DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

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Date: September 26, 2024
Rev 10/23/2024

Model Code: 2024 IFGC

Code or Rule Section: 304 Combustion Air

Code or rule section to be changed: Section 304 Combustion Air

Intended for Technical Advisory Group ("TAG"): 1346 Mechanical and Fuel Gas Code

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General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☐	☒
B. Is the proposed change required due to climatic conditions of Minnesota?	☐	☒
C. Will the proposed change encourage more uniform enforcement?	☒	☐
D. Will the proposed change remedy a problem?	☒	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☒	☐
F. Would this proposed change be appropriate through the ICC code development process?	☒	☐

Proposed Language

1. The proposed code change is meant to:

   ☒ change language contained the model code book? If so, list section(s).

   ☒ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).
   MN Rules 1346 304.1-304.6.2

   ☐ delete language contained in the model code book? If so, list section(s).

   ☒ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).
   MN Rules 1346 304.1-304.6.2

   ☒ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.
   No

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

SECTION 304 (IFGS)—COMBUSTION, VENTILATION AND DILUTION AIR

304.1 General. Where chemicals that generate corrosive or flammable products such as aerosol sprays are routinely used, one of the following shall apply to fired appliances where these chemicals can enter combustion air:

1. Fired appliances shall be located in a mechanical room separate or partitioned off from other areas with provisions for combustion and dilution air from outdoors.
2. The appliances shall be direct vent and installed in accordance with the appliance manufacturer's installation instructions.

304.2 Appliance location. *Appliances* shall be located so as not to interfere with proper circulation of combustion, ventilation and dilution air.

304.3 Draft hood/regulator location. Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the *appliance* served to prevent any difference in pressure between the hood or regulator and the *combustion air* supply.

304.4 Makeup air provisions. Where exhaust fans, clothes dryers and kitchen ventilation systems interfere with the operation of *appliances*, makeup air shall be provided.

~~**304.5 Indoor combustion air.** The required volume shall be determined in accordance with Section 304.5.1 or 304.5.2, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), Section 304.5.2 shall be used. The total required volume shall be the sum of the required volume calculated for all *appliances* located within the space. Rooms communicating directly with the space in which the *appliances* are installed through openings not furnished with doors, and through *combustion air* openings sized and located in accordance with Section 304.5.3, are considered to be part of the required volume.~~

~~**304.5.1 Standard method.** The minimum required volume shall be 50 cubic feet per 1,000 Btu/h (4.8 m3/kW) of the *appliance* input rating.~~

~~**304.5.2 Known air infiltration rate method.** Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows:~~

~~For *appliances* other than fan-assisted, calculate volume using Equation 3-1.~~

~~**Equation 3-1** $\text{Required Volume}_{other} \geq \frac{21\ \text{ft}^3}{ACH}\left(\frac{I_{other}}{1{,}000\ \text{Btu/h}}\right)$~~

~~For fan-assisted appliance, calculate volume using Equation 3-2.~~

~~**Equation 3-2** $\text{Required Volume}_{fan} \geq \frac{15\ \text{ft}^3}{ACH}\left(\frac{I_{fan}}{1{,}000\ \text{Btu/h}}\right)$~~

~~where:~~

~~I_{other} = All appliances other than fan assisted (input in Btu/h).~~
~~I_{fan} = Fan assisted *appliance* (input in Btu/h).~~
~~*ACH* = Air change per hour (percent of volume of space exchanged per hour, expressed as a decimal).~~
~~For purposes of this calculation, an infiltration rate greater than 0.60 ACH shall not be used in Equations 3-1 and 3-2.~~

~~**304.5.3 Indoor opening size and location.** Openings used to connect indoor spaces shall be sized and located in accordance with Sections 304.5.3.1 and 304.5.3.2 (see Figure 304.5.3).~~

~~**304.5.3.1 Combining spaces on the same story.** Where combining spaces on the same story, each opening shall have a minimum free area of 1 square inch per 1,000 Btu/h (2200 mm2/kW) of the total input rating of all *appliances* in the space, but not less than 100 square inches (0.06 m2). One permanent opening shall commence within 12 inches (305 mm) of the top and one permanent opening shall commence within 12 inches (305 mm) of the bottom of the enclosure. The minimum dimension of air openings shall be not less than 3 inches (76 mm).~~

~~**304.5.3.2 Combining spaces in different stories.** The volumes of spaces in different stories shall be considered to be communicating spaces where such spaces are connected by one or more permanent openings in doors or floors having a total minimum free area of 2 square inches per 1,000 Btu/h (4402 mm2/kW) of total input rating of all *appliances*.~~

304.6 Outdoor combustion air. Outdoor *combustion air* shall be provided through opening(s) to the outdoors in accordance with the following: Section 304.6.1 or 304.6.2. The minimum dimension of air openings shall be not less than 3 inches (76 mm)

1. Combustion air for Category I, III, and IV gas-fired appliances when the combined input is up to and including 400,000 Btu/hr shall be determined using Table 304.6.
2. Combustion air for power burner appliances equipped with a draft control device and having an input above 400,000 Btu/hr shall have a net free area of 0.2 square inches per 1,000 Btu/hr. Combustion air shall be provided from a single opening from the outdoors. In lieu of this requirement, combustion air requirements specified by the manufacturer for a specific power burner appliance may be approved by the building official.
3. Combustion air for power burner appliances not equipped with a draft control device and having an input above 400,000 Btu/hr shall have a net free area of 0.1 square inches per 1,000 Btu/hr. Combustion air shall be provided from a single opening from the outdoors. In lieu of this requirement, combustion air requirements specified by the manufacturer for a specific power burner appliance may be approved by the building official.

