



Certifying the  
finest in HVACR

# Hydronics Gas Service

# KATE

Knowledge Areas of  
Technician Expertise

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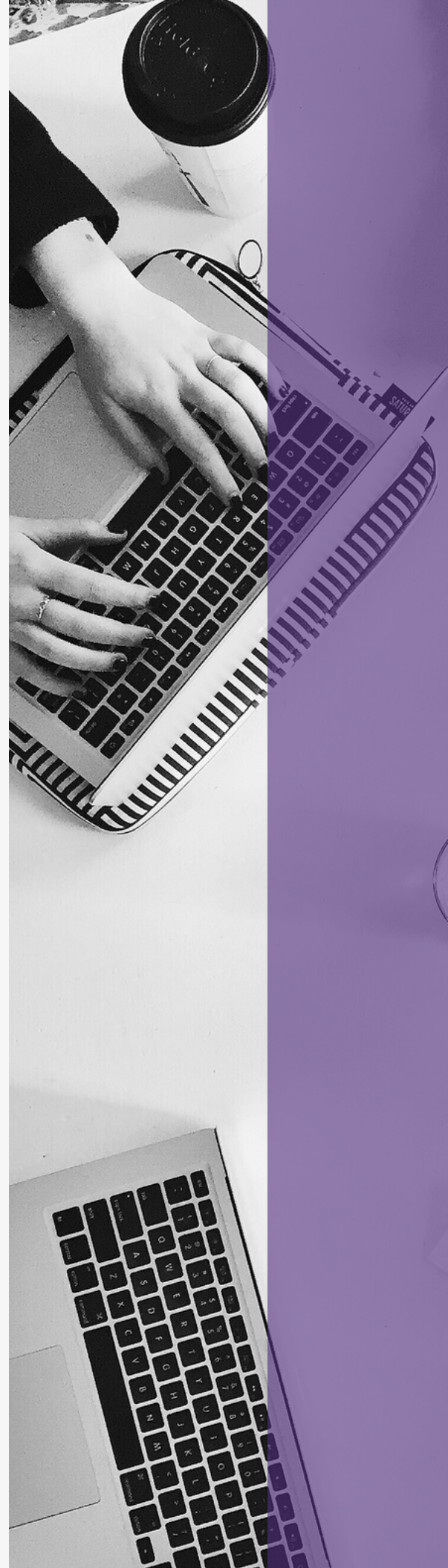
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KATES



# Hydronics Gas - Service Specialty Exam

## Exam Information & Qualifications



The Hydronics - 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 Hydronics Gas candidates have an 80% likelihood of encountering at least once during the year on a national basis. Suggested requirement is two years of field experience working on Gas Hydronics systems as a service technician and technical training for theoretical knowledge.

## Exam Copyrights

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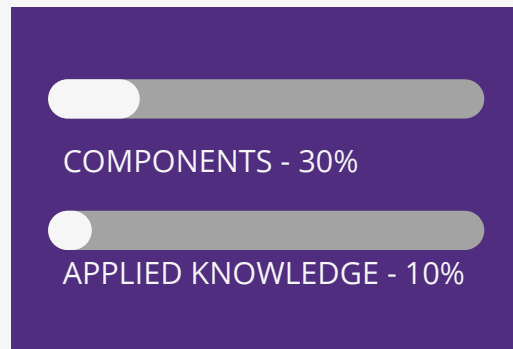
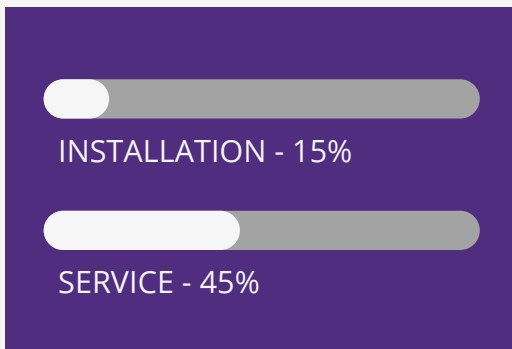
## Passing Score Development Process



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-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
- 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
- HVAC Duct Construction Standards - Metal and Flexible
- Air Diffusion Council Flexible Duct Performance & Installation Standards
- 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



# 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 **Hydronics Gas - Service Exam** and should be used as reference material.

