

# **Home Energy Savings Program**

## **Wyoming HVAC Trade Ally Manual**

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## Glossary

<b>ACCA</b>	Air Conditioning Contractors of America	<b>HES</b>	Home Energy Savings
<b>AFUE</b>	Annual Fuel Utilization Efficiency	<b>HSPF</b>	Heating Seasonal Performance Factor
<b>AHRI</b>	Air Conditioning, Heating and Refrigeration Institute	<b>HVAC</b>	Heating, Ventilation, and Air Conditioning
<b>CAC</b>	Central Air Conditioner	<b>Pa</b>	Pascal
<b>CAZ</b>	Combustion Appliance Zone Testing	<b>RMP</b>	Rocky Mountain Power
<b>CFM</b>	Cubic Feet per Minute	<b>SEER</b>	Seasonal Energy Efficiency Ratio
<b>ECM</b>	Electronically Commutated Motor	<b>TXV</b>	Thermal Expansion Valve
<b>EER</b>	Energy Efficiency Ratio	<b>QPL</b>	Qualified Products List
		<b>WCI</b>	Water Column Inches

Home's Primary System		
	Heating	Cooling
Electrically Heated System	Electric	Electric or Non-Electric
Electrically Cooled System	Non-Electric	Electric

**Electric Heat** Permanently installed, ducted system consisting of an electric furnace, heat pump or electric zonal heating system (baseboard or ceiling/wall heaters) serving as the home's current primary heat source (space heaters do not qualify)

Duct Sealing (Stand Alone) and Duct Sealing and Duct Insulation Specific:

Permanently installed, ducted system consisting of an electric furnace or heat pump serving as the home's current primary heat source

**Electric Cooling** Permanently installed, electric heat pump or ducted electric central air conditioner serving as the home's current primary cooling source. Room air conditioners and evaporative cooler do not qualify

**Non-Electric Heat** Heating system with gas, oil, wood, pellet stoves, and propane serving as the home's current primary heat source

## Version History

Version #	Section	Release Date	Revision
2.0	All	February 16, 2015	Updated with changes approved by the Wyoming Public Utilities Commission.

*Rocky Mountain Power's HES program will update this trade ally manual periodically.*

## Purpose of This Manual

This manual is meant to provide trade allies with a comprehensive overview of Rocky Mountain Power's Home Energy Savings HVAC program. It has been developed with a companion set of reference materials and applicable worksheets to assist trade allies with the installation of program-approved equipment and services.

## Home Energy Savings Overview

The RMP HES program offers cash incentives on a variety of HVAC, plumbing, and weatherization equipment and services. The program promotes installation practices that are designed to maximize system performance and efficiency. By helping customers minimize their energy use, the HES program saves customers money on their energy bill and also reduces the growing demand for power in the region.

The program was originally designed for single family installation. However, due to increased interest in multifamily<sup>1</sup>, new homes, and manufactured home installations, the program has extended incentives for each category in select states, each involving its own unique application process. Please refer to the Rocky Mountain Power Trade Ally Manual for multifamily projects and contact the program at [homeenergysavings.net](http://homeenergysavings.net) or by phone at 1-800-942-0281 for additional requirements, or email us at [HesTradeAllyRMP@rockymountainpower.net](mailto:HesTradeAllyRMP@rockymountainpower.net) to make an appointment for a pre-qualification inspection. Please refer to the HES website at [homeenergysavings.net](http://homeenergysavings.net) for additional requirements regarding new home or manufactured home incentives.

## Trade Ally Overview

A trade ally is a contractor (e.g., general, HVAC, weatherization, or plumber) or retailer who sells and/or installs qualifying equipment or performs services for home energy efficiency upgrades. There are two types of program trade allies: participating or qualifying.

### Participating trade allies:

Participating applies to a trade ally who has met the basic requirements to perform work for the HES program (outlined on the next pages).

### Qualified trade allies:

Qualified applies to a trade ally that has met the basic requirements (outlined in the next pages) and successfully completed additional relevant industry training(s) required for specific services (e.g. PTCS, BPI, NATE, etc.). Documentation of the completed training must be submitted with the participation agreement and must include the name of the individual trained, certification number, certification type, date trained, and expiration date (if applicable). See below for additional information on relevant industry trainings and certifications. If you or your technicians require additional training in order to meet program requirements, please let us know and we will work with you to identify local resources or provide on-site technical coaching.

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<sup>1</sup> 5 or more attached units with shared floors and/or walls. Properties must also be no more than four stories tall.

Program-Eligible trade allies:

The term “program-eligible trade ally” is used when a service can be completed by either a participating or qualified trade ally. This term is used on HES marketing materials and on the website to explain to customers what type of trade ally they need to hire in order to receive an incentive.

<b>Wyoming HVAC Trade Ally Requirements</b>		
<b>Equipment or Service</b>	<b>Trade Ally Type</b>	<b>Additional Qualifications</b>
95% AFUE Gas Furnace w/ECM	Program-Qualified Trade Ally	Static Pressure Test (field staff will verify)
Central Air Conditioner w/Best Practice Installation and Sizing	Program-Qualified Trade Ally	PTCS or NATE
Duct Sealing (Stand Alone)	Program-Qualified Trade Ally	PTCS, NATE, or BPI
Duct Sealing & Duct Insulation	Program-Qualified Trade Ally	PTCS, NATE, or BPI
Ductless Heat Pump	Program-Eligible Trade Ally	None
ECM on Existing Furnace	Program-Qualified Trade Ally	Static Pressure Test (field staff will verify)
Evaporative Cooler	Program-Eligible Trade Ally	None
Heat Pump Best Practice Installation and Sizing	Program-Qualified Trade Ally	PTCS or NATE
Heat Pump Conversion	Program-Eligible Trade Ally	None
Heat Pump Upgrade	Program-Eligible Trade Ally	None
Whole Home Upgrade	Various, please see individual measures for more details	Various, please see individual measures for more details

## Existing Single Family Homes Incentives

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### **95% AFUE Gas Furnace with ECM**

**Customer Incentive:** \$200

**Trade Ally Incentive:** \$50

#### **Requirements:**

- Work must be completed by a Program-Qualified Trade Ally
- Combined supply and return static pressure needs to be between 0.35-0.62 WCI (87-162 Pascal) on the highest heating or cooling fan speed setting upon installation
- All duct connections at the furnace must be sealed
- All physically accessible ducts should be fully connected

#### **Ensure the home qualifies:**

- Must be existing home, not new construction
- Must be electrically cooled with a central air conditioner serving at least 80% of the home's conditioned floor area
- Work completed must comply with all building codes and standards

#### **Additional program rules:**

- Incentive cannot exceed project costs
- Gas furnace must be installed within 90 days of purchase
- May only apply for either ECM on Existing Furnace or 95% AFUE Gas Furnace incentive per furnace

#### **Application:**

- **Central Air Conditioner and Gas Furnace Application-** completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### **Itemized receipt or invoice:**

