PACIFIC POWER

Let's turn the answers on.

Home Energy Savings Program

Washington
HVAC Trade Ally Manual

Version 2.0
Release Date – January 1, 2014

Table of Contents

Glossary

ACCA	Air Conditioning Contractors of America
AFUE	Annual Fuel Utilization Efficiency
AHRI	Air Conditioning, Heating and Refrigeration Institute
CAC	Central Air Conditioner
CAZ	Combustion Appliance Zone Testing
CFM	Cubic Feet per Minute
ECM	Electronically Commutated Motor
EER	Energy Efficiency Ratio
HES	Home Energy Savings
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilation, and Air Conditioning
PP	Pacific Power
SEER	Seasonal Energy Efficiency Ratio
TXV	Thermal Expansion Valve
QPL	Qualified Products List

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)
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, or propane serving as the home's current primary heat source

Version History

Version #	Section	Release Date	Revision
2.0	All	January 1, 2014	Updated incentives and requirements to align with the January 2014 tariff update. Added additional technical resources for Central Air Conditioner Best Practices and Installation, Heat Pump PTCS Commissioning, Controls, and Sizing

Pacific Power's HES program will update this trade ally manual periodically.

Purpose of This Manual

This manual is meant to provide program eligible HVAC trade allies with a comprehensive technical overview of HVAC equipment and services.

Home Energy Savings Overview

The PP HES program offers cash incentives on a variety of HVAC 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 not only saves customers money on their energy bill, it also reduces the growing demand for power in the region.

The program was originally designed for single family installations but due to increased interest in multi-family[1], new homes, and manufactured homes installations; the program has extended incentives to each category involving its own unique application process. Please refer to the HES website at http://homeenergysavings.net/Washington/washington_home.html for additional requirements regarding new home, manufactured home, and multi-family incentives.

Trade Ally Overview

A trade ally is a contractor (general, HVAC, weatherization, or plumber) who sells 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 is defined as a trade ally that has met the basic requirements (outlined in the Pacific Power Trade Ally Manual) to perform work for the HES program.

Qualified trade allies:
Qualified is defined as a trade ally that has met the basic requirements (outlined in the Pacific Power Trade Ally Manual) and have also successfully completed additional relevant industry training(s) required for specific services (i.e. 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). For additional information on relevant industry trainings and certifications please refer to the state's HVAC or Weatherization trade ally manuals. 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 appropriate local resources or provide on-site technical coaching.

[1] 5 or more attached units with shared floors and/or walls

Program Eligible trade allies:

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

WA HVAC Trade Ally Requirements		
Equipment or Service	**Trade Ally Type**	**Additional Qualifications**
Central Air Conditioner New Product	Program Eligible Trade Ally	None
Central Air Conditioner Best Practice Installation and Sizing	Program Eligible Trade Ally	None
Duct Sealing (Stand Alone)	Program Qualified Trade Ally	PTCS or NATE
Duct Sealing & Duct Insulation	Program Qualified Trade Ally	PTCS or NATE
Ductless Heat Pump	Program Eligible Trade Ally	None
Heat Pump Conversion	Program Eligible Trade Ally	None
Heat Pump PTCS Commissioning, Controls, and Sizing	Program Qualified Trade Ally	PTCS or NATE
Heat Pump Upgrade	Program Eligible Trade Ally	None
Heat Pump Water Heater	Program Eligible Trade Ally	None

Central Air Conditioner New Product

Customer Incentive: $50

Trade Ally Incentive: $50

Qualifications:

- Work must be completed by a program eligible trade ally
- Minimum 15 SEER as determined by AHRI Standard 210/240
- 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

Application:

- **Central Air Conditioner** – completed and signed

Itemized receipt or invoice:

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

Additional Documents:

- **AHRI Certificate**
- W-9 for businesses receiving an incentive
- Third party addendum for property owners who are not listed on the utility account and who are applying for incentives

Existing Single Family Homes Incentives Continued

Central Air Conditioner Best Practice Installation and Sizing

Customer Incentive: $50

Trade Ally Incentive: $75

Qualifications:

- Work must be completed by a program eligible trade ally
- Minimum 13 SEER as determined by AHRI Standard 210/240
- Meet air flow/refrigerant requirements
- 350 CFM/ton of airflow
- Refrigerant charge +/- 3 degrees of target subcooling
- Equipment properly sized per program requirements. Please reference ACCA's Manual J for mandatory cooling load calculation assumptions

