State of Connecticut
Department of Administrative Services
Division of Construction Services
Office of Education and Data Management

Understanding Residential HVAC Equipment Sizing

Presented by
Buck Taylor, Roltay Inc. Energy Services
for the

Office of Education and Data Management
Fall 2015 Career Development Series

Objectives

1. Participants shall understand the CT code requirements for residential mechanical equipment engineering (Manual J, S & D)
2. Participants shall understand the relationship between Manual J load calculations and Manual S Equipment Selection
3. Participants shall understand the impact of duct location and integrity (leakage) on equipment sizing
4. Participants shall understand the impact of different ventilation strategies on equipment sizing
5. Participants shall understand the primary market barriers to code adoption and engineering practices by concerned market actors

Topics

1. “Limited” Code Overview
2. Design Process Overview
3. Manual S (Equipment Selection)
4. Compliance Document Review
5. Market Support

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

Before we get started…

Lets look at an example house!

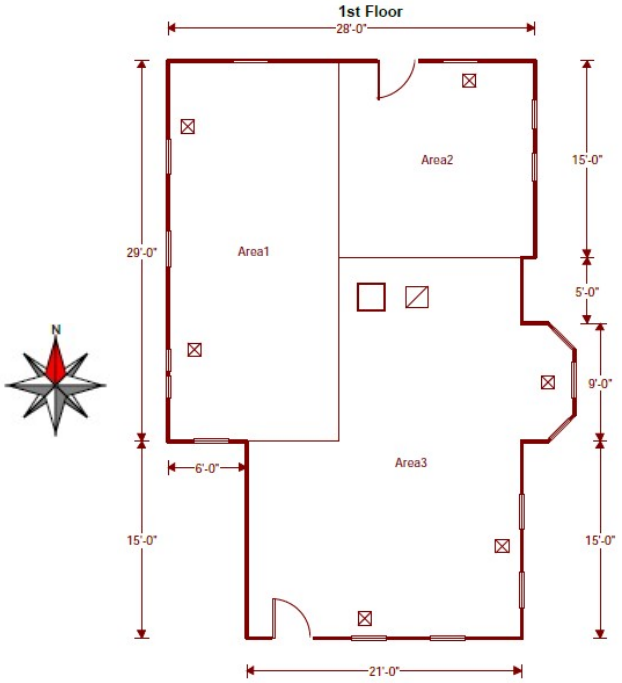
Example House #1

- West Haven, CT

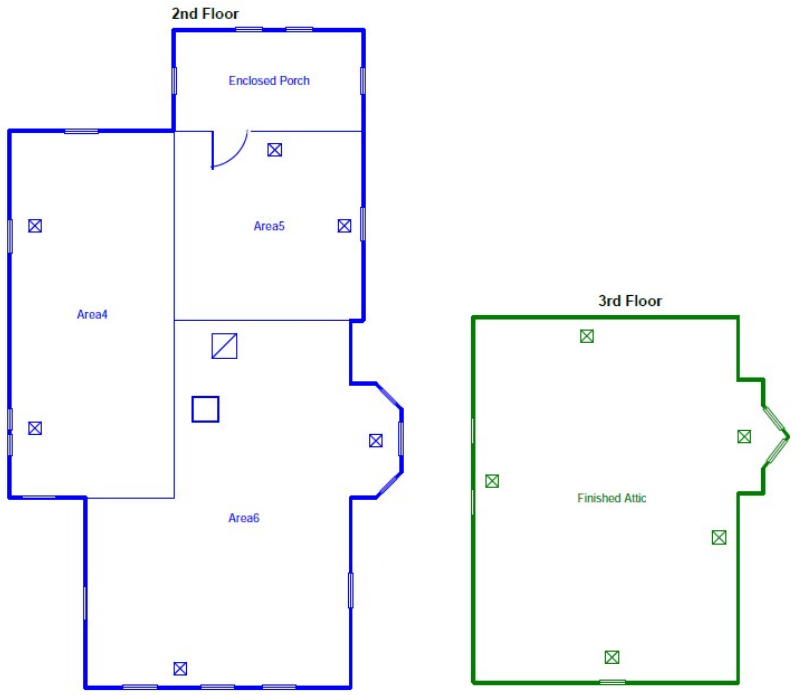
- 2 Floors + Finished Attic
- Built 1930
- 1st Flr = 1145 sq.ft.
- 2nd Flr = 1145 sq.ft.
- Attic = 632 sq.ft.
- Total = 2922 sq.ft.

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

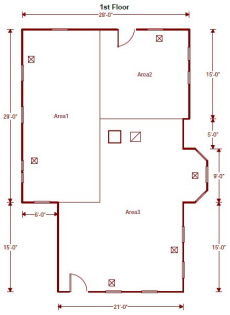
Example House #1



Example House #1



Example House #1



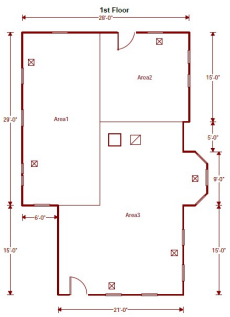
What are your gut-check estimates for heating and cooling loads for this example home?

Loads by floor (apartment)?

Entire building?

How many pieces of equipment?

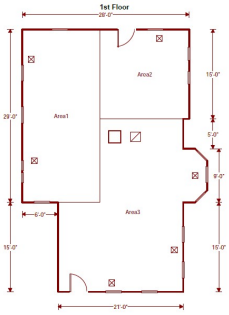
Example House #1



How do we typically go about "Engineering" a mechanical system for this house?

1. Determine scope of the project
   1. All problems are solved by installing new equipment (mentality).....
2. Solicit contractor quotes
3. Hire contractor
4. Install system

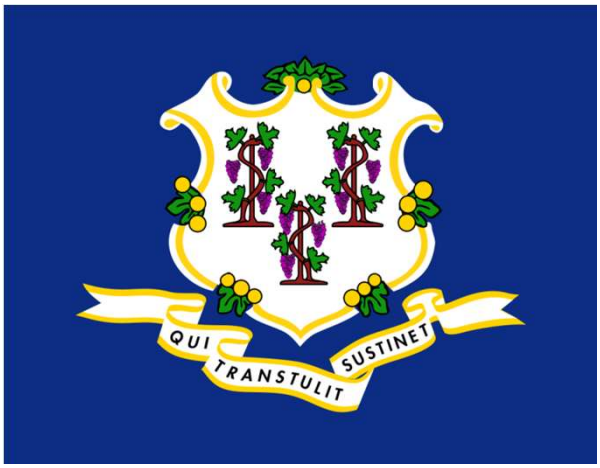
Example House #1



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

1. Perform engineering analysis
    1. Determine scope of the project
    2. Determine code requirements
    3. Inspect/test existing distribution system
    4. Calculate loads
    5. Select candidate equipment
    6. Engineer/re-engineer distribution system
2. Solicit bids
3. Hire contractor
4. Install system
5. Commission system

Code Overview



State Building Codes

2005 Connecticut Code Summary
(with 2011 Amendment)

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)

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 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)

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."

Acceptable Software Tools/Methods

- Manual J is too complex to perform by hand or with a spreadsheet! The design practitioner MUST use approved software. The software must be Manual J 8 compliant
  - There are currently 6 software packages available for load calculations. They are NOT equal in their capabilities.

ADTEK SOFTWARE

CARMEL SOFTWARE
ResLoad-J for IPAD

EnergyGauge®

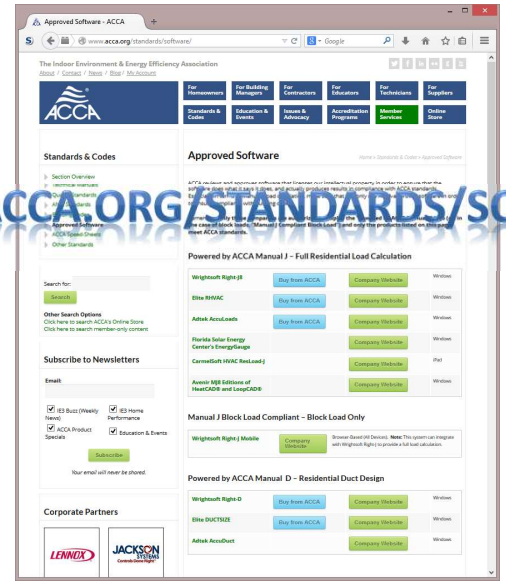
HeatCAD 2014

Avenir

Elite Software
RHVAC RESIDENTIAL HVAC LOADS

wrightsoft right-suite UNIVERSAL

ACCA Approved Software



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 Notes:
1). 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.
2). Many of these have reports stating they are "In accordance with ACCA Manual J". Needs to be in accordance with "Manual J 8".