- Product or service description and costs
- Model number
- Date work initiated
- Date work completed

#### **Additional Documents:**

- **AHRI certificate**
  - W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives
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## **Central Air Conditioner w/Best Practice Installation and Sizing**

**Customer Incentive: \$50**

**Trade Ally Incentive: \$75**

### **Requirements:**

- Work must be completed by a Program-Qualified Trade Ally
- Work must be sized per program requirements outlined on pg. 16
- Minimum 15 SEER as determined by AHRI Standard 210/240 and listed in the AHRI Certified Directory of Unitary Equipment: [ahridirectory.com](http://ahridirectory.com)
- New, air source-split equipment with a matched condensing unit and evaporator coil or packaged unitary air conditioner
- AHRI Standard Rating Cooling Capacity of 65,000 BTU/hr (5.4 tons) or less
- Air flow test and performance check:
  - Air flow must meet a minimum of 350 CFM per ton requirement
  - Refrigerant charge must be within +/- 3 degrees of target subcooling

### **Ensure the home qualifies:**

- Must be existing home, not new construction
- Window air conditioning units, package terminal units, and heat pumps are not eligible
- Work completed must comply with all building codes and standards

### **Additional program rules:**

- Incentive cannot exceed project costs
- CAC must be installed within 90 days of purchase

### **Application:**

- **Central Air Conditioner and Gas Furnace Application**– completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for you records

### **Itemized receipt or invoice:**

- Product or service description and costs
- Model number
- Date work initiated
- Date work completed

### **Additional Documents:**

- **AHRI Certificate**
  - **Manual J or equivalent load calculation**
  - W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for property owners who are not listed on the utility account and who are applying for incentives
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## Existing Single Family Homes Incentives Continued

### Duct Sealing (Stand Alone)

Home's Primary System		Customer Incentive	Trade Ally Incentive
Heating	Cooling		
Electric	Electric or Non-Electric	\$300	\$100
Non-Electric	Electric	N/A	N/A

#### Requirements:

- Work must be complete by a Program-Qualified Trade Ally
- All physically accessible ducts located in unconditioned living space must be sealed
- Duct sealing must reduce leakage by 50% or more with a 100 CFM minimum reduction
- All services must be provided in accordance with the specifications on pg. 16
- CAZ tests required for properties with non-sealed combustion heating and/or water heating appliances

#### Ensure the home qualifies:

- Must be an existing home, not new construction
- Must have a minimum of 10 linear feet of exposed ductwork located in unconditioned space
- An electric heating system must serve at least 80% of the home's conditioned living space
- Homes with non-electric heating and electric cooling do not qualify
- Work completed must comply with all building codes and standards

#### Additional program rules:

- Incentives cannot exceed project costs

#### Application:

- **Duct Sealing & Duct Insulation Application** - completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Date work initiated
- Date work completed

#### Additional Documents:

- W-9 for businesses and non-individual customers receiving an incentive
- Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives

## Existing Single Family Homes Incentives Continued

### Duct Sealing and Duct Insulation

Home's Primary System		Customer Incentive	Trade Ally Incentive
Heating	Cooling		
Electric	Electric or Non-Electric	\$600	\$200
Non-Electric	Electric	\$25	\$25

#### Requirements:

- Work must be completed by a Program-Qualified Trade Ally
- Pre-existing duct insulation levels must be less than or equal to R-2
- Duct work must be insulated to R-8 or greater
- All physically accessible ducts located in unconditioned living space must be sealed and insulated
- Duct sealing must reduce leakage to outside by 50% or more with a 100 CFM minimum reduction
- Duct sealing and duct insulation must be performed in the same project, with insulation installed after the ducts are sealed
- All services must be provided in accordance with the specifications on pg. 16
- CAZ tests required for properties with non-sealed combustion heating and/or water heating appliances

#### Ensure the home qualifies:

- Must be an existing home, not new construction
- Must have a minimum of 10 linear feet of exposed ductwork located in unconditioned space
- An electric heating or electric cooling system must serve at least 80% of the home's conditioned living space

#### Additional program rules:

- Separate trade allies may perform the duct sealing and duct insulation services. **The duct sealing trade ally listed on the application will receive the trade ally incentive**
- Incentive cannot exceed project costs

#### Application:

- **Duct Sealing & Duct Insulation** - completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Date work initiated
- Date work completed

#### Additional Documents:

- W-9 for businesses and non-individual customers receiving an incentive
- Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives

## Existing Single Family Homes Incentives Continued

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### Ductless Heat Pump

	Customer Incentive	Trade Ally Incentive
Single Head	\$1,000	\$300

#### Requirements:

- Work must be completed by a Program-Qualified Trade Ally
- Minimum 9.5 HSPF, 16 SEER
- Equipment must be a new AHRI rated ductless (mini-split) system listed in the AHRI Certified Directory: [ahridirectory.org](http://ahridirectory.org)
- Must employ an inverter driven outdoor compressor unit and a variable speed fan for indoor blower and be fully ductless
- Equipment must be installed according to specifications outlined on pg. 28

#### Ensure the home qualifies:

- Must be existing home, not new construction
- Previous primary heat source must have been a permanently installed ductless electric resistance heating system (e.g. electric baseboard, electric ceiling/wall heat) serving at least 80% of the home's conditioned area
- Incentive is not offered to customers replacing an existing ducted heat pump
- Gas, oil, wood heating, pellet stoves, and propane systems conversions do not qualify
- Work completed must comply with all building codes and standards

#### Additional program rules:

- Incentive cannot exceed project costs

#### Application:

- **Heat Pump** - completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Model numbers: indoor and outdoor
- Date work initiated
- Date work completed

#### Additional Documents:

- **AHRI certificate**
  - W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives
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## Existing Single Family Homes Incentives Continued

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### ECM on Existing Furnace

Customer Incentive: \$100

Trade Ally Incentive: \$50

#### Requirements:

- Work must be completed by a Program-Qualified Trade Ally
- Replace any existing gas furnace motor with an ECM motor

#### Ensure the home qualifies:

- Must be existing home, not new construction
- Must be electrically cooled with a central air conditioner or ducted evaporative cooler serving at least 80% of the home's conditioned floor area
- Work completed must comply with all building codes and standards

#### Additional program rules:

- Incentive cannot exceed project costs
- One incentive per motor per furnace
- May only apply for either ECM on Existing Furnace or 95% AFUE Gas Furnace incentive per furnace

#### Application:

- **Central Air Conditioner and Gas Furnace Application-** completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Model number
- Date work initiated
- Date work completed

#### Additional Documents:

- W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives
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## Existing Single Family Homes Incentives Continued

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### Evaporative Cooler Tier 2

Customer Incentive: \$200

Trade Ally Incentive: \$50

#### Requirements:

- 3,500 CFM or greater

#### Ensure the home qualifies:

- Must be existing home, not new construction
- Work complete must comply with all building codes and standards

