Duct Sealing Guidance

NEBRASKA
DEPT. OF WATER, ENERGY, AND ENVIRONMENT

Ducts inside the building envelope

Site built home

1. A visual inspection of all accessible ducts will be completed as part of the energy audit process. Any gaps or holes greater than ¼" must be sealed; and

2. A Combustion Appliance Zone (CAZ) test will be completed as part of the energy audit process and again during the quality control inspection. If, during the worst-case CAZ Test, the **air handler** causes a pressure difference in the CAZ that is negative five (**-5**) Pascal's or more (negative) the pressure can be relieved through either **return** duct sealing or pressure relief venting between the CAZ and the rest of the dwelling.

All duct sealing must be done in accordance with SWS. The method of duct sealing will depend on the location of the leak in the duct system (see **"Methods for Sealing Rigid Metal Ducts"** below). For modeling duct sealing inside the building envelope:

- Include duct sealing as part of a furnace replacement measure, or
- Limited duct sealing as health and safety measure when related to depressurization issues.

Ducts outside the building envelope

Site built home

Ducts outside the building envelope will be modeled for duct sealing using the National Energy Audit Tool (**NEAT**) as an energy conservation measure. Please refer to the information at the bottom of this document for Criteria for determining the need to model duct leakage and how. Either way Duct Pressure measurements should be entered into the audit. All ducts that have a savings to investment ratio (SIR) of 1.0 or greater (or .5 or greater for jobs for which LIHEAP funds are used) will be sealed in accordance with SWS. The method of duct sealing will depend on the location of the leak in the duct system. (see **"Methods for Sealing Rigid Metal Ducts"** below). Ducts must be sealed prior to insulating to comply with SWS.

In modeling duct sealing and duct insulation for site-built homes in **NEAT**:

Duct Insulation

- An HVAC measure to insulate ducts can be created using the [**DUCTS**] category within the [**Systems**] section. Use the [**Add Insulation**] section to enter appropriate information.

Duct Sealing

In modeling duct sealing and duct insulation outside the building envelope in NEAT:

- Include duct sealing as part of a furnace replacement measure.
- Limited duct sealing may be modeled as a health and safety measure with reference to correcting issues with depressurization and natural drafting

appliances.

- Model per guidance below for an Energy Conservation Measure:
    1. In the [**Ducts/Infiltration**] category, select the [**Evaluate Duct Sealing**] box and select [**Whole House Blower Door Measurements**] from dropdown.

When using the Whole House Blower Door Measurement method on the Ducts and Infiltration form, there is no single standard value or percentage to enter for the "After Duct Sealing and Before Other Wx" or "After Weatherization" fields. Those entries are intended to reflect estimated post-weatherization blower-door leakage, not default values.
In the NEAT/MHEA modeling logic, when only duct sealing is performed, the model assumes the envelope leakage does not change. Therefore, any reduction in whole-house CFM50 is attributed to reduced duct leakage.
If the duct leakage is not measured, a practical approach is to estimate how much duct leakage reduction is realistic based on duct condition. Please see below for additional information:

Determining reasonable values for duct related fields for Whole House Blower Door Measurement Method

1. Based on existing duct condition, estimate how much duct leakage reduction you can achieve (e.g., 1/2, 1/3,… or 1/N of existing duct leakage)
2. Enter CFM50_*postductseal* = CFM50_*prewx* – (*N-1*)*x100*
3. Enter 25 Pa for supply and return duct operating pressures before and after duct sealing (assumed; simplifies calculations)