TABLE 304.6
COMBUSTION AIR REQUIREMENTS FOR CATEGORY I, III, AND IV GAS-FIRED APPLIANCES WHEN THE COMBINED INPUT IS UP TO AND INCLUDING 400,000 BTU/HR

TOTAL INPUT OF APPLIANCES[1],THOUSANDS OF BTU/HR (KW)	REQUIRED FREE AREA OF AIR-SUPPLY OPENING OR DUCT, SQUARE INCHES (SQ MM)	ACCEPTABLE APPROXIMATE ROUND DUCT EQUIVALENT DIAMETER[2], INCH (MM)
25 (8)	7 (4500)	3 (75)
50 (15)	7 (4500)	3 (75)
75 (23)	11 (7000)	4 (100)
100 (30)	14 (9000)	4 (100)
125 (37)	18 (12 000)	5 (125)
150 (45)	22 (14 000)	5 (125)
175 (53)	25 (16 000)	6 (150)
200 (60)	29 (19 000)	6 (150)
225 (68)	32 (21 000)	6 (150)

250 (75)	36 (23 000)	7 (175)
275 (83)	40 (26 000)	7 (175)
300 (90)	43 (28 000)	7 (175)
325 (98)	47 (30 000)	8 (200)
350 (105)	50 (32 000)	8 (200)
375 (113)	54 (35 000)	8 (200)
400 (120)	58 (37 000)	9 (225)

1. For total inputs falling between listed capacities, use next largest listed input.
2. Opening size based on maximum equivalent duct length of 20 feet. For equivalent duct lengths in excess of 20 feet up to and including a maximum of 50 feet increase round duct diameter by one size.
3. If flexible duct is used, increase the duct diameter by one size and stretch with minimal sags.

304.6.1 Two-permanent-openings method. Two permanent openings, one commencing within 12 inches (305 mm) of the top and one commencing within 12 inches (305 mm) of the bottom of the enclosure, shall be provided. The openings shall communicate directly or by ducts with the outdoors or spaces that freely communicate with the outdoors. Where directly communicating with the outdoors, or where communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu/h (550 mm2/kW) of total input rating of all *appliances* in the enclosure [see Figures 304.6.1(1) and 304.6.1(2)]. Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of not less than 1 square inch per 2,000 Btu/h (1100 mm2/kW) of total input rating of all *appliances* in the enclosure [see Figure 304.6.1(3)].

304.6.2 One-permanent-opening method. One permanent opening, commencing within 12 inches (305 mm) of the top of the enclosure, shall be provided. The *appliance* shall have clearances of not less than 1 inch (25 mm) from the sides and back and 6 inches (152 mm) from the front of the *appliance*. The opening shall directly communicate with the outdoors, or through a vertical or horizontal duct, to the outdoors or spaces that freely communicate with the outdoors (see Figure 304.6.2) and shall have a minimum free area of 1 square inch per 3,000 Btu/h (734 mm2/kW) of the total input rating of all *appliances* located in the enclosure and not less than the sum of the areas of all vent connectors in the space.

~~**304.7 Combination indoor and outdoor combustion air.** The use of a combination of indoor and outdoor *combustion air* shall be in accordance with Sections 304.7.1 through 304.7.3.~~

~~**304.7.1 Indoor openings.** Where used, openings connecting the interior spaces shall comply with Section 304.5.3.~~

~~**304.7.2 Outdoor opening location.** Outdoor opening(s) shall be located in accordance with Section 304.6.~~

~~**304.7.3 Outdoor opening(s) size.** The outdoor opening(s) size shall be calculated in accordance with the following:~~

~~1. The ratio of interior spaces shall be the available volume of all communicating spaces divided by the required volume.~~

~~2. outdoor size~~ reduction factor ~~shall be one minus the ratio of interior spaces.~~

~~3. The minimum size of outdoor opening(s) shall be the full size of outdoor opening(s) calculated in accordance with Section 304.6, multiplied by the reduction factor. The minimum dimension of air openings shall be not less than 3 inches (76 mm).~~

304.8 Engineered installations. Engineered *combustion air* installations shall provide an adequate supply of combustion, ventilation and dilution air determined using engineering methods.

304.9 Mechanical combustion air supply. Where all *combustion air* is provided by a mechanical air supply system, the *combustion air* shall be supplied from the outdoors at a rate not less than 0.35 cubic feet per

minute per 1,000 Btu/h (0.034 m3/min per kW) of total input rating of all *appliances* located within the space.

1. Boiler and burner manufacturer procedures for sizing combustion air supplies are allowed when approved by the building official.

2. Direct vent appliances obtaining all combustion air from outdoors and flue gases vented to outdoors shall be installed per manufacturer's requirements.

304.9.1 Makeup air. Where exhaust fans are installed, makeup air shall be provided to replace the exhausted air.

304.9.2 Appliance interlock. Each of the *appliances* served shall be interlocked with the mechanical air supply system to prevent main burner operation when the mechanical air supply system is not in operation.

304.9.3 Combined combustion air and ventilation air system. Where *combustion air* is provided by the building's mechanical ventilation system, the system shall provide the specified *combustion air* rate in addition to the required ventilation air.

304.10 Louvers and grilles. The required size of openings for combustion, ventilation and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver, grille or screen is known, it shall be used in calculating the size opening required to provide the free area specified. Where the design and free area of louvers and grilles are not known, it shall be assumed that wood louvers will have 25-percent free area and metal louvers and grilles will have ~~75~~ 50 percent free area. Screens shall have a mesh size not smaller than 1/4 inch (6.4 mm). Nonmotorized louvers and grilles shall be fixed in the open position. Motorized louvers shall be interlocked with the *appliance* so that they are proven to be in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to prevent the main burner from igniting if the louvers fail to open during burner start-up and to shut down the main burner if the louvers close during operation.