#### Additional program rules:

- Must use evaporative cooling exclusively
- Equipment must be new, first time install
- Equipment must be on the qualified evaporative cooler list at time of installation: [rockymountainpower.net/wy-qpl](http://rockymountainpower.net/wy-qpl)
- Incentive cannot exceed project costs
- Evaporative cooler must be installed within 90 days of purchase

#### Application:

- **Evaporative Cooler Application-** completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Date work initiated
- Date work completed

#### Additional Documents:

- W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives
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## Existing Single Family Homes Incentives Continued

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### Heat Pump Conversion

Customer Incentive	Trade Ally Incentive
\$1,250	\$250

#### Qualifications:

- Minimum 9.0 HSPF, 15 SEER
- Work must be completed by a Program-Eligible Trade Ally
- Equipment must be a new, air-source split or packaged unitary heat pump with an AHRI Standard Rating Cooling Capacity of 65,000 BTU/hr (5.4 tons) or less
- New heat pump must be the current primary heat source and must service at least 80% of the home's conditioned living space
- Equipment must be listed on the AHRI Certified Directory

#### Ensure the home qualifies:

- Must be existing home, not new construction
- Previous primary heat source must have been a permanently installed electric resistance heating system (e.g. electric baseboard, electric furnace, electric ceiling/wall heat) serving at least 80% of the home's conditioned area
- Gas, oil, wood heating, pellet stoves, and propane systems conversions do not qualify
- Work completed must comply with all building codes and standards

#### Additional program rules:

- Incentive cannot exceed project costs

#### Application:

- **Heat Pump Application** - completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Model numbers: indoor and outdoor
- Date work initiated
- Date work completed

#### Additional Documents:

- **AHRI certificate**
  - W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives
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## Existing Single Family Homes Incentives Continued

### Heat Pump Upgrade

Customer Incentive	Trade Ally Incentive
\$500	\$250

#### Qualifications:

- Minimum 9.0 HSPF, 15 SEER
- Work must be completed by a Program-Eligible Trade Ally
- Equipment must be a new, air-source split or packaged unitary heat pump with an AHRI Standard Rating Cooling Capacity of 65,000 BTU/hr (5.4 tons) or less
- New heat pump must be the current primary heat source and must service at least 80% of the home's conditioned living space
- Equipment must be listed on the AHRI Certified Directory

#### Ensure the home qualifies:

- Must be existing home, not new construction
- Previous primary heat source must have a ducted electric heat pump that served at least 80% of the home's conditioned living space
- Gas, oil, wood heating, pellet stoves, and propane systems conversions do not qualify
- Work completed must comply with all building codes and standards

#### Additional program rules:

- Incentive cannot exceed project costs

#### Application:

- **Heat Pump Application** - completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Model numbers: indoor and outdoor
- Date work initiated
- Date work completed

#### Additional Documents:

- **AHRI certificate**
- W-9 for businesses and non-individual customers receiving an incentive
- Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives

## Existing Single Family Homes Incentives Continued

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### Heat Pump Best Practices Installation and Sizing

Customer Incentive	Trade Ally Incentive
\$500	\$250

#### Qualifications:

- Work must be completed by a Program-Qualified Trade Ally
- Equipment must be a new, air-source split or packaged unitary heat pump with an AHRI Standard Rating Cooling Capacity of 65,000 BTU/hr (5.4 tons) or less
- Work must be sized per program requirements outlined on pg. 16
- Equipment must be listed on the AHRI Certified Directory

#### Ensure the home qualifies:

- Must be existing home, not new construction
- Air flow must meet minimum 350 CFM
- Gas, oil, wood heating, pellet stoves, and propane systems conversions do not qualify
- Work completed must comply with all building codes and standards

#### Additional program rules:

- Incentive cannot exceed project costs

#### Application:

- **Heat Pump Application** - completed and signed
- Mail all documents so they are postmarked within 90 days of the qualifying service completion date
- Make copies for your records

#### Itemized receipt or invoice:

- Product or service description and costs
- Model numbers: indoor and outdoor
- Date work initiated
- Date work completed

#### Additional Documents:

- **AHRI certificate**
  - W-9 for businesses and non-individual customers receiving an incentive
  - Third party addendum for homeowners who are not listed on the utility account and who are applying for incentives
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## Existing Single Family Homes Incentives Continued

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### Whole Home Upgrade Package

Customer Incentive: \$1,000 bonus per home

#### Electrically Heated Homes Requirements:

Must complete the following services, one from each category:

Category	Service Options
Heating HVAC	Heat Pump <u>OR</u> Ductless Heat Pump
Duct Work (for ducted heat pumps only)	Duct Sealing <u>OR</u> Duct Sealing and Duct Insulation
Insulation	Whole Home Attic Insulation, Whole Home Wall Insulation, <u>OR</u> Whole Home Floor Insulation
Air Sealing	Air Sealing

#### Gas Heated and Electrically Cooled Homes Requirements:

Must complete the following services, one from each category:

Category	Service Options
Heating HVAC	ECM on Existing Furnace <u>OR</u> 95% AFUE Gas Furnace with ECM
Cooling HVAC	Evaporative Cooler Tier 2 <u>OR</u> Central Air Conditioner (must be ducted)
Duct Work	Duct Sealing and Duct Insulation
Insulation	Whole Home Attic Insulation <u>OR</u> Whole Home Wall Insulation

#### Ensure the home qualifies:

- Must be an existing home, not new construction
- Home must meet individual program requirements for all services completed

#### Additional Program Rules:

- Incentive cannot exceed project costs

#### Application:

- **Whole Home Upgrade One Pager**
- **Duct Sealing and Duct Insulation Application**
- **Insulation and Air Sealing Application**
- **Central Air Conditioner and Gas Furnace Application** (Electrically Cooled Homes Only)
- **Evaporative Cooler Application** (If Applicable for Electrically Cooled Homes Only)
- **Heat Pump Application** (Electrically Heated Homes Only)
- Mail all documents so they are postmarked within 180 days of the qualifying service completion
- Make copies for your records.

#### Itemized receipt or invoice and Additional Documents:

- See individual applications for more details
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## Central Air Conditioner/Heat Pump Best Practices Installation and Sizing

### Best Practice Installation

#### Air Flow Test

Air flow across the coil shall be 350 CFM/ton or greater, tested at highest heating or cooling capacity.

Air flow shall be tested after installation using a True Flow plate or using manufacturer's measurement instructions.

- Confirm air flow across the coil is 350 CFM/ton or greater, tested at highest capacity, **OR**
- Confirm temperature difference (difference between return air dry bulb temperature and supply air dry bulb temperature) is satisfactory, **OR**
- Other approved methodology (must be pre-approved by program)

#### Performance Check Requirements

Confirm measured sub-cooling is within +/- 3°F of manufacturer's target value.