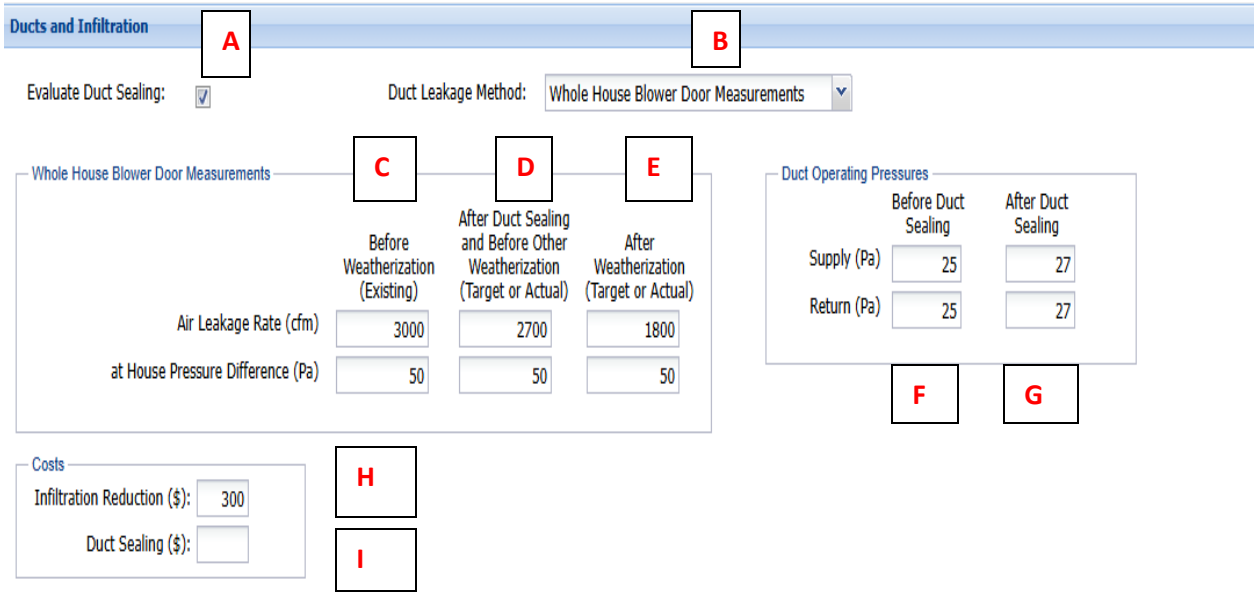
Note: You can estimate what percentage of the total leakage is from the ducts with these equations:

- Before Duct Sealing: (1.98 x N) / (central system capacity in kBtu/h)
- After Duct Sealing: 1.98 / (central system capacity in kBtu/h), after duct sealing

Example:

- Assume measured air leakage rate before weatherization = 3000 cfm@50Pa
- Assume duct sealing would reduce duct leakage to 1/4 of existing duct leakage
- Given these assumptions, CFM50_postductseal = 3000 - (4-1)x100 = 3000 - 300 = 2700 cfm@50Pa
- Further, if this duct serves a 60 kBtu/h furnace, then based on 25Pa duct operating pressure, duct leakage % would be
    - Before Duct Sealing: 1.98 x 4 / 60 = 13.3%
    - After Duct Sealing: 1.98 / 60 = 3.3%

Duct Sealing Guidance



A **Evaluate Duct Sealing**-Select this button and choose the "Duct Leakage Method" you want to use to evaluate duct sealing when ducts are located outside the thermal boundary.
B **Duct Leakage Method**, choose Duct testing method, DWEE recommends choosing Whole House Blower Door Measurement
C **Before Weatherization** -Initial Blower Door reading and House Pressure Difference (50 Pa is standard)
D-**After Duct Sealing and Before other Weatherization**-Follow formula and guidance above from Oakridge National Laboratory for calculating Duct Leakage Reduction.
E-**After Weatherization**-Use NeWAP Target Blower Door Calculator to achieve Target Blower Door
F **Before Duct Sealing**-With the air handler fan on and Blower Door off, use a manometer and static pressure probe to measure the supply and return duct pressures (WRT the interior) at the register nearest and farthest from the furnace for each supply trunk (both sides of furnace). Enter the average of the readings.
G **After Duct Sealing**- Add 2 Pa to the Before Duct Sealing pressure and enter here in both supply and return.
H **Infiltration Reduction-** Enter the cost of all the infiltration work you want done on the home. Any recommended materials or components associated with infiltration reduction costs must be itemized in detail in the comments box.
I **Duct Sealing $-**Duct Sealing Cost

