

# PTCS Duct Sealing Trainee Manual

*Updated December 2022*

Training Presented by:



Trainer Email:

Trainer Phone:

PTCS Program Staff: [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or 1.800.941.3867

Welcome to your PTCS® Duct Sealing Training! This training is designed to prepare you to seal and test ducts to PTCS specifications. We encourage you to use this manual when in the field and for future reference.

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## Performance Tested Comfort Systems® Duct Sealing Technical Specification

The Regional Technical Forum (RTF) provides guidance on installation specifications and the Bonneville Power Administration (BPA) determines when to adopt their specifications. Individual utilities may have additional requirements. Please check with your local utility for more information.

For more information on the RTF and the development of program specifications, please contact the Residential HVAC team by calling (800) 941-3867 or emailing [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov).



## PTCS Duct Sealing Specification

Updated: December, 2022

Note: Sections A, B, and C reference the pre and post-test specification. Sections 1 – 6 are in alignment with the Prescriptive Duct Sealing Specification.

### PTCS Duct Leakage Pre-Test Specifications

- A. Duct System Diagnostic Procedures:** One of the following tests shall be used to measure the duct leakage in a system, unless otherwise specified in this document.
- A.1. **Duct Leakage to Exterior Test** (Appendix A)
  - A.2. **Duct Leakage to Exterior Supply Side Only Test** (Appendix B)
- B. Home and Duct System Types**
- B.1. **Existing Home / Existing Ducts**
    - B.1.1. The air leakage of the duct system shall be measured before sealing the system using the **Duct Leakage to Exterior Test** (Appendix A).
    - B.1.2. In order to certify the ducts as PTCS, the pre-test CFM duct leakage shall be greater than or equal to 15% of the floor area if the home is less than 1667 square feet. If the home is greater than or equal to 1667 square feet, the duct leakage shall be greater than or equal to 250 CFM50.
    - B.1.3. In cases where return ducts are non-existent (building cavity return), panned joist, or inaccessible, the **Duct Leakage to Exterior Supply Side Only Test** (Appendix B) may be used to determine the duct leakage.
  - B.2. **Existing Manufactured Homes**
    - B.2.1. The air leakage of the duct system shall be measured before sealing the system using the **Duct Leakage to Exterior Test** (Appendix A).
    - B.2.2. In order to certify the ducts as PTCS, the pre-test CFM duct leakage shall be greater than or equal to 100 CFM50 for a single-wide home, 150 CFM50 for a double-wide home, or 225 CFM50 for a triple-wide home.

### Duct Sealing (Sections 1 - 6 align with the Prescriptive Duct Sealing Specification dated January 4, 2021)

1. **Ducts in Unconditioned Space:** At least 30% of the supply ducts must be located in unconditioned space and are accessible. *[Exception: Where high operating pressure leaks are located in an unconditioned space, the system shall be eligible for duct sealing, even if less than 30% of the supply ducts are in unconditioned space. A high operating pressure leak is defined as any leak occurring on the main trunk line within 15 feet of the furnace, especially those at the furnace or plenum connection.]*
  - 1.1. Ducts in basements are considered to be in conditioned space; while vented crawlspaces, attics with floor insulation, and unheated garages are considered unconditioned.
  - 1.2. The inner liner on manufactured home crossover ducts is considered accessible; while all other flexible duct connections, including those on single family homes, which have properly secured exterior liners, may be considered to have interior liners that are not accessible.
  - 1.3. The belly of manufactured homes is considered accessible if a visual inspection via non-intrusive methods (mirrors, digital cameras etc.) identifies large holes/leaks.
  - 1.4. The furnace to plenum connection is considered accessible.
2. **Previously Sealed Ducts:** Ducts must not have been previously sealed through the Performance Tested Comfort Systems or BPA's Prescriptive Duct Sealing program unless a utility pre-inspection confirms that additional duct sealing is required. Resealing of ducts is allowed should any of the following circumstances apply: rodent damage, water damage, and failure to meet minimum leakage requirements upon test, provided that all other program requirements are met.

### **3. Duct Repair**

- 3.1. All accessible portions of the duct system shall be repaired and mechanically fastened, where needed.
- 3.2. Inferior sections of duct—such as rusted, crushed, disconnected or sections otherwise ineffective—shall be repaired or replaced before duct sealing is performed.
- 3.3. When there are large gaps in sheet metal or duct connections, repairs shall be made using sheet metal, sheet metal screws, and/or mastic with mesh-reinforcing tape. Gaps greater than 1/4 inch shall be reinforced using mesh-reinforcing tape before applying mastic.
- 3.4. All metal ducts shall be secured using at least three sheet metal screws at each connection and an attempt be made to have them be equally distributed around the ducts.
- 3.5. All flexible ducts shall be joined to a section of rigid duct of matching diameter, including locations where two separate sections of flex duct meet. Both the inner and outer lining shall be secured using tensioning ties (Panduit or equivalent) tightened with a manufacturer- approved tensioning tool. Steel band clamps with worm drive tension adjusters are also acceptable.
- 3.6. In manufactured homes with two or more sections, defective or missing cross-over ducts shall be repaired or replaced.

### **4. Duct Support**

- 4.1. All accessible portions of the duct system which require support shall be supported.
- 4.2. To minimize the possibility of disconnection, flexible ducts shall be supported every 4 feet and within 3 feet of each connection to a rigid duct with straps that are not less than 1 1/2 inches wide each and that do not restrict airflow.
- 4.3. Ducts shall be supported above the ground. When contact with the ground is unavoidable, a minimum of R-4 closed-cell rigid insulation shall be placed between the duct and the ground. This duct shall not come in contact with standing water.

### **5. Duct Sealing and Acceptable Materials**

- 5.1. All accessible portions of the duct which require sealing shall be exposed and sealed with approved materials. The following are examples of sealing opportunities: Plenum; Air-handler cabinet to plenum; Plenum-to-take-off connections; Finger/dovetail joints; Branch T's, Y's and L's; Supply and Return Boots; Duct-to-duct connections; Gores on Adjustable Elbows; and End Caps.
- 5.2. Loose tape shall be removed from rigid metal ducts prior to sealing. Secured tape that remains must be completely covered with mastic which shall extend at least 1/2 inch beyond the tape edge on either side and be at least 1/8 inch thick.
- 5.3. Non-flex duct joints, connections and seams shall be sealed with UL-181 listed mastic.
  - 5.3.1. The application of mastic shall be done according to manufacturer specifications.
  - 5.3.2. Take offs and crimped fitted joints shall be mechanically secured with screws and sealed with mastic. Non-leaking seams such as S-drives or snappies are exempt from being sealed with mastic.
  - 5.3.3. On the air handler, only foil or mastic HVAC tape labeled as meeting UL-181 standards may be used.
  - 5.3.4. Cloth-backed duct tape shall not be used to seal, secure, or fasten ducts.
  - 5.3.5. Boots shall be mechanically fastened to the subfloor and sealed with UL-181 mastic or UL-181 sealant.
- 5.4. Flexible duct connections shall have the inner and outer liners secured and air-sealed with tensioning ties (Panduit or equivalent) tightened with a manufacturer-approved tensioning tool. Steel band clamps with worm drive tension adjusters are also acceptable. Tape may remain if a compression strap is installed to maintain a permanent connection.
- 5.5. The return should be sealed if it is easily accessible and in unconditioned space.
- 5.6. End caps must be made of either sheet metal or a UL-181 approved rigid product.

### **6. Duct Insulation**

- 6.1. When duct insulation is removed, the insulation shall be re-installed and securely attached to the duct system using mechanical fasteners such as, permanent plastic straps, nylon twine or fastening material specified by the insulation manufacturer. Mastic will not effectively hold insulation in place.

## 7. Combustion Appliance Requirements (Does not apply if there is no combustion appliance)

- 7.1. Whenever there is a Combustion Appliance present in the house, garage, or other attached space, a UL listed, C-UL listed, or equivalent carbon monoxide detector shall be installed.

### PTCS Duct Leakage Post-Test Specifications

#### C. Home and Duct System Types

##### C.1. Existing Home / Existing Ducts

- C.1.1. The air leakage of the duct system shall be measured after sealing using the same test method as the pre-test, the **Duct Leakage to Exterior Test** (Appendix A) or **Duct Leakage to Exterior Supply Side Only Test** (Appendix B).
- C.1.2. In order to certify the ducts as PTCS, the post-test CFM duct leakage shall not exceed 10% of the floor area served by the system (0.10 x SF CFM50) **OR** shall document a reduction of at least 50%.

##### C.2. Existing Manufactured Homes

- C.2.1. The air leakage of the duct system shall be measured after sealing using the same test method as the pre-test, the **Duct Leakage to Exterior Test** (Appendix A).
- C.2.2. In order to certify the ducts as PTCS, the post-test CFM duct leakage shall not exceed 50 CFM50 for a single wide home, 80 CFM50 for a double wide home, or 110 CFM50 for a triple wide home **OR** shall document a reduction of at least 50%.
- C.2.3. If the final tested leakage rate is greater than that specified in C.2.2., the air-handler transition-to-trunk duct connection shall be sealed.

### PTCS Duct Sealing Best Practices:

The program recommends but does not require the following as Duct Sealing best practices:

- **Duct Insulation/Asbestos:** The presence of insulation alone shall not be considered a barrier to accessibility, unless the contractor suspects asbestos may be present. If at any time asbestos is suspected to be present, it is recommended the contractor stop work immediately and notify the homeowner that the site requires professional assessment, and possibly remediation, before duct sealing work can be done.
- **Implementation Standards:** Installation must comply with all applicable codes.

## Appendix A: Duct Leakage to Exterior Test

1. Install blower door with fan bringing air into house.
2. Turn OFF air handler, dryer, all fans and combustion equipment.
3. Tape off grilles/registers. Connect duct blaster hose to return grill.
4. Open all interior doors. Close all exterior doors and windows.
5. Connect hose as shown (house wrt outside on side A).
6. Manometer **MODE** should read PR/PR.

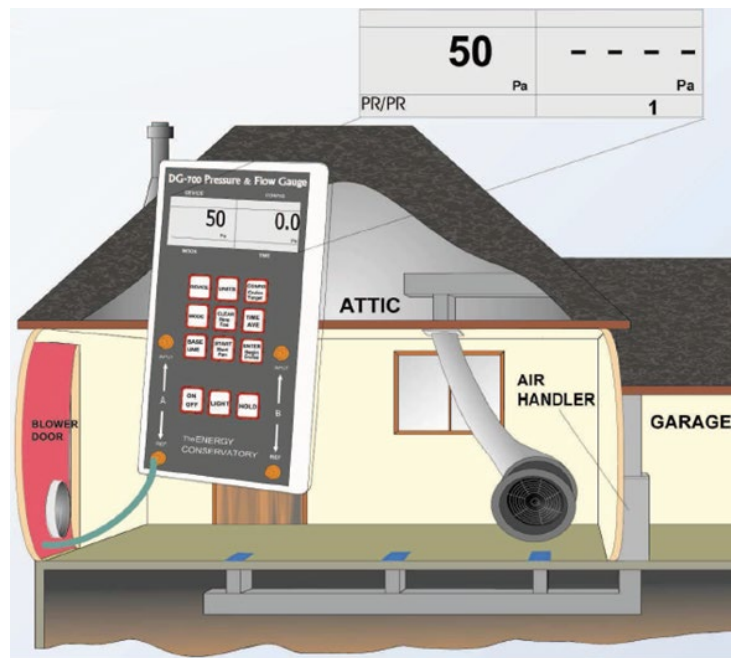


Figure 1: Duct Leakage to Exterior Test 1

7. Connect the manometer to Duct Blaster; side A to ducts (usually supply side) and side B to fan.
8. Configure manometer; **MODE:** PR/FL; **DEVICE:** DBA (if white) or DBB (if black); **TIME AVERAGE:** 1; **CONFIG:** ring you are using.
9. Turn on blower door, pressurize house to 50 Pascals (side A reading). Use cruise control if possible.
10. Pressurize the ducts (blowing air into the duct) until the pressure in the ducts side A reads 0 (with respect to the house – which means the ducts and house are both at 50 Pa with respect to outside).
11. Use the smallest ring possible to get 0 Pa. If you have to change the ring, be sure to reflect that in the manometer **CONFIG** setting.
12. Check blower door reading (house pressure wrt outside). Readjust to 50 Pa if necessary.
13. The CFM reading of the duct blaster is the leakage to outside at 50 Pa.

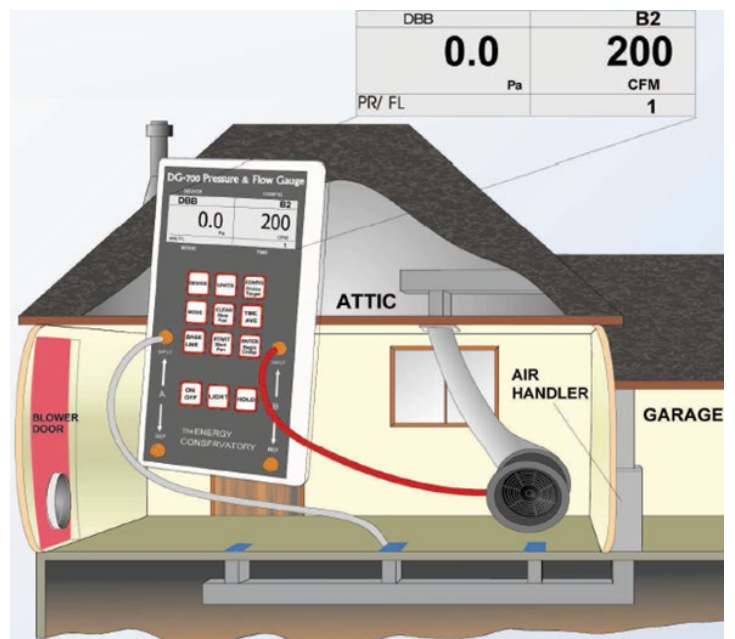


Figure 2: Duct Leakage to Exterior Test 2

## Appendix B: Duct Leakage to Exterior Supply Side Only Test

1. Isolate the supply duct from the return duct using a cardboard block or other method, typically at the furnace, and only pressurize the supply ducts with the duct blaster.



## Prescriptive Duct Sealing Specifications

Updated: April 1, 2022

1. **Previously Sealed Ducts:** Ducts must not have been previously sealed through the Performance Tested Comfort Systems or BPA's Prescriptive Duct Sealing program unless a utility pre-inspection confirms that additional duct sealing is required. Resealing of ducts is allowed should any of the following circumstances apply: rodent damage or water damage, provided that all other program requirements are met.
2. **Ducts in Unconditioned Space:** At least 30% of the supply ducts must be located in unconditioned space and are accessible. *[Exception: Where high operating pressure leaks are located in an unconditioned space, the system shall be eligible for duct sealing, even if less than 30% of the supply ducts are in unconditioned space. A high operating pressure leak is defined as any leak occurring on the main trunk line within 15 feet of the furnace, especially those at the furnace or plenum connection.]*
  - 2.1. Ducts in basements are considered to be in conditioned space; while vented crawlspaces, attics with floor insulation, and unheated garages are considered unconditioned.
  - 2.2. The inner liner on manufactured home crossover ducts is considered accessible; while all other flexible duct connections, including those on single family homes, which have properly secured exterior liners, may be considered to have interior liners that are not accessible.
  - 2.3. The belly of manufactured homes is considered accessible if a visual inspection via non-intrusive methods (mirrors, digital cameras etc.) identifies large holes/leaks.
  - 2.4. The furnace to plenum connection is considered accessible.
3. **Duct Repair**
  - 3.1. All accessible portions of the duct system shall be repaired and mechanically fastened, where needed.
  - 3.2. Inferior sections of duct—such as rusted, crushed, disconnected or sections otherwise ineffective—shall be repaired or replaced before duct sealing is performed.
  - 3.3. When there are large gaps in sheet metal or duct connections, repairs shall be made using sheet metal, sheet metal screws, and/or mastic with mesh-reinforcing tape. Gaps greater than 1/4 inch shall be reinforced using mesh-reinforcing tape before applying mastic.
  - 3.4. All metal ducts shall be secured using at least three sheet metal screws at each connection and an attempt be made to have them be equally distributed around the ducts.
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  - 4.1. All accessible portions of the duct system which require support shall be supported.
  - 4.2. To minimize the possibility of disconnection, flexible ducts shall be supported every 4 feet and within 3 feet of each connection to a rigid duct, with straps that are not less than 1 1/2 inches wide each and that do not restrict airflow.
  - 4.3. Ducts shall be supported above the ground. When contact with the ground is unavoidable, a minimum of R-4 closed-cell rigid insulation shall be placed between the duct and the ground. This duct shall not come in contact with standing water.



## 5. Duct Sealing and Acceptable Materials

- 5.1. All accessible portions of the duct which require sealing shall be exposed and sealed with approved materials. The following are examples of sealing opportunities: Plenum; Air-handler cabinet to plenum; Plenum-to-take-off connections; Finger/dovetail joints; Branch T's, Y's and L's; Supply and Return Boots; Duct-to-duct connections; Gores on Adjustable Elbows; and End Caps.
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- 5.3. Non-flex duct joints, connections and seams shall be sealed with UL-181 listed mastic.
  - 5.3.1. The application of mastic shall be done according to manufacturer specifications.
  - 5.3.2. Take offs and crimped fitted joints shall be mechanically secured with screws and sealed with mastic. Non-leaking seams such as S-drive and snappies are exempt from being sealed with mastic.
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  - 5.3.4. Cloth-backed duct tape shall not be used to seal, secure, or fasten ducts.
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- 5.4. Flexible duct connections shall have the inner and outer liners secured and air-sealed with tensioning ties (Panduit or equivalent) tightened with a manufacturer-approved tensioning tool. Steel band clamps with worm drive tension adjusters are also acceptable. Tape may remain if a compression strap is installed to maintain a permanent connection.
- 5.5. The return should be sealed if it is easily accessible and in unconditioned space.
- 5.6. End caps must be made of either sheet metal or a UL-181 approved rigid product.

## 6. Duct Insulation

- 6.1. When duct insulation is removed, the insulation shall be re-installed and securely attached to the duct system using mechanical fasteners such as, permanent plastic straps, nylon twine or fastening material specified by the insulation manufacturer. Mastic will not effectively hold insulation in place.

## 7. Combustion Appliance Requirements (Does not apply if there is no combustion appliance)

- 7.1. Whenever there is a Combustion Appliance present in the house, garage, or other attached space, a UL listed, C-UL listed, or equivalent carbon monoxide detector shall be installed.

### **Prescriptive Duct Sealing Best Practices:**

The program recommends but does not require the following as Duct Sealing best practices:

- **Duct Insulation/Asbestos:** The presence of insulation alone shall not be considered a barrier to accessibility, unless the contractor suspects asbestos may be present. If at any time asbestos is suspected to be present, it is recommended the contractor stop work immediately and notify the homeowner that the site requires professional assessment, and possibly remediation, before duct sealing work can be done.
- **Implementation Standards:** Installation must comply with all applicable codes.

## Required Documentation

The installation data can be entered in the field on a mobile device with internet access. An optional form is available for use when no internet or mobile device is accessible or the job cannot be entered for whatever reason. The customer's utility may provide their own incentive forms at their discretion and may require additional paperwork. Please contact them for more information.

The following documents are required by BPA for PTCS Duct Sealing.

- ✓ Registry Installation Report
- ✓ Equipment/Contractor Invoice

## Registry Installation Report

Report found online on <https://ptcs.bpa.gov>.

To access:

1. Sign in using installing technician's or company admin's account
2. Search for job
3. Click on measure ID link in result

or

1. Click on the measure ID link after data entry.

This report contains all the entered data and electronic acknowledgement.

## Optional PTCS Duct Sealing Installation Form

If no internet or mobile device is available or the job cannot be entered online for any reason, this form is available to record the data for later entry online. This form is aligned with the online data entry screen.

The forms can be downloaded from the registry homepage at <https://ptcs.bpa.gov> by clicking "Need an Install Form?"

There is also a copy at the end of this manual.

## Reference Materials

The tables on the following pages can be used to verify duct leakage and perform certain testing. These and more reference materials can be downloaded from the PTCS Online Registry <https://ptcs.bpa.gov> by clicking “Need Technical Support Materials?”.

# Minneapolis Duct Blaster (Series B): Flow Conversion Table

Revised January 2007

Flow (CFM)				
Fan Pressure	Open Fan	Ring 1	Ring 2	Ring 3
(Pascals)				
4				12
6				15
8				17
10				19
12				21
14				23
16				24
18				26
20				27
22				29
24				30
26	560	209	80	31
28	581	217	83	32
30	602	225	85	34
32	622	232	88	35
34	641	239	91	36
36	660	246	94	37
38	678	253	96	38
40	696	260	99	39
42	713	266	101	40
44	730	273	104	41
46	746	279	106	42
48	762	285	108	43
50	778	291	111	44
52	794	296	113	45
54	809	302	115	45
56	824	308	117	46
58	839	313	119	47
60	853	319	121	48
62	867	324	123	49
64	881	329	125	50
66	895	334	127	50
68	909	339	129	51
70	922	344	131	52
72	935	349	133	53
74	948	354	135	53
76	961	359	137	54
78	973	364	139	55
80	986	368	140	56
82	998	373	142	56
84	1010	377	144	57
86	1023	382	146	58
88	1034	386	147	58
90	1046	391	149	59
92	1058	395	151	60
94	1069	400	152	60
96	1081	404	154	61
98	1092	408	156	62
100	1103	412	157	62
102	1114	416	159	63
104	1125	420	160	64
106	1136	424	162	64
108	1147	428	164	65
110	1157	432	165	65
112	1168	436	167	66
114	1178	440	168	67
116	1189	444	170	67
118	1199	448	171	68
120	1209	452	172	68

Flow (CFM)				
Fan Pressure	Open Fan	Ring 1	Ring 2	Ring 3
122	1219	456	174	69
124	1229	459	175	70
126	1239	463	177	70
128	1249	467	178	71
130	1259	470	180	71
132	1269	474	181	72
134	1278	478	182	72
136	1288	481	184	73
138	1297	485	185	74
140	1307	488	186	74
142	1316	492	188	75
144	1325	495	189	75
146	1335	499	190	76
148	1344	502	192	76
150	1353	506	193	77
152	1362	509	194	77
154	1371	512	196	78
156	1380	516	197	78
158	1389	519	198	79
160	1397	522	200	79
162	1406	526	201	80
164	1415	529	202	80
166	1424	532	203	81
168	1432	535	205	81
170	1441	538	206	82
172	1449	542	207	82
174	1458	545	208	83
176	1466	548	209	83
178	1474	551	211	84
180	1483	554	212	84
182	1491	557	213	85
184	1499	560	214	85
186	1507	563	215	86
188	1516	566	217	86
190	1524	569	218	87
192	1532	573	219	87
194	1540	576	220	88
196	1548	578	221	88
198	1556	581	222	88
200	1564	584	223	89
202	1571	587	225	89
204	1579	590	226	90
206	1587	593	227	90
208	1595	596	228	91
210	1602	599	229	91
212	1610	602	230	92
214	1618	605	231	92
216	1625	608	232	93
218	1633	610	233	93
220	1640	613	234	93
222	1648	616	236	94
224	1655	619	237	94
226	1663	622	238	95
228	1670	624	239	95
230	1677	627	240	96
232	1685	630	241	96
234	1692	633	242	96
236	1699	635	243	97
238	1707	638	244	97
240	1714	641	245	98

Flow (CFM)

Fan Pressure	Open Fan	Ring 1	Ring 2	Ring 3
242	1721	643	246	98
244	1728	646	247	99
246	1735	649	248	99
248	1742	651	249	99
250	1749	654	250	100
252	1756	657	251	100
254	1763	659	252	101
256	1770	662	253	101
258	1777	664	254	101
260	1784	667	255	102
262	1791	670	256	102
264	1798	672	257	103
266	1805	675	258	103
268	1812	677	259	103
270	1818	680	260	104
272		682	261	104
274		685	262	105
276		687	263	105
278		690	264	105
280		692	265	106
282		695	266	106
284		697	267	107
286		700	268	107
288		702	269	107
290		705	270	108
292		707	271	108
294		710	272	108
296		712	272	109
298		714	273	109
300		717	274	110
302		719	275	110
304		722	276	110
306		724	277	111
308		726	278	111
310		729	279	111
312		731	280	112
314		734	281	112
316		736	282	113
318		738	283	113
320		741	283	113
322		743	284	114
324		745	285	114
326		748	286	114
328		750	287	115
330		752	288	115
332		754	289	115
334		757	290	116
336		759	291	116
338		761	291	116
340		764	292	117
342		766	293	117
344		768	294	118
346		770	295	118
348		773	296	118
350		775	297	119
352		777	297	119
354		779	298	119
356		781	299	120
358		784	300	120
360		786	301	120
362		788	302	121
364		790	303	121
366		792	303	121
368		795	304	122
370		797	305	122

Flow (CFM)

Fan Pressure	Open Fan	Ring 1	Ring 2	Ring 3
372		799	306	122
374		801	307	123
376		803	308	123
378		805	308	123
380		808	309	124
382		810	310	124
384		812	311	124
386		814	312	125
388		816	312	125
390		818	313	125
392		820	314	126
394		822	315	126
396		824	316	126
398		827	317	127
400		829	317	127
402		831	318	127
404		833	319	128
406		835	320	128
408		837	321	128
410		839	321	129
412		841	322	129
414		843	323	129
416		845	324	130
418		847	324	130
420		849	325	130
422		851	326	131
424		853	327	131
426		855	328	131
428		857	328	132
430		859	329	132
432		861	330	132
434		863	331	132
436		865	331	133
438		867	332	133
440		869	333	133
442		871	334	134
444		873	335	134
446		875	335	134
448		877	336	135
450		879	337	135
452		881	338	135
454		883	338	136
456		885	339	136
458		887	340	136
460		889	341	136
462		891	341	137
464		893	342	137
466		895	343	137
468		897	344	138
470		899	344	138
472		901	345	138
474		903	346	139
476		905	347	139
478		906	347	139
480		908	348	139
482		910	349	140
484		912	349	140
486		914	350	140
488		916	351	141
490		918	352	141
492		920	352	141
494		922	353	142
496		924	354	142
498		925	355	142
500		927	355	142

## Fan Flow Measurement – RetroTec

### Retrotec DU200 DucTester

Fan Press. Pa	Open High CFM	Mid CFM	Low CFM
10	100		
15	123		
20	142	30	6
25	160	34	7
30	175	37	8
35	190	41	9
40	203	44	10
45	216	46	10
50	228	49	11
55	239	52	12
60	250	54	12
65	260	57	13
70	270	59	14
75	280	61	14
80	289	63	15
85	299	66	15
90	307	68	16
95	316	70	16
100	324	72	17
105	333	74	17
110	341	75	18
115	349	77	18
120	356	79	19
125	364	81	19
130	371	83	20
135	378	84	20
140	385	86	21
145	392	88	21
150	399	89	22
155	406	91	22
160	413	92	23
165	419	94	23
170	426	95	23
175	432	97	24
180	438	98	24
185	444	100	25
190	451	101	25
195	457	103	25
200	463	104	26
205	468	106	26
210	474	107	27
215	480	108	27
220	486	110	27

Fan Press. Pa	Open High CFM	Mid CFM	Low CFM
230	497	112	28
235	502	114	28
240	508	115	29
245	513	116	29
250	518	118	30
255	524	119	30
260	529	120	30
265	534	121	31
270	539	123	31
275	544	124	31
280	549	125	32
285	554	126	32
290	559	127	32
295	564	129	33
300	569	130	33
320	588	134	34
340	607	139	36
360	625	143	37
380	642	148	38
400	659	152	39
420	676	156	41
440	692	160	42
460	708	164	43
480	724	167	44
500	739	171	45
520	754	175	46
540	769	178	47
560	783	182	48
580	797	185	50
600	811	189	51
620	825	192	52
640	839	196	53
660	852	199	54
680	865	202	55
700	878	205	56
720	891	209	57
740	903	212	58
760	916	215	58
780	928	218	59
800	940	221	60
820	952	224	61
840	964	227	62
860	975	230	63



## Program Requirements for Performance Tested Comfort Systems® and Prescriptive Duct Sealing

### Introduction

This document sets forth the minimum program requirements for trainers and trainings, technicians and installations, and quality assurance (QA) delivered in connection with the Performance Tested Comfort Systems® (PTCS) Program and the Prescriptive Duct Sealing measures. For Bonneville Power Administration (BPA) utilities, the program requirements outlined here replace the PTCS Provider Standards issued by the Regional Technical Forum.

1. **Trainer Requirements**
2. **Technician Requirements**
3. **Quality Assurance Requirements**

### 1. Trainer Requirements

- 1.1. **Minimum Trainer Qualifications** –Trainers shall meet all requirements for technician certification and meet the following minimum standards:
  - 1.1.1. **PTCS Heat Pump Commissioning Trainers** shall have a minimum two (2) years verifiable full time experience installing or inspecting the following: testing heat pump auxiliary heat controls, indoor coil airflow, sizing and refrigerant charge. Applicants' projects will be reviewed and possibly inspected for accuracy and pass rate.
  - 1.1.2. **PTCS Duct Sealing Trainers** shall have a minimum two (2) years verifiable full time experience installing or inspecting the following: duct system testing, diagnostics, repair, and sealing in site built and manufactured homes. Applicant's projects will be reviewed and possibly inspected for accuracy and pass rate.
  - 1.1.3. Maintain an acceptable history of delivered training quality, at the discretion of the BPA program manager.
  - 1.1.4. Trainers shall have training and/or teaching experience that is supported with a reference who can attest to teaching effectiveness. This must be for teaching activities that have happened in the last two years. If current trainers or applicants do not have this experience, they may conduct two trainings that may be observed, evaluated, or coached to monitor for teaching effectiveness.
  - 1.1.5. The program will have a yearly renewal requirement (i.e. attend the annual Train-the-Trainer training session provided by BPA) that will allow for new program information to be passed from the program to trainers.
  - 1.1.6. Heat Pump trainers are not required, but are encouraged to have industry certifications such as NATE or BPI.
  - 1.1.7. Trainers will be asked to provide information about their background of working with energy efficiency.
  - 1.1.8. Provisional approval is granted upon application submittal that meets these requirements. Full approval is granted following provisional approval and upon a BPA-approved PTCS certified trainer observing a training.
- 1.2. **Training Requirements** – Trainers may certify a technician in PTCS or Prescriptive Duct Sealing only if the trainee has scored not less than 80% on a BPA-provided written test and meets all other requirements for the specific training, as listed in the following sub-sections. The trainee will be able to operate necessary equipment, complete program installation form(s) and understand program QA requirements.
  - 1.2.1. **PTCS Heat Pump and Duct Sealing Trainings** Trainers must conduct at least two trainings per year. Trainings must utilize PTCS program provided presentations and collateral. Trainers must offer a PTCS program provided evaluation to trainees at the conclusion of the training and will submit evaluations to the PTCS program.





