OIL HYDRONICS SERVICE CERTIFICATION

Certification Information

Scope - Tests a candidate's knowledge of the installation, service, maintenance, and repair of hot water heating systems. System sizes are limited to 400,000 BTU or less heating capacity.

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 **Oil Hydronics** 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 Oil Hydronics 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 Hydronics** exam.

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

Oil Hydronics 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
- 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

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 - Hydronics - Oil

Service

INSTALLATION

INSTALLING OIL BOILERS

SELECTING OIL TANK LOCATION

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

SELECTING OIL BOILER SITES

- Locating boilers in attics
- Locating boilers in crawlspaces
- Locating boilers in closets
- Locating boilers in basements
- Locating boilers in utility rooms
- Locating boilers in garages
- Locating packaged rooftops with boilers
- Locating boilers outdoor

PLACEMENT OF BOILERS

- How to place boilers in attics
- How to place boilers in crawlspaces
- How to place boilers in closets
- How to place boilers in basements
- How to place boilers in utility rooms
- How to place boilers in garages
- How to place packaged rooftops with boilers
- How to place boilers outdoor

INSTALLATION OF UTILITIES

- Installation of oil supply
- Installation of oil returns
- Wiring oil boilers

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 venting equipment

INSTALLATION OF COMBUSTION AIR INLET ACCESSORIES

- Combustion air inlets in confined spaces - attics
- Combustion air inlets in confined spaces - basements
- Combustion air inlets in confined spaces - closets
- Combustion air inlets in confined spaces - crawlspaces
- Installation of powered combustion air intakes

SIZING OIL BOILERS

- Sizing for structure capacity
- Sizing for domestic water capacity
- Sizing for radiant capacity
- Sizing for total capacity
- Sizing for snow melt capacity

DUCT INSTALLATION FOR HOT WATER HEATING SYSTEMS

DUCT FAB EQPMNT - INSTALL/REPAIR DUCTS TO HW COILS

- Ductboard tools - 90 V-groove, end cutoff, female shiplap, hole cutter, stapler, etc.
- Flex tools - tensioning strap tools, knives, etc.
- Metal tools - metal snips, sheers, benders, breaks, hand formers, calipers, rulers, stapler, etc.

FIELD CONSTRUCTION/INSTALL - CONNECTING HW COILS

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

INSTALL/REPAIR METAL DUCT - CONNECTING HW COILS

- Assembly methods for rectangular duct

- Installation technique - rectangular metal
- Assembly methods for round duct
- Installation technique - round metal
- Hanging ductwork
- Sealing metal duct
- Insulation - internal and external, vapor barriers
- Assembling for low noise and low pressure drop

INSTALL/REPAIR FLEXIBLE DUCT - CONNECTING HW COILS

- Assembly methods - appropriate length
- Flexible duct joints
- Hanging flexible duct
- Installation technique - flex duct
- Sealing flexible duct

INSTALL/REPAIR DUCTBOARD - CONNECTING HW COILS

- Assembly methods for ductboard - supports
- Installation technique - ductboard
- Hanging methods for ductboard
- Sealing ductboard

INSTALL GRILLE, REGISTER, DIFFUSER, DAMPER-HW COIL

- Mounting to ductwork
- Securing methods

CHASES USED AS DUCTS FOR HW COILS

- Floor joists as air ducts
- Vertical chases

REPAIR DUCT WHEN REPLACING EQUIPMENT - HW COILS

- Reconnecting metal duct
- Reconnecting flexible duct
- Reconnecting ductboard duct

INSTALL/REPAIR OF PLENUMS & DUCT - HW COIL SYSTEMS

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

HYDRONIC COMPONENT INSTALLATION

INSTALLATION OF HEATING COMPONENTS (EMITTERS)

- Sizing and placement of baseboard units
- Sizing and placement of kickspace heaters
- Sizing and placement of unit heaters
- Sizing and placement of duct mounted heating coils
- Sizing and placement of hot water coil air handlers
- Sizing and placement of heating units
- Sizing and placement of air vents (manual or auto)
- Sizing and placement of domestic hot water heating
- Sizing and placement of radiant panels-floor and ceiling
- Sizing and placement of radiators
- Sizing, placement, and conversion of steam radiators to hot water radiators
- Sizing, placement, and conversion of steam systems to hot water systems