#### For units with a TXV:

- Confirm measured sub-cooling is within +/- 3°F of manufacturer's target value, **OR**
- Confirm amount of total charge is within +/- 2°F of manufacturer's target value, **OR**
- Confirm approach temperature matches manufacturer's recommended approach temperature

#### For units without a TXV:

- Confirm measure super heat is within +/- 5°F of manufacturer's target value, **OR**
- Confirm amount of total charge is within +/- 2°F of manufacturer's target value

### Sizing

- Capacity of the central air conditioner must be sized within one-half ton (6,000 BTU/hr) of the calculated cooling load or the next available size
- Trade ally must use required assumptions for calculated cooling load to ensure accuracy and consistency
- A sizing report shall be submitted and must include the following:
  - Vintage of house
  - Total house square footage
  - Heating load associated with:
    - Infiltration (air leakage)
    - Ducts
    - Window types and orientation
    - Walls
    - Ceiling
    - Floor
    - Internal loads
  - Total design load

## Central Air Conditioner/Heat Pump Best Practices Installation & Sizing Continued

### Appendix A TrueFlow Meter Flow Conversion Tables

#### Appendix A Flow Conversion Tables

Table A.1: Flow Conversion Table for TrueFlow Metering Plates (using Pascals)

Plate Pressure (Pascals)	Plate #14 (CFM)	Plate #20 (CFM)	Plate Pressure	Plate #14	Plate #20	Plate Pressure	Plate #14	Plate #20
10	364	487	66	934	1251	126	1291	1729
11	381	511	67	941	1261	127	1296	1735
12	398	533	68	948	1270	128	1301	1742
13	415	555	69	955	1279	129	1306	1749
14	430	576	70	962	1288	130	1311	1756
15	445	596	71	969	1298	131	1316	1763
16	460	616	72	976	1307	132	1321	1769
17	474	635	73	983	1316	133	1326	1776
18	488	653	74	989	1325	134	1331	1783
19	501	671	75	996	1334	135	1336	1789
20	514	689	76	1003	1343	136	1341	1796
21	527	706	77	1009	1351	137	1346	1803
22	539	722	78	1016	1360	138	1351	1809
23	552	739	79	1022	1369	139	1356	1816
24	563	754	80	1029	1377	140	1361	1822
25	575	770	81	1035	1386	141	1366	1829
26	586	785	82	1041	1395	142	1370	1835
27	598	800	83	1048	1403	143	1375	1842
28	609	815	84	1054	1411	144	1380	1848
29	619	829	85	1060	1420	145	1385	1854
30	630	843	86	1066	1428	146	1390	1861
31	640	857	87	1073	1436	147	1394	1867
32	651	871	88	1079	1445	148	1399	1873
33	661	885	89	1085	1453	149	1404	1880
34	671	898	90	1091	1461	150	1408	1886
35	680	911	91	1097	1469	151	1413	1892
36	690	924	92	1103	1477	152	1418	1899
37	700	937	93	1109	1485	153	1422	1905
38	709	949	94	1115	1493	154	1427	1911
39	718	962	95	1121	1501	155	1432	1917
40	727	974	96	1127	1509	156	1436	1923
41	736	986	97	1133	1517	157	1441	1930
42	745	998	98	1138	1525	158	1446	1936
43	754	1010	99	1144	1532	159	1450	1942
44	763	1022	100	1150	1540	160	1455	1948
45	771	1033	101	1156	1548	161	1459	1954
46	780	1044	102	1161	1555	162	1464	1960
47	788	1056	103	1167	1563	163	1468	1966
48	797	1067	104	1173	1570	164	1473	1972
49	805	1078	105	1178	1578	165	1477	1978
50	813	1089	106	1184	1586	166	1482	1984
51	821	1100	107	1190	1593	167	1486	1990
52	829	1111	108	1195	1600	168	1491	1996
53	837	1121	109	1201	1608	169	1495	2002
54	845	1132	110	1206	1615	170	1499	2008
55	853	1142	111	1212	1622	171	1504	2014
56	861	1152	112	1217	1630	172	1508	2020
57	868	1163	113	1222	1637	173	1513	2026
58	876	1173	114	1228	1644	174	1517	2031
59	883	1183	115	1233	1651	175	1521	2037
60	891	1193	116	1239	1659	176	1526	2043
61	898	1203	117	1244	1666	177	1530	2049
62	906	1213	118	1249	1673	178	1534	2055
63	913	1222	119	1255	1680	179	1539	2060
64	920	1232	120	1260	1687	180	1543	2066
65	927	1242	121	1265	1694	181	1547	2072
			122	1270	1701	182	1551	2078
			123	1275	1708	183	1556	2083
			124	1281	1715	184	1560	2089
			125	1286	1722	185	1564	2095

## Central Air Conditioner/Heat Pump Best Practices Installation & Sizing Continued

### Appendix A TrueFlow Meter Flow Conversion Tables

**Table A.2: Flow Conversion Table for TrueFlow Metering Plates (using In. H<sub>2</sub>O)**

Plate Pressure (In. H <sub>2</sub> O)	Plate #14 (CFM)	Plate #20 (CFM)	Plate Pressure	Plate #14	Plate #20	Plate Pressure	Plate #14	Plate #20
0.040	362	485	0.280	959	1284	0.580	1380	1848
0.045	384	515	0.285	967	1296	0.585	1386	1856
0.050	405	543	0.290	976	1307	0.590	1392	1864
0.055	425	569	0.295	984	1318	0.595	1398	1872
0.060	444	594	0.300	993	1329	0.600	1404	1880
0.065	462	619	0.305	1001	1340	0.605	1410	1888
0.070	479	642	0.310	1009	1351	0.610	1415	1895
0.075	496	665	0.315	1017	1362	0.615	1421	1903
0.080	513	686	0.320	1025	1373	0.620	1427	1911
0.085	528	708	0.325	1033	1384	0.625	1433	1919
0.090	544	728	0.330	1041	1394	0.630	1438	1926
0.095	559	748	0.335	1049	1405	0.635	1444	1934
0.100	573	767	0.340	1057	1415	0.640	1450	1942
0.105	587	786	0.345	1064	1425	0.645	1455	1949
0.110	601	805	0.350	1072	1436	0.650	1461	1957
0.115	615	823	0.355	1080	1446	0.655	1467	1964
0.120	628	841	0.360	1087	1456	0.660	1472	1972
0.125	641	858	0.365	1095	1466	0.665	1478	1979
0.130	653	875	0.370	1102	1476	0.670	1483	1986
0.135	666	892	0.375	1110	1486	0.675	1489	1994
0.140	678	908	0.380	1117	1496	0.680	1494	2001
0.145	690	924	0.385	1124	1506	0.685	1500	2009
0.150	702	940	0.390	1132	1516	0.690	1505	2016
0.155	713	955	0.395	1139	1525	0.695	1511	2023
0.160	725	971	0.400	1146	1535	0.700	1516	2030
0.165	736	986	0.405	1153	1544	0.705	1522	2038
0.170	747	1001	0.410	1160	1554	0.710	1527	2045
0.175	758	1015	0.415	1167	1563	0.715	1532	2052
0.180	769	1030	0.420	1174	1573	0.720	1538	2059
0.185	779	1044	0.425	1181	1582	0.725	1543	2066
0.190	790	1058	0.430	1188	1591	0.730	1548	2074
0.195	800	1072	0.435	1195	1601	0.735	1554	2081
0.200	810	1085	0.440	1202	1610	0.740	1559	2088
0.172	752	1007	0.445	1209	1619	0.745	1564	2095
0.176	760	1018	0.450	1216	1628	0.750	1569	2102
0.180	769	1030	0.455	1222	1637			
0.184	777	1041	0.460	1229	1646			
0.188	786	1052	0.465	1236	1655			
0.192	794	1063	0.470	1242	1664			
0.196	802	1074	0.475	1249	1673			
0.200	810	1085	0.480	1256	1681			
0.205	821	1099	0.485	1262	1690			
0.210	830	1112	0.490	1269	1699			
0.215	840	1125	0.495	1275	1707			
0.220	850	1138	0.500	1281	1716			
0.225	860	1151	0.505	1288	1725			
0.230	869	1164	0.510	1294	1733			
0.235	879	1176	0.515	1301	1742			
0.240	888	1189	0.520	1307	1750			
0.245	897	1201	0.525	1313	1758			
0.250	906	1213	0.530	1319	1767			
0.255	915	1226	0.535	1326	1775			
0.260	924	1237	0.540	1332	1783			
0.265	933	1249	0.545	1338	1792			
0.270	942	1261	0.550	1344	1800			
0.275	950	1273	0.555	1350	1808			
			0.560	1356	1816			
			0.565	1362	1824			
			0.570	1368	1832			
			0.575	1374	1840			

