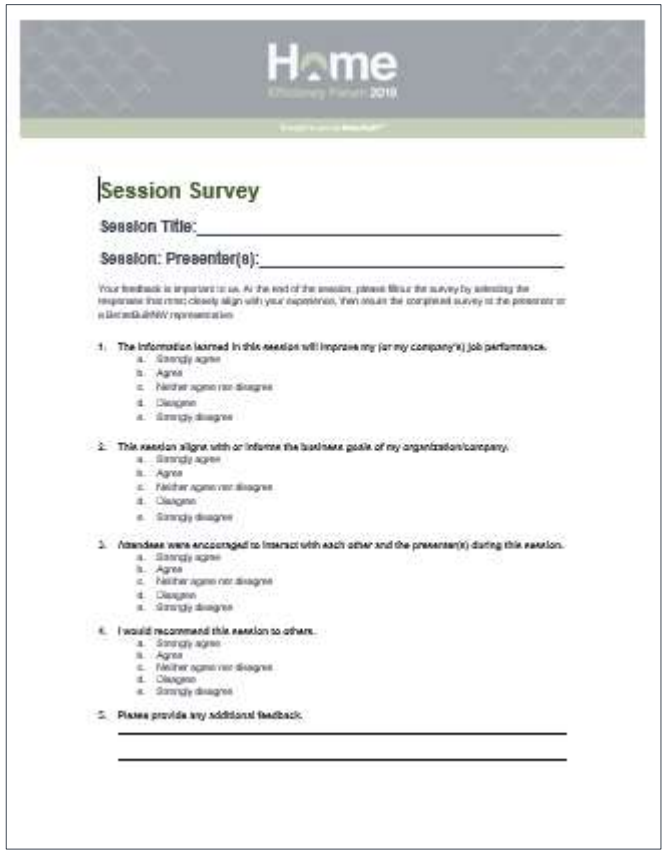
“Manual R”
Rightsizing Mini Splits for High Performance Homes

Greg Davenport
Ingo Stroup
Ryan Nieto

Session Survey Instructions

At the end of each session, you will be given 5 minutes to complete the session survey.

- Complete the survey using the mobile app or paper versions
- Provide the paper surveys to the room moderator or to the BetterBuiltNW table
- We appreciate your feedback



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Session Survey

Session Title:_____

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Your feedback is important to us. At the end of the session, please fill out the survey by selecting the responses that most closely align with your experience, then return the completed survey to the presenter or a BetterBuiltNW representative.

1. The information learned in this session will improve my (or my company's) job performance.
   a. Strongly agree
   b. Agree
   c. Neither agree nor disagree
   d. Disagree
   e. Strongly disagree
2. This session aligns with or informs the business goals of my organization/company.
   a. Strongly agree
   b. Agree
   c. Neither agree nor disagree
   d. Disagree
   e. Strongly disagree
3. Attendees were encouraged to interact with each other and the presenter(s) during this session.
   a. Strongly agree
   b. Agree
   c. Neither agree nor disagree
   d. Disagree
   e. Strongly disagree
4. I would recommend this session to others.
   a. Strongly agree
   b. Agree
   c. Neither agree nor disagree
   d. Disagree
   e. Strongly disagree
5. Please provide any additional feedback.

_____

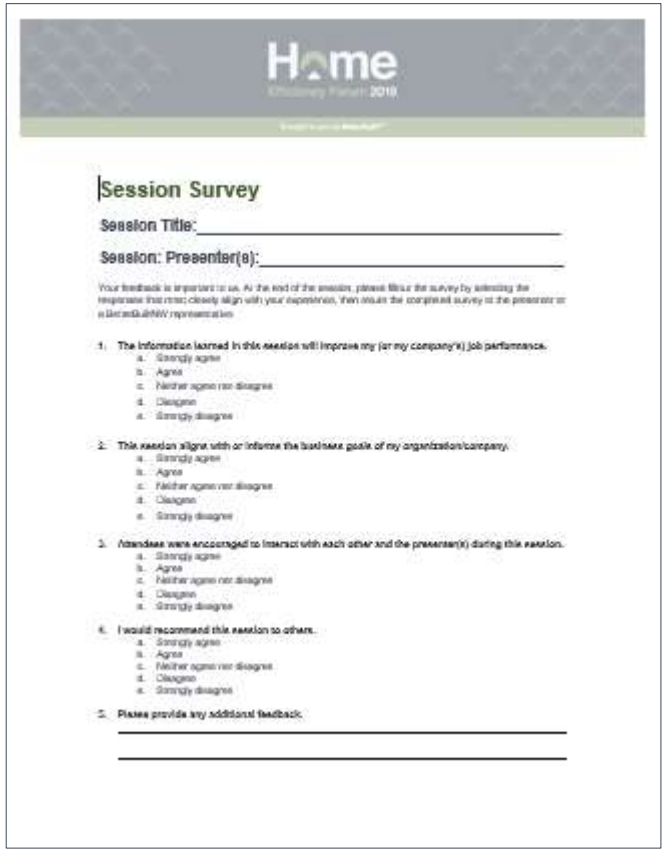
_____

Complete the Session Survey

Manual R - "R" is for Rightsizing!

(Lunch and Learn)

- Greg Davenport
- Ryan Nieto
- Ingo Stroup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5. Please provide any additional feedback.

_____

_____

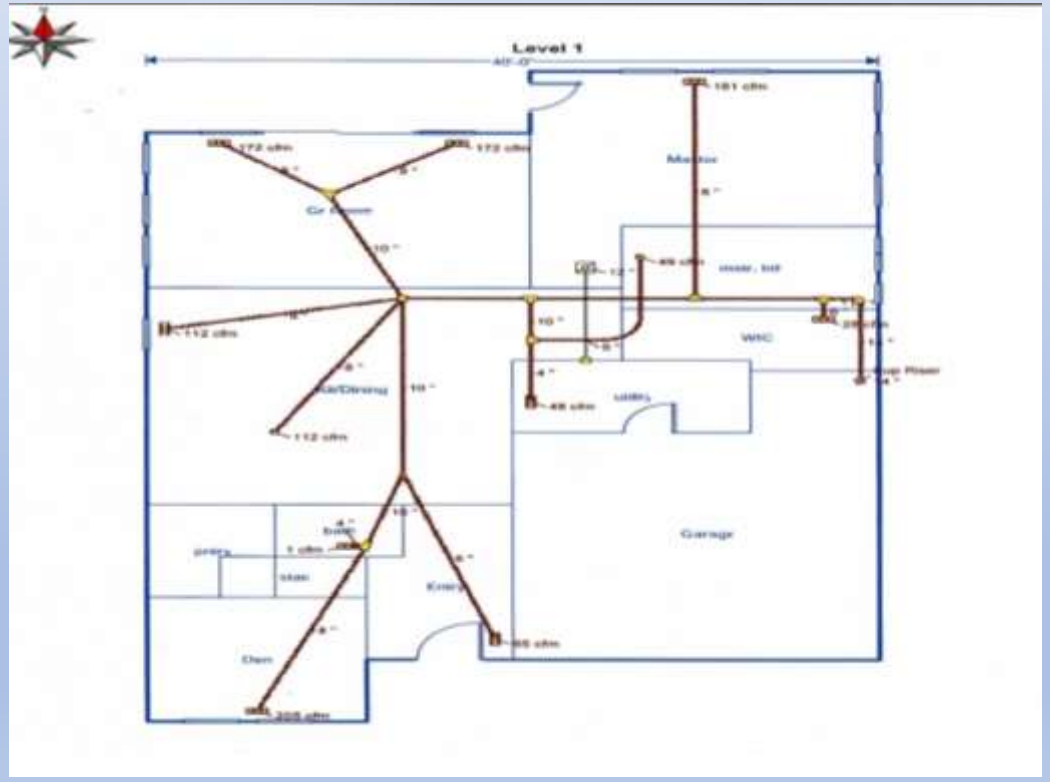
RESNET Rating Provider

Independent Testing & Inspection / IR Thermography/QAD Services

Efficient HVAC Design

High Performance homes coupled with low performance systems, designs & installs

Contractor Designs



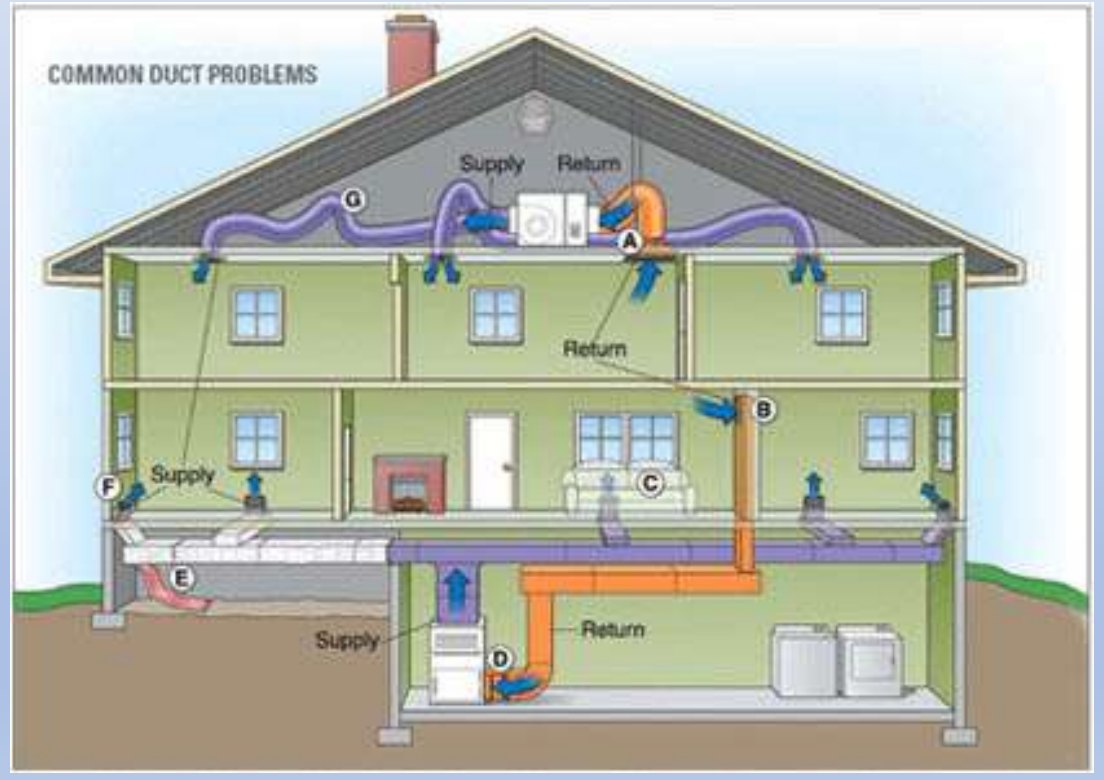
Contractor Installs

Where’s my air flow?

Indoor Air Quality?

Let’s MOVE from old school havoc to “healthy, clean, efficient, modern comfort.”

Old School Havoc



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s Ormond st

The perils of oversizing any heating/cooling system

All heating/cooling systems will suffer if oversized

Short cycling reduces comfort and energy performance

Zoned comfort in every room probably is not the best approach in a low load home

Over sized systems cost more than needed

Over sized systems short cycle which increases wear and tear on equipment and reduces lifespan