INSTALLATION OF COMPONENTS

- Location, selection, and sizing of circulators
- Location and sizing of Expansion tanks
- Location of Air Separators
- Location of Pressure Reducing Valve
- Location of Backflow Preventer
- Location and sizing of Relief Valves
- Location of Zone Valves
- Location of Flow Check Devices
- Location of indirect hot water heating
- Location and placement of heat emitters
- Location of Low water cutoffs
- Location of manual reset aquastats

INSTALLATION OF PIPING SYSTEMS

- Installation of Series-loop system
- Installation of One-pipe system
- Installation of Two-pipe system (Reverse return)
- Installation of Two-pipe system (direct return)
- Installation of Primary-secondary piping system
- Installation of multiple zone systems
- Installation of system bypass and boiler bypass piping
- Installation of Indirect Water Heaters
- Installation of Low Water Cutoffs
- Installation of direct water heaters
- Installation and selection of antifreeze solutions

INSTALLING ACCESSORIES

INSTALLING THERMOSTATS

- Locating and mounting
- Wiring electromechanical thermostats
- Wiring electronic thermostats
- Programming of electronic thermostats
- Installation of Outdoor Reset Controls

INSTALLING HUMIDIFIERS

- Installing humidifiers
- Wiring humidifiers
- Controlling humidifiers

INSTALLING ELECTRONIC AIR CLEANERS

- Installing electronic air cleaners
- Wiring electronic air cleaners
- Controlling electronic air cleaners

START-UP AND CHECKOUT

PRE-START PROCEDURE

- Oil supply and proper shutoff
- Electrical
- Adequate combustion air provisions
- Venting system
- Coils connected to ducted systems
- Condensate system
- Filling and purging boiler and piping system

START-UP PROCEDURES AND CHECKS

- Voltage checks
- Check thermostat and set heat anticipator
- Motor checks
- Water circulation checks
- Airflow checks for coils connected to ducted systems
- Check call for heat sequences
- Oil supply checks including purging fuel lines

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

Pressurization for leak detection

AIRFLOW - DUCTED SYSTEMS W/ HOT WATER COILS

AIRFLOW VELOCITY MEASUREMENTS

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

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)

WATER MEASUREMENTS

WATER PRESSURE MEASUREMENTS

Pressure Requirements
Pump head
Static fill pressure
Pressure Drop

WATER VOLUME MEASUREMENTS

GPM Requirements

TEMPERATURE MEASUREMENTS

Temperature Rise
Temperature Drop

FREEZE PROTECTION FLUID

Checking and correcting acidity

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

SETUP

Nozzle wrench
Oiling cans
Electrode/Nozzle gauge
Flame mirror

SERVICE

PLANNED MAINTENANCE

SYSTEM MECHANICAL PM CHECKS

Filter-check and change
Lubrication
Cabinet care
Fan blades / blower scroll
Oil connections
Flue / vent stack inspection
Combustion air supply
Duct inspection for systems with hot water coils installed in ducts
Heat exchanger - inspection, cleaning, replace gaskets etc
Burner assembly
System airflow
Oil tank
Combustion tests
Combustion chamber inspection
Barometric regulator
Combustion air supply
Expansion Tank
Water Treatment
Circulators

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
Air distribution blower motor
Boiler operating sequence
Thermostat calibration and operation
Fan switch and high limit control
Limit controls operation
Aquastat operation
Low Water Cut Off (LWCO) Operation

DIAGNOSTICS AND REPAIR

TROUBLESHOOTING SEQUENCE OF OPERATION

Check for proper sequence of operation
Interpreting system fault during sequence interruption

ANALYZING REPORTED SYMPTOMS

Insufficient / no heat
Short cycle
Humidity problems

- Drafty
- Noise problems
- System runs continuously
- High utility bills
- Wide swings in room temperatures
- Air quality - odors, fumes, etc.
- Noisy conditions due to air in piping

