North Dakota Weatherization Field Standards

Home Weatherization Assistance Program

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Note: This complete document is available at www.karg.com/nd_wx_project.htm

State of North Dakota
Department of Commerce
Division of Community Services (DCS)
Paul Govig, Director

Energy Division
Howard Sage, Weatherization Program Administrator
400 East Broadway
Bismarck, ND 58502
(701) 328-4140

11800 Room-to-Room Pressure Testing

11810 Air Handler Pressure Balance Testing for Site-Built Homes

11811 Introduction

This test procedure is performed only in dwellings with air handlers. Room-to-room pressure(s) should be measured in all rooms with forced air heating return or supply ducts and operable doors, after all weatherization installations have been completed. The procedure indicates the magnitude of:

1. Duct leakage to the outdoors, either through supply or return ducts.
2. Imbalances of air distribution resulting from closed interior doors. These closed doors can act as dampers to the free flow of air within the conditioned space of the dwelling.
3. Imbalances of air distribution resulting from airflow differences between the supply side and return side of the ductwork, for example, a restricted return truck.

11812 Test Procedure

1. Set house up in winter operating mode.
2. Run a pressure hose from the main body of the house to the outdoors.
3. Set up a magnehelic gauge zeroed at 15 Pa or a digital pressure gauge in the main body of the house.
4. Record any pressure difference between the main body of the dwelling and the outdoors. This is the reference background pressure.
   a. A reference background pressure might be due to stack-effect air leakage (especially if it is cold outdoors) or wind.
5. Turn on the air handler and measure the pressure of the main body of the house with reference to the outdoors.
   a. If the pressure difference between the main body and the outdoors is different with the air handler on than with the air handler off, there is probably some duct leakage to the outdoors
      i. Either from the return side of the system (the pressure difference of the dwelling with reference to outdoors will move toward positive when the air handler is activated), or
      ii. From the supply side of the system (the pressure difference of the dwelling with reference to outdoors will move toward negative when the air handler is activated).
6. Close all interior doors.

7. Repeat the pressure measurement from the main body of the house with reference to the outdoors.
   a. If this pressure is different than it was when all the interior doors were open, the interior doors are acting as dampers to the air distribution system. This can cause thermal discomfort and stuffiness in the room and it can increase the air leakage of the dwelling when the air handler is running.
8. Take the pressure gauge, being careful to level and zero on 15 Pa when using a magnehelic gauge, and measure the pressure difference across all interior doors. Pressure test and record measurements for all rooms with reference to the main body of the house. Make sure that registers and grilles are not blocked, even though they appear open. Provide pressure relief to any room with readings greater than 3 Pascals by:
   b. Opening the door slightly while measuring the pressure difference across the door. Open the door until the pressure difference is less than 3 Pascals and measure the square inches of opening. This is the number of square inches:
      i. The door must be undercut (this usually works well in mobile homes).
      ii. A direct grille, offset grilles, or jump duct must be to properly relief the pressure imbalance caused by the distribution system when the door is closed.
9. Turn off air handler and return house to the condition it was in before testing began.

11900 Duct Leakage Testing

11910 Introduction

Duct leakage can lead to many problems in a dwelling, the most common one being wasted energy. Other problems can include thermal discomfort, substandard indoor air quality, and combustion venting failure.

Ductwork leakage can take place 1) within the confines of the conditioned envelope of the building or 2) to and from the outdoors.

Leakage to or from the outdoors wastes more energy than leakage within the confines of the thermal envelope. Mobile home ducts and site built homes with ductwork in crawl spaces or attics are susceptible to leakage to and from the outdoors.

On the other hand, although duct leakage within the conditioned envelope usually does not have a significant energy impact, it might impose a hazard to occupant health by causing poor indoor air quality or backdrafting of combustion

appliances. These potential problems are addressed on site by an IAQ appraisal and by performing the worst-case draft test (refer to page 111).

Pressure pan and duct blower testing must be done in some dwellings to determine if ducts are leaking to a significant degree to or from the outdoors.

11920 Duct Leakage Standards

The following standards shall be followed for mobile homes (including double-wide mobile homes) and site-built homes, including manufactured housing.