- 1.2.2. PTCS Heat Pump Trainings** shall prepare the trainee to demonstrate understanding of auxiliary heat control requirements, airflow testing using approved methods, sizing, and refrigerant charge methods. The training must include hands-on experience, and all trainees must demonstrate their skills to pass the class.
- 1.2.3. PTCS Duct Sealing Trainings** shall prepare the trainee to demonstrate competency in duct system testing, diagnostics, repair, and sealing in site built and manufactured homes; capture and record required CFM duct leakage measurements; conduct a total duct leakage test; and conduct a duct leakage to outside test.
- 1.2.4.** Trainers shall provide student with dated proof of training completion after the students have demonstrated mastery of the subject.
- 1.2.5.** Trainers will confirm an individual's training completion status to BPA and/or BPA utilities upon request.

## 2. Technician Requirements

- 2.1.** Technician shall submit dated proof of training completion for the measures they install. In addition to PTCS or Prescriptive Certifications from BPA-approved trainers, additional acceptable trainings are listed below.
- 2.1.1.** PTCS Heat Pump alternatives: BPI® AC and Heat Pump Professional, NATE® Heat Pump Service Certification, CheckMe!, a two year vocational degree in Air Source Heat Pump installations, or a verifiable apprenticeship with a BPA-approved technician lasting a minimum of 2 years.
- To receive alternative certification a technician must complete the following steps:
- 1) Watch the flow plate instruction and heat pump sizing videos on the BPA YouTube Channel page:
    - <https://www.youtube.com/watch?v=iKOakSgQPm8&t=4s>
    - <https://www.youtube.com/watch?v=yrmN3ZuAv90>
    - <https://www.youtube.com/watch?v=yc4H9vnbHhs&t=3s>
    - <https://www.youtube.com/watch?v=vVoCDs3rkC0>
  - 2) Complete the PTCS Heat Pump Admin/Sales class on the PTCS Learning Management Site:
    - <https://clearesult.moodle.school/login/index.php>
  - 3) Quick call with a PTCS Trainer to go over any other details (ESP probe locations, TrueFlow® Air handler Flow Meter, etc.). Regardless of certification type, technician shall be trained to use a TrueFlow® Air Handler Flow Meter.
- 2.1.2.** PTCS Ground Source Heat Pumps require a heat pump credential identified in 2.3.1, and an International Ground Source Heat Pump Association (IGSHPA) certification. Ground Source Heat Pumps may be installed by both a PTCS Heat Pump technician and an IGSHPA certified technician or one technician certified in both.
- 2.1.3.** PTCS and Prescriptive Duct Sealing training alternatives: [Please see the Prescriptive Duct Sealing Program Requirements](#). A certified PTCS Trainer can approve a technician for PTCS Duct Sealing certification if the technician demonstrates adequate experience and knowledge required to certify duct sealing to meet Prescriptive and PTCS standards. Technicians seeking to PTCS certify duct sealing shall have been trained to test duct leakage according to PTCS standards.
- 2.2.** Technicians who attend a PTCS Duct Sealing training will also be certified for Prescriptive Duct Sealing. Technicians can complete the online [Prescriptive Duct Seal Certification Training](#) to be certified for only Prescriptive Duct Sealing.
- 2.3.** Technicians must create an account on the PTCS Online Registry at <https://ptcs.bpa.gov>, and enter projects there. Projects must be approved in Registry before incentives can be paid.
- 2.4.** Technicians must complete, sign, and submit the Certified Technician Application to BPA and be approved prior to installing heat pump or duct sealing measures. Technicians will be ineligible to do work or access the online







- 2.5. registry until the application has been approved.
- 2.6. Technicians are responsible for maintaining current knowledge of technical standards and program requirements. BPA offers technicians annual continuing education classes for this purpose, and technicians are strongly encouraged to attend.
- 2.7. New PTCS Heat Pump technicians shall inform the PTCS program of the first three projects to be input into the registry for quality assurance inspections of installations through video or photo review. Technicians with high quality assurance inspection failure rates will be subject to increased quality assurance inspections.
- 2.8. Technicians shall respond promptly and correctly to data input issues and QA inspections. Technicians are required to correct errors identified during the QA inspection within 10 business days of notification. Failure to do so may result in disqualification from BPA programs.

### 3. Quality Assurance (QA) Requirements

- 3.1. **Heat Pump QA Inspectors** shall have documented experience commissioning and/or co-commissioning a minimum of 10 certified systems, and possess current PTCS certification (or other approved certification). Utility employees may request an opportunity to demonstrate testing skills to BPA as a substitute. Heat Pump QA Inspectors shall participate in BPA's annual PTCS continuing education or PTCS refresher webinars to stay on top of program specs and issues. BPA reserves the right to consider other performance issues, in addition to QA performance.
- 3.2. **Duct System QA Inspectors** shall have documented experience testing and/or co-testing a minimum of 10 systems and possess current certification (or other approved alternative). Utility employees may request an opportunity to demonstrate testing skills to BPA as a substitute. Duct system QA Inspectors shall participate in BPA's annual PTCS continuing education or PTCS refresher webinars to stay on top of program specs and issues. BPA reserves the right to consider other performance issues, in addition to QA performance.
- 3.3. New QA inspectors must [submit an application](#) and be approved by the program prior to performing inspections.
- 3.4. Certified inspectors may not conduct QA inspections in a territory where they install PTCS or prescriptive duct sealing measures.
- 3.5. Utilities may request reimbursement from BPA for inspections they conduct by submitting a Letter of Interest. The Letter of Interest and submittal instructions are available by request to the BPA program manager.
- 3.6. Only QA inspections performed by a BPA-approved QA inspector shall be entered in the online registry. BPA will coordinate efforts to achieve a QA rate of approximately 10% of all projects per program year.
- 3.7. Inspectors shall use BPA Quality Assurance Inspection Forms to collect inspection data and determine whether a site has passed or failed inspection. Inspectors shall record these results in the PTCS online registry.
- 3.8. The QA inspector has the responsibility to: (1) fail any system that he/she finds does not meet installation specifications adopted by BPA at the time of installation; (2) report that failure to the BPA program manager, utility and technician; (3) identify corrective actions required to bring substandard systems up to measure specifications; (4) support BPA audits of prior QA inspections as requested.
- 3.9. *Timeliness:* For QA to be most effective, an inspection should be done within 90 days or, in new homes, before owner occupies the home.
- 3.10. Repeated failures will lead to additional training requirements or other measures to improve technician performance. Failure to improve performance may lead to technician removal from the program.





**3.11. Duct Sealing Inspections** shall be designated as passing according to these requirements:

- 3.11.1.** A visual inspection shows that high pressure areas have been sealed (air handler, supply, plenum, and take-offs). Physical items to check: UL-181 Mastic is applied according to manufacturer's specifications, straps are used if needed, no ducts are disconnected, no tape is used on the system except UL 181 tape on the access cover only, and a CO detector is installed in homes with combustion air zones.
- 3.11.2.** In addition to the visual inspection, PTCS duct sealing jobs shall not have duct leakage (CFM) exceeding 120% of the program requirements,
- 3.11.3.** "Fail" if it does not meet any of the applicable inspection criteria. The technician must return to the jobsite and perform the required corrections.
- 3.11.4.** Duct Accessibility: The following guidelines can be used to determine if a portion of a duct system is accessible or not. Accessible ducts do not require drywall patching, are within reasonable reach by an average person, and do not require destruction of duct insulation. Technicians may consider pressure boundary manipulation (bringing ducts within pressure boundaries of the house) as an alternative to sealing difficult to reach ducts.

**3.12. Heat Pump Inspections** shall be designated as passing according to these requirements:

- 3.12.1.** Equipment – meets program-required at least 9.0 HSPF/7.6 HSPF2 and 14 SEER/13.4 SEER2 requirements for PTCS measures and federal minimum standard for commissioning, controls, & sizing measures
- 3.12.2.** External Static Pressure – measurement at or below 0.8 inches of water (200 Pa). See spec for a different requirement pertaining to a VSHP.
- 3.12.3.** Airflow measurement at or above 325 CFM/ton (this allows for testing equipment error rate). The CFM/ton may be lower if recommended by the heat pump manufacturer.
  - 1) For projects with an airflow value submitted using the ESP-CFM Manufacturer Table methodology, the inspector will note the airflow value using observable fan settings and available ESP-CFM tables.
    - If fan settings are not observable, airflow will be tested using a TrueFlow® Air Handler Flow Meter for reference purposes only.
  - 2) Airflow measurement is not required for variable speed systems, but airflow should be confirmed if performing an inspection at the time of installation.
- 3.12.4.** Auxiliary heat settings are set to only come on at or below 35°F in normal (no defrost) operation.
- 3.12.5.** Refrigerant charge: use the minimum expected temperature split method and/or verification of compliance with manufacturer requirements for line set length and ounces of refrigerant added. Minimum temperature split testing is not required for variable speed systems.
- 3.12.6.** Ensure correct heat loss calculations and proper equipment sizing.
- 3.12.7.** "Fail" if it does not meet any of the inspection criteria. Except for sizing, the technician must return to the jobsite and perform corrections to bring the system into compliance. Incorrect sizing automatically triggers a corrective action plan or review of the contractor's sizing calculations for accuracy and appropriate inputs, if approved by BPA.



## Frequently Asked Questions

This document is intended to provide program specific information for utilities, PTCS certified technicians and companies about the BPA PTCS (heat pump and duct sealing) and Prescriptive duct sealing program. *Utility programs determine their own reimbursement criteria, which may include additional requirements above and beyond what BPA requires. Contractors should be aware of their customers' utility requirements before starting work.* Answers provided below may be revised if the program, BPA Implementation Manual, or PTCS specifications change.

### How to Participate

#### How can I become a certified PTCS technician?

##### 1. Get Trained

- PTCS Technician (heat pump and duct sealing): Attend and pass a training with a [BPA-approved trainer](#), or show proof of completing an approved [alternative training](#) (See *Program Requirements, Section 2*).
- Prescriptive Duct Sealing Technician: Complete the Prescriptive Duct Sealing training, a link can be found in the [Prescriptive Duct Sealing Program Requirements](#).

**2. Create an online account** on the [PTCS Online Site Registry](#) if you have not previously done so. Click on “Register” in the top right-hand corner to get started.

**3. Submit completed [Certified Technician Application](#)** along with dated proof of training by email to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov), or fax to 1-877-848-4074.

#### How can I get a PTCS Technician ID?

After the technician creates an [online account](#), the PTCS team has received the complete [application](#), and approved the training; the team will activate the account. The PTCS Technician ID will be sent to the email on file with the account.

**I have an industry certification. Can I get a certification without additional training?**

We accept several industry certifications. A list of all approved alternative certifications in the [PTCS Duct Sealing and Heat Pump Program Participation Requirements](#) is available.

**What if I change companies?**

Submit a new [Certified Technician Application](#) with your new company information and an explanation of what was updated to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov). Do not enter jobs completed with your new company before your account has been updated.

**How do I update my account if I get an additional certification?**

Submit a new [Certified Technician Application](#) to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) and include your new certification and relevant training information.

**Do I need a new online account for each new certification I obtain?**

No. We will update your existing account with the additional certifications listed on your application.

**If I get locked out of my account or forget my password, should I create a new account?**

No. Please don't create another account since it will generate a duplicate account. Contact the customer service team by email at [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or by phone at 1-800-941-3867 and we can help you get the information you need.

**How do I become a trainer and/or inspector?**

Start by reviewing the [Program Participation Requirements](#), [Trainer Participation Application](#), and [Quality Assurance Inspector Application](#). Contact the PTCS Program if you have any questions.

## PTCS Online Registry User Guide

The website can be found here: <https://ptcs.bpa.gov/>

The PTCS website is an online tracking tool where:

- All completed jobs are required to be entered into the online registry. Upon entry, all jobs are automatically reviewed for compliance with the specification. A status is assigned reflecting that review (status definitions are later in this section).
- New technicians must create an account to be certified and receive their PTCS technician ID
- Utilities can view and track entered jobs in their territory
- Quality Assurance inspections are entered and tracked
- Optimized for use on mobile devices

**What mobile devices can be used with the mobile PTCS site?** Smartphones (Apple, Android, etc.), tablets, and other mobile devices with internet access.

**Can the Mobile Site be used if some data is unavailable?** Yes. Enter as much data as you can then “Save Progress” to access and complete it later.

**What to do after entry?** Submit the required paperwork to the customer’s utility.

Technicians and office staff can search for and view reports for jobs entered into this system. Technician can enter projects they worked on. Contact the PTCS team at [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or call (800) 941-3867 to request additional access to view all work entered for a company or with any questions about functionality or access.

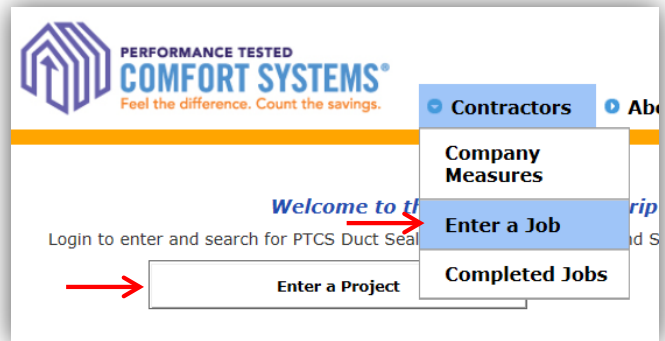
## Log In to the System/Create an Account

If you have not previously created an account on this website previously, click on “Register” in the top right-hand corner. If you have previously created an account on this website, click on “Login” in the top right-hand corner. If you need a login information reminder, click on “Forgot your Password?” or “Forgot your User Name?” on the Login screen.

The screenshot shows the PTCS Online Registry login and registration interface. At the top right, there are buttons for 'Login' and 'Register'. Below these are links for 'About the Program' and 'Contact Us!'. The main section is titled 'Login' and contains a form with 'User Name' and 'Password' input fields. There is a 'Keep Me Logged In' checkbox and a 'Log In' button. Below the form are three links: 'Create a New Account', 'Forgot your Password?', and 'Forgot your User Name?'. Red arrows point to the 'Register' button in the top right and the 'Forgot your User Name?' link at the bottom.

## Entering an Air Source Heat Pump Online

- 1) Log in to installing technician's account at <https://ptcs.bpa.gov/>
- 2) Click on "Enter a Project" button or click on "Contractors" then "Enter a Job" from menu button.



- 3) Enter site address and click "Next"
  - Address not validating? Send form to BPA by fax to (877) 848-4074 or email to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov).

- 4) Click on the correct address. If option is not available, click "Previous" to edit accordingly or contact program staff.

- 5) Enter site details
- 6) "Existing Heat System Type":
  - **New construction home:** Select newly installed heating system
  - **Existing home:** Select heating system being replaced

- 7) Select installation type
  - Option link not available? Account certification types might not be updated. Contact the BPA PTCS team.
  - Already one entered? Search for previously entered jobs for this site and/or contact the BPA PTCS team.

8) Enter duct sealing and testing information.

**Certificate Information**  
 Completed Date: 09/01/2015  
 Percent of ducts in conditioned space: Less than 50% of ducts are in unconditioned space

**Duct Sealing Data**  
 New or existing ducts?: Seal Existing Ducts  
 Is this information provided for Record Only?: No  
 What type of equipment did you use?: Energy Conservatory (Duct Blaster)

**HOUSE PRESSURIZATION**  
 House Pressurization:  50 Pa  Other: \_\_\_\_\_

**PRE-TEST**  
 Pre-Test Ring: Open  
 Pre-Test Duct Blaster Fan Pressure: 240 (Pa)  
 Pre-Test Flow: 1714 (CFM<sub>50</sub>)

**POST-TEST**  
 Post-Test Ring: 3  
 Post-Test Duct Blaster Fan Pressure: 74 (Pa)  
 Post-Test Flow: 53 (CFM<sub>50</sub>)  
 Duct Blaster Location: Kitchen  
 Pressure Tap Location: Living Room

**CAZ Test**  
 Is there a combustion appliance zone?: Yes  
 Is a CO detector installed?: Yes

**Notes**

**Callout Box 1:** The leak is calculated using the size of the ring and the pressure of the fan. The calculated reduction is based on the calculated leak.

**Callout Box 2:** Fan pressure is not the same as house pressure.

9) Check the Required Acknowledgement box, depending on who is entering this job.

**Required Acknowledgement**

By checking one box below, the PTCS certified technician or administrator entering data on behalf of the certified technician acknowledges the following:

- 1) This project and any accompanying documentation are complete and accurate.
- 2) This project may be selected for a Quality Assurance (QA) inspection and any necessary remediation will be addressed in the required timeframe.

**Certified Technician:** I certified the project and it meets program specifications.

**I am an administrator entering on behalf of the Certified Technician.**

Clicking 'Finish' will begin the validation process to determine if the data meets the PTCS specification. A status and any relevant details will appear on the next screen. By clicking 'Save Progress', no validation will be performed and entered data will be saved to allow for later completion.

**This measure provided via CheckMe!**

10) Click "Finish" to complete or "Save Progress" to complete later

- Final screen: Measure ID/Job ID numbers and status listed (includes save progress feature for later measure completion)
- "Pending" jobs are reviewed weekly; contact program staff for immediate review
- Contact program staff if job needs to be rejected, corrected, or re-entered

## Registry Statuses Explained: PTCS Duct Sealing

Each time a completed job is entered into the registry, it is assigned a status based on the input validation.

**BPA Approved:** These measures meet all of the program installation and Implementation Manual requirements and can be claimed for payment by BPA utilities.

**In Progress:** Incomplete saved job that is assigned a measure number for later completion

**PTCS Certified Only:** These measures are tested for CFM leakage and meet minimum tightness and quality installation requirements of PTCS, but did not meet the pre-test requirements for additional sealing, testing, or payment.

**BPA Pending:** This occurs when something in the job requires further review. The PTCS team reviews these on a weekly basis. Please contact us if you require more immediate review.

**Rejected:** These measures did not meet the requirements of the program.

## How to Find an Entered Job

<p>Select "Completed Jobs" from the Contractors drop down menu or by clicking "Search for Project" on the homepage.</p>	 <p>The screenshot shows the top navigation bar of the PTCS Online Site Registry. The 'Contractors' menu is open, displaying three options: 'Company Measures', 'Enter a Job', and 'Completed Jobs'. The 'Completed Jobs' option is highlighted in blue. Below the navigation bar, the page title 'Prescriptive Online Site Registry' is visible, followed by a search bar labeled 'Search for Project'.</p>
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Search for completed jobs using any type of criteria and click “Search”. Data can also be exported into a .csv file.

**TIP!** Search using very little. E.g. only the house number (“123” from 123 Main St.).

### Contractor Measures My Current Job Statistics

Please click on an item below to view details, or [click here](#) to start a new job.

Measure Installed: between  and

Measure Entered: between  and

Measure ID:

Status: (Ctrl+click to select or deselect items)  
 Accepted  
 Audit  
 BPA Approved  
 BPA Pending

Address:  \*To broaden results, omit directional words (i.e. NW, Southwest) or street types (i.e. Rd, Street)

Address Line 2:

City:

Tech ID:

Company Name:

Measure Type:

Utility: (Ctrl+click to select or deselect items)  
 Albion, City of  
 Alder Mutual Light Company  
 APS (Arizona Power Supply)  
 Ashland, City of  
 Asotin County PUD No. 1

**Search**

Reset

**Export Results**

Clicking on the measure ID will result in a report you can print and provide to the customer utility.

Measure ID	Measure Type	Entered	Status	Installed	Notes
650871 - 1234 Test test Portland, OR					
<b>1768531</b>	Prescriptive Duct Seal	2/25/2016 9:48 AM	Record Only	2/1/2016	

## Some Frequently Asked Questions about Using the Registry

### I need something edited. Help!

The PTCS team can edit submitted information for you without updating the measure ID. Contact them by email at [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or call 1.800.941.3867.

### When I submit a job online, do I have to notify the utility that it is completed or does BPA do that for me?

Yes, the responsibility is on the technician and/or their company to notify the utility that a job is complete and entered into the site registry. Please contact the utility to find out what paperwork they require and how to submit information.

**What if there is more than one heat pump job at the home?** Call the PTCS team at (800)-941-3867 or email at [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov).

**How do I enter a job with a lot number?** On the initial “Site Address” screen, please enter the site’s lot number in the “Street Address 2” field.

**What do I do if the address cannot be verified upon entry?** Please verify the address is correct and submit the form(s) by email to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or by fax to (877) 848-4074.

**What do I do if a job I enter has a status of “Pending”?**

Two Options:

- Jobs in BPA territory: This team reviews jobs in a “Pending” status on a bi-weekly basis. Please call (800)-941-3867 or email [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov).
- Jobs in ETO territory (Pacific Power or Portland General Electric): The ETO team regularly reviews jobs in a “Pending” status. Please call 1-866-365-3526 or email [residentialforms@energytrust.org](mailto:residentialforms@energytrust.org) if you require more immediate review or if you have any questions.

**How to complete a saved job?** Log into the registry using the installing technician’s account. Search for the saved job by measure ID or address and click “Continue Progress” in the search results.

**What is the difference between a job ID and a measure ID?** No difference. These terms are referring to the same number, which is currently a seven digit number.

**What do I do if I have to re-enter a job or have to fix something that was already entered and approved?**

- Jobs in BPA territory: Please call (800)-941-3867 or email [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) if you require more immediate review or if you have any questions.
- Jobs in ETO territory (Pacific Power or Portland General Electric): Please call 1-866-365-3526 or email [residentialforms@energytrust.org](mailto:residentialforms@energytrust.org)

## Quality Assurance

All PTCS certified technicians agree to have a percentage of their jobs reviewed by third party inspectors. PTCS Service Providers, such as CLEAResult and utility inspectors, conduct these site inspections and provide feedback to technicians and utilities in order to continue to improve the quality of the installations.

Quality assurance site visits include a visual inspection of equipment and testing leakage to ensure that the ducts are sealed well. There is no additional charge to the customer for these visits.

Technicians will be contacted following the inspection with regarding any required remediation action.

PTCS Duct Sealing will be inspected and graded on:

- ✓ CFM Leakage
- ✓ CO Detector Installation (if required)
- ✓ Air Handler to Plenum Connection
- ✓ Ducts in Good Repair
- ✓ Joints Fastened
- ✓ Tape Removed and/or Covered with Mastic
- ✓ Ducts Sealed
- ✓ Duct Insulation Reinstalled
- ✓ Crossover (*Manu Home Only*)

## Technician Support Plan

If you have an inspection that failed, you will be contacted about the status and what can be corrected. The image below is included at the end of this manual and depicts the process for remediating jobs.



If any corrective action is required, the homeowner must be contacted **within 10 business days of notification**. **Action must be taken within 10 business days of contact** or as soon as the homeowner is available.

## Marketing Materials to Grow Your Business: Free and Customizable

The PTCS Program has developed several marketing materials available for use. They are free to customize and use. Go to our marketing material portal to find all of these materials:

<https://www.bpa.gov/EE/Utility/marketing/Pages/BPA-Marketing-Portal.aspx>

Contact the ResHVAC team at [reshvac@bpa.gov](mailto:reshvac@bpa.gov) with any questions on customizing.

What's available:

- PTCS General Marketing: PTCS logo, tagline, and program poster
- Duct Sealing: Ad, bill stuffer, brochure, postcard, and several orientations of web banners



## Stay Informed

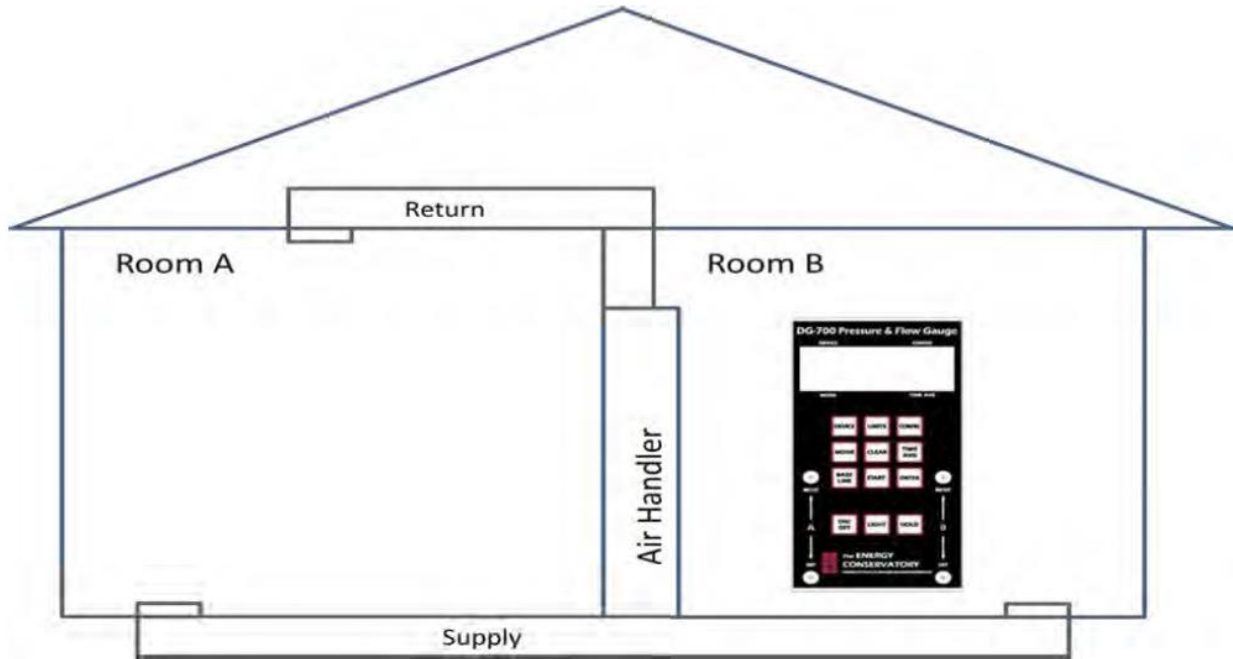
Questions? Contact your PTCS Trainer or the PTCS Program Team ([ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov); (800) 941-3867).

Stay informed by signing up for our newsletter. How to sign up:

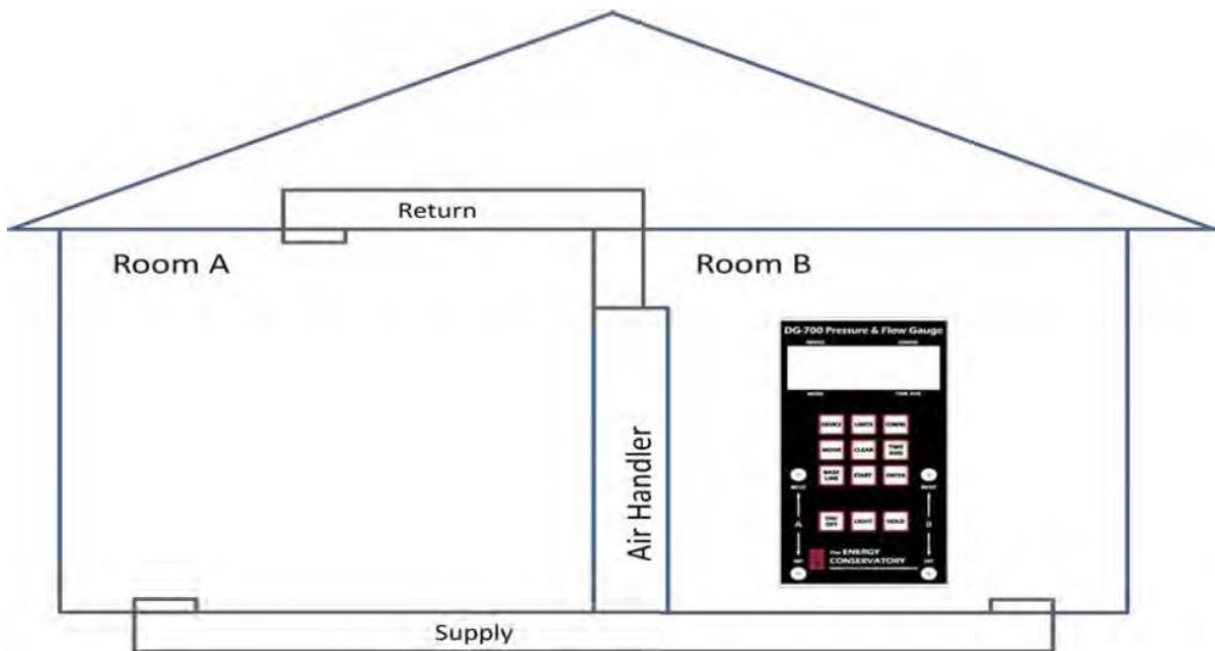
- On <https://ptcs.bpa.gov/>, click on "Stay Informed!" link at the bottom
- Email [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov)

## Student Activities

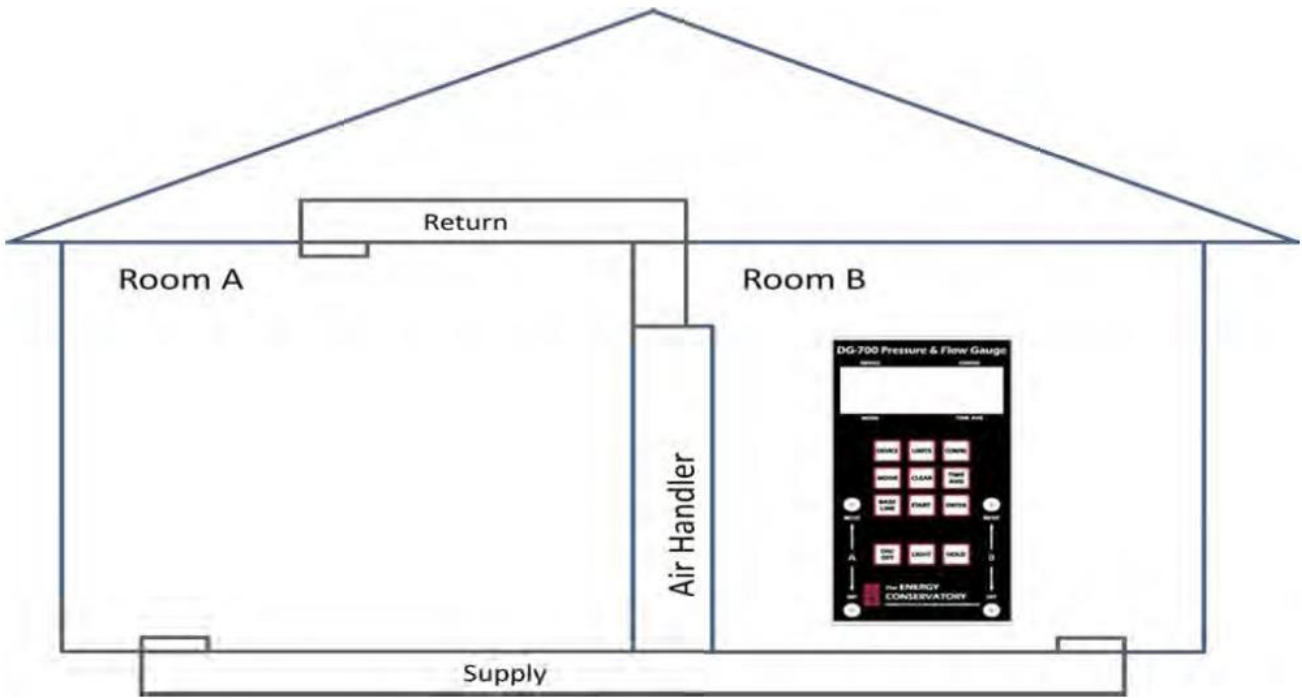
The following classroom activities are designed to help you prepare for work in the field. These should be completed in class and are not graded and your answers do not count against you.