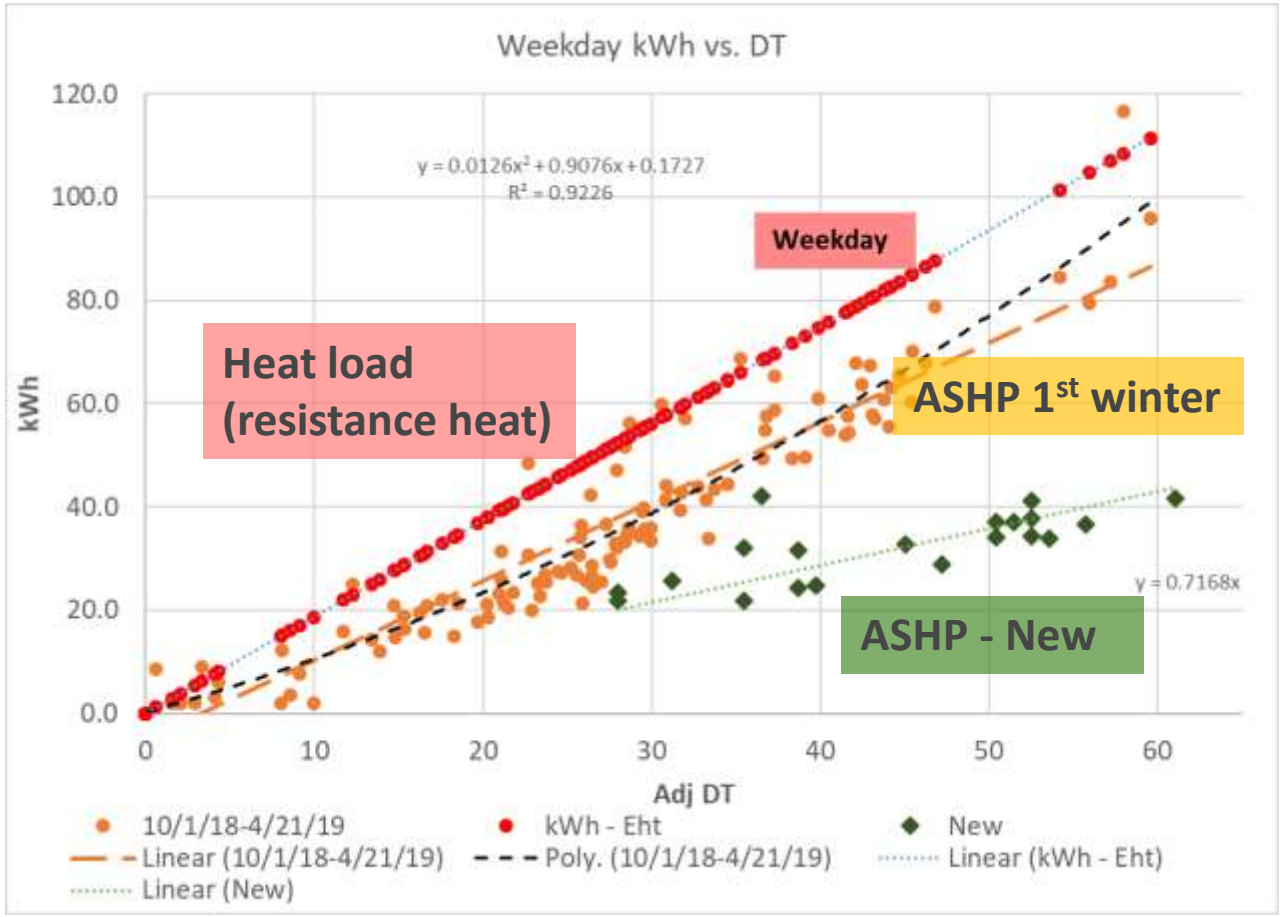
Variable speed ASHP equipment still has minimum capacities

Multi zone mini split systems may not be the best choice for low load homes - look closely at turndown ratio

EFG Office Building Heat Pump Swap-Out

Before:

After:



New installs as of 2/8/19 – 3/7/19

Many HVAC contractors fall short in the following areas:

They do not do accurate Man J load calcs before designing and bidding the project

Size mini split systems based on the number of rooms/zones – a head in every room

Think bigger is always better - Don’t worry, it’s variable speed!

Do not understand new distribution options to right size mini split systems – horizontal ducted systems and carefully designed transfer fans

Do not want to, or know how to, do good duct design/installation for high performance homes

Do not use manufacturer design tools

They need more training on how to design and install systems for cold climate areas

Heating and Cooling Load Calculations

Every project should start with a good room by room load calc for good HVAC design

Use the right design temps
Use the right wall, window, and door values
Use the right air tightness
Always get a room by room load calc

If your HVAC contractor can't, or will not, do good HVAC design for you, Consider using an HVAC designer like Energy Vanguard, Positive Energy or Building Energy HVAC Design

What are the components of a Manual J heating/cooling load calculation?

- Local design temperature (and altitude)
- Local humidity
- Building orientation
- Envelope (wall, floor, and ceiling) R values and dimensions
- Window and door U values and dimensions
- Window SHGC (solar heat gain coefficient)
- Air infiltration target – ACH50

What about Shading?

ASHRAE Design Temps

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WACs > Title 51 > Chapter 51-11C > Section 51-11C-80100

51-11C-80000 << 51-11C-80100 >> 51-11C-80500

WAC 51-11C-80100

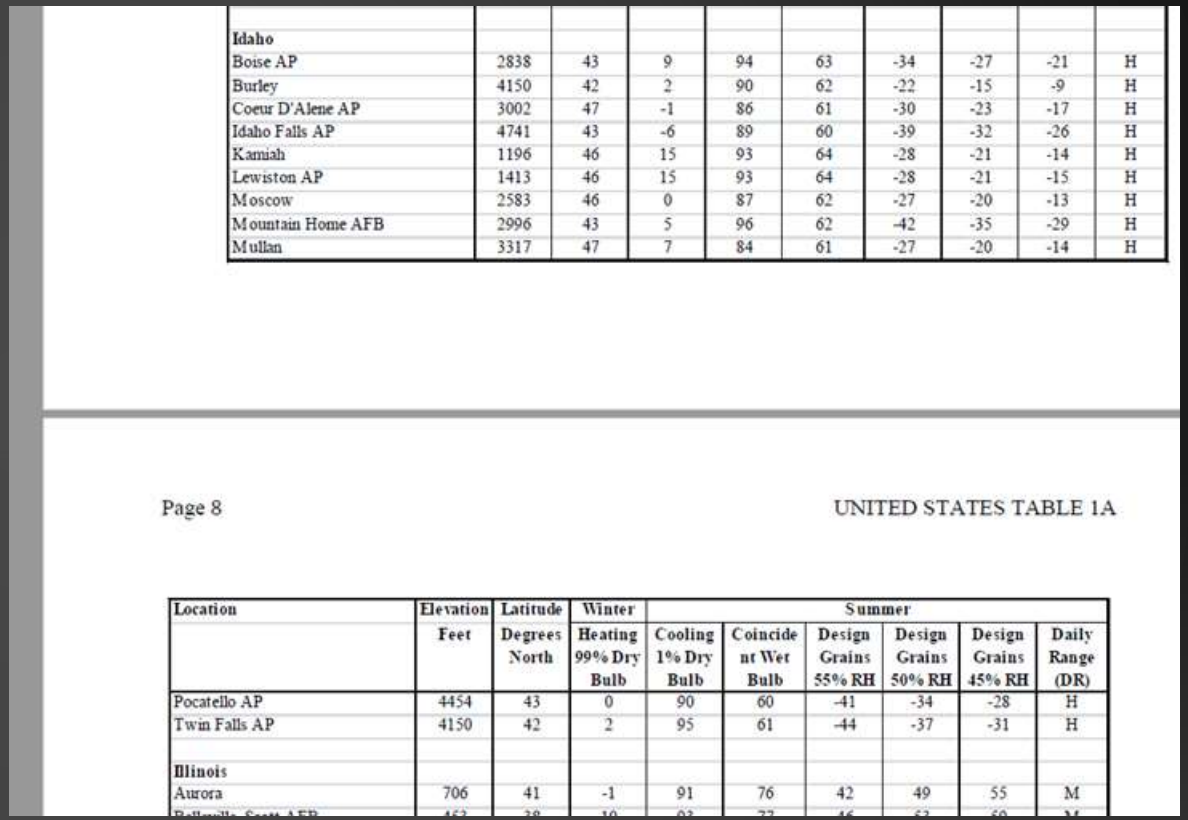
Table C-1—Outdoor design temperatures for Washington.

Table C-1
Outdoor Design Temperatures

Location	Outdoor Design Temp. Heating (°F)	Outdoor Design Temp. Cooling (°F)
Aberdeen 20 NNE	25	83
Anacortes	24	72
Anatone	-4	89
Auburn	25	84
Battleground	19	91
Bellevue	24	83
Bellingham 2 N	19	78
Blaine	17	73
Bremerton	29	83
Burlington	19	77
Chehalis	21	87
Chelan	10	89
Cheney	4	94
Chesaw	-11	81

Temp data is backwards looking

When in doubt – look at temp bin data



Idaho									
Boise AP	2838	43	9	94	63	-34	-27	-21	H
Burley	4150	42	2	90	62	-22	-15	-9	H
Coeur D'Alene AP	3002	47	-1	86	61	-30	-23	-17	H
Idaho Falls AP	4741	43	-6	89	60	-39	-32	-26	H
Kamiah	1196	46	15	93	64	-28	-21	-14	H
Lewiston AP	1413	46	15	93	64	-28	-21	-15	H
Moscow	2583	46	0	87	62	-27	-20	-13	H
Mountain Home AFB	2996	43	5	96	62	-42	-35	-29	H
Mullan	3317	47	7	84	61	-27	-20	-14	H

Page 8 UNITED STATES TABLE 1A

Location	Elevation	Latitude	Winter	Summer					
	Feet	Degrees North	Heating 99% Dry Bulb	Cooling 1% Dry Bulb	Coincident Wet Bulb	Design Grains 55% RH	Design Grains 50% RH	Design Grains 45% RH	Daily Range (DR)
Pocatello AP	4454	43	0	90	60	-41	-34	-28	H
Twin Falls AP	4150	42	2	95	61	-44	-37	-31	H
Illinois									
Aurora	706	41	-1	91	76	42	49	55	M

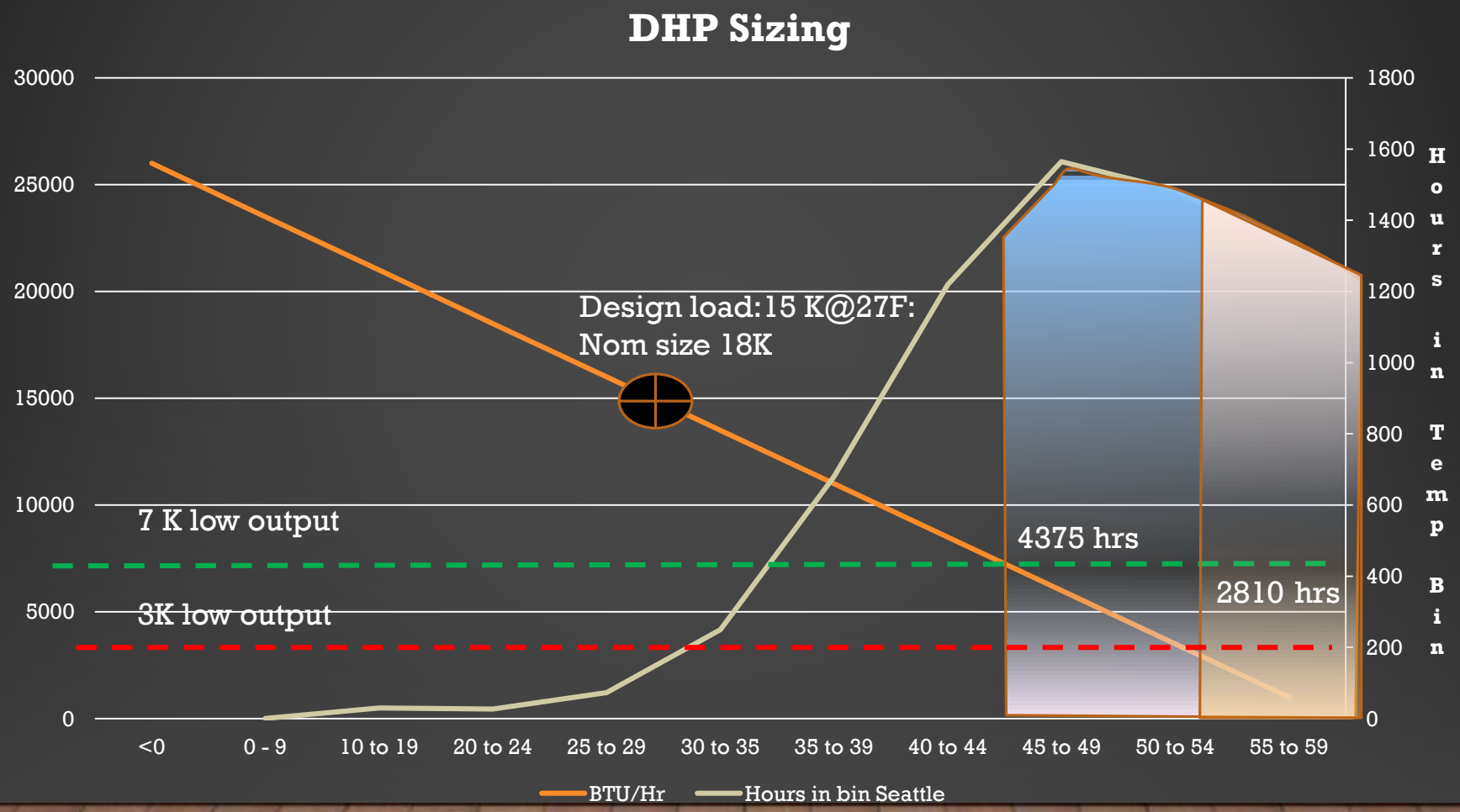
How many hours a year are at or near Winter design temp?

How many days a year are between 35 – 60 degrees?

