Central Ducted Split Heat Pump Upgrade

Photo Report

Installer:

Test Tech
Rocky Installations
River rock st, Richland, WA
5550005555
test@rmail.com

Installation Date: August 16, 2023

Installation Address: Test Street, Richland, North Carolina 99254

Building Number

A photo of the building showing the building number.

Timestamp: August 16, 2023 at 02:44 PM PDT

Geolocation: [46.2670,-119.3569](46.2670,-119.3569)

About the Report:

This report is intended to document:

1. The critical tests for evaluating the ductwork in a home to determine what, if any, duct repairs or upgrades are needed so that the upgrade to a heat pump yields the expected efficiency benefits.
2. The home’s heating and cooling loads.
3. The heat pump equipment selection.
4. The heat pump installation.

A successful central ducted split heat pump installation starts with well-sealed, insulated, and correctly sized ductwork, and careful equipment planning and selection. Proper installation and commissioning are paramount to ensuring maximum equipment efficiency and a long troublefree equipment life. The photo requirements in this document record the key steps to ensure success. It is strongly recommended a printed copy of this report be attached to the air handler as a record to help future home energy raters and HVAC techs.

About Atmospherically Vented Water Heaters

If there there are atmospherically vented appliances inside the home after the heat pump installation, a combustion safety test should have been performed to test for backdrafting. Please refer to the combustion safety documentation report if such a test was performed at this house.

Acronyms

ODU – Outdoor Unit
IDU – Outdoor Unit

Pre-Upgrade Tests

Ductwork – Photo

Photo of existing ductwork condition

Timestamp: August 16, 2023 at 02:45 PM PDT

Geolocation: 46.2669,-119.3572

Ductwork Comments: Ductwork Comment - Added

Static Pressure Test Results

Total external static pressure measurement: This measurement is akin to taking the blood pressure of a person. Having high blood pressure is an indicator of poor health. The same is true for a HVAC system. For an HVAC system, having a total external static pressure value of 0.5 i.w.c or less is good. The ducts can be repaired or upgraded to bring a high value down to a healthy value.

Pre-Upgrade Static Pressure Test – Photo

Photo of the manometer readout or screenshot from digital instrument app

Missing Photo

Airflow Test Results

In order for a heat pump to efficiently and effectively deliver the conditioned air to the house, the ducts need to be able to move enough air. This test uses the home's existing air handler to measure how much air the ducts can move. If they cannot move enough air, the ducts will need to be repaired or upgraded so that they can move enough air.

Pre-Upgrade Airflow Test Setup – Photo

Photo of the airflow test setup

Missing Photo

Pre-Upgrade Airflow Results – Photo

Photo of the manometer CFM or upload a screenshot of the instrument app

Missing Photo

Duck Leakage Test Results

Leaky ducts mean the conditioned air doesn't make it to the rooms where the conditioned air is needed. The worse kind of duct leakage is leakage to outside because that means the air you paid to conditioned is leaking outside the house. The duct leakage test measures how leaky the ducts are. Newly constructed homes have a duct leakage limit of 4 CFM25 per 100 ft^2 of conditioned floor area. In existing construction it is highly recommended that action be taken to reduce duct leakage if the duct leakage test finds the leakage rate to be greater than 12 CFM25 per 100 ft^2 of conditioned floor area.

Type Of Duct Leakage Test Performed: Total Leakage

CFM25 =24

Conditioned Floor Area (ft^2) = 1200

Duct CFM25 per 100 per ft^2 = 2.00

Planning

Proposed ODU Install Location – Photo

Photo of proposed ODU install location

Missing Photo

ODU Mounting Style: Ground Stand

Overhead Snow & Ice Protection: Awning/Cover

Manual J

Please see the PDF containing the Manual J report attached.