Application:

- **Central Air Conditioner** - completed and signed

Itemized receipt or invoice:

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

Additional Documents:

- **AHRI Certificate**
- W-9 for businesses receiving an incentive
- Third party addendum for property owners who are not listed on the utility account and who are applying for incentives

Existing Single Family Homes Incentives Continued

Duct Sealing (Stand Alone)

Electrically Heated Home Customer Incentive: $300

Electrically Cooled Home Customer Incentive: $100

Qualifications:

- 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
  **CAZ tests required for properties with non-sealed combustible heating and 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 living space
- An electric heating or electric cooling system must serve at least 80% of the home's conditioned living space

Application:

- **Duct Sealing & Duct Insulation** - completed and signed

Itemized receipt or invoice:

- Product and/or service description and costs
- Date of purchase
- Date work initiated
- Date work completed

Additional Documents:

- W-9 for businesses receiving an incentive
- Third party addendum for property owners 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

Electrically Heated Home Customer Incentive: $600
Electrically Heated Home Trade Ally Incentive: $200
Electrically Cooled Home Customer Incentive: $100
Electrically Cooled Home Trade Ally Incentive: $50
**Separate trade allies may perform the duct sealing and duct insulation services. The duct insulation trade ally will receive the trade ally incentive.*

Qualifications:

- Work must be completed by a program qualified trade ally
- Pre-existing duct insulation levels must be less than or equal to R-2 or replace all existing insulation with at least R-8
- 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 physically accessible ducts located in unconditioned living space must be insulated
- Services must result in final duct insulation of R-8 or greater
  ***CAZ tests required for properties with non-sealed combustible heating and water heating appliances*
  ****Duct sealing and duct insulation must be performed in the same project, with insulation installed after the ducts are sealed*

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 living space
- An electric heating or electric cooling system must serve at least 80% of the home's conditioned living space

Application:

- **Duct Sealing & Duct Insulation** - completed and signed

Itemized receipt or invoice:

- Product and/or service description and costs
- Date of purchase
- Date work initiated
- Date work completed

Additional Documents:

- W-9 for businesses receiving an incentive
- Third party addendum for property owners who are not listed on the utility account and who are applying for incentives

Existing Single Family Homes Incentives Continued

Ductless Heat Pump[2]

Customer Incentive: $1,000

Trade Ally Incentive: $300

Qualifications:

- Work must be completed by a program eligible trade ally
- Minimum 10 HSPF
- Equipment must be a new AHRI rated ductless (mini-split) system listed in the AHRI Certified Directory: ahridirectory.org.
- Equipment must be installed according to specifications outlined on pg. 25
- Must employ an inverter driven outdoor compressor unit and a variable speed fan for indoor blower and be fully ductless

Ensure the home qualifies:

- 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, and propane systems conversions do not qualify
- Incentive is not offered to customers replacing an existing ducted heat pump

Application:

- **Heat Pump -** completed and signed

Itemized receipt or invoice:

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

Additional Documents:

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

[2] Service may be performed on manufactured homes.

Existing Single Family Homes Incentives Continued

Heat Pump Conversion[3]

Customer Incentive: $1,250

Trade Ally Incentive: $500

Qualifications:

- Minimum 9.5 HSPF
- 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

Ensure the home qualifies:

- 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, and propane systems conversions do not qualify

Application:

- **Heat Pump** - completed and signed

Itemized receipt or invoice:

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

Additional Documents:

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

[3] Services may be performed on manufactured homes.