Additional options for duct sealing only:

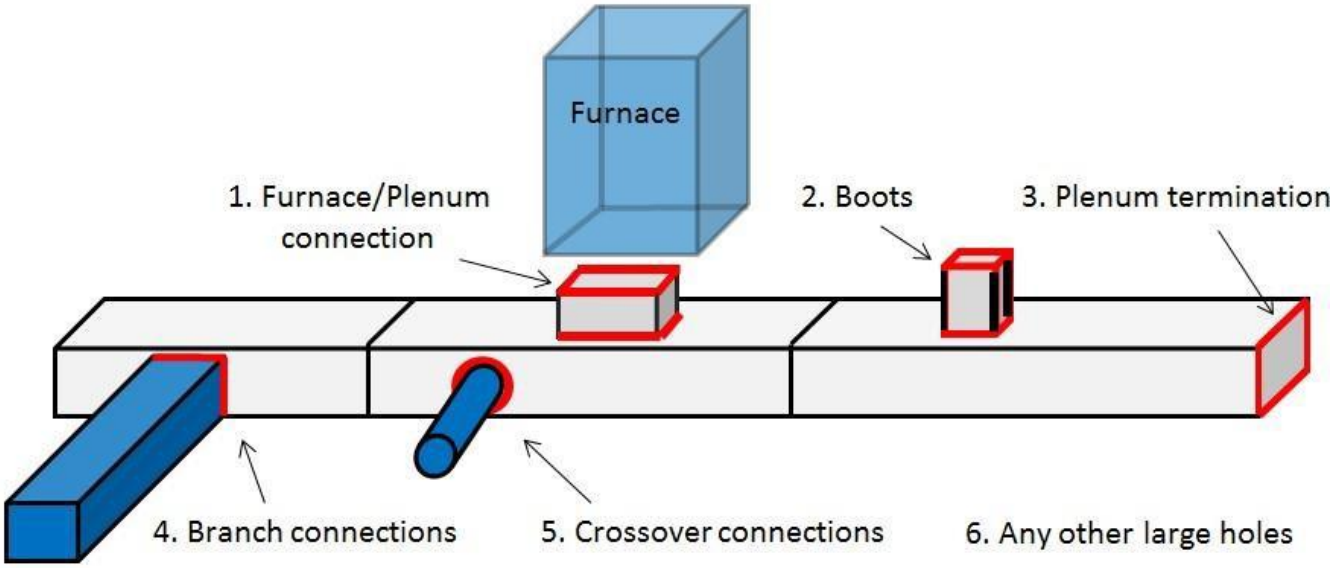
- Limited duct sealing may be modeled as a health and safety measure
- Duct sealing and duct insulation can be included as part of a furnace replacement measure

Duct Sealing Guidance

Manufactured home

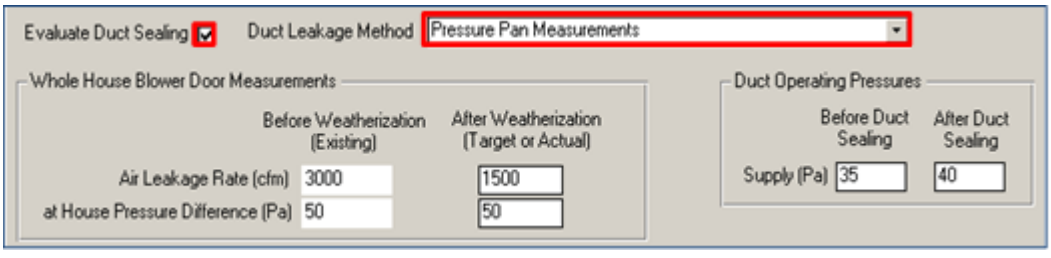
Ducts in the floor or attic cavities are considered outside the building envelope and will be modeled using Manufactured Home Energy Audit (MHEA) tool as an energy conservation measure. All ducts that have a SIR of 1.0 or greater (or .5 or greater for jobs for which LIHEAP funds will be used) will be sealed in accordance with SWS. The method of duct sealing will depend on the location of the leak in the duct system (see **"Methods for Sealing Rigid Metal Ducts"** below).

