

**AIR DISTRIBUTION**

**Certification Information**

**Scope** - Tests a candidate's knowledge of the installation, service, maintenance, and repair of HVAC systems. System sizes are limited to 12,000 CFM or less airflow.

**Qualifications**

Y 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 a CORE SERVICE exam.

Y This test will measure what 80% of the Air Distribution candidates have an 80% likelihood of encountering at least once during the year on a NATIONAL basis.

Y Suggested requirement is two years of field experience working on Air Distribution systems as a service technician and technical training for theoretical knowledge.

**Test Specifications**

<table>
<thead>
<tr>
<th>Closed Book</th>
<th>2.5 Hour Time Limit</th>
<th>100 Questions</th>
<th>Passing Score: PASS/FAIL</th>
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<table>
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<tr>
<th>SECTION AREA DESCRIPTION</th>
<th>SECTION PERCENTAGE</th>
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<tbody>
<tr>
<td>Installation</td>
<td>20%</td>
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<tr>
<td>Service</td>
<td>40%</td>
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<tr>
<td>System Components</td>
<td>25%</td>
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<tr>
<td>Applied Knowledge</td>
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**Air Distribution Industry References**

The reference materials listed 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
  - “D”, “J”, “QI” - Quality Installation, and “S”
- ACCA Manuals “1” and “RS” - Latest Editions
- ACCA Residential Duct Diagnostics and Repair - Latest Edition
- AHRI-Hydonics Section-IBO/RAH Latest Edition
- International Mechanical Code - Latest Edition with Addendum
- International Plumbing Code - Latest Edition with Addendum
- Uniform Mechanical Code - Latest Edition with Addendum
- ENERGY 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
- 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

**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.

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Air Distribution - Low Pressure
Service

INSTALLATION

DUCT FABRICATION

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, shears, benders, breaks, hand formers, calipers, rulers, stapler, etc.

FABRICATION TECHNIQUES FOR METAL DUCT
Seam types - pittsburgh and snap lock
Joint types - drive slips, reinforced drive slips, "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

DUCT INSTALLATION

FIELD CONSTRUCTION / INSTALLATION
Ductboard installation technique
Techniques for joining dissimilar duct
Duct of alternate materials - wood, aluminum, etc.

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

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 DUCTS
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

AIRFLOW MEASUREMENTS

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

AIRFLOW PRESSURE MEASUREMENTS
Overview of static pressure measurements
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 (Static CFM)

SERVICE
AIR BALANCING
GATHERING DESIGN INFORMATION
Interpreting system design
Interpreting specifications
Interpreting equipment information
Interpreting control data
Modifying system design

PREPARATION OF SYSTEM FOR AIR TESTS
Locating registers, grilles, equipment, controls, and dampers in building walkthrough
Setting dampers for tests
Setting thermostat for tests
Checking for proper fan operation and rotation
Checking for proper static pressure and temperature

PROCEDURES FOR CONDUCTING AIR TESTS
Measurements of each supply outlet - 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 airflow to verify that it is within +/- 10%

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

BASIC HVAC SYSTEM ANALYSIS
NOISE PROBLEMS
Interpreting supply / return air volume
Interpreting supply / return air velocity
Noise problems
Blower cavitation
Oil canning
Motor / belt noise
Vibration

HIGH UTILITY BILLS
Interpreting supply / return air temperature
Interpreting supply / return air volume
Evaluating duct leakage
Evaluating duct insulation
Envelope infiltration
Thermostat air sensing

WIDE TEMPERATURE SWINGS
Interpreting supply / return air temperature
Interpreting supply / return air volume
Evaluating duct leakage
Evaluating duct insulation
Envelope infiltration
Thermostat air sensing

SINGLE AREA IS HOT OR COLD
Interpreting supply / return air temperature
Interpreting supply / return air volume
Evaluating duct leakage
Evaluating duct insulation
Envelope infiltration
Thermostat air sensing

INDOOR AIR QUALITY
Number of air changes per hour
Odor control
Contaminants

ANALYZING REPORTED SYMPTOMS IN COOLING
POOR COOLING
Interpreting supply / return air temperature
Interpreting supply / return air volume
Interpreting supply / return air velocity
Determining and interpreting the sensible heat ratio
Evaluating duct leakage
Using temperature drop across evaporator coil

HUMIDITY PROBLEMS
Interpreting wet bulb and dry bulb temperatures
Interpreting supply / return air volume
Determining and interpreting the sensible heat ratio
Evaluating duct leakage

DRAFTY
Interpreting supply / return air temperature
Interpreting supply / return air volume
Interpreting supply / return air velocity