## Central Air Conditioner/Heat Pump Best Practices Installation & Sizing Continued

**Table B.1: Flow Resistance Correction Factors (using Pascals)**

		Normal System Operating Pressure in Pascals (NSOP)																				
		10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
TrueFlow System Operating Pressure in Pascals. (TF SOP)	10	1.00	1.10	1.18	1.26	1.34	1.41	1.48	1.55	1.61	1.67	1.73	1.79	1.84	1.90	1.95	2.00	2.05	2.10	2.14	2.19	2.24
	12	0.91	1.00	1.08	1.15	1.22	1.29	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83	1.87	1.91	1.96	2.00	2.04
	14	0.85	0.93	1.00	1.07	1.13	1.20	1.25	1.31	1.36	1.41	1.46	1.51	1.56	1.60	1.65	1.69	1.73	1.77	1.81	1.85	1.89
	16	0.79	0.87	0.94	1.00	1.06	1.12	1.17	1.22	1.27	1.32	1.37	1.41	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.73	1.77
	18	0.75	0.82	0.88	0.94	1.00	1.05	1.11	1.15	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49	1.53	1.56	1.60	1.63	1.67
	20	0.71	0.77	0.84	0.89	0.95	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58
	22	0.67	0.74	0.80	0.85	0.90	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51
	24	0.65	0.71	0.76	0.82	0.87	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44
	26	0.62	0.68	0.73	0.78	0.83	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39
	28	0.60	0.65	0.71	0.76	0.80	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34
	30	0.58	0.63	0.68	0.73	0.77	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29
	32	0.56	0.61	0.66	0.71	0.75	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25
	34	0.54	0.59	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21
	36	0.53	0.58	0.62	0.67	0.71	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18
	38	0.51	0.56	0.61	0.65	0.69	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15
	40	0.50	0.55	0.59	0.63	0.67	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12
	42	0.49	0.53	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09
	44	0.48	0.52	0.56	0.60	0.64	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07
	46	0.47	0.51	0.55	0.59	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04
	48	0.46	0.50	0.54	0.58	0.61	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00	1.02
50	0.45	0.49	0.53	0.57	0.60	0.63	0.66	0.69	0.72	0.75	0.77	0.80	0.82	0.85	0.87	0.89	0.92	0.94	0.96	0.98	1.00	

		Normal System Operating Pressure in Pascals (NSOP)																				
		50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150
TrueFlow System Operating Pressure in Pascals. (TF SOP)	50	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58	1.61	1.64	1.67	1.70	1.73
	55	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51	1.54	1.57	1.60	1.62	1.65
	60	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.55	1.58
	65	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.41	1.44	1.47	1.49	1.52
	70	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34	1.36	1.39	1.41	1.44	1.46
	75	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29	1.32	1.34	1.37	1.39	1.41
	80	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.37
	85	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21	1.24	1.26	1.28	1.31	1.33
	90	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18	1.20	1.22	1.25	1.27	1.29
	95	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15	1.17	1.19	1.21	1.24	1.26
	100	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12	1.14	1.16	1.18	1.20	1.22
	105	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09	1.11	1.13	1.15	1.18	1.20
	110	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07	1.09	1.11	1.13	1.15	1.17
	115	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14
	120	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12
	125	0.63	0.66	0.69	0.72	0.75	0.77	0.80	0.82	0.85	0.87	0.89	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10
	130	0.62	0.65	0.68	0.71	0.73	0.76	0.78	0.81	0.83	0.85	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.07
	135	0.61	0.64	0.67	0.69	0.72	0.75	0.77	0.79	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.05
	140	0.60	0.63	0.65	0.68	0.71	0.73	0.76	0.78	0.80	0.82	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.98	1.00	1.02	1.04
	145	0.59	0.62	0.64	0.67	0.69	0.72	0.74	0.77	0.79	0.81	0.83	0.85	0.87	0.89	0.91	0.93	0.95	0.96	0.98	1.00	1.02
150	0.58	0.61	0.63	0.66	0.68	0.71	0.73	0.75	0.77	0.80	0.82	0.84	0.86	0.88	0.89	0.91	0.93	0.95	0.97	0.98	1.00	

$$\text{Flow Resistance Correction Factor} = \sqrt{\text{NSOP} / \text{TF SOP}}$$

