

Understanding Residential HVAC Equipment Sizing

Code Requirements for Manual S
(2012 IRC, IMC, IECC)

Objectives

- Participants shall understand the current and upcoming CT code requirements for residential mechanical equipment engineering (Manual J, S & D)
- Participants shall understand the relationship between Manual J load calculations and Manual S Equipment Selection
- Participants shall understand the need for Manual S equipment sizing (in accordance with the 2012 ICC code)

Topics

1. “Limited” Code Overview
2. Design Process Overview
3. Manual S (Equipment Selection)
4. Review & Examples

Handouts

- Copy of this presentation
- 2012 Connecticut Code Summary
- Design FAQ
- CT Code – QIV Comparison
- CT Municipal Design Table 2015
- Example OEM Engineering Data
- Example OEM Capacity Report
- Example Manual J-S Report
- Manual-S Demo Interpolation Spreadsheet

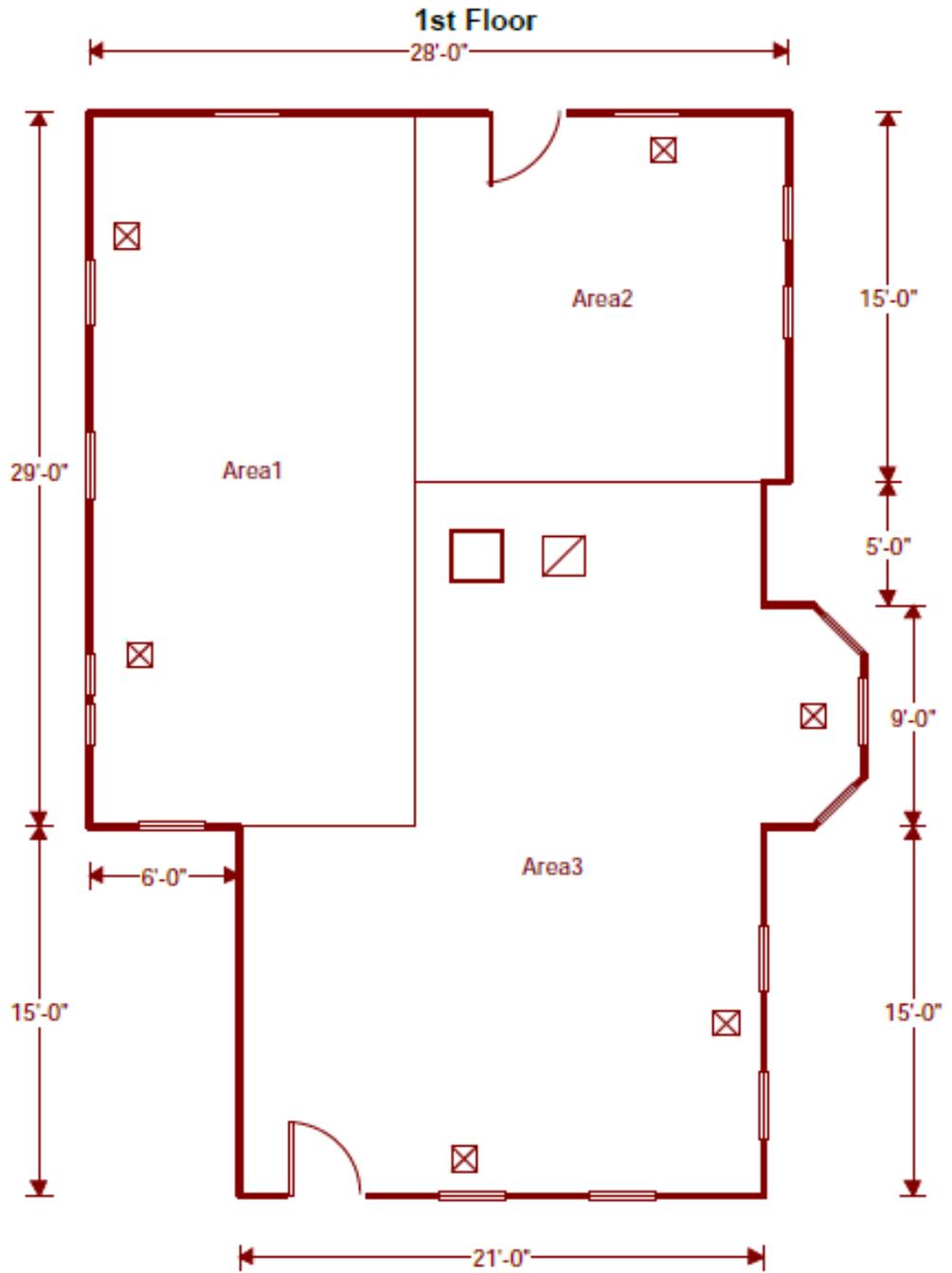
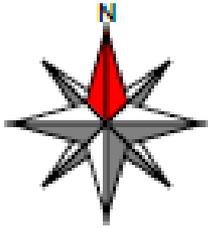
Example House #1



- West Haven, CT
- 2 Floors + Finished Attic
- Built 1930
- 1st Flr = 1145 sq.ft.
- 2nd Flr = 1145 sq.ft.
- Attic = 632 sq.ft.
- Total = 2922 sq.ft.

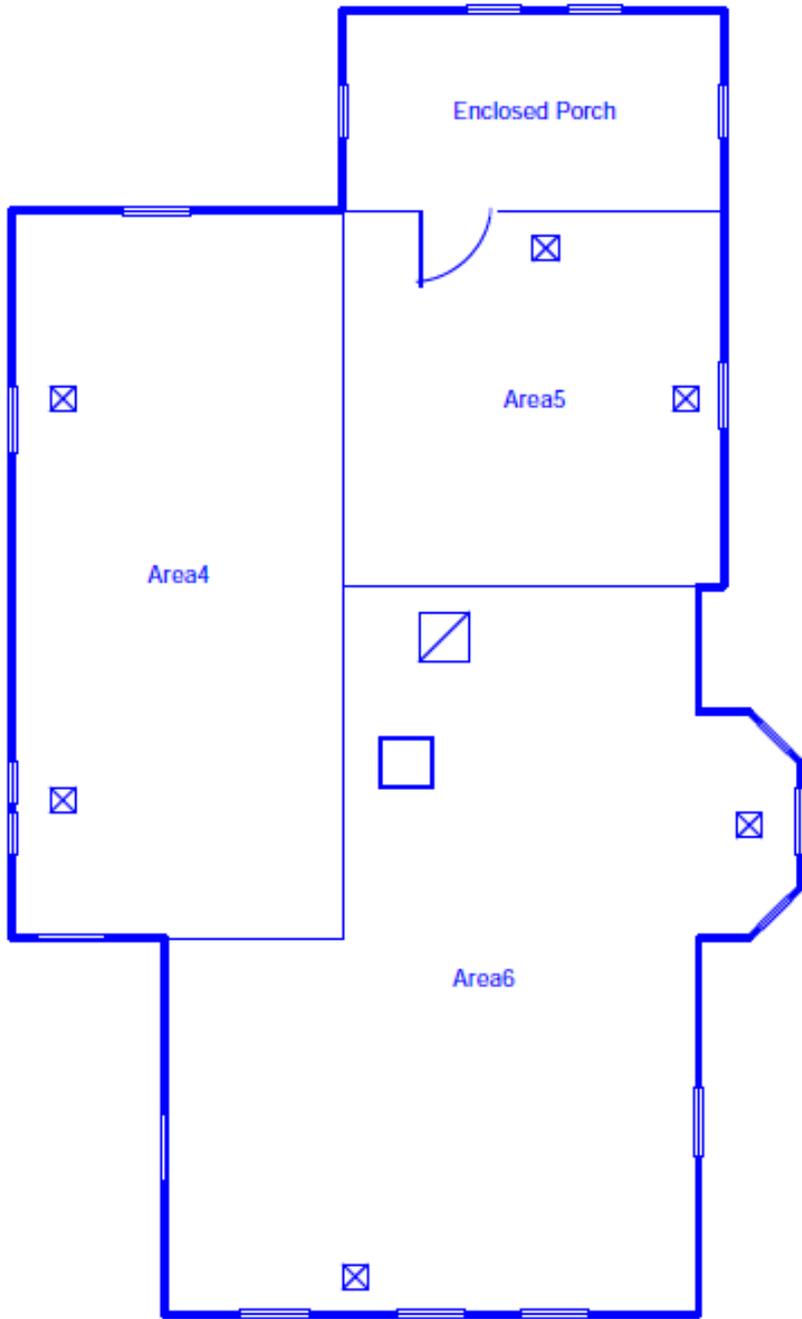
- Attic Ceilings Insulated
- Windows Updated
- New “insulated” siding

Example House #1

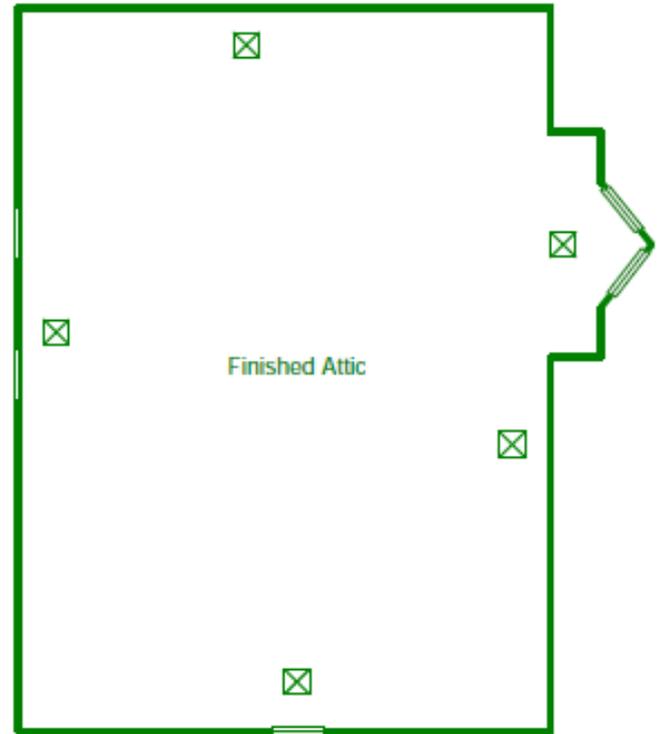


Example House #1

2nd Floor



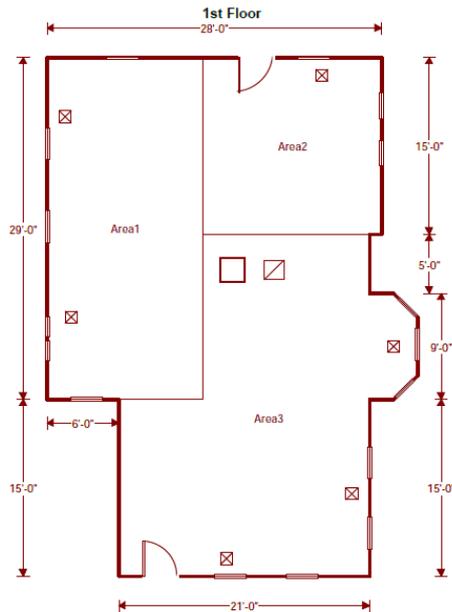
3rd Floor



Example House #1



How do we **typically** go about “Engineering” a mechanical system for this house?

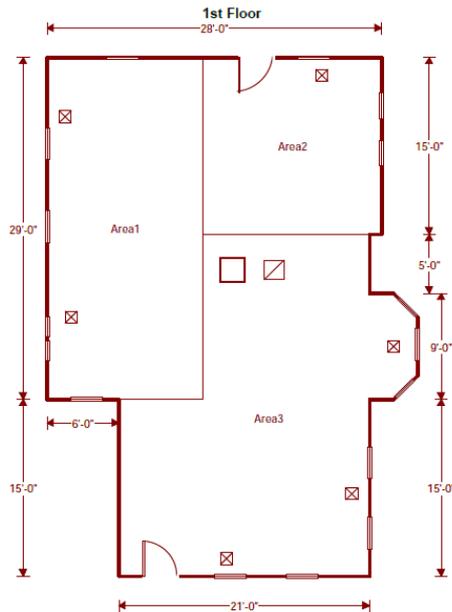


1. Determine scope of the project
2. Solicit contractor quotes
3. Hire contractor
4. Install system
5. Pay contractor

Example House #1



What is the **correct** way to go about “Engineering” a mechanical system for this house?



1. Determine scope of the project
2. Determine code requirements
3. Perform engineering analysis
4. Solicit bids
5. Hire contractor
6. Install system
7. Commission system
8. Pay contractor

Code Overview



State Building Codes

2005 Connecticut Code Summary (with 2009 Amendments)

2003 International Building Code. (IBC)

2003 International Existing Building Code (IEBC)

2003 International Plumbing Code. (IPC)

2003 International Mechanical Code. (IMC)

2009 International Energy Conservation Code (IECC)

2009 International Residential Code. (IRC)

2011 National Electrical Code (NFPA-70) (NEC)

2012 Connecticut Code Summary

(Proposed Adoption Fall 2015)

2012 International Building Code. (IBC)

2012 International Existing Building Code (IEBC)

2012 International Plumbing Code. (IPC)

2012 International Mechanical Code. (IMC)

2012 International Energy Conservation Code (IECC)

2012 International Residential Code. (IRC)

2014 National Electrical Code (NFPA-70) (NEC)

2011 Connecticut Amendment

Effective: Oct 6, 2011

SECTION 29-252-1d Amended....

DELETE 2006 IECC, substitute with 2009 IECC Amendments:

403.2.1.1 Duct Insulation Values prescribed must be Installed values.

403.2.3 No building cavities may be used as supply or return “ducts”. (2003 IMC/IRC allowed returns)

403.6 Equipment Sizing (*Mandatory*). Heating and cooling equipment shall be sized in accordance with ACCA Manual S, based on building loads calculated in accordance with ACCA Manual J (or other approved methods – none listed).