ANALYZING REPORTED SYMPTOMS IN HEATING
POOR HEATING
Interpreting supply / return air temperature
Interpreting supply / return air volume
Interpreting supply / return air velocity
Evaluating duct leakage
Using temperature drop across evaporator coil

HUMIDITY PROBLEMS
Interpreting wet bulb and dry bulb temperatures
Interpreting supply / return air volume
Determining the need for additional humidity
Evaluating duct leakage

**DRAFTY**
- Interpreting supply / return air temperature
- Interpreting supply / return air volume
- Interpreting supply / return air velocity

**PLANNED MAINTENANCE**
**MECHANICAL PLANNED MAINTENANCE**
- Performance checks - heat exchanger temperature rise
- Fan blades / blower scroll
- Diffusers, grilles, and registers
- Lubrication of blowers

**AIRFLOW MEASUREMENTS**
**AIRFLOW CHECKS & DESIGN TOOLS**
- Using temperatures to determine airflow
- Using manufacturer's airflow charts and/or tables
- Measuring total supply and return airflow

**SYSTEM COMPONENTS**

**INTRODUCTION TO BASIC SYSTEMS & COMPONENTS**

**HEAT TRANSFER AND THE BASIC COOLING CYCLE**
- Heat transfer and cooling
- Basic refrigeration circuit - 10 components
- Dynamic analysis of temperatures and pressure in the refrigerant circuit.
- Psychrometrics
- Subcooling
- Superheat

**NON-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

**ELECTRIC HEAT CONTROLS**
- Sequencers - warp switch
- Sequencers - electronically sequenced relays

**DUCT SYSTEMS**

**BASIC DUCT SYSTEMS**
- Overview of duct systems for split and package systems
- Duct configuration - extended plenum
- Duct configuration - reducing extended plenum
- Duct configuration - perimeter radial
- Duct configuration - perimeter loop
- Duct configuration - overhead radial
- Duct configuration - branching flexible
- Duct configuration - concentric

**DUCT LOCATION**
- Attic
- Basement
- Crawlspace
- Slab
- Roof
- Furr down
- Exposed
- Chases

**BASIC ZONE SYSTEMS**
- Equipment zoned
- Air side zoned

**DUCT MATERIALS**
- Define / recognize ductboard
- Define / recognize metal duct
Define / recognize flexible duct
Define / recognize PVC pipe
Insulating material

FITTING NOMENCLATURE
Define / recognize plenum
Define / recognize transition
Define / recognize elbow - 90 degrees and 45 degrees
Define / recognize round duct
Define / recognize rectangular duct
Define / recognize turning vanes
Return configurations - ducted, central, etc.
Define / recognize wye - rectangular and round
Define / recognize damper - rectangular and round
Sheet metal duct joints - "s" and drive, snaplock, button lock, etc.

DAMPERS
Balancing
Splitters
Economizers
Fresh air
Fire

GRILLES
Types and uses
Selecting grilles by volume and velocity

REGISTERS
Types and uses
Selecting registers
Selecting registers by use of fan specifications
Selecting registers by air spread and throw capacity

DIFFUSERS
Types and uses
Selecting diffusers
Selecting diffusers by use of fan specifications
Selecting diffusers by air spread and throw capacity

FILTRATION SYSTEMS
Media type filters
Electronic air cleaners (EAC's)
Electrostatic filters - non-electric

VENTILATION SYSTEMS
Attic exhaust
Residential exhaust(s)
Lt. Commercial exhaust(s)
Heat / energy recovery ventilators
Infiltration

HUMIDIFIERS
Fundamentals of operation
Types
Duct material requirements
Installation support and location

BASIC GAS FURNACES
GAS HEAT - COMPONENTS
Define heat exchanger
Define limit controls
Define vent system
Define burners
Define fan controls
Define gas valve
Combustion air proving (pressure) switch

GAS HEAT - OPERATION
Define combustion air system
Air side requirements
Define sequence of operation
BASIC OIL FURNACES

OIL HEAT - COMPONENTS
  Define heat exchanger
  Define limit controls
  Define vent system
  Define oil burners

OIL HEAT - OPERATION
  Define combustion air system
  Air side requirements
  Define sequence of operation

BASIC AIR CONDITIONING / HEAT PUMPS

BASIC COMPONENTS
  Define evaporator
  Define condenser
  Define compressor
  Define metering device
  Reversing valves
  Defrost controls

BASIC OPERATION
  Define sequence of operation
  Air side requirements

BASIC AIRFLOW PRINCIPLES

INTRODUCTION TO AIRFLOW
  Velocity
  Static pressure
  Airflow volume - CFM / SCFM (Static CFM)

BLOWERS AND FANS
  Define sequence of operation
  Air side requirements
  Motor selection