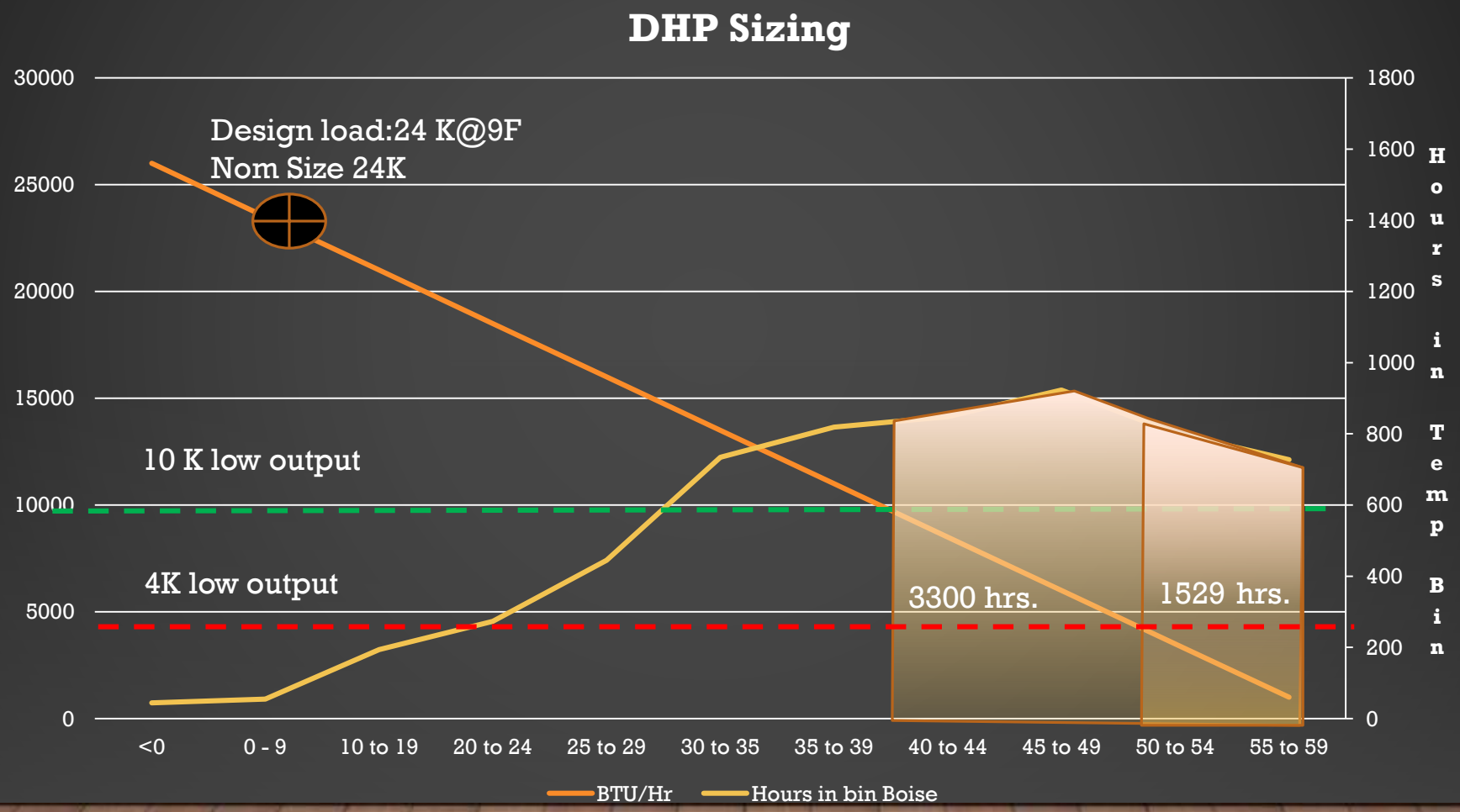
It is the majority of the year here in the Pacific NW!

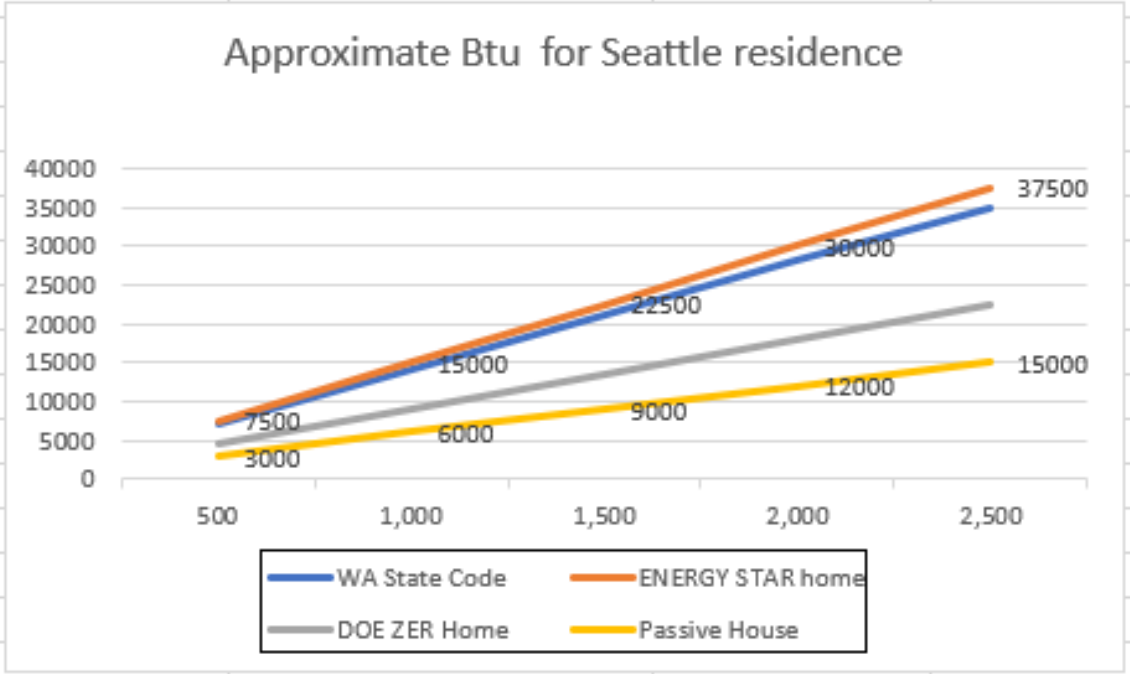
HVAC Design must consider
shoulder season performance carefully

SEATTLE DHP, LOW OUTPUT SIZING

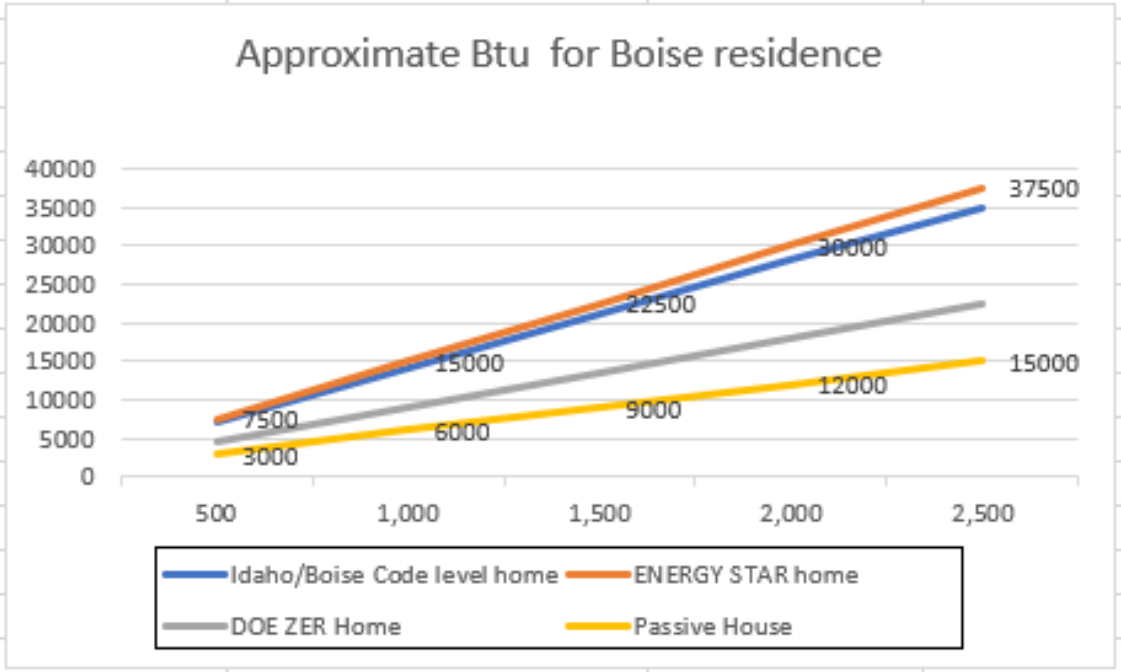


BOISE DHP, LOW OUTPUT SIZING



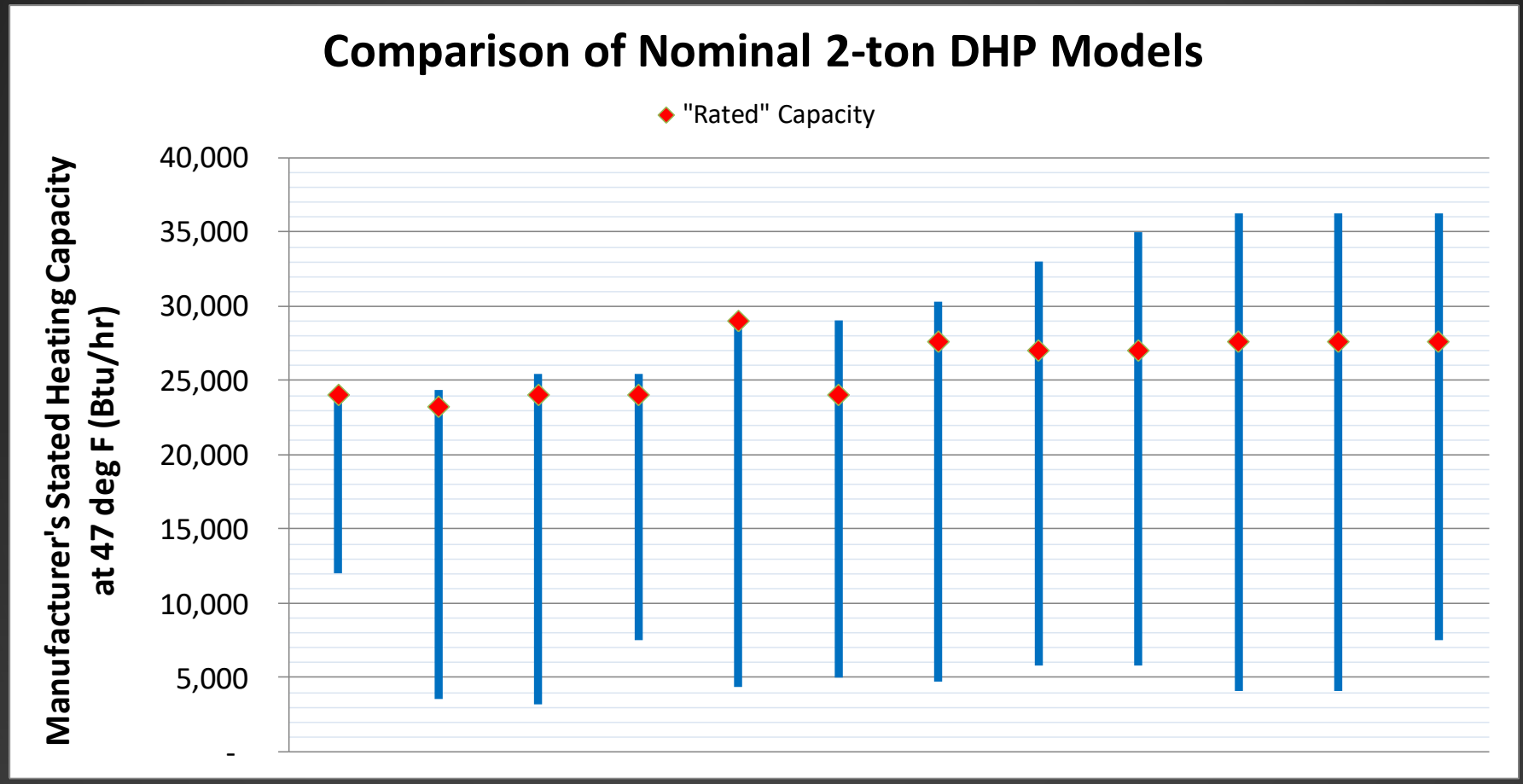


	Code heating Btu/s.f.	ENERGY STAR heating Btu/s.f.	DOE ZER Btu/s.f.	Passive heating /S.f.	Passive cooling/s.f.
Seattle	14	15	9	6	4
Seattle Design Temps	Heating	Cooling			
	24F	83F			
Home size in s.f.	Code heating Btu	ENERGY STAR heating Btu	DOE ZER Btu	Passive heating	Passive cooling
500	7000	7500	4500	3000	2000
1,000	14000	15000	9000	6000	4000
1,500	21000	22500	13500	9000	6000
2,000	28000	30000	18000	12000	8000
2,500	35000	37500	22500	15000	10000



