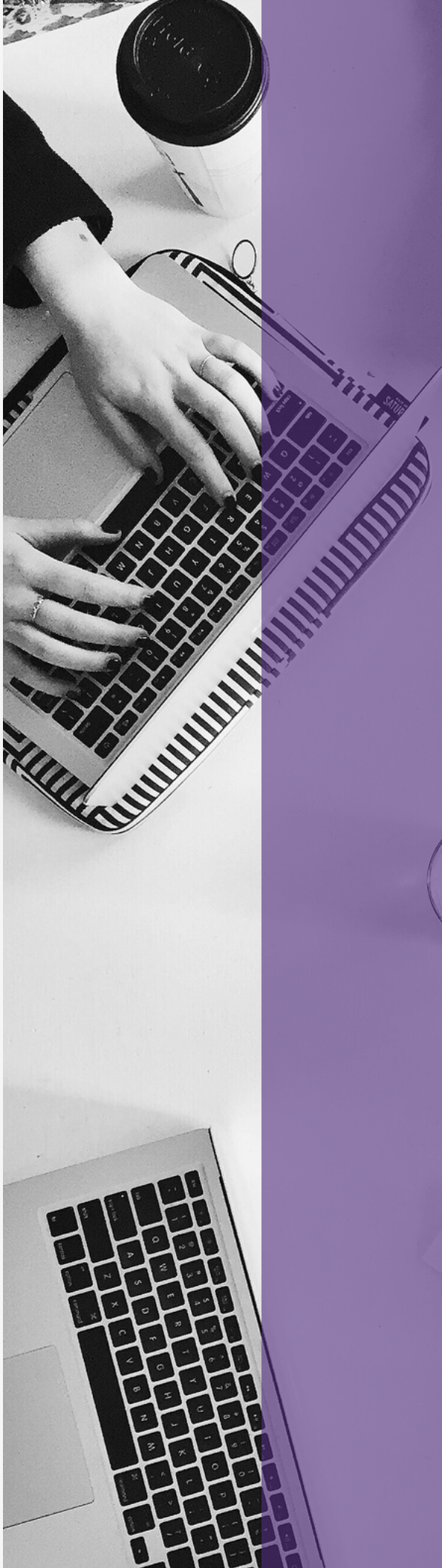


Air-toAir Heat Pump- Installation Specialty Exam

Exam Information & Qualifications

The Air to Air Heat Pump - Installation 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 installation 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 an installation technician and technical training for theoretical knowledge.

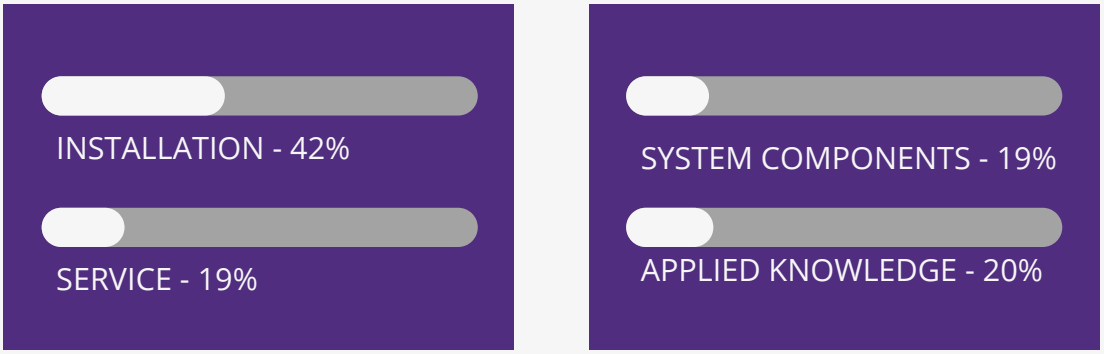
Exam Copyrights

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-Hydronics 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
- orth 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 preperation 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 outdoor temperature sensors
  - Setting balance point for dual fuel applications
- 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 - checking equipment match
  - 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
- Leak Detection Tools
  - Soap solution
  - Electronic leak detectors
  - Ultrasonic leak detector
  - Use of dye leak detectors

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

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
- Airflow Pressure Measurements
  - Overview of static pressure measurements
  - Electronic manometer / pressure measurement
  - Gauge / meter calibration
  - Absolute vs. Gauge Pressure