Software Not ACCA Approved

Code Officials Advice:

DISCLOSURE: I am not a lawyer, this is my opinion only, it does not reflect the views of the DAS, nor any municipalities (anywhere). There is a significant disparity in the capabilities of many of the software solutions currently in the marketplace:

1). If you want to accept questionable software reports, request from the software manufacturer a certified statement from a licensed engineer stating the software is compliant with current ACCA Manual J "8" requirements.
2). I highly recommend the formation of a committee represented by code officials, DAS, engineers, subject matter experts, contractors, trade organizations (ACCA) and any other interested parties (software vendors, utilities) to review the currently available software and compile a list of acceptable software for dissemination across all jurisdictions.

HANDOUTS

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)

2012 International Residential Code

N1101.7 (R102.1.1) Above code programs.
The *building official* or other authority having jurisdiction shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. Buildings *approved* in writing by such an energy-efficiency program shall be considered in compliance with this code. The requirements identified as "mandatory" in Chapters 4 and 5 of this code, as applicable, shall be met.

N1103.1.1 (R403.1.1) Programmable thermostat.
Where the primary heating system is a forced-air furnace, at least one thermostat per dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

N1103.1.2 (R403.1.2) Heat pump supplementary heat (Mandatory).
Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

N1103.2.1 (R403.2.1) Insulation (Prescriptive).
Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.

Exception: Ducts or portions thereof located completely inside the *building thermal envelope*.

N1103.2.2 (R403.2.2) Sealing (Mandatory).
Ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with Section M1601.4.1 of this code.

Exceptions:
1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.

Code Comparison

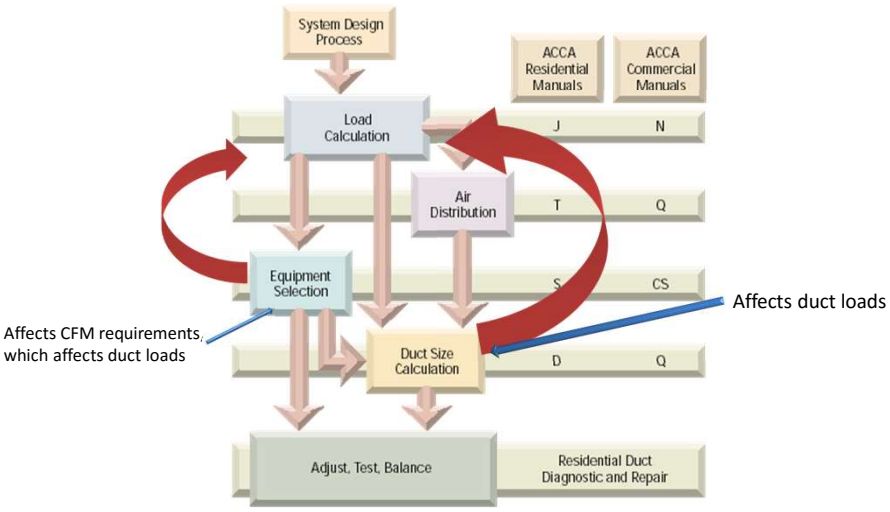
ACCA Standard 5 (Quality Install)	Component	2005 Connecticut Code (2009, 2011 & 2013 Amendments)	2012 Connecticut Code	Energy Star (Homes 3.0 / Quality Installation)
ANSI/ACCA 2 Manual J - 2011 J-8 (version 2) *(Block - Room-by-room)*	**Manual J** (Load calculations)	IRC 2009: ***M1401.3*** ACCA Manual J8-02 IECC 2009: ***403.6*** CT 2011 Amend: *(Mandatory) Load Calculation* ACCA Manual J-8 (version 2)	IRC 2012: ***M1401.3*** ACCA Manual J8-11 IECC 2012: ***403.6*** *(Mandatory)* ACCA Manual J	J-8 Required: *(Room-by-room)*
ANSI/ACCA 1 Manual D - 2009 *(None - Complete)*	**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 *(Complete)*
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: *(Mandatory) Equipment Sizing* ACCA Manual S	IRC 2012: ***M1401.3*** ACCA Manual S IECC 2012: ***403.6*** *(Mandatory)* ACCA Manual S	S-2004 Required
Estimated, recommended, or per code for new construction	**Building Infiltration** (Testing with Blower Door)	IECC 2009: *Option* ***402.4.2.1***	IECC 2012: ***R402.4.1.2*** *3 ACH_{50}*	Required
Required: *New: 6% Total,* *Exist: 20% of design cfm, or 50% reduction*	**Duct Leakage** (Testing with Duct Blaster)	IECC 2009: ***403.2.2*** *Sealing (Mandatory)* ***8-12cfm/100ft²***	IRC 2012: ***N1103.2.2*** *Sealing (Mandatory)*, ***3-4cfm/100ft²*** IECC 2012: ***403.2.2*** *Sealing (Mandatory)*, ***3-4cfm/100ft²***	Required: *6cfm/100ft²*
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

Design Process Overview

The design of residential mechanical systems is an iterative process of using Manual J, S & D.

Design Process Overview



ACCA – Contracting Business Magazine, Spring 2003

Design Process Overview

Design Process Overview

1. Because the design of residential mechanical systems is complex, it is imperative that good engineering software be utilized. It abstracts away much of the complexity - making for a much shorter and accurate process.

2. A professional is only as good as the tools he/she utilizes in their practices. Good design software is no exception.

What is Manual J?

1. "Modeling" of the average peak building loads at local climatic conditions
2. Performs a peak time-of-day fenestration calculation for cooling
3. Includes internal gains for cooling, but not for heating
4. Can perform a "Block" or "Room-by-room" load calculation
5. Manual J (when performed aggressively) will over-estimate actual loads by 10% to 40%

HANDOUTS

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)
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	LITCHFIELD	704	4	88	71	33	Hartford Brainard Field	CT	19	41	6	88	72
CANTERBURY	WINDHAM	395	6	86	73	10	Norwich	CT	197	41	7	86	73
CANTON	HARTFORD	695	4	88	71	10	Hartford Brainard Field	CT	19	41	6	88	72
CHAPLIN	WINDHAM	392	6	86	73	18	Norwich	CT	197	41	7	86	73
CHESHIRE	NEW HAVEN	261	4	87	72	13	Waterbury	CT	850	41	2	85	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

Local Outdoor 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)
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
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BETHANY	NEW HAVEN	512	5	84	73	8	New Haven	CT	14	41	7	84	73
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CANAAN													72
CANTERB													73
CANTON													72
CHAPLIN													73
CHESHIRE													71
CHESTER	MIDDLESEX	223	8	85	72	15	New London	CT	10	41	5	85	72
CLINTON	MIDDLESEX	63	7	84	73	20	New Haven	CT	14	41	7	84	73

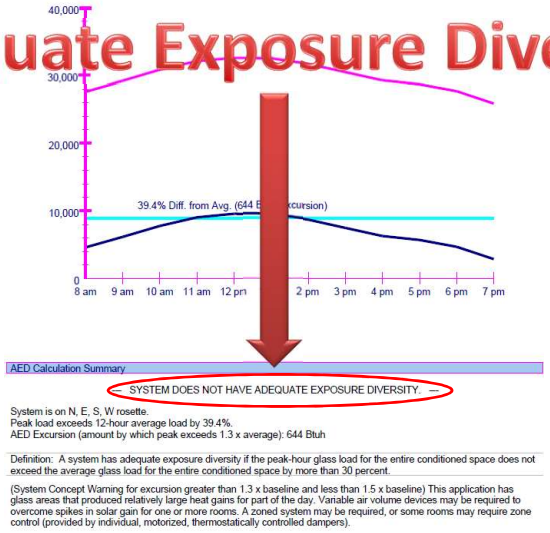
All values derived from 2009 ASHRAE Handbook-Fundamentals Chapter 1 Psychrometrics Equations 3 & 4