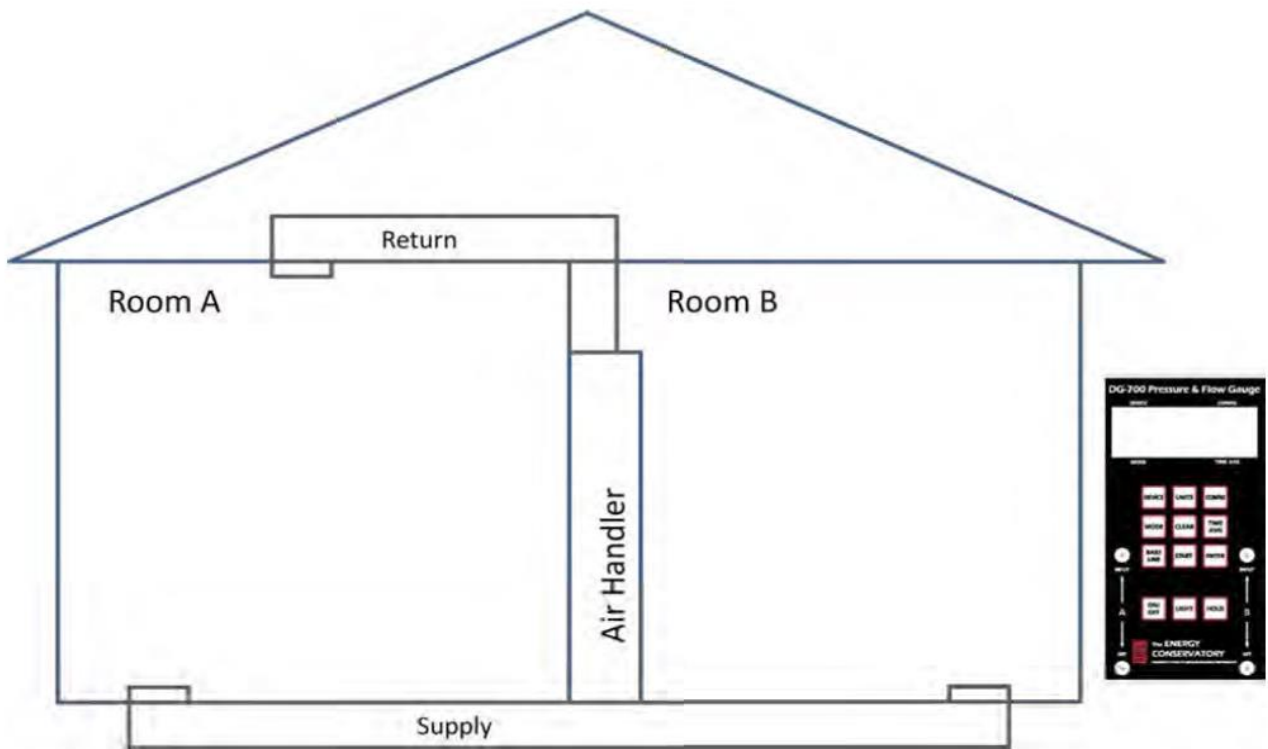
**House with reference to outside**



**House with reference to attic**



**Supply ducts with reference to house**



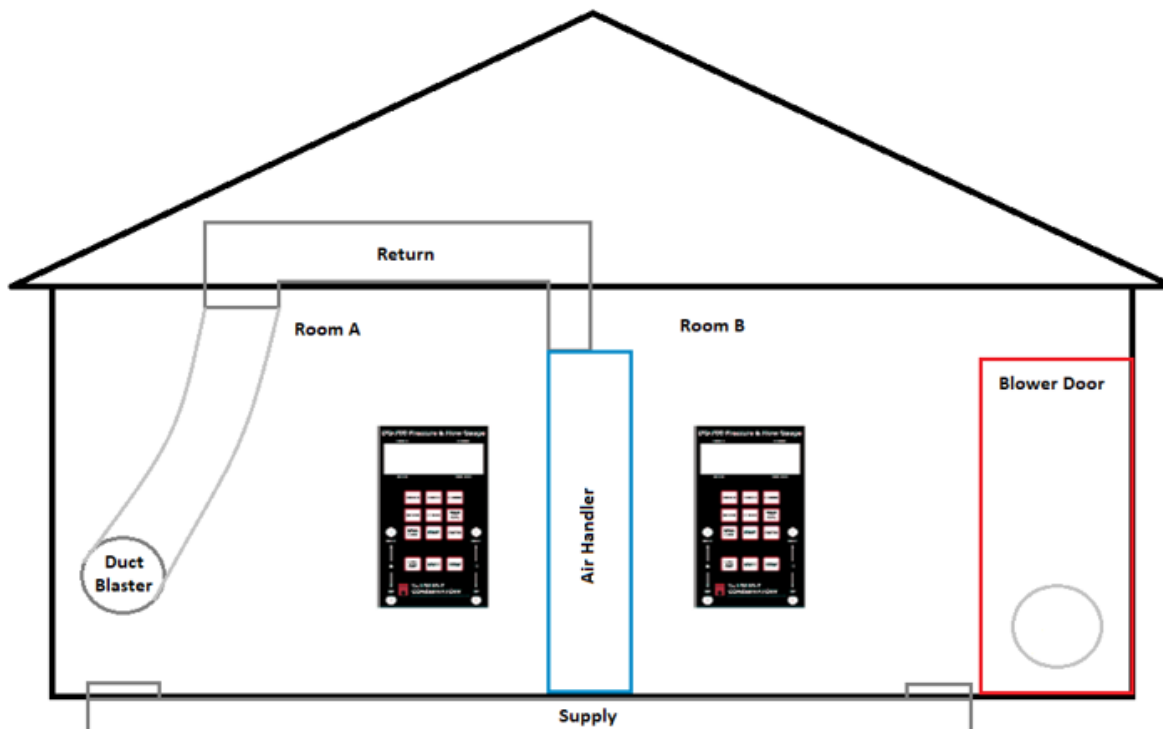
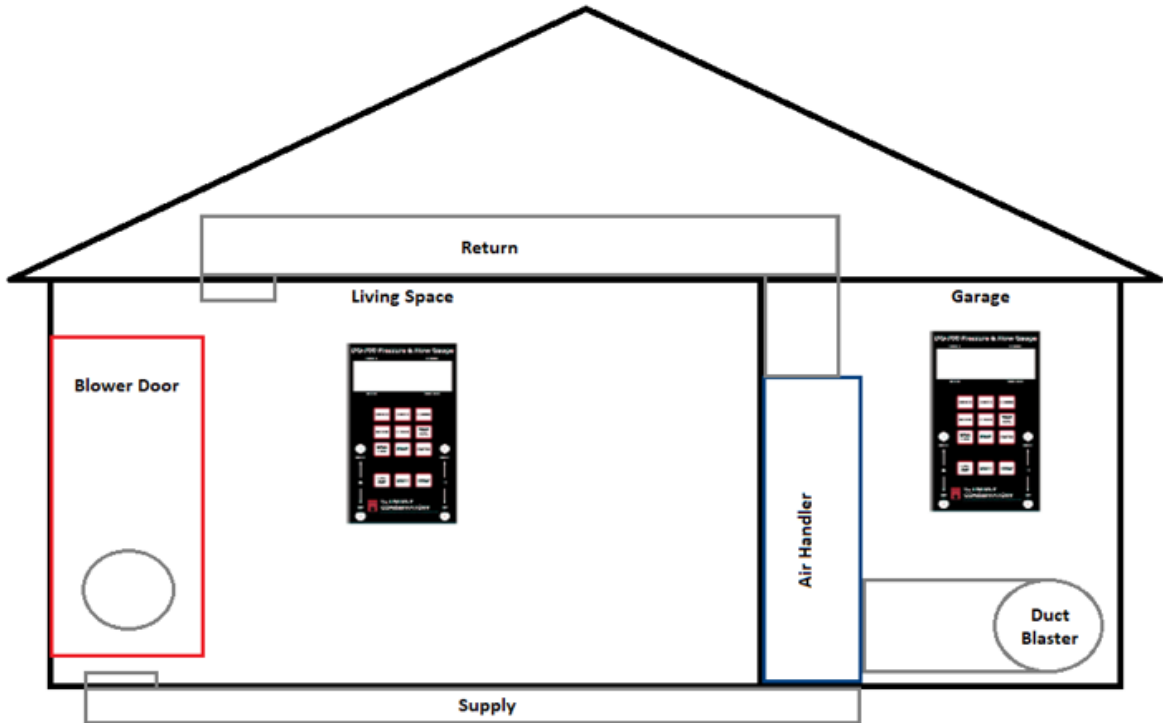
**House with reference to attic**

## Student Activities

The following classroom activities are designed to help you prepare for work in the field. These should be completed in class, are not graded, and your answers do not count against you.

**Draw lines to indicate where manometer tubes will be needed for a leakage to outside test in the following two exercises.**

### Duct Leakage to Outside

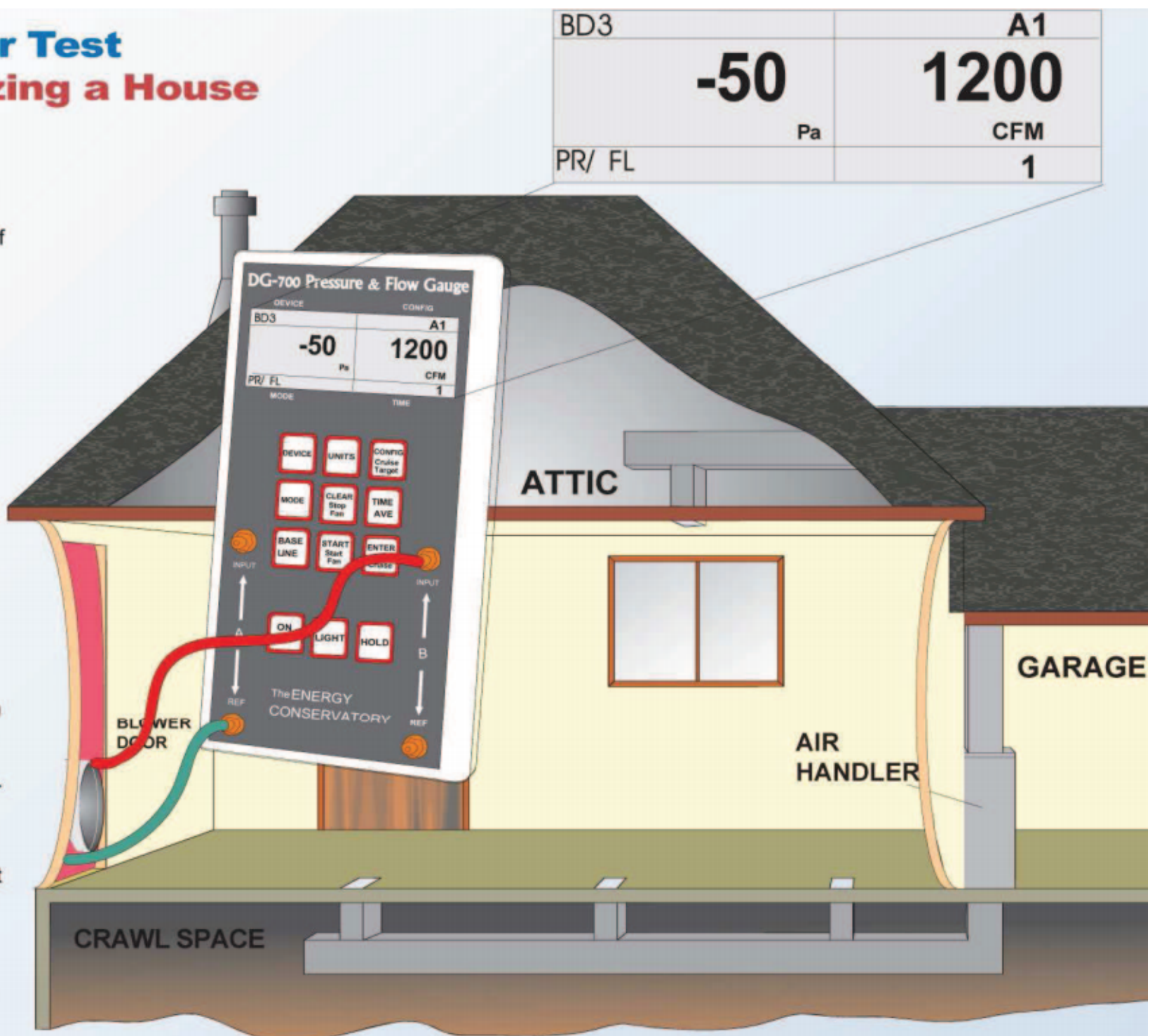


# Blower Door Test

## Depressurizing a House

### STEPS

1. Install blower door with fan exhausting air from house. Rings must be to the inside of the house.
2. Connect hoses as shown.
3. Manometer **MODE** should read PR/FL, **CONFIG** should reflect ring used (open, A, B, or C), and **DEVICE** should reflect BD3.
4. Open all interior doors. Close all exterior doors and windows.
5. Turn OFF airhandler, dryer, all fans and combustion equipment.
6. Turn on blower door, depressurize house to -50 Pascals (side A reading), +/- 0.5 Pa. (hint: canvas should be bulging inward). Use the smallest ring possible to get to -50 Pa. If you have to change the ring, be sure to reflect that in the manometer **CONFIG** setting.
7. Record reading on side B. This is your house cfm leakage at 50 Pa.

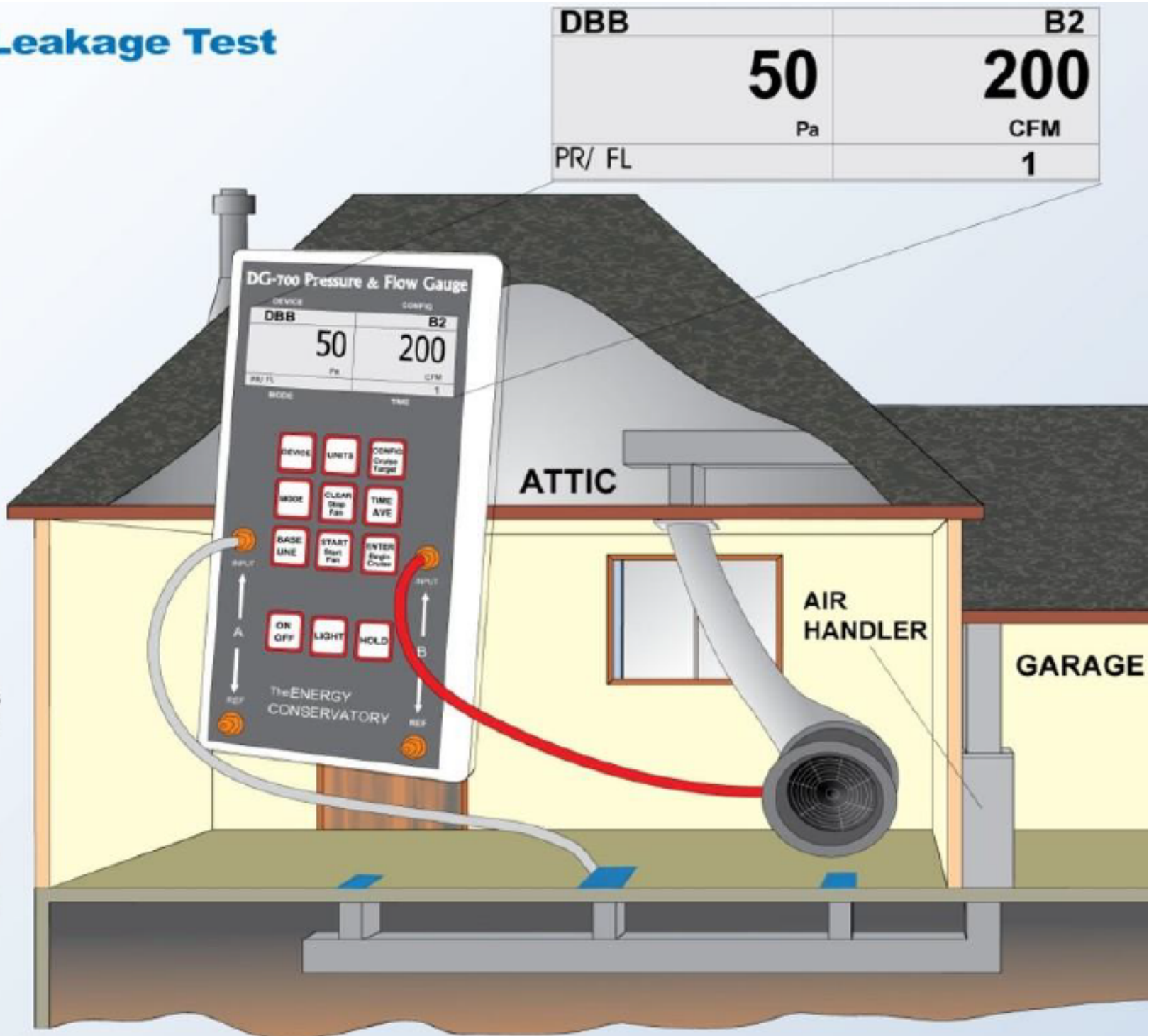




# Total Duct Leakage Test

## STEPS

1. Connect manometer to DuctBlaster; side A to ducts (usually supply side) and side B to fan.
2. Configure manometer;  
**MODE:** PR/ FL  
**DEVICE:** DBA (if white) or DBB (if black)  
**TIME AVERAGE:** 1  
**CONFIG:** ring you are using
3. Turn air handler and all combustion equipment off, interior doors open, and at least one window to exterior must be open.
4. Pressurize the ducts (blowing air into the ducts) until the pressure in the ducts side A reads 50 (with respect to the house)
5. Use the smallest ring possible to get to 50 Pa. If you have to change the ring, be sure to reflect that in the manometer **CONFIG** setting
6. The CFM reading is the total leakage (leakage to outside plus leakage to the house) at 50 Pa.



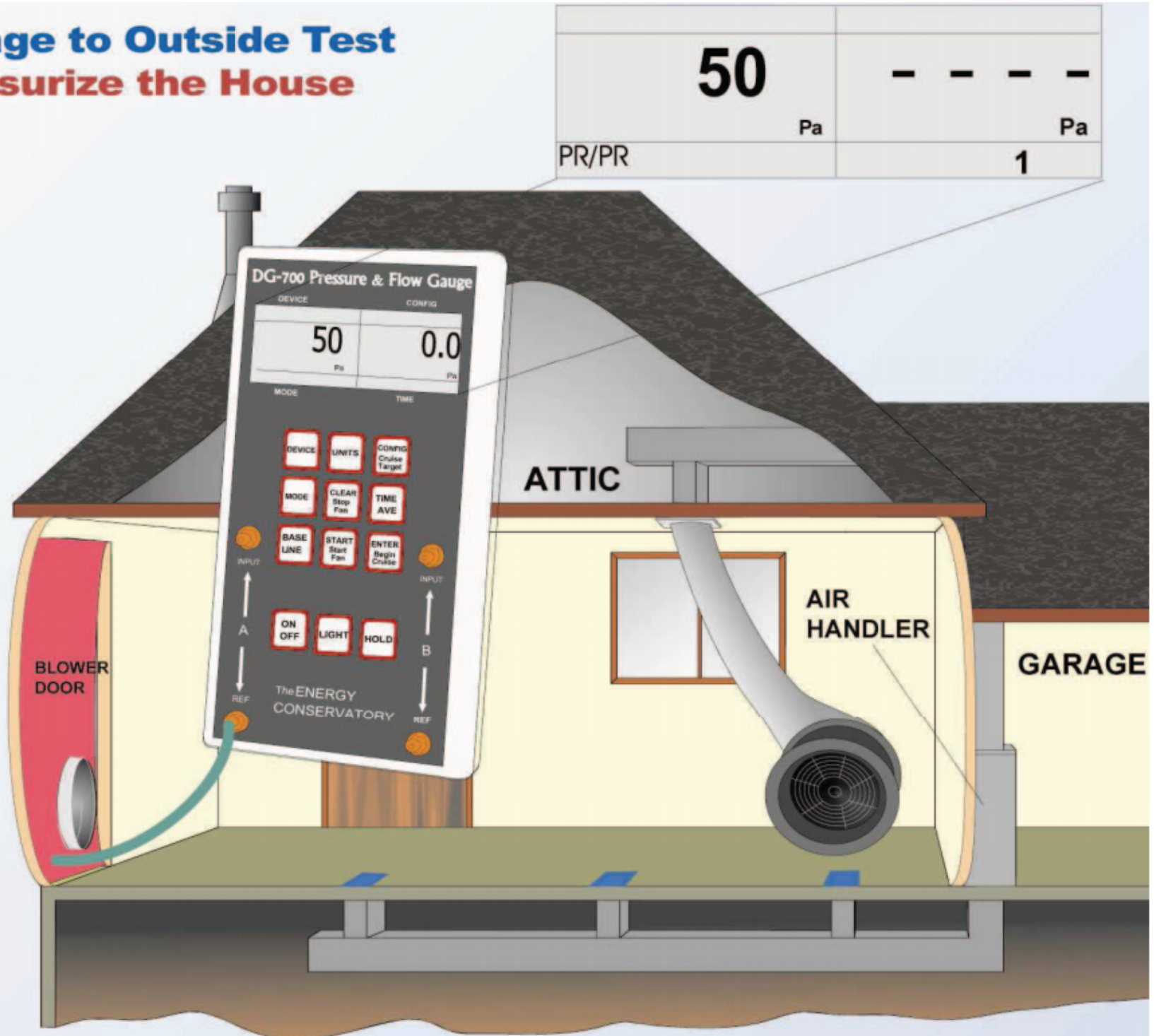
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# Duct Leakage to Outside Test

## Part 1 Pressurize the House

### STEPS

1. Install blower door with fan bringing air into house.
2. Turn OFF airhandler, dryer, all fans and combustion equipment.
3. Tape off grilles/registers.
4. Open all interior doors. Close all exterior doors and windows.
5. Connect hose as shown (house wrt outside on Side A).
6. Manometer **MODE** should read PR/PR.
7. Turn on blower door, pressurize house to 50 Pascals (side A reading). Use cruise control if possible.



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# Duct Leakage to Outside Test

## Part 2 Pressurize the Ducts

### STEPS

8. Connect manometer to DuctBlaster; side A to ducts (usually supply side) and side B to fan.

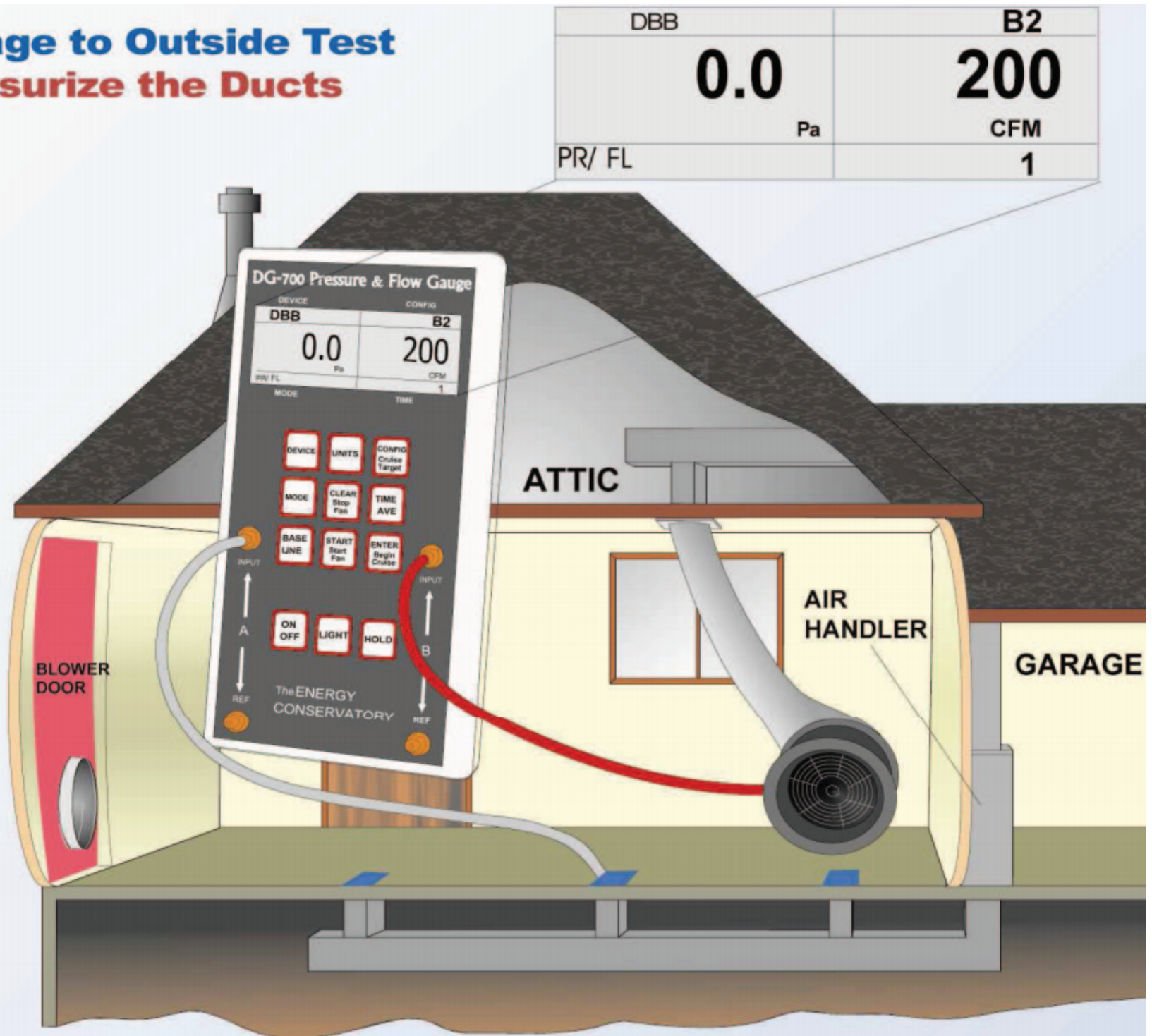
9. Configure manometer;  
**MODE:** PR/ FL  
**DEVICE:** DBA (if white) or DBB (if black)  
**TIME AVERAGE:** 1  
**CONFIG:** ring you are using

10. Pressurize the ducts (blowing air into the ducts) until the pressure in the ducts side A reads 0 (with respect to the house – which means the ducts and house are both at 50 Pa with respect to outside).

