

CORE

SERVICE EXAM

Exam Information

Scope - Tests a candidate's general knowledge, construction knowledge, and HVACR specific knowledge in the areas of safety, tools, soft skills, heat transfer, comfort, and electrical.

Qualifications

- This is a test for **TECHNICIANS** in the HVACR industry. The test is designed for top level service technicians. This test is a requirement for NATE certification.

Test Specifications

Closed Book 1.5 Hour Time Limit 50 Questions Passing Score: PASS/FAIL

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

SECTION AREA DESCRIPTION	SECTION PERCENTAGE
Safety, Tools, & Soft Skills	30%
Heat Transfer & Comfort	20%
Electrical	50%

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 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 Code Council – Latest Editions
 - Mechanical, Plumbing, Energy Conservation, and Residential
- 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
- Generally accepted HVACR textbooks
- Generally accepted construction textbooks
- OSHA safety standards
- National Fire Protection Association – Latest Editions
 - Gas, Oil, and Electric

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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Core Service

SAFETY, TOOLS, & SOFT SKILLS

COMMUNICATIONS FOR HVAC TECHNICIANS

WRITING FOR TECHNICIANS

Symbols of writing - letters, numbers, Roman numerals
Writing for easy reading
Composing and generating writing. Descriptive, narrative and explanatory writing.
Writing with appropriate language
Writing with clarity, unity of thought and coherence
Writing to persuade
Writing informal documents
Vocabulary. Choosing appropriate words to say what you mean. Uses of slang and jargon.
Writing instructions

READING AND ENGLISH COMPREHENSION

Setting priorities on main ideas and supporting information
Seeing cause and effects relationships in instructions
Adjusting reading rates to purpose
Following complex written instructions
Determining word meanings from context clues
Using dictionaries to determine word meaning
Recognizing important details
Determining sequence of events
Following directions involving substeps
Interpreting diagrams and graphs
Using reference books
Responding to non verbal or written communications such as warning signs and material conditions
Adjusting reading based on writers style and vocabulary

GRAMMAR, PUNCTUATION & SPELLING IN WRITING

Use of proper written style and grammar
Basics of punctuation
Keys to better spelling
Good grammar for effective communications

REPORT WRITING

Gathering information. Note taking. Using primary and secondary sources.
Interpreting data - fact and opinion
Reporting from sources other than personal
Matching reports to readers
Writing accurate, proper forms with complete data

ORAL COMMUNICATIONS

Giving proper oral instructions
Developing listening skills. Determining accuracy of what is heard.
Giving, receiving and interpreting oral feedback. Feedback forms.
Using diction, voice control, posture, gestures, eye contact, and confidence to achieve effective oral communication
Social implications of non verbal language
Communicating with analogy, repetition, and figurative language
Logical delivery of ideas
Recognizing and using defensive / non-defensive producing language
Questioning techniques

MATHEMATICS

ARITHMETIC

Whole numbers - add, subtract, multiply and divide
Fractions - add, subtract, multiply and divide
Decimals - add, subtract, multiply and divide
Percentages, ratios, and proportions
Rounding off of values
Interpolation
Using sequences and series to predict results

- Calculators
- Combined calculations
- Mixed numbers
- Conversion of number forms

ALGEBRA

- Basic linear single variable equations
- Using algebraic graphs
- Using basic algebra in problem solving
- Transposing formulas

TOOLS & SCALES - BASIC MATH MEASUREMENT

- Rulers, compass, square, protractor, etc.
- Improvised measuring techniques
- Basic scale drawings
- Measurements - inches, feet, centimeters, millimeters, etc.
- Understanding tolerances

GEOMETRY

- Geometric figures used in HVAC - points, lines, rectangles, parallelograms, rhombuses, squares, trapezoids, etc.
- Units of measurement. Typical computations using geometry. The right triangle. 30-60-90, 45-45-90.
- Parallels and perpendiculars
- Concepts of three-dimensional figures. Drawing three-dimensional objects. Computations with three dim shapes.
- Estimating areas, perimeters, and volumes of irregular figures

GRAPHS, CHARTS & TABLES

- Introduction to basic graphs, plots, and tabular data
- Graphs and tables used in instruction sheets
- Blueprint reading

PROBLEM SOLVING - NON CUSTOMER

- Understanding the nature of a problem
- Using mathematical induction
- Selecting strategic options
- Introduction to logical problem solving. Using estimates to solve reasonableness.
- Separating "validity of argument" from "truth of statement"
- Using points of view for problem solving