### Installation

- INSTALLING GAS BOILERS SELECTING GAS BOILER SITES
  - Locating boilers in attics Locating boilers in crawlspaces Locating boilers in closets Locating boilers in basements Locating boilers in utility rooms Locating boilers in garages Locating boilers outdoor
- PLACEMENT OF BOILERS
  - How to place boilers in attics
  - How to place boilers in crawlspaces How to place boilers in closets How to place boilers in basements
  - How to place boilers in utility rooms How to place boilers in garages How to place boilers outdoor
- INSTALLATION OF UTILITIES
  - Installation of gas piping Installation of field wiring Convert from natural gas to LP Pressure testing
- INSTALLATION OF METAL VENTING SYSTEMS
  - Determination of routing
  - Cutting of metal vent systems to proper length Assembly of metal vent systems
  - Securing of metal vent systems Installation of vent termination
- INSTALLATION OF PVC / ABS VENTING SYSTEMS
  - Determination of routing
  - Cutting PVC & ABS pipe to proper length Dry-fitting the assembly
  - Sealing PVC pipe Sealing ABS pipe Securing of pipe
  - Installation of vent termination
- INSTALL CONDENSATE DRAINS -CONDENSING BOILERS
  - Determination of routing
  - Cutting PVC pipe to proper length Dry- fitting the assembly
  - Sealing PVC pipe Securing of pipe
  - Installation of condensate drainpan - attic installations Installation of condensate drain pumps

# KATES Knowledge Areas of Technician Expertise

## Installation (continued)

- INSTALLATION OF COMBUSTION AIR INLET ACCESSORIES
  - Combustion air inlets in confined spaces - attics
  - Combustion air inlets in confined spaces - basements
  - Combustion air inlets in confined spaces - closets
  - Combustion air inlets in confined spaces- crawlspaces
  - Installation of powered combustion air intakes
- SIZING GAS BOILERS
  - Sizing for structure capacity
  - Sizing for domestic water capacity
  - Sizing for radiant capacity
  - Sizing for total capacity
  - Sizing for snow melt capacity

## DUCT INSTALLATION FOR HOT WATER HEATING SYSTEMS

- DUCT FAB EQPMNT - INSTALL/REPAIR DUCTS TO HW COILS
  - 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.
- FIELD CONSTRUCTION/INSTALL-CONNECTING HW COILS
  - Duct board installation technique
  - Techniques for joining dissimilar duct
  - Duct of alternate materials- wood, aluminum, etc.
  - INSTALL/REPAIR METAL DUCT - CONNECTING HW COILS
    - Assembly methods for rectangular duct
    - Installation technique - rectangular metal
    - Assembly methods for round duct
    - Installation technique - round metal
    - Hanging duct work
    - Sealing metal duct
    - Insulation - internal and external, vapor barriers
    - Assembling for low noise and low pressure drop
- INSTALL/REPAIR FLEXIBLE DUCT - CONNECTING HW COILS
  - Assembly methods- appropriate length
  - Flexible duct joints
  - Hanging flexible duct
  - Installation technique - flex duct
  - Sealing flexible duct
- INSTALL/REPAIR DUCTBOARD- CONNECTING HW COILS
  - Assembly methods for duct board - supports
  - Installation technique - duct board
  - Hanging methods for duct board
  - Sealing ductboard



# KATES Knowledge Areas of Technician Expertise

## Installation (continued)

- INSTALL GRILLE, REGISTER, DIFFUSER, DAMPER-HWCOIL
  - Mounting to ductwork
  - Securing methods
- CHASES USED AS DUCTS FOR HOT WATER COIL SYSTEMS
  - Floor joists as air ducts
  - Vertical chases
- REPAIR DUCT WHEN REPLACING EQUIPMENT- HW COILS
  - Reconnecting metal duct
  - Reconnecting flexible duct
  - Reconnecting ductboard duct
- INSTALL/REPAIR OF PLENUMS & DUCT - HW COIL SYSTEMS
  - Sizing plenums for physical fit
  - Types and styles of plenums selected
  - Insulation of plenums and ducts