11. Use the smallest ring possible to get to 0 Pa. If you have to change the ring, be sure to reflect that in the manometer **CONFIG** setting

12. Check blower door reading (house pressure wrt outside). Readjust to 50 Pa if necessary.

13. Reconnect the manometer to the DuctBlaster. The CFM reading is the leakage to outside at 50 Pa.



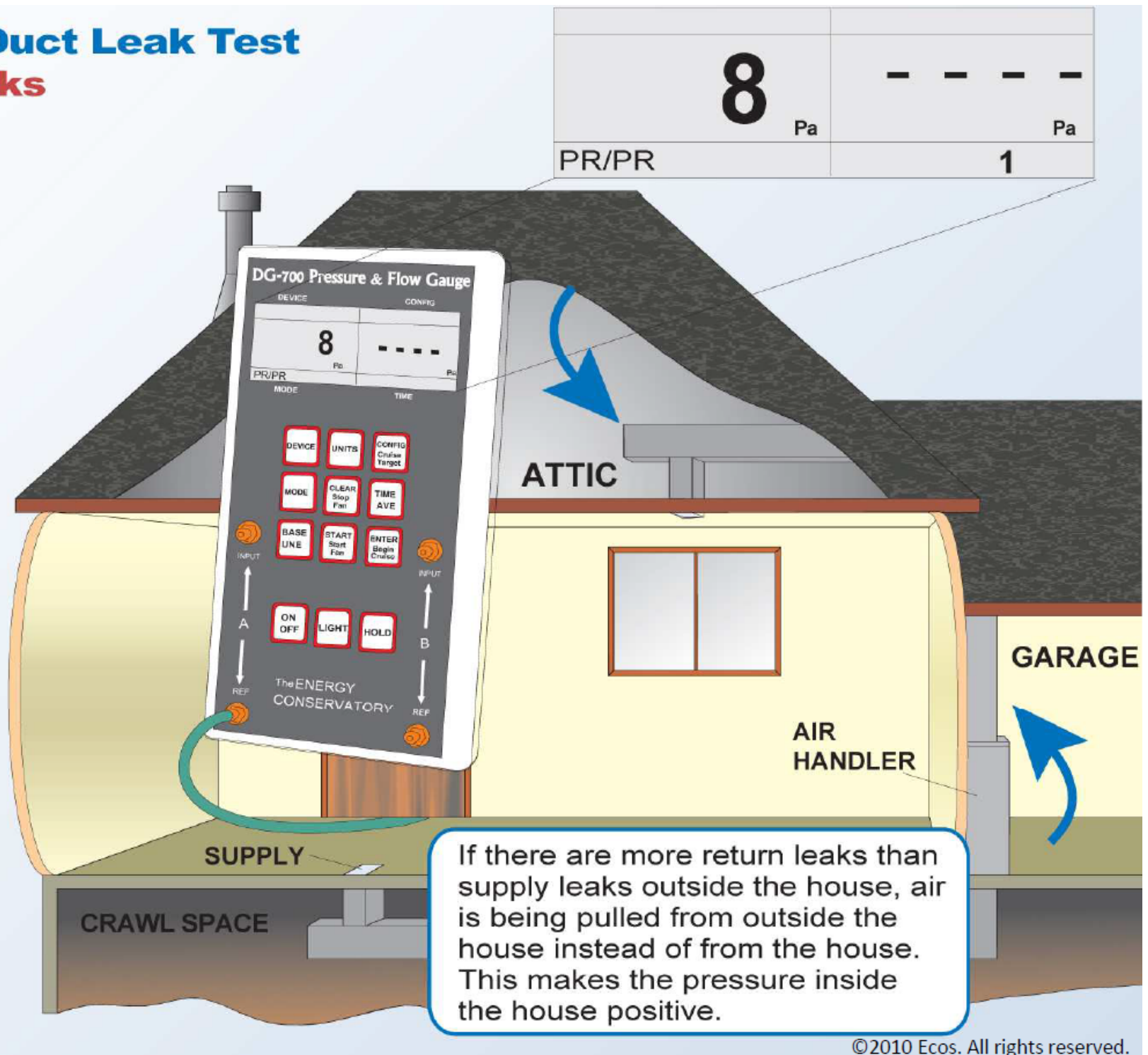
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# Dominant Duct Leak Test

## Return Leaks

### STEPS

1. Set manometer to PR/PR.
2. Connect probe from outside to side A.
3. Close exterior doors and open interior doors.
4. Turn OFF dryer, all fans and combustion equipment.
5. Record Pressure reading on side A (baseline pressure).  
**Turn on furnace fan**
6. Record reading on side A. If the house becomes more pressurized (compared to baseline) you have more return leaks than supply leaks.



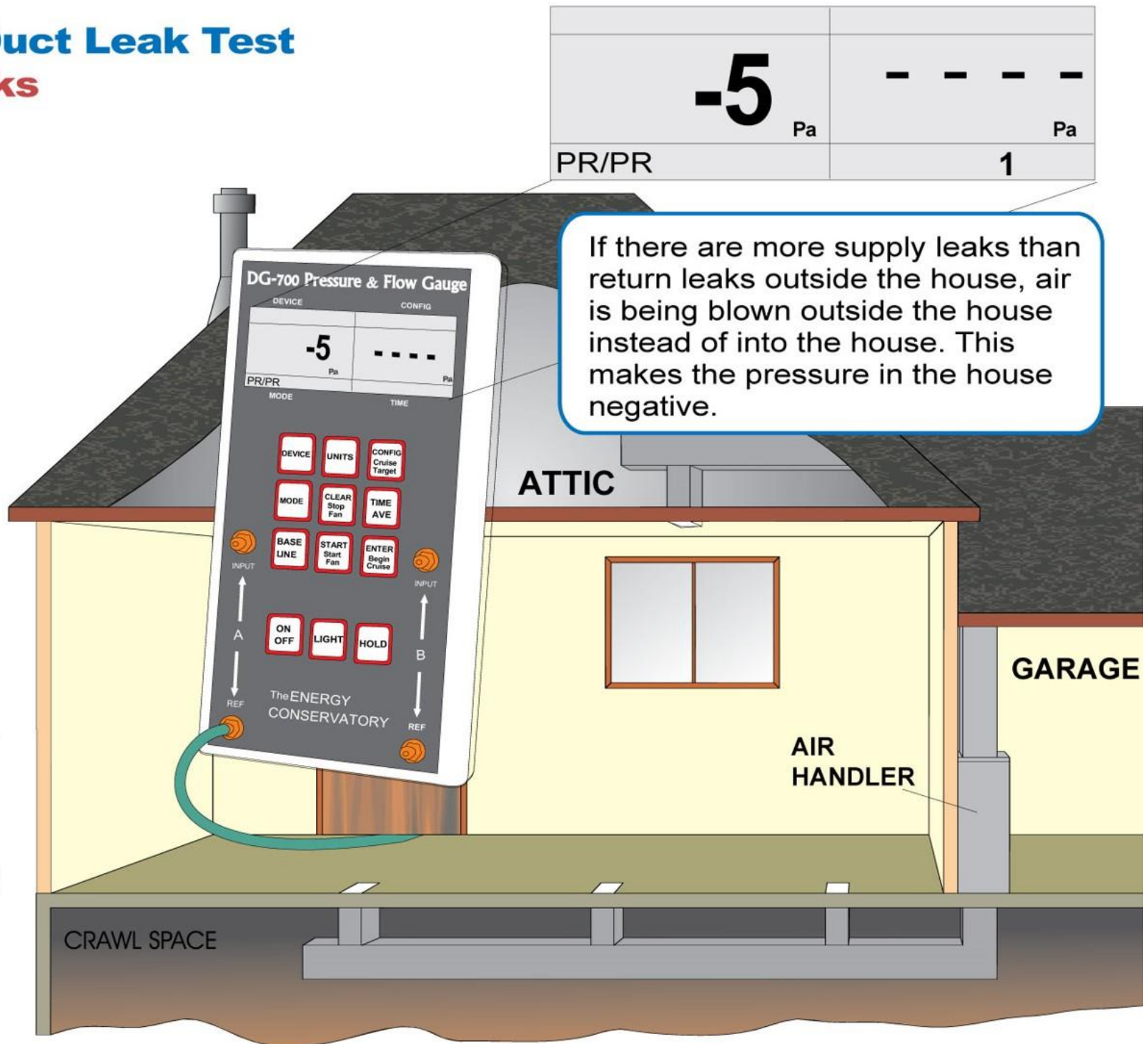
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# Dominant Duct Leak Test

## Supply Leaks

### STEPS

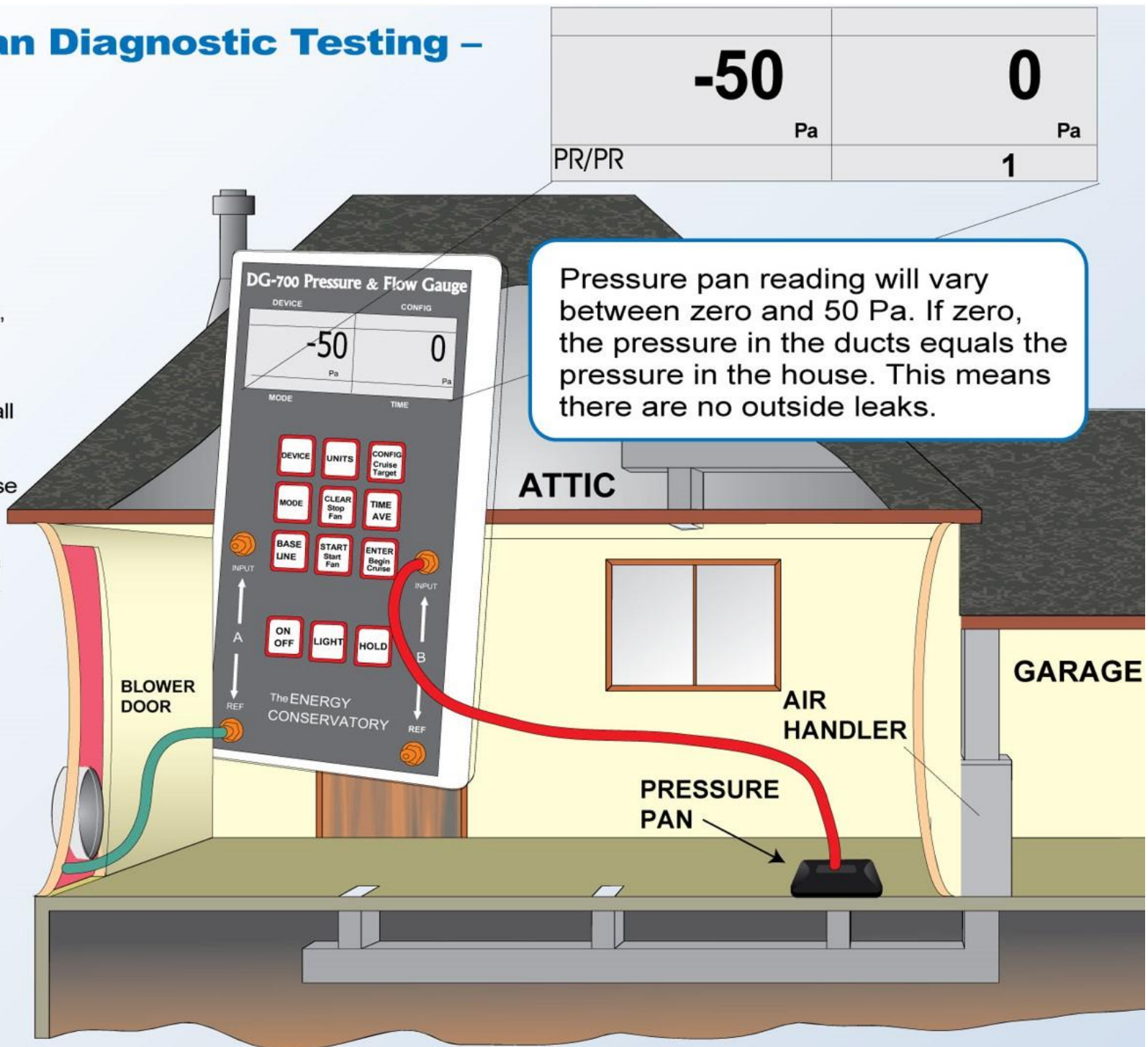
1. Set manometer to PR/PR.
2. Connect probe from outside to side A.
3. Close exterior doors and open interior doors.
4. Turn OFF dryer, all fans and combustion equipment.
5. Record Pressure reading on side A (baseline pressure).
6. Record reading on side A. If the house becomes more depressurized (compared to baseline) you have more supply leaks than return leaks.



# Pressure Pan Diagnostic Testing – No leaks

## STEPS

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.



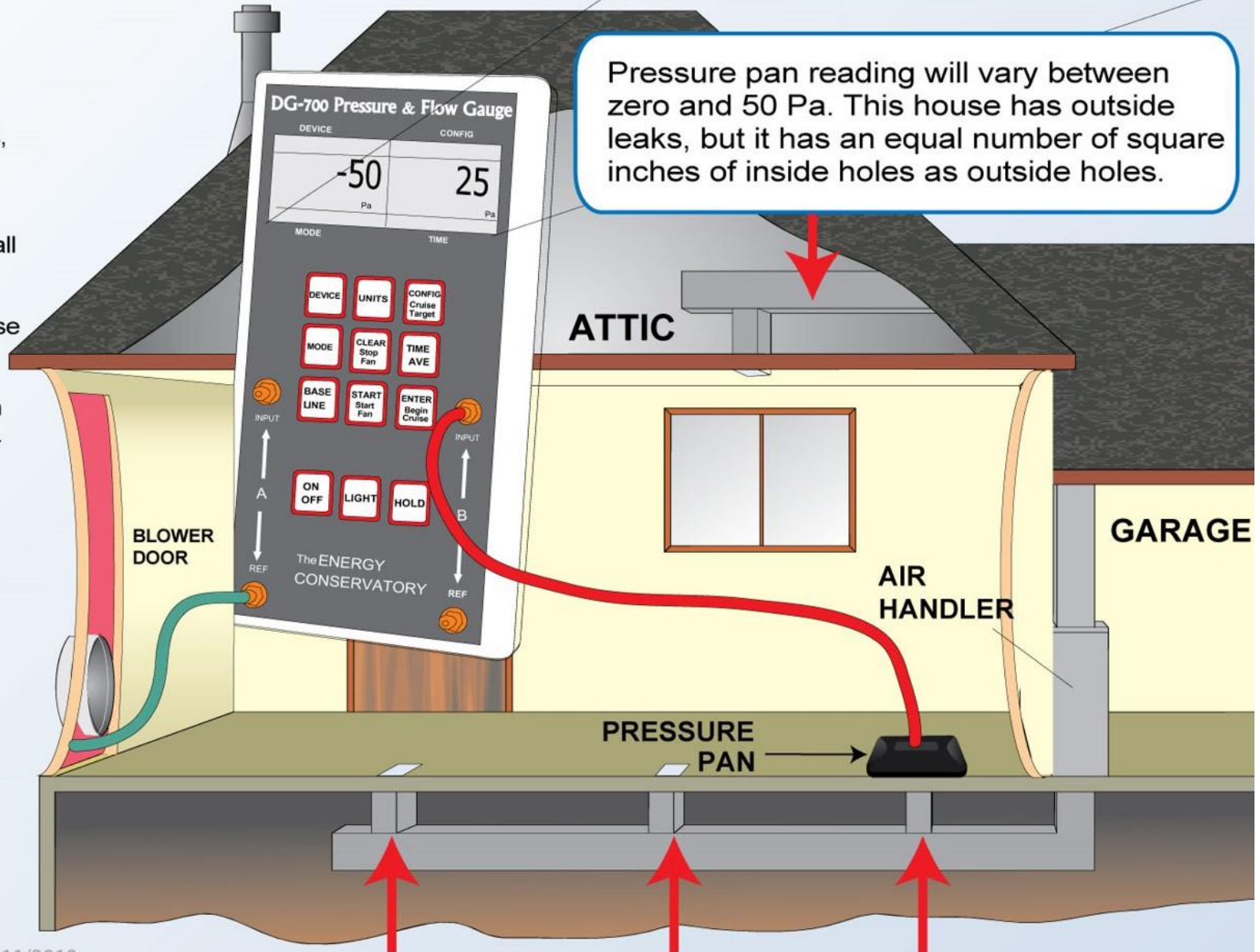
# Pressure Pan Diagnostic Testing – Equal inside and outside holes

## STEPS

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.

	<b>-50</b>	<b>25</b>
	Pa	Pa
PR/PR		<b>1</b>

Pressure pan reading will vary between zero and 50 Pa. This house has outside leaks, but it has an equal number of square inches of inside holes as outside holes.



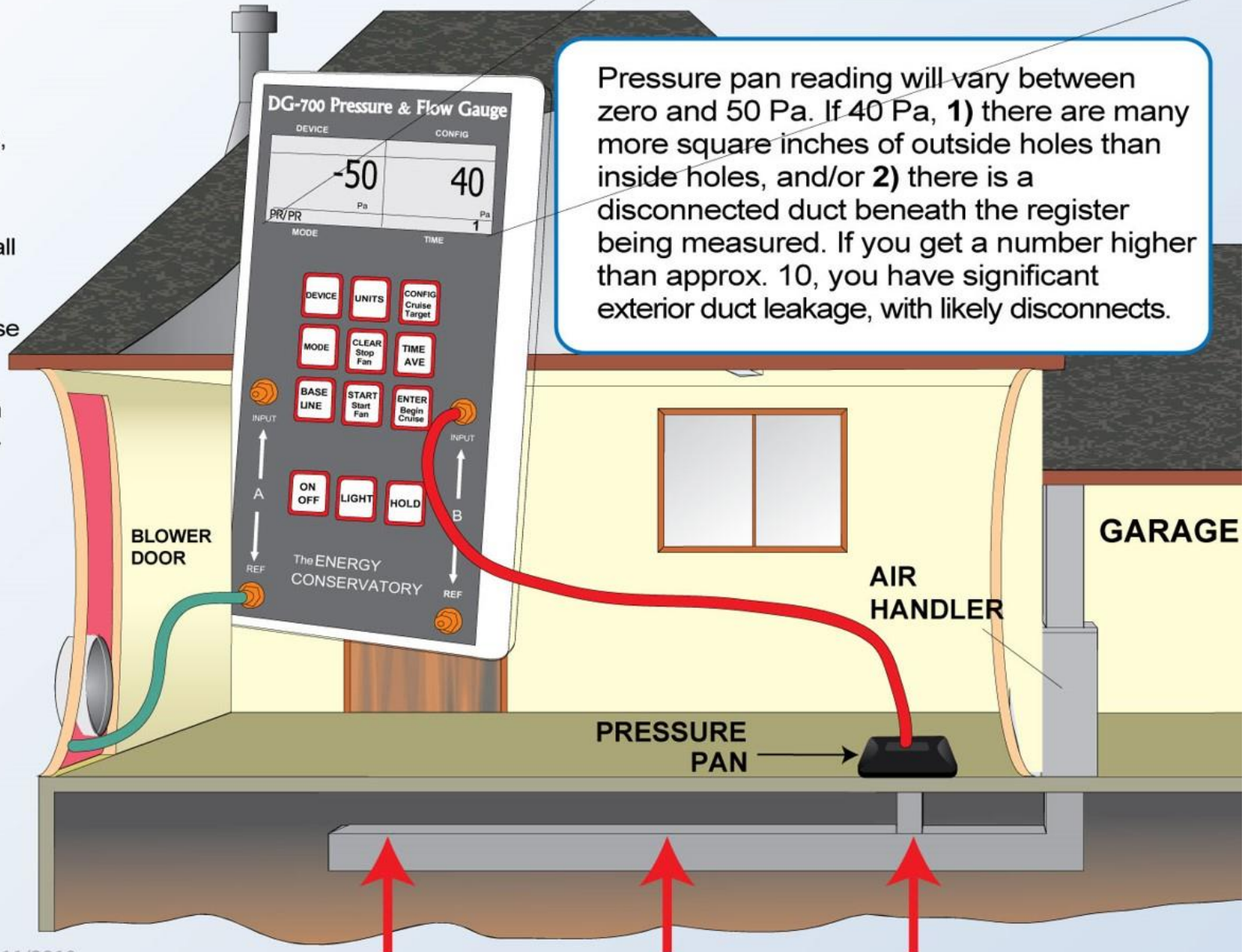
# Pressure Pan Diagnostic Testing – Outside holes greater than inside holes

## STEPS

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.

-50	40
Pa	Pa
PR/PR	1

Pressure pan reading will vary between zero and 50 Pa. If 40 Pa, **1**) there are many more square inches of outside holes than inside holes, and/or **2**) there is a disconnected duct beneath the register being measured. If you get a number higher than approx. 10, you have significant exterior duct leakage, with likely disconnects.

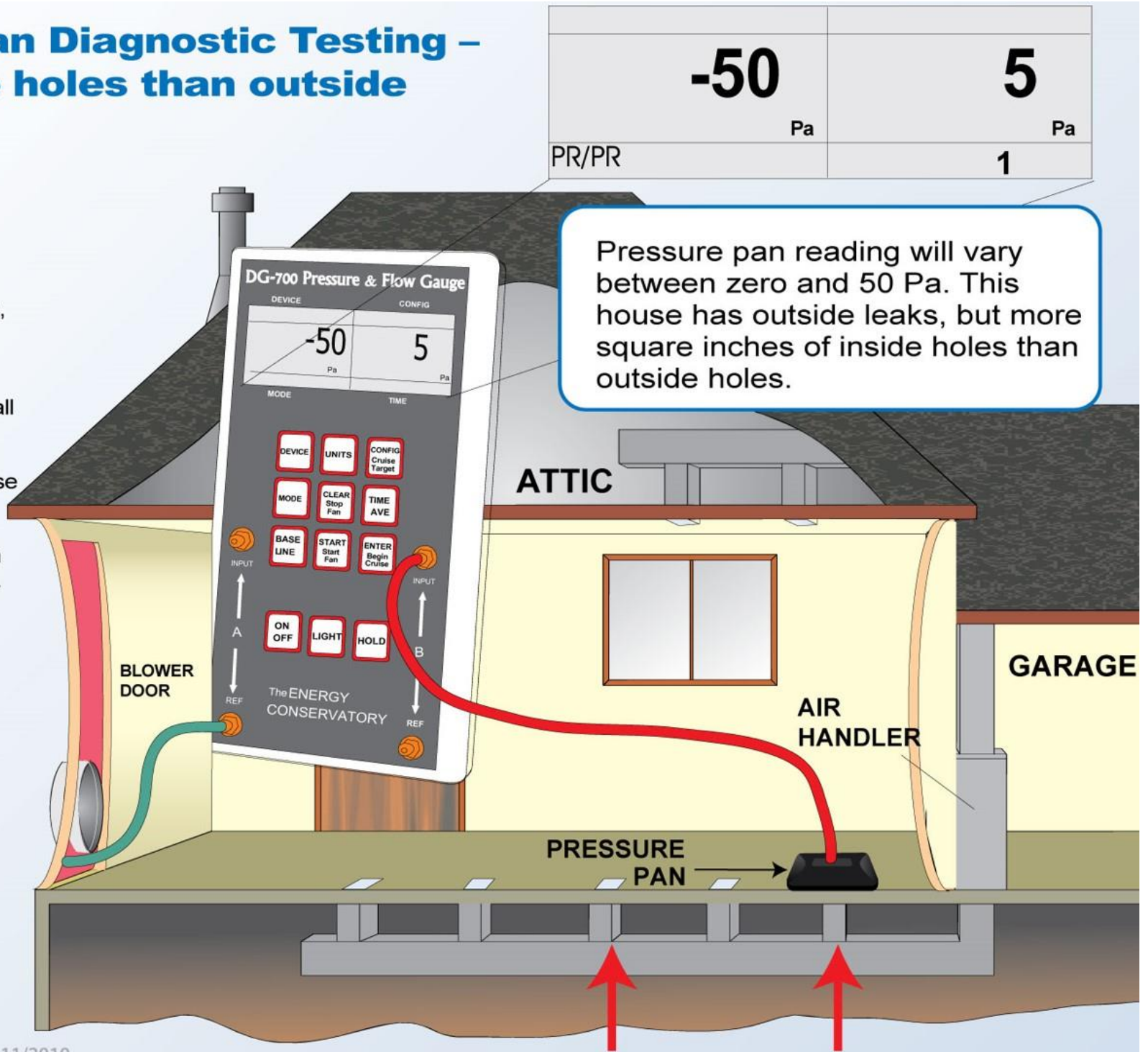




# Pressure Pan Diagnostic Testing – More inside holes than outside

## STEPS

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.



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## Prescriptive Duct Sealing Option

PTCS Duct Sealing is an alternate program available with some additional testing. Prescriptive Duct Sealing requires you to seal all opportunities and does not require any blower door or duct blaster testing. Please contact the utility to ensure they offer this incentive prior to obtaining this certification.

Upon completion of the PTCS Duct Sealing Class you'll be certified to perform both PTCS Duct Sealing and Prescriptive Duct Sealing. Technicians can also complete the standalone online Prescriptive Duct Sealing Certification Training to get certified for only Prescriptive Duct Sealing. A link to that training can be found in the Prescriptive Duct Sealing Program Requirements document at [https://www.bpa.gov/EE/Sectors/Residential/Documents/Prescriptive\\_Duct\\_Sealing\\_Program\\_Requirements.pdf](https://www.bpa.gov/EE/Sectors/Residential/Documents/Prescriptive_Duct_Sealing_Program_Requirements.pdf).

## PTCS Duct Sealing Class Summary

The PTCS Duct Sealing Training class is two days. The classroom portion of the training module consists of a Power Point presentation, demonstrations with the equipment, and practice activities on paper as well as with props and testing equipment. It also includes additional quizzes that reinforce the training objectives.

### Course Content

**Section 1: Introduction & Pressure Basics**

**Section 2: Manometer & Blower Door**

**Section 3: Duct Blaster**

**Section 4: Duct Leakage to Outside Test**

**Section 5: Diagnosis & Planning**

**Section 6: Duct Sealing & Repair**

**Section 7: Manufactured Homes**

**Section 8: Combustion Safety**

**Section 9: Participation Rules & Paperwork**

**Section 10: Resources**

**Field Training**

**Certification Exam!**

The field portion of the training is a crucial piece for successfully teaching the concepts. The class will go to a site or multiple sites and seal ducts in an existing home and/or a manufactured home.

## Training Presentation

The following duct sealing presentation is divided into 10 sections and is designed to allow you to follow along with the in-class presentation. You are encouraged to take notes in the spaces provided and use this for future reference.



# PTCS® Duct Sealing Certification Training Effective January, 2023

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## Agenda & Logistics

- ▶ *Trainer Introduction*
- ▶ *Agenda*
  - ▶ In-Class and Off-Site Training Schedule
  - ▶ Exam
- ▶ *Logistics*
  - ▶ Restroom Location
  - ▶ Breaks and Lunch
  - ▶ Review Folder Contents
- ▶ *Symbols*



In spec



Common inspection failure

▶ 2

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## The PTCS Program

- ▶ Pacific Northwest regional program promoting quality duct sealing and installation of AHRI rated high efficiency heat pumps
- ▶ Measures offered are:
  - PTCS and Prescriptive Duct Sealing
  - Variable Speed Heat Pump
  - Air Source Heat Pump
  - Ground Source Heat Pump
- ▶ 76\* participating Pacific Northwest Utilities
- ▶ 2100\* active technicians
- ▶ 118,500\* approved HVAC installations since 2006
- ▶ 6.4 million population and 2.5 million housing units in BPA territory

▶ 2

\*As of March 2021

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## Course Content

- ▶ *Section 1:* Introduction & Pressure Basics
- ▶ *Section 2:* Manometer & Blower Door
- ▶ *Section 3:* Duct Blaster
- ▶ *Section 4:* Duct Leakage to Outside Test
- ▶ *Section 5:* Diagnosis & Planning



▶ 4

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## Course Content, *continued*

- ▶ *Section 6:* Duct Sealing and Repair
- ▶ *Section 7:* Manufactured Homes
- ▶ *Section 8:* Combustion Safety
- ▶ *Section 9:* Participation Rules & Paperwork
- ▶ *Section 10:* Resources
- ▶ **Certification Exam!**



▶ 5

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## Section 1 of 10: **Introduction & Pressure Basics**



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## Why Quality Installation Matters

- ▶ **Primary goal:** Reduce leakage and reduce waste energy on forced air systems.
- ▶ **Customers:** Address comfort problems, lower bills, and improve indoor air quality.
- ▶ **Regional Power Utilities** keep electric rates low, which helps avoid the cost of building new electric power generation.

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## Section 1: Introduction and Pressure Basics



- ▶ Prescriptive vs PTCS
- ▶ What's Involved?
- ▶ Building Science Overview
  - ▶ Pressure
  - ▶ Flow
  - ▶ Outside vs. Inside Ducts
- ▶ Equipment Preview



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## Types of Duct Sealing Certifications

- ▶ **PTCS Duct Sealing**
  - ▶ Pre and post duct leakage testing required
- ▶ **Prescriptive Duct Sealing**
  - ▶ Duct testing not required, but all other sealing specs required
  - ▶ Required to seal all opportunities
  - ▶ Check which measures your utility offers
  - ▶ This training certifies you for both!

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## What's Involved?

1. Measuring the leakage with fans



2. Sealing all opportunities



3. Measuring again for the difference\*

\* Prescriptive duct sealing does not require measuring leakage.

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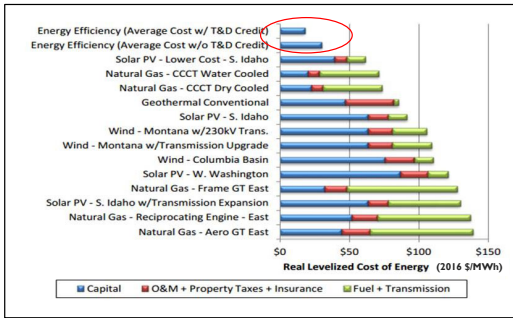
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## Cost of Electricity



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## Know Before You Begin...

- ▶ Duct installation must comply with all applicable codes. **(Note: PTCS is not a code requirement)**
- ▶ Ducts cannot be approved if they have previously sealed through this PTCS or the Prescriptive Duct Sealing programs unless a utility pre-inspection confirms additional sealing is required.
  - ▶ Resealing of ducts is allowed should any of the following circumstances apply: rodent damage or water damage, provided that all other program requirements are met.

**Best Practice:** Check with utility to confirm program requirements.

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### What is Pressure?

