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Builder Insight

TECHNICAL BULLETIN

Pressure Losses in Oval Ducts and Fittings

BC HOUSING

OVERVIEW

Today's higher energy efficiency requirements have changed the design of gas furnaces and other heating appliances. Typically, energy efficiency is achieved with either a larger furnace or increasing airflow in the heating system. Smaller homes, greater energy efficiency requirements, and reduced wall thickness has led designers away from using 6" round ducts "squashed" to fit 2x4 walls.

A recent study detailed in this bulletin measured typical pressure losses in oval ducts and fittings used in residential construction. This new data makes it possible to design duct systems for multi-storey residences more accurately, resulting in better air distribution and fewer resident complaints about inadequately conditioned rooms. It also helps eliminate the need for supplementary electric heating in upstairs bedrooms located far from the furnace.

Builder Insight is a series of bulletins and companion videos designed to provide practical information on new technologies, research results, good building practices and emerging technical issues in residential construction to Licensed Residential Builders and others in the industry.

This bulletin was developed in collaboration with the Thermal Environmental Comfort Association (TECA) and industry partners.

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What is an oval duct?

Oval ducts are not new and the fittings are standard. *Figure 1* shows a cross section of two sizes of oval duct, 6" and 8". These are nominal dimensions with actual dimensions shown in *Figure 2*.

Riser Ducts

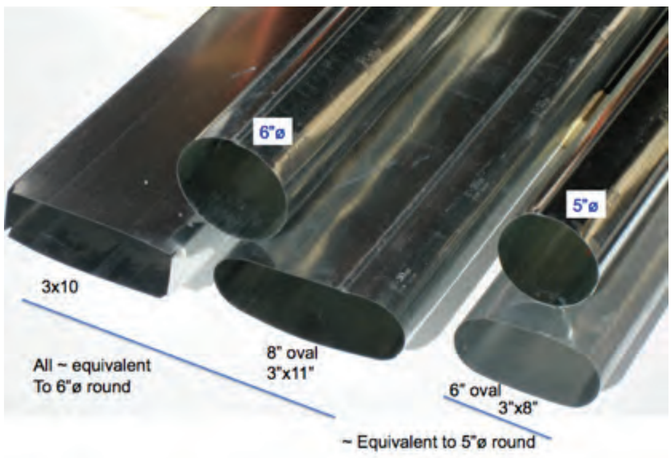


Figure 1: Comparison of oval, round and square ducts of roughly equivalent cross section

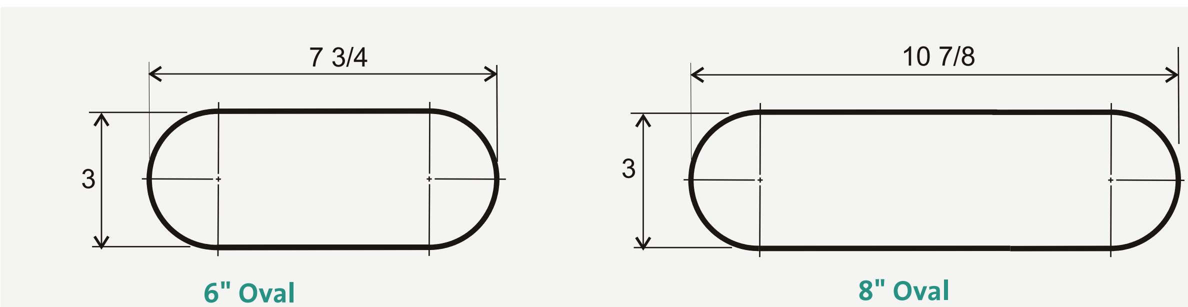


Figure 2: Actual size of 6" and 8" oval ducts

Although a 6" oval duct (called 6" oval) is typically sold as an "equivalent" to a 6" diameter round duct, they are not actually equivalent. The cross sectional area of a 6" oval duct is only 75% of that of a 6" round duct. An equivalent round duct would have a 5.1" diameter. This means that for a 6" oval to achieve the same flow rate as a 6" round, the airflow velocity in the oval duct is higher, leading to a greater pressure drop.

