

AIR DISTRIBUTION

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 12,000 CFM or less airflow.

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 **Air Distribution** 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 Air Distribution 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 **Air Distribution** exam.

SECTION AREA DESCRIPTION	SECTION PERCENTAGE
Installation	40%
Service	10%
System Components	28%
Applied Knowledge	22%

Air Distribution 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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Air Distribution - Low Pressure

Installer

INSTALLATION

DUCT FABRICATION

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.

FABRICATION TECHNIQUES FOR METAL DUCT

Making seams - pittsburgh and snap lock

Making transverse joints - drive slips, reinforced drive slips, "s" slip, and standing "s" slip

Making cross breaks in rectangular duct

Crimping round pipe

FABRICATION TECHNIQUES FOR DUCTBOARD

Layout of duct fitting

Groove cutting - hand / machine

Use of joint tape

DUCT INSTALLATION

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

SYSTEM SETUP

PREPARING SYSTEM FOR OPERATION

Removing shipping restraints

Inspecting for concealed damage

Inspect wiring

SETTING DAMPER POSITIONS

Determining estimated damper positions

Setting and securing position

SETTING REGISTERS AND DIFFUSERS

Determining estimated damper positions

Setting/securing position

SETTING BLOWER SPEEDS

Determining appropriate setting

Setting blower for setup checks

Setting blower for system operation

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

BASIC AIR DISTRIBUTION SYSTEM INSPECTION

STRUCTURAL INTEGRITY

Duct support

Joint integrity

NOISE PROBLEMS

Oil canning

Vibration

AIR LEAKS

Smoke test - positive and negative envelope pressure

INSPECTION AND REPAIR OF METAL DUCT SYSTEMS

INSPECTING FOR STRUCTURAL INTEGRITY

Inspecting joints

Inspecting seams

Locating improper openings

Inspecting for proper support

INSPECTING FOR LEAKS

Visual inspection

Inspection by sound

INSPECTING FOR NOISE

Identifying air velocity noise

Identifying mechanical noise

REPAIRING METAL DUCT SYSTEMS

Repairing leaks
Repairing noise problems

Repairing structural integrity problems
Repairing/replacing internal and external insulation

INSPECTION AND REPAIR OF DUCTBOARD SYSTEMS

INSPECTING FOR STRUCTURAL INTEGRITY

Inspecting joints
Inspecting seams
Locating improper openings
Inspecting for proper support

INSPECTING FOR LEAKS

Visual inspection
Inspection by sound

INSPECTING FOR NOISE

Identifying air velocity noise
Identifying mechanical noise

REPAIRING DUCTBOARD DUCT SYSTEMS

Repairing leaks
Repairing noise problems
Repairing structural integrity problems

INSPECTION AND REPAIR OF FLEXIBLE DUCT SYSTEMS

INSPECTING FOR STRUCTURAL INTEGRITY

Inspecting joints
Locating improper openings
Inspecting for proper support
Inspecting for improper routing

INSPECTING FOR LEAKS

Visual inspection
Inspection by sound

INSPECTING FOR NOISE

Identifying air velocity noise
Identifying mechanical noise

REPAIRING FLEXIBLE DUCT SYSTEMS

Repairing leaks
Repairing noise problems
Repairing structural integrity problems

INSPECTION AND REPAIR OF GRILLES AND REGISTERS

INSPECTING FOR STRUCTURAL INTEGRITY

Inspecting joints
Inspecting for proper mounting
Inspecting for proper settings and adjustments

INSPECTING FOR NOISE

Inspecting for noise with operating blower
Inspecting for proper seal
Inspecting for proper settings

REPAIRING GRILLES AND REGISTERS

Repairing leaks
Repairing noise problems
Repairing structural integrity problems

INSPECTING FOR LEAKS

Visual inspection
Inspection by sound

INTRODUCTION TO ELECTRICAL TROUBLESHOOTING

LOW VOLTAGE FIELD WIRING

Voltage tests
Troubleshooting equipment with electronic devices
Equipment continuity tests

LINE VOLTAGE FIELD WIRING

Voltage tests
Troubleshooting equipment with electronic devices

SYSTEM COMPONENTS

INTRODUCTION TO SYSTEMS

HEAT TRANSFER AND THE BASIC COOLING CYCLE

Heat transfer and cooling

Basic refrigeration circuit - 7 components

DUCT SYSTEMS

BASIC DUCT SYSTEMS

Overview of duct systems

Duct configuration - extended plenum

Duct configuration - reducing extended plenum

Duct configuration - perimeter radial

Duct configuration - perimeter loop

Duct configuration - overhead radial

Duct configuration - branching flexible

Duct configuration - concentric

DUCT LOCATION

Attic

Basement

Crawlspace

Slab

Roof

Furr down

Exposed

Chases

BASIC ZONE SYSTEMS

Equipment zoned

Air side zoned

DUCT MATERIALS

Define / recognize ductboard

Define / recognize metal duct

Define / recognize flexible duct

Define / recognize PVC pipe

Insulating material

FITTING NOMENCLATURE

Define / recognize plenum

Define / recognize transition

Define / recognize elbow - 90 degrees and 45 degrees

Define / recognize round duct

Define / recognize rectangular duct

Define / recognize turning vanes

Return configurations - ducted, central, etc.

Define / recognize wye - rectangular and round

Define / recognize damper - rectangular and round

Sheet metal duct joints - "s" and drive, snaplock, button lock, etc.