ANALYZING COMBUSTION

- CO2 and O2 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 - SYSTEMS W/ HW COILS

- Temperature checks
- Checking system static pressure
- Checking total CFM
- Checking supply CFM at registers and diffusers
- Checking return CFM
- Checking for leaks in supplies
- Checking for leaks in returns

ELECTRICAL CIRCUIT CHECKS

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

ELECTRICAL COMPONENT CHECKS

- Thermostat
- High voltage transformers
- Low voltage transformers
- Oil burner motor
- Electrodes
- Flame sensor/cad cell
- Overcurrent protection
- Relays and contactors
- Capacitor - Burner Motor
- Limit control-high temperature
- Door interlock switch
- Burner motor
- Stack switches-flame proving
- Circulators
- Zone Valves
- Boiler water controls (high limit, low limit, and operating)
- Low water cut off
- Flow switch

REPAIR EXCLUDING POWER BURNER

- Electrical wiring
- Flue stack / venting system
- Combustion chamber-lining
- Oil lines
- Shafts, bearings, mounts etc
- Circulators - shafts, bearings, mounts, etc.
- Piping repair

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 and Contactors
- Motor, shaft, and wheel-Burner, Pumps, etc.
- Capacitors
- Oil pump-Fuel Unit
- Safety circuit switches-limit
- Barometric damper
- Primary control
- Cad cells
- Blast tubes
- Fan and limit switches
- Circuit boards – fan
- Circulators
- Zone Valves for non-radiant systems
- Zone Valves for radiant systems
- Boiler water controls
- Bearing Assemblies
- Low Water Cut Off (LWCO)
- Indoor/Outdoor Resets
- Modulating Valves
- Mixing Valves
- Boiler Protection

VENT SYSTEM CHECKS

- 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

SYSTEM WATER SIDE DIAGNOSTICS

- Temperature checks
- Checking system water pressure

- Checking zone valve operation
- Checking supply GPM
- Checking for leaks in supplies
- Checking for leaks in returns
- Checking low water cutoffs
- Checking flow control valves
- Checking mixing valves
- Checking relief valves

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 FOR SYSTEMS WITH HOT WATER COILS

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 pump operation and rotation
- Checking for proper static pressure and temperature

PROCEDURES FOR CONDUCTING AIR TESTS

- Measurements of each supply outlet - total readings
- Measurements of each return inlet - total readings

MAKING ADJUSTMENTS

- Adjust airflow to achieve required total airflow Re-
  measure total supply and return grille airflow Adjust
  dampers to obtain design airflow
- Re-measure total 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

WATER BALANCING

GATHERING DESIGN INFORMATION

Interpreting system design
Interpreting specifications
Interpreting equipment information
Interpreting control data
Modifying system design

PREPARATION OF SYSTEM FOR WATER TESTS

Locating equipment and controls building walkthrough
Setting equipment and controls for tests
Setting thermostat for tests
Checking for proper pump operation and rotation
Checking for proper pressure and temperature

PROCEDURES FOR CONDUCTING WATER TESTS

Measurements of each supply outlet - total readings
Measurements of each return inlet - total readings

MAKING ADJUSTMENTS

Adjust flow to achieve required total flow
Re-measure total supply and return flow
Adjust valves to obtain design flow
Re-measure total flow to verify that it is within +/- 10%

FINAL TEST

Comparing manufacturer's equipment information with test results
Record equipment data
Test and record full load motor amperes
Test and record voltage
Test and record motor and pump RPM with visible components
Test and record supply and return pressures
Test and record supply and return temperatures - heat and cool

COMPLETION OF APPROPRIATE FORMS

HVAC system report
System diagrams
Instrument list - including calibration dates

BASIC HVAC SYSTEM ANALYSIS

NOISE PROBLEMS

Interpreting supply / return water volume
Noise problems
Pump cavitation
Oil canning
Motor / belt noise
Vibration

HIGH UTILITY BILLS

Interpreting supply / return water temperature
Interpreting supply / return water volume
Evaluating Leakage
Evaluating Insulation
Envelope infiltration
Thermostat location and adjustment