Round ducts provide more efficient flow than oval or rectangular ducts. Although round ducts are preferred, they cannot be used in all applications, such as air delivery from the first floor to the second through a 2x4 wall. A combination of round, oval and/or rectangular ducts are installed with different fittings to transition between different duct types.

There are many types of fittings to choose from. A typical “wall stack” requires two fittings, one at the bottom and one at the top (*Figure 3*).

Fittings are the major cause of pressure drop in any residential duct system. If this pressure drop is not considered when designing the system, some rooms will receive insufficient air, making them cold in winter and hot in summer. Homeowners who notice rooms with insufficient heating should first notify their builder. Note: This condition may be covered under new home warranty. (Details of what may be covered can be found in *The Residential Construction Performance Guide*.

Data exists on pressure drops for round and various rectangular trunk duct fittings, however there is little data available on losses for oval fittings used in residential construction. A TECA study, with funding from BC Housing and other partners, determined the pressure drop of different oval fitting wall stacks.

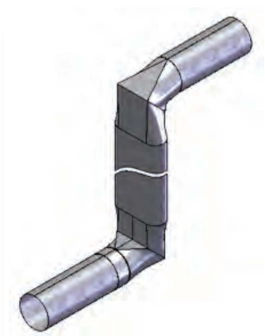


Figure 3: Typical oval wall stack

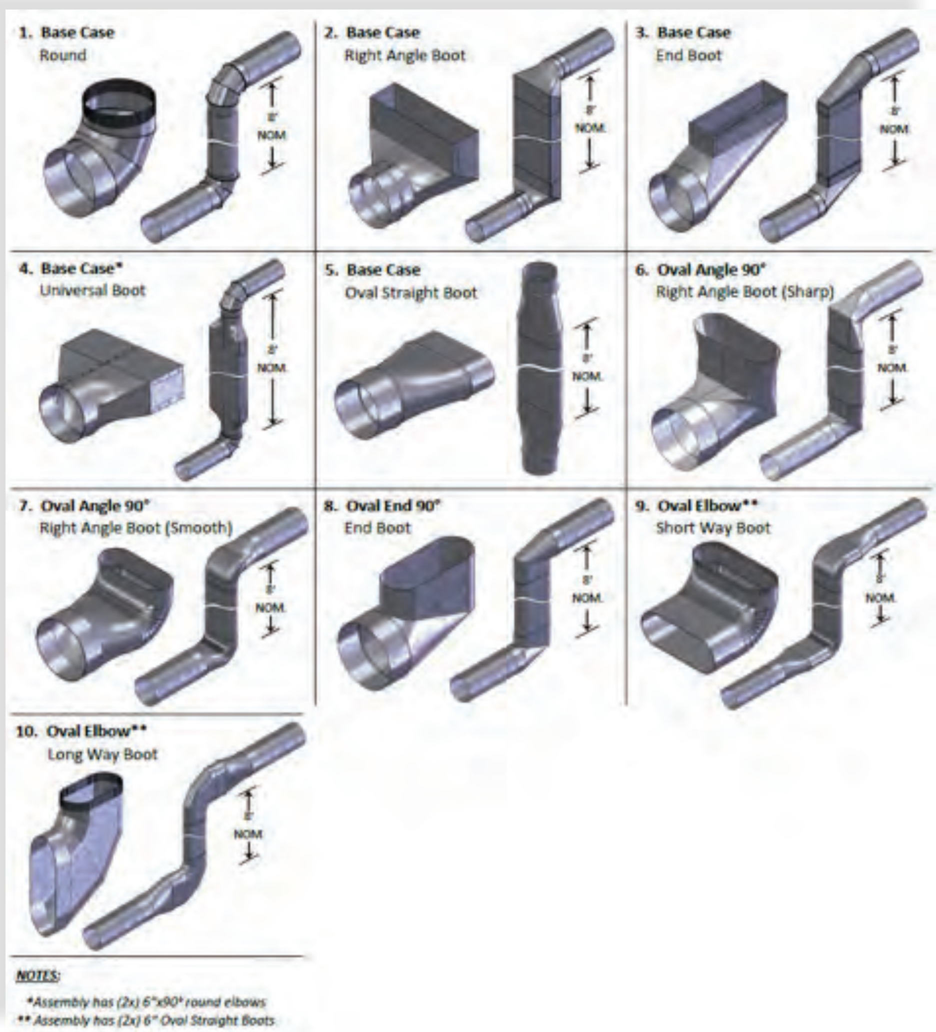


Figure 4: Tested wall stack configurations

Pressure Drop Testing

For the study, tests were designed to represent actual field conditions of 10 common stack systems used to move air between floors (*Figure 4*). There was one base case consisting of a round duct, three configurations with rectangular ducts, and the remaining six configurations with different round-to-oval and oval-to-round duct fittings. The same fitting was used at the top and bottom of the stack.

Tests were done at four velocities: 400, 600, 800 and 1,000 feet per minute. For simplicity, no duct air leakage was assumed. Extensive field testing over the last 20 years shows that branch airflow leakage of standard round sheet metal duct systems varies from 10% to 50%, with 15% to 25% being the typical range. Leakage depends on the length of the branch run and the number of fittings.

