ADDENDA

ANSI/ASHRAE Addendum ag to
ANSI/ASHRAE Standard 62.1-2022

Ventilation and Acceptable Indoor Air Quality

Approved by ASHRAE and the American National Standards Institute on April 30, 2024.

This addendum was approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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FOREWORD

Addendum ag replaces the calculation method in Normative Appendix B, "Separation of Exhaust Outlets and Outdoor Air Intakes," with a new method based on ASHRAE Research Project (RP) 1635. This research was sponsored by ASHRAE Technical Committee (TC) 4.3. RP-1635 provides 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 ANSI/ASHRAE Standard 62.1-2022, Ventilation and Acceptable Indoor Air Quality*, and model building codes. This new procedure makes use of the knowledge provided in Chapter 45 of the 2015 version of* ASHRAE Handbook—HVAC 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 underpredicts and overpredicts 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.

The equation for determining heated exhaust is derived from the EPA's User's Guide for the Industrial Source Complex (ISC3) Dispersion Models *(1995), Equation 1-10.*

References

EPA. 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Vol. 2: Description of Model Algorithms*. Research Triangle Park, NC: U.S. Environmental Protection Agency. EPA-454/B-95-003B.*

Informative Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ag to Standard 62.1-2022

Modify Normative Appendix B as shown below. The remainder of Normative Appendix B is unchanged.

B1. GENERAL

This appendix presents an alternative procedure for determining separation distance between outdoor air intakes and exhaust air and vent outlets. This analytical method can be used instead of Table 5-1.

Exhaust air and vent outlets, as defined in Table 5-1, shall be located no closer to outdoor air intakes, or to operable windows, skylights, and doors, both those on the subject property and those on adjacent properties, than the minimum separation distance (*L*) specified in this section. The distance (*L*) is defined as the shortest "stretched string" distance measured from the closest point of the outlet opening to the closest point of the outdoor air intake opening, or to the operable window, skylight, or door opening, along a trajectory as if a string were stretched between them.

B1.1 Application. ~~Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45[5] and ANSI/AIHA Z9.5[6] Nonlaboratory exhaust~~ <u>Exhaust</u> outlets and outdoor air intakes or other openings shall be separated in accordance with <u>Section B2</u>. ~~the following.~~

<u>**Exceptions to B1.1:**</u>

- <u>a. Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45 and ANSI/AIHA Z9.5.</u>
- <u>b. Laboratory and industrial ventilation process exhausts are not addressed by this procedure.</u>
- <u>c. Large, industrial-sized combustion flues and stacks are not addressed by this procedure.</u>
- <u>d. Packaged units that have integral exhaust and intake locations are not addressed by this procedure.</u>
- <u>e. Evaporative heat rejection equipment is not addressed by this procedure.</u>
- <u>f. The minimum separation distances for heat rejection equipment shall conform to Table 5-1.</u>
- <u>g. Separation distances do not apply when exhaust and outdoor air intake systems are controlled such that they cannot operate simultaneously.</u>

~~**B1.2 Outdoor Air Intakes.** The minimum separation distance between exhaust air/vent outlets, as defined in Table 5-1, and outdoor air intakes to mechanical ventilation systems, or to operable windows, skylights, and doors that are required as part of natural ventilation systems, shall be equal to distance (L) determined in accordance with Section B2.~~

~~**Exception to B1.2:** Separation distances do not apply when exhaust and outdoor air intake systems are controlled such that they cannot operate simultaneously.~~

~~**B1.3 Other Building Openings.** The minimum separation distance between building exhaust air/vent outlets, as defined in Table 5-1, and operable openings to occupiable spaces shall be half of the distance (L) determined in accordance with Section B2. The minimum separation distance between either Class 3, Class 4, cooling tower, or combustion appliance/equipment exhaust air/vent outlets and operable openings to occupiable spaces shall be equal to the distance (L) determined in accordance with Section B2.~~

~~**B1.4 Additional Limitations for Noxious or Dangerous Air.** The minimum separation distance between exhausts located less than 65 ft (20 m) vertically below outdoor air intakes or operable windows and doors shall be equal to a horizontal separation only as determined in accordance with Section B2; no credit may be taken for any vertical separation.~~

~~**B1.5 Equipment Wells.** Exhaust air outlets that terminate in an equipment well that also encloses an outdoor air intake shall meet the separation requirements of this section and, in addition, shall either~~

~~a. terminate at or above the highest enclosing wall and discharge air upward at a velocity exceeding 1000 fpm (5 m/s) or~~
~~b. terminate 3 ft (1 m) above the highest enclosing wall (with no minimum velocity).~~

~~**Exception to B1.5:** Exhaust air designated as Class 1 or Class 2.~~

~~**B1.6 Property Lines.** The minimum separation distance between exhaust air/vent outlets and property lines shall be half of the distance (L) determined in accordance with Section B2.~~

~~**Exception to B1.6:** For Class 3, Class 4, or combustion appliance/equipment exhaust air, where the property line abuts a street or other public way, no minimum separation is required if exhaust termination is at least 10 ft (3 m) above grade.~~

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 B-1 shall be used.~~

~~**B2.2 Velocity Method.** The value of *L* shall be determined using Equation B-1 (IP) or B-2 (SI).~~

$$L = 0.09 \times \sqrt{Q} \times (\sqrt{DF} - U/400)\ [ft] \quad (B\text{-}1)$$

$$L = 0.04 \times \sqrt{Q} \times (\sqrt{DF} - U/2)\ [m] \quad (B\text{-}2)$$

~~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 B-1, *U* shall be determined using Table B-2.~~

