

GAS FURNACES

INSTALLATION 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

- Y This is a test and certification for **TECHNICIANS** in the HVAC industry. The test is designed for top level installation 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 INSTALL exam**.
- Y This test will measure what 80% of the **Gas Furnaces** candidates have an 80% likelihood of encountering at least once during the year on a **NATIONAL** basis.
- Y Suggested requirement is one year of field experience working on Gas Furnaces systems as an installation 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 **Gas Furnaces** exam.

SECTION AREA DESCRIPTION	SECTION PERCENTAGE
Installation	40%
Service	10%
System Components	30%
Applied Knowledge	20%

Gas 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.

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Heating - Warm Air - Gas

Installer

INSTALLATION

INSTALLING GAS FURNACES

SELECTING GAS 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 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 installations

CONNECTING UTILITIES

- Connection of gas piping
- Connection of field wiring

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
- Installation of vent termination

INSTALLATION OF PVC / ABS VENTING SYSTEMS

- Determination of routing
- Cutting PVC & ABS pipe to proper length Dry-fitting the assembly
- Sealing PVC pipe
- Sealing ABS pipe
- Securing of pipe
- Installation of vent termination

INSTALLATION OF CONDENSATE DRAINS FOR COND. FURN.

- Determination of routing
- Cutting PVC pipe to proper length
- Dry-fitting the assembly
- Sealing PVC pipe
- Securing of pipe
- Installation of condensate drain pan - attic installations
- Installation of condensate drain pumps

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

INSTALLING ECONOMIZERS

- Installing economizers
- Wiring economizers
- Controlling economizers

START-UP AND CHECKOUT

PRE-START PROCEDURES

- Gas supply and proper shutoff
- Electrical
- Adequate combustion air provisions
- Venting system
- Ductwork system
- Condensate system

START-UP PROCEDURES AND CHECKS

- Voltage checks

- Check thermostat and set heat anticipator
- Motor checks
- Airflow checks
- Check call for heat sequences
- Manifold gas pressure check
- Flame quality check
- Firing rate

LEAK DETECTION TOOLS

- Soap solution
- Electronic leak detectors
- Ultrasonic leak detector
- Use of dye leak detectors
- Pressurization for leak detection
- Meter calibration and maintenance

AIRFLOW MEASUREMENTS

INTRODUCTION TO AIRFLOW MEASUREMENTS

- Introduction to airflow
- Static pressure

AIRFLOW VELOCITY MEASUREMENTS

- Introduction to airflow velocity
- Velometer - electronic and mechanical
- Anemometer
- Velocity measurement procedures
- Gauge calibration

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

AIRFLOW VOLUME MEASUREMENTS

- Introduction to volume
- Airflow hood
- Formulae for determining CFM of air
- Formulae for weight of air
- Locations for air volume measurements

AIRFLOW CHECKS & DESIGN TOOLS

- Using manufacturer's airflow charts and tables
- Using a duct calculator and design charts

SERVICE

DIAGNOSTICS

STARTUP REPAIRS

- Electrical wiring
- Electrical components
- Fuel supply
- Flue stack / venting system
- Condensate / drain system

INTRODUCTION TO ELECTRICAL TROUBLESHOOTING

LOW VOLTAGE CIRCUITS

- Voltage tests
- Current tests
- Equipment continuity tests
- Ground tests

LINE VOLTAGE CIRCUITS

- Voltage tests
- Current tests
- Component tests
- Circuit tracing line voltages

Equipment continuity tests

Ground tests

Polarity tests

SYSTEM COMPONENTS

INTRODUCTION TO SYSTEMS

HEAT TRANSFER

Fundamentals of heat transfer

Basic gas furnace components

FUNDAMENTALS OF GAS COMBUSTION

Types of gases - Natural and Manufactured

Requirements for proper combustion - fuel, air, heat By-products from combustion

FURNACE CONFIGURATIONS & APPLICATIONS

GAS FURNACES WITH SPLIT SYSTEM AIR CONDITIONER

Introduction to gas furnace with split system AC

Electrical layouts

Specifications

Attic layouts

Crawlspace layouts

Closet layouts

Basement layouts

Ventilation options

Regional considerations

MULTI-POSITION FURNACE

Four-way Three-

way Two-way

PACKAGED GAS FURNACE SYSTEMS

Introduction to package gas furnace systems

Electrical layouts

Specifications

Single story applications Multi-story applications

Applied with crawlspace duct designs

Ventilation options

Economizer options

Regional considerations

COMBUSTION PROCESS FOR GAS FURNACES SYSTEMS

COMBUSTION - NATURAL GAS

Describe methane's role in combustion

Describe carbon dioxide as a product of combustion

Describe oxygen's role in combustion

Describe carbon monoxide as a product of combustion

Describe ethane's role in combustion

COMBUSTION - MANUFACTURED GAS

Describe liquefied petroleum's role in combustion

Describe butane's role in combustion

Describe propane's role in combustion

Describe oxygen's role in combustion

FUNDAMENTALS OF GAS COMBUSTION SYSTEMS

Category I - Negative pressure vent - non-condensing

Category II - Negative pressure vent - condensing

Category III - Positive pressure vent - non-condensing

Category IV - Positive pressure vent - condensing

NATURAL DRAFT GAS FURNACE

OPERATION

Overview of operation for standing pilot furnace

Overview of operation for intermittent pilot furnace

Overview of operation for direct ignition furnace

IGNITION

Basics of operation
Types of ignition systems

VENTING

Categories of venting systems
Types of venting systems
Construction materials

CONTROL FUNCTIONS

Fan control
Heat exchanger limit control Roll-
out switch
Flame proving - flame switch and thermocouple
Gas valve
Door interlocks