Referenced Standard: ACCA Manual J-02, 8th edition (not 7)

Referenced Standard: ACCA Manual S-04

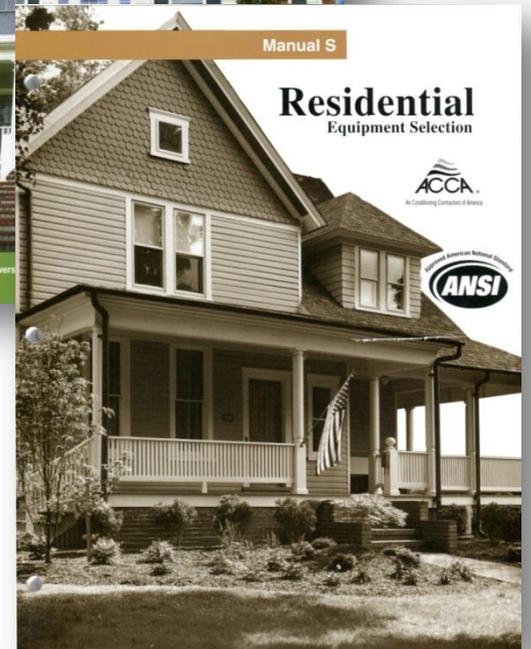
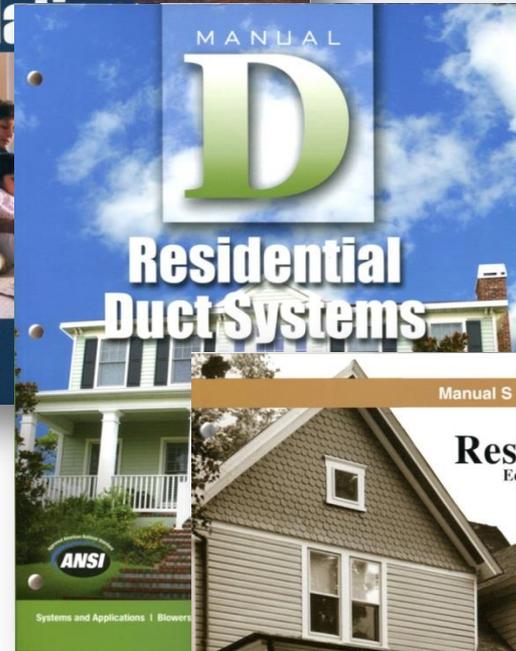
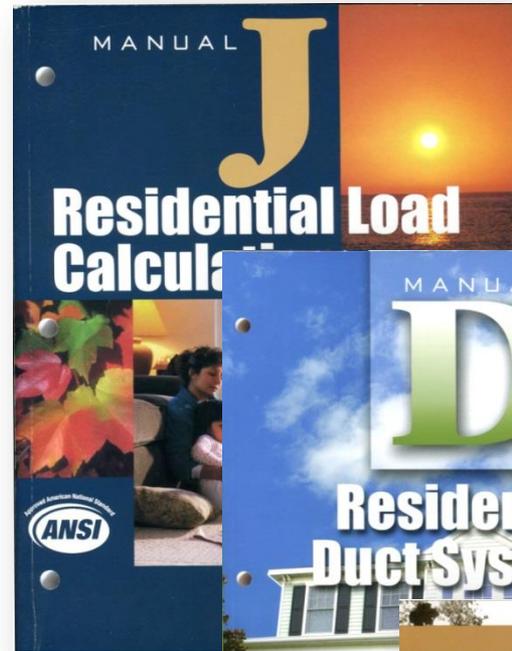
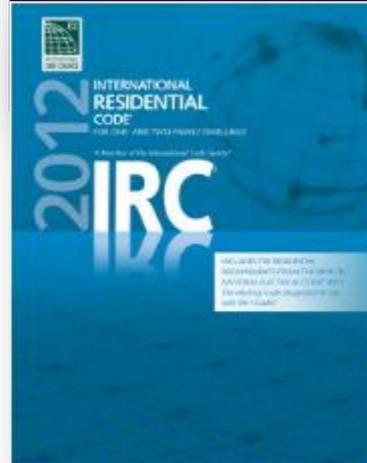
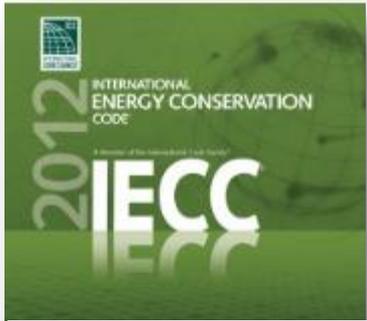
2012 International Residential Code 2012 International Energy Conservation Code

**N1103.6 (R403.6) Equipment sizing (Mandatory) & M1401.3 Sizing.
R403.6 Equipment Sizing (Mandatory).**

“Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies.”

Code Comparison

ACCA Standard 5 (Quality Install)	Component	2005 Connecticut Code (2009, 2011 & 2013 Amendments)	2012 Connecticut Code	Energy Star (Homes 3.0 / Quality Installation)
ANSI/ACCA 2 Manual J - 2011 J-8 (version 2) <i>(Block - Room-by-room)</i>	Manual J (Load calculations)	IRC 2009: M1401.3 ACCA Manual J8-02 IECC 2009: 403.6 CT 2011 Amend: <i>(Mandatory) Load Calculation</i> ACCA Manual J-8 (version 2)	IRC 2012: M1401.3 ACCA Manual J8-11 IECC 2012: 403.6 <i>(Mandatory)</i> ACCA Manual J	J-8 Required: <i>(Room-by-room)</i>
ANSI/ACCA 1 Manual D - 2009 <i>(None - Complete)</i>	Manual D (Duct design)	IRC 2009: M1601.1, M1602.2 ACCA Manual D-09	IRC 2012: M1602.2 ACCA Manual D-09 IMC 2012: 603.2 ACCA Manual D	Required <i>(Complete)</i>
ANSI/ACCA 3 Manual S - 2004 (2nd Edition - 2014)	Manual S (Equipment/component selection)	IRC 2009: M1401.3 ACCA Manual S-2004 IECC 2009: 403.6 CT 2011 Amend: <i>(Mandatory) Equipment Sizing</i> ACCA Manual S	IRC 2012: M1401.3 ACCA Manual S IECC 2012: 403.6 <i>(Mandatory)</i> ACCA Manual S	S-2004 Required
Estimated, recommended, or per code for new construction	Building Infiltration (Testing with Blower Door)	IECC 2009: <i>Option 402.4.2.1</i>	IECC 2012: R402.4.1.2 <i>3 ACH₅₀</i>	Required
Required: <i>New: 6% Total, Exist: 20% of design cfm, or 50% reduction</i>	Duct Leakage (Testing with Duct Blaster)	IECC 2009: 403.2.2 Sealing (Mandatory) 8-12cfm/100ft	IRC 2012: N1103.2.2 Sealing (Mandatory) ² 3-4cfm/100ft IECC 2012: 403.2.2 Sealing (Mandatory) ² 3-4cfm/100ft	Required: $\leq 6\text{cfm}/100\text{ft}^2$
Required	Airflow Testing (Balancing / Total / Static)	Not Cited	Not Cited	Required
Required	Commissioning (Charge, electrical, airflow testing & documentation)	Not Cited	Not Cited	Required

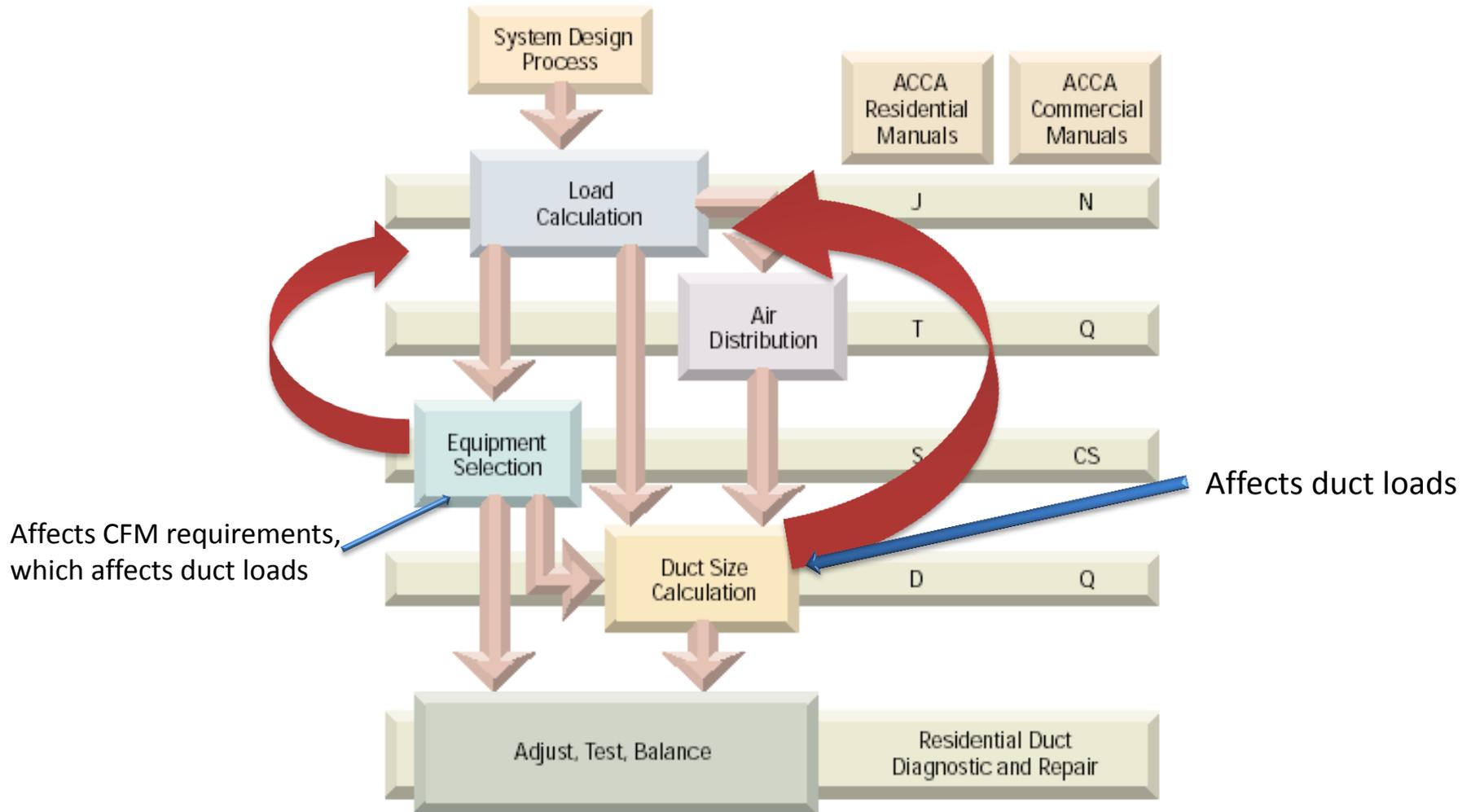


The Design Process

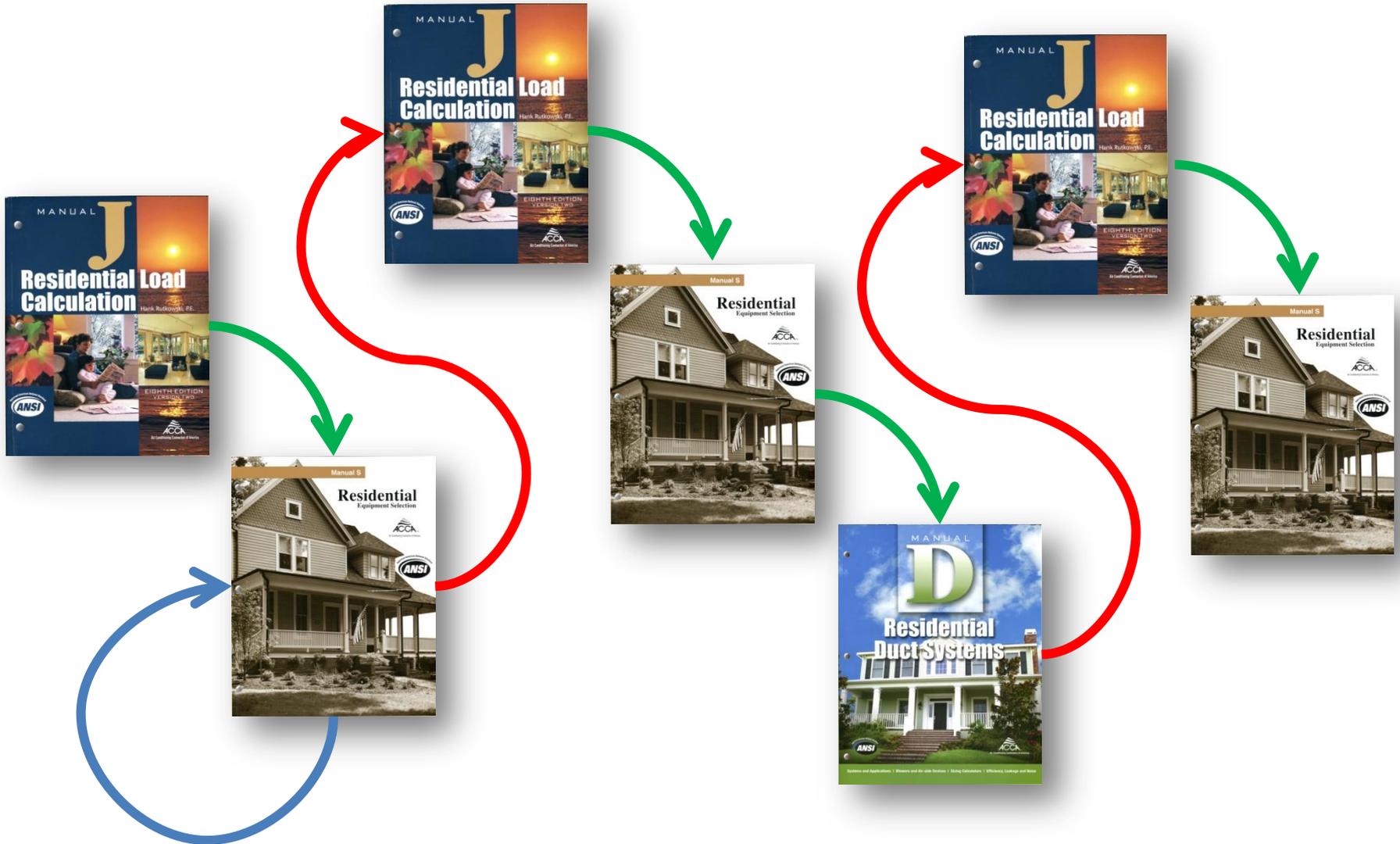
SAY MAN, YOU DO MANUAL J'S?

**IT WOULD BE A LOT COOLER IF YOU
DID.**

Design Process Overview



Design Process Overview



What is Manual J?

1. “Modeling” the peak building loads at local climatic conditions
 1. Do NOT change outdoor or indoor design conditions. (This will create psychrometric errors)
2. Manual J (when performed aggressively) will still over-estimate actual loads by 10% to 40%

Local Design Conditions

Connecticut Location		Connecticut Design Data				Miles To Reference	ACCA Table 1A (Reference Design Data)						
City	County	Elevation	Winter Heating 99% dB	Summer Cooling 1% dB	Cooling 1% (wB)		Design Reference City	State	Elevation	Latitude	Heating 99% (dB)	Cooling 1% (dB)	Cooling 1% (wB)
ABINGTON	WINDHAM	653	5	86	73	20	Norwich	CT	197	41	7	86	73
ANDOVER	TOLLAND	405	5	88	72	19	Hartford Brainard Field	CT	19	41	6	88	72
ANSONIA	NEW HAVEN	90	7	84	73	8	New Haven	CT	14	41	7	84	73
ASHFORD	WINDHAM	698	5	86	73	25	Norwich	CT	197	41	7	86	73
AVON	HARTFORD	287	5	88	72	6	Hartford Brainard Field	CT	19	41	6	88	72
BARKHAMSTED	LITCHFIELD	562	4	88	72	16	Hartford Brainard Field	CT	19	41	6	88	72
BEACON FALLS	NEW HAVEN	133	5	88	72	7	Waterbury	CT	850	41	2	85	71
BERLIN	HARTFORD	161	5	88	72	10	Hartford Brainard Field	CT	19	41	6	88	72
BETHANY	NEW HAVEN	512	5	84	73	8	New Haven	CT	14	41	7	84	73
BETHEL	FAIRFIELD	376	4	87	72	15	Waterbury	CT	850	41	2	85	71
BETHLEHEM	LITCHFIELD	833	2	85	71	10	Waterbury	CT	850	41	2	85	71
BLOOMFIELD	HARTFORD	134	6	88	72	6	Hartford Brainard Field	CT	19	41	6	88	72
BOLTON	TOLLAND	736	6	88	71	15	Windsor Locks Bradley Field	CT	197	42	8	88	71
BOZRAH	NEW LONDON	180	7	86	73	8	Norwich	CT	197	41	7	86	73
BRANFORD	NEW HAVEN	41	7	84	73	7	New Haven	CT	14	41	7	84	73
BRIDGEPORT	FAIRFIELD	28	12	84	72	2	Bridgeport	CT	10	41	12	84	72
BRIDGEWATER	LITCHFIELD	706	3	86	71	11	Waterbury	CT	850	41	2	85	71
BRISTOL	HARTFORD	312	5	88	72	12	Hartford Brainard Field	CT	19	41	6	88	72
BROOKFIELD	FAIRFIELD	498	3	86	72	12	Waterbury	CT	850	41	2	85	71
BROOKLYN	WINDHAM	211	7	86	73	16	Norwich	CT	197	41	7	86	73
BURLINGTON	HARTFORD	750	3	88	71	11	Hartford Brainard Field	CT	19	41	6	88	72
CANAAN													72
CANTERBURY													73
CANTON													72
CHAPLIN													73
CHESHIRE													71
CHESTER	MIDDLESEX	225	8	85	72	19	New London	CT	10	41	9	85	72
CLINTON	MIDDLESEX	63	7	84	73	20	New Haven	CT	14	41	7	84	73

All values derived from 2009 ASHRAE Handbook-Fundamentals Chapter 1 Psychrometrics Equations 3 & 4

What is Manual S?