	Code heating Btu/s.f.	ENERGY STAR heating Btu/s.f.	DOE ZER Btu/s.f.	Passive heating /S.f.	Passive cooling/s.f.
Boise	20	17	14	8	8
Boise Design Temps	Heating	Cooling			
	9F	94F			
Home size in s.f	Code heating Btu	ENERGY STAR heating Btu	DOE ZER Btu	Passive heating	Passive cooling
500	10000	8500	7000	4000	4000
1,000	20000	17000	14000	8000	8000
1,500	30000	25500	21000	12000	12000
2,000	40000	34000	28000	16000	16000
2,500	50000	42500	35000	20000	20000

SIZING DUCTLESS HEAT PUMPS



M-SERIES

SUBMITTAL DATA: MSZ-FH12NA & MUZ-FH12NAH
12,000 BTU/H WALL-MOUNTED HEAT PUMP SYSTEM

Job Name:

System Reference:

Indoor Unit: MSZ-FH12NA	Outdoor Unit: MUZ-FH12NAH
	

Heating at 47°F[2]	Maximum Capacity	Btu/h	21,000
	Rated Capacity	Btu/h	13,600
	Minimum Capacity	Btu/h	3,700
	Maximum Power Input	W	2,300
	Rated Power Input	W	950
	Power Factor	%	96 / 96
Heating at 17°F[3]	Maximum Capacity	Btu/h	13,600
	Rated Capacity	Btu/h	8,000
	Maximum Power Input	W	1,900
	Rated Power Input	W	720
Heating at 5°F[4]	Maximum Capacity	Btu/h	13,600
	Maximum Power Input	W	1,930
Heating at -4°F[5]	Maximum Capacity	Btu/h	11,690
Heating at -13°F[6]	Maximum Capacity	Btu/h	9,920
	SEER		26.1
	EER[1]		13.8
	HSPF (IV)		11.5

M-Series — **SUBMITTAL DATA: MXZ-3C24NAHZ2**
MULTI-INDOOR INVERTER HEAT-PUMP SYSTEM — MITSUBISHI ELECTRIC

Job Name:
System Reference: Date:

Outdoor Unit: MXZ-3C24NAHZ2

ACCESSORIES
The outdoor unit is delivered with the base pan heater factory installed.
- ☐ Airflow Guide (PAC-SH96SG-E)
- ☐ 3/8" x 1/2" Port Adapter (MAC-A454JP-E)
- ☐ 1/2" x 3/8" Port Adapter (MAC-A455JP-E)
- ☐ 1/2" x 5/8" Port Adapter (MAC-A456JP-E)
- ☐ M-NET Adapter (PAC-IF01MNT-E)

(For data on specific indoor units, see the MXZ-C Technical and Service Manual.)

Specifications			Model Name
Unit Type			MXZ-3C24NAHZ2
Cooling* (Non-ducted / Ducted)	Rated Capacity	Btu/h	22,000 / 23,600
	Capacity Range	Btu/h	12,600 - 23,600
	Rated Total Input	W	1,630 / 2,360
Heating at 47°F* (Non-ducted / Ducted)	Rated Capacity	Btu/h	[illegible],000 / 24,600
	Capacity Range	Btu/h	11,400 - 30,600
	Rated Total Input	W	[illegible]
Heating at 17°F* (Non-ducted/Ducted)	Rated Capacity	Btu/h	14,000 / 14,000
	Maximum Capacity	Btu/h	25,000 / 24,600

One zone calling – ACCA

Multiple zones calling – not ACCA

MXZ-3C24NAHZ2
2) HEATING

Rated Q(Btu/h): 25000 W: 1725
Max. Q(Btu/h): 30600 W: 4540

Indoor D.B. / Outdoor W.B. (°F)	(°C)		80°F/26.7°C Max.	Rated	75%	50%	25%	Min.	70°F / 21.1°C Max.	Rated	75%	50%	25%	Min.	60°F/15.6°C Max.	Rated	75%	50%	25%	Min.
65	18.3	Q[Btu/h]	38201	31380	23535	-	-	17806	39602	32531	24398	-	-	18459	40788	33505	25129	-	-	19011
		W	4804	2030	1712	-	-	1512	4625	1954	1648	-	-	1456	4490	1898	1600	-	-	1413
60	15.6	Q[Btu/h]	35737	29748	22311	-	-	16600	37120	30899	23174	-	-	17242	38290	31873	23905	-	-	17785
		W	4569	1966	1657	-	-	1457	4398	1892	1595	-	-	1403	4270	1837	1549	-	-	1362
55	12.8	Q[Btu/h]	33297	28116	21087	-	-	15402	34661	29267	21950	-	-	16033	35814	30241	22681	-	-	16567
		W	4377	1875	1581	-	-	1415	4175	1789	1508	-	-	1350	4053	1737	1464	-	-	1310
50	10.0	Q[Btu/h]	30978	26484	19863	-	-	14266	32325	27635	20726	-	-	14886	33464	28609	21457	-	-	15411
		W	4157	1767	1490	-	-	1363	4003	1702	1435	-	-	[illegible]	3849	1637	1380	-	-	1262
47	7.2	Q[Btu/h]	28707	25505	19129	-	-	13145	30003	26656	19992	-	-	13738	[illegible]1099	27630	20722	-	-	14240
		W	3975	1751	1476	-	-	1324	3793	1670	1408	-	-	[illegible]	3647	1606	1354	-	-	1214

Application Note 1036: Applying MXZ-C Multi-Zone Systems

Load Calculations

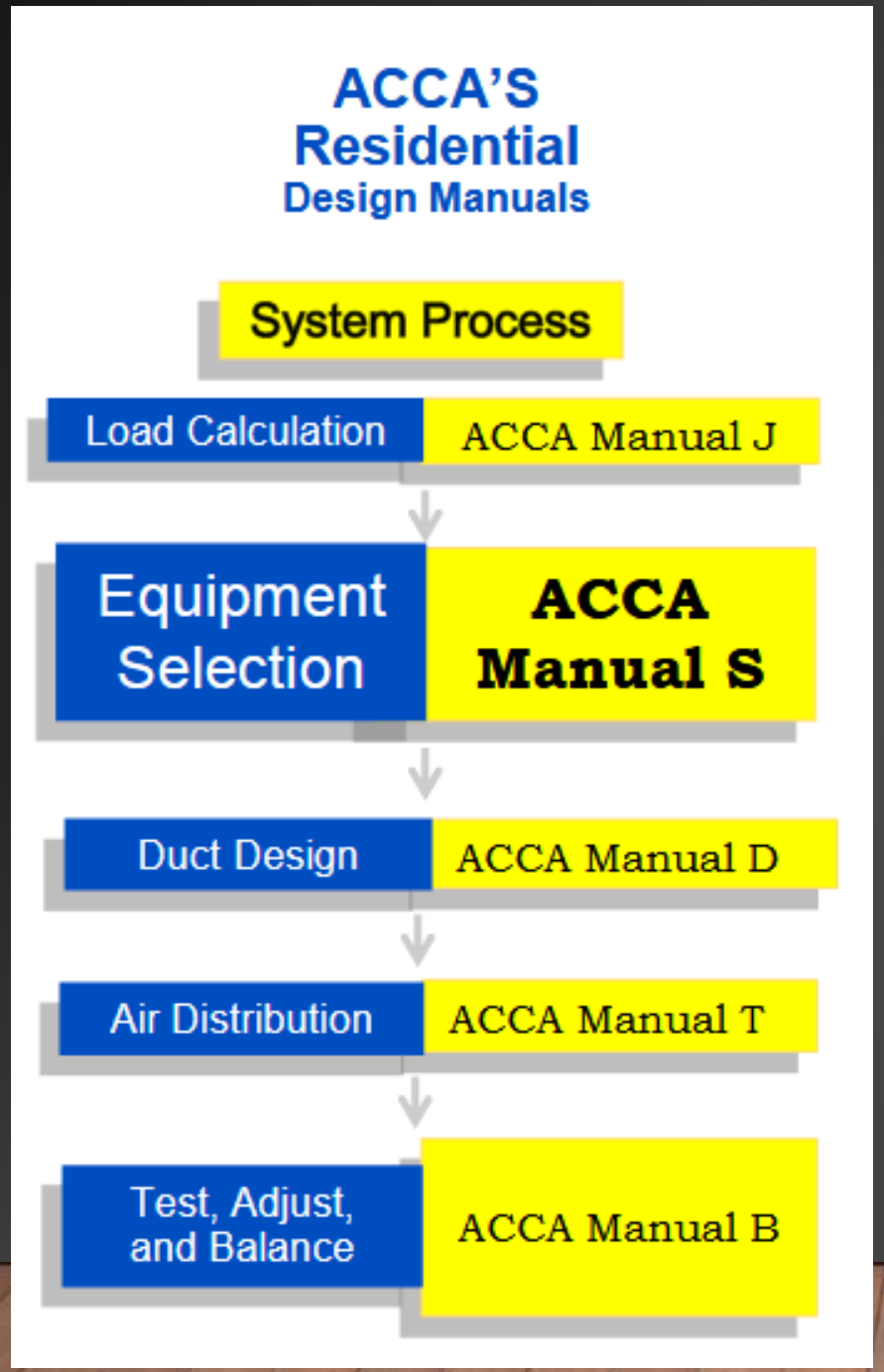
Heating and cooling systems in homes are commonly oversized which increases installation costs, wastes energy, and reduces comfort and moisture control. The best method for zoned systems is room-by-room load calculations to assure the proper indoor unit size is selected. Properly sized equipment will last longer, provide greater comfort, and save the homeowner money. This will in turn provide the homeowner with a higher level of satisfaction with the equipment and the installing contractor.

Properly sizing equipment is not just isolated to residential applications. Commercial buildings will also benefit from the proper sizing of equipment. Make sure load calculations follow the methodology approved in the Air Conditioning Contractors of America (ACCA) Manual J (or equivalent).

Passive Structures

Passive structures can pose a unique challenge because of the minimal heating and cooling loads. In many cases, room or zone heating and cooling loads can be as small as 500 – 1000 btuh or less. The key is to select, install and operate the equipment so it doesn't short cycle. The best passive building energy usage will occur when the system can modulate and operate for extended periods of time. Short cycling can also cause humidity control issues in humid climates. The following guidelines should be used when selecting and installing equipment in these buildings.

a. Properly size the equipment based on an accurate load calculation.
b. Do not use multiple indoor units if their capacity in each area will exceed the load in that space. In other words, one indoor unit mounted in a central location, that matches the structure heating and cooling loads will be better than two indoor units mounted in separate locations that are larger capacity than needed.
c. In many cases a 1 to 1 indoor/outdoor system may be a better choice than a multi-zone MXZ-C system or splitting the needed indoor zones with two smaller systems that better match the total.
d. High efficiency transfer fans are better to distribute the heating and cooling from one central location than having two oversized indoor units mounted in separate areas. Transfer fans work best when their inlet is installed as close to the operating indoor unit space as possible.



Right Sizing – Manual R

How can the system be optimized for shoulder season perfomance?

Principles of Manual R
Right Sizing for good year-round performance of a mini split system

Remember shoulder season is most of the year here in the Pacific Northwest

Choose smaller systems whenever possible

Avoid multi zone systems when possible (sometimes ok for single story homes)

Use single zone systems whenever possible

Single zone systems cost less
Using single zone systems usually costs about the same as multi zones

Do not be afraid of a little supplemental heat if it will get you to a better sized system strip or bathroom supplemental

Distribution is the real challenge in low load homes. Consider using compact ducted systems and/or carefully designed transfer fans.
Always do good duct design – Manual D

Sometimes in the Pacific NW a mini split in the great room plus electric resistance in the bedrooms is a great cost-effective solution

Smaller independent ODUs allow for simultaneous heating and cooling

Sometimes a central air handler connected to an energy efficient mini split is a great choice all ductwork should be in conditioned space.

Check your turndown ratios and think about shoulder season performance

Design one independent system per floor if possible – reduces stratification

Talk with design team and/or homeowner about comfort expectations and the pros and cons of different approaches

Use manufacturer design and sizing tools

Submittals are for ACCA specified testing temperatures Not for HVAC design

FUJITSU

How to Properly Size a Mini-Split

National surveys have determined that well over 50% of HVAC companies do not properly size central air cooling and heating systems the correct way. The largest and most common mistake is oversizing or under sizing a cooling system. While a Fujitsu inverter system is more forgiving and will ramp down when oversized to produce the correct BTU's to match the load of the space, who wants to pay for more equipment than is needed?

Fujitsu has devised a BTU calculator which is based on a Manual J, (which has been used as an industry standard for decades), minus the duct work. The BTU load calculator is the most effective tool made for the HVAC professional to assure home owners that they have correctly sized the Fujitsu equipment to the living space correctly. Using the Fujitsu Load Calculator can make you more competitive. Why oversize and pay more for equipment? Use Fujitsu's Load Calculator and win more jobs!

Here you can see our BTU Load Calculator that is available to you on the Fujitsu Portal.