USE OF COMPUTERS

- Introduction to basic computers
- Use of computers in recordkeeping
- Use of computers in the field

PERSONAL ETHICS AND CONDUCT

PERSONAL CHARACTERISTICS

- Understanding what honesty means
- Understanding what dependability means
- Understanding what a positive work ethic means
- Understanding what patience means
- Understanding what tolerance means
- Understanding cultural differences

BEHAVIOR HABITS IN THE WORKPLACE

- Understanding what integrity means
- Understanding what a good attitude means
- Understanding what loyalty means
- Understanding in the workplace
- Proper dress in the workplace
- Understanding what teamwork means
- Understanding what time management means
- Consequences of substance abuse

INTERPERSONAL RELATIONS

RESPONDING TO CUSTOMER NEEDS

- Understanding customer requirements
- Gathering information on a service request
- Evaluating customer service information

HANDLING CUSTOMER COMPLAINTS

- Using listening skills with a customer complaint
- Evaluating complaint information
- Selecting response options with customer complaints
- Resolving customer complaints
- Using good questioning skills with a customer conflict
- Understanding the consumers rights
- Understanding manufacturers and dealer warranties
- Reconciling differences of opinions
- Understanding verbal agreements

THE TECHNICIAN'S ROLE IN SALES

- Determining technician involvement in sales
- Determining needs
- Understanding features and benefits
- Making a good sales presentation
- Understanding customer sales requests
- Planning reaction to sales requests
- Importance of accurate and crisp communication
- Listen to purchasing needs

TECHNICIAN'S ROLE AS CUSTOMER EDUCATOR

- Evaluating a need for customer education - questioning skills
- Putting an educational strategy together
- Executing an educational strategy

FABRICATION TOOLS

HAND TOOLS

- Screwdrivers and nut drivers
- Wrenches, pliers, and allen wrenches
- Socket sets
- Levels and squares
- Tool maintenance and care
- Saws and files
- Drills, countersink, reamers, and bits
- Punches, taps, and dies
- Hammers
- Metal tools - metal snips, sheers, benders, breaks, hand formers, calipers, rulers, stapler, etc.

TUBING TOOLS

- Benders - spring, lever, etc.
- Flaring tools
- Tube cutters
- Swaging tools
- Reamers

HANDLING HAZARDOUS MATERIALS

GOVERNMENT REGULATIONS

- Transportation regulations for hazardous materials
- Health and safety regulations for hazardous materials
- Environmental regulations for hazardous materials

SAFETY

PERSONAL SAFETY AND WORK PRACTICES

- Regulations concerning confined spaces, hard hats, etc.
- Safety with hand tools
- Safe handling of hazardous materials
- Using ladders and scaffolds
- Safety within confined spaces
- Safe driving practices
- Clothing, safety equipment, and hard hats
- Safety glasses
- Hearing protection
- Safe practices in troubleshooting and repair
- Using warning symbols

PERSONAL SAFETY AROUND MOVING MACHINERY

- Blowers
- Condenser fans
- Pulleys
- Clothing requirements

ELECTRICAL SAFETY

- Overview of electrical safety
- Grounding - GFI requirements on outdoor extension cords
- Personal protection

SAFE SOLDERING PRACTICES

- Overview of safety
- Oxygen and acetylene safety
- Using purging gases - Nitrogen, Carbon Dioxide, etc.
- Fire extinguishers
- Documentation for hazardous materials - Material Safety Data Sheets (MSDS)

HAZMAT TRAINING

- Signage for hazardous materials
- Securing hazardous materials for transport

BASIC CONSTRUCTION DESIGNS

PLANS AND SPECIFICATIONS

- Construction
- Materials
- Layout

PLUMBING (PIPING) LAYOUTS

- Construction
- Materials
- Layout

ROOM SPECIFICATIONS - CLEAR SPAN & CEILING HEIGHTS

- Construction
- Materials
- Layout

ROOFS

- Construction
- Materials
- Layout

CEILINGS

- Construction
- Materials
- Layout

WALLS

- Construction
- Materials
- Layout

FLOORS

- Construction
- Materials
- Layout

ROOFING

- Construction
- Materials
- Layout

GIRDERS & TRUSSES

- Construction
- Materials
- Layout

CHIMNEYS

- Construction
- Materials
- Layout

HEAT TRANSFER & COMFORT

TEMPERATURE AND HUMIDITY MEASUREMENTS

PHYSICAL MEASUREMENTS - TEMPERATURE & HEAT

- Latent heat
- Sensible heat
- Temperature
- Fundamentals of humidity
- Convection
- Conduction
- Radiation
- BTU - Definition and use