Existing Single Family Homes Incentives Continued

Heat Pump PTCS Commissioning, Controls, and Sizing

Customer Incentive: $200

Trade Ally Incentive: $200

Qualifications:

- Work must be completed by a program qualified trade ally
- Minimum 9.0 HSPF
- Minimum 14 SEER
- Equipment must be installed according to specifications outlined on pg. 34

Ensure the home qualifies:

Gas, oil, and propane systems conversions do not qualify

Application:

- **Heat Pump -** completed and signed

Itemized receipt or invoice:

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

Additional Documents:

- **Completed and signed PTCS Air Source Heat Pump Form**
- W-9 for businesses receiving an incentive
- Third party addendum for property owners who are not listed on the utility account and who are applying for incentives

Existing Single Family Homes Incentives Continued

Heat Pump Upgrade[4]

Customer Incentive: $150
Trade Ally Incentive: $100

Qualifications:

- Minimum 9.5 HSPF
- 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

Ensure the home qualifies:

- Work must be completed by a program eligible trade ally
- Previous primary heat source must have been a heat pump that served at least 80% of the home's conditioned area
- Gas, oil, and propane systems conversions do not qualify

Application:

- **Heat Pump -** completed and signed

Itemized receipt or invoice:

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

Additional Documents:

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

[4] Services may be performed on manufactured homes.

Existing Single Family Homes Incentives Continued

Heat Pump Water Heater[5]

Customer Incentive: Up to $600 [6]
Trade Ally Incentive: $200

Qualifications:

- Work must be completed by a program eligible trade ally
- Product must meet the Northern Climate Specifications found at neea.org/northernclimatespec
- Previous product must be an electric water heater

Application:

- **Heat Pump Water Heater -** completed and signed

Itemized receipt or invoice:

- Product brand
- Model number
- Product and installation costs
- Date of purchase
- Date work initiated
- Date work completed

Additional Documents:

- W-9 for businesses receiving an incentive
- Third party addendum for property owners who are not listed on the utility account and who are applying for incentives

[5] Services may be performed on manufactured homes.
[6] Customer incentive subject to change at any time, please visit pacificpower.net/incentives for details

Existing Single Family Homes Incentives Continued

Whole Home Upgrade Package

Customer Incentive: $1,000 bonus per home

Qualifications:

Installation of the following per program requirements:

- Air Sealing
- Duct Sealing & Duct Insulation (if main heat source is not ducted)
- Heat Pump or Ductless Heat Pump
- Whole-Home Attic Insulation
- Whole-Home Wall Insulation

Application:

The following applications must be completed and signed:

- **Insulation**
- **Duct Sealing & Duct Insulation**
- **Heat Pump**

Central Air Conditioner New Product

Incentive: $100

Qualifications:

- Work must be completed by a program eligible trade ally
- Minimum 18 SEER as determined by AHRI Standard 210/240
- 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

Application:

- **New Homes** – completed and signed

Itemized receipt or invoice:

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

Additional Documents:

- **AHRI Certificate**
- W-9 for businesses receiving an incentive

New Homes Incentives Continued

Ductless Heat Pump

Incentive: $1,300

Qualifications:

- Work must be completed by a program eligible trade ally
- Minimum 10 HSPF
- Equipment must be a new AHRI rated ductless (mini-split) system listed in the AHRI Certified Directory: ahridirectory.org.
- Equipment must be installed according to specifications outlined on pg. 25
- Must employ an inverter driven outdoor compressor unit and a variable speed fan for indoor blower and be fully ductless

Application:

- **New Homes -** completed and signed

Itemized receipt or invoice:

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

Additional Documents:

- **AHRI certificate**
- W-9 for businesses receiving an incentive

New Homes Incentives Continued

Heat Pump

Incentive: $250

Qualifications:

- Minimum 9.5 HSPF
- 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

Application:

- **New Home** - completed and signed

Itemized receipt or invoice:

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

Additional Documents:

- **AHRI certificate**
- W-9 for businesses receiving an incentive

Duct Sealing and Duct Insulation

Electrically Heated Home Customer Incentive: $600
Electrically Heated Home Trade Ally Incentive: $200
Electrically Cooled Home Customer Incentive: $100
Electrically Cooled Home Trade Ally Incentive: $50
**Separate trade allies may perform the duct sealing and duct insulation services. The duct insulation trade ally will receive the trade ally incentive.*

Qualifications:

- Work must be completed by a program qualified trade ally
- Pre-existing duct insulation levels may not exceed R-2
- 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 physically accessible ducts located in unconditioned living space must be insulated
- Services must result in final duct insulation of R-8 or greater
  ***CAZ tests required for properties with non-sealed combustible heating and water heating appliances*
  ****Duct sealing and duct insulation must be performed in the same project, with insulation installed after the ducts are sealed*

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 living space
- An electric heating or electric cooling system must serve at least 80% of the home's conditioned living space