For the test apparatus, fittings were crimped so airflow went from the small to the large end. All joints, gores and snap-lock seams were sealed.

Pressure drop across the bottom and top fitting was measured in inches of water (one inch of water equals 248.8 Pa). A correction was applied to account for the pressure change when velocity alters (static regain).

Results

Results are presented in two ways, both are used by trades:

Equivalent length: This is the length (measured in feet) of straight round duct with the same pressure drop and airflow as the stack assembly. This is a simple method, but duct lengths are difficult and time consuming to determine, particularly at the initial design stage when the installer does not know framing methods and other details that change between design and construction. *Table 1* shows the equivalent length for the complete stack assembly.

Configuration #	Stock #	Fitting Size	Equivalent Length (ft)			# Fittings
			Bottom	Top	Total	
1	120500	5" x 90° Round	14	17	31	0.9
	120600	6" x 90° Round	17	17	34	0.9
2	076310	6" Round – 3"x10" Rectangle	15	25	41	1.1
3	086310	6" Round – 3"x10" Rectangle	47	45	92	2.6
4	096310	6" Round – 3"x10" Rectangle	19	26	46	1.3
5	099500	5" Round – 6" Oval (3"x7-3/4")	0	0	1	0.0
	099600	6" Round – 6" Oval (3"x7-3/4")	11	7	20	0.6
6	097500	5" Round – 6" Oval (3"x7-3/4")	11	18	29	0.8
	097602	6" Round – 6" Oval (3"x7-3/4")	46	62	110	3.1
	097608	6" Round – 8" Oval (3"x10-7/8")	35	19	55	1.5
7	097600	6" Round – 6" Oval (3"x7-3/4")	37	40	77	2.2
8	098500	5" Round – 6" Oval (3"x7-3/4")	16	7	24	0.7
	098600	6" Round – 6" Oval (3"x7-3/4")	97	46	149	4.2
	098608	6" Round – 8" Oval (3"x10-7/8")	37	22	60	1.7
9	111939	6" Oval (3"x7-3/4")	52	31	85	2.4
10	111936	6" Oval (3"x7-3/4")	89	31	123	3.5

Stack configuration used in *Figure 5* example. Pressure drop across the 2-fitting stack is equivalent to the typical pressure drop from 3.1 fittings

Table 1: Pressure losses for fittings and system

Number of fittings: Since fittings account for most pressure losses, the number and type of fittings between the furnace and register gives a good indication of the total pressure drop. The loss for the wall stack, including the fittings, is given as the equivalent number of fittings in *Table 1*.