11921 Mobile Homes

1. If there is a belly return system in the mobile home, convert it to a living-space return system (refer to Section 7700 on page 79).
2. For a living-space return system, if the sum of the pressure pan readings is 3 Pascal or less:[2]
   a. Visually check furnace-plenum joint and repair and seal with mastic, if necessary, and
   b. Visually check all boots and repair and seal with mastic, if necessary.
3. For a living-space return system, if the sum of the pressure pan readings is between 3 and 5 Pascals:
   a. Visually check all boots and repair and seal with mastic, if necessary.
   b. Visually check any crossover ducts and repair and seal with mastic, if necessary. Make sure these ducts are supported properly.
   c. Visually check furnace-plenum joint and repair and seal with mastic, if necessary, and
   d. Goal: Reduce the sum of pressure pan readings to 3 Pascals or less.
4. For a living-space return system, if the sum of the pressure pan readings is greater than 5 Pascals:
   a. Repair and seal as in 3 above, and
   b. Perform duct blower test and implement duct-blower guided duct repair and sealing. Refer to page 121, Duct Blower Testing.
   c. Goal: Reduce duct leakage to the outdoors, as measured with a duct blower and blower door, to10 percent of conditioned floor area.

11922 Site-Built Homes, Including Manufactured Housing

1. For ducts located in unconditioned spaces:

[2] The pressure pan readings must be adjusted for house/zone pressure differences. See Pressure Pan Multipliers chart and test on page 120 for instructions.

a. If possible, convert the unconditioned space where the ducts are located to a conditioned space, making sure the air and thermal barriers are installed effectively.
    i. Demonstrate the effectiveness of this weatherization work by performing a house-to-zone pressure and flow test (if possible) before and after converting the unconditioned space to a conditioned space.
    ii. Always repair disconnected ducts in the space.
    iii. It is preferred to seal the shell of the space rather than sealing the duct joints.
b. If the unconditioned space is impossible to convert to a conditioned space or it is determined impractical to convert to a conditioned space:
    i. Use a duct blower to determine the duct leakage to the outdoors. Examples of these types of unconditioned spaces include crawlspaces, unconditioned basements, attics, attached or tuck-under garages, and exterior walls.
    ii. Repair, seal with mastic, and thermally insulate ducts in unconditioned spaces to at least an R-8.
    iii. Goal: Reduce duct leakage to the outdoors, as measured with a duct blower and blower door, to 10 percent of conditioned floor area.

2. For ducts located in conditioned spaces, such as a basement or crawlspace:
    a. Perform a house-to-zone pressure and flow test (if conditions warrant) to determine if the space in question is conditioned in terms of its shell air barrier. The house-to-zone pressure should be 20 Pascals or less.
    b. Visually inspect the conditioned space to ensure that the shell is properly insulated.
    c. If it is determined that weatherization work should be done to the shell of the conditioned space housing the ducts, perform a house-to-zone pressure and flow test (if possible) before and after the work to quantify the effectiveness of the work.
        i. Always repair disconnected ducts in the space.
        ii. Sealing the shell of the space rather than sealing the duct joints is preferred.
        iii. Goal: The house-to-zone pressure should be 20 Pascals or less.

11930 Pressure Pan Testing Procedures[3]

11931 Introduction

Pressure pan testing helps find ductwork leaks or disconnections that are connected to outdoor air. Testing before and after duct sealing gives an indication of the effectiveness of sealing efforts. Pressure pans do not read duct leakage directly; they infer leakage to the outdoors by reading the pressure at individual registers.

11932 Test Procedure

1. Install the blower door for a depressurization test. Make sure the dwelling is set up for winter conditions.
2. Open all interior doors, including the door to the basement if the basement is considered conditioned space (heating system, water heater, washer or dryer located there and it is determined that the basement is part of the conditioned envelope),
3. Make sure the furnace burner and air handler is off and will not start during the testing. Remove the furnace filter and ensure that all registers, grilles, and balancing dampers are fully open.[4]
   a. Exception: When performing pressure pan testing in a mobile home, block the filter opening by covering the filter with a plastic bag and reinserting the filter with the bag over it. This blocks the filter opening and results in more accurate pressure pan testing. When the testing is completed, make sure to remove the plastic bag from around the filter.
4. Temporarily seal outside combustion air inlets or ventilation system connections that are directly connected to the duct system. These connections will show up as large leaks if not sealed prior to testing. If supply ducts are located in a garage or other unconditioned space, seal these registers so that the register opening does not show up as a duct leak.
5. Open attics, crawl spaces, garages, and other unconditioned spaces to the outdoor air as much as possible. If the basement is being treated as an unconditioned space, open it to the outdoor air.
6. Only one person at a time should be taking pressure pan readings. Having 2 registers in different parts of the duct covered by a pressure pan at the same time can affect readings.
7. Depressurize the dwelling to -50 Pascals with the blower door.