Application:

- **Multi-family** - completed and signed

Itemized receipt or invoice:

- Product and/or service description and costs
- Date of purchase
- Date work initiated
- Date work completed

Additional Documents:

- W-9 for businesses receiving an incentive
- Third party addendum for property owners who are not listed on the utility account and who are applying for incentives

Multi-family Incentives Continued

Ductless Heat Pump

Customer Incentive: $1,000

Trade Ally Incentive: $300

Qualifications:

- Work must be completed by a program eligible trade ally
- Minimum 10 HSPF
- Equipment must be a new AHRI rated ductless (mini-split) system listed in the AHRI Certified Directory: ahridirectory.org.
- Equipment must be installed according to specifications outlined on pg. 25
- Must employ an inverter driven outdoor compressor unit and a variable speed fan for indoor blower and be fully ductless

Ensure the home qualifies:

- 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, and propane systems conversions do not qualify
- Incentive is not offered to customers replacing an existing ducted heat pump

Application:

- **Multi-family -** completed and signed

Itemized receipt or invoice:

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

Additional Documents:

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

Central Air Conditioner Best Practices Installation & 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

Appendix A Flow Conversion Tables

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

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

Appendix A TrueFlow Meter Flow Conversion Tables

Table A.2: Flow Conversion Table for TrueFlow Metering Plates (using In. H_2O)

Plate Pressure	Plate #14	Plate #20
(In. H_2O)	(CFM)	(CFM)
0.040	362	485
0.045	384	515
0.050	405	543
0.055	425	569
0.060	444	594
0.065	462	619
0.070	479	642
0.075	496	665
0.080	513	686
0.085	528	708
0.090	544	728
0.095	559	748
0.100	573	767
0.105	587	786
0.110	601	805
0.115	615	823
0.120	628	841
0.125	641	858
0.130	653	875
0.135	666	892
0.140	678	908
0.145	690	924
0.150	702	940
0.155	713	955
0.160	725	971
0.165	736	986
0.170	747	1001
0.175	758	1015
0.180	769	1030
0.185	779	1044
0.190	790	1058
0.195	800	1072
0.200	810	1085
0.172	752	1007
0.176	760	1018
0.180	769	1030
0.184	777	1041
0.188	786	1052
0.192	794	1063
0.196	802	1074
0.200	810	1085
0.205	821	1099
0.210	830	1112
0.215	840	1125
0.220	850	1138
0.225	860	1151
0.230	869	1164
0.235	879	1176
0.240	888	1189
0.245	897	1201
0.250	906	1213
0.255	915	1226
0.260	924	1237
0.265	933	1249
0.270	942	1261
0.275	950	1273
0.280	959	1284
0.285	967	1296
0.290	976	1307
0.295	984	1318
0.300	993	1329
0.305	1001	1340
0.310	1009	1351
0.315	1017	1362
0.320	1025	1373
0.325	1033	1384
0.330	1041	1394
0.335	1049	1405
0.340	1057	1415
0.345	1064	1425
0.350	1072	1436
0.355	1080	1446
0.360	1087	1456
0.365	1095	1466
0.370	1102	1476
0.375	1110	1486
0.380	1117	1496
0.385	1124	1506
0.390	1132	1516
0.395	1139	1525
0.400	1146	1535
0.405	1153	1544
0.410	1160	1554
0.415	1167	1563
0.420	1174	1573
0.425	1181	1582
0.430	1188	1591
0.435	1195	1601
0.440	1202	1610
0.445	1209	1619
0.450	1216	1628
0.455	1222	1637
0.460	1229	1646
0.465	1236	1655
0.470	1242	1664
0.475	1249	1673
0.480	1256	1681
0.485	1262	1690
0.490	1269	1699
0.495	1275	1707
0.500	1281	1716
0.505	1288	1725
0.510	1294	1733
0.515	1301	1742
0.520	1307	1750
0.525	1313	1758
0.530	1319	1767
0.535	1326	1775
0.540	1332	1783
0.545	1338	1792
0.550	1344	1800
0.555	1350	1808
0.560	1356	1816
0.565	1362	1824
0.570	1368	1832
0.575	1374	1840
0.580	1380	1848
0.585	1386	1856
0.590	1392	1864
0.595	1398	1872
0.600	1404	1880
0.605	1410	1888
0.610	1415	1895
0.615	1421	1903
0.620	1427	1911
0.625	1433	1919
0.630	1438	1926
0.635	1444	1934
0.640	1450	1942
0.645	1455	1949
0.650	1461	1957
0.655	1467	1964
0.660	1472	1972
0.665	1478	1979
0.670	1483	1986
0.675	1489	1994
0.680	1494	2001
0.685	1500	2009
0.690	1505	2016
0.695	1511	2023
0.700	1516	2030
0.705	1522	2038
0.710	1527	2045
0.715	1532	2052
0.720	1538	2059
0.725	1543	2066
0.730	1548	2074
0.735	1554	2081
0.740	1559	2088
0.745	1564	2095
0.750	1569	2102