Manual J Notes or Comments: Notes on Manual-J

Equipment Selection

The selected heat pump's extended heating and cooling performance tables are shown below. These tables were used in concert with the ASHRAE heating and cooling design conditions, and Manual J load calculations to select the best equipment to fit the home's heating and cooling needs.

MFG's Heating Performance Table – Photo

The selected heat pump's extended heating performance table

Missing Photo

Aux Heat Lockout Above This Temperature (°F): 35

Compresser Lockout Below This Temperature (°F): 42

Dual Fuel Switch Over Temperature (°F): 35

MFG's cooling performance table – Photo

The selected heat pump's extended cooling performance table

Missing Photo

Ductwork Concluding Comments: comments on the pre-installation

Installation

ODU Nameplate – Photo

Missing Photo

IDU Nameplate – Photo

Missing Photo

ODU Circuit Breaker – Photo

Missing Photo

IDU Circuit Breaker – Photo

Missing Photo

Installation Tests

Nitrogen Pressure Test Setup – Photo

The test is conducted at 500 PSI or the manufacturer's recommended test pressure.

Missing Photo

Nitrogen Pressure Decay Test Results – Photo

A passing temperature-compensated nitrogen pressure decay test will show zero or almost zero pressure decay after 10 minutes. This means the system's connections have been tested to withstand the maximum operating pressures and there are no leaks in the system.

Missing Photo

Vacuum Decay Test Setup – Photo

A good vacuum decay test setup will have the micron gauge located as close to the equipment as possible. It will have an isolation valve in the setup so that the vacuum pump and vacuum hose can be isolated from the system during the decay measurement period.

Missing Photo

Vacuum Decay Test Results – Photo

A passing vacuum decay test is one where the system's vacuum does not rise above 500 microns in 10 minutes with the vacuum pump and vacuum hose isolated from the system. This indicates the system contains no moisture and is leak free.

Missing Photo

Refrigerant Adjustments

Refrigerant Adjustments (if applicable) – Photo

Photo of scale readout and calculations for refrigerant charge adjustment

Missing Photo

Additional Refrigerant Added
Feet of line set beyond factory charge = 12
Ounce of refrigerant per foot of line set = 12
Ounces of additional refrigerant = 144

Notes About Refrigerant Quantity Adjustments Or Weigh In: Test comments

Line Set Protection – Photo

The line set and line set to wall penetration should be protected from damage by UV, rain, and pests.

Missing Photo

Plenum Connections – Photo

The supply and return plenum connections to the air handler cabinet should be sealed, insulated, and have a vapor barrier.

Missing Photo

Post-Installation

Post-Install Airflow Test Setup – Photo

Missing Photo

Post-Install Airflow Test Results – Photo

Generally, a heat pump should move approximately 400 CFM per ton of heating/cooling capacity +/- 15%.

Missing Photo

Post-Install Static Pressure Test Setup – Photo

Missing Photo

Post-Install Static Pressure Test Results – Photo

Generally, an efficiently running system will have a total external static pressure of 0.5 i.w.c or less.
i.w.c stands of inches of water column which is the standard unit of measurement for this test.

Missing Photo

Thermostat Setting – Photo

Photo of thermostat setting for auxiliary heat lockout or dual fuel switch over temperature.

Missing Photo

Post-Installation Notes About Thermostat Settings: Test comments

PDF of Manual J - File: Form-101-Example-1-GFAC.pdf

THE HVAC DESIGN REVIEW FORM: Example 1:

Load Calculation: **Manual J**
Equipment Selection: **Furnace and Air Conditioner**

This example illustrates a permit application packet when the HVAC Contractor used the full Manual J procedure, and when the installed equipment is a gas furnace and an air conditioner. The circled numbers on HVAC Systems Design Review Form correspond to the description in the instructions and to the locations where the information can be found on the submitted attachments.