304.11 Combustion air ducts. *Combustion air* ducts shall comply with all of the following:

1. ~~Ducts shall be constructed of galvanized steel complying with Chapter 6 of the *International Mechanical Code* or of a material having equivalent corrosion resistance, strength and rigidity.~~

~~**Exception:** Within dwellings units, unobstructed stud and joist spaces shall not be prohibited from conveying *combustion air* , provided that not more than one required fireblock is removed~~.

Ducts shall be of galvanized steel or an equivalent corrosion-resistant material. If flexible duct is used, increase the duct diameter by one size. Flexible duct shall be stretched with minimal sags.

2. Ducts shall terminate in an unobstructed space allowing free movement of *combustion air* to the *appliances*.

3. Ducts shall serve a single enclosure.

4. Ducts shall not be combined to serve both upper and lower *combustion air* openings where both such openings are used. The separation between ducts serving upper and lower *combustion air* openings shall be maintained to the source of *combustion air*.

5. Ducts shall not terminate in an attic space or crawl space. ~~be screened where terminating in an attic space.~~

6. Horizontal upper *combustion air* ducts shall not slope downward toward the source of *combustion air*.

7. The remaining space surrounding a chimney liner, gas vent, special gas vent or plastic *piping* installed within a masonry, metal or factory-built chimney shall not be used to supply *combustion air*.

Exception: Direct-vent gas-fired *appliances* designed for installation in a solid fuel burning *fireplace* where installed in accordance with the manufacturer's instructions.

8. *Combustion air* intake openings located on the exterior of a building shall have the lowest side of such openings located not less than 12 inches (305 mm) vertically from the adjoining finished ground level.

304.12 Protection from fumes and gases. Where chemicals that generate corrosive or flammable products such as aerosol sprays are routinely used, one of the following shall apply to fired *appliances* where these chemicals can enter combustion air:

1. Fired appliances shall be located in a mechanical room separate or partitioned off from other areas with provisions for combustion and dilution air from outdoors.
2. The appliances shall be direct vent and installed in accordance with the appliance manufacturer's installation instructions.

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.
   No

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)

   Section 304.5 Indoor Combustion Air and its subparagraphs should be deleted in their entirety. The indoor combustion air method relies on building infiltration in the appliance room and adjacent rooms with direct communication through permanent openings to provide combustion air. In 304.5.1 Standard Method, the infiltration rate is based on 0.50 ACH. Subparagraph 304.5.2 Known Air-Infiltration-Rate method (KAIR), equation 3-1 (other than fan assisted appliances) or 3-2 (fan assisted appliances), is used when the air infiltration rate of the structure is known to be less than 0.40 ACH and not greater than 0.60 ACH. It is unclear and even misleading of how the ACH is to be identified for calculation purposes and I could find no definitive method of how this should be determined. Typical air door tests identify the building ACH at 50 Pa pressure but this is not clearly identified as the proper method to use. An Energy Star building has a requirement of 3 ACH or less at 50 Pa (3 ACH50 which is equivalent to 0.20 inches w.c. or 25 mph wind). A very tight passive house has an ACH of no greater than 0.60 ACH50. How equations 3-1 and 3-2 were derived could not be determined, and I question their validity and reliability to calculate the volume of outdoor air introduced through building infiltration. Using ACH50 testing is a valid method to identify how well sealed a building is, but in my opinion should not be used for calculating combustion air. I would also note that an air door test creates a negative condition in the entire building, thereby causing infiltration on all exposures. In actual building operating conditions, about one-half of the building will be infiltrating (windward sides) while about one-half of the building will be exfiltrating (leeward sides), which further reduces the volume of air available for combustion air. I would also note that the ACH results from all exposed surfaces – if an appliance room is below grade, its infiltration rate will be significantly reduced, thereby resulting is much less combustion air than anticipated. The combustion air for a building should be through unobstructed openings which provide free flow of air as required by the appliances.

   Combustion air design requirements are based on a review of NFPA 54, AGA, ASHRAE, CSA B149.1-10, NB-132, existing MN code and several equipment manufacturer recommendations.

   Table 304.6 for appliances less than or equal to 400,000 Btuh input is based on CSA tables except that the table applies to non draft controlled and draft controlled appliances.

2. Why is the proposed code change a reasonable solution? It further clarifies requirements which are in the 2020 MN IFGC code and provides simpler information to contractors who may need the information.

3. What other factors should the TAG consider?

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.
   No changes.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.
   Should make compliance and enforcement more uniform and easier to achieve.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?
   Owners, contractors, building officials.
   Owners, contractorts, design engineers, building code officials.

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the alternatives are and why your proposed change is the preferred method or means to achieve the desired result.
   No

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?

   Confusion and inconsistency in the design of combustion air requirements. Proposed solutions may be different than what would be required by code officials.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.

   No

***Note: Incomplete forms may be returned to the submitter with instruction to complete the form. Only completed forms can considered by the TAG.

Methods of providing combustion air:

In all cases add 3.5% for every 1,000 feet over 1,000 feet above sea level

Direct connection:

Direct connection from outdoor air opening to the appliance.
Size determined from manufacturer's recommendations.
Motorized dampers are allowed but must be interlocked with the appliance.

Gravity air intake:

High or low air intakes with gravity air intake sized based on the required minimum free area intake per 1,000 Btuh.
Table for $\leq$ 400,000 Btuh
Vertical ducts: 1 sq. in./4,000 Btuh
Horizontal ducts: 1 sq. in./2,000 Btuh

Openings are typically continuously open whether the appliance is firing or not.