1. Iterative process using the “initial” loads from Manual J to select candidate equipment
2. Candidate equipment capacity is then adjusted based on:
 1. available CFM settings of air handler,
 2. altitude,
 3. outdoor air design temperature,
 4. return air entering conditions and,
 5. any line-set adjustments due to lifts or lengths

What is Manual D?

1. The process to design a ducted distribution system based on the CFM requirements determined by the Manual J and Manual S process.
2. Although re-engineering existing duct systems is not required – the designer/mechanic better be able to recognize the very common problems of insufficient return duct, grille and filter sizing.
3. If installing a hydronic only system, many of the Manual J software suites will help size baseboard lengths for the project.

**I ATTENDED THE 2 DAY TRAINING
CLASS**

**SO I GUESS YOU COULD SAY I PRETTY MUCH
KNOW EVERYTHING ABOUT HVAC DESIGN**

Acceptable Software Tools/Methods

- Manual J is too complex to perform by hand or with a spreadsheet! The design practitioner **MUST** use approved software.
 - There are currently 6 software packages available for load calculations. They are NOT equal in their capabilities.



ResLoad-J for IPAD



HeatCAD[®] 2014



Avenir



ACCA Approved Software

The screenshot shows the ACCA website's 'Approved Software' page. The page is titled 'Approved Software - ACCA' and is located at www.acca.org/standards/software/. The ACCA logo is prominently displayed on the left. The main navigation menu includes links for 'Standards & Codes', 'Education & Events', 'Issues & Advocacy', 'Accreditation Programs', 'Member Services', and 'Online Store'. The 'Approved Software' section is divided into two main categories: 'Powered by ACCA Manual J - Full Residential Load Calculation' and 'Manual J Block Load Compliant - Block Load Only'. Each category lists several software products with buttons to 'Buy from ACCA' or 'Company Website'.

Powered by ACCA Manual J - Full Residential Load Calculation

Software Name	Buy from ACCA	Company Website	Platform
Wrightsoft Right-J8	Yes	Yes	Windows
Elite RHVAC	Yes	Yes	Windows
Adtek AccuLoads	Yes	Yes	Windows
Florida Solar Energy Center's EnergyGauge	No	Yes	Windows
CarmelSoft HVAC ResLoad-J	No	Yes	iPad
Avenir MJ8 Editions of HeatCAD® and LoopCAD®	No	Yes	Windows

Manual J Block Load Compliant - Block Load Only

Software Name	Buy from ACCA	Company Website	Platform
Wrightsoft Right-J Mobile	No	Yes	Browser Based (All Devices)

Powered by ACCA Manual D - Residential Duct Design

Software Name	Buy from ACCA	Company Website	Platform
Wrightsoft Right-D	Yes	Yes	Windows
Elite DUCTSIZE	Yes	Yes	Windows
Adtek AccuDuct	No	Yes	Windows

WWW.ACCA.ORG/STANDARDS/SOFTWARE

Software Not ACCA Approved

MrHVAC.com

HVAC-Calc

Fire Dragon Net

O'Brien Quick Loads Pro

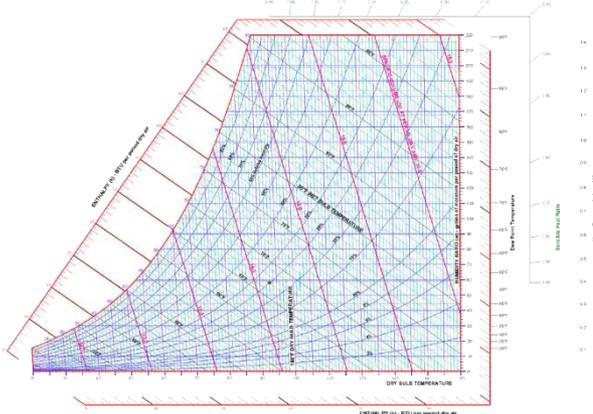
Qwickload

Loadcalc.net

Code Officials Note: None of these packages will calculate duct loads or air-conditioning loads correctly. They may be close enough for hydronic heating loads, but they are not vetted by ACCA for either.

Acceptable Software Tools/Methods

- Manual S requires Psychrometric calculations and detailed OEM performance data. It can be preformed with charts and tables, however there are a lot of numbers involved and is easy to miss-read or transcribe numbers from OEM charts. It is better to use OEM software and either Psychrometric software, or other tool (including Manual J software) to perform the calculations when possible.
- NONE of the current Manual J software suites does this perfectly or at all in some cases!

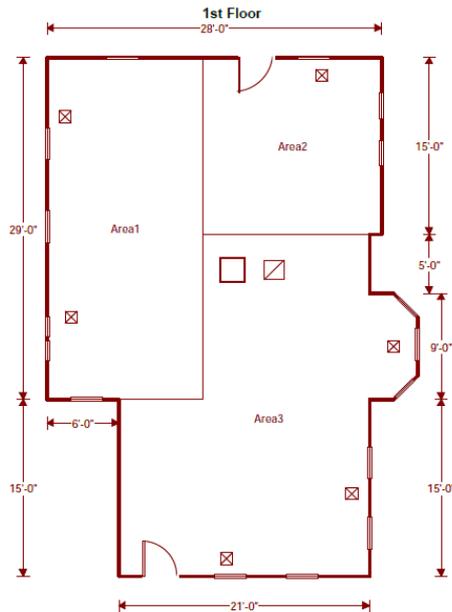


EVAPORATOR AIR				CONDENSER ENTERING AIR TEMPERATURES										
CFM	EWB	75		Total System KW**	85		Total System KW**	95		Total System KW**	105			
		Capacity MBtu/h†			Total	Sens†		Capacity MBtu/h†			Total	Sens†	Capacity MBtu/h†	
		Total	Sens†					Total	Sens†				Total	Sens†
24ANA748A30 Outdoor Section With FE4ANB006 Indoor Section – High Sta														
1200	72	59.40	29.78	3.48	55.70	28.24	3.77	51.94	26.70	4.06	48.12	25.17		
	67	53.40	35.17	3.43	49.97	33.57	3.70	46.49	31.98	3.97	42.95	30.40		
	63	49.20	33.95	3.39	45.97	32.35	3.65	42.69	30.76	3.90	39.34	29.16		
1400	62	47.99	40.50	3.37	44.82	38.85	3.63	41.61	37.21	3.88	38.35	35.57		
	57	44.41	44.41	3.33	42.02	42.02	3.59	39.59	39.59	3.83	37.10	37.10		
	72	61.59	31.59	3.57	57.63	29.99	3.87	53.63	28.40	4.16	49.57	26.82		
1470	67	55.37	37.89	3.52	51.70	36.23	3.80	48.00	34.58	4.07	44.24	32.93		
	83	51.02	36.52	3.48	47.56	34.85	3.75	44.07	33.20	4.00	40.52	31.54		
	62	49.79	44.12	3.47	46.41	42.39	3.73	43.02	40.66	3.98	39.62	38.88		
1740	57	47.24	47.24	3.44	44.64	44.64	3.71	42.00	42.00	3.95	39.30	39.30		
	72	62.20	32.18	3.61	58.17	30.57	3.91	54.09	28.97	4.20	49.97	27.37		
	67	55.93	38.79	3.56	52.19	37.11	3.84	48.42	35.45	4.11	44.59	33.76		
1800	63	51.53	37.37	3.52	48.01	35.69	3.79	44.45	34.01	4.04	40.84	32.34		
	62	50.30	45.93	3.51	46.87	43.57	3.77	43.33	41.70	4.02	40.03	39.03		

Design Summary

- Manual J
 - Determine local conditions
- Manual S
 - Select equipment with capacity adjusted for local conditions
- Manual D
 - Based on design CFM requirements

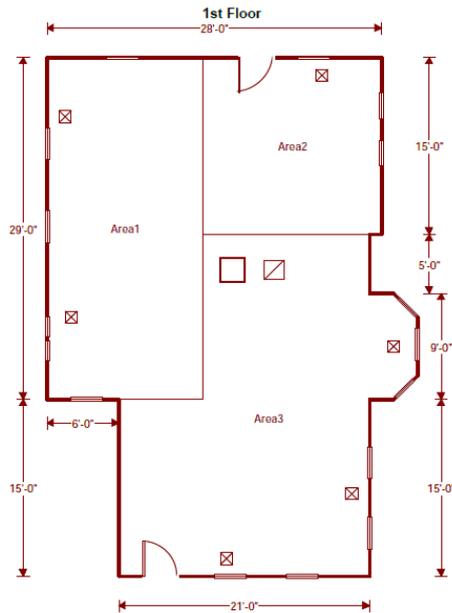
Example House #1



1. Determine scope of the project

1. Replace 1st floor furnace and Air Conditioner
2. Replace boiler that serves 2nd floor and finished attic
3. Add new air conditioner system to 2nd floor and attic