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Design Tools

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Design Software

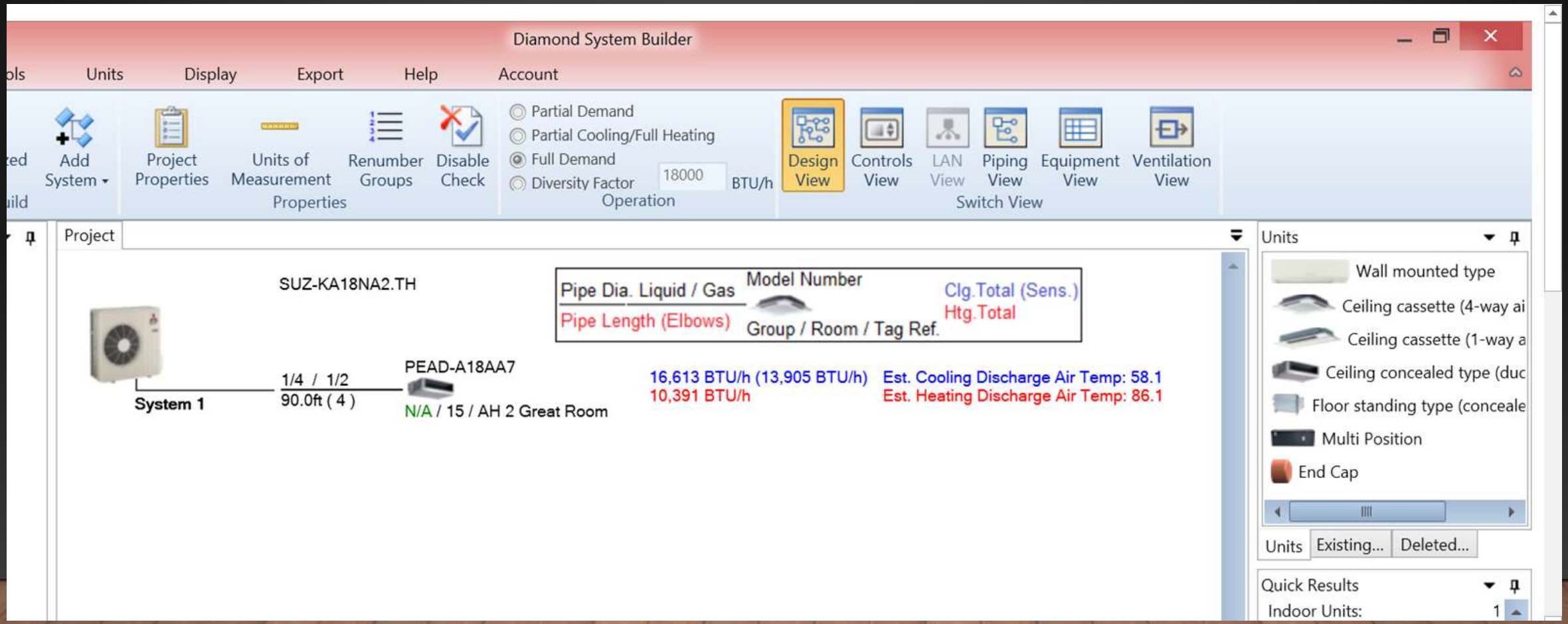
Designing and specifying the ideal HVAC system can be a time-and cost-intensive process. That's why we developed these user-friendly Windows® - based software programs; Daikin Tools®, EnergyAnalyzer® 3, and Acoustic Analyzer®.

Daikin Tools® Suite for Engineers selection software allows you to take full advantage of the engineered flexibility of Daikin Applied products and quickly size and select equipment. Once you have made all of your selections, with just a couple of clicks, you can generate complete specifications as Word documents in CSI specification format. In addition, the software creates dimensional drawings in DWG or DXF format, as well as detailed equipment schedules.

You can export your selections to your Daikin Applied Representative via e-mail for

Manufacturer Design tools give you precise heating/cooling outputs for your system at local design temps

Design tools account for things like line set lengths and altitude

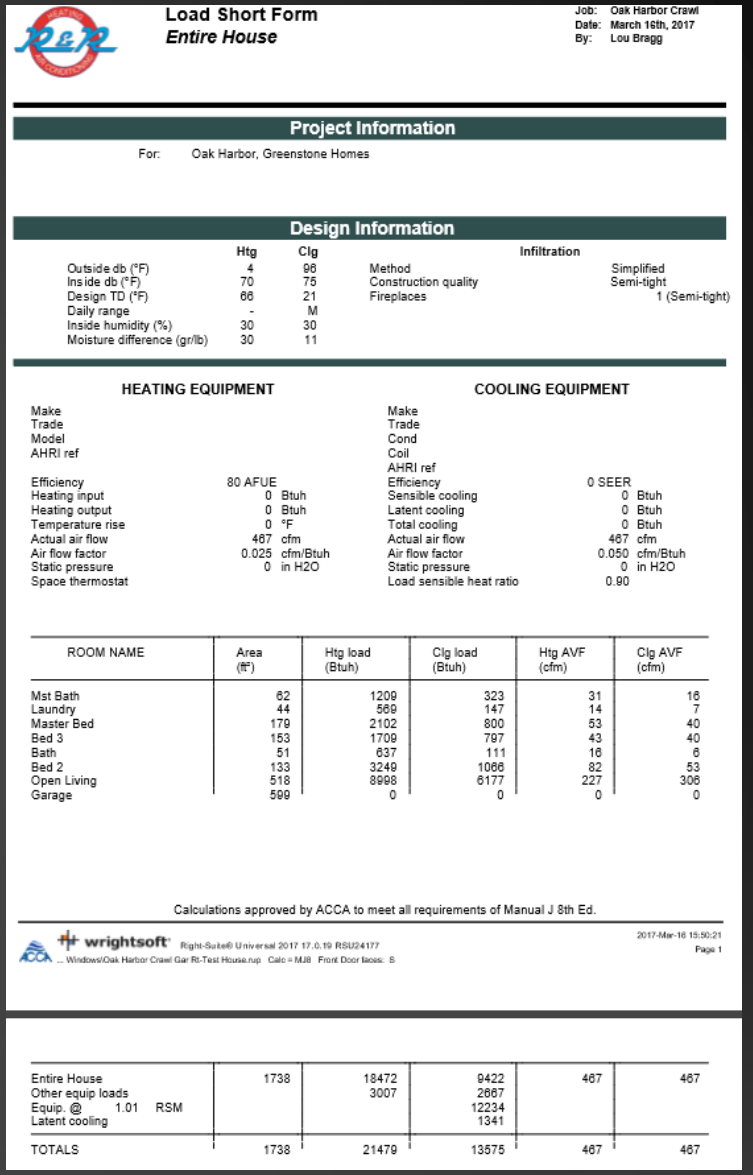


Room by room heating and cooling load calculation Manual J

Heating load 21,479 BTU

Cooling load 13,875 BTU

Bedroom 3 only 1,709 BTU



Load Short Form
Entire House

Job: Oak Harbor Crawl
Date: March 16th, 2017
By: Lou Bragg

Project Information

For: Oak Harbor, Greenstone Homes

Design Information

	Htg	Clg
Outside db (°F)	4	96
Inside db (°F)	70	75
Design TD (°F)	66	21
Daily range	-	M
Inside humidity (%)	30	30
Moisture difference (gr/lb)	30	11

Infiltration	
Method	Simplified
Construction quality	Semi-tight
Fireplaces	1 (Semi-tight)

HEATING EQUIPMENT

Make		
Trade		
Model		
AHRI ref		
Efficiency	80 AFUE	
Heating input	0	Btuh
Heating output	0	Btuh
Temperature rise	0	°F
Actual air flow	467	cfm
Air flow factor	0.025	cfm/Btuh
Static pressure	0	in H2O
Space thermostat		

COOLING EQUIPMENT

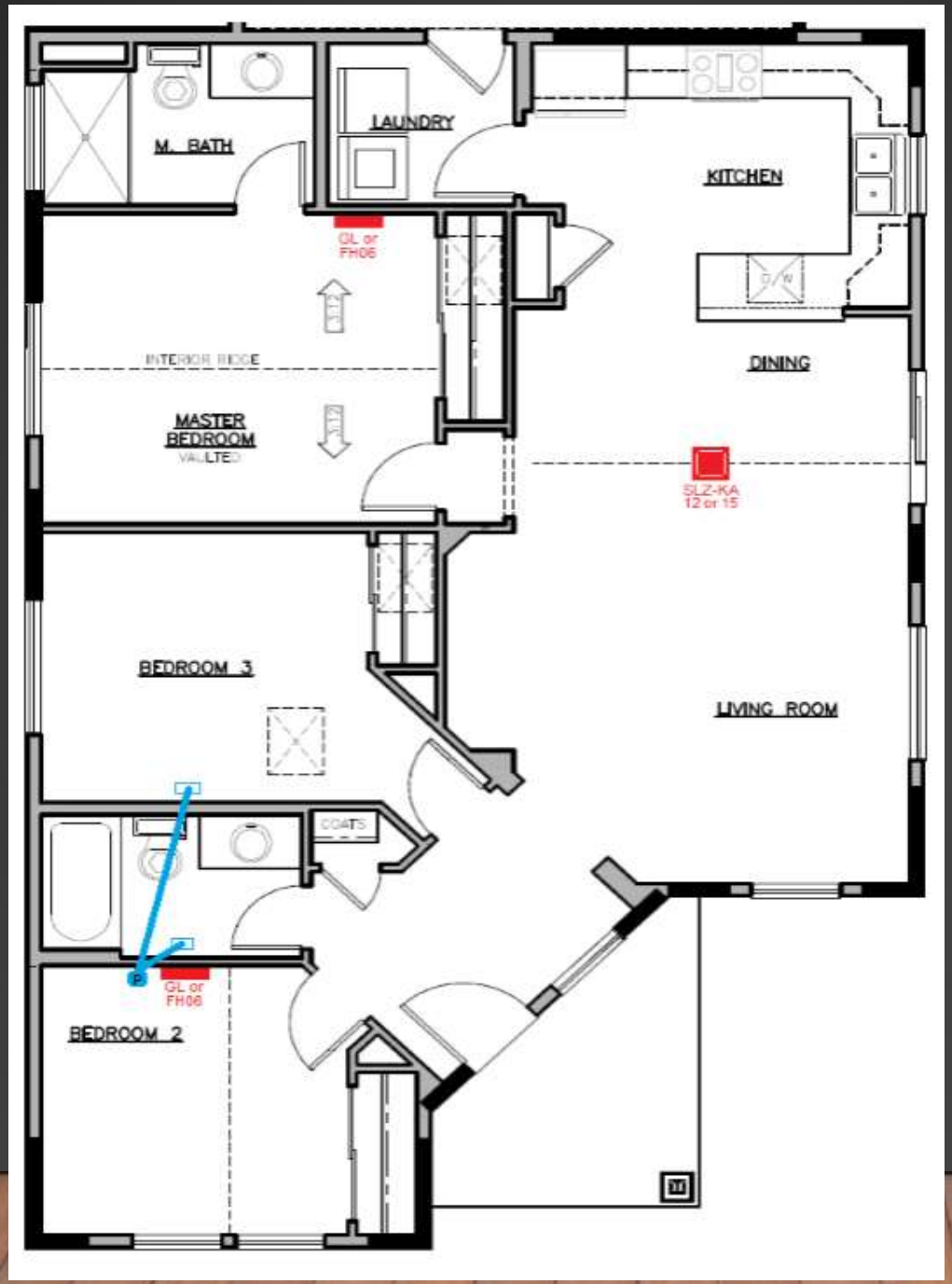
Make		
Trade		
Cond		
Coil		
AHRI ref		
Efficiency	0 SEER	
Sensible cooling	0	Btuh
Latent cooling	0	Btuh
Total cooling	0	Btuh
Actual air flow	467	cfm
Air flow factor	0.050	cfm/Btuh
Static pressure	0	in H2O
Load sensible heat ratio	0.90	

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
Mst Bath	62	1209	323	31	16
Laundry	44	569	147	14	7
Master Bed	179	2102	800	53	40
Bed 3	153	1709	797	43	40
Bath	51	637	111	16	6
Bed 2	133	3249	1066	82	53
Open Living	518	8998	6177	227	306
Garage	599	0	0	0	0

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

wrightsoft Right-Suite® Universal 2017 17.0.19 RSU24177
... Windows\Oak Harbor Crawl Gar Rt-Test House.rup Calc = MJ8 Front Door faces: S
2017-Mar-16 15:50:21
Page 1

