OIL FURNACES 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 400,000 BTU or less heating capacity.

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.
- This test will measure what 80% of the **Oil Furnaces** 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 Oil Furnaces systems as a service technician and technical training for theoretical knowledge.

Test Specifications

Closed Book 2.5 Hour Time Limit 100 Questions Passing Score: PASS/FAIL

Listed are the percentages of questions that will be in each section of the **Oil Furnaces** exam.

SECTION AREA DESCRIPTION	SECTION PERCENTAGE
Installation	20%
Service	45%
System Components	25%
Applied Knowledge	10%

Oil Furnaces 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 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
- ASHRAE Standard-62.2 - Latest Edition with Addendum
- ANSI / ASHRAE Standard-152-2004 - 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
  - 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

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 Copyrights

Heating - Warm Air - Oil

Service

INSTALLATION

INSTALLING OIL FURNACES

SELECTING OIL TANK LOCATION

- Locating oil tanks outdoors - above ground
- Locating oil tanks outdoors - below ground
- Locating oil tanks in basements

SELECTING OIL 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 ground level 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 ground level installations

INSTALLATION OF PLENUMS AND DUCT

- Sizing plenums for physical fit
- Types and styles of plenums selected
- Insulation of plenums and ducts

INSTALLATION OF UTILITIES

- Installation of oil supply
- Installation of oil returns
- Wiring oil furnaces

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
- Installing power venters

INSTALLATION OF COMBUSTION AIR INLETS 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

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.

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 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

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

START-UP AND CHECKOUT PRE-START PROCEDURES

- Oil supply and proper shutoff
- Electrical
- Adequate combustion air provisions
- Venting system
- Ductwork system
- Condensate system for AC

START-UP PROCEDURES AND CHECKS

- Voltage checks
- Check thermostat and set heat anticipator
- Motor checks-burner motor, supply blower motor
- Airflow checks - static pressure
- Check call for heat sequences
- Oil supply checks

OIL BURNER ADJUSTMENTS
- Unit preparations
- Nozzle checks
- Electrode adjustments
- Air adjustment at burner
- Adjusting oil pressure
- Adjusting draft
- Checking smoke readings
- Smoke vs. Carbon Dioxide graph
- Final adjustments
- Measuring stack temperature
- Checking ignition
- Checking pump cutoff

COMBUSTION CHECKS
- Flame checks
- Stack temperature check
- Carbon Dioxide checks
- Smoke test
- Overfire draft check
- Breech draft check
- Oxygen checks
- Efficiency check
- Burner motor checks - output pressure, amp draw, etc.
- Supply and return airflow checks

LEAK DETECTION TOOLS
- Electronic leak detectors
- Ultrasonic leak detector
- Pressurization for leak detection

OIL BURNER COMBUSTION SETUP TOOLS

OIL PRESSURE MEASUREMENTS
- High pressure dial gauges
- Vacuum dial gauges

FLUE GAS ANALYSIS
- Draft gauge
- Smoke tester
- Carbon Dioxide analyzer
- Combustion efficiency slide rule
- Stack Thermometer

LEAK DETECTION - CO
- Carbon Monoxide detector - electrical
- Carbon Monoxide detector - manual-monoxor

SETUP
- Nozzle wrench
- Oiling cans
- Electrode/Nozzle gauge
- Flame mirror

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

PLANNED MAINTENANCE

SYSTEM MECHANICAL PM CHECKS

- Air filter checks and changeout
- Lubrication
- Packaged unit cabinet care
- Fan blades / blower scroll
- Flue / vent stack inspection
- Duct
- Heat exchanger - inspection, cleaning, replace gaskets etc
- System airflow
- Oil tank
- Combustion tests
- Combustion chamber inspection
- Barometric regulator
- Combustion air supply

BURNER MECHANICAL PM CHECKS

- Oil lines / connections
- Combustion air supply check and adjustment
- Nozzle replacement
- Oil pump-pressure, vacuum etc
- Pump strainers
- Oil filter cleaning and cartridge replacement
- Electrodes - clean, inspect and adjust
- Ohm cad cell and clean
- Combustion head
- Transformers
- Burner motor

ELECTRICAL PM CHECKS

- General wiring
- Power burner operation
- Burner motor operation
- Furnace supply air blower motor
- Furnace operating sequence
- Thermostat calibration and operation
- Fan switch and high limit control

DIAGNOSTICS AND REPAIR

TROUBLESHOOTING SEQUENCE OF OPERATION

- Check for proper sequence of operation
- Interpreting system at 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 - odors, fumes, etc.

