BSR/ASHRAE Addendum ag
to ANSI/ASHRAE Standard 62.1-2016

Public Review Draft

Proposed Addendum ag to Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality

Second Public Review (July 2019)
(Draft shows Proposed Changes to Current Standard)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

This standard is under continuous maintenance. To propose a change to the current standard, use the change submittal form available on the ASHRAE website, www.ashrae.org.

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

This proposed addendum replaces the calculation method in current Normative Appendix B2 (Separation of Exhaust Outlets and Outdoor Air Intakes) with a new method based upon ASHRAE Research Project 1635 (2016). This research was sponsored by ASHRAE Technical Committee (TC) 4.3. The purpose of this Research Project is to provide a simple, yet accurate procedure for calculating the minimum distance required between the outlet of an exhaust system and the outdoor air intake to a ventilation system to avoid re-entrainment of exhaust gases. The new procedure addresses the technical deficiencies in the simplified equations and tables that are currently in Standard 62.1-2016 Ventilation for Acceptable Indoor Air Quality and model building codes. This new procedure makes use of the knowledge provided in Chapter 45 of the 2015 ASHRAE Handbook—Applications and was tested against various physical modeling and full-scale studies.

The study demonstrated that the new method is more accurate than the existing Standard 62.1 equation which under-predicts and over-predicts observed dilution more frequently than the new method. In addition, the new method accounts for the following additional important variables: stack height, wind speed and hidden versus visible intakes. The new method also has theoretically justified procedures for addressing heated exhaust, louvered exhaust, capped heated exhaust and horizontal exhaust that is pointed away from the intake.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

Addendum ag to 62.1-2016

Modify Section B2 of Normative Appendix B as shown below. The remainder of Normative Appendix B is unchanged. Modifications to Section B2 are published in Addendum v to 62.1-2016. Published addendum are posted for free on the ASHRAE website at https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda.

[…]

B1.1 Application~~. Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45[5] and ANSI/AIHA Z9.5[6] . Nonlaboratory e~~Exhaust outlets and outdoor air intakes or other openings shall be separated in accordance with the
following.

Exceptions.

- Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45[5] and ANSI/AIHA Z9.5[6]
- Laboratory and industrial ventilation process exhausts are not addressed by this procedure
- Large, industrial sized combustion flues and stacks are not addressed by this procedure
- Packaged units that have integral exhaust and intake locations are not addressed by this procedure

B2. DETERMINING DISTANCE *L*

~~The minimum separation distance (L) shall be determined using one of the following three approaches:~~

~~**B2.1 Simple Method.** A value of L in Table B2-1 shall be used.~~

~~**B2.2 Velocity Method.** The value of L shall be determined using Equation B2-1 or B2-2.~~

~~$L = 0.09 \times \sqrt{Q} \times (\sqrt{DF} - U/400)$ in feet (I-P) (B2-1)~~

~~$L = 0.04 \times \sqrt{Q} \times (\sqrt{DF} - U/2)$ in metres (SI) (B2-2)~~

~~where~~
~~Q = exhaust airflow rate, cfm (L/s). For gravity vents, such as plumbing vents, use an exhaust rate of 150 cfm (75 L/s). For flue vents from fuel-burning appliances, assume a value of 250 cfm per million Btu/h (0.43 L/s per kW) of combustion input (or obtain actual rates from the combustion appliance manufacturer.~~
~~U = exhaust air discharge velocity, fpm (m/s). As shown in Figure B2-1, U shall be determined using Table B2-3.~~
~~DF = dilution factor, which is the ratio of outdoor airflow to entrained exhaust airflow in the outdoor air intake. The minimum dilution factor shall be determined as a function of exhaust air class in Table B2-2.~~

~~For exhaust air composed of more than one class of air, the dilution factor shall be determined by averaging the dilution factors by the volume fraction of each class using Equation B2-3:~~

~~$DF = \sum(DF_i \times Q_i)/\sum Q_i$ (B2-3)~~

~~where~~
~~DF_i = dilution factor from Table B2-2 for class *i* air.~~
~~Q_i = volumetric flow rate of class *i* air in the exhaust airstream.~~

~~**TABLE B2-1 Minimum Separation Distance**~~

~~**Exhaust Air Class (See Section 5.16)**~~	~~**Separation Distance, *L*, ft (m)**~~
~~Significant contaminant or odor intensity (Class 3)~~	~~15 (5)~~
~~Noxious or dangerous particles (Class 4)~~	~~30 (10)~~

~~**TABLE B2-2 Minimum Dilution Factors**~~

~~**Exhaust Air Class (See Section 5.16)**~~	~~**Dilution Factor (DF)**~~
~~Significant contaminant or odor intensity (Class 3)~~	~~15~~
~~Noxious or dangerous particles (Class 4)~~	~~50*~~