- ▶ Weight per unit area
- ▶ Pounds per square inch (PSI)
- ▶ Inches of water column (inH<sub>2</sub>O) or (IWC)
- ▶ Pascal (Pa): Newtons per square meter



(850 lbs per 2 small feet)

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### Pressure Equivalents

- ▶ 1 PSI = 144 LBS/sq. ft.
- ▶ 1PSI = 27.7 inches of water
- ▶ 1 in H<sub>2</sub>O = 250 Pascals (Pa)
- ▶ 50Pa = 0.2 inches H<sub>2</sub>O (in H<sub>2</sub>O)
- ▶ 25Pa = 0.1 in H<sub>2</sub>O



Duct Testing will pressurize to 50 Pa or 0.2 in H<sub>2</sub>O

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### Exercise: Pressure Basics



Truck tire pressure: 32 PSI

Convert to inH<sub>2</sub>O:

$$32 \text{ PSI} \times 27.7 \text{ inH}_2\text{O/PSI} = 886.4 \text{ inH}_2\text{O}$$

Convert to Pa:

$$886.4 \text{ inH}_2\text{O} \times 250 = 221,600 \text{ Pa}$$

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## Why Does Air Leak?

Given the opportunity (a hole), air in the tire will leak, or *flow* from high pressure (inside) to low pressure (outside).



How does a tire go from 32 PSI to this?

$$\text{Flow} = \text{Pressure} \times \text{Size of Hole}$$

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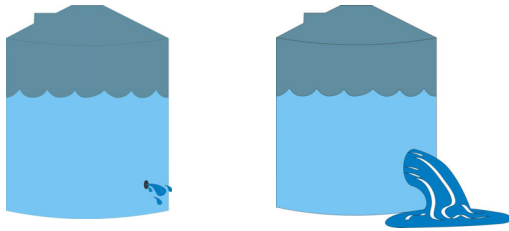
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## Flow – The Hole



Same size **tank** (pressure), different size **hole**

$$\text{Flow} = \text{Pressure} \times \text{Size of Hole}$$

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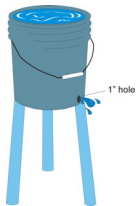
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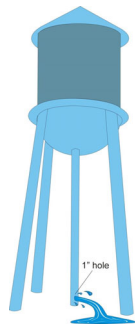
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## Flow – The Pressure

Same size **hole**; different size **tank** (pressure)



$$\text{Flow} = \text{Pressure} \times \text{Size of Hole}$$



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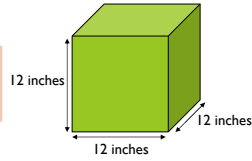
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## Flow – Calculation and Measurement

Flow CFM\* =  
Pressure difference on either side  
of the hole  $\times$  Size of Hole

\*CFM (Cubic Foot per Minute) of air:  
Rate of flow just like gallons per  
minute



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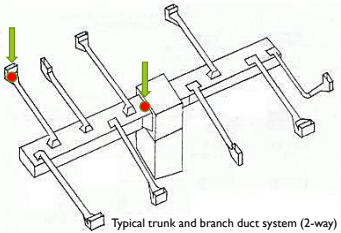
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## Pressure Basics

▶ Holes in duct systems – which hole will leak more air?



Typical trunk and branch duct system (2-way)

Answer: By the fan, where the air pressure is the highest.

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## When is a Basement Outside The Conditioned Space?

### Not Eligible

- ▶ Has a supply register or a return grille
- ▶ Has a secondary source of heat

### Eligible

- ▶ Not an active living space
- ▶ No supply grilles or return grilles

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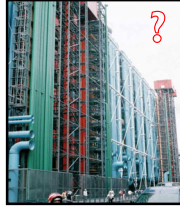
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## Outside vs. Inside

**At least 30% of supply ducts must be "outside" in unconditioned space and accessible.\***



What does "outside" mean?

**\*See exception for high operating pressure leaks in PTCS Duct Sealing specification section 1.**

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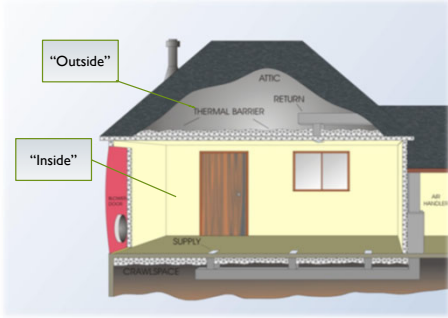
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## Outside vs. Inside



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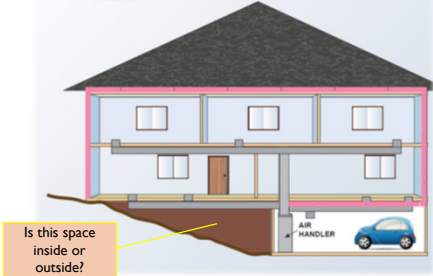
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## Outside vs. Inside

House Basics  
INSULATION



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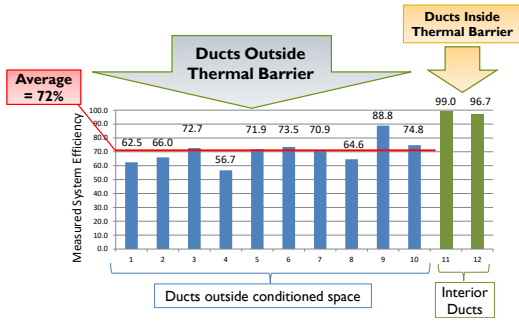
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## Outside vs. Inside Energy Savings



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## Equipment Preview



- ▶ Manometer
- ▶ Blower Door
- ▶ Duct Blaster

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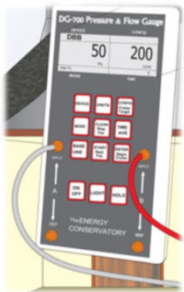
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## Preview: Manometer



- ▶ Measures...
  - ▶ Pressure and calculates CFM
  - ▶ Pressure difference between two areas
- ▶ Different types:
  - ▶ Energy Conservatory DG 1000
  - ▶ Energy Conservatory DG 700
  - ▶ Retrotec DM-2

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## New Model: DG1000



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## Preview: Blower Door



- ▶ Measures air leakage through gaps and cracks in the building shell and ducts

▶ *Example:*

*If fan is blowing 2,000 CFM out of the house, 2,000 CFM of air must be leaking in through holes in the house.*

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## Preview: Duct Blaster



- ▶ Use same principles to measure duct system leakage
- ▶ All registers are masked off for the test and the duct blaster fan is used to pressurize the duct system

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## Equipment Maintenance

- ▶ **Manometers**
    - ▶ Should be recalibrated every two years
    - ▶ A field calibration check should be completed annually or whenever a gauge has been dropped or damage suspected. This procedure can be found at the link below.
  - ▶ **Flow Plates**
    - ▶ Modified and damaged flow places will give you incorrect readings
    - ▶ Energy Conservatory can provide gasket replacements
  - ▶ **Blower Door and Duct Blaster Fans**
    - ▶ These maintain their calibration unless physical damage occurs to the fan or flow sensing system. A fan field check procedure can be found at the link below.
    - ▶ Visit: <https://energyconservatory.com/calibration-repair/> for more info.
- ▶ 31

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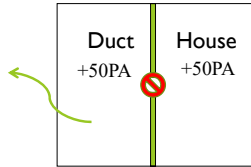
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## Duct Leakage to Outside

Using the blower door to equalize pressure between the ductwork and the house, we eliminate any leaks to the **inside** and are able to determine how much leakage to the **outside** there is.



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## The Bad and the Ugly



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## Section 2 of 10: Manometer & Blower Door



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Section 2: Manometer and Blower Door

### Section 2: Manometer and Blower Door

- ▶ Manometer
  - ▶ Channels
  - ▶ Manometer Law Expression
- ▶ Blower Door
  - ▶ What It Does and Parts Review
  - ▶ Blower Door Safety
  - ▶ Pressure Conversion
  - ▶ Depressurizing a House
- ▶ Off-Site Exercises

▶ 35

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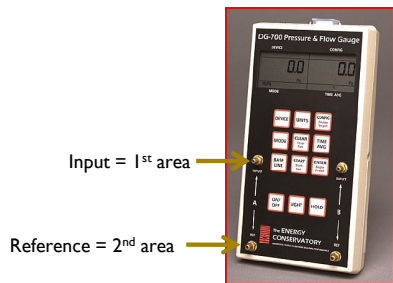
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Section 2: Manometer and Blower Door

### The DIGITAL Manometer



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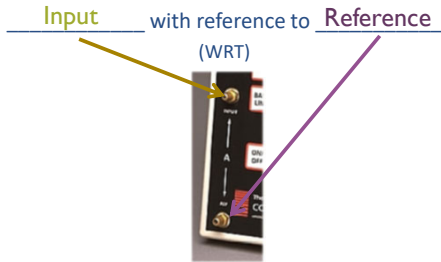
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## The Manometer

The Manometer Law:



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## The Manometer Law

The **manometer law**: simple expression allowing us to keep things straight when taking pressure measurements in a building



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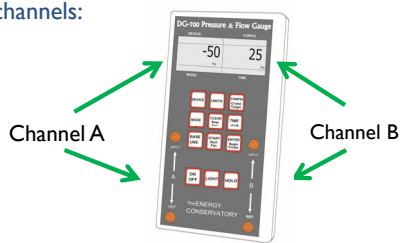
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## The Manometer

The DG-700 manometer also has 2 channels:



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## The Manometer

Displays the *difference* in pressure between the **input** and the **reference**.

*Does not display the difference in pressure between channels.*



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## Exercise - Manometer Connections

Draw connections noted on house diagrams on **page 26 and 27** of your trainee manual.

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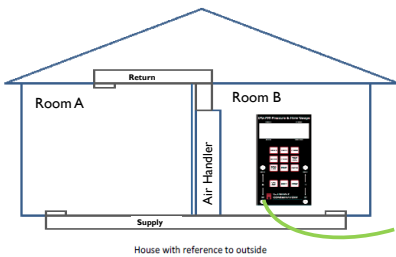
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## House WRT Outside

Manometer Exercise Sheet



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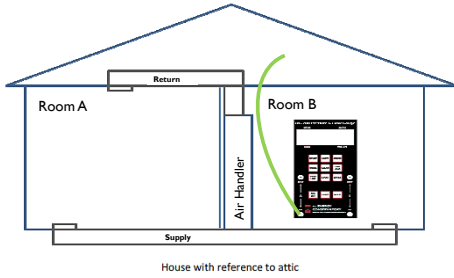
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### House WRT Attic



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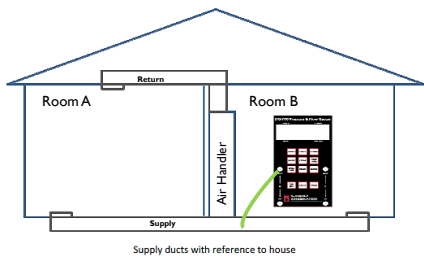
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### Supply Ducts WRT House



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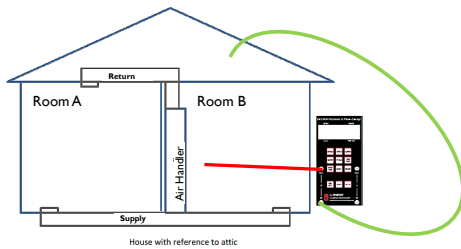
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### House WRT Attic



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## Blower Door: What It Measures

One tool with many uses...

- ▶ Measures air leakage rates and identifies air leaks in a building shell
- ▶ Locates duct leakage
- ▶ Pressurizes the house during a Leakage to Outside duct test
- ▶ Requirement for PTCS program



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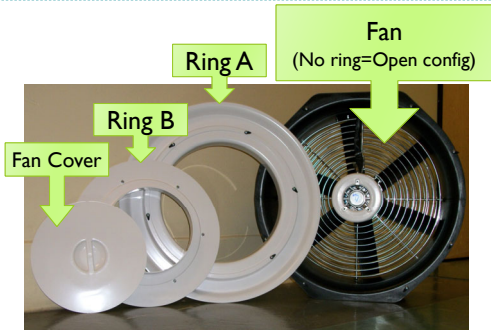
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## Blower Door Parts: Rings



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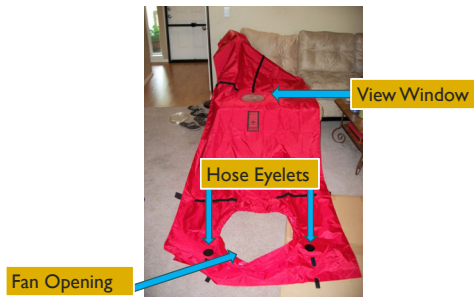
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## Parts: Nylon Skin

Fits over metal door frame with Velcro snaps



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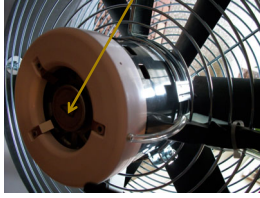
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### Parts: Pressure Sensor Ring

Pressure Sensor



Manometer measures pressure difference

Higher pressure drop = More flow

Flow = Pressure x Size of Hole

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### Parts: Blower Door Controller



- ▶ Controls fan speed
- ▶ Turn knob until house pressure is 50 Pa WRT outside
- ▶ “Can’t Reach Fifty” (CRF) Factors

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### Flow Range

Pressure x Hole Size = Flow

Energy Conservatory Blower Door Model 3	
Fan Configuration	Flow Range (CFM)
Open Fan	6,300–2,430
Ring A	2,800–915
Ring B	1,100–300
Ring C	330–85

Larger opening = Greater the flow

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## Handout: Convert Fan Pressure to CFM

Blower Door Flow (CFM)

Fan Pressure (Pa)	Open Fan	Ring A	Ring B	Ring C
16				89
18				94
20				99
22				104
24				109
26	2,484	931	305	114
28	2,576	965	316	118
30	2,664	998	327	122
32	2,749	1,030	338	127

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## Blower Door Safety



**1. Do not use the blower door if you see:**

- Fire
- Ash

2. All gas appliances (combustion furnaces and water heaters) must be off (set it to pilot)
3. Fireplace present: cover ashes with wet newsprint
4. Shut fireplace damper: if stuck open, cover fireplace

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## Asbestos

▶ **Do not use the blower door or duct blaster if you see or suspect asbestos containing materials!**

▶ It is recommended you stop work immediately and notify the homeowner that site requires professional assessment, and possibly remediation, before work or testing can be done



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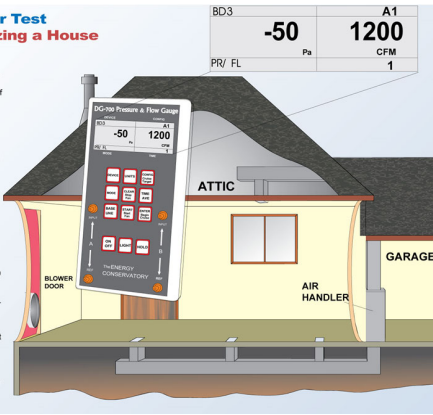
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### Blower Door Test Depressurizing a House

**STEPS**

1. Install blower door with fan exhausting air from house. Rings must be to the inside of the house.
2. Connect hoses as shown.
3. Manometer **MODE** should read **PR/FL**. **CONFIG** should reflect ring used (open AB, or CI and DV/KI, or another test).
4. Open all interior doors. Close all exterior doors and windows.
5. Turn OFF airhandler, dryer, all fans and combustion equipment.
6. Turn on blower door, depressurize house to 50 Pascals (side A reading), +1-0.5 Pa. (hint: canvas should be building inward). Use the smallest ring possible to get to -50 Pa. If you have to change the ring, be sure to reflect that in the manometer **CONFIG** setting.
7. Record reading on side B. This is your house cfm leakage at 50 Pa.   
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### Configuring the Manometer

House Pressure Fan Pressure

-50.0	130.2
Pa	Pa
PR/PR	1

- ▶ PR/PR (Pressure/Pressure) Mode
- ▶ -50.0 Pa House pressure (Channel A)
- ▶ 130.2 Fan pressure (Channel B)

House Pressure House Flow

BD 3	A1
-50.0	2041
Pa	CFM
PR/ FL	1

- ▶ PR/ FL (Pressure/Flow) Mode
- ▶ Blower Door 3 (BD 3)
- ▶ -50.0 Pa House pressure (Channel A)
- ▶ 2041 CFM House leakage (Channel B)
- ▶ Ring A (Channel B)




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### Air Leakage in Homes

- ▶ Blower door can help find air leaks, measure air sealing progress, and measure amount of leakage in a home
- ▶ Find and seal the big holes first, don't sweat the small stuff
  - ▶ **BIG LEAKS** = Holes around plumbing stacks, under bath tubs, and open framing chases leading to attic and crawlspace
  - ▶ **Small Leaks** = Caulking around door and windows
  - ▶ Duct leakage is also a building air leak




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## Air Leakage in Homes

### Is this house tight or a leaker?

Simple rule of thumb:

- ▶ If the CFM 50 < square footage of the home, not too bad

1,800 square foot home  
1,550 CFM50 **Not bad!**

1,100 square foot home  
2,140 CFM50 **Is there a window open?!**




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## House Pressure: Can't Reach 50 Pa

**Use the same house pressure for the pre- and post- testing**

Can't Reach Fifty (CRF) Factors

CAN'T REACH FIFTY FACTORS			
House Pressure	CRF Factor	House Pressure	CRF Factor
45 Pa	1.1	25	1.8
40	1.2	20	1.8
35	1.3	15	2.2
30	1.4	10	2.9

If the house can only get to 25 Pa:

Blower Door # x 1.6 = Blower Door @ 50 Pa

Test at 25 Pa and multiply the blower door CFM by 1.6.

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## What Did You Learn?

1. Is caulking around windows and doors the biggest opportunity for stopping leaks in the building (besides ducts)? How do we know?
  - ▶ **No, leaks through the attic and the floor can be greater.**
2. Is a manometer only useful when used with a Blower Door or Duct Blaster?
  - ▶ **No**
3. Can you feel the pressure of 50 Pascals?
  - ▶ **No**
4. What's the worst thing that can happen when you do a Blower Door test?
  - ▶ **BURN DOWN THE HOUSE**
5. Is 1000 CFM for a 2,000 sq ft house big or small?
  - ▶ **Small**

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## Section 3 of 10: Duct Blaster



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Section 3: Duct Blaster

### Section 3: Duct Blaster



- ▶ Parts
- ▶ Flow
- ▶ Ring Capacity
- ▶ Set Up
- ▶ Measuring and Conversion
- ▶ Off-Site Exercises

▶ 62

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Section 3: Duct Blaster

### Duct Blaster Parts



The Rings

The Fan



The Snorkel

▶ 63

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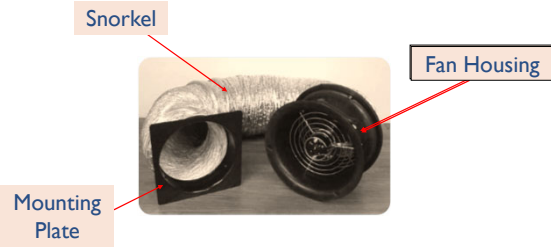
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### Duct Blaster Parts



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### Duct Blaster Parts



**Fan speed controller:**  
Control the pressure



**Rings:** Changes the size of the hole

Remember...  $Flow = Pressure \times Size\ of\ Hole$

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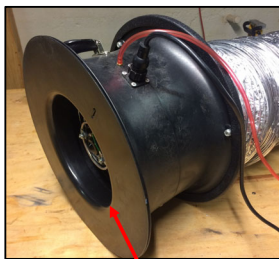
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### Duct Blaster Parts



**Place rings in the "Innie" position**



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## Ring CFM Capacity

Fan Configuration Flow Range (CFM) for Series B DB Fan	
Open (no Flow Ring)	1,500–600 CFM
Ring 1	800–225 CFM
Ring 2	300–90 CFM
Ring 3	125–10 CFM

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## Preview: Static Pressure Tap



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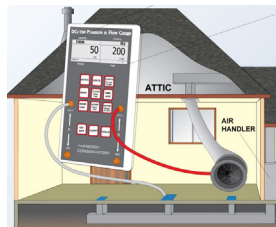
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## Types of Tests

- ▶ **Total Duct Leakage**
  - ▶ Only requires using the duct blaster
  - ▶ Measures leaks of the entire system regardless of being inside conditioned space
  - ▶ Typically used for new construction or code testing



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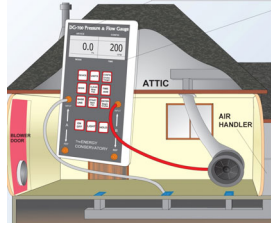
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## Types of Tests

### ▶ Leakage to Outside

- ▶ Requires running the blower door **and** duct blaster simultaneously
- ▶ Only measure leaks outside of conditioned space
- ▶ This is the **required test for PTCS!**



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## Total Duct Leakage Test: Steps

- Step 1 • Tape registers
- Step 2 • Connect duct blaster to the duct system
- Step 3 • Insert static pressure tap in one of the registers
- Step 4 • Configure manometer to read CFM AND pressures (Mode, Device, Configuration buttons)
- Step 5 • Connect hose from register to manometer, and fan pressure fitting to the manometer

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## Tape the Registers



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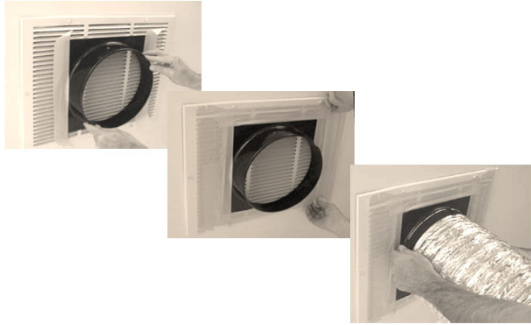
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### Attaching to the Return Grille



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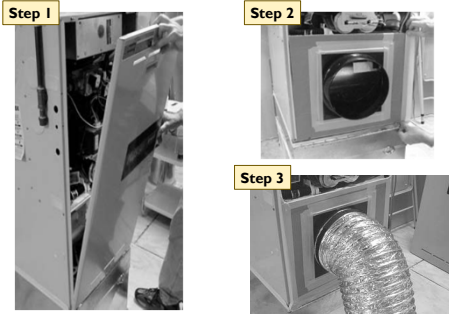
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### Attaching to the Air Handler



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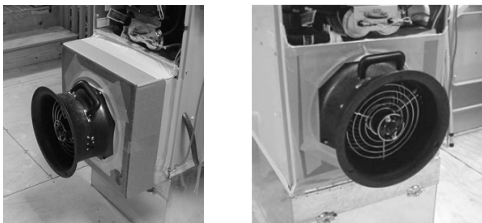
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### Direct Attachment to the Air Handler



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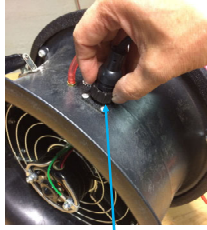
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### The Duct Blaster Connections



Fan Pressure Tap



Electrical Connection

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### Pressurizing Ducts: Duct Leakage Test



Grill covered with clear tape!

Duct blaster blows air into duct system (increases pressure)

Air blows out the leaks in the system (registers are blocked)

Air blowing in has to be blowing out (leaks)

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### Pressurizing the Ducts



Manometer 'knows' size of hole (ring) and pressure difference.

$Flow = Pressure \times Size\ of\ Hole$

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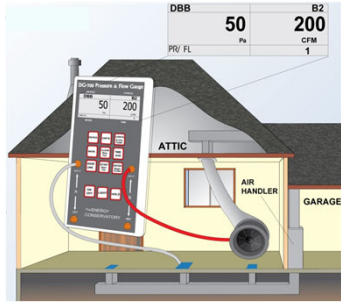
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### The Set Up

- ▶ **Side A:** measures duct pressure
- ▶ **Side B:** measures fan pressure and calculates flow reflected as CFM




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### Total Duct Leakage Test: Steps

- Step 1** • Tape registers
- Step 2** • Connect duct blaster to the duct system
- Step 3** • Insert static pressure tap in one of the registers
- Step 4** • Configure manometer to read CFM AND pressures (Mode, Device, Configuration buttons)
- Step 5** • Connect hose from register to manometer, and fan pressure fitting to the manometer

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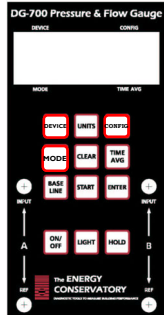
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### Configuring the Manometer



- MODE** Tells manometer what measurements to display (e.g. pressure or flow)
- DEVICE** Tells manometer what equipment is being used
- CONFIG** Tells manometer what the equipment configuration is (ring number)

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### Configuring the Manometer - MODE

**MODE** Tell it what you want to read

- PR/PR** Measures pressure difference between "input" and reference on both channels A and B
- PR/FL** Measures amount pressure recorded (channel A) and amount of air flowing through device (channel B)
- PR/FL50** Calculates amount of air flow through device on channel B if pressure on channel A was 50Pa (for homes only)
- PR/FL@25** Calculates amount of air flow through device on channel B if pressure on channel A was 25 Pa (for ducts)

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### Configuring the Manometer - DEVICE

**DEVICE** Tell it what you're connected to

- BD3** Blower Door Model 3
- DB A** Duct Blaster Model A (White Fan)
- DB B** Duct Blaster Model B (Black Fan)
- TF, EXH, BD4, etc.** TrueFlow Plate and other Energy Conservatory Equipment.

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### Configuring the Manometer - CONFIG

**CONFIG** Tell it how big the hole is (what ring)

- Open** Open fan, no ring attached
- A1** Ring A (Blower door); Ring 1 (Duct Blaster)
- B2** Ring B (Blower Door); Ring 2 (Duct Blaster)
- C3** Ring C (Blower Door); Ring 3 (Duct Blaster)

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## Configuring the Manometer

Duct Pressure Fan Pressure

50.0	180.3
Pa	Pa
PR/PR	1

- PR/PR (Pressure/Pressure) Mode
- 50.0 Pa Duct pressure (Channel A)
- 180.3 Fan pressure (Channel B)

Duct Pressure Duct Flow

50.0	212
Pa	CFM
PR/FL	1

- PR/FL (Pressure/Flow) Mode
- Duct blaster B (DB B)
- 50.0 Pa Duct pressure (Channel A)
- 212 CFM Duct leakage (Channel B)
- Ring 2 (Channel B)



What does the beeping sound mean?

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## Convert Fan Pressure to CFM

Minneapolis Duct Blaster (Series B): Flow Conversion Table

Fan Pressure	Flow (CFM)			
	Open Fan	Ring 1	Ring 2	Ring 3
122	1219	456	174	69
124	1229	459	175	70
126	1239	463	177	70
128	1249	467	178	71
130	1259	470	180	71
132	1269	474	181	72
134	1278	478	182	72
136	1288	481	184	73
138	1297	485	185	74
140	1307	488	186	74
142	1316	492	188	75
144	1325	495	189	75
146	1335	499	190	76
148	1344	502	192	76
150	1353	506	193	77
152	1362	509	194	77
154	1371	512	196	78

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## Duct Pressure: Can't Reach 50 Pa

Use the same duct pressure for the pre and post testing

Can't Reach Fifty (CRF) Factors

If the ducts can only get to 25 Pa:

Duct Blaster #  $\times$  1.6 = Duct Leakage @ 50 Pa

CAN'T REACH FIFTY FACTORS			
House Pressure	CRF Factor	House Pressure	CRF Factor
45 Pa	1.1	25	1.6
40	1.2	20	1.8
35	1.3	15	2.2
30	1.4	10	2.9

Test at 25 Pa and multiply the duct leakage CFM by 1.6.

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### Testing at 50Pa versus 25Pa

▶ PTCS requires testing ducts at 50 Pa test pressure

- ▶ Unless the ducts or house won't reach pressure, then use a correction factor

▶ Many other organizations test at 25 Pa

- ▶ WA, MT, ID state energy code
- ▶ RESNET, ENERGY STAR® Homes

Duct Pressure Fan Pressure

DB B	B2
<b>50.0</b>	<b>212</b>
Pa	CFM
PR/ FL	1

Duct Pressure Duct Flow

DB B	B2
<b>25.0</b>	<b>133</b>
Pa	CFM
PR/ FL	1

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### What did you learn?

- Are the rings supposed to be put on the fan in the Innie position or Outie position?
  - ▶ **Innie**
- How do you know which ring to use?
  - ▶ **Start with middle size. If you can't get to 50 Pa, put on a bigger one.**
- Can the Manometer inform the tester of all of these items at one time? **Fan Pressure, Duct Pressure and Fan CFM.**
  - ▶ **In configuring, you choose fan Pressure OR Fan CFM**
- In configuring the manometer, what three buttons do you need to use (remember M,D,C)?
  - ▶ **More Darn Calculations**
- If you seal the ducts and you reduce the duct leakage to the outside by 300 CFM, how much would you reduce the house leakage by?
  - ▶ **300 CFM**

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## Section 4 of 10:

# Duct Leakage to Outside




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## Section 4: Duct Leakage to Outside

- ▶ How to measure the leaks that cause wasted energy leakage to outside
  - ▶ Ducts on Inside
  - ▶ Pre-Leakage Requirements
  - ▶ Really Leaky Systems
  - ▶ Testing Set-Up

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## Leakage to Outside



*Pressurizing the house to 50 Pa stops the leaks that are inside the house*

- ▶ ~~Total Leakage~~ **Not for PTCS**
  - ▶ Only use duct blaster
- ▶ Leakage to outside
  - ▶ Use duct blaster and blower door
    - ▶ Won't let duct leaks go back into house; only measures outside duct leaks

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## Ducts on the Inside



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## Ducts Sealing in Basements

- ▶ May improve comfort
- ▶ May be critical in avoiding back drafting
- ▶ Energy savings of less than 2%



**DC** Duct sealing in basements not eligible. However, vented crawlspaces, attics with floor insulation, and unheated garages considered unconditioned space.