ANALYZING COMBUSTION

Carbon Dioxide checks for efficiency
Interpreting a smoke test
Balancing excess air and the smoke test
Diagnosing air leaks and efficiency loss
Diagnosing low draft-stack, overfire
Diagnosing excessive draft-stack, overfire
Diagnosing excessive draft on off cycle
Interpreting steady state efficiency measurements - stack loss calculations
Interpreting oxygen content for combustion diagnostics

SYSTEM AIR SIDE DIAGNOSTICS

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
High voltage transformer
Low voltage transformer
Power burner
Room thermostat
Electronic controllers - input / output

ELECTRICAL COMPONENT CHECKS

Room thermostat
High voltage transformers
Low voltage transformers
Oil burner motor
Electrodes
Flame sensor/cad cell
Overcurrent protection
Relays and contactors
Capacitor - supply air blower
Limit control-high temperature
Door interlock switch
Supply air motor
Stack switches-flame proving

REPAIR EXCLUDING POWER BURNER

Electrical wiring
Flue stack / venting system
Combustion chamber-lining
Oil lines
Supply air blowers-shafts, bearings, mounts etc

REPAIR - POWER BURNERS

Output pressure adjustment
Bleeding air
Cleaning burner - end cone, blower wheel, blast tube, etc.
Clean and adjust electrodes

COMPONENT REPLACEMENTS

High voltage transformers
Low voltage transformers
Flame retention heads
Electrodes

- Nozzle
- Combustion chamber
- Heat exchanger
- Oil burner blower
- Relay
- Supply air blower- motor, wheel
- Capacitors
- Oil pump
- Safety circuit switches-limit
- Barometric damper
- Primary control
- Cad cells
- Blast tubes
- Fan and limit switches
- Circuit boards - fan

VENT SYSTEM CHECKS

- Checking draft
- Correcting insufficient draft
- Checking for leaks
- Checking for obstructions - vent connection and chimney

DIAGNOSING OIL COMBUSTION PROBLEMS

- Overheated nozzle
- Sooting
- Discolored flame
- Intermittent flame
- Partial burner flame-low viscosity
- Delayed ignition - puffback
- Carbon build up
- Retention head burnoff
- Trip on high limit-overfiring
- Carbon Monoxide
- Off center burn
- Airtube burn-off
- Nozzle afterdrip
- Lack of ignition
- Afterburn
- Low capacity-clogging, oil supply contamination

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

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 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

SYSTEM COMPONENTS

- INTRODUCTION TO SYSTEMS
- OIL TRANSFER PRINCIPLES
  - Fundamentals of oil transfer
  - Basic oil supply circuit
- FURNACE CONFIGURATIONS & APPLICATIONS
- FURNACE CONFIGURATIONS
  - Upflow
  - Downflow
  - Horizontal
  - Lowboy
- OIL FURNACES WITH SPLIT SYSTEM AIR CONDITIONER
  - Introduction to oil furnace with split system AC
  - Electrical layouts
  - Specifications
  - Attic layouts
  - Crawlspace layouts
  - Closet layouts
  - Basement layouts
  - Ventilation options
  - Regional considerations
- MULTI-POSITION FURNACE
  - Two way
  - Three way
- COMBUSTION PROCESS FOR OIL FURNACES
- COMBUSTION - FUEL OIL
  - Describe combustion of fuel oil
  - Describe carbon dioxide as a product of combustion
  - Describe oxygen's role in combustion
  - Describe carbon monoxide as a product of incomplete combustion
  - Water vapor as product of combustion
  - Contaminants from improper combustion
  - Effects of contaminated oil on combustion
- FUNDAMENTALS OF OIL COMBUSTION FURNACES
  - Natural draft oil furnaces
  - Overview of operation for oil furnaces
- VENT SYSTEMS
  - Fundamentals of natural draft systems
  - Natural draft systems with power venters

Vent system options-masonry chimneys, manufactured chimneys
Role of barometric dampers in vent systems

CONTROL FUNCTIONS

Fan control
Heat exchanger limit control
Flame proving - cad cell
Introduction to primary controls
Door interlocks
Room thermostats