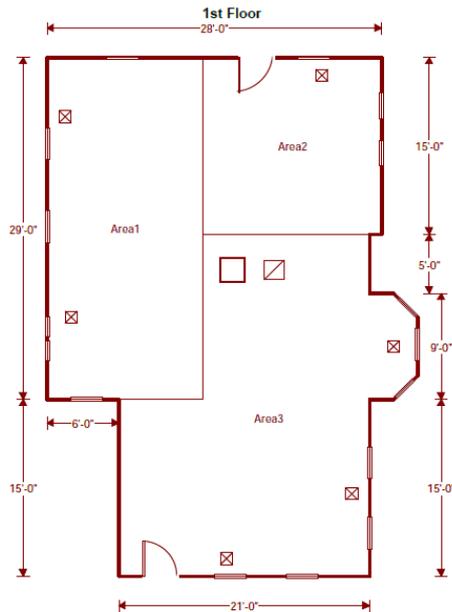
Example House #1



2. Determine code requirements

1. Manual J (Entire building)
2. Manual S (all systems)
3. Manual D – New A/C system only

Example House #1



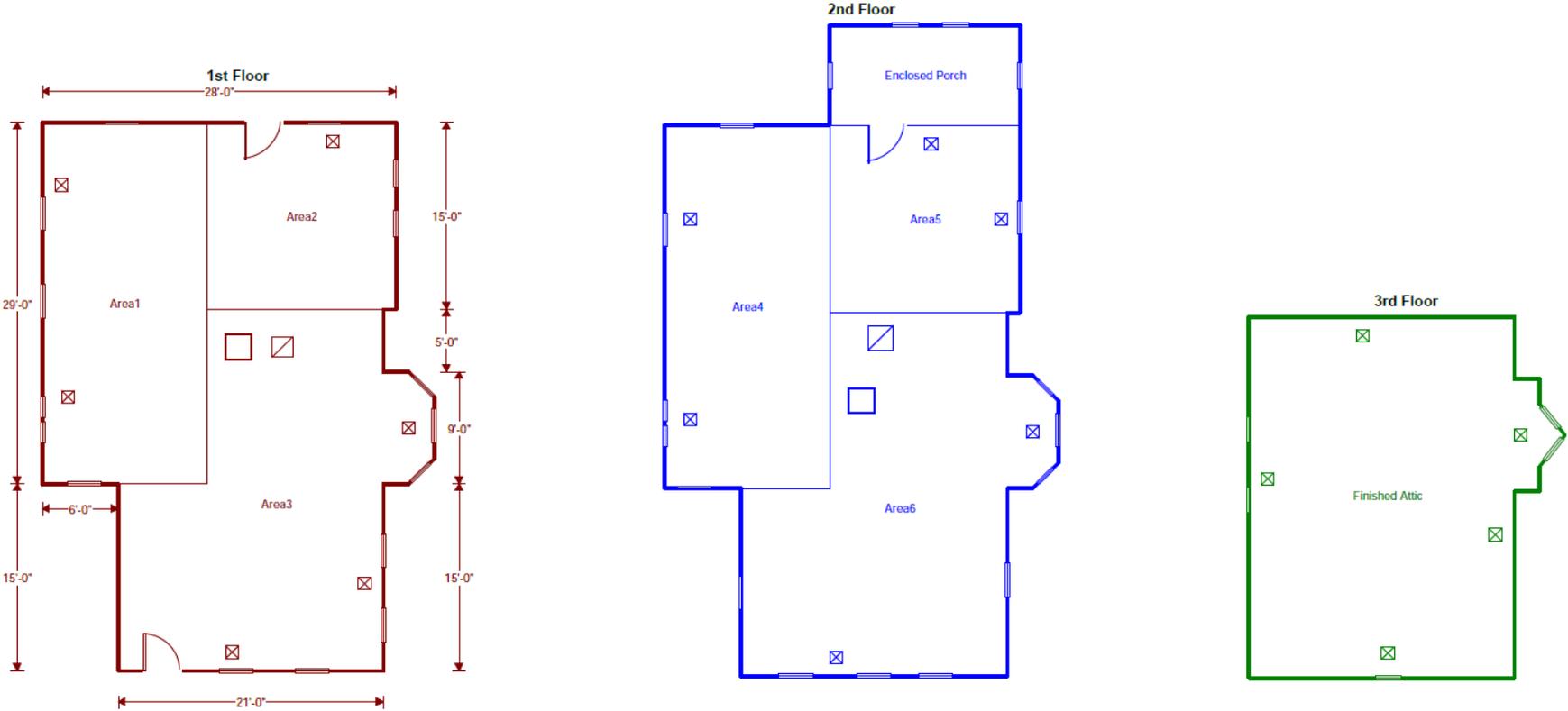
3. Perform engineering analysis

1. Manual J (Entire building)
2. Manual S (all systems)
3. Manual D – New A/C system only

Local Design Conditions

Connecticut Location		Connecticut Design Data					ACCA Table 1A (Reference Design Data)							
City	County	Elevation	Winter Heating 99% dB	Summer Cooling 1% dB	Cooling 1% (WB)	Miles To Reference	Design Reference City	State	Elevation	Latitude	Heating 99% (dB)	Cooling 1% (dB)	Cooling 1% (WB)	
THOMASTON	LITCHFIELD	407	4	87	72	11	Waterbury	CT	850	41	2	85	71	
THOMPSON	WINDHAM	634	6	84	70	19	Worcester	MA	986	42	5	83	69	
TOLLAND	TOLLAND	629	6	88	71	15	Windsor Locks Bradley Field	CT	197	42	8	88	71	
TORRINGTON	LITCHFIELD	753	3	88	71	16	Hartford Brainard Field	CT	19	41	6	88	72	
TRUMBULL	FAIRFIELD	289	11	84	72	6	Bridgeport	CT	10	41	12	84	72	
UNION	TOLLAND	864	6	88	70	20	Windsor Locks Bradley Field	CT	197	42	8	88	71	
VERNON	TOLLAND	527	7	88	71	11	Windsor Locks Bradley Field	CT	197	42	8	88	71	
VOLUNTOWN	NEW LONDON	275	7	86	73	8	Norwich	CT	197	41	7	86	73	
WALLINGFORD	NEW HAVEN	88	7	84	73	12	New Haven	CT	14	41	7	84	73	
WARREN	LITCHFIELD	1292	0	85	71	22	Waterbury	CT	850	41	2	85	71	
WASHINGTON	LITCHFIELD	847	2	85	71	12	Waterbury	CT	850	41	2	85	71	
WATERBURY	NEW HAVEN	588	3	86	71	7	Waterbury	CT	850	41	2	85	71	
WATERFORD	NEW LONDON	78	9	85	72	2	New London	CT	10	41	9	85	72	
WATERTOWN	LITCHFIELD	619	3	86	71	7	Waterbury	CT	850	41	2	85	71	
WEST HARTFORD	HARTFORD	176	5	88	72	1	Hartford Brainard Field	CT	19	41	6	88	72	
WEST HAVEN	NEW HAVEN	70	7	84	73	3	New Haven	CT	14	41	7	84	73	
WESTBROOK	MIDDLESEX	30	9	85	72	19	New London	CT	10	41	9	85	72	
WESTON	FAIRFIELD	310	9	84	71	7	Norwalk	CT	397	41	9	84	71	
WESTPORT	FAIRFIELD	25	10	85	72	5	Norwalk	CT	397	41	9	84	71	
WETHERSFIELD	HARTFORD	70	6	88	72	5	Hartford Brainard Field	CT	19	41	6	88	72	
WILLINGTON	TOLLAND	768	6	88	71	20	Windsor Locks Bradley Field	CT	197	42	8	88	71	
WILTON	FAIRFIELD	333	9	84	71	5	Norwalk	CT	397	41	9	84	71	
WINCHESTER	LITCHFIELD	1324	1	88	71	22	Hartford Brainard Field	CT	19	41	6	88	72	
WINDHAM	WINDHAM	310	7	86	73	11	Norwich	CT	197	41	7	86	73	
WINDSOR	HARTFORD	55	9	89	71	5	Windsor Locks Bradley Field	CT	197	42	8	88	71	
WINDSOR LOCKS	HARTFORD	130	8	88	71	0	Windsor Locks Bradley Field	CT	197	42	8	88	71	
WOLCOTT	NEW HAVEN	605	3	86	71	11	Waterbury	CT	850	41	2	85	71	
WOODBIDGE	NEW HAVEN	332	6	84	73	6	New Haven	CT	14	41	7	84	73	
WOODBURY	LITCHFIELD	269	4	87	72	5	Waterbury	CT	850	41	2	85	71	
WOODSTOCK	WINDHAM	572	6	84	70	23	Worcester	MA	986	42	5	83	69	

Manual J – Load Calculations



Design Information

	Htg	Clg		Infiltration
Outside db (°F)	7	84	Method	Simplified
Inside db (°F)	70	75	Construction quality	Loose
Design TD (°F)	63	9	Fireplaces	1 (Semi-loose)
Daily range	-	M		
Inside humidity (%)	50	50		
Moisture difference (gr/lb)	48	40		

Inside humidity (%)	50	50
Moisture difference (gr/lb)	48	40

HEATING EQUIPMENT

Make	n/a	
Trade	n/a	
Model	n/a	
AHRI ref	n/a	
Efficiency		n/a
Heating input		

COOLING EQUIPMENT

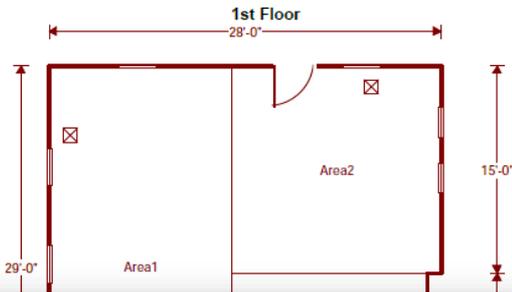
Make	n/a	
Trade	n/a	
Cond	n/a	
Coil	n/a	
AHRI ref	n/a	
Efficiency		n/a
Sensible cooling		0 Btuh

ROOM NAME		Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Baseboard (ft)		Clg AVF (cfm)
					Low	High	
Boiler	d	1777	58557	23490	98	69	1100
Furnace	d	1145	36351	12703	61	43	587
Entire House	d	2922	94909	36195	158	112	1845
Other equip loads			0	0			
Equip. @ 1.00 RSM				36195			
Latent cooling				8693			
TOTALS		2922	94909	44888	158	112	1845

Bold/italic values have been manually overridden

Calculations approved by ACCA to meet all requirements of Manual J 8th Ed.

Manual J – Load Calculations



Load Short Form
Furnace
Roitay Inc. Energy Services

Job:
Date: May 01, 2015
By:

98 Overbrook Road, Madison, CT 06443 Phone: 203-672-1330 Email: buck@roitay.com Web: www.Roitay.com

Project Information

For: Manual S Demo
West Haven, CT 06516

Design Information

	Htg	Clg	Infiltration	
Outside db (°F)	7	84	Method	Simplified
Inside db (°F)	70	75	Construction quality	Loose
Design TD (°F)	63	9	Fireplaces	1 (Semi-loose)
Daily range	-	M		
Inside humidity (%)	50	50		
Moisture difference (gr/lb)	48	40		

HEATING EQUIPMENT

Make York
Trade Latitude TG8S
Model TG8S100B12MP11
AHRI ref

COOLING EQUIPMENT

Make Bryant
Trade BRYANT HEATING AND COOLING SYS...
Cond 123ANA018****C*
Coil CNPV*2417AL*++TDR

ROOM NAME		Area (ft ²)	Htg load (Btuh)	Clg load (Btuh)	Baseboard (ft)		Clg AVF (cfm)
					Low	High	
1st Floor Zone	p	1145	36351	13868	61	43	641
Furnace	d	1145	36351	12703	61	43	587
Other equip loads			0	0			
Equip. @ 1.00 RSM				12703			
Latent cooling				4308			
TOTALS		1145	36351	17010	61	43	587

Calculations approved by ACCA to meet all requirements of Manual J 8th Ed.



Right-Suite® Universal 2015.15.0.15 RSU19562
...nsort HVAC/Roitary Projects/Uiang/Uiang_wAC.np Calc - M08 Front Door faces: 0

2015-May-21 19:33:20
Page 3

Manual J – Load Calculations



Load Short Form
Boiler
 Rollay Inc. Energy Services

Job:
 Date: May 01, 2015
 By:

98 Overbrook Road, Madison, CT 06443 Phone: 203-672-1330 Email: buck@rollay.com Web: www.Rollay.com

Project Information

For: Manual S Demo
 West Haven, CT 06516

Design Information

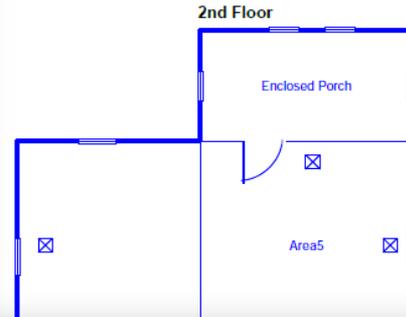
	Htg	Clg	Infiltration	
Outside db (°F)	7	84	Method	Simplified
Inside db (°F)	70	75	Construction quality	Loose
Design TD (°F)	63	9	Fireplaces	1 (Semi-loose)
Daily range	-	M		
Inside humidity (%)	50	50		
Moisture difference (gr/lb)	48	40		

HEATING EQUIPMENT

Make Advantase

COOLING EQUIPMENT

Make Rvnt



ROOM NAME		Area (ft ²)	Htg load (Btuh)	Clg load (Btuh)	Baseboard (ft)		Clg AVF (cfm)
					Low	High	
2nd Floor Zone	p	1145	30096	16567	50	35	773
Attic Zone	p	632	28461	9246	47	33	431
Boiler	d	1777	58557	23490	98	69	1100
Other equip loads			0	0			
Equip. @ 1.00 RSM				23490			
Latent cooling				4385			
TOTALS		1777	58557	27876	98	69	1100

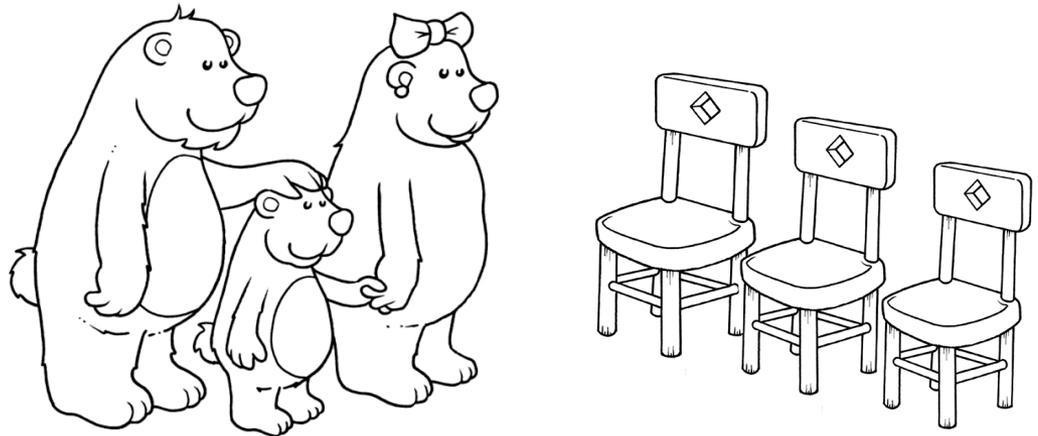
Calculations approved by ACCA to meet all requirements of Manual J 8th Ed.

Manual S

The Practical Definition

Manual S Definition

- The process by which the design practitioner determines the suitability of a candidate mechanical comfort system to meet the design loads of a building.



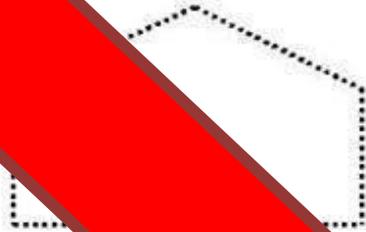
Air Conditioner Heat Pump Sizing Chart

Preparing your sizing chart

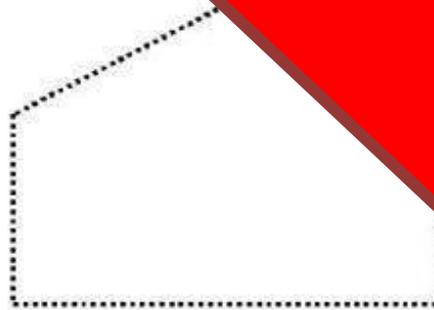
1. Print out the chart
2. Leave it on the floor
3. Follow the instructions



1 1/2 to 2 ton



2 1/2 ton



4 to 5 ton

Sizing chart

1. Stand on the curb
2. Hold the sizing chart up
3. Look at the house through each hole
4. If the house fits in a hole, that's the size unit to use

What is a [redacted] certificate for?

AHRI Certificate Number: 4739804 Date: 6/15/2012

Product: [redacted] Condensing Unit, Coil with Blower

Model Number: [redacted]****B

Model Number: [redacted]

Model Number: PG95

Manufacturer: PAYNE HEATING

Model Name: PAYNE PA13

Manufacturer responsible for the rating combination is PAYNE HEATING AND

Follows in accordance with AHRI Standard 210 for Unitary Air-Conditioning Equipment and subject to verification by AHRI-sponsored, independent

Rated Cooling Capacity (Btuh):	17800
Rated Cooling Rating (Cooling):	12.00
Rated Cooling Rating (Cooling):	14.50

AHRI (210) [redacted] at 29.92" hg

The information on this certificate is a voluntary rerate of previously published data, unless accompanied with a WAC.

CERTIFICATE NO.: 129842531579632819

©2012 Air-Conditioning, Heating, and Refrigeration Institute

What is an AHRI Rating Document for?



Certificate of Product Ratings

AHRI Certified Reference Number: 4739804 Date: 6/15/2012

Product: Split System: Air-Cooled Condensing Unit, Coil with Blower
Outdoor Unit Model Number: PA13NA018****B
Indoor Unit Model Number: CAP**2417A**

Furnace Model Number: PG95XA*30040A***
Manufacturer: PAYNE HEATING AND COOLING
Trade/Brand name: PAYNE PA13

Manufacturer responsible for the rating of this system combination is PAYNE HEATING AND COOLING

Rated as follows in accordance with AHRI Standard 210/240-2008 for Unitary Air-Conditioning and Air-Source Heat Pump Equipment and subject to verification of rating accuracy by AHRI-sponsored, independent, third party testing:

Cooling Capacity (Btuh):	17800
EER Rating (Cooling):	12.00
SEER Rating (Cooling):	14.50



* Ratings followed by an asterisk (*) indicate a voluntary rating of previously published data, unless accompanied with a WAS, which indicates an involuntary rating.

DISCLAIMER

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CERTIFICATE VERIFICATION

The information for the model cited on this certificate can be verified at www.ahridirectory.org, click on "Verify Certificate" link and enter the AHRI Certified Reference Number and the date on which the certificate was issued, which is listed above, and the Certificate No., which is listed below.



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CERTIFICATE NO.: 126842531576632619

- DOE requires it.
- It only tells us what it can do in a lab – for comparison to other systems at the same conditions.
- It does NOT predict how it will perform on our project!

Manual S Procedure

- Adjust capacity for the following effects/factors:
 1. Altitude
 2. Entering coil air conditions
 1. Adjusted for Duct gains/losses (leakage, R-values)
 2. Ventilation
 3. CFM Settings
 1. Airflow set for Sensible Heat Ratio (Cooling)
 4. Line-Sets

WHY?

- Why do we need to do a load calculation (Manual J) and equipment selection (Manual S) on an existing house?
 - Can't I just use the same size as what was already there before if the customer isn't complaining?

BECAUSE

- The original system was MOST likely not properly engineered to begin with,
- Buildings change over time:
 - Weatherization
 - Improvements: Insulation, windows, etcetera...
 - Additional space: additions, finished basements, attics, etcetera.
- Modern equipment doesn't necessarily work the same as the system that is being replaced.

SO?

- OK – so isn't equipment selection based on the loads? Can't I just pick a system based on the loads?
- Well no!

Manual J  Equipment Selection

Equipment capacity is rated at certain laboratory conditions. The designer needs to determine how it will operate at local climatic and building operating conditions.