~~*Does not apply to fume hood exhaust. See Section B1.1.~~

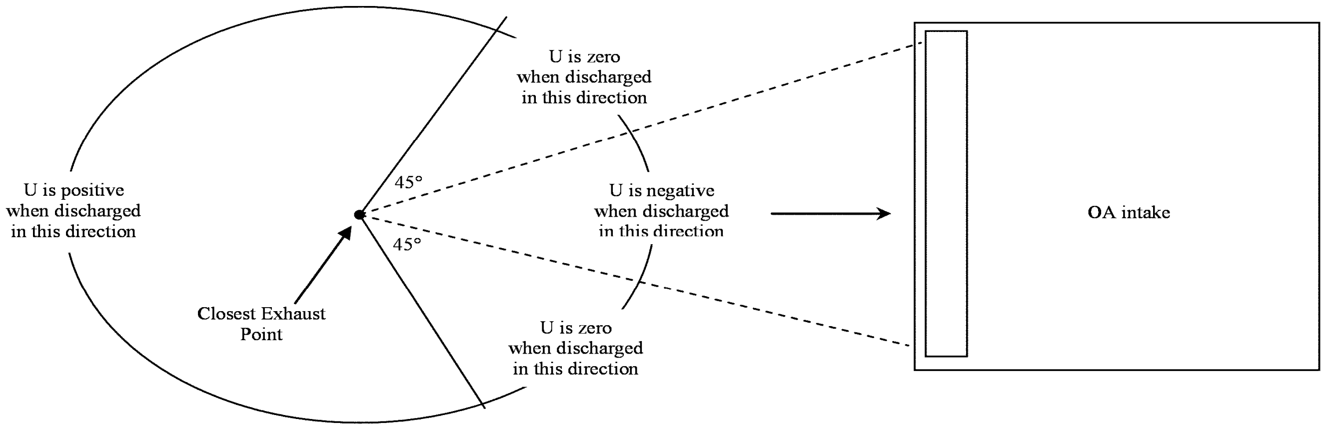

FIGURE B2-1 Exhaust air discharge velocity (*U*).

TABLE B2-3 Exhaust Air Discharge Velocity

Exhaust Direction/Configuration	**Exhaust Air Discharge Velocity (*U*) Modifier**
Exhaust is directed away from the outdoor air intake at an angle tha is greater than 45 degrees from the direction of a line drawn fron the closest exhaust point to the edge of the intake	*U* given a positive value
Exhaust is directed toward the intake bounded by lines drawn from the closest exhaust point to the edge of the intake	*U* given a negative value
Exhaust is directed at an angle between the two above cases	*U* is zero
Vents from gravity (atmospheric) fuel-fired appliances, plumbing vents, and other nonpowered exhausts, or if the exhaust discharge is covered by a cap or other device that dissipates the exhaust airstream	*U* is zero
Hot gas exhausts such as combustion products if the exhaust stream is aimed directly upward and unimpeded by devices such as flue caps or louvers	Add 500 fpm (2.5 m/s) upward velocity to *U*

B2.3 Concentration Method.

Determine the acceptable concentration for health (C_{health}) and odor (C_{odor}) for each emitted chemical, compound or mixture. At a minimum evaluate compounds of common interest and corresponding mixtures listed in Tables 6.2.3.1 and 6.2.3.2.

Design the exhaust and intake systems such that the maximum concentration at the intake (C_{max}) is less than the acceptable concentrations of all evaluated compounds and mixtures.

$C_{max} < C_{health}$ (B2.3.1)

$C_{max} < C_{odor}$ (B2.3.2)

~~At a minimum, determination of C_{max} shall consider wind speed, wind direction, exhaust exit velocity and momentum, geometry of building and adjacent structures, and architectural screens. Wind tunnel modeling is an acceptable design method.~~

B2.1 General Equations. Minimum separation distance L shall be calculated using Equations B2.1-1 through B2.1-6.

$$F1 = 13.6 \frac{DF Q_e}{U_H} \qquad \text{(B2.1-1)}$$

$$F2 = 33.37\, h_s^2 + 254.9\, \beta \frac{B_{fac} h_s Q_e}{d_e U_H} + 486.9\, \beta \left[\frac{B_{fac} Q_e}{d_e U_H}\right]^2 \qquad \text{(B2.1-2)}$$

$$Bfac = \left[1 + \left(\frac{580{,}000\,(T_s - T_a) T_s}{{T_a}^2 U_H V_e}\right)\right]^{0.5} \qquad \text{(SI)} \qquad \text{(B2.1-3)}$$

$$Bfac = \left[1 + \left(\frac{15\,(T_s - T_a) T_s}{{T_a}^2 U_H V_e}\right)\right]^{0.5} \qquad \text{(I-P)} \qquad \text{(B2.1-4)}$$

$$V_e = Q_e \Big/ (\pi d_e^2/4) \qquad \text{(B2.1-5)}$$

$\textit{Find maximum of } [F1$

$- F2] \textit{ by varying } U_H \textit{ between } 300\ fpm\ (1.5\ m/s) \textit{ and the maximum wind speed. If local wind speed data is not av}$

