AIR DISTRIBUTION SERVICE CERTIFICATION

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

- 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. Once certification is obtained it lasts for five years.
- 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.
- 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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</thead>
</table>

Listed are the percentages of questions that will be in each section of the Air Distribution exam.

<table>
<thead>
<tr>
<th>SECTION AREA DESCRIPTION</th>
<th>SECTION PERCENTAGE</th>
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</thead>
<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>
<td>15%</td>
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</table>

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 “T” and “RS” - Latest Editions
- ACCA Residential Duct Diagnostics and Repair - Latest Edition
- AHRI-Hydronics 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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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, sheers, 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

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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

CONDENSATE 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
CFM_n \over CFM_0 = \frac{RPM_n}{RPM_0} \quad o = old, \quad n = new \quad CFM \text{ and RPM are interchangeable.}

\left(\frac{CFM_n}{CFM_0}\right)^2 = \frac{Sp_n}{Sp_0} \quad \text{OR} \quad \frac{CFM_n}{CFM_0} = \sqrt{\frac{Sp_n}{Sp_0}}

CFM_n = CFM_0 \times \frac{RPM_n}{RPM_0} \quad \text{OR} \quad \frac{CFM_n}{CFM_0} = \sqrt{\frac{Sp_n}{Sp_0}}

\left(\frac{CFM_n}{CFM_0}\right)^3 = \frac{BHP_n}{BHP_0} \quad \text{OR} \quad \frac{CFM_n}{CFM_0} = \sqrt[3]{\frac{BHP_n}{BHP_0}}

CFM_n = CFM_0 \times \sqrt[3]{\frac{BHP_n}{BHP_0}} \quad \text{OR} \quad \frac{CFM_n}{CFM_0} = \left(\frac{BHP_n}{BHP_0}\right)^{1/3}

Hydronics: \quad \Delta P = Sp. \quad CFM = \text{GPM}, \quad RPM = \text{GPM}

\text{MAT} = (OAT \times %OA) + (RAT \times %RA)

Btuhr hydronic (H_2O only) = 500 \times \text{GPM} \times \Delta T

Btuhr sensible (at sea level) = 1.08 \times \text{CFM} \times \Delta T

Btuhr latent (at sea level) = 0.68 \times \text{CFM} \times \Delta \text{Grains}

Btuhr total (at sea level) = 4.5 \times \text{CFM} \times \Delta \text{Enthalpy}

\text{CFM} = \frac{AC/\text{Hr} \times \text{Volume}}{60 \text{ min}}

V = 4005 \times \sqrt{V_p}

V_p = \left(\frac{V}{4005}\right)^2

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

1 \text{ IWC} = 0.0360 \text{ PSI}

1 \text{ PSI} = 27.72 \text{ IWC}

Pressure 1 \times \text{Volume 1} = Pressure 2 \times \text{Volume 2}

Area = \pi \times \text{radius}^2

A^2 + B^2 = C^2

\text{Diameter} = \frac{\text{Circumference}}{\pi}

\text{FR} = \frac{\text{ASP} \times 100}{\text{TEL}} \quad (\text{IWC}/100)

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

\text{Round Duct Area (ft}^2) = \frac{\pi \times \text{diameter}^2}{576}

mfd = \frac{(2650 \times I)}{E}

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

\text{CFM} = \frac{(\text{Watts} \times 3.413)}{(\Delta T \times 1.08)}

\text{C_T (Series)} = \frac{1}{\text{C}_1} + \frac{1}{\text{C}_2} + \ldots + \frac{1}{\text{C}_n}

\text{C_T (Parallel)} = \text{C}_1 + \text{C}_2 + \ldots + \text{C}_n
# Temperature Pressure Chart – at sea level

Pressure (PSIG), Vacuum (in. Of Hg) – Bold Italic Figures
To determine subcooling for 404A, 407C, and 422D, use BUBBLE POINT values (temperatures above 50°F – gray background)
To determine superheat for 404A, 407C, and 422D, use DEW POINT values (temperatures 50°F and below)

<table>
<thead>
<tr>
<th>TEMP. °F</th>
<th>22</th>
<th>134a</th>
<th>404A</th>
<th>407C</th>
<th>410A</th>
<th>422D</th>
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