ACCA Air Conditioning Contractors of America

Residential Plans Examiner Review Form for HVAC System Design (Loads, Equipment, Ducts)

Form RPER 1.01 8 Mar 10

County, Town, Municipality, Jurisdiction
Header Information

Contractor: ABC Heating and Air Conditioning Company
Mechanical License #: MCL# 123456789
Building Plan #: Model P987654321, dated 1 June 2010
Home Address (Street or Lot#, Block, Subdivision): 123 Elm Street, Ames, Iowa

REQUIRED ATTACHMENTS[1]	ATTACHED
Manual J1 Form (and supporting worksheets):	Yes ☒ No ☐
or MJ1AE Form[2] (and supporting worksheets):	Yes ☐ No ☒
OEM performance data (heating, cooling, blower):	Yes ☒ No ☐
Manual D Friction Rate Worksheet:	Yes ☒ No ☐
Duct distribution system sketch:	Yes ☒ No ☐

HVAC LOAD CALCULATION (IRC M1401.3)

Design Conditions

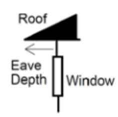
Winter Design Conditions
- Outdoor temperature (1): -6 °F
- Indoor temperature (2): 70 °F
- Total heat loss (13): 59,326 Btu

Summer Design Conditions
- Outdoor temperature (3): 90 °F
- Indoor temperature (4): 75 °F
- Grains difference (5): 38 (6) Gr @ 50 % Rh
- Sensible heat gain (15): 23,807 Btu
- Latent heat gain (16): 4,771 Btu
- Total heat gain (17): 28,578 Btu

Building Construction Information

Building
- Orientation (Front door faces) (7): North
  (North, East, West, South, Northeast, Northwest, Southeast, Southwest)
- Number of bedrooms (8): 3
- Conditioned floor area (9): 1,792 Sq Ft
- Number of occupants (10): 4

Windows
- Eave overhang depth (11): 2 Ft
- Internal shade (12): Blinds, light, 45 Angle (Blinds, drapes, etc)
- Number of skylights (13): 2



HVAC EQUIPMENT SELECTION (IRC M1401.3)

Heating Equipment Data
- Equipment type (18): Gas Furnace (Furnace, Heat pump, Boiler, etc.)
- Model (19): XYZ 080-14
- Heating output capacity (20): 64,000 Btu (Heat pumps - capacity at winter design outdoor conditions)
- Auxiliary heat output capacity (21): N/A Btu

Cooling Equipment Data
- Equipment type (22): Air Conditioner (Air Conditioner, Heat pump, etc)
- Model (23): XYZ 030 Condenser 030 Coil
- Sensible cooling capacity (24): 21,400 Btu
- Latent cooling capacity (25): 7,900 Btu
- Total cooling capacity (26): 29,300 Btu

Blower Data
- Heating CFM (27): 1,185 CFM
- Cooling CFM (28): 1,000 CFM

HVAC DUCT DISTRIBUTION SYSTEM DESIGN (IRC M1601.1)

- Design airflow (29): 1,117 CFM
- External Static Pressure (ESP) (30): 0.75 IWC
- Component Pressure Losses (CPL) (31): 0.40 IWC
- **Available Static Pressure (ASP)** (32): 0.35 IWC
  ASP = ESP - CPL
- Longest supply duct (33): 278 Ft
- Longest return duct (34): 110 Ft
- **Total Effective Length (TEL)** (35): 388 Ft
- **Friction Rate:** (36): 0.09 IWC
  Friction Rate = (ASP × 100) ÷ TEL

Duct Materials Used (circle)
Trunk Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify)
Sheet metal (insulated (37)
Branch Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify)
Flex duct (insulated R- (38)

I declare the load calculation, equipment selection, and duct system design were rigorously performed based on the building plan listed above, I understand the claims made on these forms will be subject to review and verification.

Contractor's Printed Name: Bartholomew J. Simpson
Date: 1 April 2010
Contractor's Signature: Bart Simpson

Reserved for use by County, Town, Municipality, or Authority having jurisdiction.