AHRI Rating – Cooling (& HP's)

- Doesn't include affects of:
 - Altitude
 - Duct thermal gains/losses
 - Duct static pressures
 - Affects fan power and heat
 - Affects airflow and actual Sensible Heat Ratio
 - Outdoor air temperature (difference)
 - Line-sets
 - Charge adjustments to compensate for length, lifts, size

AHRI Rating – Heating (Combustion)

- Doesn't include affects of:
 - Altitude
 - Duct thermal gains/losses (not significant)
 - Duct static pressures
 - Affects fan power and heat (not significant)

Manual S (Equipment Selection)



Line Sets

VAPOR LINE SIZING AND COOLING CAPACITY LOSS PURON REFRIGERANT 1-STAGE AIR CONDITIONER APPLICATIONS

LONG LINE APPLICATION: An application is considered "Long line" when the total equivalent tubing length exceeds 80 ft or when there is more than 20 Ft vertical separation between indoor and outdoor units. These applications require additional accessories and system modifications for reliable system operation. The maximum allowable total equivalent length is 250Ft. The maximum vertical separation is 200 Ft when outdoor

unit is above indoor unit, and 80 Ft when the outdoor unit is below the indoor unit. Refer to Accessory Usage Guideline below for required accessories. See Long-Line Application Guideline for required piping and system modifications. Also, refer to the table below for the acceptable vapor tube diameters based on the total length to minimize the cooling capacity loss.

Unit Nominal Size (Btuh)	Acceptable Liquid Line Diameters (In. OD)	Acceptable Vapor Line Diameters (In. OD)	Cooling Capacity Loss (%) Total Equivalent Line Length (ft.)												
			Standard Application			Long Line Application Requires Accessories									
			25	50	80	80+	100	125	150	175	200	225	250		
18000 1 Stage Puron AC	3/8	1/2	1	2	3	3	4	6	7	8	9	10	12		
		5/8	0	0	1	1	1	1	2	2	3	3	3		
24000 1 Stage Puron AC	3/8	5/8	0	1	1	1	2	3	3	4	4	5	6		
		3/4	0	0	0	0	0	1	1	1	1	1	2		
		7/8	0	0	0	0	0	0	0	0	0	0	1		
30000 1 Stage Puron AC	3/8	5/8	1	2	3	3	3	4	5	6	7	8	9		
		3/4	0	0	1	1	1	1	2	2	2	3	3		
		7/8	0	0	0	0	0	1	1	1	1	1	1		
36000 1 Stage Puron AC	3/8	5/8	1	2	4	4	5	6	7	9	10	11	13		
		3/4	0	0	1	1	1	2	2	3	3	4	4		
		7/8	0	0	0	0	0	1	1	1	1	2	2		
42000 1 Stage Puron AC	3/8	3/4	0	1	2	2	2	3	4	4	5	6	6		
		7/8	0	0	1	1	1	1	2	2	2	3	3		
		1 1/8	0	0	0	0	0	0	0	0	0	0	1		
48000 1 Stage Puron AC	3/8	3/4	0	1	2	2	3	4	5	5	6	7	8		
		7/8	0	0	1	1	1	2	2	2	3	3	4		
		1 1/8	0	0	0	0	0	0	0	0	1	1	1		
60000 1 Stage Puron AC	3/8	3/4	1	2	4	4	5	6	7	9	10	11	12		
		7/8	0	1	2	2	2	3	4	4	5	5	6		
		1 1/8	0	0	0	0	1	1	1	1	1	1	2		

Standard Length = 80 Ft or less total equivalent length

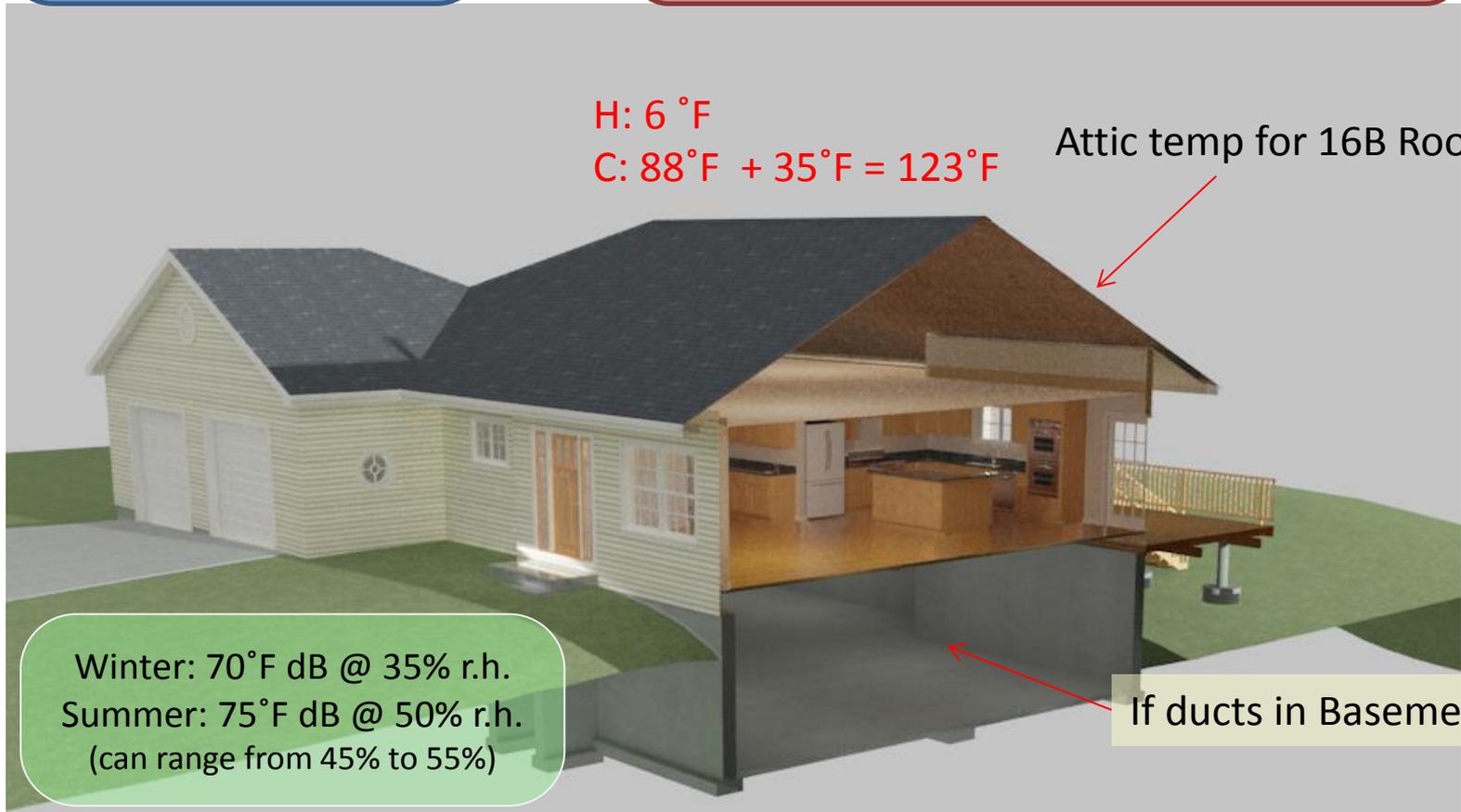
Applications in this area are long line. Accessories are required as shown recommended on Long Line Application Guidelines

Applications in this area may have height restrictions that limit allowable total equivalent length, when outdoor unit is below indoor unit See Long Line Application Guidelines

Design Conditions - Ducts

Winter: 99% dB
Hartford = 6°F dB

Summer: 1% dB and 1% (coincidence) wB
Hartford = 88°F dB, 72°F wB



H: 6 °F
C: 88°F + 35°F = 123°F

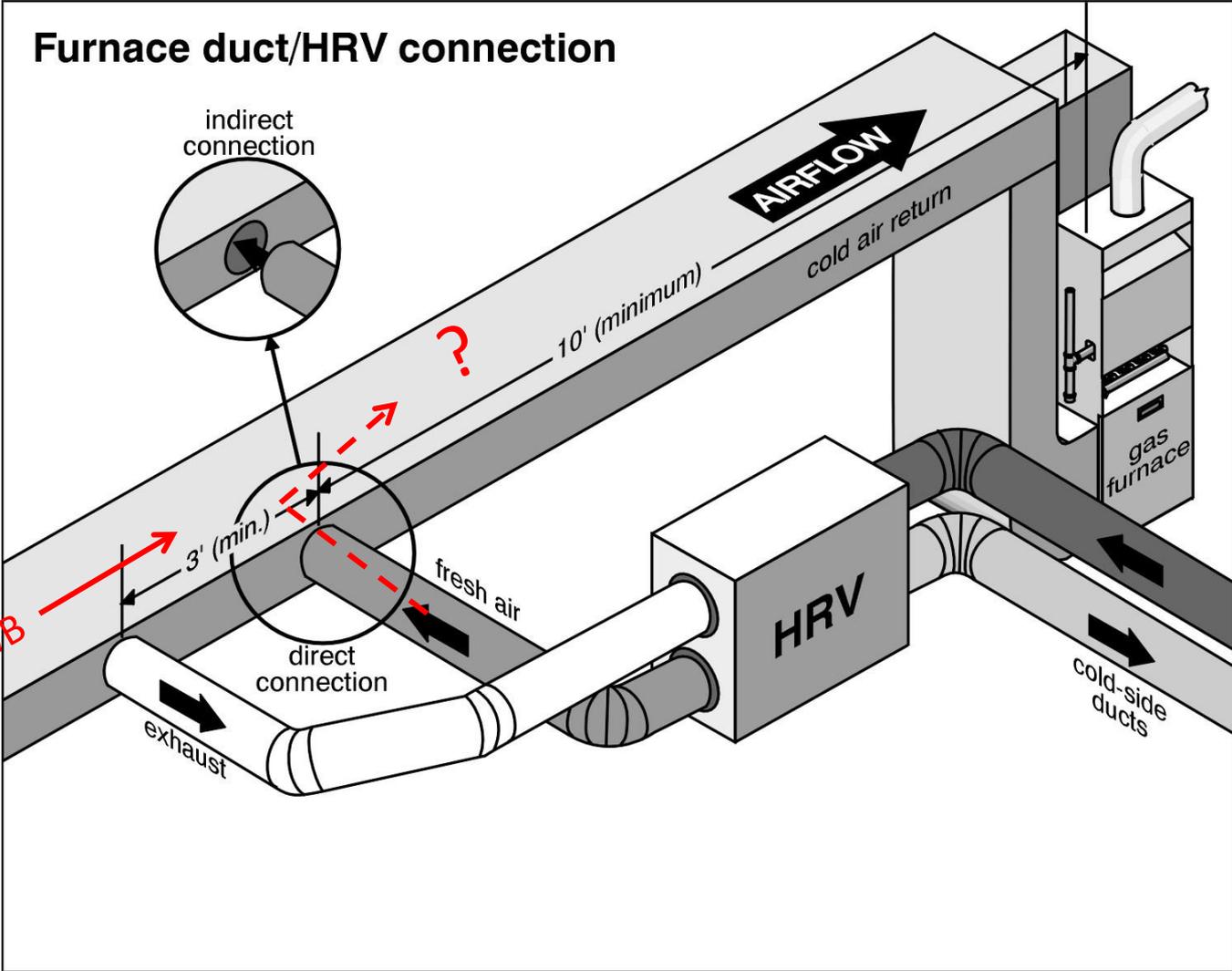
Attic temp for 16B Roof?

Winter: 70°F dB @ 35% r.h.
Summer: 75°F dB @ 50% r.h.
(can range from 45% to 55%)

If ducts in Basement?

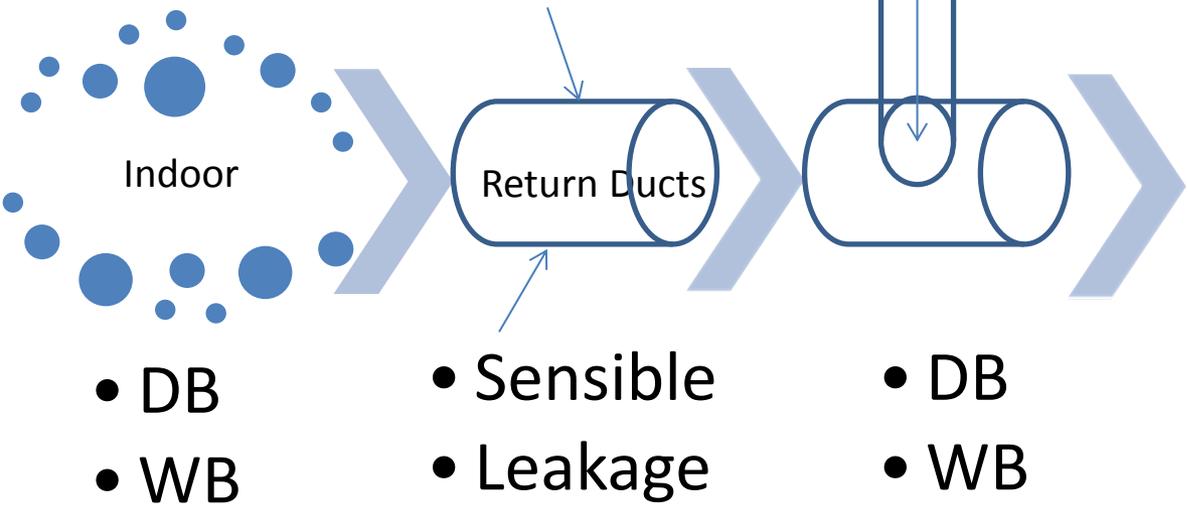
H: 50°F + (6°F x 0.3) = 51.8°F
C: 75°F

Ventilation



Manual S (Equipment Selection)

75°F dB @ 50% R.H.
(62.5°F wB)



Final Condition

- DB
- WB



77.2°F dB / 64.5°F wB ?

Entering Air

Capacity Interpolator

Design conditions

EDB (°F)

78.4

EWB (°F)

64.9

ODB (°F)

84.0

AVF (cfm)

593

Manufacturer performance data

12508 Btuh 5206 Btuh 17714 Btuh 0.71

Cooling Coil Interpolator - System 1

System 1 Design Conditions

Outdoor Dry Bulb:

84

°F

Supply Airflow:

593

CFM

Entering Wet Bulb:

63.4

°F

Entering Dry Bulb:

75.3

°F

EDB Low 75 EDB High 80

Sensible Capacity
Btuh

12548	14740
12188	14380
13315	15820
12935	15440
10238	12430
9888	12080
10705	13210
10355	12860

System 1 Loads

EDB (Btuh/cfm-°F) 0.835

Adjustments

Capacity (Btuh)

Convert excess latent capacity to sensible

Results

Total load (Btuh)	Sensible load (Btuh)	Latent load (Btuh)	Load SHR	Total capacity (Btuh)	Sensible capacity (Btuh)	Latent capacity (Btuh)	Capacity SHR
16486	11547	4939	0.70	17642	13081	4561	0.74

Capacity % of load: 107, 113, 92

Meets Manual S requirements

OK

Cancel

Help

Units

English Metric

Temperature: °F °C

Air Flow: CFM L/sec

Capacity: Btuh W

Other Adjustments

Elevation Derating: 1 Miscellaneous: 1

Errors

No errors were found.