Motorized dampers are allowed but must be interlocked with the appliance.

Mechanically introduced combustion air:

Combustion air introduced through powered ventilation system.

Allows for tempering of combustion air before introducing it into the appliance space.

Outdoor air dampers interlocked with appliance.

One method of control:
Maintain slightly positive pressure in boiler room (0.02 inches w.c.)
Outdoor air dampers will be fully open when operating.
Relief dampers go fully open. Barometric dampers in relief to maintain 0.02 inches w.c.
Return air dampers modulate to maintain positive pressure.

Minimum outdoor air required is 0.35 cfm/BHP.
BHP = 33,475 Btuh

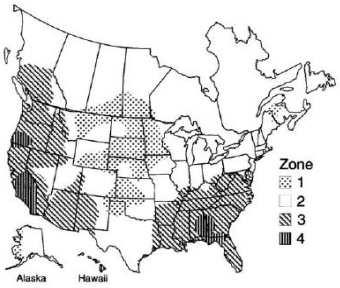
Calculation of Air Changes per Hour based on ACH50

50 Pa = 0.20 in. w.c. = 20 mph wind

If air leakage tests are performed at 50 Pa, what would the ACH under natural driving forces?

The conversion is:
ACH50/n-Factor = ACHnat

The n factor is a value developed by LBL to calculate the natural air change rate based on the blower door test results



N-Factor is a result of:
-Geographic location
-Wind shielding
-Building height

For Zones 1 and 2, we get:

n-factors					
Zone	**No. of stories-->**	**1**	**1.5**	**2**	**3**
1	Well-shielded	18.6	16.7	14.8	13.0
	Normal	15.5	14.0	12.4	10.9
	Exposed	14.0	12.6	11.2	9.8
2	Well-shielded	22.2	20.0	17.8	15.5
	Normal	18.5	16.7	14.8	13.0
	Exposed	16.7	15.0	13.3	11.7

Example calculations:

Air door test result is 3 ACH. What is ACHnat?

ACHnat					
Zone	**No. of stories-->**	**1**	**1.5**	**2**	**3**
1	Well-shielded	0.16	0.18	0.20	0.23
	Normal	0.19	0.21	0.24	0.28
	Exposed	0.21	0.24	0.27	0.31
2	Well-shielded	0.14	0.15	0.17	0.19
	Normal	0.16	0.18	0.20	0.23
	Exposed	0.18	0.20	0.23	0.26

Air door test result is 6 ACH. What is ACHnat?

ACHnat					
Zone	**No. of stories-->**	**1**	**1.5**	**2**	**3**
1	Well-shielded	0.32	0.36	0.41	0.46
	Normal	0.39	0.43	0.48	0.55
	Exposed	0.43	0.48	0.54	0.61
2	Well-shielded	0.27	0.30	0.34	0.39
	Normal	0.32	0.36	0.41	0.46
	Exposed	0.36	0.40	0.45	0.51

Air door test result is 0.6 ACH (passive solar house). What is ACHnat?

ACHnat					
Zone	**No. of stories-->**	**1**	**1.5**	**2**	**3**
1	Well-shielded	0.03	0.04	0.04	0.05
	Normal	0.04	0.04	0.05	0.06
	Exposed	0.04	0.05	0.05	0.06
2	Well-shielded	0.03	0.03	0.03	0.04
	Normal	0.03	0.04	0.04	0.05
	Exposed	0.04	0.04	0.05	0.05

Note that the combustion air requirements of Section 304.5.1 and 304.5.2 require
using equations 3-1 or 3-2 if air infiltration rate is less than 0.40 ACH
and an infiltration rate greater than 0.60 ACH shall not use these equations,

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COMBUSTION AIR

Questions are frequently asked about combustion air requirements for furnaces and boilers. S.B.C. Section 7722 speaks of these requirements.

In new construction, combustion air must be installed for all units. This is a requirement of the code and becomes even more necessary because of energy conservation regulations which limit the amount of air infiltration. The two methods of installing combustion air are described in the State Building Code. It reads as follows:

"SBC 7722 Combustion Air Intakes

(1) Fuel Inputs above 500,000 BTU per hour.

(a) All boiler rooms and furnace rooms shall be provided with an opening to the outside air. The free area of such opening shall not be less than one square inch for each 5,000 BTU per hour of fuel consumed, except the minimum free area of such opening shall not be less than 100 square inches.

(b) The use of manual operated dampers is not approved.

(c) The use of motorized dampers is approved where the motor is inter-connected with the burner(s) of direct-fired equipment which will open the damper, when burner(s) is operating. The burner and damper shall be so inter-connected so that the burner shall not start before the damper is open.

(2) Fuel Inputs less than 500,000 BTU per hour.

(a) Outside air to the appliance area for proper fuel combustion shall be provided by openings to the outside of the building or to spaces freely communicating to the outside of the building. The openings of ducts supplying such air shall have unobstructed areas not less than the area of the minimum required common flue of flues serving the heating system and other fuel burning appliances in the area, and shall discharge such outside air at a point not more than one foot above the floor.

(b) Air for combustion may be introduced into the return air plenum of forced air system provided that an unobstructed opening into the appliance area is installed in the supply side of the system. The opening shall have a minimum area of 50% of the common flue area.

(c) When a furnace is installed in a small utility room or other confined space, a sufficient quantity of air must enter the space in which the furnace is located to supply both the air required for combustion and for ventilating the space to prevent it from becoming overheated.

1. Combustion air opening shall be as outlined in part (a) above.

2. Ventilation air shall be supplied to the confined space through two openings to the interior of the building and located as follows:

Ventilation air outlet grille located in the wall or door at a height above the draft hood opening. The free area of the opening shall be 1/2 square inch for each 1,000 BTU per hour of input.