[3] This section is primarily based on *Using a Pressure Pan to Diagnose Duct* Leakage by The Energy Conservatory, March 2002. This document is available on the Internet at www.energyconservatory.com/manuals.html. When you get to this page, find “Pressure Pan User Manual”.
[4] Before fully opening or changing the position of balancing dampers, mark their position so that they can be returned to that position after the pressure pan testing.

8. Make sure the pressure pan is properly connected to the manometer. The proper connection should be reading the space under the pressure pan with reference to the main dwelling pressure.
9. Place the pressure pan completely over each register and grille in conditioned areas.
   a. If a register or grille is larger than the pressure pan, cover the oversized portion of the register or grille with tape while the reading is recorded.
   b. If access to a register or grille is difficult, for example at a kitchen counter kick space, cover the entire opening with tape and insert the pressure probe through the tape (near the center of the taped opening) while the reading is recorded.
   c. When two registers or grilles are closely connected to the same duct run (for example, two registers on opposite sides of the same partition wall), seal one and use the pressure pan on the other unsealed register or grille. Once you have taken the pressure pan reading, remove the seal before proceeding to the next register.

Table 11-8

Pressure Pan Multipliers	
House/Zone Pressure	***Pressure Pan Multiplier***
50	1.0
45	1.1
40	1.25
35	1.42
30	1.66
25	2.0
20	2.5
15	3.5
10	5.0
5	10.0

10. Record the pressure pan readings before and after duct sealing activities to get an idea of sealing effectiveness. It will sometimes be useful to record readings during duct sealing. Always start your measurements using the blower door as a reference point and work clockwise around the dwelling.
    a. If an unconditioned space is not well connected to the outdoors (e.g. unvented crawlspaces or unvented attics) or has very large connections to the house, then the unconditioned space will be at a pressure between the outside and inside house pressure during the blower door test. In this case, the pressure pan reading will show an artificially low number. To correct this misleading number:
       i. With the dwelling at -50 Pascals, measure the pressure difference between the main dwelling and the unconditioned space in question. (For example, the house to zone pressure is 10 Pascals and the pressure pan reading is 2.0 Pascals).
       ii. Multiply the pressure pan reading by the multiplier in Table 11-8 to get the corrected and true reading. (For example, multiply the pressure pan reading of 2.0 Pascals by the

multiplier of “5”, resulting in a pressure pan reading of 10 Pascals).

11. If you are testing a house with a very leaky building shell and are not able to create a 50 Pa pressure difference with the blower door, perform your pressure pan tests with the house at the highest achievable pressure. In this case, you will need to interpret your pressure pan readings carefully. Compare the measured pressure pan reading with the maximum possible reading.
12. Record the pre- and post-weatherization readings on the Diagnostic Field Form.

11940 Duct Blower Testing for Leakage to Outdoors

11941 Introduction

This required duct blower test requires measurement of duct air leakage to the outdoors, not total duct leakage (to outdoors and indoors).

During this test procedure a blower door fan will be used to pressurize the building to the test pressure, while the duct blower system is used to pressurize the duct system to the same pressure as the building. Because the duct system and the inside of the dwelling will be at the same pressure, there will be no leakage between the ducts and the dwelling during the test.

The blower door fan should be set up to blow air into the building for pressurization. Airflow through the blower door does not need to be measured during this test. Because of this, the blower door fan can either be set up in the pressurization test mode, or it can be set up in the standard depressurization test mode, with the fan direction switch reversed to blow air into the dwelling. Refer to your blower door manual for complete instructions.

For residential duct systems, generally is recommend as the test pressure. This pressure has been adopted by the majority of residential duct testing programs in the U.S. because 25 Pascals represents a typical operating pressure seen in many residential systems.

The instructions below assume the use of The Energy Conservatory Digital Manometer, Model DG-3, and the Minneapolis Duct Blaster™.