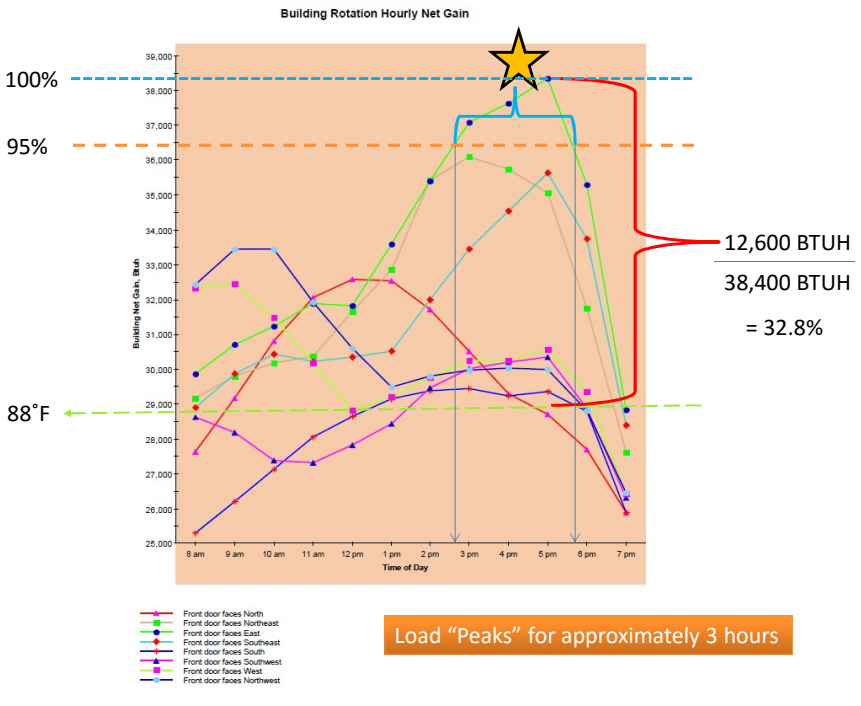
Standard Indoor Design Conditions

Winter	Summer
70°F dry-bulb	75°F dry-bulb
Not specified – (30% R.H. typical)	45% - 55% R.H. (~62°F - 63°F wet-bulb)

Manual J-8 Requirements

Adequate Exposure Diversity





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

HANDOUTS

DETAILED COOLING CAPACITIES

EVAPORATOR AIR		CONDENSER ENTERING AIR TEMPERATURES deg F															
		75			85			95			105			115			125		
CFM	EWB	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		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

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

See notes on pg. 21

What is Manual D?

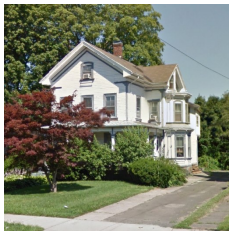
1. The process to design a ducted distribution system based on the CFM requirements determined by the Manual J and Manual S process.
2. Although re-engineering existing duct systems is not required – the designer/mechanic better be able to recognize the very common problems of insufficient return duct, 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.

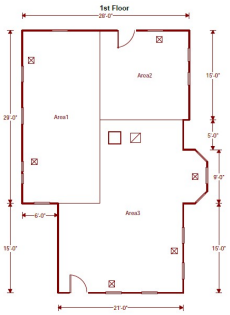
Design Summary Relationship

- Manual J
  - Determined by local conditions
- Manual S
  - Select equipment with capacity adjusted for local conditions and available airflow (CFM)
- Manual D
  - Based on design CFM requirements and what equipment can deliver

Back to our example…

Example House #1

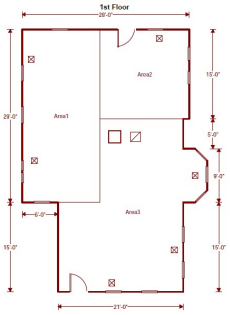




1. Determine scope of the project

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

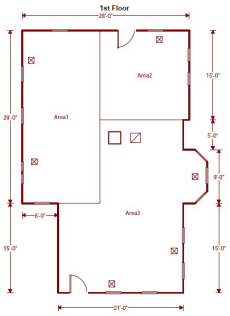
Example House #1



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

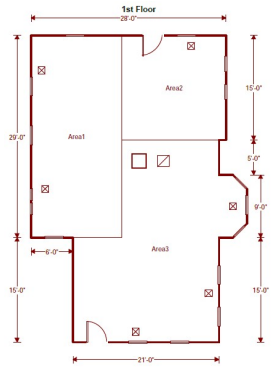
1. Manual J (Entire building)
2. Manual S (all systems)
3. Manual D – New A/C system only

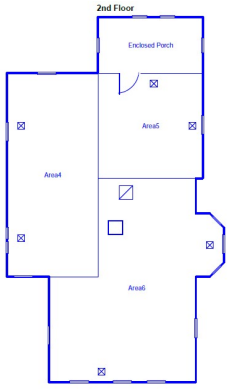
Local Design Conditions

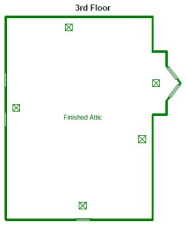
Connecticut Location		Connecticut Design Data					ACCA Table 1A (Reference Design Data)						
City	County	Elevation	Winter Heating 99% dB	Summer Cooling 1% dB	Cooling 1% (wB)	Miles To Reference	Design Reference City	State	Elevation	Latitude	Heating 99% (dB)	Cooling 1% (dB)	Cooling 1% (wB)
THOMASTON	LITCHFIELD	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
WOODBRIDGE	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

Our example is shown drawn with Wrightsoft







wrightsoft Load Short Form

Job:
Date: May 01, 2015

Design Information

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

	Htg	Clg
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) Low	Baseboard (ft) High	Clg AVF (cfm)
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.

wrightsoft Right-Suite® Universal 2015 15.0.15 RSU19562
...\Isoft HVAC\Rollay Projects\JiangJiang_wAC.isp Calc = MJ8 Print Door faces: S

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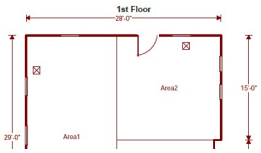
Page 1

Manual J – Load Calculations



wrightsoft Load Short Form
Furnace
Rollay Inc. Energy Services

Job:
Date: May 01, 2015
By:

96 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		
Outside db (°F)	7	*84*	**Infiltration**	
Inside db (°F)	70	75	Method	Simplified
Design TD (°F)	63	9	Construction quality	Loose
Daily range	-	M	Fireplaces	1 (Semi-loose)
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 (ft²)	Htg load (Btuh)	Clg load (Btuh)	Baseboard (ft) Low	Baseboard (ft) High	Clg AVF (cfm)
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.

wrightsoft Right-Suite® Universal 2015 15.0.15 RSU19562
...\Isoft HVAC\Rollay Projects\JiangJiang_wAC.isp Calc = MJ8 Print Door faces: S

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Page 2

Manual J – Load Calculations

wrightsoft Load Short Form
Boiler
Roltay Inc. Energy Services

Job:
Date: May 01, 2015
By:

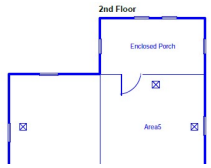
Project Information

For: Manual S Demo
West Haven, CT 06516

Design Information

	Htg	Clg
Outside db (°F)	7	84
Inside db (°F)	70	75
Design TD (°F)	63	9
Daily range		M
Inside humidity (%)	50	50
Moisture difference (gr/lb)	46	40

Infiltration
Method: Simplified
Construction quality: Loose
Fireplaces: 1 (Semi-loose)



HEATING EQUIPMENT
Make: Advantage

COOLING EQUIPMENT
Make: Rivant

ROOM NAME		Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Baseboard (ft) Low	Baseboard (ft) High	Clg AVF (cfm)
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.

wrightsoft Right-Suite® Universal 23:15 15.0.15 RSU15062
...staff HVAC\Roltay Projects\Jang\Jang_a4C.hp Calc = MJ8 Front Door faces: S
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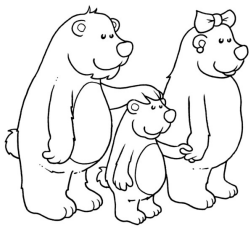
Page 2