Ventilation air inlet grille located in the wall or door at or below combustion air inlet to burner. The free area of the opening shall be 1/2 square inch for each 1,000 BTU per hour of input.

(d) Accessibility and Cleanliness. All outside air intakes shall be constructed and maintained accessible for cleaning. All openings through walls of buildings shall be not less than one foot above the grade level and be protected with screen of not more than 1/2 inch nor less than 1/4 inch mesh."

If a furnace or boiler is replaced, combustion air must be installed at that time if it was not done with the original installation. This would apply in areas under the State Code, whether or not permits are issued for mechanical installations.

When a person adds additional appliances such as a wood stove, fireplace stove, or a masonry fireplace, consideration must be given at that time to combustion air. It may have to be added if it is not a part of the new installation.

When a new appliance is added that does not have combustion air as part of the installation, it can cause a down draft in the flue of another appliance if there is no combustion air available. The solution to the problem is to provide combustion air that is available to all appliances. This may be supplied by openings that are freely communicating to the outside of the building. If a door is placed between the combustion air intake and the appliance, it must be louvered and of proper size to let air to freely pass.

In addition the room or area of the furnace or boiler must be properly ventilated. This ventilation must not be confused with combustion air. The pipe bringing in the combustion air might require insulation to eliminate condensation. An air trap is advisable to control the rapid flow of cold air. This would be done for comfort reasons only. Openings through outside wall must be protected with screen not more than one-half inch nor less than one-quarter inch mesh.