Seal the following areas (shown in red) as SIR allows in the following order:



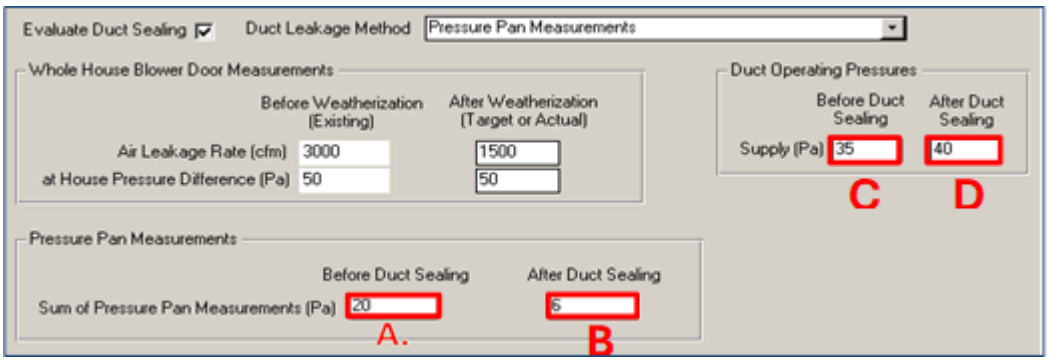
In modeling duct sealing and duct insulation outside the building envelope in MHEA:

- Include duct sealing as part of a furnace replacement measure.
- Limited duct sealing may be modeled as a health and safety measure with reference to correcting issues with depressurization and natural drafting appliances.
- Model per guidance below for an Energy Conservation Measure:
    2. In the [Ducts/Infiltration] category, select the Evaluate Duct Sealing box and select Pressure Pan Measurements from dropdown.