Interpolation Results

Total Capacity: 17545 Btuh

Power Input: 1378 kW

Sensible Capacity: 12032.2 Btuh

Close

OEM Engineering Data

84°F

AHRI Condition

DETAILED COOLING CAPACITIES

EVAPORATOR AIR		CONDENSER ENTERING AIR TEMPERATURES deg F																	
CFM	EWB	75			85			95			105			115			125		
		Capacity MBtu/h†		Total System KW**	Capacity MBtu/h†		Total System KW**	Capacity MBtu/h†		Total System KW**	Capacity MBtu/h†		Total System KW**	Capacity MBtu/h†		Total System KW**	Capacity MBtu/h†		Total System KW**
		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡	
123ANA018 - A Outdoor Section With CAP**1814A** Indoor Section																			
525	72	20.46	10.76	1.21	19.55	10.41	1.36	18.59	10.05	1.53	17.62	9.69	1.71	16.57	9.30	1.91	15.40	8.88	2.13
	67	18.79	13.26	1.22	17.95	12.90	1.37	17.05	12.52	1.53	16.12	12.14	1.72	15.13	11.74	1.92	14.03	11.30	2.13
	62	17.27	15.73	1.22	16.49	15.36	1.37	15.68	14.97	1.54	14.83	14.55	1.72	14.00	14.00	1.92	13.15	13.15	2.13
	57	16.78	16.78	1.23	16.15	16.15	1.37	15.48	15.48	1.54	14.77	14.77	1.72	14.00	14.00	1.92	13.15	13.15	2.13
600	72	20.79	11.28	1.24	19.83	10.92	1.39	18.83	10.55	1.56	17.83	10.19	1.74	16.76	9.80	1.94	15.55	9.37	2.16
	67	19.11	14.10	1.25	18.23	13.73	1.40	17.30	13.36	1.56	16.35	12.97	1.74	15.33	12.57	1.94	14.20	12.12	2.16
	62	17.66	16.88	1.25	16.87	16.49	1.40	16.06	16.06	1.56	15.32	15.32	1.75	14.51	14.51	1.94	13.61	13.61	2.16
	57	17.46	17.46	1.25	16.79	16.79	1.40	16.07	16.07	1.56	15.32	15.32	1.75	14.51	14.51	1.94	13.61	13.61	2.16
675	72	21.03	11.77	1.27	20.02	11.40	1.42	18.99	11.03	1.58	17.97	10.67	1.77	16.88	10.28	1.97	15.65	9.85	2.18
	67	19.33	14.90	1.27	18.43	14.54	1.42	17.48	14.15	1.59	16.51	13.77	1.77	15.48	13.35	1.97	14.33	12.89	2.19
	62	18.01	17.91	1.28	17.30	17.30	1.43	16.54	16.54	1.59	15.76	15.76	1.77	14.92	14.92	1.97	13.97	13.97	2.19
	57	18.01	18.01	1.28	17.30	17.30	1.43	16.55	16.55	1.59	15.76	15.76	1.77	14.92	14.92	1.97	13.97	13.97	2.19

587 CFM
63.7°F wB

Multipliers for Determining the Performance With Other Indoor Sections

Cooling Indoor Model	Capacity	Power	Furnace Model
*CAP**1814A**	1.00	1.00	
CAP**2414A**	1.01	1.01	
CAP**2417A**	1.01	1.01	
CNPF*2418A**	1.00	1.00	
CNPH*2417A**	1.00	1.00	
CNPV*1814A**	0.99	0.99	
CNPV*2414A**	1.00	1.00	
CNPV*2417A**	1.00	1.00	
CSPH*2412A**	0.97	0.97	
FE4ANF002	1.02	0.93	
FF1ENP018	0.99	0.99	
FF1ENP024	1.01	1.01	
FV4BNF002	1.02	0.93	
FX4CNF018	1.01	0.95	
FX4CNF024	1.02	0.96	
FY4ANF018	0.99	0.99	
FY4ANF024	1.00	1.00	

Cooling Indoor Model	Capacity	Power	Furnace Model
CAP**1814A**	0.98	0.92	315(A,J)AV036070
CAP**2414A**	1.00	0.94	315(A,J)AV036070
CNPH*2417A**	0.99	0.93	315(A,J)AV036070
CNPV*1814A**	0.98	0.92	315(A,J)AV036070
CNPV*2414A**	0.99	0.93	315(A,J)AV036070
CSPH*2412A**	0.95	0.89	315(A,J)AV036070
CAP**2417A**	1.01	0.95	315(A,J)AV048090
CNPH*2417A**	0.99	0.93	315(A,J)AV048090
CNPV*2417A**	0.99	0.93	315(A,J)AV048090
CSPH*2412A**	0.95	0.90	315(A,J)AV048090
CNPH*2417A**	0.99	0.93	355AAV042040
CSPH*2412A**	0.95	0.90	355AAV042040
CAP**2417A**	1.00	0.94	355AAV042060
CNPH*2417A**	0.99	0.93	355AAV042060
CNPV*2417A**	0.99	0.93	355AAV042060
CSPH*2412A**	0.95	0.90	355AAV042060
CNPH*2417A**	0.99	0.93	355AAV042080
CSPH*2412A**	0.95	0.90	355AAV042080

OEM Engineering Data

DETAILED COOLING CAPACITIES#

EVAPORATOR AIR		CONDENSER AIR					
CFM	EWB °F (°C)	75 (23.9)			85 (29.4)		
		Capacity MBtuh†		Total Sys- tem KW**	Capacity MBtuh†		Total Sys- tem KW**
Total	Sens‡	Total	Sens‡				
PA13NA018—B Outdoor Sec							
525	72 (22.2)	20.35	10.09	1.19	19.43	9.75	1.35
	67 (19.4)	18.72	12.43	1.19	17.86	12.08	1.37
	62 (16.7)	17.21	14.74	1.21	16.41	14.38	1.38
	57 (13.9)	16.70	16.70	1.22	16.05	16.05	1.38
600	72 (22.2)	20.73	10.59	1.20	19.69	10.22	1.37
	67 (19.4)	19.03	13.21	1.22	18.14	12.88	1.39
	62 (16.7)	17.59	15.82	1.23	16.79	15.44	1.40
	57 (13.9)	17.38	17.38	1.24	16.69	16.69	1.40
675	72 (22.2)	21.01	11.06	1.22	19.88	10.67	1.39
	67 (19.4)	19.25	13.95	1.24	18.34	13.61	1.41
	62 (16.7)	17.94	17.79	1.26	17.20	17.20	1.43
	57 (13.9)	17.92	17.92	1.26	17.20	17.20	1.43

Detailed cooling capacities are based on indoor and outdoor unit at the same elevation per ARI standard 210/240-94. If additional tubing length and/or indoor unit is located above outdoor unit, a slight variation in capacity may occur.

* Tested combination.

† Total and sensible capacities are net capacities. Blower motor heat has been subtracted.

‡ Sensible capacities shown are based on 80° F (27° C) entering air at the indoor coil. For sensible capacities at other than 80° F (27° C), deduct 835 Btuh (245 kW) per 1000 CFM (480 L/S) of indoor coil air for each degree below 80° F (27° C), or add 835 Btuh (245 kW) per 1000 CFM (480 L/S) of indoor coil air per degree above 80° F (27° C). When the required data falls between the published data, interpolation may be performed.

** System kw is total of indoor and outdoor unit kilowatts.

†† At TVA rating indoor condition (75° F edb/63° F ewb). All other indoor air temperatures are at 80° F edb.

NOTE: When the required data falls between the published data, interpolation may be performed. Extrapolation is not an acceptable practice.

EWB — Entering Wet Bulb

NOTE: When the required data fall between the published data, interpolation may be performed. Extrapolation is not an acceptable practice.

Interpolate OEM Data

DEMO - Manual S Interpolating Calculator

		Outdoor Ambient							
		75		85		84			
		Total	Sensible	Total	Sensible	Total	Sensible	Adj Sens @ 75.2F	
CFM	587								
Amb	84								
dB	75.2								
wB	63.7								
	525	67	18790	13260	17950	12900	18034.0	12936.0	10831.8
	525	62	17270	15730	16490	15360	16568.0	15397.0	13292.8
	600	67	19110	14100	18230	13730	18318.0	13767.0	11362.2
	600	62	17660	16880	16870	16490	16949.0	16529.0	14124.2
		5			wB Adj	525	17066.4	14560.3	12456.1
		1.7	0.835		wB Adj	600	17414.5	15589.9	13185.1
BTU Adj / 1000 cfm	835				CFM Adj	75	4.640267	13.7288	9.7208
					CFM Adj	62	17354	15411	13059
					SHR:		0.753		

OEM Tools

http://rpmobbry.wrightsoft.com/ Performance Calculator



Equipment Performance Calculator



1 Inputs

ZIP Code: 06405
Weather location: Bridgeport, CT, US

auto

Cooling ODB: 84

Heating ODB: 7.0

Air flow: 587

Cooling IDB: 75.2

Cooling IWB: 63.7

Cooling IRH: 53.5

Heating IDB: 70

2 Selection filter

Outdoor model: 123ana Manufacturer: Bryant

Indoor model: cnpv System type: Split AC

Furnace model: Rated Clg Capacity: < 1.5 Ton

Phase: 1Ø 3Ø Voltage: All

Use advanced filter

	Min	Max
Air flow (cfm):	500	625
Sensible cooling capacity (Btuh):		
Latent cooling capacity (Btuh):		
Total cooling capacity (Btuh):	16000	20000
SEER:	13	15
Cooling input power (kW):	0	0
Heating capacity (Btuh):	0	0
HSPF:	0	0
Heating input power (kW):	0	0

3 Results - Selected unit

Outdoor: 123ANA018000BC

Indoor: CNPVP2414ALA

Furnace:

Type: Dom SplitAC, 208/230, 1Ø

AHRI rated	Adjusted	Valid range: 525 - 675
600	587	
	13059	
	4295	
17500	17354	
13.00		
0.00	1.38	
0	0	
0.00		
0.00	0.00	

UnitType	Model Number	Indoor	Furnace	Tot.Cap	CoolEff	Htg.Cap	Htg.Eff	CFM	Voltage	Phase	Cool KW	Heat KW
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	912TA3606V14A-A	18100	15.0	0	0.00	605	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	925SA36040E17A-A	17700	14.5	0	0.00	530	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	925TA36040E17A-A	17700	14.5	0	0.00	530	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	986TA30040V14A-A	17800	14.5	0	0.00	545	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	986TA36040V17A-A	17700	14.5	0	0.00	530	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	986TA36060V14A-A	17800	14.5	0	0.00	555	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	CVLAAR036105	17900	15.0	0	0.00	583	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP1917ALA	CVMAAR036105	17600	15.0	0	0.00	521	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP2414ALA		17500	13.0	0	0.00	600	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP2414ALA	313AAV024045	17800	14.5	0	0.00	550	208/230	1	0.00	0.00
Dom SplitAC	123ANA018000BC	CNPVP2414ALA	3131AV024045	17800	14.5	0	0.00	550	208/230	1	0.00	0.00

OEM Tools

1 Inputs

ZIP Code:

Weather location:

Cooling ODB:

Heating ODB:

Air flow:

Cooling IDB:

Cooling IWB:

Cooling IRH:

Heating IDB:

3 Results - Selected unit

Outdoor:

Indoor:

Furnace:

Type:

AHRI rated	Adjusted	
<input type="text" value="600"/>	<input type="text" value="587"/>	Valid range: 525 - 675
	<input type="text" value="13059"/>	
	<input type="text" value="4295"/>	
<input type="text" value="17500"/>	<input type="text" value="17354"/>	
<input type="text" value="13.00"/>		
<input type="text" value="0.00"/>	<input type="text" value="1.38"/>	
<input type="text" value="0"/>	<input type="text" value="0"/>	
<input type="text" value="0.00"/>		
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	

Manufacturer:

System type:

Log Capacity:

Voltage:

	Min	Max
(cfm):	<input type="text" value="500"/>	<input type="text" value="625"/>
(3tuh):	<input type="text" value=""/>	<input type="text" value=""/>
(3tuh):	<input type="text" value=""/>	<input type="text" value=""/>
(3tuh):	<input type="text" value="16000"/>	<input type="text" value="20000"/>
SEER:	<input type="text" value="13"/>	<input type="text" value="15"/>
(kW):	<input type="text" value="0"/>	<input type="text" value="0"/>
(3tuh):	<input type="text" value="0"/>	<input type="text" value="0"/>
HSPF:	<input type="text" value="0"/>	<input type="text" value="0"/>
(kW):	<input type="text" value="0"/>	<input type="text" value="0"/>

OEM Tools



Case Summary Report

Roltay Inc. Energy Services

Job: #Bryant1 12/13/2014

98 Ovebrook Road, Madison, CT 06443 Phone: 2036721330 Email: buck@roltay.com Web: www.roltay.com

Case 1

Outdoor: 123ANA018000BC Indoor: CNPVP2414ALA

Type: Dom SplitAC, 208/230, 1ø

SODB (°F)	SIDB (°F)	SIRH	SIWB (°F)	WODB (°F)	WIDB (°F)	Elev (ft)	Suction line loss (ft)	AVF (cfm)
84.0	75.2	53.5	63.7	7.0	70.0	0	1.4	587

	Unit AVF (cfm)	Net Cool Sensible (Btuh)	Net Cool Latent (Btuh)	Net Cool Capacity (Btuh)	SEER	Cool kW	Net Heat Capacity (Btuh)	HSPF	Heat kW
AHRI Rated:	600	0	0	17500	13.00	0.00	0	0	0
Adjusted:	587	13059	4295	17354		1.38	0		0

Using 3rd party coils

- Manual S requires extended performance rating data.
- OEM must provide tools or custom calculations to meet the requirements for Manual S.
 - Many 3rd party coils do not currently provide such tools, or
 - 3rd party coils instructs designer to use OEM data for their products!



Using 3rd party coils

HEATING PERFORMANCE DATA							
UNIT MODEL	NOMINAL COOLING BTUH	HEAT CFM	GPM HTG	BTUH (1000) AT ENTERING WATER TEMPERATURE			
				120°F	130°F	140°F	180°F
24EVBQ	18,000 / 24,000	800	3.5	26.1	31.2	36.5	57.3
		700		24.0	28.8	33.6	52.8
		600		21.8	26.2	30.5	48.0
		500		19.4	23.2	27.1	42.6
36EVBQ	30,000 / 36,000	1200	3.5	34.0	40.7	47.5	74.7
		1050		31.2	37.4	43.7	68.6
		900		28.5	34.2	39.9	62.7
		750		25.5	30.6	35.7	56.1
48EVBQ	42,000 / 48,000	1600	3.5	48.3	57.9	67.6	106.2
		1400		44.6	53.5	62.4	98.1
		1200		40.2	48.2	56.3	88.4
		1000		35.9	43.0	50.2	78.9

NOTES:

1. Heating output of fan coil will not exceed net output of water heater.
2. Approved for installation with 0" clearance to combustible materials.
3. Heat BTUH is at 70°F entering air temperature.
4. 180° EWT and these capacities are not available with standard water heaters.

What About Heating?

Table 18 – Altitude Derate Multiplier for U.S.A.

ALTITUDE		PERCENT OF DERATE	DERATE MULTIPLIER FACTOR*
FT.	M		
0-2000	0-610	0	1.00
2001-3000	610-914	4-6	0.95
3001-4000	914-1219	6-8	0.93
4001-5000	1219-1524	8-10	0.91
5001-6000	1524-1829	10-12	0.89
6001-7000	1829-2134	12-14	0.87
7001-8000	2134-2438	14-16	0.85
8001-9000	2438-2743	16-18	0.83
9001-10,000	2743-3048	18-20	0.81

*Derate multiplier factors are based on midpoint altitude for altitude range.

What About Heating?