## HYDRONIC COMPONENT INSTALLATION

- INSTALLATION OF HEATING COMPONENTS (EMITTERS)
  - Sizing and placement of baseboard units
  - Sizing and placement of kickspace heaters
  - Sizing and placement of unit heaters
  - Sizing and placement of duct mounted heating coils
  - Sizing and placement of hot water coil air handlers Sizing and placement of heating units
  - Sizing and placement of air vents (manual or auto)
  - Sizing and placement of domestic hot water heating
  - Sizing and placement of radiant panels-floor and ceiling
  - Sizing and placement of radiators
  - Sizing, placement, and conversion of steam radiators to hot water radiators
  - Sizing, placement, and conversion of steam systems to hot water systems
- INSTALLATION OF COMPONENTS
  - Location, selection, and sizing of circulators
  - Location and sizing of Expansion tanks
  - Location of Air Separators
  - Location of Pressure Reducing Valve Location of Backflow Preventer Location and sizing of Relief Valves Location of Zone Valves
  - Location of Flow Check Devices Location of indirect hot water heating Location and placement of heat emitters Location of Low water cutoffs
  - Location of manual reset aquastats
  -

# KATES

Knowledge Areas of  
Technician Expertise

### Installation (continued)

- INSTALLATION OF PIPING SYSTEMS
  - Installation of Series-loop system
  - Installation of One-pipe system
  - Installation of Two-pipe system(Reverse return)
  - Installation of two-pipe system (direct return)
  - Installation of Primary-secondary pipingsystem
  - Installation of multiple zone systems
  - Installation of system bypassand boiler bypasspiping
  - Installation of Indirect Water Heaters
  - Installation of Low Water Cutoffs
  - Installation of directwater heaters
  - Installation and selection of antifreeze solutions

### Installing Accessories

- Wiring Units and Control Wiring
  - Sizing and connecting electrical power to manufacturer's requirements
  - Connecting control circuits
- INSTALLING THERMOSTATS
  - Locating and mounting
  - Wiring electromechanical thermostats
  - Wiring electronic thermostats
  - Programming of electronic thermostats
  - Installation of Outdoor Reset Controls
- INSTALLING HUMIDIFIERS
  - Installing humidifiers Wiring humidifiers Controlling humidifiers
- INSTALLING ELECTRONIC AIR CLEANERS
  - Installing electronic air cleaners
  - Wiring electronic air cleaners
  - Controlling electronic air cleaners

# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### Start-Up and Checkout

- Pre-Start Procedures
  - Gas supply and proper shutoff Electrical
  - Adequate combustion air provisions Venting system
  - Coils connected to ducted systems Condensate system
  - Filling and purging boiler and piping system
- Start-Up Procedures and Checks
  - Voltage checks
  - Check thermostat and set heat anticipator Motor checks
  - Water circulation checks
  - Airflow checks for coils connected to ducted systems
  - Check call for heat sequences
  - Manifold gas pressure check
  - Flame quality check
  - Firing rate
- Leak Detection Tools
  - Soap solution
  - Electronic leak detectors
  - Ultrasonic leak detector
  - Pressurization for leak detection
  - Meter calibration and maintenance

### Airflow - Ducted Systems With Hot Water Coils

- AIRFLOW VELOCITY MEASUREMENTS
  - Pitot tube and manometer in measuring static pressure
  - Discharge velocity equipment
  - Velometer - electronic and mechanical
  - Anemometer
  - Velocity measurement procedures
  - Gauge calibration
  - Velocity

# KATES

Knowledge Areas of  
Technician Expertise

## Installation (continued)

### Refrigerant Circuit Tools

- 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
- AIR VOLUME MEASUREMENTS
  - Airflow hood
  - Formulae for determining CFM of air Formulae for weight of air
  - Locations for air volume measurements Airflow volume - CFM / SCFM (StaticCFM)

### Water Measurements

- TEMPERATURE MEASUREMENTS
  - Temperature Rise Temperature Drop
- WATER PRESSURE MEASUREMENTS
  - Pressure Requirements Pump head
  - Static fill pressure Pressure Drop
- WATER VOLUME MEASUREMENTS
  - GPM Requirements
- FREEZE PROTECTION FLUID
  - Checking and correcting acidity

# KATES

## Knowledge Areas of Technician Expertise

### Service

#### Planned Maintenance

- SYSTEM MECHANICAL PM CHECKS
  - Filters - check and change Lubrication
  - Cabinet care
  - Fan blades/ blower scroll Gas connections
  - Flue / vent stack inspection Combustion air supply
  - Duct inspection for systems with hot water coils installed in ducts Heat exchanger - inspection, cleaning, replace gaskets etc
  - Burner assembly System airflow Expansion tank Water treatment Circulators
- COMBUSTION PM CHECKS
  - Sequence of operation checks Air intake / exhaust
  - Flame color Flame size Ignition Temperature rise
- ELECTRICAL PM CHECKS
  - General wiring Induced draft motor Supply air motor Operation sequence
  - Thermostat calibration and operation Fan switch and high limit control Limit controls operation
  - Aquastat operation
  - Low Water Cut Off (LWCO) Operation