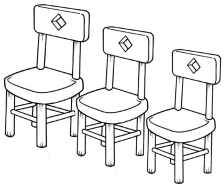
Manual S

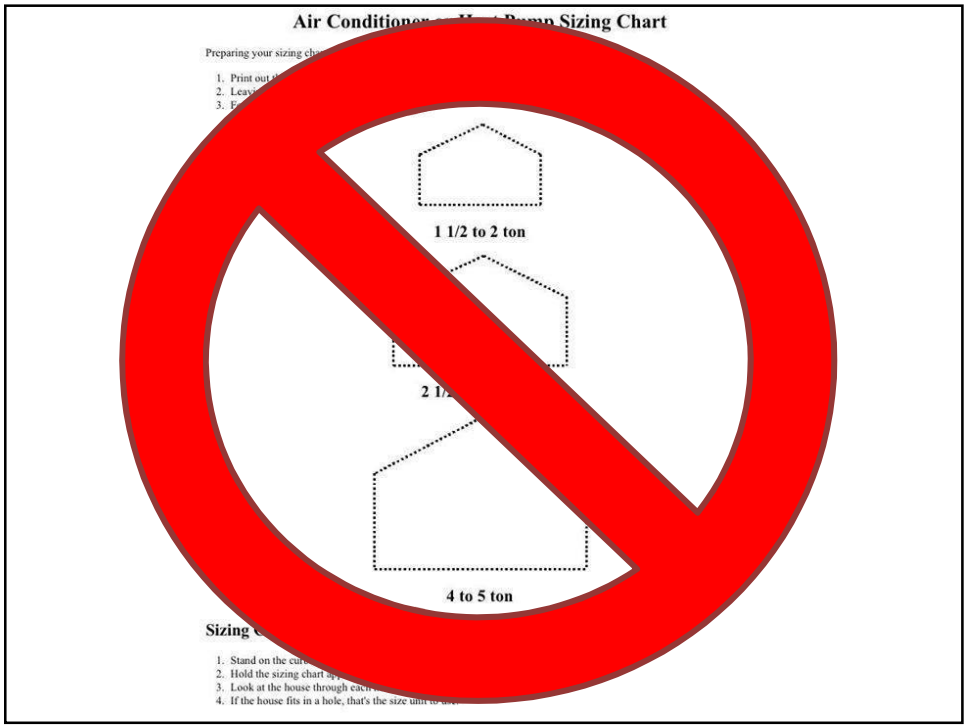
The Practical Definition

Manual S Definition

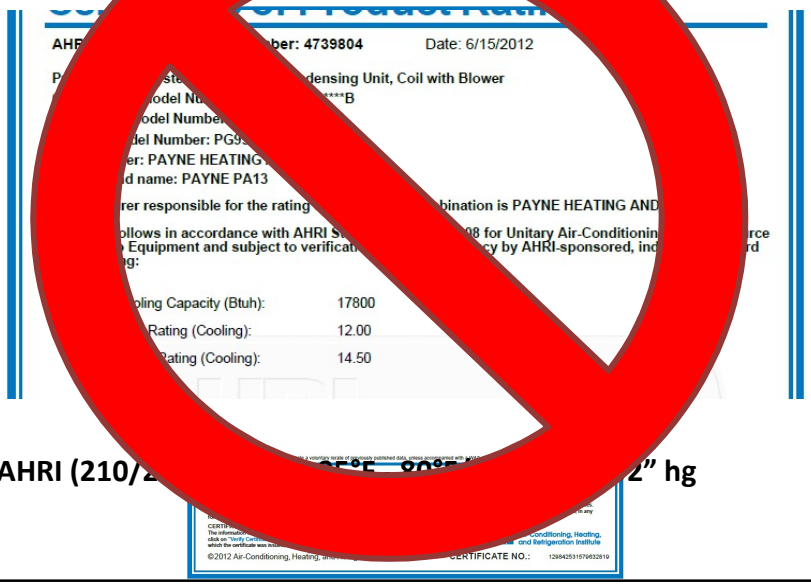
- The process by which the design practitioner determines the suitability of a candidate mechanical comfort system to meet the design loads of a building.







What is a ment for?



AHRI (210/2 2" hg

What is an AHRI Rating Document for?

- DOE requires it for NAECA (Appliance Efficiency Act).
- It only tells us what a system can do in a lab – for comparison to other systems at the same laboratory conditions.
- It does NOT predict how it will perform on a given 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…

- Isn't equipment selection based on the loads?
- Can't I just pick as system based on the loads?
- ….Well not always!

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.

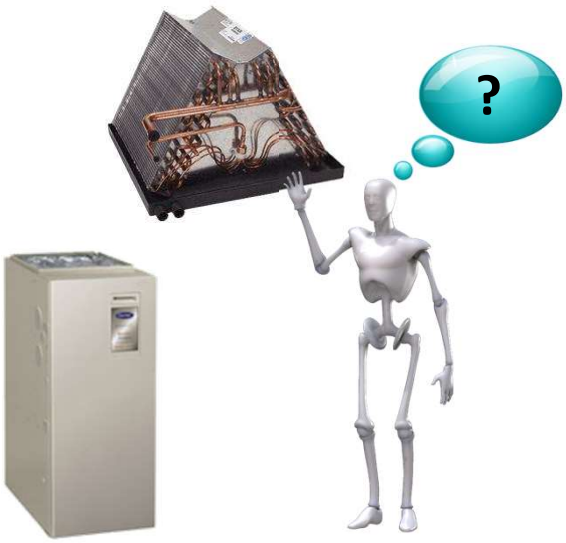
AHRI Rating – Cooling (& HP's)

- 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 equivalvent 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

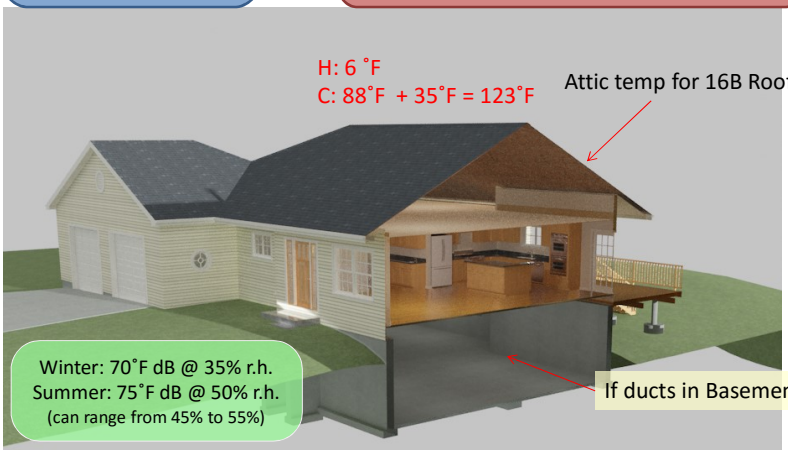
Design Conditions - Ducts

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?

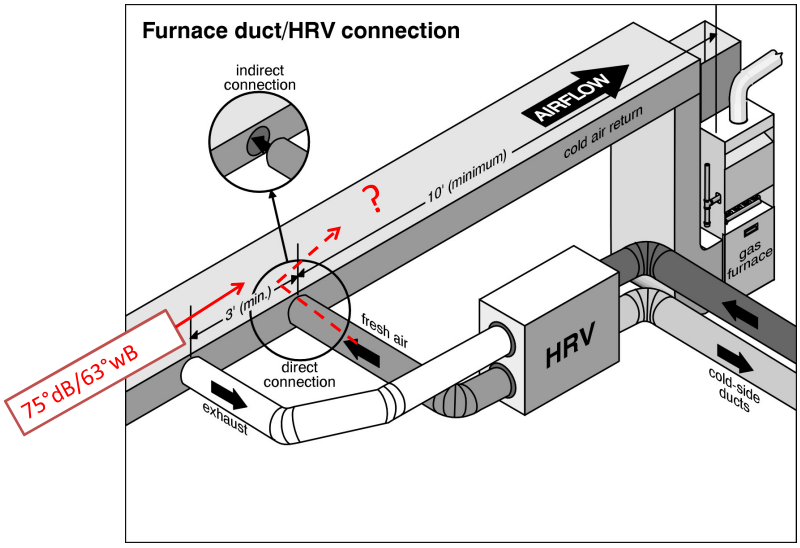


Winter: 70˚F dB @ 35% r.h.
Summer: 75˚F dB @ 50% r.h.
(can range from 45% to 55%)

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)