NATURAL DRAFT OIL FURNACE - COMPONENTS

OIL SUPPLY SYSTEMS

Above ground tanks
Below ground tanks
Indoor tanks
Supply lines
Filters
Manual shutoffs
Single pipe systems
Two pipe systems
Single pipe to two pipe conversion
Electric shutoffs, solenoids
Check valves

POWER BURNERS

Functions of the power burner
Gun type burners
Single stage pumps
Two stage pumps
Combustion air blowers
Flame retention heads
Combustion intakes - outdoor

COMBUSTION CHAMBERS

Construction
Refractory
Non refractory
Stainless steel
Role of configuration in proper combustion

HEAT EXCHANGERS

Construction
Materials
Functions of heat exchanger

NOZZLES

Construction
Flow rates
Angles and patterns
Effects of excess air
Atomization
Selection of nozzles
Effects of viscosity on nozzle flowrate and pattern
Filters for nozzles

COMBUSTION AIR REQUIREMENTS

OUTDOOR AIR SPECIFICATIONS

Attic applications
Crawlspace applications
Closet applications
Basement applications
Rooftop applications

AIR DISTRIBUTION

DUCT SYSTEMS

Duct system design
Duct configurations - extended plenum, reducing trunk etc.

Return configurations
Return grille locations
Supply locations

SUPPLY BLOWERS

Introduction to supply blowers
Supply blowers - types and selection
Blower operation
Fan laws

WIRING LAYOUTS

POWER WIRING

Power wiring for split system furnace

LOW VOLTAGE

Overview of low voltage wiring

ELECTROMECHANICAL SENSING CONTROLS

ELECTROMECHANICAL ROOM THERMOSTATS

Basic thermostat types and operation
Selecting room thermostats and sub-bases
Thermostat terminals and wiring
Using electromechanical thermostats
Selecting location
Role of anticipators in thermostatic control

ELECTROMECHANICAL TEMPERATURE CONTROLS

Introduction to bimetal controls
Disc type temperature limit controls
Fuses and fuse links
Fossil fuel kits
Motor overloads
Stack temperature controls

PRESSURE CONTROLS

Operation of pressure control-power venters
Using pressure controls-power venters
Vacuum relief valve to regulate inlet combustion air

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

ELECTRONIC CONTROLS

OVERVIEW OF SYSTEM ELECTRONIC CONTROLLERS

Input / output operations
Logic

ELECTRONIC THERMOSTATS

Fundamentals of electronic thermostats
Selecting electronic thermostats
Overview of electronic thermostat operation
Fossil fuel kits for use with heat pumps

ELECTRONIC TMERS

Introduction to blower delay timers
Purging timers

PRIMARY CONTROLS

Basic construction of oil furnace primary controls
Basics of operation - oil furnace primary controls

APPLIED KNOWLEDGE: REGS, CODES, & DESIGN

AIR QUALITY REGULATIONS

INDOOR AIR QUALITY

Fresh air supplies

FUEL HANDLING AND STORAGE REQUIREMENTS

Storage tank regulations-above the ground

- Storage tank regulations-below ground

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
- Safety listings - UL / ARL / ETL

STATE AND LOCAL REGULATIONS AND CODES

STATE AND LOCAL REGULATIONS

- State licensing requirements for technicians
- Use of Carbon Monoxide detectors
- Smoke detector requirements

CODES

- Plumbing
- Municipalities
- Oil furnace for light commercial
- Oil furnace for residential

FIRE PROTECTION REGULATIONS AND CODES

COMBUSTION AIR

- Sizing air intakes in confined spaces
- Sources of combustion air

FURNACE ACCESS

- Access to furnace
- Access to service panel

OIL PIPING

- Sizing for capacity
- Length limitations
- Attachment to appliance

INSTALLATIONS

- Installation of oil burning equipment

VENTING REQUIREMENTS

- Venting of oil burning equipment

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 - OIL FURNACE EQUIPMENT

OIL 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
- Fuel oil burner - forced air system

VENTING

- Sizing flue pipe
- Flue pipe layout
- Adapting vent draft control - damper
- Roof fittings - cap, collar, flashing, etc.
- Pipe types - L-metal

DESIGN CONSIDERATIONS - EXTERNAL COMPONENTS

DIFFUSERS, REGISTERS, AND GRILLES

- Selecting diffusers, grilles, and registers for capacity
- Selecting diffusers, grilles, and registers for reduced sound
- Selecting diffusers, grilles, and registers for throws, spread, and pressure drop
- Locations