#### Diagnostics and Repair

- TROUBLESHOOTING SEQUENCE OF OPERATION
  - Check for proper sequence of operation
  - Interpreting system fault during sequence interruption
- ANALYZING REPORTED SYMPTOMS
  - Insufficient / no heat
  - Short cycle
  - Humidity problems
  - Drafty
  - Noise problems
  - System runs continuously High utility bills
  - Wide swings in room temperatures Air quality
  - Noisy conditions due to air in piping

# KATES

Knowledge Areas of  
Technician Expertise

### Service (continued)

- ANALYZING COMBUSTION
  - CO<sub>2</sub> and O<sub>2</sub> checks for efficiency
  - Balancing combustion, ventilation, primary and secondary air Analyzing air leaks and efficiency loss
  - Analyzing low draft-stack, overfire Analyzing excessive draft-stack, overfire Analyzing excessive draft on off cycle
  - Interpreting steady state efficiency measurements - stack loss calculations
- SYSTEM AIR SIDE DIAGNOSTICS - SYSTEMS W/ HW COILS
  - Temperature checks
  - Checking system static pressure Checking total CFM
  - Checking supply CFM at registers and diffusers Checking return CFM
  - Checking for leaks in supplies Checking for leaks in returns
- ELECTRICAL CIRCUIT CHECKS
  - Supply voltage Supply air blower Thermostat Transformers
  - Electronic controllers - input / output Flame rectification
  - Pilot ignition
  - Thermocouple / power pile generator Gas valve
- ELECTRICAL COMPONENT CHECKS
  - Thermostat
  - Transformers
  - Overcurrent protection Relays and contactors Capacitors
  - Pressure controls
  - Limit controls-high temperature Centrifugal switch
  - Door interlock switch Circulators
  - Zone valves
  - Boiler water controls (high limit, low limit, operating) Low water cut-off
  - Flow switch
- REPAIR
  - Electrical wiring
  - Electrical components
  - Fuel supply
  - Flue stack / venting system
  - Condensate / drain system
  - Piping repair
  -

# KATES

Knowledge Areas of  
Technician Expertise

## Service (continued)

- COMPONENT REPLACEMENTS
  - Transformers
  - Relays and contactors
  - Indoor blowers
  - Capacitors
  - Heat exchanger
  - Gas valve
  - Safety circuit switches
  - Draft motor
  - Pilot / ignitor assembly
  - Flame sensing rod
  - Circulators
  - Zone Valves for non-radiant systems
  - Zone Valves for radiant systems Boiler water controls
  - Bearing Assemblies
  - Low Water Cut Off (LWCO)
  - Indoor/Outdoor Resets
  - Modulating Valves
  - Mixing Valves
  - Boiler Protection
- VENT SYSTEM CHECKS
  - Natural / atmospheric draft Forced draft
  - Induced draft
- DIAGNOSING GAS COMBUSTION PROBLEMS
  - Flame "roll-out" Flame "lift-off" Discolored flame Intermittent flame  
Partial burner flame Delayed ignition Carbon build up Flashback
  - Trip on high limit Carbon Monoxide
- SYSTEM WATER SIDE DIAGNOSTICS
  - Temperature checks
  - Checking systemwater pressure
  - Checking zone valve operation
  - Checking supply GPM
  - Checking for leaksin supplies
  - Checking for leaks in returns
  - Checking low water cutoffs
  - Checking flow control valves
  - Checking mixing valves
  - Checking relief valves

# KATES

Knowledge Areas of  
Technician Expertise

## Service (continued)

### Overview of Electrical Troubleshooting

- LOW VOLTAGE CIRCUITS
  - 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
  - Voltage tests Current tests Component tests
  - Circuit tracing line voltages Troubleshooting with schematics Troubleshooting without schematics Equipment continuity tests
  - Ground tests

### Gas Pressure Measurements & Detection

- PRESSURE MEASUREMENTS
  - Manometer
  - Dial gauge
- LEAK DETECTION
  - Leak detection solution
  - Electronic leak detectors

