OIL 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

- 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. Once certification is obtained it lasts for five years.
- 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 one year of field experience working on Oil 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 **Oil Furnaces** exam.

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

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

Installer

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 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
- 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
- Measuring stack temperature

COMBUSTION CHECKS
- Flame checks
- Stack temperature check
- Carbon Dioxide checks
- Smoke test
- Overfire draft check
- Breech draft check
- Oxygen checks
- Efficiency check

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

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 AND REPAIRS

ELECTRICAL CIRCUIT CHECKS
- Supply voltage
- Room thermostat

ELECTRICAL COMPONENT CHECKS
- Room thermostat
- Overcurrent protection
- Door interlock switch

TROUBLESHOOTING SEQUENCE OF OPERATION
- Check for proper sequence of operation
- Interpreting system at sequence interruption

REPAIR EXCLUDING POWER BURNER
- Electrical wiring
- Flue stack / venting system
- Oil lines

- REPAIR - POWER BURNERS
  - Bleeding air
  - Adjust electrodes
- VENT SYSTEM CHECKS
  - Checking for leaks
  - Checking for obstructions - vent connection and chimney
- SYSTEM AIR SIDE DIAGNOSTICS
  - Checking for leaks in supplies
  - Checking for leaks in returns
- ANALYZING COMBUSTION
  - Carbon Dioxide checks for efficiency
  - Performing and reading a smoke test
  - Diagnosing vent system leaks

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 monoxide as a product of incomplete combustion
  - Water vapor as product of 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

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
- Materials
- Role of configuration in proper combustion

NOZZLES

- Flow rates
- Angles and patterns
- Effects of excess air
- Filters for nozzles

COMBUSTION AIR REQUIREMENTS

OUTDOOR AIR SPECIFICATIONS

- Attic applications
- Crawlspace applications
- Closet applications
- Basement applications
- Rooftop applications

AIR DISTRIBUTION

DUCT SYSTEMS

- Duct configurations - extended plenum, reducing trunk etc.
- Return configurations
- Return grille locations
- Supply locations

SUPPLY BLOWERS

- Introduction to supply blowers
- Supply blowers - types
- Blower operation

WIRING LAYOUTS

POWER WIRING

- Power wiring for split system furnace

LOW VOLTAGE

- Overview of low voltage wiring

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

FURNACE ACCESS

Access to furnace
Access to service panel

INSTALLATIONS

Installation of oil burning equipment - NFPA 31

OIL PIPING

Sizing for capacity
Length limitations
Attachment to appliance

COMBUSTION AIR

Sizing air intakes in confined spaces
Sources of combustion air

VENTING REQUIREMENTS

Venting of oil burning equipment-NFPA 211

DESIGN CONSIDERATIONS - COMFORT

INDOOR AIR QUALITY

Ventilation - comfort
Air cleaning for comfort

SOUND LEVEL

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

DESIGN CONSIDERATIONS - EQUIPMENT

OIL FURNACES WITH SPLIT SYSTEM AIR CONDITIONER

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 - COMPONENTS

DIFFUSERS, REGISTERS, AND GRILLES

Selecting diffusers, grilles, and registers
Modifying locations

ACCESSORIES

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

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

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

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

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

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

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

Btuh hydronic (H_2O only) = 500 × GPM × ΔT
Btuh sensible (at sea level) = 1.08 × CFM × ΔT
Btuh latent (at sea level) = 0.68 × CFM × ΔGrains
Btuh total (at sea level) = 4.5 × CFM × ΔEnthalpy

$CFM = \frac{AC/Hr \times Volume}{60\ min}$ $V = 4005 \times \sqrt{Vp}$ $Vp = \left(\frac{V}{4005}\right)^2$

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

1 IWC = 0.0360 PSI
1 PSI = 27.72 IWC

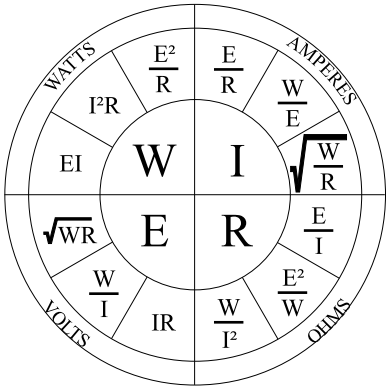
Pressure 1 × Volume 1 = Pressure 2 × Volume 2

$Area = \pi \times radius^2$

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

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

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



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

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

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

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

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

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

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

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)
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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