**TABLE 11 - ORIFICE SIZE* AND MANIFOLD PRESSURES FOR GAS INPUT RATE
(TABULATED DATA BASED ON 20,000 BTUH HIGH-HEAT / 13,000 BTUH LOW-HEAT PER BURNER,
DERATED 2%/1000 FT ABOVE SEA LEVEL)**

ALTITUDE RANGE (ft)		AVG. GAS HEAT VALUE AT ALTITUDE (Btu/cu ft)	SPECIFIC GRAVITY OF NATURAL GAS							
			0.58		0.60		0.62		0.64	
			Orifice No.	Mnfl'd Press High/Low	Orifice No.	Mnfl'd Press High/Low	Orifice No.	Mnfl'd Press High/Low	Orifice No.	Mnfl'd Press High/Low
U.S.A. and Canada	0 to 2000	900	43	3.5 / 1.5	43	3.6 / 1.5	43	3.8 / 1.6	42	3.2 / 1.3
		925	44	3.8 / 1.6	43	3.5 / 1.5	43	3.6 / 1.5	43	3.7 / 1.6
		950	44	3.6 / 1.5	44	3.8 / 1.6	43	3.4 / 1.4	43	3.5 / 1.5
		975	44	3.4 / 1.5	44	3.6 / 1.5	44	3.7 / 1.6	44	3.8 / 1.6
		1000	44	3.3 / 1.4	44	3.4 / 1.4	44	3.5 / 1.5	44	3.6 / 1.5
		1025	45	3.8 / 1.6	44	3.2 / 1.4	44	3.3 / 1.4	44	3.4 / 1.5
		1050	45	3.6 / 1.5	45	3.7 / 1.6	45	3.8 / 1.6	44	3.3 / 1.4
		1075	45	3.4 / 1.4	45	3.5 / 1.5	45	3.7 / 1.5	45	3.8 / 1.6
		1100	45	3.3 / 1.4	45	3.4 / 1.4	45	3.5 / 1.5	45	3.6 / 1.5

This is an example for 94% AFUE Natural Gas Furnace

Sizing Goals

ACCA's summary page of sizing parameters.

There are important footnotes for differences between wet climate zones and dry climate zones as well as cold winters and not so cold winter zones.

Overview of Size Limits for Residential HVAC Equipment								
Equipment ^a Tested and Rated by the AHRI	Attributes of Local Climate Notes b, c	Issue	Minimum (deficient) and Maximum(excessive) Capacity Factors. ^d					
			Single-Speed Compressor			Multi- and Variable-Speed Compressor		
			Air-Air	GLHP ^e	GWHP ^f	Air-Air	GLHP ^e	GWHP ^f
Air-Air and Water-Air Cooling-Only & Heat Pump	Mild Winter or Has a Latent Cooling Load	Total	0.90 to 1.15		1.25	0.90 to 1.20 _{ducted} 1.30 _{ductless} 0.90 to 1.25		
		Latent	Minimum = 1.00. Preferred maximum = 1.50 (may exceed 1.5 if no reasonable alternative).					
		Sensible	Minimum = 0.90. Maximum determined by total and latent capacities.					
Air-Air and Water-Air Heat Pump Only	Cold Winter and No Latent Cooling load	Total	Maximum capacity = Manual J total cooling load plus 15,000 Btuh; Minimum factor = 0.90					
		Latent	Latent capacity for summer cooling is not an issue.					
		Sensible	Not an issue (determined by the limits for total cooling capacity).					
<p>a) Central ducted; ductless single-split; ductless multi-split equipment. AHRI: Air Conditioning, Heating and Refrigeration Institute. b) Mild winter: Heating degree days for base 65°F divided by cooling degree days for base 50°F less than 2.0. Cold winter = 2.0 or more. c) Latent cooling load: Manual J sensible load divided by Manual J total load less than 0.95. No latent load = 0.95 or more. d) Minimum and maximum capacity factors operate on the total, latent, and sensible capacity values produced by an accurate Manual J load calculation (per Section 2 of the Eighth Edition of Manual J, version 2.0 or later). Multiply a size factor by 100 to convert to a percentage. For example, 1.15 excess capacity = 115% excess capacity. e) GLHP: Ground loop heat pump (water in buried closed pipe loop). f) GWHP: Ground water heat pump (ground water from well, pond, lake, river, etc., flows through equipment and is discarded).</p>								
Electric Heating Coils	Furnaces; Heat Pump supplement; emergency	Load (Btuh)	Maximum KW	Minimum Capacity Factor	Maximum Capacity Factor			
		≤ 15,000	5.0	Satisfy Load	See Maximum KW			
		> 15,000	See Min and Max	0.95	1.75			
Minimum and maximum capacity factors operate on the heating load produced by an accurate Manual J load calculation. Multiply a size factor by 100 to convert to a percentage.								
Natural Gas, Oil, Propane Furnaces	Duty	Minimum Output Capacity		Maximum Output Capacity				
	Heating only			1.40				
	Heating-Cooling Preferred	1.00						
	Heating-Cooling Allowed			2.00				
Minimum and maximum capacity factors operate on the heating load produced by an accurate Manual J load calculation. Multiply a size factor by 100 to convert to a percentage. For heating-cooling duty, boiler performance must be compatible with the cooling equipment.								
Electric, and Fossil Fuel Water Boilers	Duty	Minimum Output Capacity		Maximum Output Capacity				
	Gravity or forced convection terminals in the space, water coil in duct or air-handler.	1.00		1.40				
Minimum and maximum capacity factors operate on the heating load produced by an accurate Manual J load calculation. Multiply a size factor by 100 to convert to a percentage. Refer to OEM guidance if boiler is used for potable water heat, or snow melting.								
Hot Water Coils	Duty	Minimum Factor		Maximum Factor				
	Gravity or forced convection terminals in the space.			1.00		Two-position 1.25	Throttling 1.50	
	Water coil in duct or air-handler.							
Minimum and maximum capacity factors operate on the heating load produced by an accurate Manual J load calculation. Multiply a size factor by 100 to convert to a percentage. Two-position= open-close valve; Throttling = Full modulating 2-way or 3-way valve.								
Electric and Fossil Fuel Water Heaters		The space heating load is the Manual J load. The total load is the space heating load plus the potable water load. Refer to OEM guidance for selection and sizing guidance.						
Dual Fuel Systems		Heat pump sizing rules apply, heating equipment sizing rules apply, see Section N2-12.						
Ancillary Dehumidification		See Section N2-13. May allow +15,000 Btuh excess cooling capacity for cold winter climate.						
Humidifiers		Minimum capacity ≥ humidification load, excess capacity dependent on smallest size available						
AHAM Cooling and Heat Pump Equipment		See Section N2-15 for sizing rules.						
Direct Evaporative Cooling Equipment		See Section N2-16 for sizing rules.						

Sizing Factors for Connecticut

General Cooling Capacity Factors			
<i>Equipment Tested and Rated by AHRI</i>	Single Speed Compressors	Multi/Variable Speed Compressors	GWHP
Total Maximum sizing factor	1.15	1.20 (multi), 1.30 (variable)	1.25(single), 1.30(multi), 1.35(variable)
Latent	Minimum = 1.0 (may go to 1.50 or higher if needed to meet sensible minimum)		
Sensible	Minimum = 0.90		
General Heating Capacity Factors			
Minimum	1.0		
Maximum	1.4 (up to 2.0 allowed)		

ANSI/ACCA 3 Manual S – 2014 summary page of sizing parameters – boiled down for Connecticut.

Sizing Heat Pumps

- Heat Pumps are sized to the **COOLING** load only.
- The balance of any heating that cannot be met by the compressors shall be provided by a supplemental system (stage)
 - Electric resistance
 - Hot water coil
 - Baseboard
 - Radiant

A/C Sizing Exceptions

- For cooling - multi / variable speed systems usually come only in **1-ton** increments. The latest Manual S addresses this with the higher sizing factors, however you may still end up over the maximum on smaller houses (loads).
 - Sizing factors are static and make it more difficult for smaller loads (smaller houses have a penalty versus larger houses).
 - Base/old sizing factor is 1.15, now up to 1.3 for high-end variable refrigerant flow systems

Sizing Boilers

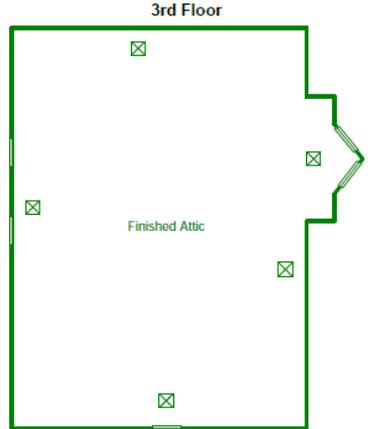
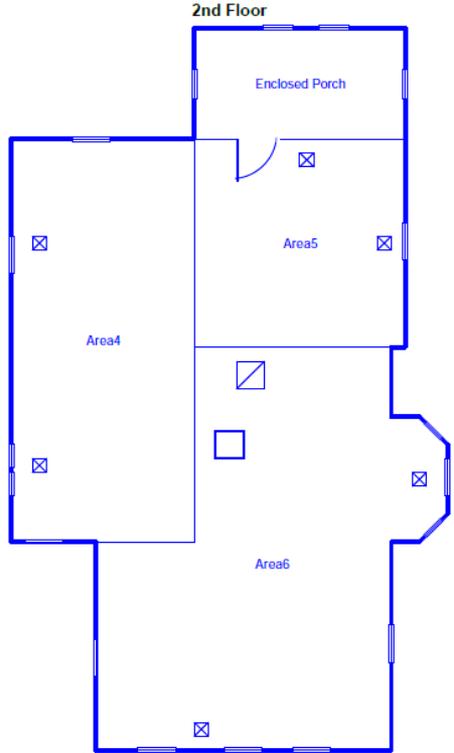
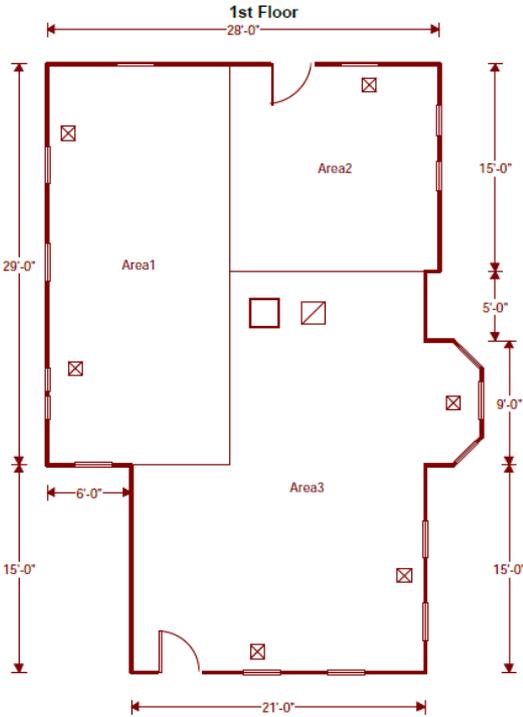
- For heating with boilers that also serve DHW, an additional water load sizing should be considered given that peak heating loads usually occur just before dawn, and it is possible that occupants may be using showers at the same time.
 - Newest Manual S tries to address this with upper limit factor of 2.0 (base/old limit is 1.4).
 - Better addressed by adding storage tank (60 gal +) and sizing boiler within 1.4 factor, or
 - Use Tankless water heater!

Newer Variable Capacity Systems

- Allowed to oversize by 30% (1.3 sizing factor)
- Heat Pumps are sized to COOLING load
- High-End Heat Pumps
 - Use higher capacity compressor (digital or DC drive), and
 - May have capacity controls to limit system capacity
- A/C units (some examples):
 - Mini-splits (not all)
 - Lennox XC-25
 - Maytag iQ Drive series
 - Waterfurnace 7-series

Documentation

Manual S – Documents



Manual S Documents



Case Summary Report

Roltay Inc. Energy Services

Job: #Bryant1 12/13/2014

98 Ovebrook Road, Madison, CT 06443 Phone: 2036721330 Email: buck@roltay.com Web: www.roltay.com

Case 1

Outdoor: 123ANA018000BC Indoor: CNPVP2414ALA

Type: Dom SplitAC, 208/230, 1ø

SODB (°F)	SIDB (°F)	SIRH	SIWB (°F)	WODB (°F)	WIDB (°F)	Elev (ft)	Suction line loss (ft)	AVF (cfm)
84.0	75.2	53.5	63.7	7.0	70.0	0	1.4	587

	Unit AVF (cfm)	Net Cool Sensible (Btuh)	Net Cool Latent (Btuh)	Net Cool Capacity (Btuh)	SEER	Cool kW	Net Heat Capacity (Btuh)	HSPF	Heat kW
AHRI Rated:	600	0	0	17500	13.00	0.00	0	0	0
Adjusted:	587	13059	4295	17354		1.38	0		0

Manual S – Documents



Manual S Compliance Report
Boiler
Roitay Inc. Energy Services

Job:
Date: May 01, 2015
By:

98 Overbrook Road, Madison, CT 06443 Phone: 203-672-1330 Email: buck@roitay.com Web: www.Roitay.com

Project Information

For: Manual S Demo
West Haven, CT 06516

Cooling Equipment

Design Conditions

Outdoor design DB:	84.0°F	Sensible gain:	23490 Btuh	Entering coil DB:	75.7°F
Outdoor design WB:	73.0°F	Latent gain:	4385 Btuh	Entering coil WB:	62.8°F
Indoor design DB:	75.0°F	Total gain:	27876 Btuh		
Indoor RH:	50%	Estimated airflow:	1100 cfm		

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Split AC	Model:	123ANA030****C*+FX4DN(B,F)037L
Manufacturer:	Bryant		
Actual airflow:	1100 cfm		
Sensible capacity:	23574 Btuh	100% of load	
Latent capacity:	5099 Btuh	116% of load	
Total capacity:	28673 Btuh	103% of load	SHR: 82%

Heating Equipment

Design Conditions

Outdoor design DB:	7.0°F	Heat loss:	58557 Btuh	Entering coil DB:	70.0°F
Indoor design DB:	70.0°F				

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Gas boiler	Model:	AG4-HN
Manufacturer:	Advantage		
Actual airflow:	0 cfm		
Output capacity:	88000 Btuh	150% of load	

The above equipment was selected in accordance with ACCA Manual S.



Manual S Compliance Report
Furnace
Roitay Inc. Energy Services

Job:
Date: May 01, 2015
By:

98 Overbrook Road, Madison, CT 06443 Phone: 203-672-1330 Email: buck@roitay.com Web: www.Roitay.com

Project Information

For: Manual S Demo
West Haven, CT 06516

Cooling Equipment

Design Conditions

Outdoor design DB:	84.0°F	Sensible gain:	12703 Btuh	Entering coil DB:	75.2°F
Outdoor design WB:	73.0°F	Latent gain:	4308 Btuh	Entering coil WB:	63.7°F
Indoor design DB:	75.0°F	Total gain:	17010 Btuh		
Indoor RH:	50%	Estimated airflow:	587 cfm		

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Split AC	Model:	123ANA018****C*+CNPV*2417AL***TRD
Manufacturer:	Bryant		
Actual airflow:	587 cfm		
Sensible capacity:	13059 Btuh	103% of load	
Latent capacity:	4305 Btuh	100% of load	
Total capacity:	17365 Btuh	102% of load	SHR: 75%

Heating Equipment

Design Conditions

Outdoor design DB:	7.0°F	Heat loss:	36351 Btuh	Entering coil DB:	68.8°F
Indoor design DB:	70.0°F				

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Gas furnace	Model:	TG8S100B12MP11
Manufacturer:	York		
Actual airflow:	1149 cfm		
Output capacity:	80000 Btuh	220% of load	Temp. rise: 63 °F

The above equipment was selected in accordance with ACCA Manual S.