### Air Balancing For Systems With Hot Water Coils

- GATHERING DESIGN INFORMATION
  - Interpreting system design
  - Interpreting specifications Interpreting equipment information Interpreting control data
  - Modifying system design



# KATES

## Knowledge Areas of Technician Expertise

### Service (continued)

- PREPARATION OF SYSTEM FOR TESTS
  - Locating registers, grilles, equipment, controls, dampers and valves in building walkthrough
  - Setting dampers and valves for tests
  - Setting thermostat for tests
  - Checking for proper fan pump operation and rotation
  - Checking for proper static pressure and temperature
- PROCEDURES FOR CONDUCTING AIR TESTS
  - Measurements of each supply outlet - total readings
  - Measurements of each return inlet - total readings
- MAKING ADJUSTMENTS
  - Adjust airflow to achieve required total airflow
  - Re- measure total supply and return grille airflow
  - Adjust dampers to obtain design airflow
  - Re-measure total water-flow and air-flow to verify that it is within design requirements
- FINAL TEST
  - Comparing manufacturer's equipment information with test results  
Record sheave, pulley, and belt sizes data
  - Test and record full load motor amperes Test and record voltage
  - 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
- COMPLETION OF APPROPRIATE FORMS
  - HVAC system report System diagrams
  - Duct traverse or data pulley forms Instrument list - including calibration dates

### Water Balancing

- GATHERING DESIGN INFORMATION
  - Interpreting system design
  - Interpreting specifications
  - Interpreting equipment information
  - Interpreting control data
  - Modifying system design

# KATES

## Knowledge Areas of Technician Expertise

### Service (continued)

- PREPARATION OF SYSTEM FOR WATER TESTS
  - Locating equipment and controls building walkthrough Setting equipment and controls for tests
  - Setting thermostat for tests
  - Checking for proper pump operation and rotation Checking for proper pressure and temperature
- PROCEDURES FOR CONDUCTING WATER TESTS
  - Measurements of each supply outlet - total readings Measurements of each return inlet - total readings
- MAKING ADJUSTMENTS
  - Adjust flow to achieve required total flow Re-measure total supply and return flow Adjust valves to obtain design flow
  - Re-measure total flow to verify that it is within +/- 10%
- FINAL TEST
  - Comparing manufacturer's equipment information with test results Record equipment data
  - Test and record full load motor amperes Test and record voltage
  - Test and record motor and pump RPM with visible components Test and record supply and return pressures
  - Test and record supply and return temperatures - heat and cool
- COMPLETION OF APPROPRIATE FORMS
  - HVAC system report System diagrams
  - Instrument list - including calibration dates

### Basic HVAC System Analysis

- NOISE PROBLEMS
  - Interpreting supply/ return water volume Noise problems
  - Pump cavitation Oil canning Motor / belt noise Vibration
- HIGH UTILITY BILLS
  - Interpreting supply/ return water temperature
  - Interpreting supply / return water volume Evaluating Leakage
  - Evaluating
  - Insulation
  - Envelope infiltration
  - Thermostat location and adjustment

# KATES Knowledge Areas of Technician Expertise

### Service (continued)

- WIDE TEMPERATURE SWINGS
  - Interpreting supply/ return water temperature Interpreting supply / return water volume Interpreting Leakage
  - Interpreting Insulation Envelope infiltration Thermostat air sensing
- SINGLE AREA IS HOT OR COLD
  - Interpreting supply/ return water temperature Interpreting supply / return water volume Evaluating Leakage
  - Evaluating Insulation Envelope infiltration Thermostat air sensing Zone Valves Circulator
  - Circulatorcontrols Venting
  - Variable speed pumps Multi- zone controls
  - Set point boiler protection
- INDOOR AIR QUALITY
  - Number of air changesper hour Odor control
  - Contaminants
  - Humidity

### Analyzing Reported Symptoms in Heating

- IMPROPER HEATING
  - Interpreting supply/ return water temperature (TD)
  - Interpreting supply / return water volume
  - Interpreting system sizing
  - Evaluating leakage
  - Temperature
  - Drop/Riseof air in ducted hot water coil systems
  - Zone Valves
  - Circulators
  - Circulator controls
  - Outdoor Reset
  - Control Venting
- HUMIDITY PROBLEMS
  - Interpreting Low Humidity
  - Interpreting High Humidity
  - Interpreting Correct Humidity
- DRAFTY
  - Interpreting supply/ return water and air temperature
  - Interpreting supply / return water and air volume