ELECTRONIC CONTROLS

OVERVIEW OF ELECTRONIC CONTROLLERS
  Input / output operations
  Logic
  Electronic interface
  Tap boards

ELECTRONIC THERMOSTATS
  Fundamentals of electronic thermostats
  Selecting electronic thermostats
  Overview of electronic thermostat operation
  Electronic fossil fuel kits

ZONE CONTROLS
  Fundamentals of zone controls
  Selecting zone controls
  Typical zone control logic
  Bypass dampers
  Types of zone controls

ELECTRONIC COMPRESSOR CONTROLS
  Compressor staging controls
  Compressor time delays

ELECTRONIC TIMERS
  Introduction to blower delay timers

ECONOMIZER CONTROLLERS
  Dry bulb controllers
  Enthalpy controllers
  Potentiometers
  Sensors

ELECTROMECHANICAL SENSING CONTROLS
ELECTROMECHANICAL WALL THERMOSTATS

Basic thermostat types and operation
Thermostat terminals and wiring
Selecting wall thermostats and sub-bases
Using electromechanical thermostats

ELECTROMECHANICAL TEMPERATURE CONTROLS
Introduction to bimetal controls
Disc type temperature limit controls
Overview of electric heat high limits
Fuses and fuse links
Motor overloads
Fossil fuel kits

PRESSURE CONTROLS
Introduction to disc type pressure controls and hi/low controls
Selection of disc type pressure controls
Using disc type pressure controls
Low ambient cooling controls

ELECTROMECHANICAL OUTDOOR THERMOSTATS
Overview of outdoor thermostats
Outdoor thermostat wiring

APPLIED KNOWLEDGE: REGS, CODES, & DESIGN

AIR QUALITY REGULATIONS
INDOOR AIR QUALITY
Fresh air supplies

ELECTRICAL CODE
REQUIREMENTS
Overview of electrical code
Circuit breaker and fuse requirements
General wiring practices
Class I wire sizing
Class II wire sizing
Conduit sizing
Definitions

STATE AND LOCAL REGULATIONS AND CODES

STATE AND LOCAL REGULATIONS
State requirements for technicians

CODES
Plumbing
Municipalities
HVAC for Lt. Commercial

FIRE PROTECTION REGULATIONS AND CODES
REQUIRED COMPONENTS
Return air sensors
Fire dampers

FIRE PREVENTION
Overview

DESIGN CONSIDERATIONS - COMFORT
TEMPERATURE
Designing for capacity
Using standards

HUMIDITY
Role of humidity in comfort
Using standards

INDOOR AIR QUALITY
Ventilation - comfort
Air cleaning for comfort
Standards for air quality
Outside air

SOUND LEVEL
Equipment location considerations
Isolation, mounting pad, duct, and structure
**Duct systems - flex joints**

**ZONING**
- Single zone
- Multizone

**DESIGN CONSIDERATIONS - RESIDENTIAL**

**SPLIT SYSTEMS**
- Ventilation - fresh air
- Ventilation - equipment

**AIR BALANCING**
- Duct sizing
- Blower speed adjustments
- Damper position adjustments
- Measurement of air flow rate

**DESIGN CONSIDERATIONS - COMPONENTS**

**DIFFUSERS**
- Selecting diffusers for capacity
- Selecting diffusers for reduced sound
- Selecting diffusers for spread, throw, and pressure drop
- Locations

**GRILLES**
- Selecting grilles for capacity
- Selecting grilles for reduced sound
- Selecting location

**REGISTERS**
- Selecting registers for capacity
- Selecting registers for reduced sound
- Selecting registers for spread, throw, and pressure drop
- Locations

**DUCTS & FITTINGS**
- Specifying physical dimensions
- Sketching duct layout
- Duct fitting equivalency - EQ to duct size

**SPECIAL DUCTS & FITTINGS**
- Working drawings vs. Isometric drawings
- Markings and abbreviations for duct fitting and manufacturing
- Measurement for replacement of special duct or fitting

**STATIC PRESSURE LOSSES IN FILTRATION SYSTEMS**
- Filter grilles
- Electronic air cleaners (EAC's)
- Electrostatic
- Media type filters

**BLUEPRINT READING**
- Determination of dimension from scale blueprint / plans
- Introduction to blueprints/plans reading
- Visualizing duct layout from blueprints/plans

**MECHANICAL CODE**

**EQUIPMENT ACCESS**
- Minimum clearance
- Electrical disconnects
- Fire dampers

**REFRIGERANT LINE ROUTING**
- Support requirements
- Inspection requirements

**CONDESATE DRAINS**
- Materials
- Sizing

**INDUSTRY STANDARDS**

**EQUIPMENT STANDARDS**
Introduction to industry standards
ARI standards for ratings
SYSTEM STANDARDS
   Introduction to industry standards
   Industry standards