[1] The AHJ shall have the discretion to accept Required Attachments printed from approved ACCA software vendors, see list on page 2 of instructions.
[2] If abridged version of Manual J is used for load calculation, then verify residence meets requirements, see Abridged Edition Checklist on page 13 of instructions.

Figure 1: Sample Completed HVAC System Design Review Form – Manual J/Gas Furnace & A/C

Part I: Manual J – Forms used for Load Calculations

Worksheet A Location and Design Conditions			
State: Iowa	**City:** Ames	**Elevation** = 955 Ft	**Latitude** = 42 Degrees North
Indoor Conditions, Heating: **DB** = 70 °F (2) 20%		**Indoor Conditions, Cooling:** **DB** = 75 °F (4)	**RH** = 50% (6)
Table 1 Conditions **99% DB** = -6 °F (1)	**1% DB** = 90 °F (3)	**Grains Difference** = 38 (5)	**Daily Range** = Medium
Design Temperature Differences	**HTD** = 70 - (-6) = 76 °F		**CTD** = 90 - 75 = 15 °F

Form J1

1	**Name of Room** Smith Residence						**Entire House**							
2	**Running Feet of Exposed Wall**						2 x (56 + 32) = 176							
3	**Ceiling Height (Ft) and Gross Wall Area (SqFt)**						8 & 10	1,408 + 696 = 2,104						
4	**Room Dimensions (Ft) and Floor Plan Area (SqFt)**						56 x 32	(9) 1,792						
5	**Ceiling Slope (Deg.) and Gross Ceiling Area (SqFt)**						0	1,792						
Type of Exposure			**Const.. Number**	**Panel Faces**	**HTM Htg.**	**HTM Clg.**	**Area or Length**	**Btuh Heating**	**Btuh S-Clg.**	**Btuh L-Clg.**	**Area or Length**	**Btuh Heating**	**Btuh S-Clg.**	**Btuh L-Clg.**
6a	**Windows and Glass Doors**	a	Unit A = 1G	N	37.24	11.09	43.75	1,629	485					
		b	Unit A = 1G	E / W	37.24	37.10	43.75	1,629	1,623					
		c	Unit B = 1G	N	33.44	11.16	14.00	468	156					
		d	Unit B = 1G	S	33.44	15.81	28.00	936	443					
		e	Unit C = 1G	W	41.04	39.63	58.00	2,380	2,299					
		f	Unit D = 1G	S	41.04	17.30	47.13	1,934	815					
		g	Unit E = 1G	N	31.92	12.58	10.31	329	130					
		h	Unit E = 1G	S	31.92	22.88	10.31	329	236					
		i	(7)											
		j												
6b	**Skylights**	a	Unit 1 = 8G	N	98.42	100.75	8.00	787	806					
		b	Unit 2 = 8G	S	68.97	92.94	32.00	2,207	2,974					
		c												
7	**Wood and Metal Doors**	a	11N		26.60	9.1	21.0	559	191					
		b	11N		26.60	9.1	21.0	559	191					
		c												
8	**Above Grade Walls and Partitions**	a	14A-8		6.92	1.16	1,207	8,347	1,395					
		b	15A-4sffc wall		10.41	2.10	600	6,246	1,257					
		c	15A-4sffc part		0.90	0.18	96	87	17					
		d												
		e												
		f												
		g												
9	**Below Grade Walls**	a	15A-4sffc-4		6.00		284	1,705						
		b	15A-4ffc-8		4.71		224	1,055						
		c												
10	**Ceilings**	a	16B-30ad		2.43	1.60	1,752	4,261	2,803					
		b												
		c												
11	**Floors**	a	19B-osp		2.43	0.48	736	1,788	352					
		b	22B-5ph		44.76		64	2,865						
		c	21A-32		1.52		544	827						
		d												
12	**Infiltration**		**Heating Load (Btuh)**		Effect ACH	0.408	**WAR** 1.00	11,237			**WAR**			
			Sensible Load (Btuh)			0.194			1,054					
			Latent Load (Btuh)							1,651				
13	**Internal**	a	**Occupants at 230 and 200 Btuh**			(10)	4		920	800				
		b	**Scenario Number**		1				2,400					
		c	**Default Adjustments**		None									
		d	**Custom Appliances**		NA									
		e	**Plants**		None									
14	**Subtotals**		Sum lines 5 through 12					52,164	20,548	2,451				
15	**Duct Loads**		**EHLF & ESGF**		0.049	0.026		2,561	530					
			ELG							565				
16	**Ventilation Loads**		Vent Cfm	70	E Cfm	70		1,987	459	1,755				
17	**Winter Humidification Load**				Gal / Day	7.1		2,614						
18	**Piping Load**													
19	**Blower Heat**								1,707					
20	**AED Excursion & Latent Moisture Migration Load**							(14)	(15)	(16)				
21	**Total Load**		Sum Lines 13 Through 19					59,326	23,807	4,771				