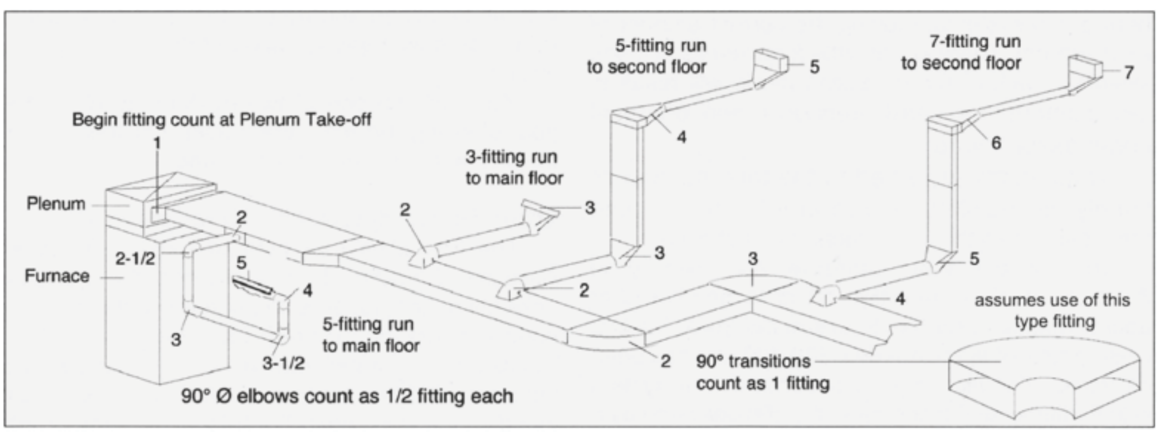
Duct size for the required flow can be found from tabulated values, such as those found in the TECA publication *Quality First™ Forced Air Guidelines*. This method includes an allowance for the length of standard duct typically found in residential construction.

Equivalent length of the stack varied from virtually zero to 150 ft. The equivalent number of fittings varied from zero to four.

The TECA publication *Quality First™ Forced Air Guidelines* publishes duct sizes for required flows.

Example

Figure 5 shows an example of a residential supply air duct with two wall stacks (shown as rectangular). The longest run in the example is the seven-fitting run to the second floor. Assuming the design used the oval stack tested as configuration 6 in *Figure 4* (6" Oval Angle 90°), the stack system would be considered equivalent to 3.1 fittings (*Table 1*), as opposed to the actual two fittings. This changes the branch from a seven-fitting branch to an eight-fitting branch and pressure drop is increased. This increase must be taken into account when sizing the duct to achieve the required airflow rate to the upper floor.



Fitting Count: Because airflow through 90° round elbows is less turbulent than through other fittings, these fittings can be counted as **half a fitting**. All other fittings count as **one fitting.**

Figure 5: Example of a supply air trunk with branch systems

Interior wall thicknesses are decreasing, with some 2x6 supporting walls changing to 2x4 to accommodate open concept floor plans.

Key Points

- Competing trends of reducing furnace sizes and increasing energy efficiency has resulted in smaller furnaces operating at higher airflow rates.
- Industry installs more oval ducts to accommodate the increasing use of open floor plans and thin interior walls.
- A 6" oval duct has a cross sectional area only 75% of a 6" round duct, leading to higher airflow velocities and increased pressure drops. Fittings are the major cause of pressure drops in any duct system. Consider pressure drops when designing a ducting system.

More Information

1. *Quality First™ Forced Air Guidelines Manual,* available from www.teca.ca
2. *The Principles of Moving Air*, available from www.teca.ca
3. *Residential Air System Design Technical Manual*, available from www.hrai.ca
4. *Maintenance Matters 3: Avoiding Condensation Problems*, available from www.bchousing.org
5. *Maintenance Matters 14: Avoiding Exhaust Duct Problems*, available from www.bchousing.org
6. *Residential Construction Performance Guide for New Homes Covered by Home Warranty Insurance in British Columbia,* available from www.bchousing.org

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