Manual S – Documents

Cooling Equipment

Design Conditions

Outdoor design DB:	84.0°F	Sensible gain:	12703 Btuh	Entering coil DB:	75.2°F
Outdoor design WB:	73.0°F	Latent gain:	4308 Btuh	Entering coil WB:	63.7°F
Indoor design DB:	75.0°F	Total gain:	17010 Btuh		
Indoor RH:	50%	Estimated airflow:	587 cfm		

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Split AC				
Manufacturer:	Bryant	Model:	123ANA018****C*+CNPV*2417AL***TDR		
Actual airflow:	587 cfm				
Sensible capacity:	13059 Btuh	103% of load			
Latent capacity:	4305 Btuh	100% of load			
Total capacity:	17365 Btuh	102% of load	SHR: 75%		

Heating Equipment

Design Conditions

Outdoor design DB:	7.0°F	Heat loss:	36351 Btuh	Entering coil DB:	68.8°F
Indoor design DB:	70.0°F				

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Gas furnace				
Manufacturer:	York	Model:	TG8S100B12MP11		
Actual airflow:	1149 cfm				
Output capacity:	80000 Btuh	220% of load		Temp. rise:	63 °F

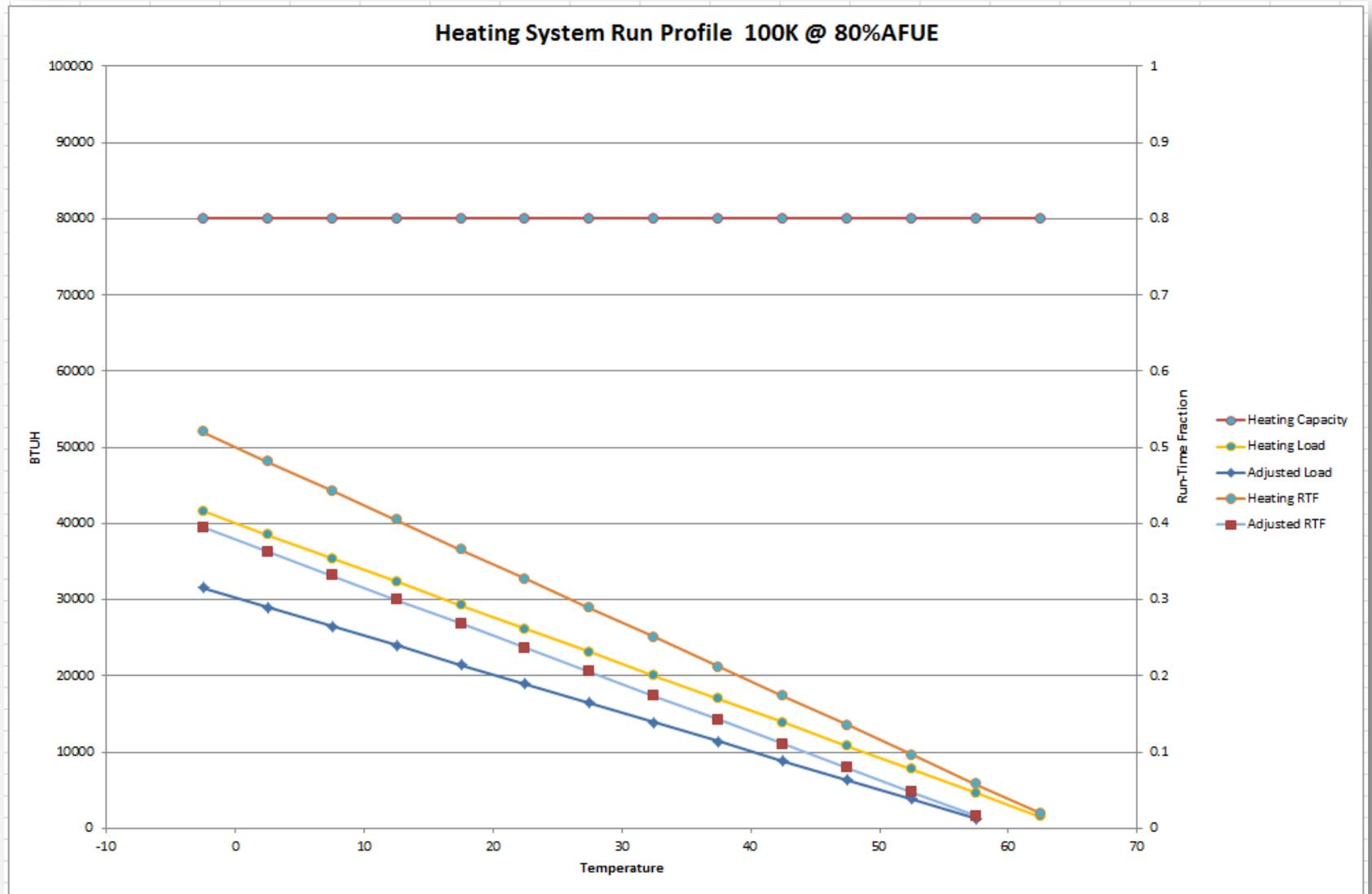
Oversizing



					Annual		Annual	Fraction
Gross	AFUE	Net	ΔT	CFM	Run Hrs.	Flue BTU	Flue BTU	Flue
70000	72	50400	80	583	1880	19600	36848000	1
100000	72	72000	80	833	1316	28000	36848000	1
100000	80	80000	70	1058	1184	20000	23680000	0.64264
100000	86	86000	65	1225	1101	14000	15414000	0.41831
100000	94	94000	50	1741	1008	6000	6048000	0.16413
48000	94	45120	45	928	2100	2880	6048000	0.16413

Contractors tend to size replacements “like for like”. This results in potential (significant) issues with airflow and draft (flue gasses condensing prematurely)!

Oversizing



Manual S – Documents

Cooling Equipment

Design Conditions

Outdoor design DB:	84.0°F	Sensible gain:	23490 Btuh	Entering coil DB:	75.7°F
Outdoor design WB:	73.0°F	Latent gain:	4385 Btuh	Entering coil WB:	62.8°F
Indoor design DB:	75.0°F	Total gain:	27876 Btuh		
Indoor RH:	50%	Estimated airflow:	1100 cfm		

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Split AC		
Manufacturer:	Bryant	Model:	123ANA030****C**+FX4DN(B,F)037L
Actual airflow:	1100 cfm		
Sensible capacity:	23574 Btuh	100% of load	
Latent capacity:	5099 Btuh	116% of load	
Total capacity:	28673 Btuh	103% of load	SHR: 82%

Heating Equipment

Design Conditions

Outdoor design DB:	7.0°F	Heat loss:	58557 Btuh	Entering coil DB:	70.0°F
Indoor design DB:	70.0°F				

Manufacturer's Performance Data at Actual Design Conditions

Equipment type:	Gas boiler		
Manufacturer:	Advantage	Model:	AG4-HN
Actual airflow:	0 cfm		
Output capacity:	88000 Btuh	150% of load	

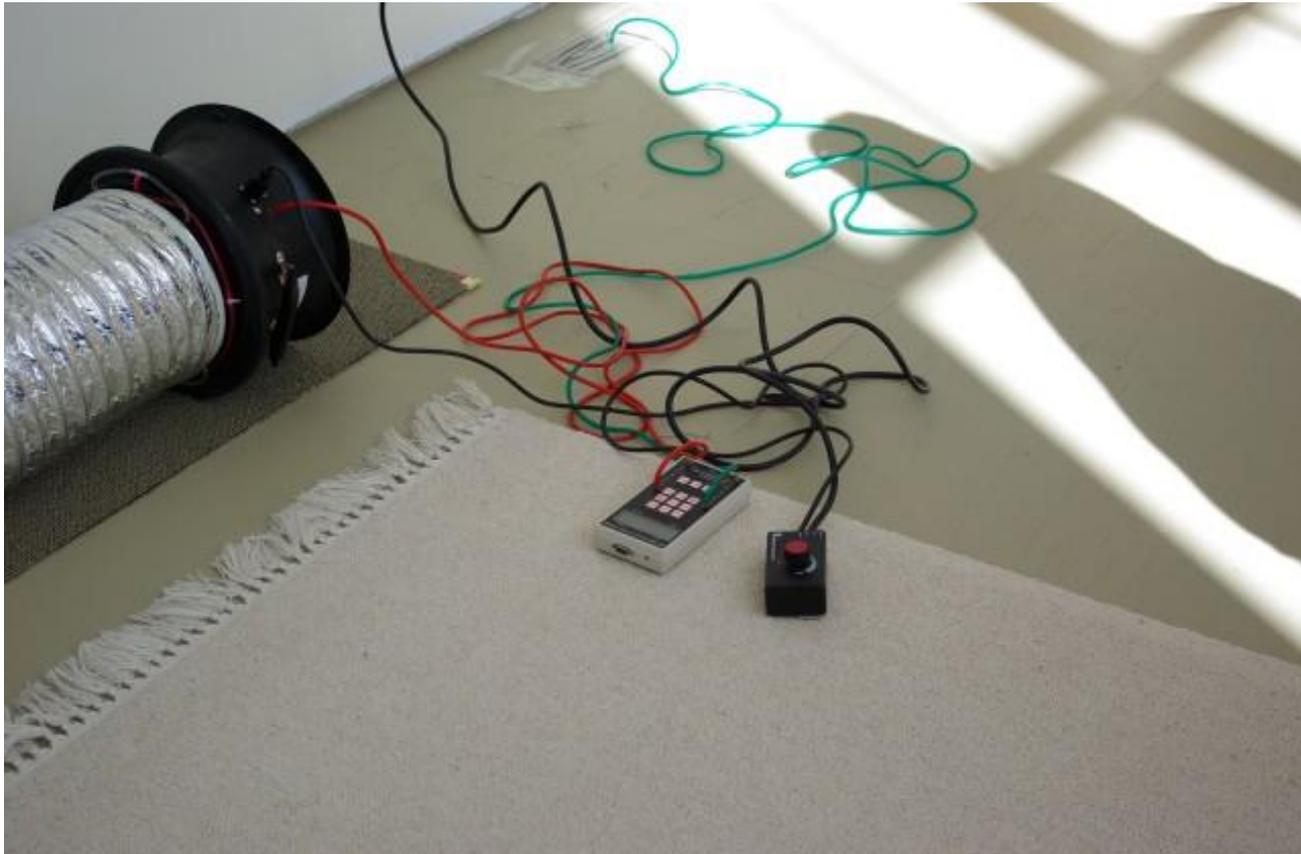
Resources

- www.ct.gov/dcs/
- publicecodes.cyberregs.com/icod/index.htm
- www.acca.org
- www.hvac-quality.com

Questions?

Other

Duct Blaster



Duct Sealing Note

- Seal Duct system correctly – these are examples of thoughtlessness!

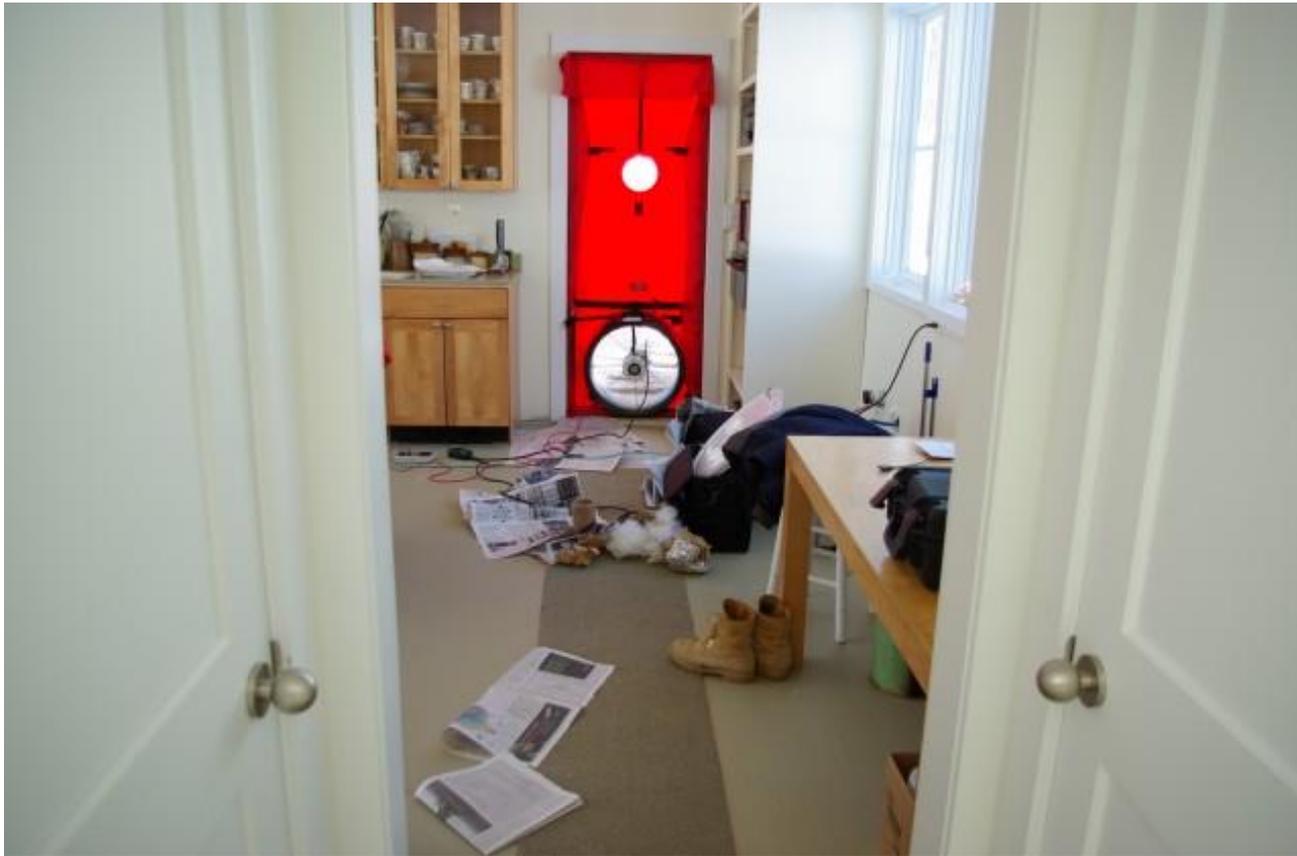


Duct Sealing Note

- Ducts get sealed first, then insulated.
 - In this case, these ducts are lined.



Blower Door – Infiltration Testing



Infiltration Testing

- IECC 2009: Optional
- IECC 2012: 3 Air Changes per Hour at 50 pascals aka 3 ACH₅₀ (0.2 i.w.c.)

Infiltration Comparison

Example Typical Infiltration Rates for Homes (Air Changes per Hour)

Type of Treatment	ACH50	ACHnat*
2012 Connecticut Code	3.0	0.17 - 0.23
New home with special airtight construction and a controlled ventilation system	1.5 – 2.5	0.10 – 0.17
Energy efficient home with continuous air barrier system	4.0 – 6.0	0.27 – 0.41
Standard new home	7.0 – 15.0	0.47 – 1.01
Standard existing home	10.0 – 25.0	0.68 – 1.69
Older, leaky home	20.0 – 50.0	1.35 – 3.38
<p>*The conversion between ACH50 and ACHnat is only an estimate for normal exposure for 2-story home. ACHnat is used in load calculations.</p>		

Infiltration & Duct Leakage

- Both affect heat loss/gain and comfort.
- Both can cause unwanted effects to combustion appliances.
- Both affect the sizing of the A/C system and CFM requirements – which can affect duct sizing.
- Duct leakage can drive (or induce) building infiltration.

Thank you

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