## Central Air Conditioner/Heat Pump Best Practices Installation & Sizing Continued

**Table B.2: Flow Resistance Correction Factors (using In. H<sub>2</sub>O)**

		Normal System Operating Pressure in In. H <sub>2</sub> O (NSOP)																					
		0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	
TrueFlow System Operating Pressure in In. H <sub>2</sub> O (TF SOP)	0.04	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.66	1.73	1.80	1.87	1.94	2.00	2.06	2.12	2.18	2.24	2.29	2.35	2.40	2.45	
	0.05	0.89	1.00	1.10	1.18	1.26	1.34	1.41	1.48	1.55	1.61	1.67	1.73	1.79	1.84	1.90	1.95	2.00	2.05	2.10	2.14	2.19	
	0.06	0.82	0.91	1.00	1.08	1.15	1.22	1.29	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83	1.87	1.91	1.96	2.00	
	0.07	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.25	1.31	1.36	1.41	1.46	1.51	1.56	1.60	1.65	1.69	1.73	1.77	1.81	1.85	
	0.08	0.71	0.79	0.87	0.94	1.00	1.06	1.12	1.17	1.22	1.27	1.32	1.37	1.41	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.73	
	0.09	0.67	0.75	0.82	0.88	0.94	1.00	1.05	1.11	1.15	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49	1.53	1.56	1.60	1.63	
	0.10	0.63	0.71	0.77	0.84	0.89	0.95	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	
	0.11	0.60	0.67	0.74	0.80	0.85	0.90	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	
	0.12	0.58	0.65	0.71	0.76	0.82	0.87	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	
	0.13	0.55	0.62	0.68	0.73	0.78	0.83	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	
	0.14	0.53	0.60	0.65	0.71	0.76	0.80	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	
	0.15	0.52	0.58	0.63	0.68	0.73	0.77	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	
	0.16	0.50	0.56	0.61	0.66	0.71	0.75	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	
	0.17	0.49	0.54	0.59	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	
	0.18	0.47	0.53	0.58	0.62	0.67	0.71	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	
	0.19	0.46	0.51	0.56	0.61	0.65	0.69	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	
	0.20	0.45	0.50	0.55	0.59	0.63	0.67	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	
	0.21	0.44	0.49	0.53	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	
	0.22	0.43	0.48	0.52	0.56	0.60	0.64	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	
	0.23	0.42	0.47	0.51	0.55	0.59	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	
0.24	0.41	0.46	0.50	0.54	0.58	0.61	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00		

		Normal System Operating Pressure in In. H <sub>2</sub> O (NSOP)																					
		0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	
TrueFlow System Operating Pressure in In. H <sub>2</sub> O (TF SOP)	0.20	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58	1.61	1.64	1.67	1.70	1.73	
	0.22	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51	1.54	1.57	1.60	1.62	1.65	
	0.24	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.55	1.58	
	0.26	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.41	1.44	1.47	1.49	1.52	
	0.28	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34	1.36	1.39	1.41	1.44	1.46	
	0.30	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29	1.32	1.34	1.37	1.39	1.41	
	0.32	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.37	
	0.34	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21	1.24	1.26	1.28	1.31	1.33	
	0.36	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18	1.20	1.22	1.25	1.27	1.29	
	0.38	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15	1.17	1.19	1.21	1.24	1.26	
	0.40	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12	1.14	1.16	1.18	1.20	1.22	
	0.42	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09	1.11	1.13	1.15	1.18	1.20	
	0.44	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07	1.09	1.11	1.13	1.15	1.17	
	0.46	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	
	0.48	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	
	0.50	0.63	0.66	0.69	0.72	0.75	0.77	0.80	0.82	0.85	0.87	0.89	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	
	0.52	0.62	0.65	0.68	0.71	0.73	0.76	0.78	0.81	0.83	0.85	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.07	
	0.54	0.61	0.64	0.67	0.69	0.72	0.75	0.77	0.79	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.05	
	0.56	0.60	0.63	0.65	0.68	0.71	0.73	0.76	0.78	0.80	0.82	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.98	1.00	1.02	1.04	
	0.58	0.59	0.62	0.64	0.67	0.69	0.72	0.74	0.77	0.79	0.81	0.83	0.85	0.87	0.89	0.91	0.93	0.95	0.96	0.98	1.00	1.02	
0.60	0.58	0.61	0.63	0.66	0.68	0.71	0.73	0.75	0.77	0.80	0.82	0.84	0.86	0.88	0.89	0.91	0.93	0.95	0.97	0.98	1.00		

$$\text{Flow Resistance Correction Factor} = \sqrt{\text{NSOP} / \text{TF SOP}}$$

## **Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation**

### **D.1. HVAC DUCT SEALING AND INSULATION<sup>1</sup>**

- a) Uninsulated flex-ducts shall be replaced with R-8 flex-ducts. Sheet metal/rigid ducts with less than R-3 insulation shall be insulated to a minimum R-11
- b) Ducts shall be properly supported before insulation is installed. All new and all accessible existing duct joints and metal joints shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps and tightened with a tool manufactured specifically for tightening nylon/plastic straps around HVAC duct (hand tightening is not acceptable). Stainless steel worm drive clamps are also allowed. Mastic and/or tape shall not be used as mechanical fasteners.
- c) All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums outside the conditioned space shall be sealed at all joints and corners, including prefabricated joints, with duct mastic meeting UL 181 standards. It is unnecessary to seal longitudinal seams unless they are damaged. Tape is not allowed except for use on operable doors in the system such as on the air handler. In this case, cleaning the joint at an operable door with a suitable solvent and sealing with a UL-181BMX listed tape may be used.
- d) Ducts located outside of the conditioned space, including plenums and boots shall be insulated. All duct insulation should be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape may be used on insulation seams to provide a continuous barrier.
- e) Ducts shall be completely insulated with a material that has a facing with an approved vapor barrier and flame spread rating of 50 for single family and 25 for multi-family or per local code.

### **I. GENERAL SPECIFICATIONS**

1. These specifications apply to existing residential (retrofit) weatherization for single family homes, manufactured homes, and qualifying multi-family buildings that are three floors or fewer above grade.
2. Weatherization measures shall be installed in accordance with these specifications, all applicable State and local codes, HUD code, and federal regulations. In cases where a federal, state or local code or regulation exceeds the requirements herein, that code or regulation shall apply. If the federal, state or local code or regulation does not exceed the requirements herein, then the requirements contained in this specification shall apply.
3. An inspector or representative of the utility (who has demonstrated competency of understanding these specifications through successful passing of an approved written test) shall inspect projects to verify and document projects comply with these specifications.
4. All weatherization shall be completed in a manner that will provide a safe, permanent, effective, and professional installation.
5. Insulation shall be installed in areas of the envelope that separate conditioned space and unconditioned or outside spaces where none exists or where R-value is less than that described in the measure description of the reporting software.
6. In manufactured homes, all combustion appliances, except gas cooking appliances and gas clothes dryers, shall have outside combustion air ducted directly to the appliance. Fireplaces and wood-burning stoves shall have tight-fitting glass or metal doors that cover the entire opening of the firebox. All dryer ducts must be vented to the outside to control moisture.
7. All existing spot ventilation systems are in good working order (i.e. meet the ducting specs; see Section MV).