Define/recognize flexible/canvas connector

DAMPERS

Balancing

Splitters

Economizers

Fresh air

Fire

GRILLES

Types and uses

Selecting grilles by volume and velocity

REGISTERS

Types and uses

Selecting registers

Selecting registers by air spread and throw capacity

DIFFUSERS

Selecting diffusers
Selecting diffusers by air spread and throw capacity

FILTRATION SYSTEMS

Media type filters
Electronic air cleaners (EAC's)
Electrostatic filters - non-electric

VENTILATION SYSTEMS

Attic exhaust
Residential exhaust(s)
Lt. Commercial exhaust(s)
Heat / energy recovery ventilators
Infiltration

HUMIDIFIERS

Fundamentals of operation
Types
Duct material requirements
Installation support and location

BASIC GAS FURNACES

GAS HEAT - COMPONENTS

Define heat exchanger
Define fan controls
Define limit controls
Define vent system

GAS HEAT - OPERATION

Define combustion air system
Air side requirements

BASIC OIL FURNACES

OIL HEAT - COMPONENTS

Define limit controls
Define heat exchanger
Define vent system

OIL HEAT - OPERATION

Define combustion air system
Air side requirements

BASIC AIR CONDITIONING / HEAT PUMPS

BASIC COMPONENTS

Define evaporator
Define condenser
Define compressor

BASIC OPERATION

Air side requirements

BASIC AIRFLOW PRINCIPLES

INTRODUCTION TO AIRFLOW

Velocity
Static pressure
Airflow volume - CFM / SCFM (Static CFM)

BLOWERS AND FANS

Introduction to indoor blowers
Indoor blowers - types and selection
Fan operation
Adjustable pulley

APPLIED KNOWLEDGE: REGS, CODES, & DESIGN

AIR QUALITY REGULATIONS

INDOOR AIR QUALITY

Fresh air supplies

ELECTRICAL CODE

REQUIREMENTS

Overview of electrical code

- General wiring practices
- Class I wire sizing
- Class II wire sizing
- Conduit sizing
- Definitions

STATE AND LOCAL REGULATIONS AND CODES

STATE AND LOCAL REGULATIONS

- State requirements for technicians

CODES

- Plumbing
- Municipalities
- HVAC for Lt. Commercial

FIRE PROTECTION REGULATIONS AND CODES

REQUIRED COMPONENTS

- Return air sensors
- Fire dampers

FIRE PREVENTION

- Overview

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
- Outside air

SOUND LEVEL

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

DESIGN CONSIDERATIONS - RESIDENTIAL

SPLIT SYSTEMS

- Ventilation - fresh air
- Ventilation - equipment

AIR BALANCING

- Blower speed adjustments
- Damper position adjustments

RETROFIT INSTALLATIONS

- Insulation
- Vapor barrier

DESIGN CONSIDERATIONS - COMPONENTS

BLUEPRINT READING

- Determination of dimension from scale blueprint / plans
- Introduction to blueprints/plans reading
- Visualizing duct layout from blueprints/plans

SPECIAL DUCTS & FITTINGS

- Working drawings vs. Isometric drawings
- Markings and abbreviations for duct fitting and manufacturing
- Measurement for replacement of special duct or fitting

DUCTS & FITTINGS

- Specifying physical dimensions
- Sketching duct layout
- Duct fitting equivalency - EQ to duct size

STATIC PRESSURE LOSSES IN FILTRATION SYSTEMS

Electronic air cleaners (EAC's)

Electrostatic

Media type filters

DIFFUSERS

Selecting diffusers

Proper locations

GRILLES

Selecting grilles

Proper locations

REGISTERS

Selecting registers

Proper locations

MECHANICAL CODE

EQUIPMENT ACCESS

Minimum clearance

Electrical disconnects

Fire dampers

REFRIGERANT LINE ROUTING

Support requirements

Inspection requirements

CONDENSATE DRAINS

Materials

Sizing

INDUSTRY STANDARDS

EQUIPMENT STANDARDS

Introduction to industry standards

ARI standards for ratings

SYSTEM STANDARDS

Introduction to industry standards

Industry standards

DESIGN CONSIDERATIONS - LIGHT COMMERCIAL

SPLIT SYSTEMS

System designs - closets, basements, etc.

Air distribution systems

Ventilation - fresh air

Ventilation - equipment

PACKAGED SYSTEMS

System designs

Economizers

Ventilation - equipment

AIR BALANCING

Duct sizing

Blower speed adjustments

Damper position adjustments

Measurement of air flow rate

Fan laws

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

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

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

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

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

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

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

$$V = 4005 \times .Jvp$$

$$Vp = <4.05)^2$$

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

$$1 IWC = 0.0360 PSI$$

$$1 PSI = 27.72 IWC$$

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

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

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

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

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

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

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

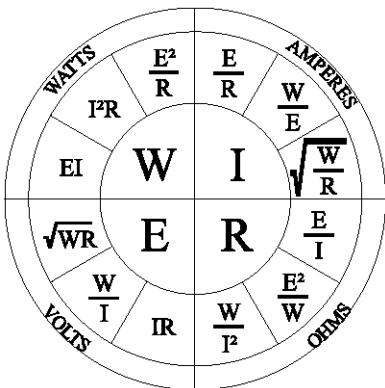
$$FR = \frac{ASP \times 100}{TEL} \quad (IWq100)$$

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

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

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

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



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**

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	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