# KATES

Knowledge Areas of  
Technician Expertise

## System Components

### Introduction to Basic Systems & Components

- Heat Transfer and the Basic Cooling Cycle
  - Fundamentals of heat transfer
  - Psychrometrics

### Boiler Configurations & Applications

- BOILER CONFIGURATIONS
  - Gravity hot water Forced hot water
  - Diverter T
  - Series loop Direct return Reverse return Pump Return
  - Air handling systems Zone Control
  - Wet-base Dry- base
  - Horizontal Tube
  - Copper fin boilers
  - Condensing Boilers
  - Wall hung boilers
  - Near boiler piping
  - Radiant
  - Primary / secondary loop piping
- GAS BOILERS WITH SPLIT OR HYDRO-AIR AC SYSTEMS
  - Introduction to gas boiler with split system
  - AC Electrical layouts
  - Specifications
  - Attic layouts
  - Crawlspace layouts
  - Closet layouts
  - Basement layouts
  - Ventilation options
  - Regional considerations

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Combustion Process for Gas Boiler Systems

- COMBUSTION - NATURAL GAS
  - Describe methane's role in combustion
  - Describe carbon dioxide as a product of combustion Describe air's role in combustion
  - Describe carbon monoxide as a product of combustion
- COMBUSTION - MANUFACTURED GAS (LPG)
  - Describe commercial propane's role in combustion Describe commercial butane's role in combustion
- FUNDAMENTALS OF GAS COMBUSTION SYSTEMS
  - Category I - Negative pressure vent - non-condensing Category II - Negative pressure vent - condensing Category III - Positive pressure vent - non-condensing Category IV - Positive pressure vent - condensing

### Natural Draft Gas Boiler - Components

- HEAT EXCHANGERS
  - Cast Iron Steel Stainless Steel
- BURNERS
  - Describe ribbon/slot burners In-shot burners
  - Power burners

### COMBUSTION AIR REQUIREMENTS

- OUTDOOR AIR SPECIFICATIONS
  - Attic applications Crawlspace applications Closet applications Basement applications Outdoor applications
- INDOOR AIR SPECIFICATIONS
  - Attic applications Crawlspace applications Closet applications Basement applications

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Air Distribution For Systems with Hot Water Coils

- DUCT SYSTEMS
  - Duct system design Duct configurations
  - Return configurations Return grille locations Supply locations
- SUPPLY BLOWERS
  - Introduction to supply blowers Supply blowers - types and selection
  - Blower operation
  - Fan laws

### HYDRONIC DISTRIBUTION

- WATER DISTRIBUTION
  - Pumps
  - Two way valves Three way valves Diverter tee systems
- PIPING SYSTEM
  - Piping system design Piping configurations
- FLUID FLOW
  - Introduction to circulators Zone Valves
  - Flow Checks Mixing valves Thermostatic valves Diverter tee systems
  - Balancing Zones
  - Compression / expansion tanks

### Wiring Layouts

- POWER WIRING
  - Power wiring for boiler
  - Power wiring for split system
  - Air Handler
- LOW VOLTAGE
  - Overview of low voltage wiring
  - Zone control wiring
  - Outdoor reset wiring

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Natural Draft Gas Boiler - Operation

- GAS BOILER - OPERATION
  - Overview of operation for standing pilot boiler Overview of operation for intermittent pilot boiler Overview of operation for direct ignition boiler
- STANDING PILOT IGNITION
  - Basics of operation Flame switch type Thermocouple type
- INTERMITTENT PILOT IGNITION
  - Spark ignited pilots
  - Hot surface ignited pilots
- DIRECT IGNITION
  - Spark ignited
  - Hot surface ignited pilots
- VENT SYSTEMS
  - Fundamentals of atmospheric draft systems Horizontal vent systems
- SEQUENCE OF OPERATION
  - Typical operation for standing pilot boiler
  - Typical operation for intermittent pilot boiler
  - Typical operation for direct ignition boiler
- CONTROL FUNCTIONS
  - Fan control
  - Heat limit control Roll- out switch
  - Flame proving Gas valve

### Induced Draft Non-Condensing - Components

- HEAT EXCHANGERS
  - Cast Iron Steel
  - Stainless steel
- BURNERS
  - Ribbon/slot burners
  - In-shot burners
- INDUCED DRAFT BLOWERS
  - Introduction
  - Role in system operation