ACCESSORIES

- Humidifier sizing
- Twinning kits
- Electronic air cleaners (EAC's)

INDUSTRY STANDARDS

EQUIPMENT STANDARDS

- Performance and safety standards- UL
- Efficiency requirements - DOE

SYSTEM STANDARDS

- Introduction to industry standards
- Industry standards

BIDS AND PROPOSALS

SYSTEM SIZING

- 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

$\frac{CFM_n}{CFM_o} = \frac{RPM_n}{RPM_o}$ *o* = old, *n* = new CFM and RPM are interchangeable.

$CFMn = CFMo \times \frac{RPM}{o}$ $RPMn = RPMo \times \frac{CFM}{o}$

$\left(\frac{CFM_n}{CFM_o}\right)^2 = \frac{Sp_n}{Sp_o}$ OR $CFMo = JSPP;$ $CFM_n = CFM_o \times \sqrt{\frac{Sp_n}{Sp_o}}$ $Sp_n = Sp_o \times \left(\frac{CFM_n}{CFM_o}\right)^2$

$(\frac{CF}{CFM_o})^3 = \frac{BHPn}{BHP_o}$ OR $CFM_o = \frac{BHPn}{BHP_o}$ $CFM_n = CFM_o \times \sqrt[3]{\frac{BHP_n}{BHP_o}}$ $BHPn = BHPo \times (\frac{CFMn}{CFM_o})^3$

Hydronics: AP =Sp, CFM = GPM, RPM= GPM

$MAT = (OAT \times \%0A) + (RATx\ \%RA)$

0 =*Outside*
T = Temperature
R =Return
M=Mixed
A=Air

Btuh hydronic (H_20 only) = 500 x GPM x AT
Btuh sensible (at sea level) = 1.08 x CFM x AT
Btuh latent (at sea level) = 0.68 x CFM x AGrains
Btuh total (at sea level)= 4.5 x CFM x AEnthalpy

$CFM = \frac{AC/Hr \times Volume}{60min}$ $V = 4005 \times .Jvp$ $Vp = <4:05)2$

Pressure (PSI)= 0.433 x Head (feet of water)

1 IWC = 0.0360 PSI
1 PSI= 27.72 IWC

Pressure 1 x Volume 1 = Pressure 2 x Volume 2

Rectangular Duct Area (ft2) = $\frac{Length \times Width}{144}$

$Area = 1t \times radius^2$

Round Duct Area (ft2) = $\frac{1t \times diameter}{576}$

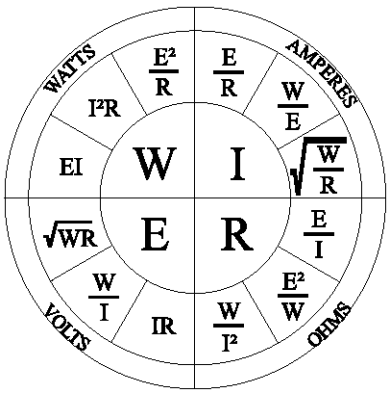
$A^2 + B^2 = C$

$Diameter = \frac{Circumference}{1t}$

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

$FR = \frac{ASP \times 100}{TEL}$ *(IWqIOO)*

CFM = Velocity (fpm) x Duct Area (ft^2)



$CFM - \frac{(Watts \times 3.413)}{\{ATx\ 1.08)}$

$Cr\ (Series) = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \ldots + \frac{1}{}}$

$C_T\ (Parallel) = C_1 + C_2 + \ldots + C_N$

TEMPERATURE PRESSURE CHART-atsealevel

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)