THERMOMETERS

- Liquid column thermometers
- Mechanical thermometers
- Electronic thermometers
- Infrared thermometers
- Gauge / meter calibration
- Recording thermometers - digital and analog
- Dry bulb and wet bulb Delta T

HUMIDITY MEASUREMENTS

- Sling psychrometer
- Wet and dry bulb thermometers
- Electronic humidity measurement
- Gauge / meter calibration
- Using psychrometric chart
- Humidity probes attachments for use with electrical meters
- Enthalpy

COMFORT

TEMPERATURE

- Role of temperature in comfort
- Regional temperature considerations and comfort

HUMIDITY

- Role of humidity in comfort
- Adjusting system performance for humidity control

INDOOR AIR QUALITY

- Ventilation - comfort
- Air cleaning for comfort
- Odor control

SOUND

- Equipment
- Airflow

BASIC SCIENCE

CHEMISTRY BASICS

- Properties of matter - atoms, elements, and molecules
- How chemicals react with each other
- Role of chemistry at the jobsite
- Oxidation and combustion
- Weight and density of materials

PHYSICAL MEASUREMENTS - PRESSURE

- Overview of pressure systems
- Pressure laws and pressure measurement terminology
- Temperature vs. Pressure

MECHANICS

- Simple machines - levers, gears, etc.
- Conservation of energy
- Gas laws
- Complex machines - how mechanisms work
- Basics of electricity and magnetism
- Basics of fluid mechanics

ELECTRICAL

BASIC ELECTRICITY

ELECTRONS IN ELECTRICITY

Fundamental electrical concepts - volts, amps, etc.
Electrical charge, negative, positive, ions, ionization
Conductors
Insulators

ELECTRICAL BASIC TERMS

Voltage - volts, potential difference, polarity, and ground
Amps - milliamps, microamps, etc.
Resistance - Ohm's, megohms, etc.
Power - watts

MAGNETISM

Magnetic principles in electricity
Magnetic components - coils
Magnetic components - transformer

DC CIRCUITS

Simple DC circuit
Basic control and loads
Ohm's Law in DC circuits
Polarity

AC CIRCUITS

Introduction to AC circuits
Effects of AC on controls and loads

INTRODUCTION TO BASIC CIRCUIT ANALYSIS

Difference between AC & DC power
Ohm's Law
Current distribution in multiple load circuits
Complex circuits
Series circuits
Parallel circuits

ELECTRICITY - GENERATION AND DISTRIBUTION

Introduction to electrical distribution - phases & voltages
Impact of available electrical power on electrical equipment - total load
Transformer distribution

SOLID STATE ELECTRONICS

Introduction to basic solid state components - diodes, triacs, etc.
Fundamental solid state circuits
Overview of solid state devices in HVAC
Solid state sensing devices - temperature, pressure, light, etc.

POWER

Electrical power formulae - conversion of power
Introduction to power factor

ELECTRICAL LOADS

Capacitive - momentary and continuous
Inductive - momentary and continuous
Resistive - momentary and continuous

AC MOTORS

SINGLE PHASE MOTORS

Types - mount, enclosure, other mechanical characteristics, etc.
Components - stator, rotor, start relay, capacitor, number of poles, etc.
Operating principles - inductive, capacitive reactance, power factor, etc.
Torque characteristics
Tapped multi-speed
Selecting single phase motors

SINGLE PHASE MOTOR TYPES

Capacitor start induction run motor (CSIR)
Capacitor start capacitor run motor (CSCR)
Permanent split capacitor (PSC)
Shaded pole
Split-phase motor (RSIR)
Variable speed motors - ECM, BPM, and VSIM

THREE PHASE MOTORS

Types - mount, enclosure, other mechanical characteristics, etc.

Components - stator, rotor, etc.

Operating principles - power factor, etc.