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Induced Draft Non-Condensing - Operation

- GAS BOILER - OPERATION
  - Standing pilot boiler Intermittent pilot boiler Direct ignition boiler
- STANDING PILOT IGNITION
  - Basics of operation Flame proving
- INTERMITTENT PILOT IGNITION
  - Spark ignited pilots
  - Hot surface ignited pilots
- DIRECT IGNITION
  - Spark ignited
  - Hot surface ignited pilots
- VENT SYSTEMS
  - Vertical vent systems Horizontal vent systems
- SEQUENCE OF OPERATION
  - Typical operation for standing pilot boiler Typical operation for intermittent pilot boiler Typical operation for direct ignition boiler
- CONTROL FUNCTIONS
  - Venting fan control Heat limit control Roll-out switch Flame proving
  - Air pressureproving switch Gas valve
  - Pump/circulator control Ignition control
  - Gas pressureproving switch

### Induced Draft Condensing - Components

- HEAT EXCHANGERS
  - Cast Iron Steel
  - Stainless steel
  - Aluminum
  - Secondary heat exchanger
- BURNERS
  - In-shot burners
- INDUCED DRAFT BLOWERS
  - Introduction
  - Role in system operation



# KATES Knowledge Areas of Technician Expertise

## System Components (continued)

### Induced Draft Condensing - Operation

- GAS BOILER - OPERATION
  - Intermittent pilot boiler
  - Direct ignition boiler
- INTERMITTENT PILOT IGNITION
  - Spark ignited pilots
  - Hot surface ignited pilots
- DIRECT IGNITION
  - Spark ignited
  - Hot surface ignited pilots
- VENT SYSTEMS
  - Vertical vent systems
  - Horizontal vent systems
- SEQUENCE OF OPERATION
  - Intermittent pilot boiler
  - Direct ignition boiler
- CONTROL FUNCTIONS
  - Fan control
  - Heat limit control
  - Roll-out switch
  - Flame proving
  - Air pressureproving switch Gas valve
  - Door interlocks Ignition control
  - Gas pressure provingswitch

### Non-Sensing Controls

- RELAYS AND CONTACTORS
  - Relay and contactor operation - inrush and holding Selecting relays and contactors
  - Applications for relays and contactors
- GAS VALVES - SINGLE STAGE
  - Construction Operation
  - Slow opening valves Snap opening valves Step opening valves
- GAS VALVES - TWO STAGE
  - Construction Operation

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Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Ignition Control Systems

- OVERVIEW OF IGNITION CONTROLS
  - Elements of gas boiler ignition systems
  - Ignition controls for natural draft / standing pilot boiler / manually lit ignition controls for induced draft / intermittent pilot spark ignition systems
  - Ignition controls for induced draft / intermittent pilot hot surface ignition systems Ignition controls for induced draft / direct ignition / spark ignition systems Ignition controls for induced draft / direct ignition / hot surface ignition systems
- STANDING PILOT
  - Components and functions Ignition sequence
  - Safety
- INTERMITTENT PILOT
  - Components and functions Ignition sequence
  - Safety
- DIRECT IGNITION
  - Components and functions
  - Ignition sequence
  - Safety

### Electronic Controls

- ELECTRONIC CONTROLLERS
  - Input / output operations
  - Logic
- ELECTRONIC THERMOSTATS
  - Fundamentals of electronic thermostats
  - Selecting electronic thermostats
  - Electronic thermostat operation
  - Outdoor Reset Controllers for non-zone systems
  - Outdoor Reset Controllers for zone systems (pump and/or zone valves)
- ELECTRONIC TIMERS
  - Blower delay timers

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Knowledge Areas of  
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## System Components (continued)

### Electromechanical Sensing Controls

- ELECTROMECHANICAL WALL THERMOSTATS
  - Thermostat types and operation Selecting wall thermostats and sub-bases Thermostat terminals and wiring
  - Using electromechanical thermostats Selecting location
  - Role of anticipators in thermostatic control
- ELECTROMECHANICAL TEMPERATURE CONTROLS
  - Bimetalcontrols
  - Disc type temperature limitcontrols
  - Fuses and fuse links
  - Motor overloads
- PRESSURE CONTROLS
  - Operation of pressure controls
  - Using pressure controls
  - Air proving pressure switch
  - Gas provingpressure switch

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Knowledge Areas of  
Technician Expertise