TEMP.		REFRIGERANT						
Of	OC	22	134a	404A	407C	410A	4220	507
-40	-40.0	0.6	*14.8*	4.3	*4.6*	10.7	2.3	5.4
-38	-38.9	1.4	*13.9*	5.3	3.2	12.0	*0.8*	6.4
-36	-37.8	2.2	*13.0*	6.3	*1.6*	13.4	0.4	7.5
-34	-36.7	3.1	*12.0*	7.4	0.0	14.8	1.2	8.6
-32	-35.6	4.0	*10.9*	8.5	0.8	16.2	2.1	9.8
-30	-34.4	4.9	*9.8*	9.6	1.6	17.8	3.0	11.0
-28	-33.3	5.9	*8.7*	10.8	2.5	19.3	3.9	12.2
-26	-32.2	6.9	7.5	12.0	3.5	21.0	4.9	13.5
-24	-31.1	8.0	6.3	13.3	4.4	22.7	5.9	14.8
-22	-30.0	9.1	*5.0*	14.6	5.4	24.4	7.0	16.2
-20	-28.9	10.2	*3.7*	16.0	6.5	26.3	8.1	17.6
-18	-27.8	11.4	2.3	17.4	7.6	28.1	9.2	19.1
-16	-26.7	12.6	*0.8*	18.9	8.7	30.1	10.4	20.6
-14	-25.6	13.9	0.4	20.4	9.9	32.1	11.7	22.2
-12	-24.4	15.2	1.1	22.0	11.1	34.2	12.9	23.8
-10	-23.3	16.5	1.9	23.6	12.3	36.4	14.3	25.5
-8	-22.2	17.9	2.8	25.3	13.7	38.6	15.6	27.3
-6	-21.1	19.4	3.6	27.0	15.0	40.9	17.1	29.1
-4	-20.0	20.9	4.6	28.8	16.4	43.3	18.5	30.9
-2	-18.9	22.4	5.5	30.7	17.9	45.8	20.1	32.8
0	-17.8	24.0	6.5	32.6	19.4	48.3	21.6	34.8
1	-17.2	24.9	7.0	33.6	20.2	49.6	22.5	35.8
2	-16.7	25.7	7.5	34.6	21.0	51.0	23.3	36.9
3	-16.1	26.5	8.0	35.6	21.8	52.3	24.1	37.9
4	-15.6	27.4	8.5	36.6	22.6	53.7	25.0	39.0
5	-15.0	28.3	9.1	37.7	23.5	55.0	25.8	40.0
6	-14.4	29.2	9.6	38.7	24.3	56.5	26.7	41.1
7	-13.9	30.1	10.2	39.8	25.2	57.9	27.6	42.2
8	-13.3	31.0	10.8	40.9	26.1	59.3	28.5	43.4
9	-12.8	31.9	11.3	42.0	27.0	60.8	29.5	44.5
10	-12.2	32.8	11.9	43.1	27.9	62.3	30.4	45.7
11	-11.7	33.8	12.5	44.3	28.8	63.8	31.3	46.8
12	-11.1	34.8	13.1	45.4	29.8	65.4	32.3	48.0
13	-10.6	35.8	13.8	46.6	30.7	66.9	33.3	49.3
14	-10.0	36.8	14.4	47.8	31.7	68.5	34.3	50.5
15	-9.4	37.8	15.0	49.0	32.7	70.1	35.3	51.7
16	-8.9	38.8	15.7	50.2	33.7	71.7	36.4	53.0
17	-8.3	39.9	16.4	51.5	34.7	73.4	37.4	54.3
18	-7.8	40.9	17.0	52.7	35.7	75.1	38.5	55.6
19	-7.2	42.0	17.7	54.0	36.8	76.8	39.6	56.9
20	-6.7	43.1	18.4	55.3	37.9	78.5	40.7	58.2
21	-6.1	44.2	19.1	56.6	39.0	80.3	41.8	59.6
22	-5.6	45.3	19.9	58.0	40.1	82.0	42.9	61.0
23	-5.0	46.5	20.6	59.3	41.2	83.8	44.1	62.4
24	-4.4	47.6	21.3	60.7	42.3	85.7	45.2	63.8
25	-3.9	48.8	22.1	62.1	43.5	87.5	46.4	65.2
26	-3.3	50.0	22.9	63.5	44.7	89.4	47.6	66.7
27	-2.8	51.2	23.7	64.9	45.9	91.3	48.8	68.2
28	-2.2	52.4	24.5	66.4	47.1	93.2	50.1	69.7
29	-1.7	53.7	25.3	67.8	48.3	95.2	51.3	71.2
30	-1.1	55.0	26.1	69.3	49.6	97.2	52.6	72.7
31	-0.6	56.2	26.9	70.8	50.8	99.2	53.9	74.3

CONTINUED

TEMPERATURE PRESSURE CHART-atsealevel

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)