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### Duct Leakage to Outside Test Part 1 Pressurize the House

#### STEPS

1. Install blower door with fan bringing air into house.
2. Turn OFF airhandler, dryer, all fans and combustion equipment.
3. Tape off grilles/registers.
4. Open all interior doors. Close all exterior doors and windows.
5. Connect hose as shown (house wirt outside on Side A).
6. Manometer **MODE** should read PR/PR.
7. Turn on blower door, pressurize house to 50 Pascals (side A reading). Use cruise control if possible.

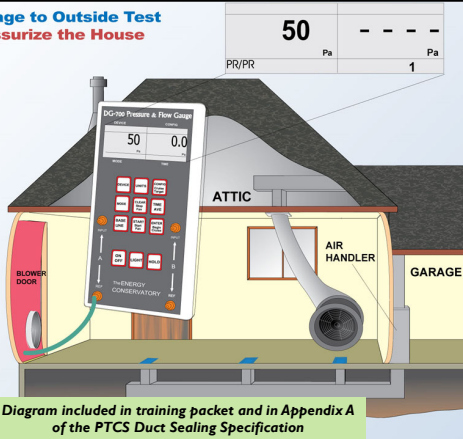


Diagram included in training packet and in Appendix A of the PTCS Duct Sealing Specification

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## Configuring the Manometer(s)

House Pressure    Fan Pressure

50.0	0.0
Pa	Pa
PR/PR	1



#### Blower Door Manometer

- ▶ PR/PR (Pressure/Pressure) Mode
- ▶ 50.0 Pa House pressure (Channel A)
- ▶ No Fan pressure connection needed (Channel B)

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### Duct Leakage to Outside Test Part 2 Pressurize the Ducts

DBB	B2
0.0	200
Pa	CFM
PR/ FL	1

**STEPS**

8. Connect manometer to DuctBlaster side A to ducts (usually supply side) and side B to fan.
9. Configure manometer:  
MODE: PR/ FL  
DEVICE: DBA (if white) or DBB (if black)  
TIME AVERAGE: 1  
CONFIG: ring you are using
10. Pressurize the ducts (blowing air into the ducts) until the pressure in the ducts side A reaches 0 (with respect to the house— which means the ducts and house are both at 50 Pa with respect to outside).
11. Use the smallest ring possible to get to 0 Pa. If you have to change the ring, be sure to reflect that in the manometer CONFIG setting.
12. Check blower door reading (house pressure w/ respect to outside). Readjust to 50 Pa if necessary.
13. Reconnect the manometer to the DuctBlaster. The CFM reading is the leakage to outside at 50 Pa.

**Diagram included in training packet and in Appendix A of the PTCS Duct Sealing Specification**

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Section 4: Duct Leakage to Outside

### Configuring the Manometer(s)

**Duct Pressure Fan Pressure**

DB B	C3
0.0	172.4
Pa	Pa
PR/PR	3

- PR/PR (Pressure/Pressure) Mode
- 0.0 Pa Duct pressure (Channel A)
- 172.4 Fan pressure (Channel B)

**Duct Pressure Duct Flow**

DB B	C3
0.0	82
Pa	CFM
PR/ FL	3

- PR/ FL (Pressure/Flow) Mode
- Duct blaster B (DB B)
- 0.0 Pa Duct pressure (Channel A)
- 82 CFM Duct leakage (Channel B)
- Ring 3 (Channel B)

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Section 4: Duct Leakage to Outside

### House or Ducts Can't Reach Pressure

**Use the same test pressure for the pre and post testing**

Can't Reach Fifty (CRF) Factors

If the house **OR** ducts can only get to 25Pa:  
Duct Blaster # x 1.6 = Duct Leakage @ 50 Pa

House Pressure	CRF Factor	House Pressure	CRF Factor
45 Pa	1.1	25	1.6
40	1.2	20	1.8
35	1.3	15	2.2
30	1.4	10	2.9

Test at 25 Pa and multiply the duct leakage CFM by 1.6.

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## Equipment Tip!

### Fan Pressure ≠ House Pressure

- ▶ Don't confuse **duct blaster fan pressure** with **blower door house pressure**
- ▶ Blower door house pressure will always be +50 Pa WRT outside unless using CRF factors
- ▶ Duct blaster fan pressure displayed on manometer channel **B** when in PR/PR mode

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## Leakage Requirements: Single Family Homes



### Qualifying Pre-Sealing Leakage

#### Pre-Test Leakage Requirements

Home <b>more than 1667 sq. ft.</b>	Equal to or greater than 250 CFM
Home <b>less than 1667 sq. ft.</b>	Equal to or greater than 15% of home sq. ft.

- ▶ Post-Sealing Leakage *Preview* (meet one of the following after sealing):
  - ▶ CFM equal to or greater than a 50% reduction OR
  - ▶ CFM equal to or less than 10% of home's sq. ft.

\* Prescriptive Duct Sealing does not have a pre-test leakage requirement

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## Leakage Requirements: Manufactured Homes



### Qualifying Pre-Sealing Leakage

#### Pre-Test Leakage Requirements

<b>Single wide</b>	Equal to or Greater than 100 CFM
<b>Double wide</b>	Equal to or Greater than 150 CFM
<b>Triple wide</b>	Equal to or Greater than 225 CFM

- ▶ Post-Sealing Leakage *Preview* (meet one of the following after sealing):
  - ▶ Single wide: Equal to or Less than 50 CFM
  - ▶ Double wide: Equal to or Less than 80 CFM
  - ▶ Triple wide: Equal to or Less than 110 CFM
  - ▶ **OR** Equal to or Less than a 50% Reduction

Prescriptive Duct Sealing does not have a pre-test leakage requirement

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### Example: Pre-Test Leakage, Site Built Home

- ▶ 2,000 sq. ft. home
- ▶ Home Pressure: 50 Pa to outside

**Pre-test leakage: 354 CFM**

- ✓ Home is greater than 1,667 sq. ft., so pre-test leakage must be greater than or equal to 250 CFM
- ✓ This home's pre-sealing leakage qualifies!

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### Recording Results – Paper Form

House Pressurized (Blower Door) to: <input checked="" type="checkbox"/> +50Pa <input type="checkbox"/> other Pa		Duct Blaster Location: <input checked="" type="checkbox"/> Return Grille <input type="checkbox"/> Other:		Pressure Tap Supply Register Location: Bathroom	
<p><b>Duct Leakage Test:</b> DUCT BLASTER CFM READING with Duct Pressure at OPa with respect to house and Blower Door @ +50Pa.</p> <p><b>Duct Blaster Fan Pressure:</b> It is the fan pressure, NOT the house pressure. (Ex. Ring 1, 78 Pa Fan Pressure, 364 CFM)</p> <p>Note: CFM leakage is calculated in the online registry using the ring size and fan pressure.</p>	<p><b>Pre-Test</b></p>	<p><b>Existing Home, Site Built</b></p>		<p><b>Manufactured Home</b></p>	
		<p>Pre-test Ring: <input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L</p>		<p><input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L</p>	
		<p>Duct Blaster Fan Pressure: 74 Pa</p>		<p>Duct Blaster Fan Pressure: _____ Pa</p>	
		<p>Duct Blaster CFM: 354 CFM</p>		<p>Duct Blaster CFM: _____ CFM</p>	
<p><b>Post-Test</b></p>	<p>Pre-leakage Requirements: <input checked="" type="checkbox"/> ≥ 250 CFM (&gt;1667 sq ft) <input type="checkbox"/> ≥ 15% of home's sq ft</p>		<p><input type="checkbox"/> ≥ 100 CFM, Single Wide <input type="checkbox"/> ≥ 150 CFM, Double Wide <input type="checkbox"/> ≥ 225 CFM, Triple Wide</p>		
	<p>Post-test Ring: <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L</p>		<p><input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L</p>		
	<p>Duct Blaster Fan Pressure: _____ Pa</p>		<p>Duct Blaster Fan Pressure: _____ Pa</p>		
	<p>Duct Blaster CFM: _____ CFM</p>		<p>Duct Blaster CFM: _____ CFM</p>		
<p>Leakage Reduction Requirements: <input type="checkbox"/> ≤ 10% of home's sq ft <input type="checkbox"/> ≥ 50% Reduction</p>		<p><input type="checkbox"/> ≤ 50 CFM, Single Wide <input type="checkbox"/> ≤ 80 CFM, Double Wide <input type="checkbox"/> ≤ 110 CFM, Triple Wide <input type="checkbox"/> ≥ 50% Reduction</p>			

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### Recording Results – Mobile Entry

2:47 PM ptc.test.tpa.gov

Welcome Contractor Role

House Pressurization

House Pressurization:  50 Pa  Other: \_\_\_\_\_ Pa

Notes on Testing

Duct Leakage Test: Duct blaster CFM reading with duct pressure at OPa with respect to house and Blower Door @ +50Pa.

Duct Blaster Fan Pressure: This is not the house pressure. Example: Ring 1, 78Pa Fan Pressure, 364 CFM)

Pre-Test

Pre-Test Leakage Requirements

Pre-Test Ring:

Pre-Test Fan Pressure:  (Pa)

Pre-Test Flow: \_\_\_\_\_

2:48 PM ptc.test.tpa.gov

Welcome Contractor Role

Post-Test Leakage Requirements

Post-Test Ring:

Post-Test Fan Pressure:  (Pa)

Post-Test Flow:  (CFM<sub>50</sub>)

Duct Blaster Location:

Pressure Tap Location:

Specification Requirements

The duct sealing at this site meets program requirements including: repairs metal duct secured with screws, flex duct interior and exterior liners secured with nylon straps or steel band clamps, ducts are supported at all the support points are mechanically

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## Really Leaky Duct Systems

### Catastrophically leaky return?



**In cases where return ducts are non-existent, panned joists, or inaccessible, a supply side only test may be used to determine the duct leakage**



- ▶ Set up duct blaster on a supply register
- ▶ Block off return at the air handler
  - ▶ Contractor bag over filter
  - ▶ Corrugated board in place of filter
- ▶ Place pressure tap at far end of supply

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## Supply Side Only Test

Conduct a Supply Side Only Test  
AFTER verifying returns like these:



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## Poor Connections



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Section 4: Duct Leakage to Outside



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Section 4: Duct Leakage to Outside

Toe Kicks: Beware!



▶ 110

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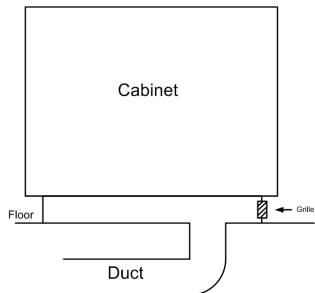
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Section 4: Duct Leakage to Outside

Toe Kicks: Beware!

Tape at the floor, not at the door!



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## Measuring Duct or Shell Leakage?



Foam Blocks will result in a lower leakage rate than taping over the register

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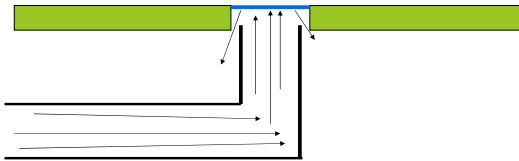
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## Foam Blocks vs Tape

If gaps exist between the boot and the floor or ceiling...

Taping over the register	Foam Block
Duct blaster will "see" the gaps	Will seal duct and not show leakage at gaps



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## Static Pressure Tap Location

- ▶ Pressure can vary by as much as 100 Pa depending on where you measure it.
- ▶ Check if pressure tap is at a representative position!
  - ✓ "Devices" (e.g., coils coupled with leaky duct systems) can cause big pressure drops.
  - ✓ Cavity returns or returns with big holes: where pressure tap is placed can have a HUGE effect! Better to just test the supply side.
  - ✓ Register with a loose duct run will record a very different pressure than one connected firmly.

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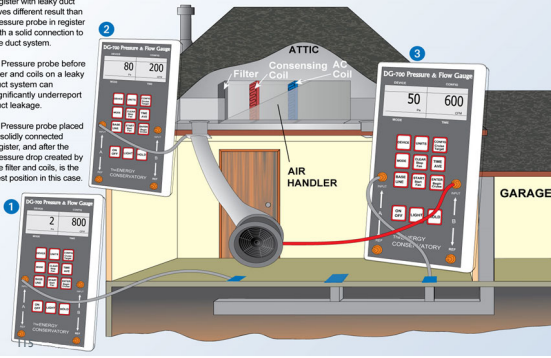
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### Placement of Pressure Probe

1. Pressure probe in register with leaky duct gives different result than pressure probe in register with a solid connection to the duct system.
2. Pressure probe before filter and coils on a leaky duct system can significantly underreport duct leakage.
3. Pressure probe placed in solidly connected register, and after the pressure drop created by the filter and coils, is the best position in this case.



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### Section 4: Duct Leakage to Outside

## Minimizing Differences in Tests



Document on form where duct blaster and pressure tap are installed!

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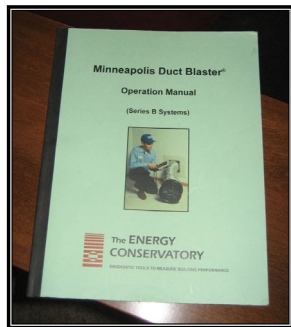
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### Section 4: Duct Leakage to Outside

## Number One Piece of Advice



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## Repeatable Testing: Careful Setup

- ✓ Best locations to connect fan to: Main return or air handler cabinet
- ✓ Don't miss registers (tape carefully for testing)
- ✓ Foam blocks result in lower leakage than taping the register
- ✓ Cavity Returns: better to just test the supply side
- ✓ "Devices" (e.g., coils) with leaky duct systems can cause pressure drops
- ✓ One or both sides very leaky? Consider a split system result. Block off one side of system at air handler and test side of interest.
- ✓ Very leaky systems = Very different results
- ✓ Everybody test the same way

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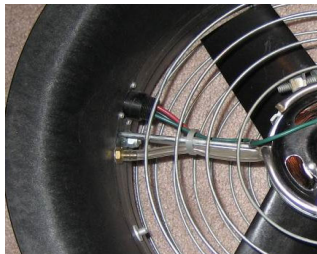
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## Sensor Sensitivity

- ▶ Check Sensor Ring for plugging (especially for a fog test)
- ▶ Check the hose connecting the pressure tap to the sensor ring



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## Anyone using AeroSeal?

- ▶ AeroSeal is approved for use with PTCS with a few exceptions:
  - ▶ Add a note upon Registry entry
  - ▶ Pre-test and post-test **MUST** satisfy program requirements
  - ▶ Both supply and return side must be sealed
  - ▶ All other specifications required including duct repair, tape removal and duct support



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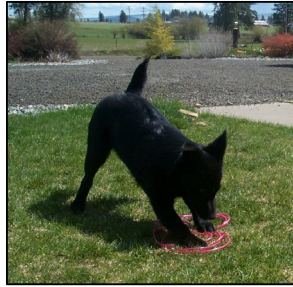
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## New Puppy, Old Hose

- ▶ Good idea to check hoses frequently
- ▶ Age
- ▶ Prolonged crimping
- ▶ Tool nicks



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## Exercise: Duct Leakage to Outside

**Draw connections between equipment and house on diagrams on page 28 of your trainee manual.**

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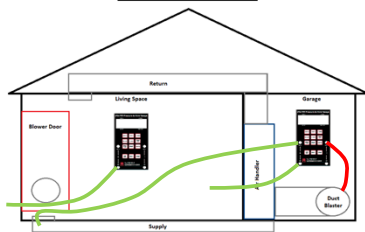
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## Exercise: Duct Leakage to Outside

Manometer Exercise Sheet



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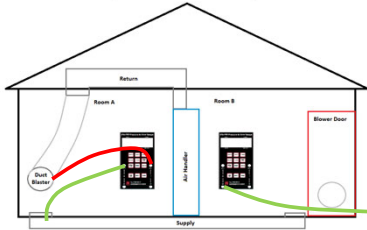
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## Exercise: Duct Leakage to Outside

Manometer Exercise Sheet



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## What did you learn?

1. Are leaks in ductwork that is located within the house (in conditioned spaces) an energy waster?
  - ▶ No
2. Do ducts that are insulated still need to be sealed?
  - ▶ Yes
3. Can you do a leakage to outside test with a Blower Door only?
  - ▶ No
4. What pressure are the ducts and what pressure is the house (both WRT outside) when you do a leakage to outside test?
  - ▶ Positive 50 Pa

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## Section 5 of 10: **Diagnosis & Planning**



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Section 5: Diagnosis and Planning

### Section 5: Diagnosis and Planning

- ▶ Initial Inspection
- ▶ Plan of Action
- ▶ Is Duct Sealing Enough?



▶ 127

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Section 5: Diagnosis and Planning

### Inspect Before You Test

- ▶ The occupants—do ask and do tell
- ▶ Four of your five senses: eyes, ears, nose and sense of touch



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### General Advice!

- ▶ Keep an open mind: observations and testing lead to conclusions
- ▶ Diagnosing is like solving a murder mystery: likelihood of a conspiracy of suspects
- ▶ Gather all the facts before jumping to conclusions



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### Purposes of the Initial Inspection

- ▶ Find the major problems
- ▶ Decide if duct sealing is enough
- ▶ Decide if part or the whole duct system needs replacing
- ▶ Decide what further tests need to be done



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### Questions for Occupant

- ▶ Do you have rooms that are too cold in winter and/or too hot in summer?
  - ▶ *May help find duct disconnects and/or proof of poor duct design*
- ▶ Do you pay high energy bills?
  - ▶ *Gives you a sense of occupants' frustration levels and their energy use. If you are familiar with typical energy use in your area, looking at their bills can give you a wealth of information.*



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## Questions for Occupant

- ▶ Do you notice any unusual smells when the air handler turns on?
  - ▶ Smells such as creosote, *eau de crawlspace*, or garage odors can give you solid clues concerning disconnected ducts.
- ▶ Do you notice insulation on your furnace filter?
  - ▶ Insulation on the furnace filter is another good indicator of serious duct problems in the attic.



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## Conducting the Visual Inspection

- ▶ Really obvious or **DUH** (dumb, unbelievably humbling) tests inside the house
  - ▶ Does air come out of all the registers?
    - ▶ If not, dampers may be shut, but it might also be due to disconnects.
  - ▶ When you remove the register or grille, do you see duct work? Or do you see the crawlspace, the attic or the neighbor's cat?

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## The Never Connected and the Disconnected



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### Look for **BIG** Leaks



▶ Disconnects or “never connects” are more common than expected.

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### Look in the Duct System’s Access Points



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### Do You See the Duct or the Dirt?



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### Duct or Dirt?



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### Signs of Leaks Behind Insulation

- ▶ Look for insulation dirty from years of air leakage known as "ghosting"



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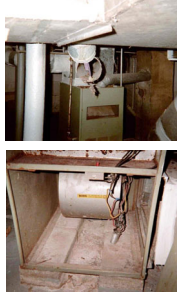
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## More **BIG** Holes

- ▶ Is test meaningful with huge disconnects?
- ▶ Systems not really connected probably can't be pressurized to 50 Pa
- ▶ Make note on form if house couldn't be pressurized and number of disconnects



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## Sealing Big Leaks

- ▶ Sealing big leaks improves air flow to registers
- ▶ May restrict airflow through the fan, creating greater static pressure at the fan.
  - ▶ Fixing large holes may cause air conditioners and heat pumps to freeze up and cause gas furnaces short cycle on the high limit.



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## Panned and Cavity Returns

**Simply BIG leaks spread over a large area**

- ▶ Hard to seal
- ▶ Consider replacing them if possible
- ▶ Add end caps on panned returns



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## Panned and Cavity Returns



- ▶ Find these **BEFORE** starting testing and sealing
- ▶ Do a supply side only test

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## Where to Start

- ▶ Areas that yield the greatest sealing bang for your buck:
  - ▶ **High-pressure areas** (air handler connection, plenum, trunk line)
  - ▶ **Supply Side**
  - ▶ **Common problem areas** (Y's, takeoffs and elbows)
- ▶ Don't seal ducts in conditioned space
- ▶ Seal returns, but don't sweat the details here

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## The Distance Rule

The greater the distance from the fan, the more a leak becomes a hole.

- ▶ Near the fan: greatest pressure in the system (usually 40–100 Pa)
- ▶ Fan discharge: hottest or coldest air
- ▶ Air handler and plenum: sweat the details here

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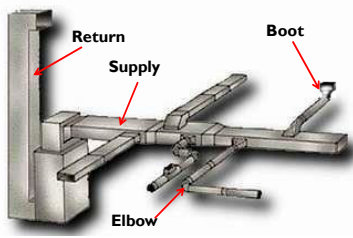
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## Follow the Pressure

Boots for show, plenums for dough!



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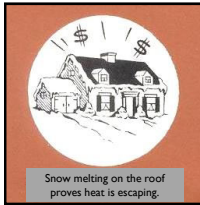
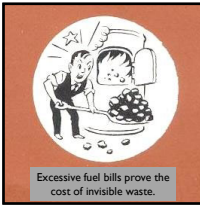
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## What Problems Are You Trying to Fix?

If the problem is one of higher than expected costs, duct sealing may be enough.



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## Diagnosis

- ▶ The Three R's of Duct Triage
  - ▶ Repair
  - ▶ Replace
  - ▶ Reengineer



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### Partial List of Repairs

• Panned over joists	• Rusted out sheet metal
• Undersized return duct work	• Rodent-infested anything
• Broken electronic air cleaners	• Damaged duct board
• Wet flex ducts	• Crushed registers and grilles
• Crushed flex ducts	• Flaking flex ducts
• Fittings that can be replaced by less restrictive ones	

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### When to Replace

- ▶ The duct system is falling apart:
  - ▶ Rusted sheet metal
  - ▶ Rotting flex duct
  - ▶ Duct board filleted open or air barrier missing;
- ▶ Replacing deteriorating ducts is often faster than repairing and sealing them.
- ▶ Often times easier to sell, too.

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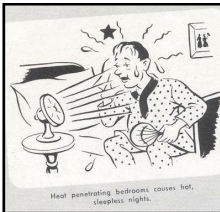
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### What Problems Are You Trying to Fix?

- ▶ Fixing comfort problems usually requires reengineering, so don't overpromise results
  - ▶ A room that needs 300 CFM still needs 300 CFM no matter how leaky



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## Other Diagnostic Tests

- ▶ Further Pinpoint Leaks with Diagnostic Equipment
- ▶ Dominant Duct Leakage Test
- ▶ Pressure Pans



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### Dominant Duct Leak Test Return Leaks

**STEPS**

1. Set manometer to PR/PR.
2. Connect probe from outside to side A.
3. Close exterior doors and open interior doors.
4. Turn OFF dryer, all fans and combustion equipment.
5. Record pressure reading on side A (baseline pressure).
6. Turn on the furnace fan.
7. Record reading on side A. If the house becomes more depressurized (compared to baseline) you have more supply leaks than return leaks.

If there are more return leaks than supply leaks outside the house, air is being pulled from outside the house instead of from the house. This makes the pressure inside the house positive.

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### Dominant Duct Leak Test Supply Leaks

**STEPS**

1. Set manometer to PR/PR.
2. Connect probe from outside to side A.
3. Close exterior doors and open interior doors.
4. Turn OFF dryer, all fans and combustion equipment.
5. Record Pressure reading on side A (baseline pressure).
6. Record reading on side A. If the house becomes more depressurized (compared to baseline) you have more supply leaks than return leaks.

If there are more supply leaks than return leaks outside the house, air is being blown outside the house instead of into the house. This makes the pressure in the house negative.

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## Advice For Reaching CFM Targets

- ▶ Use pressure pan/dominant duct leakage testing to locate where the remaining leaks are.
- ▶ Sometimes ducts in inaccessible places are the culprit, particularly in older homes with joist run returns or balloon framing.
- ▶ Don't forget that PTCS allows for a split test of the supply side only in homes with inaccessible returns. See appendix B of the [PTCS specs](#) for instructions.




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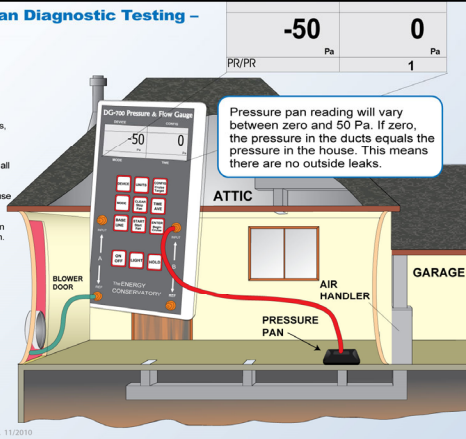
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### Pressure Pan Diagnostic Testing – No leaks

#### STEPS

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.




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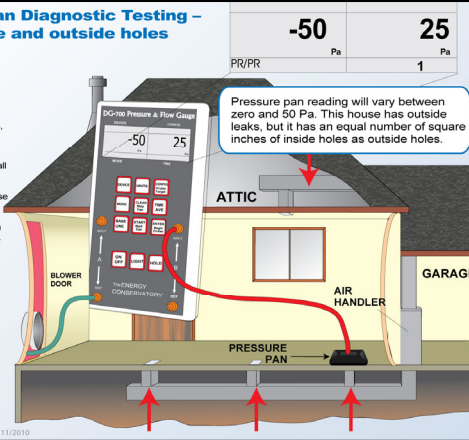
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### Pressure Pan Diagnostic Testing – Equal inside and outside holes

#### STEPS

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.




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### Pressure Pan Diagnostic Testing – Outside holes greater than inside holes

-50	40
Pa	Pa
PR/PR	1

**STEPS**

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.

Pressure pan reading will vary between zero and 50 Pa. If 40 Pa, 1) there are many more square inches of outside holes than inside holes, and/or 2) there is a disconnected duct beneath the register being measured. If you get a number higher than approx. 10, you have significant exterior duct leakage, with likely disconnects.

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### Pressure Pan Diagnostic Testing – More inside holes than outside

-50	5
Pa	Pa
PR/PR	1

**STEPS**

1. Open all registers.
2. Remove the furnace filter.
3. Open all interior doors, close all exterior doors and windows.
4. Turn off furnace, and all combustion appliances.
5. Depressurize the house to -50 Pa.
6. Connect pressure pan to manometer as shown.

Pressure pan reading will vary between zero and 50 Pa. This house has outside leaks, but more square inches of inside holes than outside holes.

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Section 5: Diagnosis and Planning

## Section 5: What did you learn?

- ▶ Does fixing ductwork sometimes cause unexpected bad consequences (can the cure be worse than the illness)?
  - ▶ Yes
- ▶ Are 2 people testing a house likely to come up with identical answers if the duct blaster and/or static pressure tap were in different locations?
  - ▶ No, testing technique does matter for repeatable results.
- ▶ Should you start with the easily accessible leaks, like the boots?
  - ▶ No
- ▶ What are the most important leaks to seal, no matter what the Duct Blaster™ tells you?
  - ▶ High-pressure leaks and disconnects are the highest priority.

▶ 161

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## Section 6 of 10: Duct Sealing & Repair



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Section 6: Duct Sealing and Repair

### Fix the Leaks!



- ▶ What is considered accessible?
- ▶ Duct Insulation
- ▶ Keys to Tighter Ducts
- ▶ Tape
- ▶ Supporting Ducts
- ▶ Tools & Materials

▶ 163

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Section 6: Duct Sealing and Repair

### Fasten, Support, and Seal 'Em!

 **All accessible portions shall be repaired, mechanically fastened, supported, and exposed and sealed with approved materials where needed.**

▶ 164

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## What's Considered "Accessible"?

-  **▶ Air handler to plenum connection**
-  **▶ Interior liners on manufactured home crossover ducts**
-  **▶ Flex ducts connections with properly secured exterior liners may have interior liners that are not accessible**
-  **▶ Belly of manufactured home if non-intrusive visual inspection identifies large holes**

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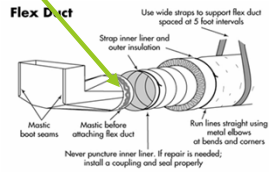
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## Items You Don't Have to Seal



-  **▶ The liner seam of round sheet metal**
-  **▶ Between the inner liner of flex duct and sheet metal fittings**



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## Duct Insulation

-  **▶ Not a barrier to accessibility**
-  **▶ When removed, shall be re-installed and securely attached with mechanical fasteners, such as...**
  - ▶ Permanent plastic straps**
  - ▶ Nylon twine**
  - ▶ Fastening material specified by manufacturer**
-  **▶ Mastic cannot effectively hold insulation in place**



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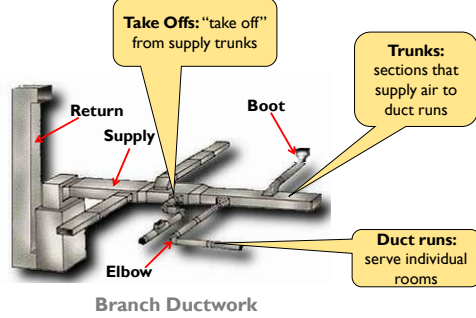
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## Glossary



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## Keys to Tighter Ducts

1. Remove old tape
2. Mechanically fasten and make necessary repairs
  - ▶ Tension tie inside and outside liners of flex duct and screw together metal duct
  - ▶ Secure insulation with nylon webbing, Panduit™ straps or other lasting material.
3. Support ducts and fasten boots to subfloor
4. Seal with UL-181 listed mastic
  - ▶ Plug, don't paint: **Mastic should be about the thickness of a nickel to seal**
5. Reinstall insulation

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## Tape Removal

- ▶ Tape can cover poor workmanship; mastic cannot
- ▶ Tape is neither a fastener nor a permanent sealant
- ▶ **Tape must be removed!**



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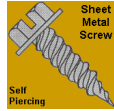
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## Mechanically Fastened



- ▶ **Each connection must be mechanically fastened before sealing with at least 3 screws**

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## Maximize Long-Term Energy Efficiency



Pay attention to gores

- ▶ **Seal with Mastic**
- ▶ Tape: not a fastener or permanent sealant

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## Mechanical Fastening & Mastic



- ▶ Permanent Fix
- ▶ Mechanically attached sheet metal sealed with mastic is permanent
- ▶ Tape of any kind might not be permanent
- ▶ Tape of any kind allows for poor workmanship

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### Sealing Locations

- ▶ Air handler to plenum
- ▶ Plenums
- ▶ Take-offs
- ▶ Slip joints
- ▶ Branches, Ts and Ys
- ▶ Elbows and gores
- ▶ Boots



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### Applying Mastic



- ▶ PLUG, don't paint!
- ▶ Thick as a nickel (about 1/16 in. thick)!