Energy Efficiency

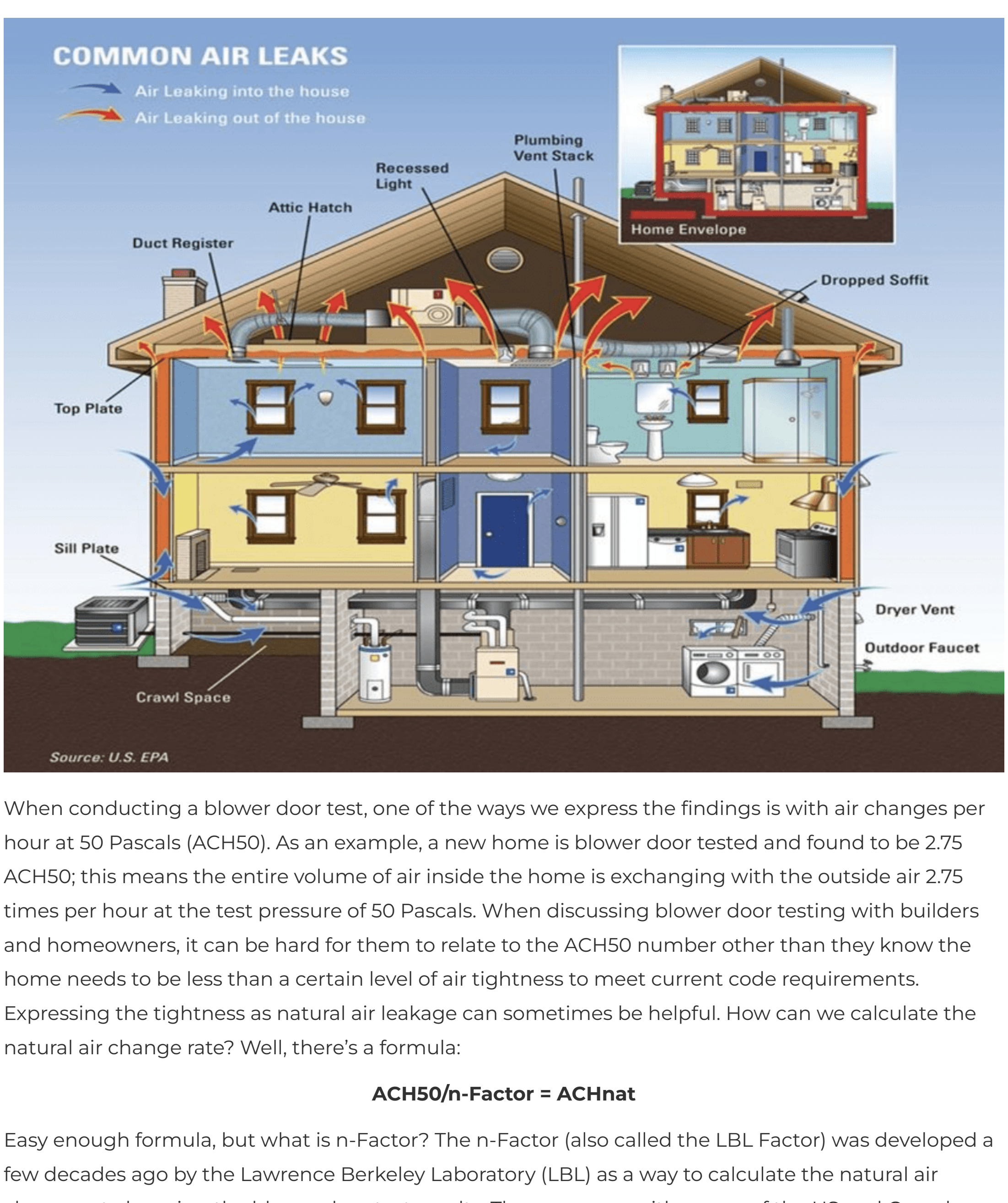
50 Pa = 0.20 in. w.c. = 20 mph wind

May 15, 2023

Measuring Natural Air Leakage

How to calculate ACHnat and reasons it can be a useful metric

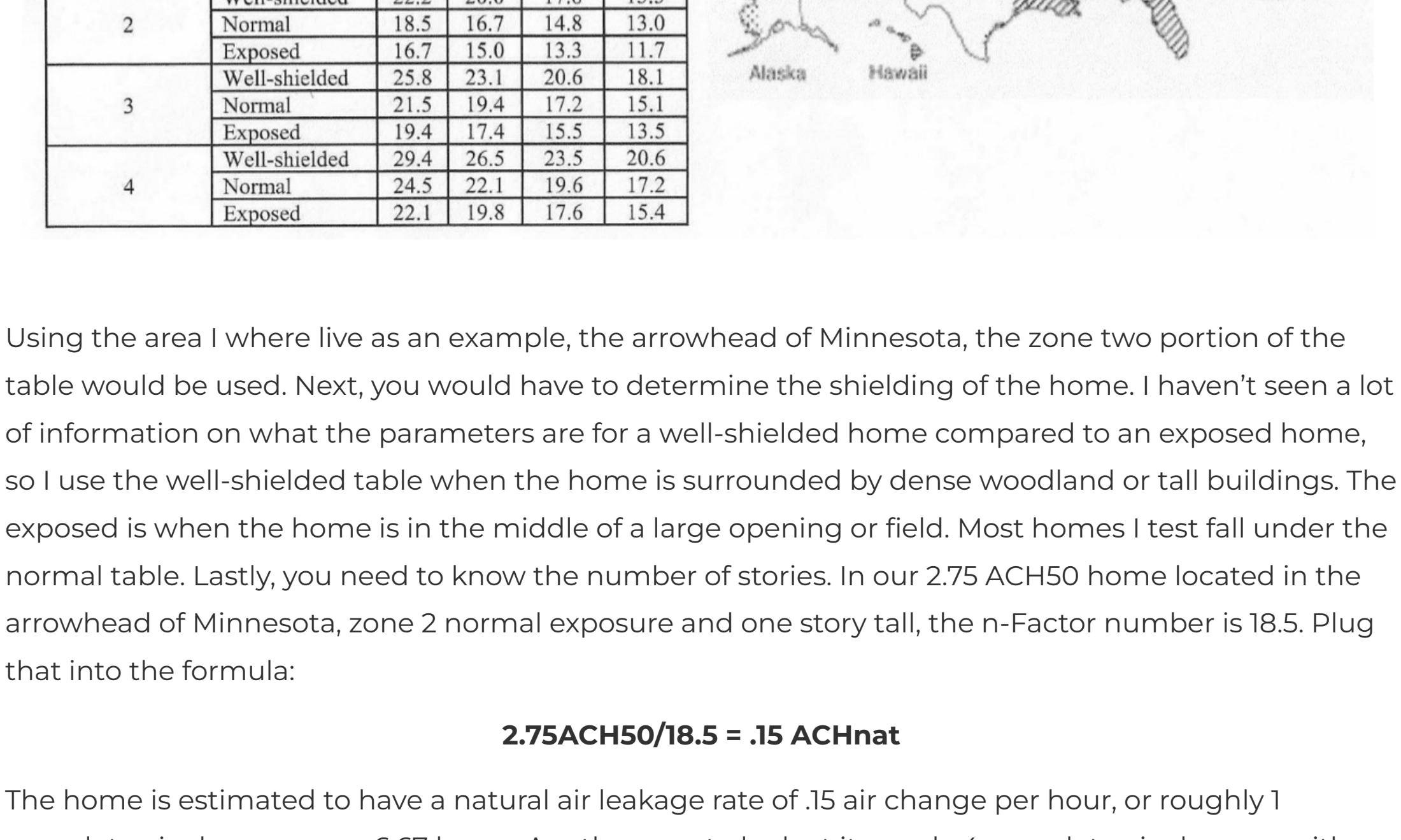
By: Randy Williams



When conducting a blower door test, one of the ways we express the findings is with air changes per hour at 50 Pascals (ACH50). As an example, a new home is blower door tested and found to be 2.75 ACH50; this means the entire volume of air inside the home is exchanging with the outside air 2.75 times per hour at the test pressure of 50 Pascals. When discussing blower door testing with builders and homeowners, it can be hard for them to relate to the ACH50 number other than they know the home needs to be less than a certain level of air tightness to meet current code requirements. Expressing the tightness as natural air leakage can sometimes be helpful. How can we calculate the natural air change rate? Well, there's a formula:

ACH50/n-Factor = ACHnat

Easy enough formula, but what is n-Factor? The n-Factor (also called the LBL Factor) was developed a few decades ago by the Lawrence Berkeley Laboratory (LBL) as a way to calculate the natural air change rate by using the blower door test results. They came up with a map of the US and Canada that uses wind data for the given location, how well-shielded the home is, and how many stories the home has. The illustration and chart are used to determine the n-Factor for a given area.



	n-factors				
Zone	# of stories →	1	1.5	2	3
1	Well-shielded	18.6	16.7	14.8	13.0
	Normal	15.5	14.0	12.4	10.9
	Exposed	14.0	12.6	11.2	9.8
2	Well-shielded	22.2	20.0	17.8	15.5
	Normal	18.5	16.7	14.8	13.0
	Exposed	16.7	15.0	13.3	11.7
3	Well-shielded	25.8	23.1	20.6	18.1
	Normal	21.5	19.4	17.2	15.1
	Exposed	19.4	17.4	15.5	13.5
4	Well-shielded	29.4	26.5	23.5	20.6
	Normal	24.5	22.1	19.6	17.2
	Exposed	22.1	19.8	17.6	15.4

Using the area I where live as an example, the arrowhead of Minnesota, the zone two portion of the table would be used. Next, you would have to determine the shielding of the home. I haven't seen a lot of information on what the parameters are for a well-shielded home compared to an exposed home, so I use the well-shielded table when the home is surrounded by dense woodland or tall buildings. The exposed is when the home is in the middle of a large opening or field. Most homes I test fall under the normal table. Lastly, you need to know the number of stories. In our 2.75 ACH50 home located in the arrowhead of Minnesota, zone 2 normal exposure and one story tall, the n-Factor number is 18.5. Plug that into the formula:

2.75ACH50/18.5 = .15 ACHnat

The home is estimated to have a natural air leakage rate of .15 air change per hour, or roughly 1 complete air change every 6.67 hours. Another way to look at it, nearly 4 complete air changes with outside air per day.