WIDE TEMPERATURE SWINGS

Interpreting supply / return water temperature
Interpreting supply / return water volume
Interpreting Leakage
Interpreting Insulation
Envelope infiltration
Thermostat air sensing

SINGLE AREA IS HOT OR COLD

Interpreting supply / return water temperature
Interpreting supply / return water volume

Evaluating Leakage
Evaluating Insulation
Envelope infiltration
Thermostat air sensing
Zone Valves
Circulator
Circulator controls
Venting
Variable speed pumps Multi-
zone controls
Set point boiler protection

INDOOR AIR QUALITY

Number of air changes per hour
Odor control
Contaminants
Humidity

ANALYZING REPORTED SYMPTOMS IN HEATING

IMPROPER HEATING

Interpreting supply / return water temperature (TD)
Interpreting supply / return water volume
Interpreting system sizing
Evaluating leakage
Temperature Drop/Rise of air in ducted hot water coil systems
Zone Valves
Circulators
Circulator controls
Outdoor Reset Control
Venting

HUMIDITY PROBLEMS

Interpreting Low Humidity
Interpreting High Humidity
Interpreting Correct Humidity

DRAFTY

Interpreting supply / return water and air temperature
Interpreting supply / return water and air volume

SYSTEM COMPONENTS

INTRODUCTION TO BASIC SYSTEMS & COMPONENTS

HEAT TRANSFER

Fundamentals of heat transfer
Psychrometrics

BOILER CONFIGURATIONS & APPLICATIONS

BOILER CONFIGURATIONS

Gravity hot water
Forced hot water
Diverter tee
Series loop
Direct return
Reverse return
Pump Return
Air handling systems
Zone Control
Wet-base Dry-
base
Horizontal Tube
Near boiler piping
Radiant
Primary / secondary loop piping

OIL BOILER WITH SPLIT OR HYDRO-AIR AC SYSTEMS

Introduction to oil boiler with split system AC
Electrical layouts

- Specifications
- Attic layouts
- Crawlspace layouts
- Closet layouts
- Basement layouts
- Ventilation options
- Regional considerations

OIL TRANSFER PRINCIPLES

- Fundamentals of oil transfer
- Basic oil supply circuit

COMBUSTION PROCESS FOR OIL BOILERS

COMBUSTION - FUEL OIL

- Describe combustion of fuel oil
- Describe carbon dioxide as a product of combustion
- Describe air'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 BOILERS

- Natural draft oil boilers
- Overview of operation for oil boilers

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 limit control
- Flame proving
- Introduction to primary controls
- Door interlocks
- Room thermostats

ATMOSPHERIC OIL BOILERS - 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/fuel units
- Two stage pumps /fuel units
- 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 vs. pressure
- 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
- Outdoor applications

AIR DISTRIBUTION FOR SYSTEMS WITH HOT WATER COILS

DUCT SYSTEMS

- Duct system design
- Duct configurations
- Return configurations
- Return grille locations
- Supply locations

SUPPLY BLOWERS

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

HYDRONIC DISTRIBUTION

WATER DISTRIBUTION

- Pumps
- Two way valves
- Three way valves
- Diverter tee systems

PIPING SYSTEM

- Piping system design
- Piping configurations

FLUID FLOW

- Introduction to circulators
- Zone Valves
- Flow Checks
- Mixing valves
- Thermostatic valves
- Diverter tee systems
- Balancing Zones
- Compression / expansion tanks

WIRING LAYOUTS

POWER WIRING

- Power wiring for boiler
- Power wiring for split system air handler

LOW VOLTAGE

- Overview of low voltage wiring
- Zone control wiring
- Outdoor reset wiring

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

FLUID LEVEL AND FLOW CONTROLS
- Operation of low water controls
- Using low water controls
- Operation of fluid flow switches
- Using fluid flow switches

NON-SENSING CONTROLS

RELAYS AND CONTACTORS
- Relays and contactors
- Relay and contactor operation - inrush and holding
- Selecting relays and contactors
- Applications for relays and contactors