Ventilation Effect

Indoor

Return Ducts

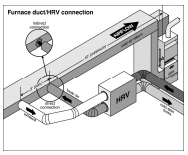
Final Condition

- DB
- WB

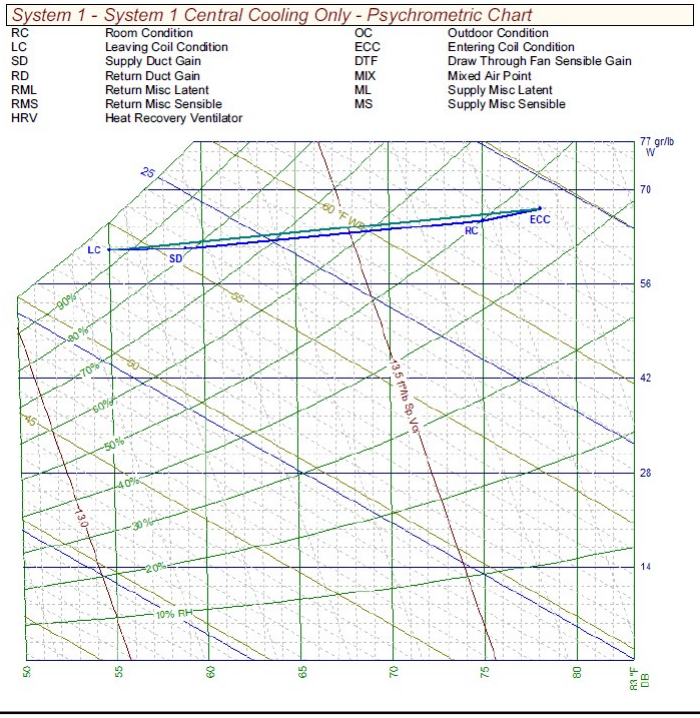
- Sensible
- Leakage

- DB
- WB

- DB
- WB

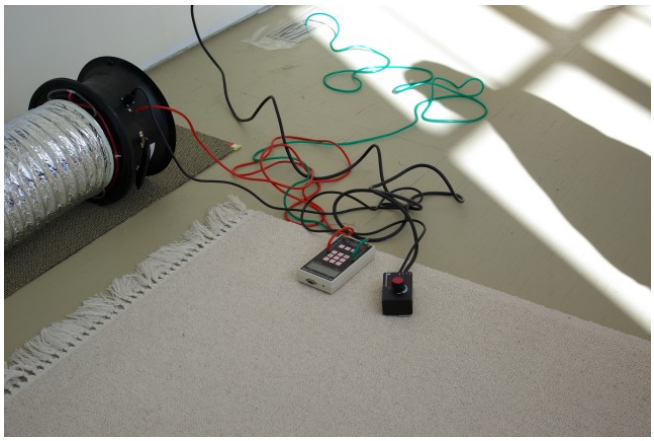


78.2°F dB / 64.5°F wB ?



Sidebar: Infiltration & Duct Leakage

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 ACH_{50} (0.2 i.w.c.)

Infiltration Comparison

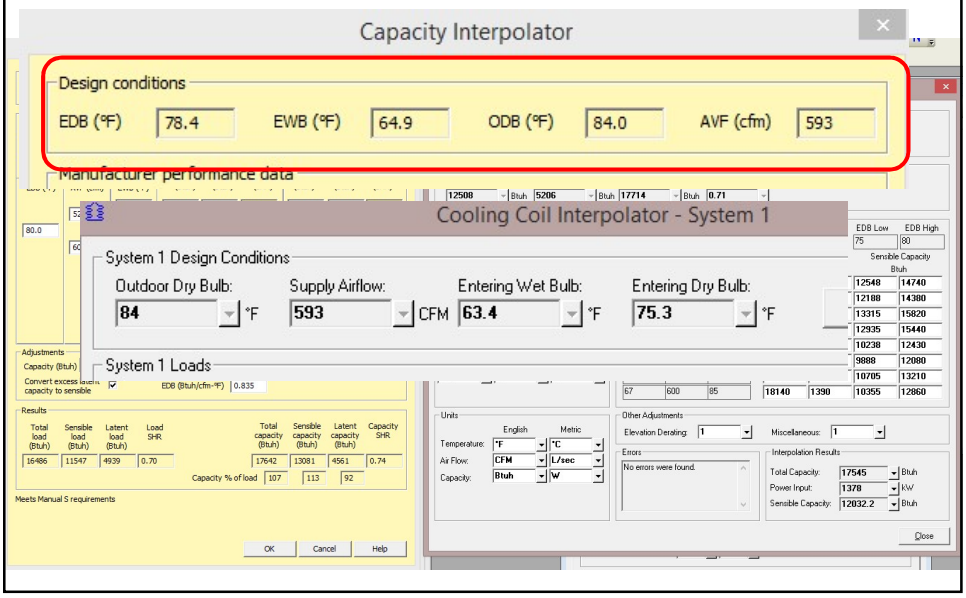
Example Typical Infiltration Rates for Homes (Air Changes per Hour)		
Type of Treatment	ACH50	**ACHnat***
2012 Connecticut Code	3.0	**0.17 - 0.23**
New home with special airtight construction and a controlled ventilation system	1.5 – 2.5	**0.10 – 0.17**
Energy efficient home with continuous air barrier system	4.0 – 6.0	**0.27 – 0.41**
Earlier MEC homes (80's – 90's)	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**
***The conversion between ACH50 and ACHnat is only an estimate for a 2-story home with normal exposures. ACHnat is used in load calculations.**		

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.

Manual S – Using available tools

Entering Air



OEM Engineering Data

84°F

AHRI Condition

587 CFM
63.7°F wB

DETAILED COOLING CAPACITIES

EVAPORATOR AIR		CONDENSER ENTERING AIR TEMPERATURES deg F																			
		75			85			95			105			115			125				
CFM	EWB	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**		
		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡			
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		

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

See notes on pg. 21

OEM Engineering Data

DETAILED COOLING CAPACITIES#

EVAPORATOR AIR		CONDEN					
		75 (23.9)			85 (29.4		
CFM	EWB °F (°C)	Capacity MBtuh†		Total System KW**	Capacity MBtuh†		Total System KW**
		Total	Sens‡		Total	Sens‡	
		PA13NA018—B Outdoor Sect					
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	14.39	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	12.86	1.39
	62 (16.7)	17.59	15.82	1.23	16.78	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

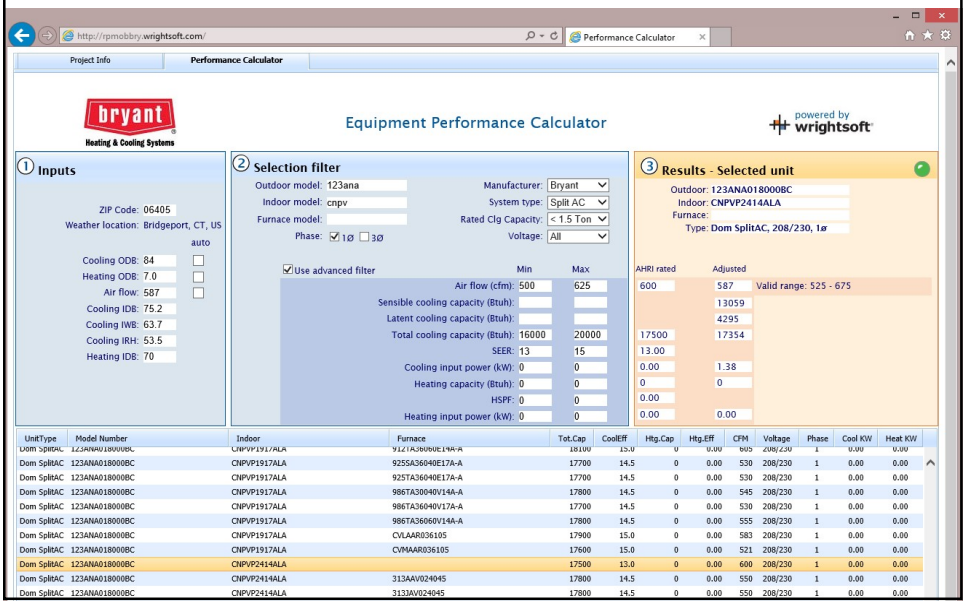
NOTE: When the required data fall between the published data, interpolation may be performed. Extrapolation is not an acceptable practice.

Interpolate OEM Data

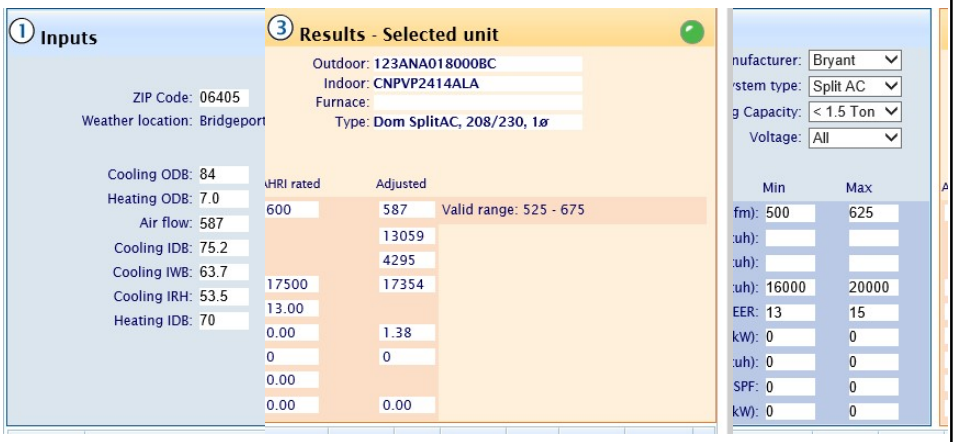
DEMO - Manual S Interpolating Calculator

			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			600	17414.5	15589.9	13185.1
BTU Adj / 1000 cfm		835			CFM Adj	75	4.640267	13.7288	9.7208
						62	17354	15411	13059
						SHR:	0.753		

OEM Tools



OEM Tools



OEM Tools

bryant
Heating & Cooling Systems

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.	Mnfld Press High/Low	Orifice No.	Mnfld Press High/Low	Orifice No.	Mnfld Press High/Low	Orifice No.	Mnfld 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

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]					
		Cooling Capacity (Btuh)	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).					