COMPONENTS

Heat exchangers
Burners

COMBUSTION AIR REQUIREMENTS

DIRECT VENT (OUTDOOR AIR) SPECIFICATIONS

Attic applications
Crawlspace applications
Closet applications
Basement applications

NON-DIRECT VENT (INDOOR AIR) SPECIFICATIONS

Attic applications
Crawlspace applications
Closet applications
Basement applications

AIR DISTRIBUTION

DUCT SYSTEMS

Duct system design
Duct configurations
Return configurations
Return grille locations
Supply locations
Duct locations - attic, basement, crawlspace, slab, roof, furr down, and exposed
Fitting nomenclature - plenum, transition, elbow, round duct, rectangular duct

SUPPLY BLOWERS

Introduction to supply blowers
Supply blowers - types
Blower operation

WIRING LAYOUTS

POWER WIRING

Power wiring for package unit furnace
Power wiring for split system furnace

LOW VOLTAGE

Overview of low voltage wiring

INDUCED DRAFT NON-CONDENSING FURNACE

OPERATION

Overview of operation for standing pilot furnace
Overview of operation for intermittent pilot furnace
Overview of operation for direct ignition furnace

IGNITION

Basics of operation
Types of ignition systems

VENTING

Categories of venting system
Types of venting systems
Construction materials

CONTROL FUNCTIONS

Fan control

- Heat exchanger limit control Roll-out switch
- Flame proving - flame sensor and thermocouple
- Pressure proving switch
- Gas valve
- Door interlocks
- Ignition control

COMPONENTS

- Heat exchangers
- Burners
- Induced draft blowers

INDUCED DRAFT CONDENSING FURNACE

OPERATION

- Overview of operation for intermittent pilot furnace
- Overview of operation for direct ignition furnace

IGNITION

- Basics of operation
- Types of ignition systems

VENTING

- Category IV venting system
- Types of venting systems
- Construction materials

CONTROL FUNCTIONS

- Fan control
- Heat exchanger limit control Roll-out switch
- Flame proving - flame sensor and thermocouple
- Pressure proving switch
- Gas valve
- Door interlocks
- Ignition control
- Condensate proving switch

COMPONENTS

- Heat exchangers
- Burners
- Induced draft blowers

APPLIED KNOWLEDGE: REGS, CODES, & DESIGN

AIR QUALITY REGULATIONS

INDOOR AIR QUALITY

- Fresh air supplies

ELECTRICAL CODE

REQUIREMENTS

- Overview of electrical code
- General wiring practices

STATE AND LOCAL REGULATIONS AND CODES

STATE AND LOCAL REGULATIONS

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

CODES

- Plumbing
- Municipalities
- Gas furnace for Lt. Commercial
- Gas furnace for Residential

FIRE PROTECTION REGULATIONS AND CODES

REQUIRED COMPONENTS

- Return air sensors
- Fire dampers

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 - EQUIPMENT

GAS 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

PACKAGED SYSTEMS

- System designs
- Equipment location
- Electrical layouts
- Ventilation - fresh air
- Mounting of equipment
- Combustion air

COMBUSTION GAS VENTING

- Sizing flue pipe - ICC tables
- Flue pipe layout - ICC tables
- Adapting vent draft control - damper
- Roof fittings - cap, collar, flashing, etc.
- Pipe types - PVC and B-metal

DESIGN CONSIDERATIONS - COMPONENTS

DIFFUSERS, REGISTERS, AND GRILLES

- Selection considerations
- Locations

ACCESSORIES

- Humidifier locating
- Electronic air cleaners (EAC's)

MECHANICAL CODE

COMBUSTION AIR

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

FURNACE ACCESS AND CLEARANCES

- Access to furnace
- Access to service panel
- Combustible clearances

GAS PIPING

- Length limitations
- Attachment to appliance

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

o = old, *n* = 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: AP = SP, CFM = GPM, RPM = GPM

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

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

$$Btuh \text{ hydronic (H}_2\text{O only)} = 500 \times GPM \times AT$$

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

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

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

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

$$V = 4005 \times .Jvp$$

$$Vp = <4.05)^2$$

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

$$1 IWC = 0.0360 PSI$$

$$1 PSI = 27.72 IWC$$

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

$$Area = 1t \times radius^2$$

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

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

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

$$Round \text{ Duct Area (ft}^2) = \frac{1t \times diameter}{576}$$

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

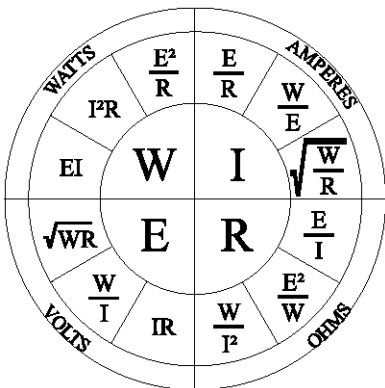
$$FR = \frac{ASP \times 100}{TEL} \quad (IWq100)$$

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

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

$$Cr \text{ (Series)} = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \dots + \frac{1}{CN}}$$

$$Cr \text{ (Parallel)} = C1 + C2 + \dots + CN$$



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	<i>14.8</i>	4.3	4.6	10.7	2.3	5.4
-38	-38.9	1.4	<i>13.9</i>	5.3	3.2	12.0	0.8	6.4
-36	-37.8	2.2	<i>13.0</i>	6.3	1.6	13.4	0.4	7.5
-34	-36.7	3.1	<i>12.0</i>	7.4	0.0	14.8	1.2	8.6
-32	-35.6	4.0	<i>10.9</i>	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**

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TEMP.		REFRIGERANT						
•F	OC	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	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	250.8	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	258.8	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