Figure 2: J1 Worksheets A and Form J1

Part II: Manual S – Equipment Expanded Performance Data

XYZ Furnace Company

MODEL	060 - 14	080 - 14	080 - 16
TYPE	Downflow / Horizontal	Downflow / Horizontal	Downflow / Horizontal
RATINGS			
Input BTUH	60,000	80,000	80,000
Capacity BTUH (ICS)	48,000	64,000	64,000
AFUE	80.0	80.0	80.0
Temp. rise (Min.-Max.) °F.	30 - 60	35 - 65	35 - 65

Figure 3: Furnace Performance Data

Based on the heating output and temperature rise (TR) limitations the airflow should be about 1,185 CFM, based on: CFM = 64,000 ÷ (50°F × 1.1 × 1.0) = 1,185 CFM

CFM = Btu ÷ (TR × 1.1 × ACF) where:

CFM: Cubic Feet per Minute, the volume of air moving through the equipment Btu/h: The heating capacity of the furnace or other heat source. The XYZ 80-14 has an output capacity of 64,000 Btu.

1.08: A physics constant that converts pounds of air to a volume of air.

ACF: Altitude Correction Factor, for homes at elevations above 1,000 feet. Ames Iowa elevation is 955 ft. therefore, the AC is 1.0.

For the air conditioner, below, the outdoor design temperature for this example is 90°F, this designer interpolated the value between the 85°F and the 95°F cooling performance values. In these situations, one could verify the math, or "eyeball" the listed capacity and ensure it falls within the other two capacities listed. Verifying the math may be of value however, the important element to verify is that the cooling equipment does not exceed the capacity limitations.

The Latent capacity was determined by subtracting the Sensible capacity from the Total capacity (29,300 – 21,400 = 7,900).

Note the air flow required to deliver the capacities stated (1,000 CFM).

XYZ Performance Data

Model 030 HP (Fan Coil FC030) @ 1,000 CFM

OD Dry Bulb (F)	Indoor Entering Wet Bulb (F)	Total Capacity	Sensible Capacity at Entering Dry Bulb Temperature (F)			
			72	75	78	80
85	59	28,400	22,600	25,300	27,800	29,400
	63	29,900	18,800	21,600	[illegible]	[illegible]
	67	32,100	15,100	17,900	[illegible]	[illegible]
	71	34,700	11,400	14,200	[illegible]	[illegible]
95	59	27,300	22,200	24,900	[illegible]	[illegible]
	63	28,700	18,500	21,200	[illegible]	[illegible]
	67	30,800	14,700	17,500	20,400	22,200
	71	33,300	11,000	13,700	16,600	18,500
105	59	26,200	21,900	24,500	27,100	27,200
	63	27,600	18,100	20,900	23,600	25,400
	67	29,700	14,300	17,200	20,000	21,800
	71	32,100	10,600	13,300	16,200	18,100

OD Dry Bulb – Outdoor Dry Bulb, the outdoor temperature.