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<sup>1</sup> Source: Regional Technical Forum Residential Weatherization Specifications August 30, 2011

## Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation Continued

8. All homes that have any weatherization measures installed shall receive:

- a) *Care for Your Air: A Guide to Indoor Air Quality, EPA*
- b) *Indoor Air Quality Homeowner Disclosure Form*

### II. GENERAL MATERIAL SPECIFICATIONS

1. Materials used shall meet or exceed applicable local, state and federal codes and regulations. All materials shall be installed in accordance with manufacturer's instructions.
2. All materials shall be resistant to corrosion, degradation from ultraviolet light, and be compatible with other elements and materials (e.g. will not react chemically, etc.) so as to enhance long life expectancy of installed measures.
3. Structural members and building components shall be free of decay and structurally sound before the weatherization measure is installed.
4. Weatherization materials, products and labor shall be warranted by the Installer against failure due to manufacturing and installation defects for a period of at least 2 years, from the installation date, except that sealed, insulated-glass units shall be warranted against failure of the seal for a minimum of 5 years. The Installer shall provide a written warranty, with the installation date, to the Homeowner or Homeowner Designee. Manufacturers' written warranties may be used by Installers to satisfy a part of this requirement where appropriate.
5. The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals is the accepted standard for R-value/U-factor of materials used by Installers. Products that vary from ASHRAE may be acceptable if they comply with current Federal Trade Commission (FTC) certifications, testing and labeling rules, and have independent laboratory testing which indicates the product's R-value/U-factor. The National Fenestration Rating Council (NFRC) Certified Products Database (CPD) shall be used to determine U-factors for windows and doors.
6. All materials used for thermal insulation shall meet the requirements contained in the applicable material specifications listed below. Certain requirements in these specifications refer to voluntary standards such as ASTM International ([HUastm.orgUH](http://www.astm.org)) for specific test methods or physical properties. For purposes of compliance with this weatherization specification, the referenced voluntary standard shall be considered as mandatory.
 

a) Mineral Fiber Blankets/Batts	ASTM C 665
b) Mineral Fiber Loose Fill	ASTM C 764
c) Cellulose Loose Fill	ASTM C-739
	FR 1209
	CFR 1404
d) Perlite	ASTM C-549
e) Vermiculite	ASTM C-516-96e1
f) Polystyrene Board	ASTM C-578
g) Polyurethane and Polyisocyanurate Board	ASTM C 591

## **Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation Continued**

7. Insulation materials including facings (except foam plastic insulation—see Specification II-8) shall be installed in accordance with requirements of the International Building Code (IBC) flame spread and smoke developed. Requirements do not apply to facings, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.
8. Installation of foam plastic insulation shall comply with thermal and ignition barrier code requirements for "foam plastics," as defined by the local building code. Spray or injected foam insulation shall be installed by a manufacturer recognized (or other equivalently trained) licensed trade ally.
9. All insulation materials installed shall meet the requirements of the Federal Trade Commission Labeling Rule (16 CFR 460).
10. Caulking shall be one of the following materials conforming to the federal specifications listed below or material demonstrating equivalent performance in resiliency and durability. The cartridge or tube containing the caulking material shall be labeled indicating conformance to the applicable federal specification:
  - a. Silicone Rubber TT-S-1543A
  - b. Polysulfide or Polyurethane  
(single component) TT-S-230C  
Polysulfide or Polyurethane
  - c. (multiple component) TT-S-227E
  - d. Acrylic Terpolymer  
(single component) TT-S-230C
  - e. Butyl Rubber TT-S-1657
  - f. Acrylic Latex ASTM C834

## **Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation Continued**

### **III. General Weatherization Requirements**

#### **1. Human Contact Areas**

Fibrous insulation installed in human contact areas shall be covered with a vapor permeable air barrier (i.e. house wrap, foam board, plywood, gypsum board, vapor permeable FSK) to limit human exposure to insulation fibers. Materials such as non-vapor permeable plastic sheeting and non-vapor permeable FSK shall not be used for this purpose. Vertical and overhead surfaces containing fibrous insulation, in areas that are routinely accessed by building occupants, shall also be covered. All covering shall meet applicable codes.

#### **2. Electrical Wiring**

- a) Insulation shall not be installed in contact with active knob and tube wiring.
- b) For all types of electrical wiring, all electrical splices, junctions, connections, fixtures and switches must be contained in code compliant and covered electrical boxes prior to being covered with insulation.

#### **3. Combustion Appliance Exhaust Ventilation Inspection (Does not apply if windows are the sole weatherization measure installed.)**

- a) Combustion heating and water heating systems shall be visually inspected at accessible locations for signs of improper venting and to observe that combustion vent flue terminates outdoors. Visual inspections shall be documented by trade ally.
- b) Repairs shall be made prior to project completion to assure that exhaust venting at accessible locations is continuously connected between the appliance and outdoors ending in a code approved vent cap.
- c) Homeowners shall be notified of signs of improper venting, damaged venting, corrosion or deterioration of equipment or venting system and encouraged to contact a heating or water heating trade ally or fuel utility for further inspection.
- d) Gas clothes dryers shall be vented to outside.
- e) Homes with unvented combustion heating appliances are not eligible.

#### **4. Carbon Monoxide Detectors**

- a) Carbon monoxide detectors shall be installed in all family living units containing a permanently installed combustion appliance

##### **All Carbon Monoxide Detectors shall:**

- a) Be Underwriters Laboratories Tested and Listed to ANSI/UL 2034-09

##### **Carbon Monoxide Detectors should:**

- a) Include an electrochemical sensor
- b) Be powered by long-life lithium type battery
- c) Include a digital readout that automatically displays the current CO level detected when an alarm signal is activated
- d) Include a data feature which is activated when the test/reset or memory button is pressed, and the readout shall include the current CO level detected down to 10 parts per million (ppm), the highest level detected down to 10 ppm, and for how long the peak level was detected

## **Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation Continued**

### **Locked Battery Compartment**

- a) Battery should be factory pre-installed within a compartment which has a separate battery door that is locked closed with a tamper-resistant screw
- b) Battery compartment should not be accessible without removing alarm from its mounting

### **Five-Year Warranty**

CO detector manufacturer should warrant alarm and sensor for minimum 5 years, and shall guarantee that battery provided will power alarm for minimum 5 years without replacement

### **Installation Requirements**

- a) CO detector shall be installed in all family living units containing a permanently installed combustion appliance.
- b) CO detector installed in accordance to manufacturer installation instructions
- c) Detector shall not be installed within unconditioned space, furnace closet or garage

### **Occupant Education**

- a) The CO detector shall be tested upon completion of installation, and the occupant shall be instructed how to operate, test and maintain the alarm
- b) The occupant shall be instructed how to properly respond to an alarm signal
- c) The occupant shall be provided with the manufacturer's owner's manual

## **Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation Continued**

### **D HOME – HVAC DUCT SEALING AND INSULATION**

- a) Uninsulated flex-ducts shall be replaced with R-8 flex-ducts. Sheet metal/rigid ducts with insulation of R-2 or less shall be insulated to a minimum R-8.
- b) Ducts shall be properly supported before insulation is installed. All new and all accessible existing duct joints and metal joints shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps and tightened with a tool manufactured specifically for tightening nylon/plastic straps around HVAC duct. (hand tightening is not acceptable). Stainless steel worm drive clamps or other methods approved in writing by the program are also allowed. Mastic and/or tape shall not be used as mechanical fasteners.
- c) All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums outside the conditioned space shall be sealed at all joints and corners, including prefabricated joints, with duct mastic meeting UL 181 standards. It is unnecessary to seal longitudinal seams unless they are damaged. Tape is not allowed except for use on operable doors in the system such as on the air handler. In this case, cleaning the joint at an operable door with a suitable solvent and sealing with a UL-181BMX listed tape may be used.
- d) Ducts located outside of the conditioned space, including plenums and boots shall be insulated. All duct insulation should be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape may be used on insulation seams to provide a continuous barrier.
- e) Ducts shall be completely insulated with a material that has a facing with an approved vapor barrier and flame spread rating of 50 for single family and 25 for multi-family or per local code.