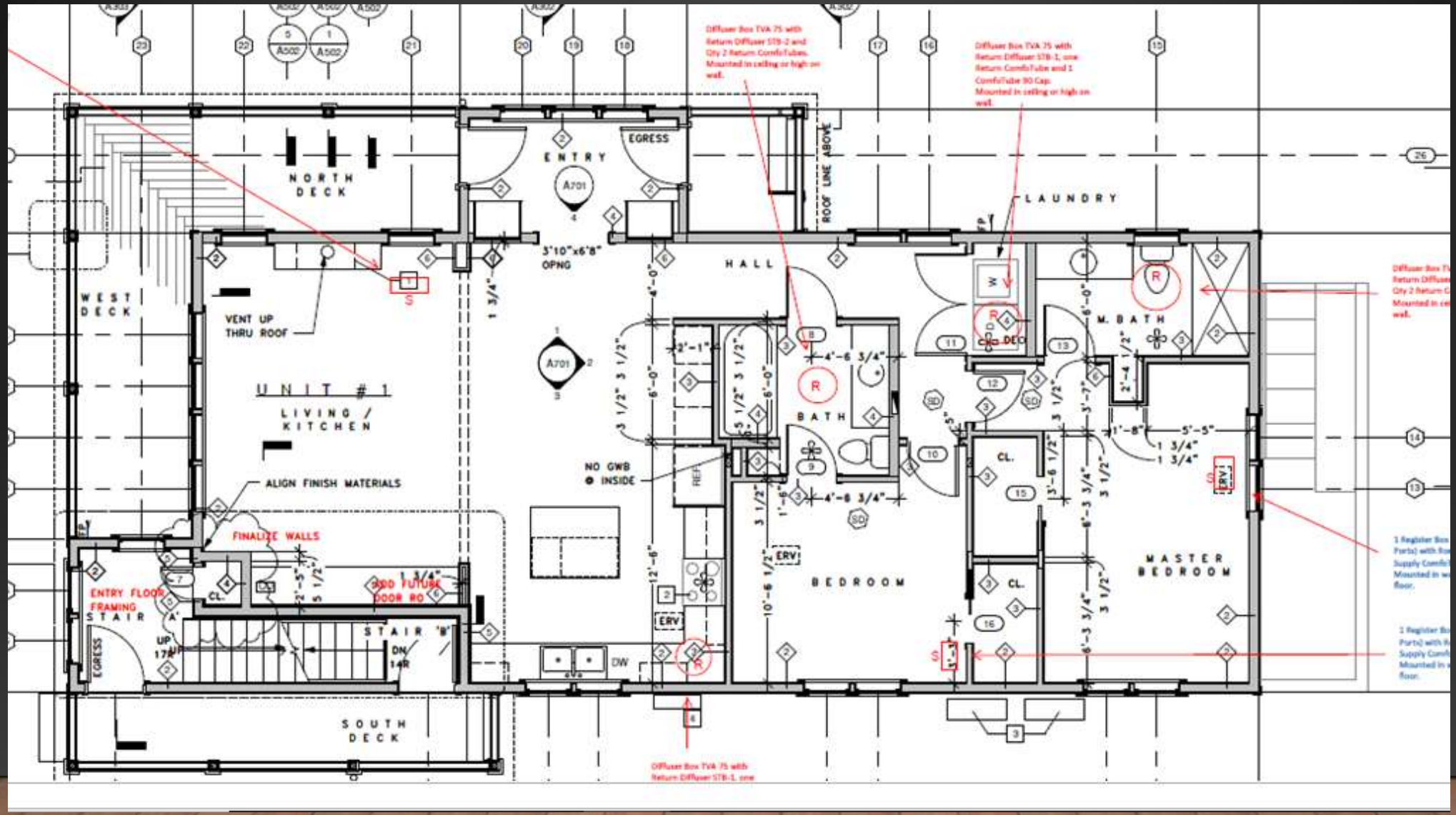
Entire House	1738	18472	9422	467	467
Other equip loads		3007	2667		
Equip. @ 1.01 RSM			12234		
Latent cooling			1341		
TOTALS	1738	21479	13575	467	467


M. BATH
LAUNDRY
KITCHEN
GL or FH06
INTERIOR RIDGE
DINING
MASTER BEDROOM
VAULTED
SLZ-KA 12 or 15
BEDROOM 3
LIVING ROOM
COATS
GL or FH06
BEDROOM 2


James Morgan


James Morgan

Bainbridge Net Zero Duplex



Heating input	0 Btuh	Sensible cooling	0 Btuh
Heating output	0 Btuh	Latent cooling	0 Btuh
Temperature rise	0 °F	Total cooling	0 Btuh
Actual air flow	640 cfm	Actual air flow	640 cfm
Air flow factor	0.025 cfm/Btuh	Air flow factor	0.040 cfm/Btuh
Static pressure	0 in H2O	Static pressure	0 in H2O
Space thermostat		Load sensible heat ratio	0.97

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
Upper	1382	11287	10212	286	410
Lower	1265	13955	10545	354	423
Entire House	2647	25242	15948	640	640
Other equip loads		0	0		
Equip. @ 0.87 RSM			13811		
Latent cooling			547		
TOTALS	2647	25242	14358	640	640

Version 1 – Single zone 12k Btu in Great Room + electric resistance in bedrooms

Developer decides he wants A/C in both bedrooms – because 13,600 Btu of cooling in the great room just is not enough in an apartment that only has <11,000 of total cooling load

Version 2 – Single zone 6 or 9k Btu in Great Room plus single zone 9k with horizontal ducted serving both bedrooms. Developer likes because it gives each apartment some redundancy

Discussion between builder and HVAC contractor – HVAC contractor does not want to install horizontal Ducted units (he did a bunch of them in another big multi family development on Bainbridge – he knows how). HVAC Contractor prefers multi zone systems with heads.

Had discussion with developer and shared engineering manual on multi zone turndown ratios for low load homes vs single zone systems.

Had discussion with HVAC contractor about pros and cons of single zone systems vs multi zone systems for low load homes – he seemed to get it at the time

M-Series | **SUBMITTAL DATA: MXZ-3C24NAHZ2**
MULTI-INDOOR INVERTER HEAT-PUMP SYSTEM | MITSUBISHI ELECTRIC

Job Name:
System Reference: Date:

Outdoor Unit: MXZ-3C24NAHZ2

ACCESSORIES
The outdoor unit is delivered with the base pan heater factory installed.
- ☐ Airflow Guide (PAC-SH96SG-E)
- ☐ 3/8" x 1/2" Port Adapter (MAC-A454JP-E)
- ☐ 1/2" x 3/8" Port Adapter (MAC-A455JP-E)
- ☐ 1/2" x 5/8" Port Adapter (MAC-A456JP-E)
- ☐ M-NET Adapter (PAC-IF01MNT-E)

(For data on specific indoor units, see the MXZ-C Technical and Service Manual.)

Specifications			Model Name
Unit Type			MXZ-3C24NAHZ2
Cooling* (Non-ducted / Ducted)	Rated Capacity	Btu/h	22,000 / 23,600
	Capacity Range	Btu/h	12,600 - 23,600
	Rated Total Input	W	1,630 / 2,360
Heating at 47°F* (Non-ducted / Ducted)	Rated Capacity	Btu/h	[illegible],000 / 24,600
	Capacity Range	Btu/h	11,400 - 30,600
	Rated Total Input	W	[illegible]
Heating at 17°F* (Non-ducted/Ducted)	Rated Capacity	Btu/h	14,000 / 14,000
	Maximum Capacity	Btu/h	25,000 / 24,600

Approximately 45-60%

One zone calling

Multiple zone calling

MXZ-3C24NAHZ2
2) HEATING

Rated Q(Btu/h): 25000 W: 1725
Max. Q(Btu/h): 30600 W: 4540

Indoor D.B. / Outdoor W.B. (°F)	(°C)		80°F/26.7°C Max.	Rated	75%	50%	25%	Min.	70°F / 21.1°C Max.	Rated	75%	50%	25%	Min.	60°F/15.6°C Max.	Rated	75%	50%	25%	Min.
65	18.3	Q[Btu/h]	38201	31380	23535	-	-	17806	39602	32531	24398	-	-	18459	40788	33505	25129	-	-	19011
		W	4804	2030	1712	-	-	1512	4625	1954	1648	-	-	1456	4490	1898	1600	-	-	1413
60	15.6	Q[Btu/h]	35737	29748	22311	-	-	16600	37120	30899	23174	-	-	17242	38290	31873	23905	-	-	17785
		W	4569	1966	1657	-	-	1457	4398	1892	1595	-	-	1403	4270	1837	1549	-	-	1362
55	12.8	Q[Btu/h]	33297	28116	21087	-	-	15402	34661	29267	21950	-	-	16033	35814	30241	22681	-	-	16567
		W	4377	1875	1581	-	-	1415	4175	1789	1508	-	-	1350	4053	1737	1464	-	-	1310
50	10.0	Q[Btu/h]	30978	26484	19863	-	-	14266	32325	27635	20726	-	-	14886	33464	28609	21457	-	-	15411
		W	4157	1767	1490	-	-	1363	4003	1702	1435	-	-	[illegible]	3849	1637	1380	-	-	1262
47	7.2	Q[Btu/h]	28707	25505	19129	-	-	13145	30003	26656	19992	-	-	13738	[illegible]1099	27630	20722	-	-	14240
		W	3975	1751	1476	-	-	1324	3793	1670	1408	-	-	[illegible]	3647	1606	1354	-	-	1214

Version 3

I propose the following after our discussions and plan review. This proposal includes both units.

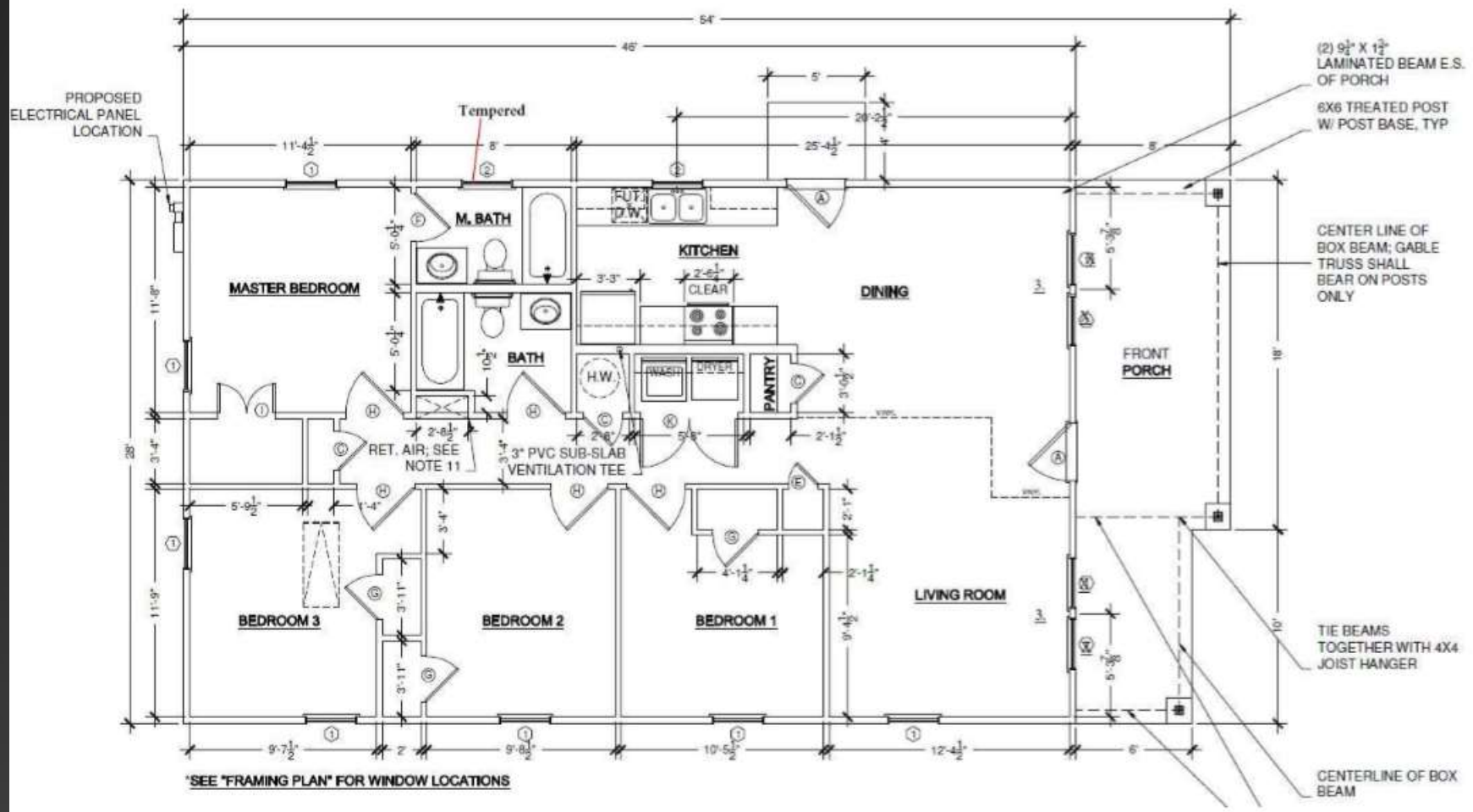
- Provide, design and install **(2) Mitsubishi MXZ-3C24NAHZ2 Hyper Heat** mini split heat pumps at properties listed above.
- Provide and install **(2) Mitsubishi MSZ-GL12NA** wall units in each Livingroom on West exterior wall above windows - as discussed.
- Provide and install **(2) Mitsubishi MSZ-GL09NA** wall units in each Master Bedroom on South exterior wall - as discussed.
- Provide and install **(2) Mitsubishi MSZ-GL06NA** wall units in each Extra Bed on West exterior wall - as discussed.
- The (2) outdoor unit will set on concrete pads – as discussed
- Lines will run down inside of building – as discussed
- 1-year labor, 12-year parts & 12-year compressor included.