DESIGN CONSIDERATIONS - LIGHT COMMERCIAL
SPLIT SYSTEMS
   System designs - closets, basements, etc.
   Air distribution systems
   Ventilation - fresh air
   Ventilation - equipment

PACKAGED SYSTEMS
   System designs
   Economizers
   Ventilation - equipment

AIR BALANCING
   Duct sizing
   Blower speed adjustments
   Damper position adjustments
   Measurement of air flow rate
   Fan laws

BIDS AND PROPOSALS
SYSTEM SIZING
   Survey of requirements
   Selecting equipment
   Selecting accessories

PREPARATION FOR AIR DISTRIBUTION PROPOSAL
   Understanding forms for proposals and bids
   Understanding legal implications of a bid
\[ \frac{\text{CFM}_n}{\text{CFM}_0} = \frac{\text{RPM}_n}{\text{RPM}_0} \quad o = \text{old}, n = \text{new} \]

 CFM and RPM are interchangeable.

\[ \left( \frac{\text{CFM}_n}{\text{CFM}_0} \right)^2 = \frac{\text{Sp}_n}{\text{Sp}_0} \quad \text{OR} \quad \text{CFM}_n = \text{CFM}_0 \times \sqrt{\frac{\text{Sp}_n}{\text{Sp}_0}} \]

\[ \left( \frac{\text{CFM}_n}{\text{CFM}_0} \right)^3 = \frac{\text{BHP}_n}{\text{BHP}_0} \quad \text{OR} \quad \text{CFM}_n = \text{CFM}_0 \times \sqrt[3]{\frac{\text{BHP}_n}{\text{BHP}_0}} \]

\[ \text{AP} = \text{Sp}, \quad \text{CFM} = \text{GPM}, \quad \text{RPM} = \text{GPM} \]

**MAT** = \((\text{OAT} \times \%0A) + (\text{RAT} \times \%RA)\)

0 = Outside

T = Temperature

R = Return

M = Mixed

A = Air

**AC/Hr x Volume**

\[ \text{CFM} \times \frac{60 \text{min}}{\text{V}} = 4005 \times \text{Jvp} \]

\[ \text{VP} = (4:05)^2 \]

**Pressure (PSI) = 0.433 \times \text{Head (feet of water)}**

1 PSI = 27.72 IWC

1 IWC = 0.0360 PSI

**Pressure 1 x Volume 1 = Pressure 2 x Volume 2**

**Area** = \(1\pi \times \text{radius}^2\)

\[ A^2 + B^2 = C \]

**Diameter** = \(1\pi \times \text{Circumference}\)

\[ \text{ASP} \times 100 \]

FR = TEL \((\text{IWq100})\)

\[ \text{CFM} = \text{Velocity (fpm)} \times \text{Duct Area (ft}^2\) \]

**Btuhydronic \((H_2O \text{only}) = 500 \times \text{GPM} \times \text{AT}**

**Btuhensible \((\text{at sea level}) = 1.08 \times \text{CFM} \times \text{AT}**

**Btuhlatent \((\text{at sea level}) = 0.68 \times \text{CFM} \times A\text{Grains}**

**Btuhtotal \((\text{at sea level}) = 4.5 \times \text{CFM} \times A\text{Enthalpy}**

\[ (\text{Length} \times \text{Width}) \]

**Rectangular Duct Area \((\text{ft}^2) = \frac{144}{\text{Length} \times \text{Width}}**

**Round Duct Area \((\text{ft}^2) = \frac{576}{\text{1txdiameter}} (2650 \times 1)**

\[ mfd = \frac{27.72 \times \text{IWC}}{E} \]

\[ \text{CFM} = \text{Velocity (fpm)} \times \text{Duct Area (ft}^2\) \]

\[ \text{CFM} = (\text{Watts} \times 3.413) \]

\[ \text{Cr (Series)} = \frac{1}{1 + \frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_n}} \]

\[ \text{Cr (Parallel)} = C_1 + C_2 + \ldots + C_n \]
Pressure (PSIG), Vacuum (in. Hg)-Bold Italic Figures
To determine subcooling for 404A, 407C, and 4220, use BUBBLE POINT values (temperatures above 50°F -gray background)
To determine superheat for 404A, 407C, and 4220, use DEW POINT values (temperatures 50°F and below)

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Pressure (PSIG), Vacuum (in. of Hg) - Bold Italic Figures
To determine subcooling for 404A, 407C, and 4220, use BUBBLE POINT values (temperatures above 50°F - gray background)
To determine superheat for 404A, 407C, and 4220, use DEW POINT values (temperatures 50°F and below)