Central Air Conditioner Best Practices Installation & Sizing Continued

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

Normal System Operating Pressure in Pascals (NSOP)

TrueFlow System Operating Pressure in Pascals. (TF SOP)	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
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)

TrueFlow System Operating Pressure in Pascals. (TF SOP)	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150
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

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

The ENERGY CONSERVATORY
DIAGNOSTIC TOOLS TO MEASURE BUILDING PERFORMANCE

Central Air Conditioner Best Practices Installation & Sizing Continued

Table B.2: Flow Resistance Correction Factors (using In. H_2O)

Normal System Operating Pressure in In. H_2O (NSOP)

TrueFlow System Operating Pressure in In. H_2O (TF SOP)	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
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_2O (NSOP)

TrueFlow System Operating Pressure in In. H_2O (TF SOP)	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
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

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

The ENERGY CONSERVATORY
DIAGNOSTIC TOOLS TO MEASURE BUILDING PERFORMANCE

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

D.1. HVAC DUCT SEALING AND INSULATION[7]

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).

[7] 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) 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
c.	Polysulfide or Polyurethane (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 U**(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.

d) CAZ testing may be omitted if a visual inspection of the combustion equipment and venting indicates that combustion gases are properly venting to outside the house and a carbon monoxide detector is installed meeting all of the requirements and recommendations of Section III.4. Carbon Monoxide Detectors.

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 3 Pascals with reference to outside.

CAZ Failure

If a CAZ fails the worst case depressurization test by being depressurized by more than 3 Pascals, 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[8]

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.

Required Tools

- Ratchet Flaring Tool 
- Programmable Refrigerant Charging Scale 
- R410A Gauge and Hose Set 
- Torque Wrench 

Installation Best Practices

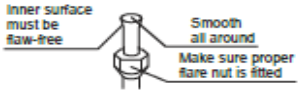
Follow manufacturer's installation instructions. This guide is not intended to replace manufacturer's specifications.

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

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 for more information.

Brought to you by neea

[8] Sourced: http://smartwaterheat.org/

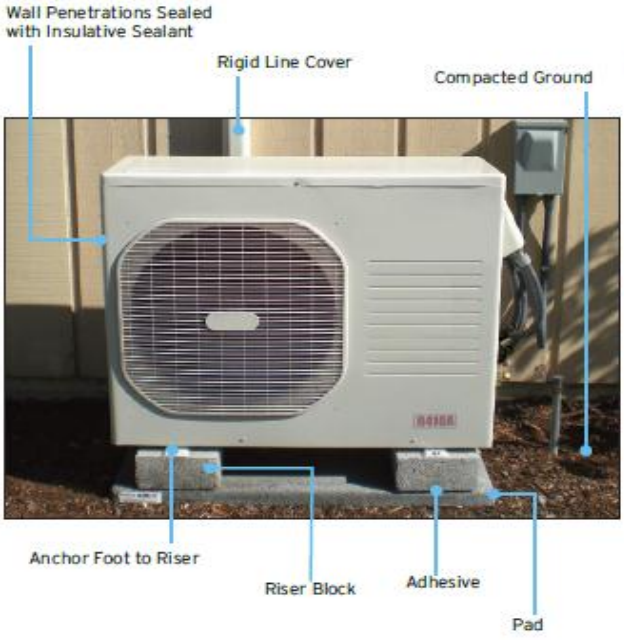
Ductless Heat Pump Continued

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 has more information about ductless heating and cooling systems

Well-Installed Outdoor + Indoor Units = Satisfied Homeowner



CONTRACTOR RESOURCES

For more information visit **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 for more information. Brought to you by neea

Heat Pump PTCS Commissioning, Controls, and Sizing[9]

PTCS
Performance Tested Comfort Systems

PTCS® Air Source Heat Pump Form

All sections must be filled out, signed, and dated by a PTCS Certified Technician at the time of installation. A copy of the completed form must be promptly submitted to the utility and homeowner in accordance with utility policy. Please enter this form online at www.ptcsnw.com or fax to 877-848-4074. Questions? Call 800-941-3867 or email ResHVAC@bpa.gov.