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 though equipment and is discarded).

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		1.00	1.40
	Heating-Cooling Preferred			
	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, blower 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.

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.

HANDOUTS

General Cooling Capacity Factors			
Equipment Tested and Rated by AHRI	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)		

Sizing Factors for Connecticut

General Cooling Capacity Factors			
Equipment Tested and Rated by AHRI	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

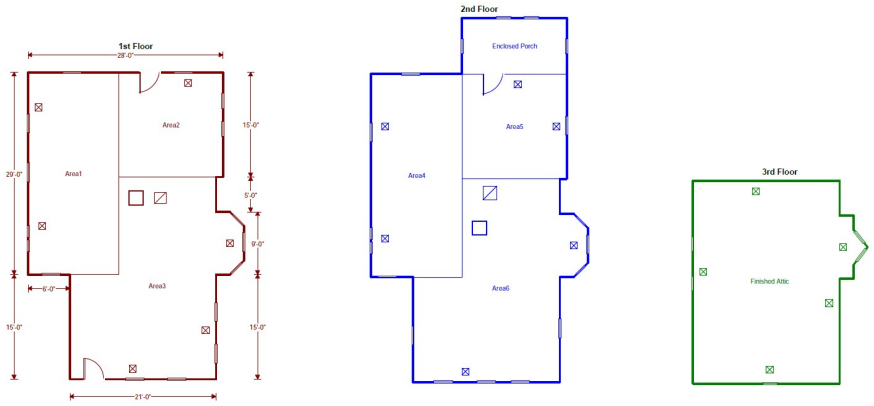
- For heating with boilers that also serve DHW, an additional water load may be considered given that peak heating loads usually occur just before dawn, and it is possible that occupants may be using showers at the same time.
  - Manual S tries to address this with upper limit factor of 2.0 (base/old 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 & A/C units:
  - Use higher capacity compressor (digital or DC drive), and
  - May have capacity controls to limit system capacity
- Some examples:
  - Mini-splits (multi-heads, not all)
  - Lennox XC-25 series
  - Maytag iQ Drive series
  - Waterfurnace 7-series

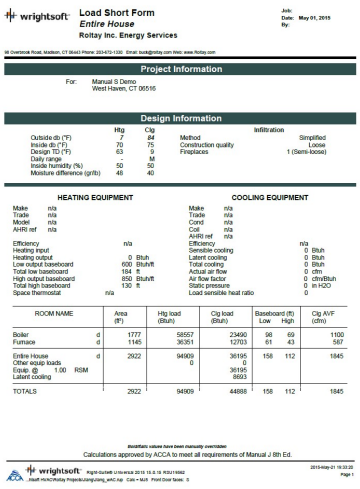
Compliance Documentation

Equipment Selection– Documentation



Must Have BOTH:
Manual J
Manual S

Manual J + Manual S



wrightsoft Load Short Form
Entire House
Roltay Inc. Energy Services

Job:
Date: May 01, 2015
By:

Project Information

For: Manual S Demo
West Haven, CT 06516

Design Information

	Htg	Clg
Outside db (°F)	7	84
Inside db (°F)	70	75
Design TD (°F)	63	9
Daily range	-	M
Inside humidity (%)	50	50
Moisture difference (grn/lb)	48	40

Infiltration

Method	Simplified
Construction quality	Loose
Fireplaces	1 (Semi-loose)

HEATING EQUIPMENT

Make	n/a
Trade	n/a
Model	n/a
AHRI ref	n/a
Efficiency	n/a
Heating input	
Heating output	0 Btuh
Low output baseboard	600 Btuh/ft
Total low baseboard	164 ft
High output baseboard	850 Btuh/ft
Total high baseboard	130 ft
Space thermostat	n/a

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
Latent cooling	0 Btuh
Total cooling	0 Btuh
Actual air flow	0 cfm
Air flow factor	0 cfm/Btuh
Static pressure	0 in H2O
Load sensible heat ratio	0

ROOM NAME		Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Baseboard (ft) Low	Baseboard (ft) High	Clg AVF (cfm)
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.

wrightsoft Right-Suite® Universal 2015 15.0.15 RSU19562
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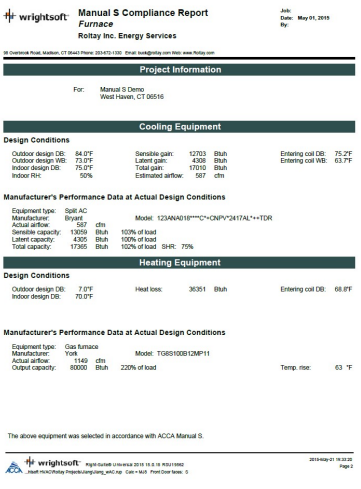
Page 1



wrightsoft Manual S Compliance Report
Furnace
Roltay Inc. Energy Services

Job:
Date: May 01, 2015
By:

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				
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

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

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Page 2

Manual J - 8

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

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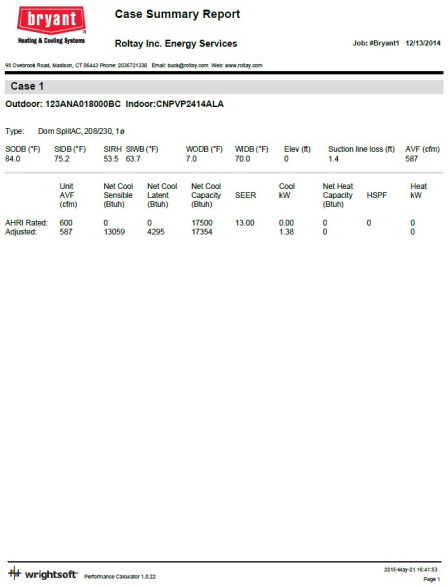
Residential Heat Loss and Heat Gain Calculation

In accordance with ACCA Manual J

HANDOUTS



bryant
Heating & Cooling Systems

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

wrightsoft Performance Calculator 1.6.22 2015-May-21 16:41:53 Page 1

Manual S OEM Online Calculators

bryant
Heating & Cooling Systems

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 – OEM Documents

DETAILED COOLING CAPACITIES

EVAPORATOR AIR		CONDENSER ENTERING AIR TEMPERATURES deg F															
		75			85			95			105			115			125		
CFM	EWB	Capacity MBtuh† Total	Capacity MBtuh† Sens‡	Total System KW**	Capacity MBtuh† Total	Capacity MBtuh† Sens‡	Total System KW**	Capacity MBtuh† Total	Capacity MBtuh† Sens‡	Total System KW**	Capacity MBtuh† Total	Capacity MBtuh† Sens‡	Total System KW**	Capacity MBtuh† Total	Capacity MBtuh† Sens‡	Total System KW**	Capacity MBtuh† Total	Capacity MBtuh† Sens‡	Total System KW**
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