## Applied Knowledge (continued)

### Regulations for Environmental Protection

- INDOOR AIR QUALITY
  - Fresh air supplies

### ELECTRICAL CODE

- ELECTRIC REQUIREMENT
  - Overview of electric code
  - Overcurrent protection
  - Wiring methods and materials
  - Line voltage wiring sizing
  - Low voltage wiring sizing
  - Conduit sizing
  - Definitions
  - Safety listings - UL / ARL / ETL

### State and Local Regulations and Codes

- STATE AND LOCAL REGULATIONS
  - State requirements for technicians
  - Use of Carbon Monoxide detectors
  - Smoke detector requirements
  - Gas detectors
- CODES
  - Plumbing Municipalities
  - Gas boiler for Lt. Commercial
  - Gas boiler for Residential

### Fire Protection Regulations and Codes

- REQUIRED COMPONENTS
  - Return air sensors
  - Fire dampers
  - Smoke dampers
  - Components
- COMBUSTION AIR
  - Sizing air intakes in confined spaces
  - Sources of combustion air

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Knowledge Areas of  
Technician Expertise

## Applied Knowledge (continued)

- BOILER ACCESS
  - Access to boiler for service
  - Access to utilities for service
- GAS PIPING
  - Sizing for capacity
  - Length limitations
  - Attachment to appliance
- INSTALLATIONS
  - Installation of gas burning equipment
- FIRE PREVENTION
  - Overview of fire prevention
- VENTING REQUIREMENTS
  - Specifications for venting
  - Types of venting systems to be used

## Design Considerations - Comfort

- TEMPERATURE
  - Designing for capacity
  - Using industry standards
- HUMIDITY
  - Role of humidity in comfort
  - Using industry standards
- INDOOR AIR QUALITY
  - Ventilation - comfort Air cleaning for comfort
  - Industry standards for air quality
- SOUND LEVEL
  - Equipment location considerations
  - Isolation, mounting pad, duct, and structure

# KATES Knowledge Areas of Technician Expertise

## Applied Knowledge (continued)

### Design Considerations - Gas Boiler Equipment

- GAS BOILERS WITH SPLIT OR HYDRO-AIR AC SYSTEMS
  - System designs- closets, basements, etc.
  - Equipment location
  - Electrical layouts
  - Ventilation - fresh air
  - Regional design considerations
  - Combustion flue gases
  - Ventilation - equipment
  - Condensate drains / pans
  - Mounting of equipment
  - Combustion air
  - Fuel gas atmospheric burner- forced air system
- COMBUSTION GAS VENTING
  - Sizing flue pipe
  - Flue pipe layout
  - Adapting vent draft control - damper
  - Roof fittings - cap, collar, flashing, etc.
  - Pipe types - PVC and B-metal

### Design Considerations - External Components

- FLUID DISTRIBUTION ACCESSORIES
  - Distribution for capacity including baseboard, floor, kick-space, panel and other emitters
  - Distribution for reduced sound including baseboard, floor, kick-space, panel and other emitters
  - Locations
- AIR SIDE ACCESSORIES
  - Humidifier sizing
  - Twinning kits
  - Electronic air cleaners (EAC's)
  - Selecting diffusers, grilles, registers for systems with distribution devices in ducts.
- MECHANICAL CODE COMBUSTION AIR
  - Air intakes confined spaces

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Knowledge Areas of  
Technician Expertise

## Applied Knowledge (continued)

### Mechanical Code

- COMBUSTION AIR
  - Air intakes in confined spaces
  - Sources of combustion air
- BOILER ACCESS
  - Access to boiler for service Access to utilities for service
- GAS PIPING
  - Sizing for capacity Length limitations
  - Attachment to appliance
- WATER PIPING
  - Cross Contamination/backflow prevention

### Industry Standards

- EQUIPMENT STANDARDS
  - Performance and safety standards
  - Efficiency requirements
  - Manufacturers specifications
- SYSTEM STANDARDS
  - Industry standards BIDS AND PROPOSALS SYSTEMSIZING
  - Survey of requirements
  - Selecting equipment
  - Sizing components
  - Adding accessories
  - Basic calculation of heating loads
- ESTIMATING INSTALLATION
  - Installation price Understanding proposal forms
  - Understanding bid forms - bid to specs and flat rate pricing
  - Legal implications of a bid
- EFFECT OF ELECTRICAL SUPPLY ON BID
  - Effects of electrical power on bid
  - Electrical analysis - power