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### Mastic Used, But Still Leaking



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## Too Thin to Win



Not applying enough mastic will allow air to continue leaking out.

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## Plenum Corners

Seal corners on factory-made boxes and plenums



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## Where Tape is Allowed?



**Approved tape is only allowed on the air handler cabinet and air handler to plenum connection**

- ▶ Not all tape is created equal
- ▶ At air handler, use foil faced, butyl backed “roll mastic” sealant

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## Duct Tape is Temporary

TABLE 2: SUMMARY OF DUCT TAPE FAILURES:

# of Tests	Test Type	Description	Typical Failure Time	Typical Leakage
8	Aging	5 different grades	7 days	42%
5	Aging	181B-FX	10 days	18%
4	Baking	3 different grades	34 days	16%
1	Baking	181B-FX	60 days	30%

**Max Sherman**  
**Iain Walker**  
*Energy Performance of Buildings Group  
Lawrence Berkeley National Laboratory  
University of California*

Source: eetd.lbl.gov/IE/pdf/LBNL-41434.pdf

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## Air Handler to Plenum



- ▶  **Approved tape is only allowed on the air handler cabinet and air handler to plenum connection**
- ▶ All other connections on plenum must be sealed with mastic!

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## Supporting Ducts

 **All accessible portions of the duct system shall be supported**



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## Supporting Flex Ducts

- ▶ Must use 1 1/2" or wider straps
- ▶ Supports must be spaced no greater than 4' apart
- ▶ Limit sagging and unnecessary bends
- ▶ Avoid ground contact. If unavoidable, R-4 min closed cell foam board can be placed between the duct and ground



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## The Permanent Heimlich Maneuver



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## Thermo Pan



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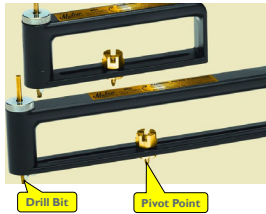
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## Circle Cutters



- ▶ Cut circles in flat sheet metal, allowing access to the inside of the duct to be sealed from the inside.

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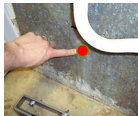
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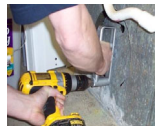
## Circle Cutter: Making Access Holes



**Step 1:** Attach Circle Cutter drill bit to a drill; drill a hole in center of the circle to be cut



**Step 2:** Adjust Pivot Point Set Screw for size hole to be cut (usually 1/2")



**Step 3:** Place the Pivot Point into drilled hole (Step 1); drill a starting hole on circumference of circle to be cut

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## Circle Cutter: Making Access Holes, continued



**Step 4:** Push Circle Cutter around to cut out circle; inspect sharp edges before sealing



**Step 5:** Seal ALL seams (reach through access hole)  
*Tip: brush attached to a stick is useful to seal out of reach seams*



**Step 6:** Close gap between seams by screwing them together before sealing.

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### Circle Cutter: Making Access Holes, continued



**Step 7:** Seal all seams with a thick coat of mastic.



**Step 8:** Reach up and seal the Furnace to Can connection on all four sides

Furnace to Can Connection

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### Circle Cutter: Making Access Holes, continued



**Step 9:** Apply a thick coat of mastic around the rim of the access hole



**Step 10:** Attach a rectangular plate over the hole

- Must overlap each side by at least 2"
- Use at least three screws per side so plate lays flat

**Apply a UL-181 metal tape along all four sides**

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### Take Offs



Flexible elbows can be used as Take Offs



Saddle take off



Flat surface take off

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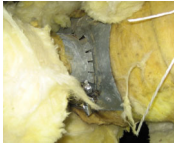
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### Cone Saddle Take Offs

- ▶ Usually are attached to the duct, with the insulation pinned between the take off and the duct it's attached to.
- ▶ Because insulation can't stop air from leaking, the insulation must be removed from under the take off before applying the mastic.



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### Sealing Cone Saddle Take Offs



**Step 1:** Unscrew take off and pull insulation back so the take off can be reattached without pinning insulation under the take off



**Step 2:** Place take off onto the duct; ensure no gap is between take off and duct.

No gaps between take off and duct

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### Sealing Cone Saddle Take Offs, continued



**Step 3:** Screw the take off back onto the duct; ensure it remains flush with duct



**Step 4:** Apply mastic around joint between take off and duct; include surfaces of take off and duct

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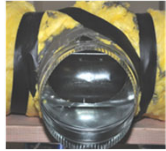
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### Sealing Cone Saddle Take Offs, continued



No insulation gaps on the duct

**Step 5:** Fold the pushed back insulation onto the duct section; use wet mastic to glue insulation to duct work



**Step 6:** Reattach insulation with duct strapping or tensioning tie

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### Crimping Tool



Used to fit two sections of the same size of metal duct together. Circumference of one duct section is reduced by crimping it so it can easily fit into the non-crimped section.

*Tip: Always use gloves when working with sheet metal*

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### Using the Crimping Tool



**Step 1:** Seat a section of duct fully into jaws of the crimper; squeeze tight



**Step 2:** Continue all the way around, ensuring complete coverage

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## Using the Crimping Tool



**Step 3:** After duct is fully crimped, insert fully into uncrimped section



**Step 4:** Mechanically fasten the two sections together using at least three sheet metal screws equally spaced.

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## Notcher Tool



Used to take a triangle “bite” out of the edge of sheet metal to make start collars from either straight pipe or elbows.

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## Using the Notcher Tool, continued



**Step 1:** Insert the sheet metal fully into the jaws of the Notcher; squeeze tight until a triangle drops out



**Step 2:** Continue around making the notches about 1–2 inches apart; **fold every other tab** back so it projects out at 90 degrees

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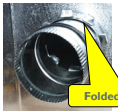
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## Using the Notcher Tool, continued



**Step 3:** Insert non-folded tabs into the duct opening; push duct into opening so folded tabs are flush with duct



**Step 4:** Reach in to take off and fold tabs back against inside of duct



**Step 5:** Screw the take off in place using at least 4 screws

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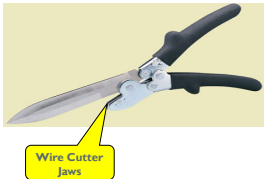
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## Flex Duct Knife



Used to cut flex duct and spiral wire of the flex duct. Has a dual edge blade that allows for cutting in two directions.

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## Using the Flex Duct Knife



**Step 1:** Puncture flex duct with tip of the knife; ensure it is the outer liner, the insulation and the inner liner



**Step 2:** Cut around the duct; ensure to cut through all the layers

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### Using the Flex Duct Knife, continued



**Step 3:** Cut the wire inside the inner liner using the wire cutter. NEVER use snips for this.



**Step 4:** Use the knife to cut away any remaining material. Don't pull the duct apart!

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### Tensioning Ties and The Tensioning Tool



**SMC** Flexible duct connections shall have the inner and outer liners secured and air-sealed with tensioning ties (Panduit or equivalent) tightened with a manufacturer-approved tensioning tool.



**SMC** All flex duct shall be joined to a section of rigid duct of matching diameter including locations where two separate sections of flex duct meet

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### Using Tensioning Ties



**Step 1:** Pull back the outer liner and insulation exposing at least one foot of inner liner



**Step 2:** Pull inner liner over the sheet metal duct part you are connecting to; pull liner up at least 2"



**Step 3:** Place tie around duct (ribs to the inside); ensure liner is under the tie and hand tighten

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## Using Tensioning Tool



**Step 4:** Insert the end of the tie into the tensioning tool; squeeze several times until tie is tight



**Step 5:** Pull duct insulation and outer liner up over metal pipe as much as possible



**Step 6:** Place and hand tighten a tie around the outer liner; tightly secure outer liner with tensioning tool

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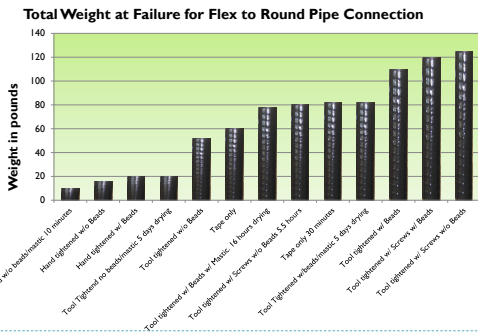
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## Flex Duct Torture Test



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## Attaching the Boot to the Sub-Floor

**SEC Boots shall be mechanically fastened to the sub-floor.**

They are often not, leaving large gaps. Roofing nails or sheetrock screws must be driven through the boot into the sub-floor to fix the gaps.



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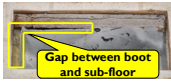
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### Attaching the Boot to the Sub-Floor, continued



**Step 1:** Make a hole in boot with a punch or awl to ease nailing the boot



Roofing nail placed in punched hole



**Step 2:** Hammer nail through boot into sub-floor using a sheet metal hammer

*Note: Hammer side used to drive nails on long sides of the boot.*

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### Attaching the Boot to The Sub-Floor, continued



**Step 3:** Drive screws flush with boot using right angle drill; register must fit into boot after repairs



**Step 4:** Replace register into boot flat against the floor

*Note: If it does not lay flat, nails or screws may need to be driven deeper into the boot.*

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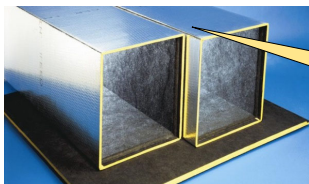
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### Duct Board



Foil is the air barrier; must be airtight

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### Thermo Flex Brand Flex Duct



Do not repair or seal, REPLACE!

Inner liner is mesh, so outer liner is the air barrier and often deteriorated

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### How Would You Fix This?



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### Toe Kicks: How Would You Seal These?



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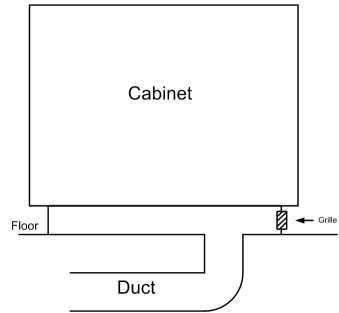
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### Toe Kicks: How Would You Seal This?



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### How Would You Fix These?



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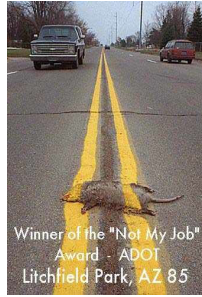
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## The Rules

- ▶ Do No Harm
- ▶ Seal outside ducts
- ▶ Seal big holes
- ▶ Seal high pressure holes
- ▶ Don't waste time on returns if there is no return
- ▶ Make your work permanent
- ▶ Measure your work to prove what you did and improve crew morale
- ▶ Reward the people doing the hard work
- ▶ Clean up!




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## Leakage Requirements: Single Family Homes

- ▶ Qualifying Pre-Sealing Leakage **Reminder**
  - ▶ Home more than 1,667 sq. ft.: Equal to or greater than 250 CFM
  - ▶ Home less than 1,667 sq. ft.: Equal to or greater than 15% of home sq. ft.
- ▶ Post-Sealing Leakage (meet one of the following after sealing):

Post-Test Leakage Requirements	
CFM equal to or greater than a <b>50% reduction</b>	<b>OR</b>
CFM equal to or less than <b>10% of home's sq. ft.</b>	

Prescriptive Duct Sealing does not require post-test leakage testing

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## Leakage Requirements: Manufactured Homes

- ▶ Qualifying Pre-Sealing Leakage **Reminder**
  - ▶ Single wide: Equal to or Greater than 100 CFM
  - ▶ Double wide: Equal to or Greater than 150 CFM
  - ▶ Triple wide: Equal to or Greater than 225 CFM
- ▶ Post-Sealing Leakage (meet one of the following after sealing):

Post-Test Leakage Requirements	
Single wide	Equal to or Less than 50 CFM
Double wide	Equal to or Less than 80 CFM
Triple wide	Equal to or Less than 110 CFM
<b>OR</b> Equal to or Less than a <b>50% Reduction</b>	

Prescriptive Duct Sealing does not require post-test leakage testing

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### Example: Post-Test Leakage, Site Built Home

- ▶ 2,000 sq. ft. home
- ▶ Home Pressure: 50 Pa to outside
- ▶ Pre-test leakage: 354 CFM (Qualifies)

**Target Post-test leakage (target only):**

- ✓ 175 CFM or less (At least a 50% reduction)
- OR
- ✓ 200 CFM or less (At least 10% of floor area)

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### Recording Results

House Pressurized (Blower Door) to:		Duct Blaster Location:		Pressure Tap Supply Register Location:	
<input checked="" type="checkbox"/> +50Pa <input type="checkbox"/> Other Pa		<input checked="" type="checkbox"/> Return Grille <input type="checkbox"/> Other:		Bathroom	
		Existing Home, Site Built		Manufactured Home	
<b>Duct Leakage Test:</b> DUCT BLASTER CFM READING with Duct Pressure at 0Pa with respect to house and Blower Door @ +50Pa.	<b>Pre-Test</b>	Pre-test Ring <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open	<input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open	<input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L
		Duct Blaster Fan Pressure	74 Pa		
		Duct Blaster CFM	354 CFM		
<b>Duct Blaster Fan Pressure:</b> It is the fan pressure, NOT the house pressure. (Ex. Ring 1, 78 Pa Fan Pressure, 364 CFM)	<b>Post-Test</b>	Pre-leakage Requirements	<input checked="" type="checkbox"/> ≥ 250 CFM (>1667 sq ft) <input type="checkbox"/> ≥ 15% of home's sq ft	<input type="checkbox"/> ≥ 100 CFM, Single Wide <input type="checkbox"/> ≥ 150 CFM, Double Wide <input type="checkbox"/> ≥ 225 CFM, Triple Wide	
		Post-test Ring	<input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open	<input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open
		Duct Blaster Fan Pressure	122 Pa		
		Duct Blaster CFM	174 CFM		
		Leakage Reduction Requirements	<input type="checkbox"/> ≤ 10% of home's sq ft <input checked="" type="checkbox"/> ≥ 50% Reduction	<input type="checkbox"/> ≤ 50 CFM, Single Wide <input type="checkbox"/> ≤ 80 CFM, Double Wide <input type="checkbox"/> ≤ 110 CFM, Triple Wide <input type="checkbox"/> ≥ 50% Reduction	

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### Section 6: What Did You Learn?

1. True or False – Duct tape is the best fastener (why else would it be named that?)  
▶ **False**
2. If ducts are covered with insulation, should you leave them alone (either because it is an air barrier or so you don't damage the insulation)?  
▶ **No**
3. Which of the following describe ducts?
  - ▶ Panned joists
  - ▶ Boots
  - ▶ Trunk
  - ▶ Duct board
  - ▶ Flex duct
  - ▶ All of the above
4. True or False – You only need a thin layer of mastic.  
▶ **False**

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## Section 7 of 10: Manufactured Homes




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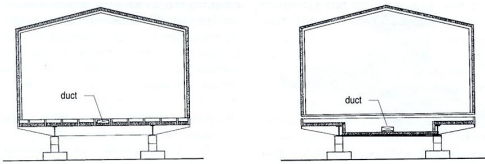
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Section 7: Manufactured Homes

### The Basics: Mobile Home Heating System



Duct Location	
Lengthwise Joists	Main duct installed between floor joists, touching flooring material
Crosswise Joists	Main duct installed below the floor joists

▶ 226

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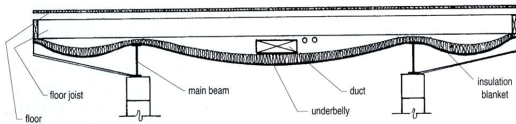
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Section 7: Manufactured Homes

### Crosswise Floor Joists



- ▶ Underbelly drops down in the center
- ▶ Provides more room in the duct and insulating blanket below the duct

▶ 227

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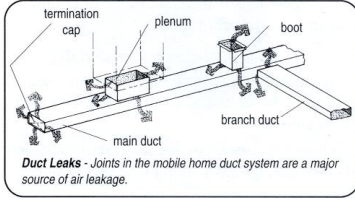
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## Parts of the Duct System



**Duct Leaks** - Joints in the mobile home duct system are a major source of air leakage.

- ▶ Most, if not all of this, is within underbelly
- ▶ Majority accessible from inside home or underneath by disconnecting crossover

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## Duct Blaster™ Fan Connections



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## Duct Blaster Fan Connections

- ▶ Four Common Connection Points
  - ▶ Open Plenum
  - ▶ Furnace Opening
  - ▶ Furnace Return
  - ▶ Supply Register



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### Open Plenum Connection

1. Wipe away any dust around base of the plenum (tape will not stick well to dusty surfaces)



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### Open Plenum Connection

2. Cover plenum base with a piece of cardboard with a Duct Blaster fan-sized hole; cover all other openings with tape



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### Open Plenum Connection

3. Connect Duct Blaster Fan to the cardboard with tape



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## Furnace Opening Connection

1. Use piece of cardboard and tape to seal off the return to the furnace



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## Furnace Opening Connection

2. Cover opening of the furnace with a piece of cardboard with a hole cut in it where snorkel can attach. Cover all other openings with tape



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## Furnace Opening Connection

3. Connect the Duct Blaster snorkel to the cardboard with tape



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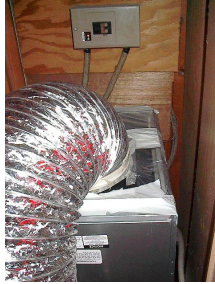
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### Furnace Return Connection

- ▶ Attach the Duct Blaster snorkel to the furnace return; cover any gaps with tape



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### Snorkel to Register Connection

1. Remove the register cover; set aside
2. Connect Duct Blaster snorkel to the open register using tape. Remember to tape off the return when using this method.



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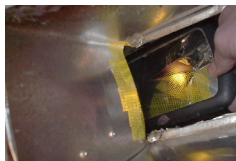
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### Repair the Boot

- ▶ Remember to always repair the boot!
- ▶ Don't have a mirror? Take a picture with your phone to check boot condition



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## End Caps



- ▶ **End caps required on ducts extending beyond last register**
- ▶ **Construct using sheet metal or other UL-181 approved rigid material**
- ▶ **Seal with mastic**

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### End Caps:

**Step 1:** Cut sheet metal scoop a little smaller than needed and place into boot.



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### End Caps:

**Step 2:** Screw into place and seal with mastic.



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End Caps:

**Step 3:** Lateral ducts sometimes need end caps too.



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End Caps:

**Step 4:** Screw in place and prep for mastic.



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**Plenum Seal** →

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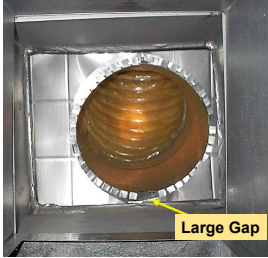
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## Plenum Connection



Connection below a plenum (view from above)



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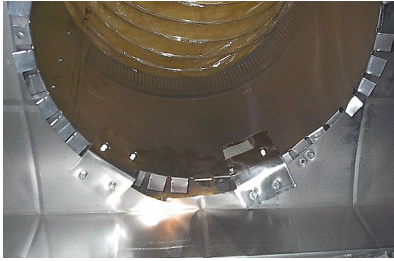
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### Plenum Connection:

**Step 1:** Sheet metal straps and screws are used to secure the cross-over to the duct.



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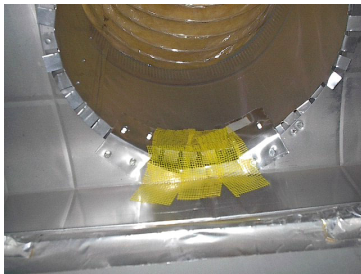
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### Plenum Connection:

**Step 2:** Mesh is used to cover the rest of the gap.



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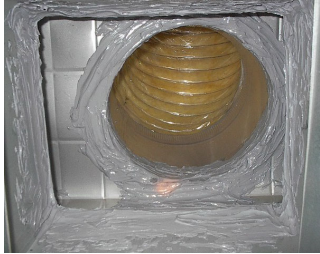
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Plenum Connection:

**Step 3:** Finally, all seams around the cross-over to duct are sealed, as well as the furnace to plenum seams.



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1. Use a duct knife to cut into the plenum. Make this cut directly below the furnace.



2. Use shears to cut a hole large enough to allow access to the interior of the plenum.

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3. Scope for any major leakage. Ensure all the flanges that secure the furnace to the plenum are securely folded over.



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4. Apply mastic to the seams where the furnace and plenum connect. Use mesh tape first to cover gaps larger than 1/4 inch.



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5. Apply mastic to the outside seams if there is nothing structural in the way (flooring trusts, 240 volt wiring).



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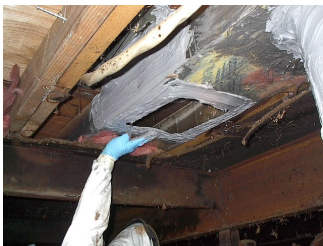
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6. Now repair the opening you made to the plenum by first applying mastic to the edge of the hole you cut.



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- Using a screw gun, fasten a piece of sheet metal to cover the entire opening. Make sure there are no gaps around the existing hole.



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- Apply mastic to the edge of the sheet metal cover to ensure a tight seal.



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- Use screws and washers, or a stapler, to attach a Tyvek™ patch over the hole in the belly.



Straight Staple



Stitch Staple

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10. Apply mastic to the entire edge of the Tyvek to ensure a tight seal.



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## Cross-Over Repairs



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1. Remove the old cross-over duct and any remnants that were used to connect it to the take-off. A clean working surface is needed for a tight seal.



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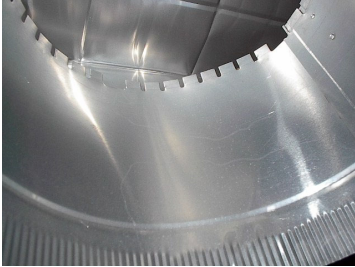
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2. Look for unfolded connection tabs in the interior of the take-off were it connects to the duct.



▶ 261

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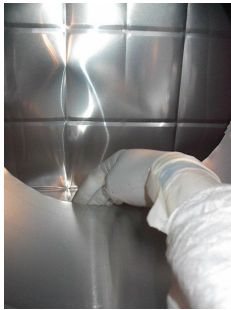
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3. Fold over any unfolded connection tabs.



▶ 262

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4. Using a screw gun, attach the connection lip to the duct work. Use at least one screw on all four sides to secure it to the duct.



▶ 263

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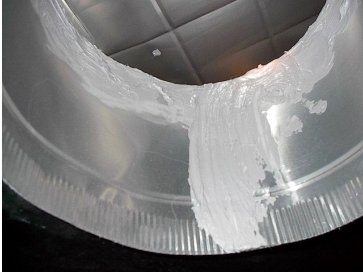
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5. Apply mastic to the duct take-off seam.



▶ 264

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6. Slip the inner lining of the cross-over, around the take-off of the duct work. Slide the lining up far enough so that two loops of the inner lining support are inside the ductwork.



▶ 265

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7. Hand tighten the Panduit™ strap around the inner lining of the crossover.



8. Use the Panduit™ gun to tighten and snip off the excess strap.

*The ribs of the strap should face inside.*

▶ 266

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9. Prepare a Panduit™ strap for the exterior of the cross-over duct. Place it around the cross-over down from the connection.



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10. Hand tighten the Panduit™ strap around the outer lining of the crossover.



11. Use the Panduit™ gun to tighten and snip off the excess strap.

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12. Make sure the cross-over duct is elevated at least 6 inches off the ground.



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## Carpe Seal 'Em



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## Section 8 of 10: Combustion Safety



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## Section 8: Combustion Safety

- ▶ CO Alarm Requirement
- ▶ Carbon Monoxide
- ▶ Combustion Safety Plan



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### Combustion Equipment? CO Alarm Required

**If there's anything that burns any fuel in the house or attached structure, the program requires that a CO alarm be installed.**

- ▶ No matter if it uses gas, propane, fuel oil, wood, etc. – just that it burns something




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### Combustion Safety Testing Can Include...

- ▶ Polluting equipment not allowed in a home
- ▶ Carbon Monoxide (CO) testing
- ▶ Gas leak testing
- ▶ Back drafting testing in room with CAZ equipment
- ▶ Carbon monoxide monitor requirement
- ▶ Measurement of flue gases

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### Affect of Carbon Monoxide (CO)

Even in small concentrations, it can cause sickness and even death.

PPM CO in air	Symptoms experienced by healthy adults	Comments
Less than 35 ppm	No effect in healthy adults	35 ppm is WISHA 8-hour average permissible limit
200 ppm	Headache, fatigue, nausea, dizziness	200 ppm is the WISHA ceiling limit
400 ppm	Severe headache, fatigue, nausea, dizziness, confusion, can be life-threatening after 3 hrs of exposure	
1,500 ppm	Headache, dizziness, nausea, convulsions, collapse, death within 1 hour	Greater than 1,500 ppm are considered "immediately dangerous to life or health"
3,000 ppm	Death within 30 minutes	
6,000 ppm	Death within 10-15 minutes	
12,000 ppm	Nearly instant death	

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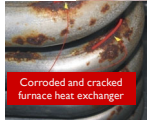
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### Causes of CO in Homes

- ▶ Urban Traffic
- ▶ Cars started in garages
- ▶ Unvented combustion equipment
- ▶ Backdrafting combustion equipment
- ▶ Failed heat exchangers



#### General Rule

If there is combustion, there might be CO

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### Unvented Combustion Equipment: Not Safe



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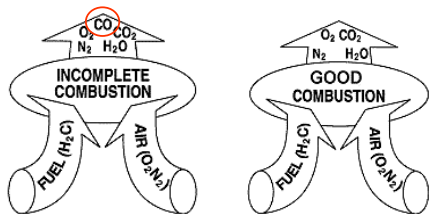
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### CO By-Product of Incomplete Combustion



Large amounts of heat energy are released during the combustion process

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## Potential Negative Effects of Duct Sealing

- ▶ A lower rate of dilution
- ▶ Back drafting of combustion equipment
- ▶ Build up of CO in the home



*Duct Sealing companies should have a plan to reduce liability*

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## Why Category I Appliances Vent

- ▶ When air is heated the molecules move further apart making it less dense than the surrounding air.
- ▶ Denser air pushes the lighter air up the vent.



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## Buoyancy Creates Draft Pressure

The driving force that moves a hot air balloon up is the same driving force that vents the gas water heater.

Buoyancy, not heat.



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## Driving Forces That Make Air Move

- ▶ Wind
- ▶ Stack (Chimney Effect)
- ▶ Exhaust Fans
- ▶ Duct Leakage
- ▶ Unbalanced Forced Air Systems (interior door closure)

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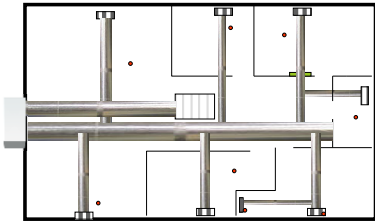
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## Door Open Air Circulation Path



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House Pressures Resulting from Closed Interior Doors



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## Kitchen Exhaust Fans



Downdraft



Big updraft

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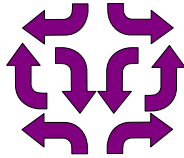
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## Competing Pressures

- ▶ Driving forces compete for the same air
- ▶ Draft is a very weak force; loses out to stronger pressures



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## DO NOT Create Back Drafting Problems

- ▶ Turning on exhaust fans and leaky supply ducts outside the house can create negative pressure in the room where the combustion equipment is located.
  - ▶ May cause combustion gases to be pulled down the flue
- ▶ Back drafting combustion appliances can produce large amounts of CO, often in the thousands of parts per million.



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## Section 9 of 10: Participation Rules & Paperwork



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Section 9: Participation Rules & Paperwork

### Section 9: Participation Rules & Paperwork

- ▶ Next Steps to Certification
- ▶ Online Account
- ▶ Technician Application
- ▶ Entering a Job into the Mobile Registry
- ▶ Quality Assurance Inspections

▶ 289

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Section 9: Participation Rules & Paperwork

### Next Steps to Certification

- Step 1**
  - Pass this training's exam
- Step 2**
  - Create online account on [prcs.bpa.gov](https://prcs.bpa.gov)
- Step 3**
  - Submit [Certified Technician Application](#) found in "How to Participate" section on [www.bpa.gov/goto/reshvac](https://www.bpa.gov/goto/reshvac)

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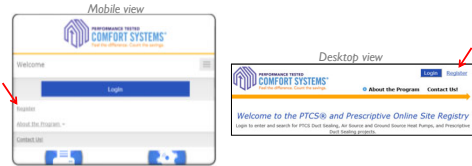
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### Step 2: Create Online Account Now!

Go to [ptcs.bpa.gov](http://ptcs.bpa.gov) and click "Register" to create a profile.



Account will be activated and tech ID assigned when all the steps are completed.

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### Step 3: Certified Technician Application

Find it at the end of your Trainee Manual or in "How to Participate" section on [www.bpa.gov/goto/resHVAC](http://www.bpa.gov/goto/resHVAC)

Submit photos or scans of completed & signed application by email to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or fax it to 1-877-848-4074

Note: Submit this form when tech is new, receives additional training, or needs to update company info.

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### Next Steps: Some Clarification

- ▶ A non-PTCS Certified technician can seal the ducts, but a PTCS certified technician **must** perform the leakage tests and inspect the duct sealing.
- ▶ Certification will follow you to any company. Submit new Certified Technician Application to update information.