KATES Knowledge Areas of Technician Expertise

Installation (continued)

- 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 and Design Tools
  - Using manufacturer's airflow charts and tables
  - Using a duct calculator and design charts

Duct Fabrication

- Fabrication Techniques for Metal Duct
  - Seam types - Pittsburgh and snap lock
  - Joint Types - drive cleats, reinforced drive cleats, "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

Retrofitting

- Equipment Component Retrofitting
  - Changing out an outdoor unit
  - Changing out an indoor unit
  - Modifying ductwork for replacement equipment

KATES Knowledge Areas of Technician Expertise

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 checks
  - Compressor circuits
  - Condenser fan circuits
  - Indoor blower circuits
  - Thermostat circuits
  - Transformer circuits
  - Defrost control circuits
  - Indoor auxiliary heat circuits
  - Reversing valve solenoid circuits
  - Electronic controllers - input / output
- Electrical Component Checks
  - Thermostat
  - Transformers
  - Overcurrent protection
  - Relays and contactors
  - Condenser fans
  - Indoor blowers
  - Solenoid valves coils
  - Defrost termination control
  - Outdoor thermostats
- Repair
  - Refrigerant circuit on coils
  - Ductwork
  - Electrical wiring
- Replacements
  - Outdoor units
  - Indoor coils

KATES Knowledge Areas of Technician Expertise

Service (continued)

Introduction to Electrical Troubleshooting

- Low Voltage Circuits
  - Voltage tests
  - Equipment continuity tests
- Line Voltage Circuits
  - Voltage tests
  - Component continuity tests
  - Ground tests
  - Current Tests

System Components

Introduction to Systems

- Heat Transfer Principles
  - Heat transfer - evaporation and condensation
  - Basic refrigeration circuit - components
  - Temperature and pressure in the refrigerant circuit
- 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

KATES Knowledge Areas of Technician Expertise

System Components (continued)

- 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
  - Adjust airflow per capacity requirements
- The Basic Heat Pump Refrigerant Circuit
  - 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 materials - metal, ductboard, flexible duct, PVC, etc.
  - 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.
  - Duct locations - attic, basement, crawlspace, slab, roof, furr down, and exposed
  - Fitting nomenclature - plenum, transition, elbow, round duct, rectangular duct, turning vanes, wyes, and sheet metal duct joints

KATES Knowledge Areas of Technician Expertise

System Components (continued)

Wiring Layouts

- Power Wiring
  - Overview of single and three-phase wiring
- Low Voltage
  - Overview of low voltage wiring

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 Valves
  - Front and back seating service valves
  - Gauge port (e.g., king valve, 2 or 3 position service valve)
- 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
  - Role of indoor blowers
  - Role of outdoor fans

KATES Knowledge Areas of Technician Expertise

System Components (continued)

- Line Sets
  - Introduction and selection of line sets
  - Application considerations when using or reusing line sets
- Air Side Components
  - Outside air dampers, ventilation fillings, economizers
  - Electronic air cleaners (EAC's) Electrostatic filters - non-electric, Media type filters
  - Insulating material
  - Flexible duct materials
- Grilles, Registers, & Diffusers
  - Types and uses
- Fasteners
  - Screws, bolts, nuts, washers, lockpins, rivets, etc.
- Electrical Components
  - Overcurrent protection, capacitors, solenoids, crankcase heaters, transformers, etc.
  - Auxiliary heat
- Reversing Valves
  - Basics of operation and components
- Constant Airflow Motors
  - Motor mounting and installation requirements
  - Electronic interface and setting for airflow requirements

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
- Outdoor thermostats
  - Outdoor temperature controls

KATES Knowledge Areas of Technician Expertise

System Components (continued)

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
- Electric 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 controllers

KATES Knowledge Areas of Technician Expertise

Applied Knowledge: Regs, Codes, and Design

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

KATES Knowledge Areas of Technician Expertise

Applied Knowledge (continued)

Design Considerations - Comfort

- Temperature
  - Designing for capacity
- Indoor Air Quality
  - Outside air
- 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
- 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

KATES Knowledge Areas of Technician Expertise

Applied Knowledge (continued)

Design Considerations - Components

- Diffusers, Registers, And Grilles
  - Selecting diffusers, grilles, and registers (for capacity, throw, spread, pressure drop, and reduced sound)
  - Modifying locations
- 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

Mechanical Code

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