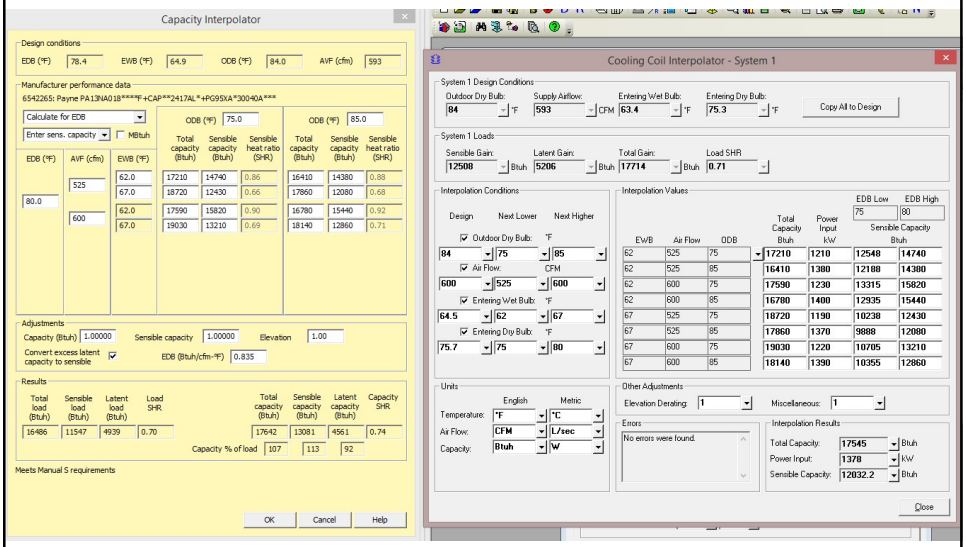
Multipliers for Determining the Performance With Other Indoor Sections

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	

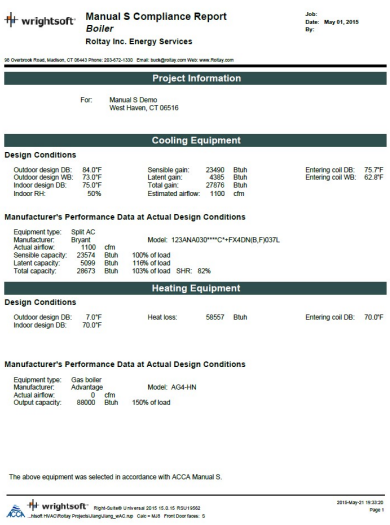
See notes on pg. 21

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 Docs with Load Calc Software



OEM Docs with Load Calc Software



wrightsoft Manual S Compliance Report
Boiler
Roltay Inc. Energy Services

Job:
Date: May 01, 2015
By:

98 Overbrook Road, Madison, CT 06443 Phone: 203-672-1330 Email: buck@roltay.com Web: www.Roltay.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				
Manufacturer:	Bryant	Model:	123ANA030****C*+FX4DNB,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			

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

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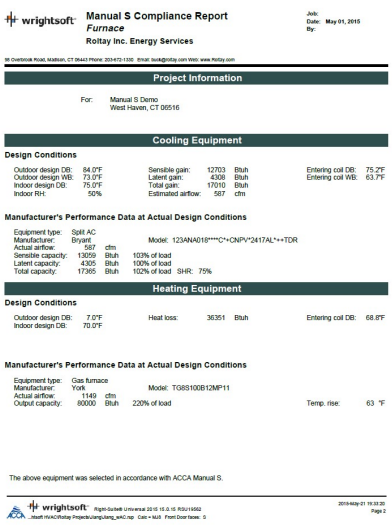
Page 1



wrightsoft Manual S Compliance Report
Furnace
Roltay Inc. Energy Services

Job:
Date: May 01, 2015
By:

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

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

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Page 2

OEM Docs with Load Calc Software

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

OEM Docs with Load Calc Software

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	

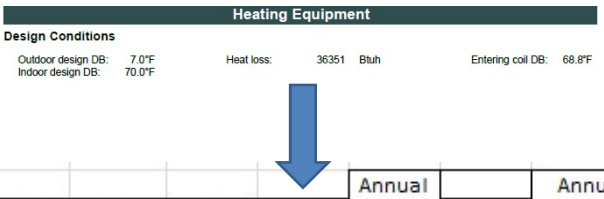
OEM Docs with Spreadsheet Interpolator

DEMO - Manual S Interpolating Calculator

CFM	587								
Amb	84		Outdoor Ambient						
dB	75.2		75		85		84		
wB	63.7		Total	Sensible	Total	Sensible	Total	Sensible	Adj Sens @ 75.2F
	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			600	17414.5	15589.9	13185.1
BTU Adj / 1000 cfm		835			CFM Adj	75	4.640267	13.7288	9.7208
						62	17354	15411	13059
						SHR:	0.753		

Sidebar: Oversizing Illustrated

Oversizing



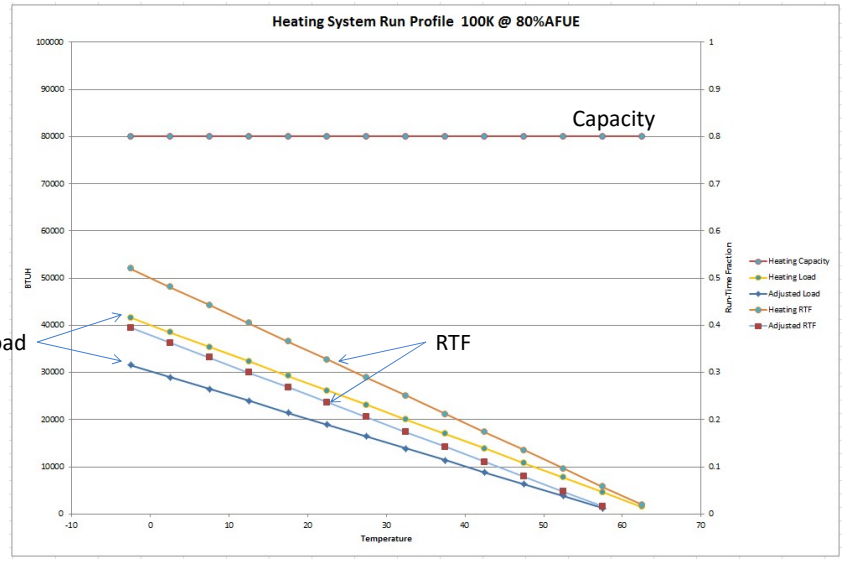
Gross	AFUE	Net	ΔT	CFM	Annual Run Hrs.	Flue BTU	Annual Flue BTU	Fraction Flue
70000	72	50400	80	583	1880	19600	36848000	1
100000	72	72000	80	833	1316	28000	36848000	1
100000	80	80000	70	1058	1184	20000	23680000	0.64264
100000	86	86000	65	1225	1101	14000	15414000	0.41831
100000	94	94000	50	1741	1008	6000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