Elements 25 and 26 are interpolated from the circled equipment capacity values.

Correction Factors for other Airflows

	Airflow	Total Capacity	Sensible Capacity
Low	875	0.98	0.93
High	1125	1.02	1.06
Multiply rated capacity data by factor.			

Figure 4: Air Conditioner's Expanded Performance Data

Part III: Manual D Duct Sizing

The XYZ FR 08-14 blower assembly can deliver approximately 1,117 CFM on Med-Lo fan speed and 1,000 CFM on Low fan speed. 1,117 CFM is an acceptable amount of airflow for the furnace (this equates to a 53°F TR), and 1,000 CFM is the volume of air necessary for the cooling system. For more explanation, see the discussion about "Adjusting Design Airflow" (page 7) in "Understanding and Using the HVAC System Design Review Form."

XYZ Furnace Company Blower Data

Air Delivery – CFM (with filter)

Unit Size	Return Air Entry	Fan Speed	External Static Pressure (inches water column) 0.75							
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
FR 060-14	1 side or bottom	High	1100	1065	1005	945	900	805	730	610
		Med-Low	890	865	810	765	705	620	540	475
		Low	745	710	670	625	565	505	425	360
FR 080-14	1 side or bottom	High	1740	1705	1660	1615	1570	1500	1425	1355
		Med-High	1500	1470	1445	1410	1375	1330	1280	1210
		Med-Low	1340	1315	1300	1270	1235	1200	1140	1095
		Low	1195	1175	1165	1130	1100	1070	1030	975
FR 080-16	1 side or bottom	High	2250	2175	2090	2020	1930	1855	1760	1670
		Med-High	2020	1950	1900	1840	1790	1710	1640	1545
		Med-Low	1725	1690	1660	1630	1575	1520	1460	1370
		Low	1490	1480	1460	1440	1380	1340	1295	1230

‡ • Airflow shown is for bottom only return-air supply with factory supplied 1-in. washable filter (0.05 IWC).

Figure 5: Blower Performance Data

Friction Rate Worksheet

Step 1) Manufacturer's Blower Data (30) (29)

External static pressure (ESP) = 0.75 IWC Cfm = 1,185

Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil	0.18
Electric resistance heating coil	
Hot water coil	
Heat exchanger	
Low efficiency filter	
High or mid-efficiency filter	0.13
Electronic filter	
Humidifier	
Supply outlet	0.03
Return grille	0.03
Balancing damper	0.03
UV lights or other device	

Total component losses (CPL) (31) 0.40 IWC

Step 3) Available Static Pressure (ASP) (32)

ASP = (ESP - CPL) = (0.75 - 0.40) = 0.35 IWC

Step 4) Total Effective Length (TEL) (33) (34) (35)

Supply-side TEL + Return-side TEL = (278 + 110) = 388 Feet

Step 5) Friction Rate Design Value (FR) (36)

FR value from friction rate chart = 0.09 IWC/100

$$FR = \frac{ASP \times 100}{TEL}$$

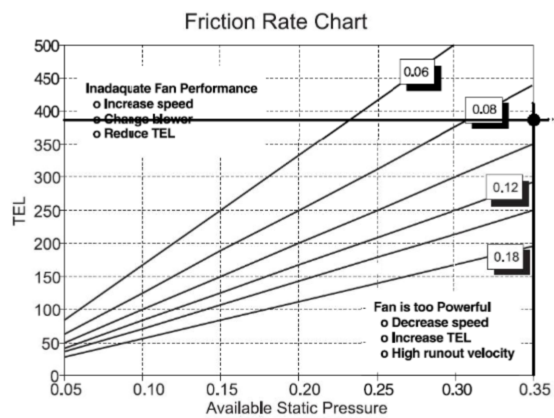


Figure 6: Example Friction Rate Worksheet

Page 6

Duct Sketch