Before moving on, lets look at what the effect is on the example house if it were three stories in an exposed location of zone 1.

2.75 ACH50 / 9.8 = .28 ACHnat

We've nearly doubled the estimated natural air change rate by building the home in the winter zone 1, making the building taller and moving the structure to the middle of a field.

All that being said, the calculated ACHnat number isn't very reliable. It can vary widely based on several variables unique to every home. These variables include the difference between inside and outside temperatures, wind speed and direction, the location of the air leaks in the home, and the effects of any mechanical ventilation happening in the home. This mechanical ventilation effect may be designed, such as when using different exhaust fans, or by accident, when there are leaky ducts located outside the building envelope. The ACHnat number isn't great, but it is the best "estimate" I'm aware of.

What can be done with the ACHnat number? Well, we can estimate the heating cost of the air leaks. You'll need some additional information for this calculation, such as the cost of the heating fuel expressed in cost per BTU, the efficiency of the heating system, the heating degree days (HDD) for the location of the home, the CFM50 blower door number and a constant, the number 26.

(26 x HDD x cost of the fuel/Btu x CFM50) / (n-Factor x efficiency of the heating system)

Back to our original example home in Northern Minnesota, with 9750 heating degree days. The home is heated with a 65% efficient fuel oil boiler (140,000 btu/gallon) with fuel costs at $3 per gallon ($.000021/btu). We will need to use the blower door CFM number instead of the air changes per hour number, 550 CFM50. The example home has a total of 12,000 ft^3. Plug all these numbers into the formula:

(26 x 9750 HDD x $.000021 x 550 CFM50)/(18.5 n-fact. x .65 heating efficiency) =$248 per year

The estimated cost of air leakage is $248 per heating season. Change the home to a 3-story built in the middle of a field; the cost increases to $460.

If you live in a cooling-dominated climate, a similar formula can calculate the cost of air leaks when cooling the home.

(.026 x CDD x fuel (cost of electricity / kWh) x CFM50) / (n-factor x SEER)

The formula takes into account sensible cooling only; latent cooling can also have a big effect on costs. The estimated cost due to air leakage in heating and cooling can then be used as a factor when deciding how much to spend on air sealing improvements for the home.

There's another area where knowing the estimated ACHnat can be important, and that's in calculating ventilation rates. ASHRAE 62.2-2010 and 62.2-2013 allow the natural air leakage rate for the home to be included in the required mechanical ventilation rate. The ventilation rate formula for 62.2-2010 is:

Ventilation required = (.01 x conditioned area) + (7.5 x (bedrooms + 1))

Back to our example house, which has 3 bedrooms.

(.01 x 1500) + (7.5 x 4) = 45CFM required

According to 62.2-2010, the home is required to have 45 CFM of mechanical ventilation. 62.2 assumes that most homes will have some natural air leakage, this can be accounted for when calculating the required ventilation rates. To calculate the natural air leakage rate in CFM, use the formula:

CFM50 / n-Factor = CFMnat

550 CFM50 / 18.5 = 30 CFMnat

The example home has a natural air leakage rate of 30 CFM. With ASHRAE 62.2-2010, we can't simply subtract the natural air changes from the required ventilation rate. More math is required. 62.2-2010 assumes there is 2 cfm natural leakage per 100 square feet of floor area.

Square feet of floor area / 100 square feet x 2 = CFMinc

Back to our example house:

1500 square feet / 100 square feet x 2 = 30 CFMinc

We now need to subtract the CFM included number from the calculated CFM natural number. The formula is:

(CFMnat – CFMinc) / 2 = CFMexcess

30 CFMnat -30 CFMexcess / 2 = .5 CFMexcess

The last part of the calculation is to subtract the CFM excess from the CFM required and we will have the required ventilation rate that takes into account the natural air leaks.

45 CFM required – .5 CFMexcess = 44.5 required ventilation

That was a lot of work to reduce the required ventilation rate by half a CFM from the original ventilation calculation. In this home, the reduction isn't worth the effort when using 62.2-2010. The calculation for the inclusion of air leakage in the 62.2-2013 is much simpler, though the calculation for required ventilation rate is different:

Ventilation required = (.03 x conditioned area) + (7.5 x (bedrooms + 1))

(.03 x 1500) + (7.5 x 4) = 60 CFM required

As you can see, the required ventilation when using ASHRAE 62.2-2013 is 25% is higher than 2010, but we are able to use the entire natural air infiltration rate calculation when using the 2013 version:

CFMreq – CFMnat = CFMvent

60 CFMreq – 30 CFMnat = 30 CFM required ventilation

Depending on which version of ASHRAE 62.2 you base ventilation rates on, you end up with two different requirements. 44.5 CFM using 2010 and 30 CFM using 2013. Without accounting for the natural air leakage of the home, the 2013 ventilation rate would have been much higher. One note on using ASHRAE 62.2, know which version your local codes use; there are older versions of 62.2 used in areas of the country. The example home in Northern Minnesota wouldn't use any version of ASHRAE 62.2 in calculating ventilation rates, Minnesota has its own ventilation rate formula, and natural ventilation is not allowed to be accounted for.