Site Information (Please print clearly)

PTCS Tech #	PTCS Tech Name	Install Date	Customer's Electric Utility
Customer Name	Installation Site Address*		
Site City*	Site State*	Site Zip Code*	Customer Phone # ( ) -

Home Type *(provide information for just one type, either a Site Built or Manufactured Home)*:

Site Built Home: ☐ Existing ☐ New Construction *Site Built Home Foundation Type:* ☐ Crawl Space ☐ Full Basement ☐ Half Basement ☐ Slab	*Manufactured Home:* ☐ Y ☐ N *# of Sections for a Manufactured Home:* ☐ 1 ☐ 2 ☐ 3 *Super Good Cents?* ☐ Y ☐ N

Year Built: *Heated area (sq.ft):* *Energy Star?* ☐ Y ☐ N	*Heating System Being Replaced:* ☐ Elec. Furnace ☐ Heat Pump ☐ Gas Furnace ☐ Other *(specify)*: *Gas Company (if applicable):*	Duct Sealing: if not required, indicate why ☐ ≥50% inside conditioned space ☐ ducts were previously PTCS certified ☐ pretest leakage <BPA requirements

**If mailing address is different, record here (#, City, St, Zip):*

New Heat Pump Equipment Data *Definitions: (OD) = Outdoor (ID) = Indoor*

AHRI #	SEER**	HSPF**	EER
OD and ID Unit Make:	OD Unit *Model #*	OD Unit *Capacity (tons)*	
	ID Unit *Model #*	_____ Number of compressor stages or ☐ Inverter driven heat pump	

***Bonneville Power Administration standards are 9.0 HSPF, 14 SEER. Check with utility regarding equipment eligibility if below these standards.*

External Static Pressure Test

Check unit operating at full capacity unless conditions do not permit. Attach additional sheets as needed if test must be re-run.

1. Record expected CFM/ton based on fan wiring board settings 2. Measure return static pressure 3. Measure supply plenum static pressure 4. Calculate external static pressure: add values in #2 and #3 together, ignoring the minus sign and providing absolute value.	1a. Testing Mode Used: ☐ Heating ☐ Cooling 2. Return Static Pressure 3. Supply Static Pressure	1b. CFM/Ton Setting: Units (check one) ☐ Pa ☐ Inches H_2O *Use same units for all tests* 4. External Static Pressure	***Note:*** *An External Static Pressure of 200 Pa (0.8 Inches H_2O) or more in Step 4 can result in extreme fan energy use and early fan failure.*

TrueFlow Test

Use the Performance Checks in the Reference Materials section at bpa.gov/reshvac/ to determine acceptable performance, unless using alternative method.

1. Measure Normal System Operating Pressure (NSOP) [A] 2. Check TrueFlow plate size and units 3. Note TrueFlow plate location 4. Measure Supply Pressure with TrueFlow plate in (TFSOP) [B] 5. Calculate Correction Factor [C]	1. NSOP [A]	2. Plate Size ☐ 14 ☐ 20	Units (check one) *Use same units for all tests* ☐ Pa ☐ Inches H_2O
	3. Filter Location: ☐ Air Handler ☐ Return Grille ☐ Other (specify):		
	4. TFSOP [B]	5. Correction Factor [C] from table or calculatev ([A]/[B])	
	6. Plate Pressure	7. Raw Flow CFM from tables [D]	

TrueFlow test continues on other side

Last updated: September 2012

Page 1 of 2

[9] Sourced: http://www.bpa.gov/energy/n/residential/ptcs/PTCS_Air_Source_Heat_Pump_form.pdf