#### **1. Combustion Appliance Zone Testing**

- a) In homes with one or more non-sealed combustion appliances for the purpose of space heating or water heating, a "worst case depressurization test" shall be performed after air sealing, for all Combustion Appliance Zones (CAZ).
- b) A CAZ is a conditioned space or enclosed area that contains a combustion appliance for the purpose of space heating or water heating.
- c) A combustion appliance is any appliance that burns fuel, such as natural gas, propane, oil, or wood. This includes furnaces, boilers, water heaters, wood stoves, and fireplaces.

## Duct Sealing (Stand Alone); Duct Sealing & Duct Insulation Continued

### CAZ Test Procedure

All kitchen, bathroom, and clothes dryer exhaust fans shall be turned on. If the house has a forced air heating system, its air handler fan shall be turned on its highest setting. All interior doors shall be closed if doing so makes the combustion appliance zone more negative.

### CAZ Standard

Worst case depressurization with all exhaust fans running shall not de-pressurize a combustion appliance zone by more than the recommended amount listed below.

### CAZ Depressurization Limits

Venting Condition	Limit (Pascals)
Orphan natural draft water heater (including outside chimneys)	-2
Natural draft boiler or furnace commonly vented with water heater	-3
Natural draft boiler or furnace with vent damper commonly vented with water heater	-5
Individual natural draft boiler, furnace or domestic hot water heater	-5
Mechanically-assisted draft boiler or furnace commonly vented with water heater	-5
Mechanically-assisted draft boiler or furnace alone, or fan-assisted DHW alone	-15
Chimney-top draft inducer (Exhausto-type or equivalent); High static pressure flame retention head oil burner; Direct-vented appliances/Sealed combustion appliances	-50

### CAZ Failure

If a CAZ fails the worst case depressurization test by being depressurized by more than the recommended amounts listed above, the homeowner must be informed in writing of any potentially hazardous condition or situation, with recommendations to remedy or mitigate the condition or situation.

## Ductless Heat Pump<sup>2</sup>

# BEST PRACTICES FOR INSTALLING DUCTLESS HEATING & COOLING SYSTEMS

## A CONTRACTOR'S GUIDE

### Generate customer referrals and increase sales through quality installations.

Properly installed ductless systems heat and cool homes at a fraction of the cost of baseboard and wall heaters. By following installation best practices and providing homeowner education you will ensure satisfied customers.

### Installation Best Practices

Follow manufacturer's installation instructions. This guide is not intended to replace manufacturer's specifications.

#### OUTDOOR UNIT (COMPRESSOR)

- Set the unit on a stable, level surface
- Utilize risers to prevent debris and snow build-up to allow better defrost water drainage
- Secure outdoor units to a pad, risers and/or the surface on which they are set using bolts and/or adhesive



#### REFRIGERANT TUBING

- DO NOT REUSE factory tubing flares and fittings
- Create new flares using appropriate R410A flaring tool and measurement gauge
- Apply refrigerant oil to the ends of each flare
- Connect tubing on indoor and outdoor units with R410A nuts (supplied with units) using a torque wrench tightened to manufacturer's specifications



#### CONDENSATE DRAIN

- Must slope downhill and can be routed with line set or run to a different termination point
- Cannot terminate in a crawlspace or on a pathway

#### Required Tools

Ratchet Flaring Tool



Programmable Refrigerant Charging Scale



R410A Gauge and Hose Set



Torque Wrench



#### REFRIGERANT CHARGE

- Adjust refrigerant charge **ONLY IF NECESSARY**, most installations do not require adjustment from pre-charge levels
- Gauges are not needed to verify refrigerant levels; if an adjustment is needed, use a scale when adding/removing refrigerant
- Consult manufacturer's installation manual to verify refrigerant protocols as specifications change often

#### LINE SET INSULATION AND PROTECTION

- Insulation must cover entire line set length to avoid condensation and decreased efficiency
- Once insulated, protect the outdoor portion of line set with rigid line cover to avoid premature insulation damage
- Add UV tape as needed to ensure entire length is UV protected



- All penetrations through the shell of the home must be sealed with insulative sealant, any insulation disturbed by installed line set must be returned to original (or better) condition

#### COLD CLIMATE RECOMMENDATIONS

- Use a pan heater to avoid defrost discharge freezing inside compressor
- Increase clearance under the outdoor unit to promote easy drainage and reduce snow and ice build-up
- Consider wall-mount brackets to maximize outdoor unit clearance

Visit [GoingDuctless.com](http://GoingDuctless.com) for more information.

Brought to you by 

<sup>2</sup> Sourced: <http://smartwaterheat.org/>

## Ductless Heat Pump Continued

### Homeowner Education

Educating homeowners about their new ductless system will reduce call backs and generate referrals from satisfied customers.

- Ensure the homeowner has a copy of the manufacturer's operation manual that comes with the indoor unit and refer to the manual during your unit operation walk-through or training
- Provide your customer with a copy of the Project's "Homeowner's Guide" and remind the homeowner that [GoingDuctless.com](http://GoingDuctless.com) has more information about ductless heating and cooling systems



### Well-Installed Outdoor + Indoor Units = Satisfied Homeowner

Wall Penetrations Sealed with Insulative Sealant

Rigid Line Cover

Compacted Ground



Anchor Foot to Riser

Riser Block

Adhesive

Pad

Indoor Unit is Centrally Located in Home for Best Air Circulation

Indoor Unit is Installed High on Wall



Indoor Unit is Level

### CONTRACTOR RESOURCES

For more information visit [GoingDuctless.com](http://GoingDuctless.com) or call (503) 467-2159.

**"I think that it is the best way to heat and cool my house by far. I will never live without one from now on."**

*Ryan-Polson, Mont.*

Disclaimer: This document is only to be used as a general guide for providing quality installations. For complete information regarding ductless heating and cooling system features, benefits, operation, maintenance and installation requirements, review the manufacturer's installation manual of the product being installed and attend a manufacturer's training. Images of specific manufacturer product lines are not placed as endorsements, nor does this guide guarantee their quality.

The NW Ductless Heat Pump Project is an initiative of the Northwest Energy Efficiency Alliance, an alliance of the Northwest utilities and energy efficiency partners.

Visit [GoingDuctless.com](http://GoingDuctless.com) for more information.

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