$/s\ (300\ fpm) \textit{ to } 10\ m/s\ (2000\ fpm).$ ~~$and\ (2000\ fpm\ (10\ m)\ /\ (s))$~~

$$if\ max[F1 - F2] > 0;\ L = [F1 - F2]^{0.5} \qquad \text{(B2.1-6)}$$

$$if\ max[F1 - F2] \le 0;\ L = 0$$

where:

- *Q* = exhaust airflow rate, cfm (L/s). For gravity vents, such as plumbing vents, use an exhaust rate of 150 cfm (75 L/s). For flue vents from fuel-burning appliances, assume a value of 250 cfm per million Btu/h (0.43 L/s per kW) of combustion input (or obtain actual rates from the combustion appliance manufacturer.
- *U* = exhaust air discharge velocity, fpm (m/s). As shown in Figure B2-1, *U* shall be determined using Table B2-3.
- *DF* = dilution factor, which is the ratio of outdoor airflow to entrained exhaust airflow in the outdoor air intake. The minimum dilution factor shall be determined as a function of exhaust air class in Table B2-1.
- L = minimum separation (stretched string as shown in Figure 6-1) distance (m, ft);
- U_H = wind speed at stack top (m/s; fpm);
- T_s = exhaust temperature (K; R);

- T_a = ambient temperature (K; R);
- h_s = stack height above the top the air intake (m; ft);
- Q_e = exhaust air volume flow rate (m^3/s; cfm); for gravity vents, such as plumbing vents, use an exhaust rate of 150 cfm (75 L/s); for flue vents from fuel-burning appliances, assume a value of 250 cfm per million Btu/h (0.43 L/s per kW) of combustion input (or obtain actual rates from the combustion appliance manufacturer;
- d_e = exhaust diameter (m; ft); for rectangular exhaust (capped, horizontal or vertical), an equivalent round stack diameter shall be calculated using the following equation:
  $d_{e,,eff}$ = [Exhaust Area x 4/π]$^{0.5}$ (B2.1-7)
  for louvered round or rectangular exhaust (capped, horizontal or vertical), an equivalent round stack diameter should be calculated as follows:
  $d_{e,eff}$ = [Exhaust Area x Open Fraction x 4/π]$^{0.5}$ (B2.1-8)
  For heated capped or horizontal (including louvered) exhaust, the exhaust diameter prescribed in B.2.2.5 applies.
- β = 1 for uncapped stacks and 0 for capped or horizontal (includes louvered) exhaust.

The following equations shall be used to determine whether the exhaust is considered heated

$$T_c = 0.0297\left(\frac{v_s^{\frac{1}{3}}}{d_{e,eff}^{\frac{2}{3}}}\right)T_s \qquad (SI)$$

$$T_c = 0.00626\left(\frac{v_s^{\frac{1}{3}}}{d_{e,eff}^{\frac{2}{3}}}\right)T_s \qquad (IP)$$

Where

- T_c is the crossover temperature difference in (K; R); If T_c < T_s – T_a, the exhaust is considered to be heated.
- v_s = exhaust velocity (m/s; fpm); $v_s = \frac{Q_e}{d_{e\_eff}}$

Table B2-1. Minimum Dilution Factors, DF

Exhaust Type	**Minimum Dilution Factor, DF**
Class 1 air exhaust/relief outlet	5
Class 2 air exhaust/relief outlet	10
Class 3 air exhaust/relief outlet	50

Class 4 air exhaust/relief – based on kitchen grease hoods	300
Wood burning kitchen exhaust	700
General Boilers, Natural Gas and Fuel Oil, Based on NOx ppm factor (see Note 1)	2.8*p
Garage entry, automobile loading area, or drive-in queue (light duty gasoline vehicles)	50
Diesel generators, diesel truck loading area or dock, diesel bus parking/idling area (see Note 2)	2000*e
Cooling tower exhaust (based chemicals used for treatment)	10
Notes: 1. p is ppm NOx. If the NOx ppm is 10 ppm, p = 10 and DF = 28 2. e = 1 - the efficiency of the odor filter. (e.g. if the filter is 80% efficient, e = 0.2 and DF = 400)	