Nominal system size is double actual heating load

Minimum heat capacity at 47F is 11,400 Btu – approximately 102 % of Upper Unit and 85% of lower unit

Minimum cooling output is 12,600 Btu – 120% of cooling load

York County Habitat - Dupont Plan



Dupont Load Calculation

Project Report

General Project Information

Project Title:	Habatit For Humanity
Designed By:	Benny Etter
Project Date:	Wednesday, March 16, 2016
Client Name:	Habatit For Humanity
Client Address:	341 Walnut St
Client City:	Rock Hill SC
Company Name:	Airtek Of York County
Company Representative:	Benny Etter
Company Address:	2366 Anderson Rd
Company City:	Rock Hill SC 29704

Design Data

Reference City:		Rock Hill, South Carolina
Building Orientation:		Front door faces North
Daily Temperature Range:		Medium
Latitude:	34	Degrees
Elevation:	470	ft.
Altitude Factor:	0.983	
Elevation Sensible Adj. Factor:	1.000	
Elevation Total Adj. Factor:	1.000	
Elevation Heating Adj. Factor:	1.000	
Elevation Heating Adj. Factor:	1.000	

	Outdoor Dry Bulb	Outdoor Wet Bulb	Outdoor Rel.Hum	Indoor Rel.Hum	Indoor Dry Bulb	Grains Difference
Winter:	23	21.39	80%	n/a	70	n/a
Summer:	94	74	40%	50%	75	31

Check Figures

Total Building Supply CFM:	708	CFM Per Square ft.:	0.593
Square ft. of Room Area:	1,195	Square ft. Per Ton:	821
Volume (ft³) of Cond. Space:	9,600		

Building Loads

Total Heating Required Including Ventilation Air:	15,802 Btuh	15.802	MBH
Total Sensible Gain:	15,315 Btuh	88	%
Total Latent Gain:	2,153 Btuh	12	%
Total Cooling Required Including Ventilation Air:	17,468 Btuh	1.46	Tons (Based On Sensible + Latent)