Heat Pump PTCS Commissioning, Controls, and Sizing Continued

6. Measure plate pressure 7. Enter Raw Flow CFM from tables [D] 8. Calculate Corrected Flow (CFM =CF x [D]) 9. Calculate CFM/ton	8. Corrected Flow CFM = [C] x [D]	9. CFM/ton	Is flow at or above 350 CFM/ton? ☐ Y ☐ N If not, specify manufacturer CFM/ton requirement:

Refrigerant Charge Information/Testing

Does indoor unit have an ECM blower? ☐ Y ☐ N	OD air temp *Required* °F	Mode unit tested in: ☐ Heating ☐ Cooling ☐ Alternative *If > 65°F, test in cooling; if≤ 65°F, test in heating.*
Stage/Capacity Tested: ☐ High ☐ Low ☐ Other (specify):	Total lineset length ft.	Refrigerant Adjustment: ☐ Added _____oz. ☐ Removed _____oz. ☐ None

Performance Check: Run unit for at least 15 minutes in compressor-only mode before taking readings.

Use the Performance Checks in the Reference Materials section at bpa.gov/reshvac/ to determine acceptable performance, unless using alternative method.

Heating Mode (65°F or lower)	Cooling Mode (higher than 65°F)	Alternative Method
Supply Air (SA) Temp:	Discharge Pressure:	Specify method used:
Return Air (RA) Temp:	Discharge Temp [A]:	Target:
Temp Split (SA – RA):	Liquid Line Temp [B]:	Test result:
Expected Temp Split from table: Is it acceptable? ☐ Y ☐ N	Sub cooling [A] – [B]: Is it acceptable? ☐ Y ☐ N	Is it acceptable? ☐ Y ☐ N

Controls

Compressor Low Ambient Lockout control (LAL) setting: (For ALL systems, single and multi-stage compressors) ☐ 0°F ☐ _____°F or ☐ LAL not installed	Auxiliary (strip) heat lockout: ☐ ≥ 35°F ☐ ≥ 40°F ☐ Other:_____ Make *and* Model of Indoor Thermostat:
Single Capacity Compressor Systems: ☐ Applicable ☐ Not Applicable	Confirm discharge air temp. sensor is either not installed or is disabled ☐ Confirmed
Multiple Capacity Compressor systems: (☐ Applicable ☐ Not Applicable) ☐ If the discharge air sensor control is used to control auxiliary heat, confirm it is set no higher than 85°F or, ☐ If staging thermostat is set warmer than 85°F, confirm resistance heat cannot operate at temperatures above 35°F	

Installation/Technician Notes:

Required Signatures:

This section shall be filled out by the electrical utility account holder. This form must be signed by the person whose name appears on the electric utility account. ENERGY INFORMATION RELEASE: The undersigned utility customer requests and authorizes the specified utility to release billing and usage information for the account listed below to the PTCS program. With this authorization, the PTCS program can request billing information for up to two years pre-installation and two years post-installation. The utility customer also hereby releases the utility company from any and all liability arising from or connected with providing this information.

Electric Utility:	Account #:
Account holder name: *(Please print clearly)*	
Account holder signature:	Date:

By signing below, technician certifies that this form and any accompanying documentation are complete and accurate, and that all measures associated with this project were completed as of the signature date below.

Technician name: *(Please print clearly)*	Installation Company:
Technician signature:	Date: / Tech Phone #: ( ) -

PRIVACY ACT STATEMENT

Basic authority for collecting this information is authorized by 16 U.S.C. §§ 832 et. seq., and 838 et. seq., pursuant to Bonneville Power Administration's Conservation Program system of records established in 46 FR 31700. This information is primarily intended to further, but is incidental to the performance of, BPA's overall Energy Efficiency Program, the objective of which is to acquire energy resources through energy efficiency, to determine what cost-effective conservation and direct application renewable resources measures should be installed or adopted under different circumstances, and to provide incentives for the installation of such measures. Other routine issues of this information include: aggregation into a public database on energy efficiency; furnished to authorized personnel for installation/repair of equipment; aggregated into a database for program publicity; and in some instances information regarding buildings will be made available to subsequent purchasers of the buildings. Your disclosure of the requested information is voluntary; however failure to provide requested information means that it will not be possible for you to participate in this BPA Energy Efficiency program.

Last updated: September 2012