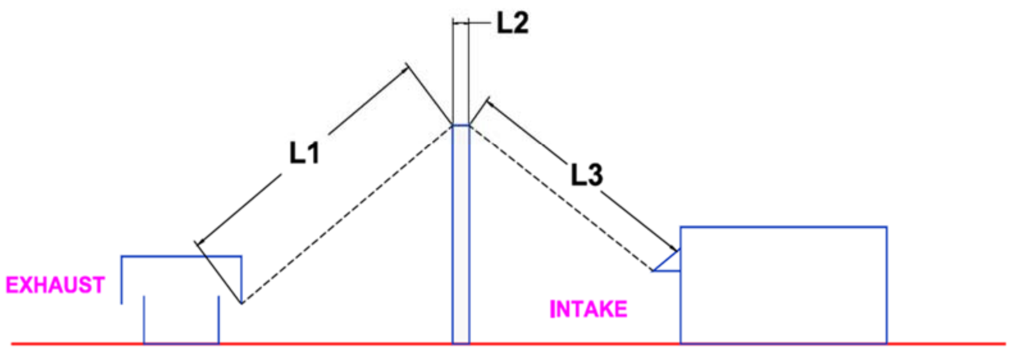

Figure B2-1 Diagram showing how to calculate string distance, L. In the figure L = L1+L2+L3

B2.2 Special Cases. When a special case occurs, the alternate compliance conditions and equations in the following sections are permitted to be used to determine input values instead of those prescribed in B2.1.

B2.2.1 Horizontal Exhaust Pointed Away from Intake. When an exhaust is pointed away from an intake and the wind is blowing toward the intake, the exhaust travels some direction upwind and then turns around.

Informative Note: The upwind distance traveled depends upon the ratio of exhaust velocity to wind speed (velocity ratio). The plume is also diluted as it travels upwind. For small velocity ratios, the exhaust turns around quickly (within $0.5d_e$ for a velocity ratio of 0.5) and for high velocity ratios, the plume travels upwind for a larger distance ($6d_e$ for a velocity ratio of 5).

B2.2.1.1 Pointed Away. "Pointed away" includes cases where the direction of the exhaust is oriented 180 degrees away from the intake ± 45 degrees.

B2.2.1.2 Allowable Adjustments. Input variables for pointed away are permitted to be adjusted as in Equations B2.2.1.2-1 and B2.2.1.2-2. Resulting value of L is permitted to be adjusted as in Equation B2.2.1.2-3.

$U_{H,pa} = V_e$ (B2.2.1.2-1)

$DF_{pa} = DF/1.7$ (B2.2.1.2-2)

$L_{pa} = L/(1.75*d_e)$ (B2.2.1.2-3)

B2.2.2 Upblast and Downblast Exhaust. For upblast exhaust (typically used for Kitchen exhaust), the effective exhaust velocity is computed using the dimension "A" for d_e in the figure below and the exhaust volume flow rate along with the Equation B2.1-5.

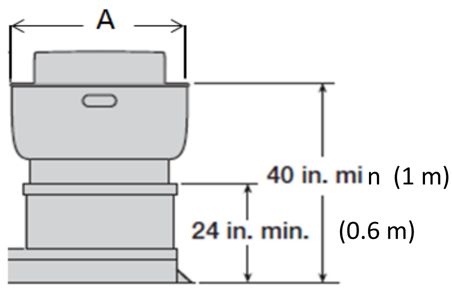

Figure B2.2.2 Typical Upblast Exhaust

B2.2.3 Downblast Exhaust. Downblast exhaust (e.g. "mushroom" exhausters) are treated the same as a capped exhaust stack and input exhaust diameter is "A" in Figure B2.2.2.

Informative Note: If the downblast stack is heated, the method in B2.2.5 is permitted to be used.

B2.2.4 Hidden Intakes. A hidden intake is one that cannot be seen if standing at the exhaust location. A hidden intake must be off the same roof as the exhaust and on a building sidewall. For hidden intakes the minimum dilution factor from Table B2-1 shall be divided by 2 as shown in Equation B2.2.4-1.

$DF_h = DF/2$ (B2.2.4-1)

Informative Note: Typically, hidden intakes are on building sidewalls or on the side of a large mechanical penthouse or unit.

B2.2.5 Capped Heated Exhaust. Capped stacks or horizontal louvered exhausts that are heated will have still have plume rise due to buoyancy effects. For capped heated exhaust, the following values shall be used in calculating the value of F2 in Equation B2.1-2.

$d_e = d_{e,capheat} = 10\ d_{e,eff}$ (B2.2.5-1)

$\beta = 1$ (B2.2.5-2)