



Certifying the  
finest in HVACR

# Gas Furnace Installation

# KATE

Knowledge Areas of  
Technician Expertise

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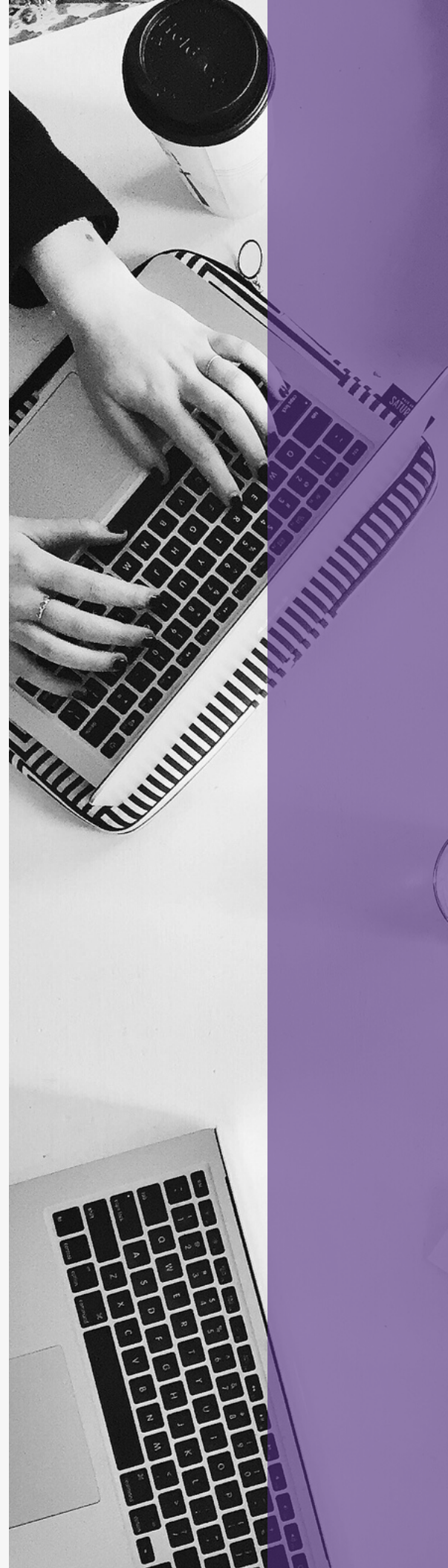
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KATES



# Gas Furnace - Installation Specialty Exam

## Exam Information & Qualifications



The Gas Furnace - Installation specialty exam tests a candidate's knowledge of the installation, service, maintenance, and repair of HVAC systems. System sizes are limited to 400,000 BTU or less heating 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 Gas Furnaces 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 Gas Furnaces systems as an installation technician and technical training for theoretical knowledge.

## Exam Copyrights

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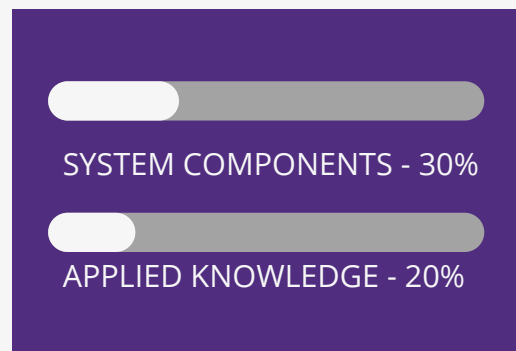
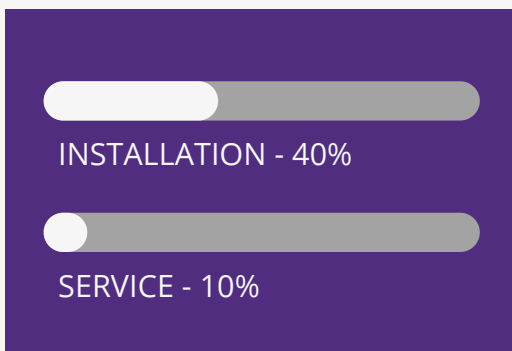
## Passing Score Development Process