TEMP.		REFRIGERANT						
•f	0C	22	134a	404A	407C	410A	4220	507
32	0.0	57.5	27.8	72.4	52.1	101.2	55.2	75.8
33	0.6	58.8	28.6	73.9	53.4	103.3	56.5	77.4
34	1.1	60.2	29.5	75.5	54.8	105.4	57.9	79.0
35	1.7	61.5	30.4	77.1	56.1	107.5	59.3	80.7
36	2.2	62.9	31.3	78.7	57.5	109.7	60.6	82.3
37	2.8	64.3	32.2	80.3	58.9	111.9	62.0	84.0
38	3.3	65.7	33.1	82.0	60.3	114.1	63.5	85.7
39	3.9	67.1	34.1	83.7	61.7	116.3	64.9	87.5
40	4.4	68.6	35.0	85.4	63.2	118.6	66.4	89.2
42	5.6	71.5	37.0	88.8	66.1	123.2	69.4	92.8
44	6.7	74.5	39.0	92.4	69.2	127.9	72.5	96.4
46	7.8	77.6	41.1	96.0	72.3	132.8	75.6	100.2
48	8.9	80.8	43.2	99.8	75.5	137.8	78.9	104.0
50	10.0	84.1	45.4	103.6	78.8	142.9	82.2	108.0
52	11.1	87.4	47.7	1092	101.7	148.1	96.1	112.0
54	12.2	90.8	50.0	1133	105.6	153.5	998	116.1
56	13.3	94.4	52.4	117.4	109.6	159.0	103.6	120.4
58	14.4	98.0	54.9	121.7	113.7	164.7	107.4	124.7
60	15.6	101.6	57.4	126.0	117.9	170.4	111.4	129.1
62	16.7	105.4	60.0	1305	122.3	176.3	1154	133.7
64	17.8	109.3	62.7	1350	126.7	182.4	1195	138.3
66	18.9	113.2	65.4	139.7	131.2	188.6	123.8	143.1
68	20.0	117.3	68.2	144.4	135.8	194.9	128.1	147.9
70	21.1	121.4	71.1	149.3	140.5	201.4	132.5	152.9
72	22.2	125.7	74.1	154.3	145.4	208.0	137.1	158.0
74	23.3	130.0	77.1	1594	150.3	214.8	1417	163.2
76	24.4	134.5	80.2	164.6	155.4	221.8	146.5	168.5
78	25.6	139.0	83.4	169.9	160.5	228.9	151.3	174.0
80	26.7	143.6	86.7	175.4	185.8	236.1	156.3	179.5
82	27.8	148.4	90.0	181.0	171.2	243.6	161.3	185.2
84	28.9	153.2	93.5	1867	176.8	251.2	1665	191.0
86	30.0	158.2	97.0	1925	182.4	258.9	1718	197.0
88	31.1	163.2	100.6	198.4	188.2	266.8	177.2	203.0
90	32.2	168.4	104.3	204.5	194.1	274.9	182.7	209.2
92	33.3	173.7	108.1	210.7	200.1	283.2	188.4	215.5
94	34.4	179.1	112.0	2170	206.3	291.6	1941	222.0
96	35.6	184.6	115.9	2234	212.5	300.3	2000	228.6
98	36.7	190.2	120.0	230.0	219.0	309.1	206.0	235.3
100	37.8	195.9	124.2	236.8	225.5	318.1	212.1	242.2
102	38.9	201.8	128.4	243.6	232.2	327.2	218.4	249.2
104	40.0	207.7	132.7	250.8	239.0	336.6	224.8	256.3
106	41.1	213.8	137.2	2578	245.9	346.2	2313	263.7
108	42.2	220.0	141.7	265.1	253.0	355.9	237.9	271.1
110	43.3	226.4	146.4	272.5	260.3	365.9	244.7	278.7
112	44.4	232.8	151.1	280.1	287.6	376.1	251.6	286.5
114	45.6	239.4	156.0	287.9	275.1	386.4	258.8	294.4
116	46.7	246.1	160.9	2958	282.8	397.0	2658	302.4
118	47.8	253.0	166.0	3038	290.6	407.8	2732	310.7
120	48.9	260.0	171.2	312.1	298.6	418.8	280.6	319.1
125	51.7	278.0	184.6	333.3	319.2	447.4	299.9	340.8
130	54.4	296.9	198.7	355.6	340.7	477.4	320.2	363.6