11942 Test Procedure

1. Close all exterior doors and windows.
2. Open all interior doors.
3. Open doors to heated or conditioned spaces. Close doors to all unconditioned spaces.
4. Install blower door properly.

5. Shut down solid-fuel appliances before activating blower door or duct blower.
6. Adjust the HVAC system controls so that the air handler fan will not turn on during the duct blower test.
7. Temporarily seal off all supply and return registers, except any central return grille being used to connect the duct blower system to the duct system.
8. Temporarily seal off all combustion air and ventilation air inlets that are directly connected to the duct system.
9. Turn off all exhaust fans, vented dryers, and room air conditioners.
10. Turn off all vented combustion appliances if there is a possibility that the space containing the appliance will be depressurized during the duct blower test.
11. Remove all filters from the duct system and air handler cabinet. If the duct blower will be installed at a central return grille, remove the filter from that grille.
12. If ducts run through unconditioned spaces such as attics, garages or crawlspaces, open vents, access panels, or doors between these spaces and the outdoors to eliminate pressure changes during the test procedure. This should also be done if the duct blower fan will be installed in an unconditioned space, for example, connected to an air handler in a garage or crawlspace.
13. On the blower door, connect the outdoor building pressure tube to the bottom tap on the 60 Pascal magnehelic gauge. The other end of this tubing should either be run to the outdoors, or to the unconditioned zone which contains the majority of the ductwork.
14. Install the duct blower at the furnace or at a large return grille.
15. Decide on the ring configuration for the duct blower.
16. Connect the digital manometer correctly:
    a. Connect a pressure hose between a register and the input tap on side “A” of the digital pressure gauge. Connect another pressure hose from the reference tap on side “A” to the interior of the dwelling. This means that if you are in the garage, the crawl space, or in the attic, you will need a pressure hose running under a door back to the interior of the house.
    b. Connect a red hose to the top tap on channel “B”. The other end of this hose is connected to the duct blower flow ring.
17. Pressurize the house with the blower door to the test pressure, 25 Pascals. Leave the blower door fan running.
18. Make sure the digital pressure gauge is set on channel “A”.
19. Set up the digital gauge properly.
    a. Turn the mode selection knob to time select and select “1 second”.

b. Turn the mode selection knob to fan select and select “8”. Choose “8-0” for no duct blower rings, “8-1” for one ring, and so on.

c. Turn the mode selection to pressure.

20. Turn on the duct blower and pressurize the ducts until the gauge reads zero, that is, the pressure between the duct system and the dwelling is zero. Leave the duct blower running.
21. Re-check the building pressure at the blower door and adjust if necessary.
22. Re-check the duct blower system and adjust if necessary.
23. On the DG-3 digital manometer, connected to the duct blower fan, turn the channel knob to “B” and turn the mode switch to “Flow”. The gauge will now display the air flow through the duct blower fan in cubic feet per minute at 25 Pascals (CFM_{25}). This fan flow is the measured duct leakage to the outdoors at the test pressure of 25 Pascals. This CFM_{25} flow can also be determined by reading fan pressure from Channel B and converting that pressure reading to flow by using the Duct Blaster™ Flow Conversion Table in the Duct Blaster™ instruction manual.
24. Check to make sure you have set the DG-3 correctly.
25. It is a good idea to move the register pressure hose to other registers. If the dwelling-to-duct pressure does not remain close to zero, there are probably significant duct leaks. Inspect and repair any obvious duct disconnects before continuing.
26. When the duct sealing and duct blower testing are completed, shut down and remove the blower door and duct blower.

The final worst-case draft test should be performed after the duct testing and duct sealing is completed.

111000 Zone Pressure Diagnostics (ZPD) Testing

111010 Introduction

Zone pressure diagnostics testing is performed to answer some fundamental questions: where is the functioning air barrier and where should it be located? These test procedures can also be used to measure the size of the leakage paths to various house zones. Leaking air often takes a path that moves through two surfaces with a cavity or zone between. These zones can include attics, basements, garages, knee-wall areas, or attached porch roofs.

ZPD procedures require the measurement of *pressure differences* across air barriers, like the pressure difference between the house and the zone (attic, for example), while the house is depressurized by a blower door to –50 Pascals. The procedures also require the determination of *flows* across air barriers. These flows can be calculated with the steps of the ZPD procedures and a computer or