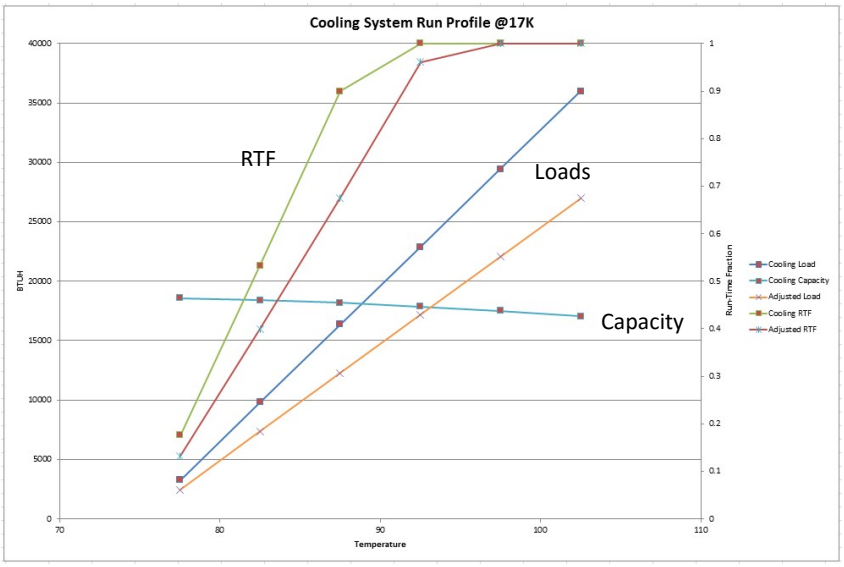
Oversizing

Bin Bracket	Bin Avg	Loss/Gain	Adjusted Loss/Gain	Capacity	Sum Hrs	EER	Power	RTF	ADJ RTF	WattHrs Run Hours	Bin Power
-35 to - 30	-32.5	60072	46701	80000	0			0.7509	0.583763	0	0
-30 to -25	-27.5	56991	44177	80000	0			0.71239	0.552212	0	0
-25 to -20	-22.5	53910	41652	80000	0			0.67387	0.52065	0	0
-20 to -15	-17.5	50830	39128	80000	0			0.63538	0.4891	0	0
-15 to -10	-12.5	47749	36603	80000	0			0.59686	0.457538	0	0
-10 to -5	-7.5	44669	34079	80000	0			0.55836	0.425988	0	0
-5 to 0	-2.5	41588	31555	80000	9			0.51985	0.394437	4.67865	0
0 to 5	2.5	38507	29030	80000	35			0.48134	0.362875	16.84681	0
5 to 10	7.5	35427	26506	80000	82			0.44284	0.331325	36.31268	0
10 to 15	12.5	32346	23982	80000	201			0.40433	0.299775	81.26933	0
15 to 20	17.5	29266	21457	80000	240			0.36582	0.268212	87.798	0
20 to 25	22.5	26185	18933	80000	382			0.32731	0.236663	125.0334	0
25 to 30	27.5	23104	16408	80000	466			0.2888	0.2051	134.5808	0
30 to 35	32.5	20024	13884	80000	848			0.2503	0.17355	212.2544	0
35 to 40	37.5	16943	11360	80000	724			0.21179	0.142	153.3342	0
40 to 45	42.5	13863	8835	80000	704			0.17329	0.110437	121.9944	0
45 to 50	47.5	10782	6311	80000	696			0.13477	0.078887	93.8034	0
50 to 55	52.5	7701	3787	80000	669			0.09626	0.047337	64.39961	0
55 to 60	57.5	4621	1262	80000	670			0.05776	0.015775	38.70087	0
60 to 65	62.5	1540	0	80000	696			0.01925	0	13.398	0
65 to 70	67.5	0		80000	714			0		0	0
70 to 75	72.5	0		18594.5	680			0		0	0
75 to 80	77.5	3271	2453	18501.2	434	13.59	1361.38	0.1768	0.132586	76.73092	104460
80 to 85	82.5	9813	7360	18337.9	343	13.05	1405.2	0.53512	0.401355	183.5466	257920
85 to 90	87.5	16356	12267	18104.7	169	12.45	1454.19	0.90341	0.677559	152.6766	222021
90 to 95	92.5	22898	17174	17801.6	34	11.81	1507.33	1	0.964745	34	51249.3
95 to 100	97.5	29440	22080	17428.5	3	11.15	1563.09	1	1	3	4689.28
100 to 105	102.5	35983	26987	16985.6	0	10.48	1620.76	1	1	0	0
105 to 110	107.5	42525	31894	16472.7	0	9.83	1675.76	1	1	0	0
110 to 115	112.5	49067	36800	15889.8	0	9.2	1727.15	1	1	0	0
					8799	983			Heating	1184.404	1.1844
					8760	450			Cooling	449.9541	0.44995

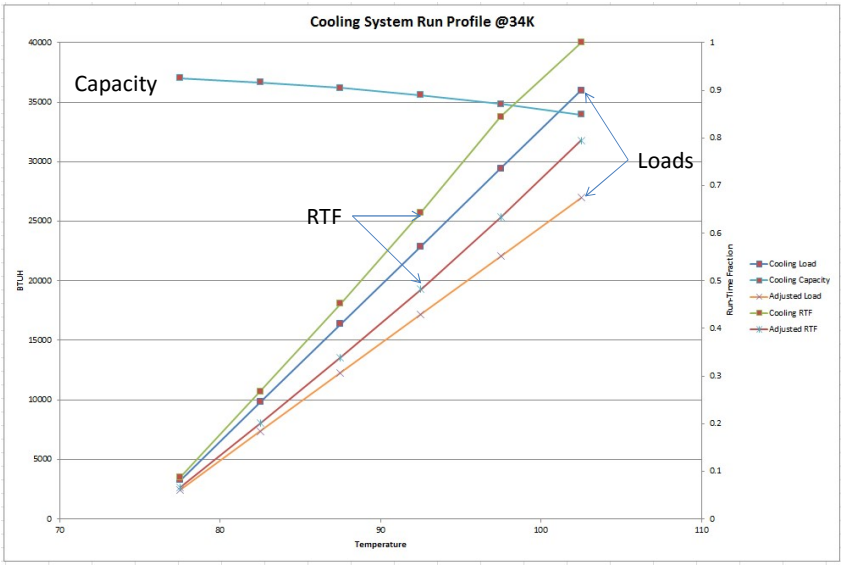
Oversizing - Heating



Proper Sized - Cooling



Oversizing - Cooling



Review Example

Page 1 **Residential Heat Loss and Heat Gain Calculation** 7/19/2015

In accordance with ACCA Manual J

Report Prepared By:

For:

WEST HAVEN, CT

Design Conditions: Easton

Indoor:		**Outdoor:**	
Summer temperature:	70	Summer temperature:	100
Winter temperature:	72	Winter temperature:	-10
Relative humidity:	50	Summer grains of moisture:	84
		Daily temperature range:	High

Building Component		Sensible Gain (BTUH)	Latent Gain (BTUH)	Total Heat Gain (BTUH)	Total Heat Loss (BTUH)
Whole House	894.8 sq.ft.	12,789	3,707	16,496 (1.5 tons)	23,268

Whole House	**894.8 sq.ft.**	**12,789**	**3,707**	**16,496 (1.5 tons)**	**23,268**
Apt #3 - End Unit - Middle & Top Floors		12,789	3,707	16,496	23,268
Dining / Living Room	314 sq.ft.	3,845	1,409	5,254	9,092
Infiltration - Tightness: Avg.; Winter ACH: 1.1 ; Summer ACH: .5		817	489	1,306	4,923
Duct - Supply below 120; Enclosed in unheated space; R-6		0	0	0	433
People	4	1,200	920	2,120	0
Floor - Over conditioned space	314.3 sq.ft.	0	0	0	0
N Wall - Wood frame, with sheathing, siding or brick, R-19 5 1/2 in.; none	78.8 sq.ft.	135	0	135	388
Glassdoor - Sliding glass door; Double pane; Wood or vinyl frame; Clear glass - Draperies or blinds; Coating: None (clear glass); No outside shading.	44 sq.ft.	878	0	878	1,983
Ceiling - Under ventilated attic; R-19 (4 - 6.5 inch); Dark	314 sq.ft.	815	0	815	1,365
Kitchen	100 sq.ft.	2,060	460	2,520	457
Infiltration - Tightness: Avg.; Winter ACH: 1.1 ; Summer ACH: .5		0	0	0	0
Duct - Supply below 120; Enclosed in unheated space; R-6		0	0	0	22
People	2	600	460	1,060	0
Miscellaneous		1,200	0	1,200	0

Page 1 **Residential Heat Loss and Heat Gain Calculation** 8/20/2015

In accordance with ACCA Manual J

Report Prepared By:

For:

WEST HAVEN, CT

Design Conditions: New Haven

Indoor:		**Outdoor:**	
Summer temperature:	70	Summer temperature:	84
Winter temperature:	72	Winter temperature:	0
Relative humidity:	50	Summer grains of moisture:	84
		Daily temperature range:	Medium

Building Component		**Sensible Gain (BTUH)**	**Latent Gain (BTUH)**	**Total Heat Gain (BTUH)**	**Total Heat Loss (BTUH)**
Whole House	**581 sq.ft.**	**8,102**	**2,832**	**10,934 (1 tons)**	**22,165**
Second Floor		8,102	2,832	10,934	22,165

Whole House	**581 sq.ft.**	**8,102**	**2,832**	**10,934 (1 tons)**	**22,165**
Second Floor		8,102	2,832	10,934	22,165
Bathroom	40 sq.ft.	132	0	132	291
Infiltration - Tightness: Poor; Winter ACH: 2.01 ; Summer ACH: .8		0	0	0	0
Duct - Supply above 120; Enclosed in unheated space; R-4		6	0	6	38
Floor - Over conditioned space	40 sq.ft.	0	0	0	0
Ceiling - Under ventilated attic; R-11 (3 - 3.5 inch); Dark	40 sq.ft.	126	0	126	253
Bedroom	216 sq.ft.	2,401	918	3,319	8,408
Infiltration - Tightness: Poor; Winter ACH: 2.01 ; Summer ACH: .8		358	458	816	4,630
Duct - Supply above 120; Enclosed in unheated space; R-4		114	0	114	1,097
People	2	600	460	1,060	0
Floor - Over conditioned space	216 sq.ft.	0	0	0	0
S Wall - Wood frame, with sheathing, siding or brick; R-11 3 1/2 in.; none	72.4 sq.ft.	115	0	115	469
Window - Double pane; Vinyl frame; Clear glass - Draperies or blinds; Coating: None (clear glass); No outside shading.	23.6 sq.ft.	533	0	533	843
Ceiling - Under ventilated attic; R-11 (3 - 3.5 inch); Dark	216 sq.ft.	681	0	681	1,369

Questions?

Resources

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

Thank you

Buck Taylor

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10:00 AM