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

# Exam Subject Areas

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



## Exam Specifications:



Passing Score: Pass/Fail



2.5 Hour Time Limit



Closed Book



100 Questions

# Industry References

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



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

**References continue on next page**

# Industry References (continued)

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



# KATES

## Knowledge Areas of Technician Expertise

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

## Installation

### Installing Gas Furnaces

- Selecting Gas Furnace Sites
  - Locating furnaces in attics
  - Locating furnaces in crawlspaces
  - Locating furnaces in closets
  - Locating furnaces in basements
  - Locating furnaces in utility rooms
  - Locating furnaces in garages
  - Locating packaged furnaces on rooftops
  - Locating packaged furnaces for outdoor installations
- Mounting Furnaces
  - How to suspend horizontal furnaces in attics
  - How to suspend horizontal furnaces in crawlspaces
  - How to mount horizontal furnaces on attic floors
  - How to mount upflow / downflow furnaces in closets
  - How to mount upflow / downflow furnaces in basements
  - How to mount upflow / downflow furnaces in utility rooms
  - How to mount upflow / downflow furnaces in garages
  - How to mount packaged furnaces on rooftops
  - How to mount packaged furnaces for outdoor installations
- Connecting Utilities
  - Connection of gas piping
  - Connection of field wiring

# KATES

Knowledge Areas of  
Technician Expertise

### Installation (continued)

- 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
- Installation of Condensate Drains for Cond. Furn.
  - Determination of routing
  - Cutting PVC pipe to proper length
  - Dry-fitting the assembly
  - Sealing PVC pipe Securing of pipe
  - Installation of condensate drain pan - attic installations
  - Installation of condensate drain pumps

### 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.
- Field Construction/Installation
  - Ductboard installation technique Techniques for joining dissimilar duct
  - Duct of alternate materials - wood, aluminum, etc.



# KATES

Knowledge Areas of  
Technician Expertise

### Installation (continued)

- Installing Metal Duct
  - Assembly methods for rectangular duct
  - Installation technique - rectangular metal
  - Assembly methods for round duct
  - Installation technique - round metal
  - Hanging ductwork
  - Sealing metal duct
  - Insulation - internal and external, vapor barriers
  - Assembling for low noise and low pressure drop
- Installing Flexible Duct
  - Assembly methods - appropriate length Flexible duct joints
  - Hanging flexible duct Installation technique - flex duct
  - Sealing flexible duct
- Installing Ductboard
  - Assembly methods for ductboard - supports
  - Installation technique - ductboard
  - Hanging methods for ductboard
  - Sealing ductboard
- Installing Grilles, Registers, Diffusers, & Damper
  - Mounting to ductwork
  - Securing methods
- Chases Used as Duct
  - Floor joists as air ducts
  - Vertical chases
- 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 electromechanical thermostats
  - Wiring electronic thermostats
  - Programming of electronic thermostats
- Installing Humidifiers
  - Installing humidifiers
  - Wiring humidifiers
  - Controlling humidifiers
- Installing Electronic Air Cleaners
  - Installing electronic air cleaners
  - Wiring electronic air cleaners
  - Controlling electronic air cleaners
- Installing Economizers
  - Installing economizers
  - Wiring economizers
  - Controlling economizers

### Start-Up and Checkout

- Pre-Start Procedures
  - Gas supply and proper shutoff
  - Electrical
  - Adequate combustion air provisions
  - Venting system
  - Ductwork system
  - Condensate system

# **KATES** Knowledge Areas of Technician Expertise

## **Installation (continued)**

- Start-Up Procedures and Checks
  - Voltage checks
  - Check thermostat and set heat anticipator
  - Motor checks
  - Airflow checks
  - 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
  - Use of dye leak detectors
  - Pressurization for leak detection
  - Meter calibration and maintenance

## **Airflow Measurements**

- Introduction to Airflow Measurements
  - Introduction to airflow
  - Static pressure
- Airflow Velocity Measurements
  - Introduction to airflow velocity
  - Velometer - electronic and mechanical
  - Anemometer
  - Velocity measurement procedures
  - Gauge calibration