Selecting multi-phase motors

Rotation

Torque characteristics

ACTUATOR MOTORS

Overview of damper motors

Dual position

Proportional

ELECTRICAL DIAGRAMS

SYMBOLS

Introduction to basic symbols

Use of symbols in diagrams

Symbol standards

FIELD WIRING DIAGRAMS

Basics of field diagram layout

Use of field diagrams

PICTORIAL DIAGRAMS

Basics of pictorial diagram layouts

Use of pictorial diagrams

SCHEMATIC (LADDER) DIAGRAMS

Basics of schematic (ladder) diagram layouts

Reading schematics for determining sequences

Reading schematics for wiring connections

ELECTRICAL METERS

ANALOG ELECTRICAL METERS

Identify meters and instruments

Analog electrical meters - use, setups, and RMS limitations - Recommended AC Installer

Voltage measurements

Resistance measurements

Amperage measurements

Use with temperature probes

Meter calibration and maintenance

Millivolt measurements

Milliampere measurements

DIGITAL ELECTRICAL METERS

Identify meters and instruments

Digital electrical meters - use and setups

Voltage measurements

Resistance measurements

Amperage measurements

Use with temperature probes

Meter calibration and maintenance

RMS - correction and meter types

Millivolt measurements

Milliampere measurements

$$\frac{CFM_n}{CFM_o} = \frac{RPM_n}{RPM_o}$$

$o = \text{old}, n = \text{new}$
CFM and RPM are interchangeable.

$$CFM_n = CFM_o \times \frac{RPM_n}{RPM_o}$$

$$RPM_n = RPM_o \times \frac{CFM_n}{CFM_o}$$

$$\left(\frac{CFM_n}{CFM_o}\right)^2 = \frac{Sp_n}{Sp_o} \quad \text{OR} \quad \frac{CFM_n}{CFM_o} = \sqrt{\frac{Sp_n}{Sp_o}}$$

$$CFM_n = CFM_o \times \sqrt{\frac{Sp_n}{Sp_o}}$$

$$Sp_n = Sp_o \times \left(\frac{CFM_n}{CFM_o}\right)^2$$

$$\left(\frac{CFM_n}{CFM_o}\right)^3 = \frac{BHP_n}{BHP_o} \quad \text{OR} \quad \frac{CFM_n}{CFM_o} = \sqrt[3]{\frac{BHP_n}{BHP_o}}$$

$$CFM_n = CFM_o \times \sqrt[3]{\frac{BHP_n}{BHP_o}}$$

$$BHP_n = BHP_o \times \left(\frac{CFM_n}{CFM_o}\right)^3$$

Hydronics: $\Delta P = Sp$, CFM = GPM, RPM = GPM

$$MAT = (OAT \times \%OA) + (RAT \times \%RA)$$

O = Outside
T = Temperature
R = Return
M = Mixed
A = Air

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

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

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

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

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

$$V = 4005 \times \sqrt{Vp}$$

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

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

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

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

$$Pressure 1 \times Volume 1 = Pressure 2 \times Volume 2$$

$$Area = \pi \times radius^2$$

$$A^2 + B^2 = C^2$$

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

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

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

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

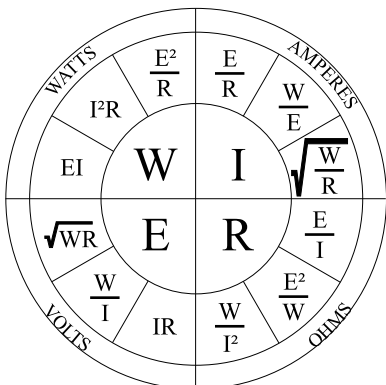
$$FR = \frac{ASP \times 100}{TEL} \text{ (IWC/100)}$$

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

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

$$C_T \text{ (Series)} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_N}}$$

$$C_T \text{ (Parallel)} = C_1 + C_2 + \dots + C_N$$



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)

TEMP.		REFRIGERANT						
°F	°C	22	134a	404A	407C	410A	422D	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 – 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)

TEMP.		REFRIGERANT						
°F	°C	22	134a	404A	407C	410A	422D	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	109.2	101.7	148.1	96.1	112.0
54	12.2	90.8	50.0	113.3	105.6	153.5	99.8	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	130.5	122.3	176.3	115.4	133.7
64	17.8	109.3	62.7	135.0	126.7	182.4	119.5	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	159.4	150.3	214.8	141.7	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	165.8	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	186.7	176.8	251.2	166.5	191.0
86	30.0	158.2	97.0	192.5	182.4	258.9	171.8	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	217.0	206.3	291.6	194.1	222.0
96	35.6	184.6	115.9	223.4	212.5	300.3	200.0	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	250.6	239.0	336.6	224.8	256.3
106	41.1	213.8	137.2	257.8	245.9	346.2	231.3	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	267.6	376.1	251.6	286.5
114	45.6	239.4	156.0	287.9	275.1	386.4	258.6	294.4
116	46.7	246.1	160.9	295.8	282.8	397.0	265.8	302.4
118	47.8	253.0	166.0	303.8	290.6	407.8	273.2	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