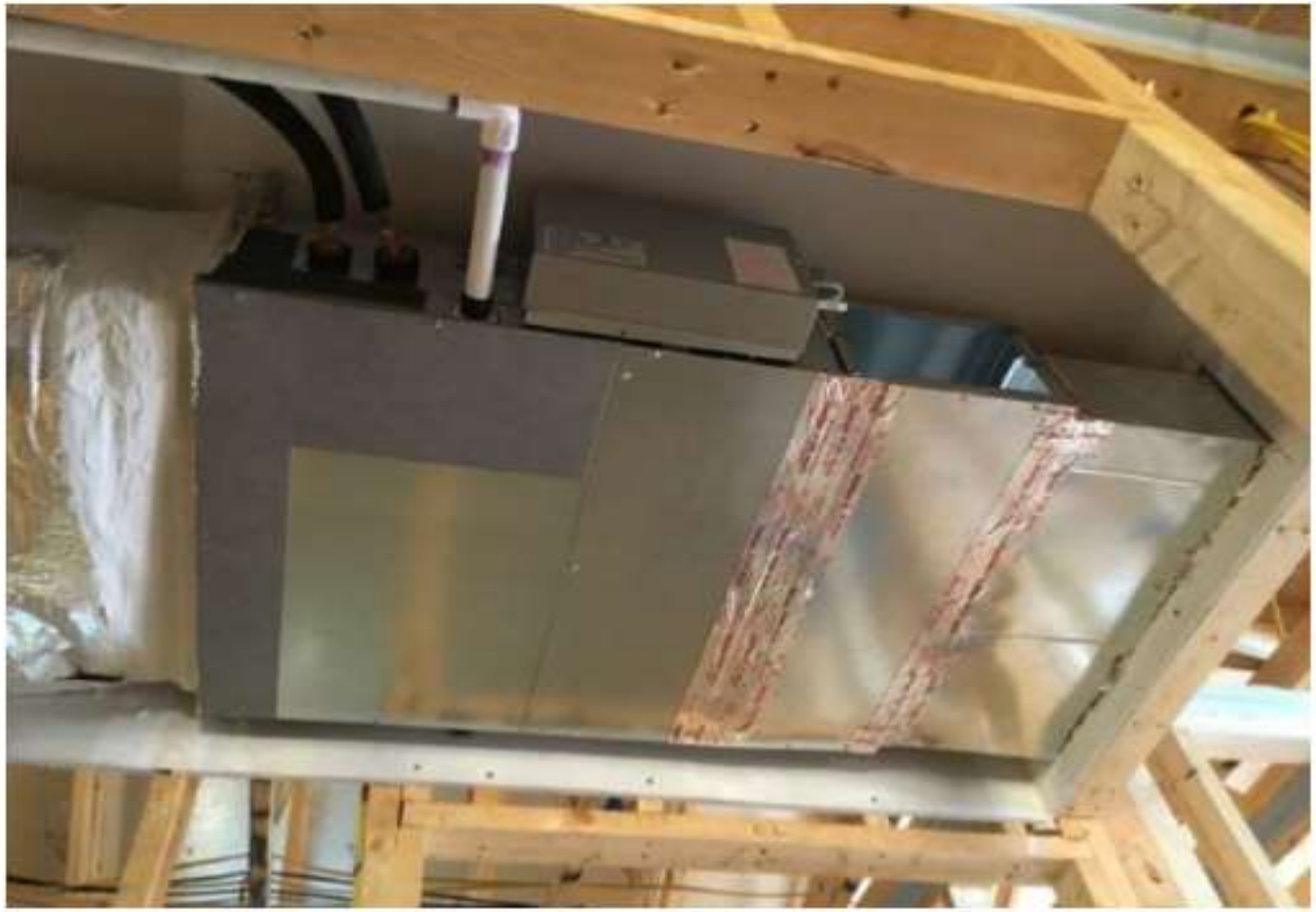
Mitsubishi Equipment Selection

- 9,000 Btu MSZ for Great Room
- 9,000 Btu SEZ for Bedrooms

Mitsubishi System Design

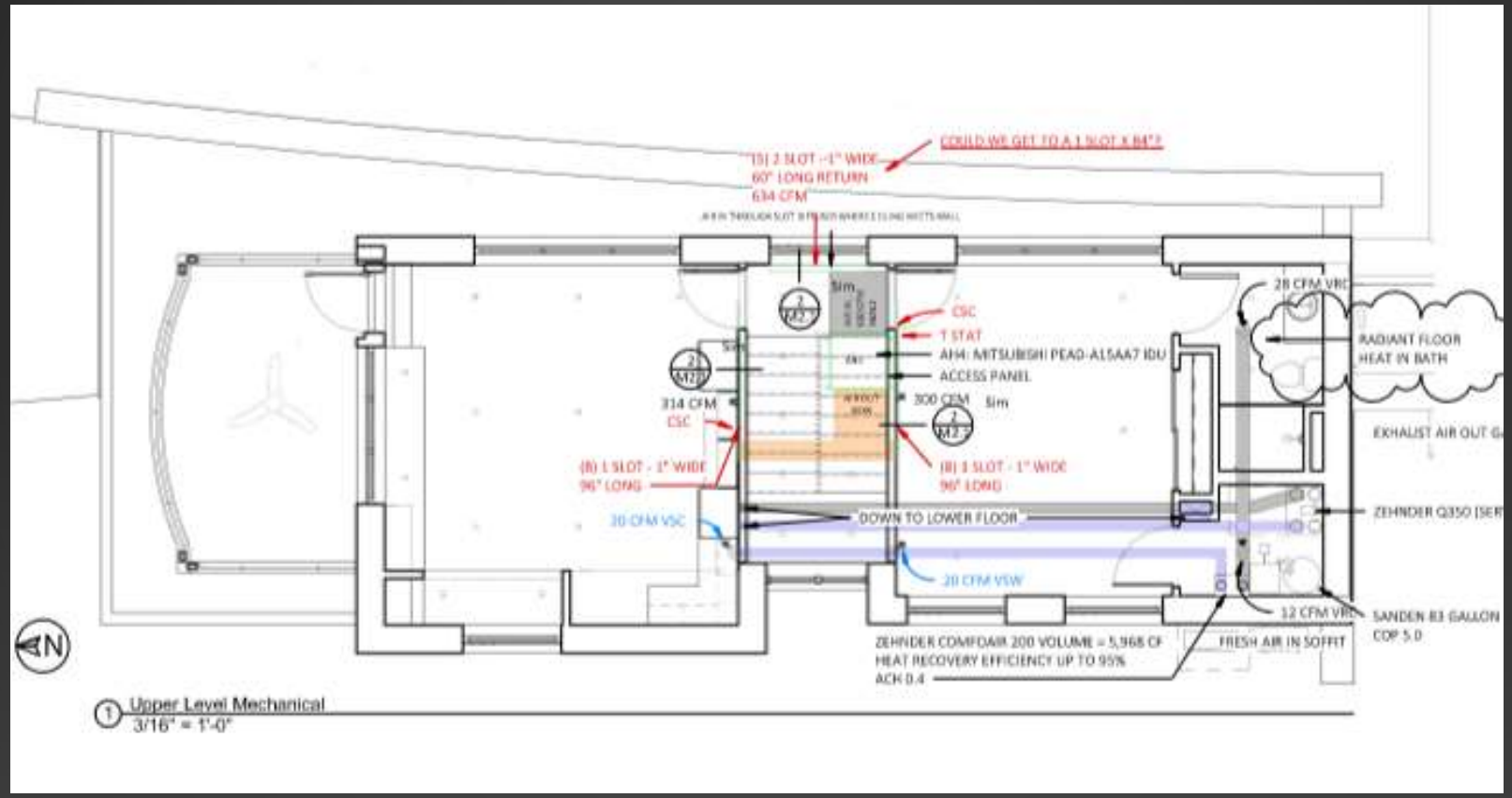
SEZ in Dropped Hallway Chase

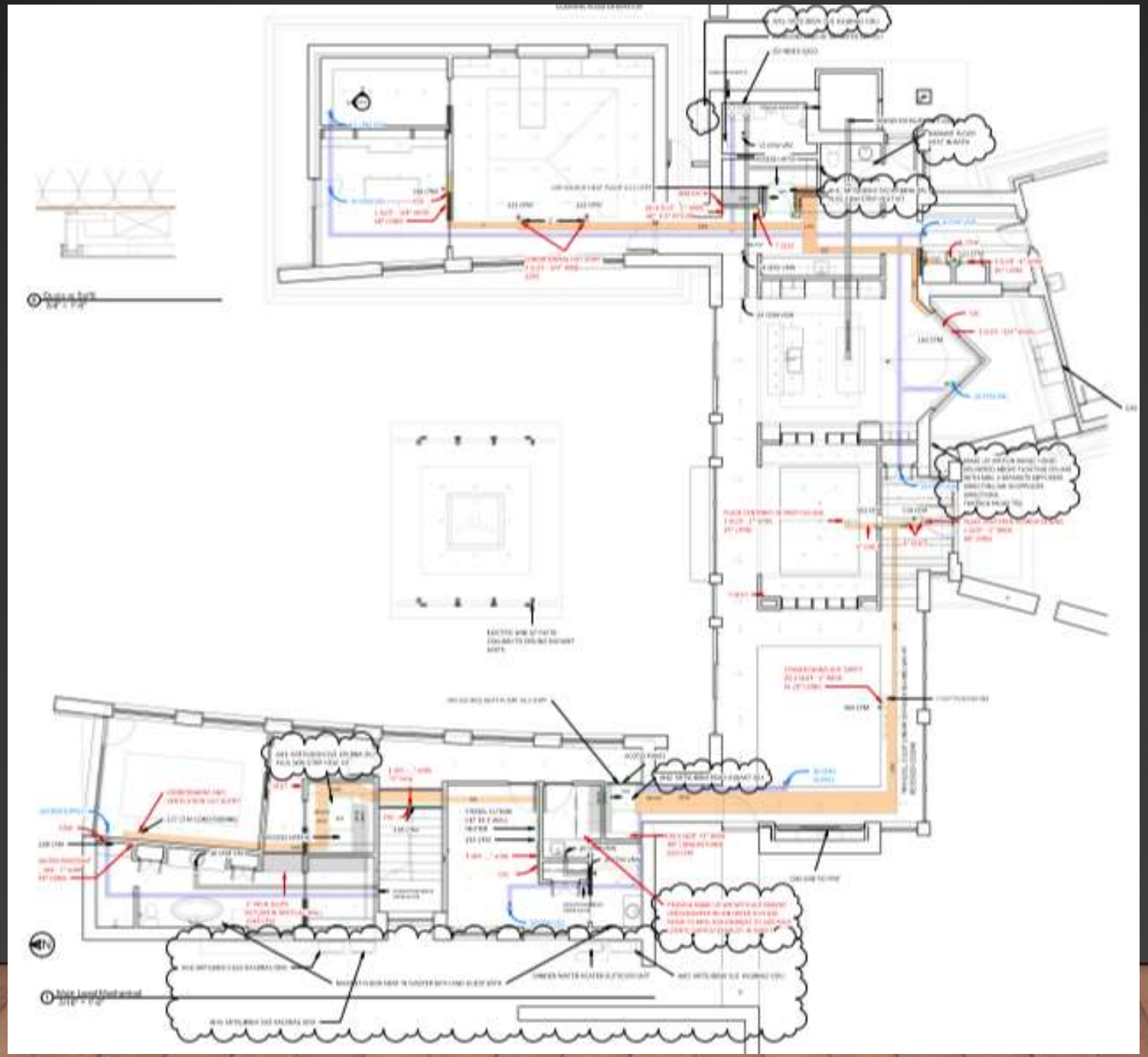
SEZ with filter box



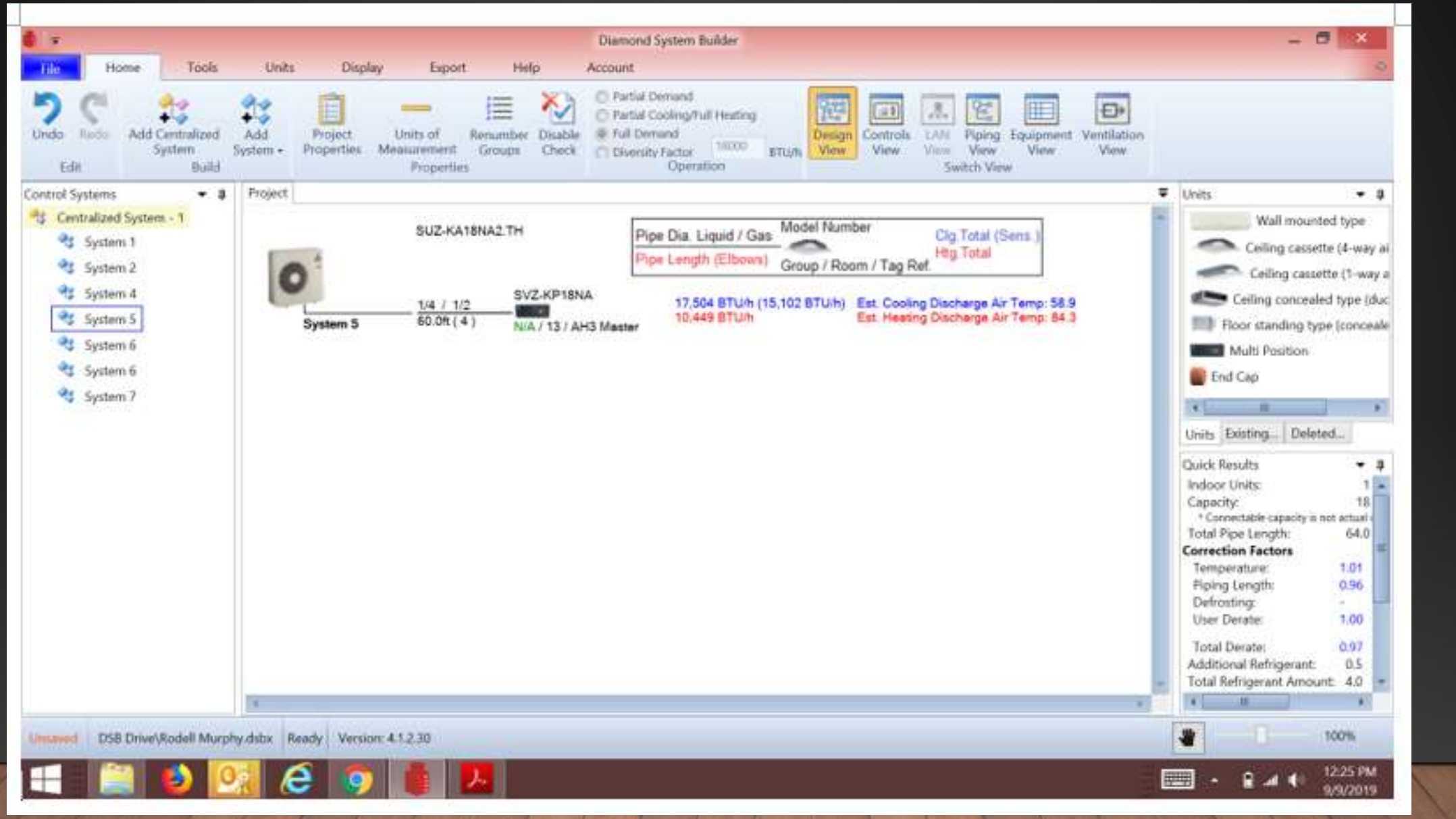
Indoor Units

Eastern WA 5,000 s.f. high end home near passive design





		Winter design temp	Summer design temp					
		4F	96F					
		Cooling load from Man J	Cooling delivered from DSB	Heating load from Man J	Heating delivered from DSB (excluding strip heat)	IDU	ODU	
Main floor	AH 3 (Master, Bed 1, etc)	18,612	17504	10037	10449	SVZ 18 + 3 kw strip heat	SUZ18	
						Min. capacity of SVZ 18 @47F is 8300 Btu. Min. capacity of SVZ 24 @47F is 14,600 Btu. Per Submittals.		
	AH 2 (great room, dining, entr	12,747	17504	10589	10449	PEAD 18	SUZ 18	
	AH 1 (kitchen, craft rooms)	13,932	17504	15014	10449	SVZ18 + 3 KW strip	SUZ 18	Min. capacity of SVZ 18 @47F is 8300 Btu. Min. capacity of SVZ 24 @47F is 14,600 Btu. Per Submittals.
Upstairs	AH 4 (upper bed 1 & 2, upper bath)	11583	13387	5931	9232	PEAD15-AA7	SUZ-KA15	
						sized for cooling and zoned separetely for stack effect upstairs		
	Load total vs DSB	56,874	65,899	41,571	40,579			
					+ 6KW strip heat on 2 air handlers			


Diamond System Builder
File
Home
Tools
Units
Display
Export
Help
Account
Undo
Redo
Edit
Add Centralized System
Add System
Build
Project Properties
Units of Measurement
Renumber Groups
Disable Check
Properties
Partial Demand
Partial Cooling/Full Heating
Full Demand
Diversity Factor
BTU/h
Operation
Design View
Controls View
LAN View
Piping View
Equipment View
Ventilation View
Switch View
Control Systems
Centralized System - 1
System 1
System 2
System 4
System 5
System 6
System 6
System 7
Project
SUZ-KA18NA2.TH
Pipe Dia. Liquid / Gas
Pipe Length (Elbows)
Model Number
Group / Room / Tag Ref.
Clg.Total (Sens.)
Htg.Total
SVZ-KP18NA
1/4 / 1/2
60.0ft (4)
System 5
N/A / 13 / AH3 Master
17,504 BTU/h (15,102 BTU/h)
10,449 BTU/h
Est. Cooling Discharge Air Temp: 58.9
Est. Heating Discharge Air Temp: 84.3
Units
Wall mounted type
Ceiling cassette (4-way ai
Ceiling cassette (1-way a
Ceiling concealed type (duc
Floor standing type (conceale
Multi Position
End Cap
Units
Existing...
Deleted...
Quick Results
Indoor Units: 1
Capacity: 18
* Connectable capacity is not actual
Total Pipe Length: 64.0
Correction Factors
Temperature: 1.01
Piping Length: 0.96
Defrosting: -
User Derate: 1.00
Total Derate: 0.97
Additional Refrigerant: 0.5
Total Refrigerant Amount: 4.0
Unsaved
DSB Drive\Rodell Murphy.dsbx
Ready
Version: 4.1.2.30
100%
12:25 PM
9/9/2019

Green Canopy Homes:

- Builds Homes, Relationships, and Businesses that Help Regenerate Communities and Environments
- Started out with high efficiency gut remodels in 2009
- Transferred to all new construction in 2013
- Built over 150 homes in Seattle and Portland
  - Most new construction has been multi-story townhomes and rowhouse
- **Every single home** has used mini-splits as the primary source of heating and cooling

Projects:

Project Stats:

- 8 Units (4 sets of 2 attached townhomes)
- 3 stories + Penthouse for rooftop deck access
- 3 bedroom / 2 baths
- Avg 1,740-ish Square Feet (1,725 - 1,769 sf)
- 4 Star Built Green

Project Stats:

- 16,080 Conditioned Square Feet
- R20 Under Slab / R5 Slab Edge
- R24 Walls (Blown-In)
- R48 Vaulted Ceiling
- ACH50 – 1.36
- Design Heating Load – 14.2 kBtu/hr
- Cooling Load – 13.4 kBtu/h
- Total Modeled Energy Consumption: 11,869 kWh

Systems:

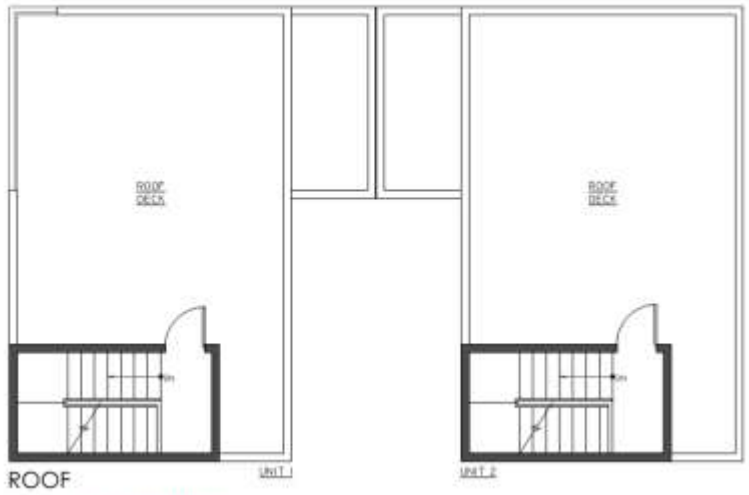
- Primary Heating/Cooling
  - Heat Pump Outdoor: MSZ - 3C24
  - Heat Pump Indoor:
    - MSZ-FH 15 (Main Floor)
    - MSZ-FH 09 (Master Bedroom)

- Supplementary Heating
  - Envi-Heaters 1,350 Btu (Minor Bedrooms)

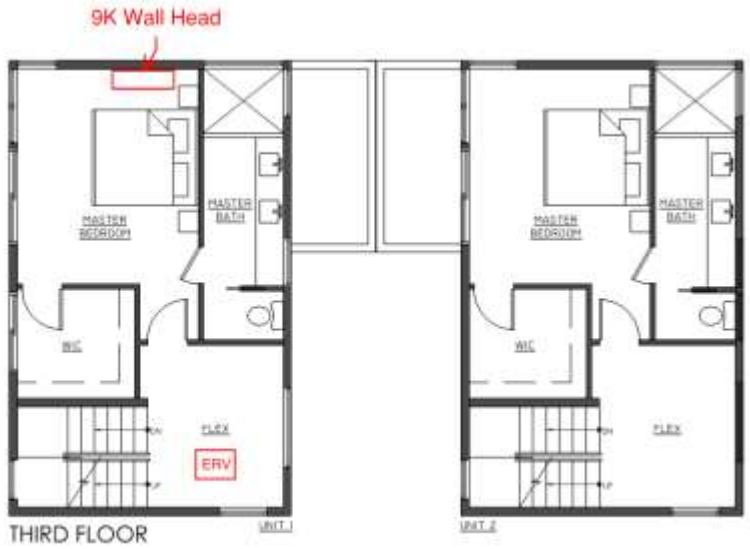
- Ventilation – 2x Spot ERV's (Main Floor, 3rd Floor)

Floorplan:


Wall Heater
Wall Heater
BEDROOM
BEDROOM
BEDROOM
FLEX
FLEX
BATH
BATH
LAUNDRY
LAUNDRY
UNIT 1
UNIT 2
SECOND FLOOR


ROOF DECK
ROOF DECK
UNIT 1
UNIT 2
ROOF


15K Wall Head
DINING
KITCHEN
KITCHEN
DINING
ENTRY
LIVING
ERV
LIVING
COVERED PORCH
COATS
COATS
ENTRY
UNIT 1
UNIT 2
FIRST FLOOR


9K Wall Head
MASTER BEDROOM
MASTER BATH
MASTER BEDROOM
MASTER BATH
WIC
WIC
FLEX
ERV
FLEX
UNIT 1
UNIT 2
THIRD FLOOR

Sense Energy Data:

Modeled Consumption:
11,869 kWh

Consumed from 5/1/19- 9/30/19:
5,331 kWh

Average Daily Consumption:
35 kWh

Average @ 365 Days:
12,775 kWh*