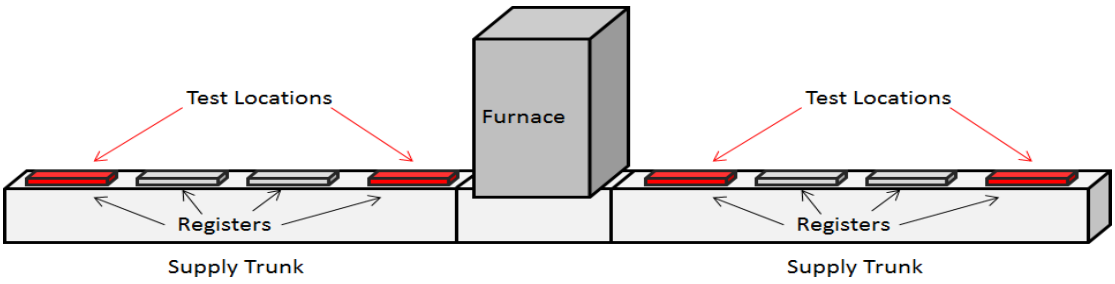


    3. Enter the following data:

Duct Sealing Guidance

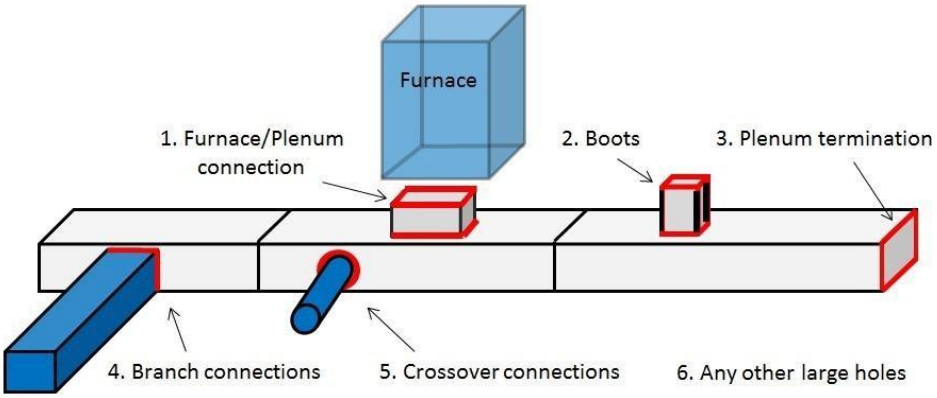


a. Before Duct Sealing – With the house depressurized to 50 Pa (WRT the outside) measure the pressure difference between each supply register and the house with a pressure pan and manometer. Enter the sum of all the measurements.
b. After Duct Sealing – Enter the total number of supply duct registers in the Home **multiplied by 2** (2 Pa is NeWAP target for MHEA)
c. Before Duct Sealing - With the air handler fan on and Blower Door off, use a manometer and static pressure probe to measure the supply duct pressures (WRT the interior) at the register nearest and farthest from the furnace for
each supply trunk (both sides of furnace). Enter the average of the readings.
d. After Duct Sealing – Add 2 Pa to the Before Duct Sealing pressure and enter here.



Seal the following areas (shown in red) as SIR allows in the following order

Duct Sealing Guidance



Duct Sealing Guidance

Methods for Sealing Rigid Metal Ducts (per SWS)

Gaps <1/4":

- Gaps up to 10 feet from furnace air handler: All seams, cracks, joints, holes, and penetrations shall be sealed using fiberglass mesh and mastic.
- Gaps 10 feet or more from furnace air handler: All seams, cracks, joints, holes, and penetrations shall be sealed using mastic.

Gaps 1/4" - 3/4":

- All seams, cracks, joints, holes, and penetrations shall be sealed in two steps:
  1. They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing
  2. They will be sealed using fiberglass mesh and mastic.

Gaps >3/4":

- All seams, cracks, joints, holes, and penetrations will be repaired using rigid duct material.
- Fiberglass mesh and mastic will overlap repair joint by at least 1" on all sides. Fiberglass mesh and mastic will be the primary seal.

Additional Considerations:

- Duct tape unlisted for a given application shall not be permitted as a sealant on any duct.

Filter Rack and Filter Rack Cover

Filter racks and covers should be modified or replaced as needed to ensure that they are airtight; keep the filter firmly in place; do not allow air to flow around the filter; and allow for easy filter replacement.

Section F from Energy Conservatory Pressure Pan tool for Diagnosing Duct Leakage

Pre-Qualifying Criteria:

There are 3 pre-qualifying criteria for determining the need to measure and repair duct system leakage for energy use reduction. All pressure pan measurements listed below are to be taken with the house depressurized by 50 Pascals with respect to outside. It is assumed that a pressure pan reading will be taken at every register and grille in the house, and that all unconditioned spaces containing ducts are well connected to the outside.

- **Criteria #1 (Tight Duct Systems):** This is your NEAT Pressure Pan Target. All pressure pan readings are less than 1.5 Pascals, and not more than 2 readings can be greater than 1.0 Pascals.

  Duct systems in **Criteria #1** houses are considered tight for typical existing systems. **Criteria #1** houses should require no direct measurement of duct leakage, and repairs for duct

leakage are not recommended unless they are very easy to make, or repair is needed to correct a health, safety, durability or comfort problem. Of the 460 systems tested in the Tooley sample, 97 (or 21%) fell into **Criteria #1** with an average leakage to the outside of 75 CFM25. ·

- **Criteria #2 (Leaky Duct Systems):** 3 or more pressure pan readings are greater than 2.0 Pascals.

  Duct systems found in houses meeting **Criteria #2** are considered leaky and repair is suggested for energy use reduction. Measurement and quantification of duct leakage is not needed because the pressure pan readings have told us that the duct system is leaky enough to warrant immediate repair work. In the Tooley sample, 167 systems (or 36%) fell into **Criteria #2** with an average leakage to outside of 940 CFM25.