# KATES

Knowledge Areas of  
Technician Expertise

### Installation (continued)

- Airflow Pressure Measurements
  - Overview of static pressure measurements
  - Inclined manometer
  - Diaphragm type differential pressure gauge
  - U-tube manometer
  - Electronic manometer / pressure measurement
  - Gauge / meter calibration
  - Absolute vs. Gauge Pressure
- Airflow Volume Measurements
  - Introduction to volume
  - Airflow hood
  - Formulae for determining CFM of air
  - Formulae for weight of air
  - Locations for air volume measurements
- Airflow Checks and Design Tools
  - Using manufacturer's airflow charts and tables
  - Using a duct calculator and design charts

### Service

#### Diagnostics

- Startup Repairs
  - Electrical wiring
  - Electrical components
  - Fuel supply
  - Flue stack / venting system
  - Condensate / drain system

# **KATES** Knowledge Areas of Technician Expertise

## **Service (continued)**

### **Introduction to Electrical Troubleshooting**

- Low Voltage Circuits
  - Voltage tests
  - Current tests
  - Equipment continuity tests
  - Ground tests
- Line Voltage Circuits
  - Voltage tests
  - Current tests
  - Component tests
  - Circuit tracing line voltages
  - Equipment continuity tests
  - Ground tests
  - Polarity tests

## **System Components**

### **Introduction to Systems**

- Heat Transfer
  - Fundamentals of heat transfer
  - Basic gas furnace components
- Fundamentals of Gas Combustion
  - Types of gases - Natural and Manufactured
  - Requirements for proper combustion - fuel, air, heat
  - By-products from combustion

# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Furnace Configurations and Applications

- Gas Furnaces With Split System Air Conditioner
  - Introduction to gas furnace with split system
  - AC Electrical layouts
  - Specifications Attic layouts
  - Crawlspace layouts Closet layouts
  - Basement layouts
  - Ventilation options
  - Regional considerations
- Multi-Position Furnace
  - Four-way
  - Three-way
  - Two-way
- Packaged Gas Furnace Systems
  - Introduction to package gas furnace systems
  - Electrical layouts
  - Specifications
  - Single story applications
  - Multi-story applications
  - Applied with crawlspace duct designs
  - Ventilation options
  - Economizer options
  - Regional considerations

### Combustion Process for Gas Furnaces Systems

- Combustion - Natural Gas
  - Describe methane's role in combustion
  - Describe carbon dioxide as a product of combustion
  - Describe oxygen's role in combustion
  - Describe carbon monoxide as a product of combustion
  - Describe ethane's role in combustion

# KATES

Knowledge Areas of  
Technician Expertise

### System Components (continued)

- Combustion - Manufactured Gas
  - Describe liquefied petroleum's role in combustion
  - Describe butane's role in combustion
  - Describe propane's role in combustion
  - Describe oxygen'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 Furnace

- Operation
  - Overview of operation for standing pilot furnace
  - Overview of operation for intermittent pilot furnace
  - Overview of operation for direct ignition furnace
- Ignition
  - Basics of operation
  - Types of ignition systems
- Venting
  - Categories of venting systems
  - Types of venting systems
  - Construction materials
- Control Functions
  - Fan control
  - Heat exchanger limit control
  - Roll-out switch
  - Flame proving - flame switch and thermocouple
  - Gas valve
  - Door interlocks

# KATES

Knowledge Areas of  
Technician Expertise

### System Components (continued)

- Components
  - Heat exchangers
  - Burners

### Combustion Air Requirements

- Direct Vent (Outdoor Air) Specifications
  - Attic applications
  - Crawlspace applications
  - Closet applications
  - Basement applications
- Non-Direct Vent (Indoor Air) Specifications
  - Attic applications
  - Crawlspace applications
  - Closet applications
  - Basement applications

### Air Distribution

- Duct Systems
  - Duct system design
  - Duct configurations
  - Return configurations
  - Return grille locations
  - Supply locations
  - Duct locations - attic, basement, crawlspace, slab, roof, furr down, and exposed
  - Fitting nomenclature - plenum, transition, elbow, round duct, rectangular duct
- Supply Blowers
  - Introduction to supply blowers
  - Supply blowers - types
  - Blower operation