Though the calculated natural air leakage rate isn't very reliable, there are still times when knowing the rate in both air changes per hour and cubic feet per minute of air leakage can be useful. Part of my job is trying to convey the importance of air sealing to both homeowners and builders; having a tool to use as a visual is often helpful.

*This article was **originally published on Green Building Advisor** and is republished with permission.*

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Randy Williams
Builder & Energy Auditor

Randy Williams started his construction career in the mid 1990's installing electrical, plumbing, and HVAC systems with his brother. In the early 2000's, his family branched into building and renovating homes and by 2005, Randy was working full-time as a general contractor. He furthered his education in 2009 becoming an energy auditor. Today, Randy works with other contractors, homeowners, and utilities performing energy audits, building diagnostics, energy design, and code-compliant testing. He is also a contributing author to several trade publications and occasionally teaches home diagnostic testing and building science topics at different trade shows and training events. Randy lives and works in the very cold climate of Northern Minnesota. Follow Randy on Instagram @northernbuiltpro and on his blog: www.northernbuilt.pro

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DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

Author/requestor: Mario Salute

Email address: mario.salute@ci.stpaul.mn.us

Telephone number: 651-266-9063

Firm/Association affiliation, if any:

Code or rule section to be changed: 603.1

Date: 11/14/2024

Model Code: 2020 IFGC

Code or Rule Section: 603.1

Topic of proposal: Log Lighters

Intended for Technical Advisory Group ("TAG"): Mechanical and Fuel Gas Code

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General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☒	☐
B. Is the proposed change required due to climatic conditions of Minnesota?	☐	☒
C. Will the proposed change encourage more uniform enforcement?	☒	☐
D. Will the proposed change remedy a problem?	☒	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☒	☒
F. Would this proposed change be appropriate through the ICC code development process?	☒	☐

Proposed Language

1. The proposed code change is meant to:

   ☐ change language contained the model code book? If so, list section(s).

   ☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

   ☒ delete language contained in the model code book? If so, list section(s).
   Yes, delete section 603.1.

   ☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

   ☐ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.
~~603.1 General. Log lighters shall be tested in accordance with CSA 8 and installed in accordance with the manufacturer's instructions~~.

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.
No

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)
The code requires log lighters to be tested in accordance with CSA 8. CSA 8 no longer exists.

2. Why is the proposed code change a reasonable solution?
There are no standards that log lighters can be tested to.

3. What other factors should the TAG consider?

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.
NA

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.
No

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.
No

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?
Mechanical

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the alternatives are and why your proposed change is the preferred method or means to achieve the desired result.
   The alternative would be to install a log lighter without a listing.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?
   Untested and unlisted appliances can be dangerous.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.
   No

***Note: The information you provide in this code change proposal form is considered Public Data and used by the TAG to consider your proposed modification to the code. Any code change proposal form submitted to DLI may be reviewed at public TAG meetings and used by department staff and the Office of Administrative Hearings to justify the need and reasonableness of any proposed rule draft subject to administrative review and is available to the public.

****Note: Incomplete forms will be returned to the submitter with instruction to complete the form. Only completed forms will be accepted and considered by the TAG. The submitter may be asked to provide additional information in support of the proposed code change.

DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

Author/requestor: John G. Smith, P.E.

Email address: jgsmith76@gmail.com

Telephone number: 612 867 3145

Firm/Association affiliation, if any: ACEC

Date: November 22, 2024

Model Code: 2024 IRC

Code or Rule Section: M1401.1

Code or rule section to be changed: M1401 General-Installation

Intended for Technical Advisory Group ("TAG"): 1346 Mechanical and Fuel Gas Code

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General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☒	☐
B. Is the proposed change required due to climatic conditions of Minnesota?	☒	☐
C. Will the proposed change encourage more uniform enforcement?	☒	☐
D. Will the proposed change remedy a problem?	☒	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☐	☒
F. Would this proposed change be appropriate through the ICC code development process?	☐	☒

Proposed Language

1. The proposed code change is meant to:

☒ change language contained the model code book? If so, list section(s).

Chapter 14 Heating and Cooling Equipment and Appliances, M1401.1 Installation

☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

MN Rules 1346 409.1.3 through 409.3.1

☐ delete language contained in the model code book? If so, list section(s).

☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

MN Rules 1346 409.1.3 through 409.3.1

☒ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

   No

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

M1401.1 Installation. Heating and cooling equipment and appliances shall be installed in accordance with the manufacturer's instructions and the requirements of this code.

Exception: Unvented heaters and appliances. Unvented room heaters, unvented infrared heaters, and unvented decorative appliances shall not be installed in any dwelling or occupancy.

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.

No

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)

   Wording of the exceptipn is from 1346.0901.5 of current MN mechanical code. For residential spaces, unvented appliances should not be allowed in any cases.

2. Why is the proposed code change a reasonable solution?

   It clearly identifies that unvented appliances are not allowed in any dwelling or occupancy.

3. What other factors should the TAG consider?
   None.

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.

   No change.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.

   Change will make enforcement easier as it clearly prohibits the identified devices, which will reduce time spent on the issue.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?

   Owners, contractors, building officials.

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the alternatives are and why your proposed change is the preferred method or means to achieve the desired result.

   No.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?

   If not adopted, unvented equipment will be allowed which is not desired for occupied spaces.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.

   No

***Note: Incomplete forms may be returned to the submitter with instruction to complete the form. Only completed forms can considered by the TAG.