  Each pressure pan reading above 1.5 Pascals should be identified and the associated duct run repaired, starting with the highest pressure pan reading and working to the lowest. It is often useful to perform mid-repair pressure pan testing to reduce the amount of time required to repair the system. Often large leaks telegraph their presence to other portions of the duct system, and once the large leaks are repaired, many other pressure pan readings drop.

  Note: You may still need to measure and quantify pre and post-retrofit duct leakage in **Criteria #2** houses if you are providing duct sealing services under a program which requires leakage testing.

- **Criteria #3 (Gray Area Systems):**

  All houses not meeting **Criteria #1** or **#2** above are classified as Gray Area Systems.

  Gray Area Systems require direct measurement and quantification of leakage to determine whether or not repairs will be cost effective. Pressure pan readings alone will not provide enough information to determine if duct repair is needed. Direct measurement is defined as measuring duct leakage to the outside in cubic feet per minute (CFM), using either a duct airtightness tester in combination with a Blower Door, or using the modified Blower Door subtraction technique. If duct leakage measurements using these methods are greater than specified program target leakage rates for your area, then repair is recommended. Forty-three percent (196) of the systems in the Tooley sample were **Criteria 3** houses, with an average leakage to outside of 353 CFM25.

  These criteria can also be used following repairs to ensure that a cost-effective repair has been accomplished. Houses that require no direct CFM leakage measurement going in (**Criteria #2 houses**), may require a leakage measurement before leaving (because they are now **Criteria #3** houses) to ensure that adequate repairs have been accomplished. The expected results of using the pressure pan criteria is that at least 50% of the houses tested

can be properly diagnosed for outside duct leakage problems without having to conduct a direct duct leakage measurement (in CFM).

Qualifications on Criteria Use: ·

- The criteria above were developed for electric heating and cooling at a cost of $0.07 to $0.08 per kwh and higher. Lower rates or different fuel types may require slight adjustments to the criteria.

- The criteria were developed to assess the potential for cost effective repair of duct leakage to the outside. The criteria cannot be used to assess interior duct leakage problems or duct leakage problems resulting in health, safety, durability or comfort concerns. If duct leakage repair is performed, examining total system air flow, airflow balancing, and proper operation of combustion appliances should be included in your work plan.

- The criteria were developed for existing duct systems with a significant portion of the duct system located outside of the conditioned house space (e.g. attics, crawlspaces, garages). The criteria are not intended for use in new construction.

- The criteria assumes that all unconditioned spaces containing ductwork are well connected to the outside (e.g. at least a 45 Pa pressure difference between the house and the unconditioned space with the house depressurized by 50 Pa to outside). If the unconditioned space is not well connected to the outside (e.g. ducts located in an unvented crawlspace or unvented attic), then the pressure pan reading will show a lower number and the criteria may require adjustment.

A-4 Maximum CAZ Depressurization Limits

Appliance Type	Max Depress.
Atmospheric water heater only (Category I, natural draft), open combustion appliances	**-2 Pa**
Atmospheric water heater (Category I, natural draft) and atmospheric furnace (Category I, natural draft), common-vented, open combustion appliances	**-3 Pa**
Gas furnace or boiler, Category I or Category I fan-assisted, open combustion appliances	**-5 Pa**
Oil or gas unit with power burner, low- or high-static pressure burner, open combustion appliances	**-5 Pa**
Closed, controlled wood-burning appliances	**-7 Pa**
Induced-draft appliances (fan at point of exit at wall), Category I with induced draft, open-combustion appliances	**-15 Pa**
Pellet stove with draft fan and sealed vent	**-15 Pa**
Gas appliances, Category III vented through the wall, forced draft, open-combustion appliances	**-15 Pa**
Direct-vent, sealed combustion appliances with forced draft	**-25 Pa**

Duct Sealing Guidance