# KATES

Knowledge Areas of  
Technician Expertise

## System Components (continued)

### Wiring Layouts

- Power Wiring
  - Power wiring for package unit furnace
  - Power wiring for split system furnace
- Low Voltage
  - Overview of low voltage wiring

### Induced Draft Non-Condensing Furnace

- Operation
  - Overview of operation for standing pilot furnace
  - Overview of operation for intermittent pilot furnace
  - Overview of operation for direct ignition furnace
- Ignition
  - Basics of operation
  - Types of ignition systems
- Venting
  - Categories of venting system
  - Types of venting systems
  - Construction materials
- Control Functions
  - Fan control
  - Heat exchanger limit control
  - Roll-out switch
  - Flame proving - flame sensor and thermocouple
  - Pressure proving switch
  - Gas valve
  - Door interlocks
  - Ignition control

# KATES

Knowledge Areas of  
Technician Expertise

### System Components (continued)

- Components
  - Heat exchangers Burners
  - Induced draft blowers

### Induced Draft Condensing Furnace

- Operation
  - Overview of operation for intermittent pilot furnace
  - Overview of operation for direct ignition furnace
- Ignition
  - Basics of operation
  - Types of ignition systems
- Venting
  - Category IV venting system
  - Types of venting systems
  - Construction materials
- Control Functions
  - Fan control
  - Heat exchanger limit control
  - Roll-out switch
  - Flame proving - flame sensor and thermocouple
  - Pressure proving switch
  - Gas valve
  - Door interlocks
  - Ignition control
  - Condensate proving switch
- Components
  - Heat exchangers
  - Burners
  - Induced draft blowers

# KATES

Knowledge Areas of  
Technician Expertise

## Applied Knowledge: Regulations, Codes and Design

### Air Quality Regulations

- Indoor Air Quality
  - Fresh air supplies

### Electrical Code

- Requirements
  - Overview of electrical code
  - General wiring practices

### State and Local Regulations and Codes

- State and Local Regulations
  - State requirements for technicians
  - Use of Carbon Monoxide detectors
  - Smoke detector requirements
- Codes
  - Plumbing
  - Municipalities
  - Gas furnace for Lt. Commercial
  - Gas furnace for Residential

### Fire Protection Regulations and Codes

- Required Components
  - Return air sensors
  - Fire dampers
- Fire Prevention
  - Overview of fire prevention
- Venting Requirements
  - Specifications for venting
  - Types of venting systems to be used

# KATES

Knowledge Areas of  
Technician Expertise

## Applied Knowledge: Regulations, Codes and Design

### 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

### Design Considerations - Equipment

- Gas Furnaces With Split System Air Conditioner
  - 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

# KATES

Knowledge Areas of  
Technician Expertise

## Applied Knowledge: Regulations, Codes and Design

- Packaged Systems
  - System designs
  - Equipment location
  - Electrical layouts
  - Ventilation - fresh air
  - Mounting of equipment
  - Combustion air
- Combustion Gas Venting
  - Sizing flue pipe - ICC tables
  - Flue pipe layout - ICC tables
  - Adapting vent draft control - damper
  - Roof fittings - cap, collar, flashing, etc.
  - Pipe types - PVC and B-metal

### Design Considerations - Components

- Diffusers, Registers, and Grilles
  - Selection considerations
  - Locations
- Accessories
  - Humidifier locating
  - Electronic air cleaners (EAC's)

### Mechanical Code

- Combustion Air
  - Sizing air intakes in confined spaces
  - Sources of combustion air
- Furnace Access and Clearances
  - Access to furnace
  - Access to service panel
  - Combustible clearances
- Gas Piping
  - Length limitations
  - Attachment to appliance

# KATES

Knowledge Areas of  
Technician Expertise

## Applied Knowledge: Regulations, Codes and Design

- Packaged Systems
  - System designs
  - Equipment location
  - Electrical layouts
  - Ventilation - fresh air
  - Mounting of equipment
  - Combustion air
- Combustion Gas Venting
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