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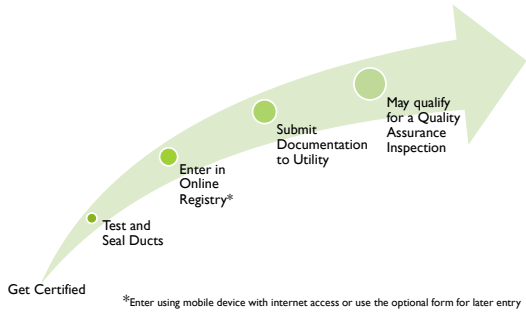
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## Beyond Certification



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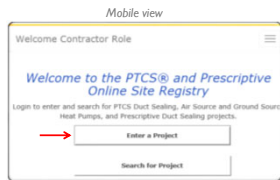
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## Entering a Job: Online Registry

- ▶ Log in to installing technician's account at [pcs.bpa.gov](https://pcs.bpa.gov) and click "Enter a Project" or click "Contractors" and select "Enter a job".
- ▶ For a guide on entering a job online, see page 19 in your Trainee Manual.



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## Mobile Registry Updates

- ▶ Online registry optimized for use on any mobile device
  - ▶ Not an app you download
- ▶ Save progress function to complete entered data later
  - ▶ Enter job data before, during, and after installation by saving your progress
- ▶ Times out after 4 hours of inactivity
- ▶ Informational bubbles explaining some program components
- ▶ Some limitations
  - ▶ No offline entry mode. Can't use without internet access.
  - ▶ Optional forms available to record data for later entry, but not required to submit.

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## Exercise: Optional Mobile Entry Practice

- ▶ Go to test site on a mobile device: <https://ptcs.test.bpa.gov>
  - ▶ Only a test environment. Nothing will publish live on this site.
- ▶ Sign in:
  - ▶ Username: TestContractor
  - ▶ Password: Ptcsl234
- ▶ Enter a job:
  - ▶ Active physical address
  - ▶ Enter any data. Some suggestions:
    - ▶ Pre-test Ring 1, Fan Pressure 86 Pa, and CFM 382
    - ▶ Post-test Ring 3, Fan Pressure 140 Pa, and CFM 74

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## Registry Entry Tip!

Fan Pressure  $\neq$  House Pressure

- ▶ Upon entry into the registry, **enter the correct duct blaster fan pressure and not the house test pressure of 50 Pa.**
- ▶ If you do this, your house may be rejected
- ▶ The registry calculates the flow in CFM using:
  - ▶ Ring Size
  - ▶ Fan Pressure

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## Troubleshooting Entry Issues

- ▶ Contact the PTCS team if:
  - ▶ Address isn't validating
  - ▶ Need to enter in a second system
  - ▶ Can't find an entered job
  - ▶ Need to edit an address or submitted data
  - ▶ Need immediate review of "Pending" entry (reviewed regularly)

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## Optional PTCS Duct Sealing Form

If no internet or mobile device is available or the job cannot be entered online for any reason, this form is available to record the data for later entry.

Can be found on [ptcs.bpa.gov](http://ptcs.bpa.gov) and at the end of your manual.

\* Some participating utilities require installation form, please check with utility prior to job submission

The image shows a screenshot of a web-based form titled "PTCS Duct Sealing Form (optional)". The form includes sections for "Job Information", "Customer Information", "Technician Information", and "Job Details". It contains numerous input fields, checkboxes, and dropdown menus for recording job data.

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## Notifying Utility of the Completed Job

- ▶ Technician or company required to notify the utility of the completed job.
- ▶ Contact customer's utility for information on required paperwork.
- ▶ Utilities have access to the online registry and are able to review completed job details.




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## Quality Assurance Inspections

- ▶ **At least 10% of all jobs are inspected for:**
  - ▶ Measured Leakage
  - ▶ CO Detector Installed, if required
  - ▶ Crossover (Manufactured Home)
  - ▶ Sealing and Repairing Air Handler to Plenum
  - ▶ Ducts in Good Repair
- ▶ Joints Fastened
- ▶ Tape Removed and/or Covered with Mastic
- ▶ Ducts Sealed
  - ▶ Duct Insulation Re-installed




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## QA Inspection Feedback & Remediation

Inspection feedback will be communicated to the technician and/or their company. See the "PTCS Technician Support Plan" at the end of your Trainee Manual for what to expect if a project does not pass inspection.



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## Section 10 of 10: Resources



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## Program Website

▶ All of the following are on this website:

<https://ptcs.bpa.gov>

- ▶ Specifications
- ▶ Requirements
- ▶ Technical and Training Resources
- ▶ Online Registry Resources
- ▶ Link to Online Marketing Portal
- ▶ Installation Forms

Welcome to the PTCS® and Prescriptive Online Site Registry



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## Program Website: Technical Resources

- ▶ Go to the "PTCS and Prescriptive Duct Sealing" section on [www.bpa.gov/goto/reshvac](http://www.bpa.gov/goto/reshvac)
- ▶ Technical Resources for Duct Sealing include:
  - ▶ Leakage Testing Diagrams
  - ▶ Blower Door Set Up Diagram
  - ▶ Flow Conversion Tables




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## Spanish Materials

- ▶ Now available in Spanish:
  - ▶ PTCS training presentations
  - ▶ Manuals
  - ▶ Tests
  - ▶ Forms
- ▶ Contact Kyle Chase at CLEARresult: [kyle.chase@clearresult.com](mailto:kyle.chase@clearresult.com)




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## Equipment Discount

- ▶ Discount now available to purchase duct testing equipment:
  - ▶ 12.5% discount for Blower Door and Duct Blasters from TEC
  - ▶ 12.5% discount for digital gauges from TEC
- ▶ Discount form included at the end of your Trainee Manual
- ▶ Submit this form to Kyle Chase at CLEARresult: [kyle.chase@clearresult.com](mailto:kyle.chase@clearresult.com)

 <small>Member of CLEARresult</small>	 <small>Member of CLEARresult</small>																				
<b>Member ENERGY STAR Home Equipment Discount List</b> <small>Available only to CLEARresult members. See the CLEARresult website for complete program details.  <a href="http://www.clearresult.com">www.clearresult.com</a> </small>																					
<table border="0"> <tr><td>NAME</td><td>_____</td></tr> <tr><td>ADDRESS</td><td>_____</td></tr> <tr><td>CITY</td><td>_____</td></tr> <tr><td>STATE</td><td>_____</td></tr> <tr><td>ZIP</td><td>_____</td></tr> </table>	NAME	_____	ADDRESS	_____	CITY	_____	STATE	_____	ZIP	_____	<table border="0"> <tr><td>PHONE (Home or Office) (List Billing Address)</td><td>_____</td></tr> <tr><td>DATE</td><td>_____</td></tr> <tr><td>SIGNATURE</td><td>_____</td></tr> <tr><td>PRINT NAME</td><td>_____</td></tr> <tr><td>DATE</td><td>_____</td></tr> </table>	PHONE (Home or Office) (List Billing Address)	_____	DATE	_____	SIGNATURE	_____	PRINT NAME	_____	DATE	_____
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## Stay Informed!

- ▶ Sign up for the Quarterly Newsletter or visit the PTCS website for the latest announcements
- ▶ Updated specifications
- ▶ Online registry changes
- ▶ Common issues in the field
- ▶ Updated program requirements
- ▶ New technical support resources
- ▶ Tips and tricks

Go to <https://tinyurl.com/ptcsnewsletter> or email [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) to sign up. Also sign up from the "Stay Informed!" link on the website.

**Stay Informed!**  
Sign Up for Our Mailing List!

We guarantee we will not spam you or sell any of your information.

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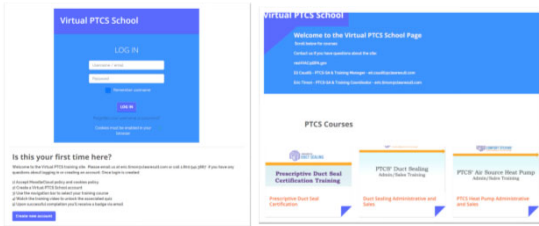
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## On-Demand Webinars

Self-led trainings available at <https://clearesult.moodle.school>

- ▶ Prescriptive Duct Sealing Certification
- ▶ Duct Sealing admin/sales training
- ▶ Heat Pump admin/sales training




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## Prescriptive Duct Sealing Training

- Step 1**
  - Create a free account at <https://clearesult.moodle.school>
- Step 2**
  - Select Prescriptive Duct Sealing Certification module on home page
- Step 3**
  - Contact [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) to add Prescriptive Certification to your account

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## NATE Continuing Education Hours

- ▶ Email us at [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov)
- ▶ Give us your
  - ▶ Name
  - ▶ Date of class
  - ▶ NATE ID#

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## What now?

- ▶ What you've done
  - ▶ Completed the classroom training
  - ▶ Create a PTCS registry account
- ▶ What's next
  - ▶ Completed final exam
  - ▶ Complete training evaluation
  - ▶ Sign up for field demonstration video call via setmore
    - ▶ [Ptcs.setmore.com](https://ptcs.setmore.com)
  - ▶ Complete prescriptive duct seal training in Moodle
    - ▶ [Clearesult.Moodle.School](https://clearesult.moodle.school)
  - ▶ Send certified technician application to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov)

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## Good luck on the Exam!

Questions?  
Comments?

Contact the PTCS Team:  
Phone: (800) 941-3867  
Email: [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov)



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## Energy Trust of Oregon Jobs

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For questions concerning PTCS installations for customers of Pacific Power or Portland General Electric, please call 1-866-365-3526 or email [Residentialforms@energytrust.org](mailto:Residentialforms@energytrust.org).



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# Certified Technician Application

## Performance Tested Comfort Systems and Prescriptive Duct Sealing

All sections of this form are required for technicians interested in participating as a program provider of PTCS® Heat Pumps, PTCS Duct Sealing, and/or Prescriptive Duct Sealing for Bonneville Power Administration (BPA). **Sole-proprietors** shall complete both Technician and Company signatures.

- 1) Create an account in the online registry at [ptcs.bpa.gov](http://ptcs.bpa.gov) if not done so already.
- 2) Submit this form by email to [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov) or by fax to 1-877-848-4074 (if applicable, include proof alternative certification).
- 3) If approved, the PTCS team will activate technician's online account and list technician information on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac).

### Contact Information

Company Name	Company Rep		
Company Address*	Company City/State/Zip*		
Technician Name	Contractor license #		
Technician Email			Phone
General Company Email			

### PTCS or Prescriptive Training Completed

Certification Type	PTCS or Prescriptive Training: Company, Instructor, or Online Module	*Alternative Certification Name & Number (if applicable)	Date Trained
PTCS Duct Sealing			
Prescriptive Duct Sealing			
PTCS Air Source Heat Pump			
**Ground Source Heat Pump	**IGSHPA # (If also certified):		

\*Some **alternative certifications** are accepted (see list of accepted alternatives in Program Requirements document on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac)). Submit documented and dated proof of training completion with this application.

\*\***Ground Source Heat Pump** installs require one PTCS Air Source Heat Pump Tech and one IGSHPA Certified Tech OR one tech certified in both PTCS and IGSHPA. If this technician is IGSHPA Certified as well as PTCS HP Certified, please provide their IGSHPA number in this field.

### Certified Technician Requirements Applicant Must Agree to:

(Participation Requirements listed on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac))

1. Maintain all state and locally required licenses and insurance coverage.
2. Comply with all appropriate specifications: Prescriptive Duct Sealing, PTCS Duct Sealing and/or PTCS Heat Pump Commissioning technical specifications.
3. Comply with all program requirements as specified in BPA Program Requirements posted on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac).
4. Conduct business in an ethical and professional manner.
5. BPA reserves the right to refuse to list a technician for any reason.
6. Accurately and completely record all jobs using the program forms and online registry.
7. Report all required job information to the customer utility in accordance with its requirements.
8. If required, contact homeowner to schedule corrective action within 10 days of receiving notice from the utility and/or Quality Assurance Inspector. Complete corrective action within 10 working days of contacting homeowner or as soon as the homeowner is available.
9. Provide and maintain current Technician and employer contact information with BPA.

**Requirements the Certified Technician’s Company (or Certified Technician, if a Sole-Proprietor) Must Agree to:**

1. Maintain all state and locally required licenses and insurance coverage (i.e. Construction Contractors Board (CCB), State license if required by law or regulations, worker’s compensation, general liability (commercial coverage), and automobile liability). Comply with all applicable employment laws.
2. Conduct all business in an ethical and professional manner.
3. Ensure technician complies with all program requirements as specified in BPA Program Requirements posted on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac).
4. Ensure technician completes all work in accordance with the:
  - a. Applicable ordinances, codes and accepted industry standards including PTCS and Bonneville Power Administration’s (BPA) standards.
  - b. Current program specifications listed on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac) using program-required methods and testing equipment where indicated.
5. Ensure technician accurately and completely records all jobs using program forms and the PTCS Online Registry and submits required project paperwork to the utility program in accordance to its requirements.
6. If required, ensure technician schedules corrective action on job within 10 days of receiving notice from the utility and/or Quality Assurance Inspector and corrective action is completed within 10 working days of contacting the homeowner, or as soon as the homeowner is available.

**Signatures**

**By signing below**, the Applicant agrees to comply with the Certified Technician Requirements and certifies that all information provided in this application is true and correct to the best of their knowledge.

Technician Signature  
*(Required)*

Date

**By signing below**, the Company Representative further certifies that they are authorized to sign on behalf of the Company, agrees to comply with Technician’s Company Requirements, and certifies that all information provided in this application is true and correct to the best of their knowledge. **This signature is required even if applicant is a sole proprietor.**

Company Representative  
Signature *(Required)*

Date

Frequently Asked Questions about the PTCS and Prescriptive Certification

(More found on the “How to Participate” Page on [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac)):

- *When do I get a PTCS Technician ID for the first time?* After your application has been reviewed and approved, the PTCS team will activate your online account and you will receive your PTCS Tech ID number by email.
- *What do I do if I change companies?* Submit this form with your updated company information listing all areas of certification.
- *What if I get an additional certification?* Submit this form with your updated training/certification information including all other areas of certification.
- *Can I enter installation data on my mobile device?* Yes, if your device has access to the internet or Wi-Fi.
- *Who do I contact with questions?* Contact your trainer or the PTCS team by calling 1-800-941-3867 or emailing ResHVAC@bpa.gov.

## PTCS® Duct Sealing Form (optional)

1) Enter all data on a mobile device or computer at [ptcs.bpa.gov](https://ptcs.bpa.gov) using the certified technician's account. This optional form can be filled out for later entry online. Issues entering data? Submit this form for entry:

- Customers of Bonneville Power Administration (BPA) utilities: email [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov), fax to 1.877.848.4074, or call 1.800.941.3867
- Customers of PGE or Pacific Power: email [Residentialforms@energytrust.org](mailto:Residentialforms@energytrust.org) or call 1.866.365.3526

2) Submit the Registry Installation Report (found online) and additional required documents to the customer utility. Unless requested by the utility, submission of this form is not required.

### Site Information

PTCS Tech #	PTCS Tech Name	Install Date	Electric Utility	
Installation Site Address		Site City	Site State	Site Zip
Home Type: <input type="checkbox"/> Existing Site Built <input type="checkbox"/> Manufactured: # of Sections <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3			Heated Area: _____ Sq Ft	
Foundation Type (Site Built): <input type="checkbox"/> Crawlspace <input type="checkbox"/> Full Basement <input type="checkbox"/> Half Basement <input type="checkbox"/> Slab				
Existing Heating System: <input type="checkbox"/> Electric Forced Air w/out AC <input type="checkbox"/> Electric Forced Air w/ AC <input type="checkbox"/> Electric Zonal <input type="checkbox"/> Air Source Heat Pump <input type="checkbox"/> Ground Source Heat Pump <input type="checkbox"/> Natural Gas Furnace (Gas Company: _____) <input type="checkbox"/> Other Non-Electric Space Heating: _____				
Back up Heat: <input type="checkbox"/> None <input type="checkbox"/> Electric Forced Air <input type="checkbox"/> Electric Zonal <input type="checkbox"/> Natural Gas Furnace <input type="checkbox"/> Non-Electric Space Heating				
Location of Duct Work. Ducts are considered to be in unconditioned space when they are in vented crawlspaces, attics, and unheated garages. Basements are considered conditioned space. The bellies of manufactured homes are considered accessible.				
Are at least 30% of supply ducts in unconditioned space and accessible? <input type="checkbox"/> Y <input type="checkbox"/> N <span style="float: right;"><i>If no, home does not qualify for duct sealing.</i></span>				
# Supply		# Returns		

### House Pressurization and Duct Blaster Tests

*Work must be done to PTCS Duct Sealing Specification found at [bpa.gov/goto/reshvac](https://bpa.gov/goto/reshvac).*

Do either of these conditions apply? <input type="checkbox"/> Record Only (No duct sealing done) <input type="checkbox"/> PTCS Certification ONLY (Pre-test leakage below requirement)		Testing Equipment Used: <input type="checkbox"/> Energy Conservatory <input type="checkbox"/> RetroTec <input type="checkbox"/> Other: _____			
Duct Insulation (select one): <input type="checkbox"/> Ducts were not insulated OR <input type="checkbox"/> Existing duct insulation was re-installed OR <input type="checkbox"/> New insulation was installed					
House Pressurized (Blower Door) to: <input type="checkbox"/> +50Pa <input type="checkbox"/> Other _____ Pa	Duct Blaster Location: <input type="checkbox"/> Return Grille <input type="checkbox"/> Other: _____	Pressure Tap Supply Register Location:			
<p><u>Duct Leakage Test:</u> DUCT BLASTER CFM READING with Duct Pressure at 0Pa with respect to house and Blower Door @ +50Pa.</p> <p><u>Duct Blaster Fan Pressure:</u> It is the fan pressure, NOT the house pressure. (Ex. Ring 1, 78 Pa Fan Pressure, 364 CFM)</p> <p><i>Note:</i> CFM leakage is calculated in the online registry using the ring size and fan pressure.</p>	Pre-Test	<b>Pre-test Ring</b>	<b>Existing Home, Site Built</b> <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<b>Manufactured Home</b> <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	
		<b>Duct Blaster Fan Pressure</b>	Pa	Pa	
		<b>Duct Blaster CFM</b>	CFM	CFM	
		<b>Pre-leakage Requirements</b>	<input type="checkbox"/> ≥ 250 CFM (>1667 sq ft) <input type="checkbox"/> ≥ 15% of home's sq ft	<input type="checkbox"/> ≥ 100 CFM, Single Wide <input type="checkbox"/> ≥ 150 CFM, Double Wide <input type="checkbox"/> ≥ 225 CFM, Triple Wide	
		Post-Test	<b>Post-test Ring</b>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Open <input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L
			<b>Duct Blaster Fan Pressure</b>	Pa	Pa
			<b>Duct Blaster CFM</b>	CFM	CFM
			<b>Leakage Reduction Requirements</b>	<input type="checkbox"/> ≤ 10% of home's sq ft <input type="checkbox"/> ≥ 50% Reduction	<input type="checkbox"/> ≤ 50 CFM, Single Wide <input type="checkbox"/> ≤ 80 CFM, Double Wide <input type="checkbox"/> ≤ 110 CFM, Triple Wide <input type="checkbox"/> ≥ 50% Reduction

**Specification Requirements**    The duct sealing at this site meets program requirements including: repairs, metal ducts secured with screws, flex duct interior and exterior liners secured with nylon straps or steel band clamps, ducts are supported and off the ground, boots are mechanically fastened to floor/ceiling, plenum, main ducts, takeoffs and boots sealed, and a good faith effort was made to remove existing duct tape and cover with mastic.         Y    N

**Combustion Appliance Zone (CAZ)**

*Check for common CAZ devices, such as fireplaces, wood stoves, gas furnaces, and gas water heaters.*

**Are there any combustion appliances in the home?**

Y    N

**Is there a UL-approved and functioning CO detector installed in the home?**    Y    N

A carbon monoxide (CO) detector installed in the home is **required** in all cases where a sealed or non-sealed combustion appliance is located in a conditioned space or attached structure i.e. garage. RECOMMENDED CO detector specifications: UL 2034/CSA 6.19-01, digital display, peak CO memory and recall.

**Notes**



## Prescriptive Duct Sealing Form

This installation form is now **required** for jobs that are not entered into the registry. Check with your local utility to determine individual requirements, as they may vary.

- If the utility **does not** require registry entry, complete and submit this installation form. Check with the customer utility for additional requirements.
- If the utility **does require** registry entry, enter all data on a mobile device or computer at [ptcs.bpa.gov](http://ptcs.bpa.gov) using the certified technician's account. Print the Registry Installation Report. Note: This form can be filled out for later entry online. Issues entering data? Submit this form for entry:
  - Customers of Bonneville Power Administration utilities can email [ResHVAC@bpa.gov](mailto:ResHVAC@bpa.gov), fax to 1.877.848.4074 or call 1-800-941-3867.
  - Customers of Portland General Electric or Pacific Power can email [Residentialforms@energytrust.org](mailto:Residentialforms@energytrust.org) or call 1.866.365.3526.

### Site Information

PTCS tech #	PTCS tech name	Install date	Electric utility	
Installation site address		Site city	Site state	Site zip
Home type: <input type="checkbox"/> Existing site built <input type="checkbox"/> Manufactured: # of sections <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3			Heated area: _____ Sq Ft	
Foundation type (site built): <input type="checkbox"/> Crawlspace <input type="checkbox"/> Full basement <input type="checkbox"/> Half basement <input type="checkbox"/> Slab				
Existing heating system:				
<input type="checkbox"/> Electric forced air w/out AC <input type="checkbox"/> Electric forced air w/AC <input type="checkbox"/> Electric zonal <input type="checkbox"/> Air source heat pump <input type="checkbox"/> Ground source heat pump <input type="checkbox"/> Natural gas furnace (Gas company: _____) <input type="checkbox"/> Other non-electric space heating: _____				
Back up Heat: <input type="checkbox"/> None <input type="checkbox"/> Electric forced air <input type="checkbox"/> Electric zonal <input type="checkbox"/> Natural gas furnace <input type="checkbox"/> Non-electric space heating				
# Supply			# Returns	
Location of duct work. Ducts are considered to be in unconditioned space when they are in vented crawlspaces, attics and unheated garages. Basements are considered conditioned space. Bellies of manufactured homes are considered accessible.				
<b>Qualifying Characteristic</b> Select one: <input type="checkbox"/> At least 30% of the supply ducts are in unconditioned space <b>and</b> accessible, <b>OR</b> <input type="checkbox"/> There are high operating pressure leaks in unconditioned space (i.e. plenum).				

### Installation Checklist

*All work must be completed to the Prescriptive Duct Sealing Specification found at [bpa.gov/goto/reshvac](http://bpa.gov/goto/reshvac).*

<b>Duct Repair</b>
Select all issues that apply: <input type="checkbox"/> No repairs done <input type="checkbox"/> Large gaps in sheet metal <input type="checkbox"/> Rusted portions <input type="checkbox"/> Missing sections
Metal duct connections: <input type="checkbox"/> No metal ducts present <b>OR</b> <input type="checkbox"/> All are fastened (e.g. 3 metal screws at each connection where required)
Flex duct connections: <input type="checkbox"/> No flex ducts present <b>OR</b> <input type="checkbox"/> All flex ducts are joined to a section of rigid duct of matching diameter
Flex duct liners: <input type="checkbox"/> No flex ducts present <b>OR</b> <input type="checkbox"/> Interior and exterior liners of flex duct connections are secured
<b>Duct Support and Connections</b>
Duct support: <input type="checkbox"/> Ducts did not require support <b>OR</b> <input type="checkbox"/> Duct supports were added
Ground contact: <input type="checkbox"/> Ducts do not contact ground <b>OR</b> <input type="checkbox"/> Closed-cell rigid insulation is under the ducts to prevent contact
Boots are mechanically fastened to the subfloor or respective surface: <input type="checkbox"/> Y <input type="checkbox"/> N <b>If no, the project will fail.</b>
<b>Duct Sealing: All accessible portions of the duct which require sealing are sealed with approved materials.</b>
This includes pulling insulation off where opportunities exist. Examples: Plenum; air-handler cabinet to plenum; plenum-to-take-off connections; finger/dovetail joints; branch T's, Y's and L's; duct-to-duct connections; and gores on adjustable elbows.
<input type="checkbox"/> Y <input type="checkbox"/> N <b>If no, the project will fail.</b>
Return was (select one): <input type="checkbox"/> Sealed <b>OR</b> <input type="checkbox"/> In conditioned space and not sealed <b>OR</b> <input type="checkbox"/> Not accessible and not sealed <b>OR</b> <input type="checkbox"/> Was not sealed but is accessible

**Duct Insulation**

Existing duct insulation was re-installed **OR**  Ducts were not insulated **OR**  New insulation was installed

**Manufactured Homes** *Select all that apply:*

Belly was accessed  Cross-over repairs were made  New cross-over was installed  End caps installed and sealed

**Combustion Appliance Zone (CAZ)**

*Check for common CAZ devices, such as fireplaces, wood stoves, gas furnaces, and gas water heaters.*

**Are there any combustion appliances in the home?**

Y  N *If yes, a CO detector must be installed.*

**Is there a UL-approved and functioning CO detector installed in the home?**  Y  N

*If no but a CAZ device is present, the project will fail.*

A CO detector installed in the home is **required** in all cases where a sealed or non-sealed combustion appliance is located in a conditioned space or attached structure i.e. garage. RECOMMENDED CO detector specifications: UL 2034/CSA 6.19-01, digital display, peak CO memory and recall.

**Notes**

## Performance Tested Comfort Systems (PTCS) Equipment Discount List

In partnership with CLEAResult, The Energy Conservatory is pleased to extend the following discounts to contractors participating in the Performance Tested Comfort Systems (PTCS) program.

Please forward completed order forms to Eli Caudill: Email: [eli.caudill@clearesult.com](mailto:eli.caudill@clearesult.com)

### Company Billing Address

Contact Name: \_\_\_\_\_  
 Company Name: \_\_\_\_\_  
 Street Address: \_\_\_\_\_  
 City, State, Zip: \_\_\_\_\_  
 Phone: \_\_\_\_\_

### Shipping Address (if different than Billing Address)

Contact Name: \_\_\_\_\_  
 Company Name: \_\_\_\_\_  
 Street Address: \_\_\_\_\_  
 City/State/Zip: \_\_\_\_\_  
 Email: \_\_\_\_\_

**All orders require payment via credit card prior to order processing.**  
**Please complete payment information below to avoid delays in processing your order request.**

Credit Card Information: \_ Visa \_ Master Card \_ Discover \_ AMEX      Name on card: \_\_\_\_\_  
 Credit Card #: \_\_\_\_\_      Exp. Date: \_\_\_\_\_      CVV# \_\_\_\_\_  
 Credit Card Address (if different from billing address above) \_\_\_\_\_

Equipment	Model Numbers	Qty	Unit Price	Less 12.5% Discount	Total Per Unit	Total
Minneapolis Blower Door™	Model 3 110V System with DG-1000 Digital Gauge		\$3,755.00	(\$469.38)	\$3,285.62	
Minneapolis Duct Blaster®	Series B110V with DG-1000 Digital Gauge		\$2,965.00	(\$370.63)	\$2,594.37	
Minneapolis Duct Blaster® without Gauge	Series B110V without DG-1000		\$1,705.00	(\$213.13)	\$1,491.87	
DG-1000 Digital Gauge (stand alone)	DG-1000 Pressure and Flow Gauge		\$1,620.00	(\$202.50)	\$1,417.50	
DG-8 Digital Gauge Pressure Gauge	DG-8 Pressure Gauge		\$549.00	(\$68.63)	\$480.37	
Digital TrueFlow® Grid Kit without Gauge (Additional Options Available)	Digital TrueFlow® Meter No Gauge		\$1071.00	(\$133.88)	\$937.12	
<b>Total Amount</b>						

Unit Prices do not include shipping charges or sales tax where applicable to TEC. Equipment will be shipped Ground UPS, unless notified otherwise, with shipping charges added to the invoice. Additional items are available from TEC and eligible for program discount.

### For product and order questions:

**The Energy Conservatory**  
 2801 21st Ave. South, Ste. 160  
 Minneapolis, MN 55407  
 Phone: (612) 827-1117 phone

### For CLEAResult Questions

**CLEAResult**  
 100 SW Main, Ste 1500  
 Portland, OR 97204  
 Phone: 503.467.2140  
 Email: [eli.caudill@clearesult.com](mailto:eli.caudill@clearesult.com)



# PTCS® Training Evaluation

Training Type and Date: \_\_\_\_\_

Trainer Name: \_\_\_\_\_

I am a:  Technician  Utility Representative  Contractor Representative  Other

	<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>	<i>Strongly Agree</i>
The trainer was prepared and organized.	1	2	3	4	5
The trainer followed the training material.	1	2	3	4	5
The trainer was helpful.	1	2	3	4	5
The trainer was easy to understand.	1	2	3	4	5
The trainer spent enough time answering questions.	1	2	3	4	5
The trainer had knowledge of the PTCS Program.	1	2	3	4	5
I felt the exercises/site visits were useful.	1	2	3	4	5
There was a good balance of hands-on and in-classroom learning.	1	2	3	4	5
I felt comfortable asking questions during the training.	1	2	3	4	5
I feel like I know who to go to if I have any questions.	1	2	3	4	5
The training materials will be good for future reference.	1	2	3	4	5
I know what I need to do to successfully install and PTCS certify jobs in the field now.	1	2	3	4	5
I understand the form requirements and know how to enter jobs into the mobile registry.	1	2	3	4	5

I felt the pace of the training was...

Too Slow  Just Right  Too Fast | *Comments?*

I felt the overall length of the training was...

Too Short  Just Right  Too Long | *Comments?*

Other comments (positive or negative):

*When complete, please hand this to your trainer.*

*Thank you for your feedback! You are helping improve this process for future technicians.*