ELECTRONIC CONTROLS

ELECTRONIC CONTROLLERS
- Input / output operations
- Logic

ELECTRONIC THERMOSTATS
- Fundamentals of electronic thermostats
- Selecting electronic thermostats
- Electronic thermostat operation
- Outdoor Reset Controllers for non-zoned systems
- Outdoor Reset Controllers for zone systems (pump and/or zone valves)

ELECTRONIC TMERS
- Blower delay timers
- Purging timers

PRIMARY CONTROLS
- Construction
- Operation

APPLIED KNOWLEDGE: REGS, CODES, & DESIGN

REGULATIONS FOR ENVIRONMENTAL PROTECTION

INDOOR AIR QUALITY
- Fresh air intake supplies

FUEL HANDLING AND STORAGE REQUIREMENTS
- Storage tank regulations-above the ground
- Storage tank regulations-below ground

ELECTRICAL CODE

ELECTRIC REQUIREMENT
- Overview of electric code
- Overcurrent protection
- Wiring methods and materials
- Line voltage wiring sizing
- Low voltage wiring sizing
- Conduit sizing

- Definitions
- Safety listings - UL / ARL / ETL

STATE AND LOCAL REGULATIONS AND CODES

STATE AND LOCAL REGULATIONS

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

CODES

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

FIRE PROTECTION REGULATIONS AND CODES

REQUIRED COMPONENTS

- Return air sensors
- Fire dampers
- Smoke dampers
- Components

COMBUSTION AIR

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

BOILER ACCESS

- Access to boiler for service
- Access to utilities for service

OIL PIPING

- Sizing for capacity
- Length limitations
- Attachment to appliance

INSTALLATIONS

- Installation of oil burning equipment

FIRE PREVENTION

- Overview of fire prevention

VENTING REQUIREMENTS

- Specifications for venting
- Types of venting systems to be used

DESIGN CONSIDERATIONS - COMFORT

TEMPERATURE

- Designing for capacity
- Using industry standards

HUMIDITY

- Role of humidity in comfort
- Using industry standards

INDOOR AIR QUALITY

- Ventilation - comfort
- Air cleaning for comfort
- Industry standards for air quality

SOUND LEVEL

- Equipment location considerations
- Isolation, mounting pad, duct, and structure

DESIGN CONSIDERATIONS - OIL BOILER EQUIPMENT

OIL BOILER WITH SPLIT OR HYDRO-AIR AC SYSTEMS

- System designs - closets, basements, etc.
- Equipment location
- Electrical layouts
- Ventilation - fresh air
- Regional design considerations
- Combustion flue gases
- Ventilation - equipment
- Condensate drains / pans
- Mounting of equipment

Combustion air
Fuel 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

FLUID DISTRIBUTION ACCESSORIES

Distribution for capacity including baseboard, floor, kick-space, panel and other emitters
Distribution for reduced sound including baseboard, floor, kick-space, panel and other emitters
Locations

AIR SIDE ACCESSORIES

Humidifier sizing
Twinning kits
Electronic air cleaners (EAC's)
Selecting diffusers, grilles, registers for systems with distribution devices in ducts.

MECHANICAL CODE

COMBUSTION AIR

Air intakes in confined spaces
Sources of combustion air

BOILER ACCESS

Access to boiler for service
Access to utilities for service

OIL PIPING

Sizing for capacity
Length limitations
Attachment to appliance

WATER PIPING

Cross Contamination/backflow prevention

INDUSTRY STANDARDS

EQUIPMENT STANDARDS

Performance and safety standards
Efficiency requirements
Manufacturers specifications

SYSTEM STANDARDS

Industry standards

BIDS AND PROPOSALS

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) = $\frac{1t \times diameter}{576}$

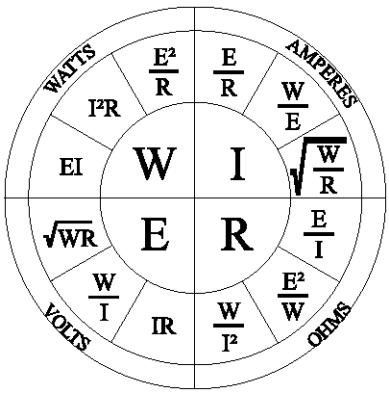
$A^2 + B^2 = C$

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

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

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