~~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 B-3.~~

~~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 B-3:~~

$$DF = \sum(DF_i \times Q_i)/\sum Q_i \quad (B\text{-}3)$$

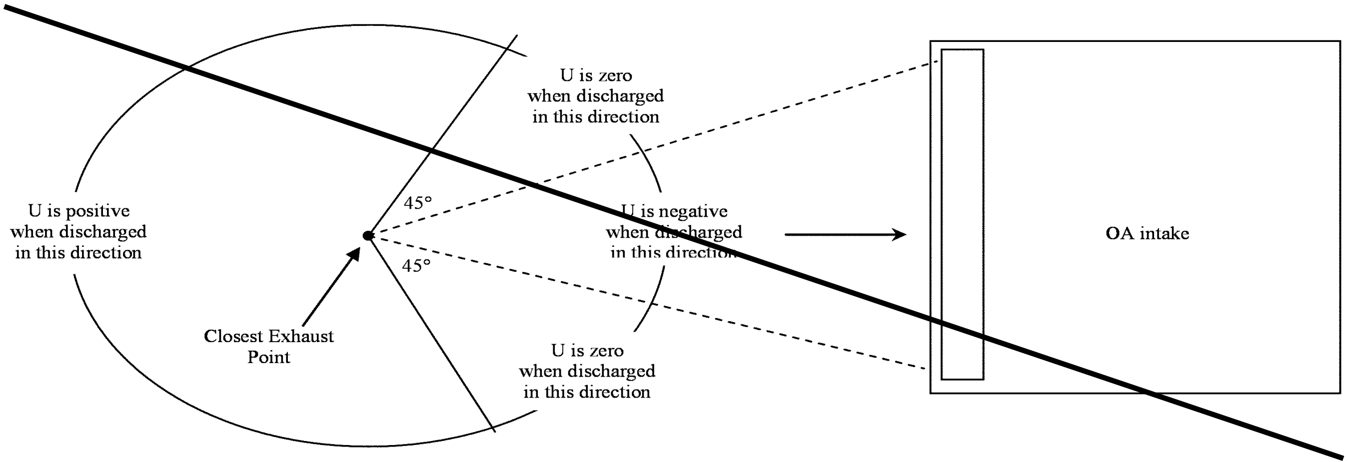
~~where~~

~~DF_i = dilution factor from Table B-2 for class *i* air.~~

~~Q_i = volumetric flow rate of class *i* air in the exhaust airstream.~~

~~**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.~~



~~**Figure B-1 Exhaust air discharge velocity (*U*).**~~

~~**Table B-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 B-2 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 that is greater than 45 degrees from the direction of a line drawn from 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*.~~

~~**Table B-3 Minimum Dilution Factors**~~

~~Exhaust Air Class (See Section 5.13)~~	~~Dilution Factor~~
~~Significant contaminant or odor intensity (Class 3)~~	~~15~~
~~Noxious or dangerous particles (Class 4)~~	~~50 [a]~~

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

$$C_{max} < C_{health} \quad (B\text{-}4)$$

$$C_{max} < C_{odor} \quad (B\text{-}5)$$

~~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. The minimum separation distance (L) shall be calculated using Equations B-1 through B-5b.

Informative Note: This standard is accompanied by a spreadsheet that assists with Appendix B calculations.

$$F1 = 13.6\frac{\text{DF} \times Q}{U_H} \qquad \text{(B-1)}$$

$$F2 = 33.37h_s^2 + 254.9\beta\frac{B_{fac} \times h_s \times Q}{d_e \times U_H} + 486.9\beta\left(\frac{B_{fac} \times Q}{d_e \times U_H}\right)^2 \qquad \text{(B-2)}$$

$$B_{fac} = \left\{1 + \left[\frac{15(T_s - T_a)T_s}{T_a^2 \times U_H \times V_e}\right]\right\}^{0.5} \qquad \text{(I-P) (B-3a)}$$

$$B_{fac} = \left\{1 + \left[\frac{580{,}000(T_s - T_a)T_s}{T_a^2 \times U_H \times V_e}\right]\right\}^{0.5} \qquad \text{(SI) (B-3b)}$$

$$V_e = Q/(\pi d_e^2/4) \qquad \text{(B-4)}$$

Find the maximum of $F1 - F2$ by varying U_H between 300 fpm (1.5 m/s) and the maximum wind speed. If local wind speed data is not available, U_H shall be varied from 300 fpm (1.5 m/s) to 2000 fpm (10 m/s).

If the maximum of $[F1 - F2] > 0$, then $L = [F1 - F2]^{0.5}$ (B-5a)

If the maximum of $[F1 - F2] \leq 0$, then $L = 0$ (B-5b)

where:

Q = exhaust airflow rate, cfm (m^3/s). For variable flow, use the minimum airflow rate. For gravity vents, such as plumbing vents, use an exhaust rate of 150 cfm (0.0075 m^3/s). For flue vents from fuel-burning appliances, assume a value of 250 cfm per million Btu/h (0.00043 m^3/s per kW) of combustion input (or obtain actual rates from the combustion appliance manufacturer

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 B-1

L = minimum separation distance (m [ft]) (stretched string as shown in Figure B-1)

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 or below the top of the air intake (m [ft]). Height above the top of the air intake is a positive number; height below the top of the air intake is a negative number

Table B-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 [a]	$2.8 \times p$
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 [b]	$2000 \times e$

a. p is the maximum NOx ppm emitted from the boiler flue. If the maximum NOx ppm is 10 ppm, p = 10 and DF = 28

b. e = 1 - the VOC removal efficiency of the odor filter as defined by manufacturer or the cognizant authority. (e.g. if the filter is 80% efficient, e = 0.2 and DF = 400)

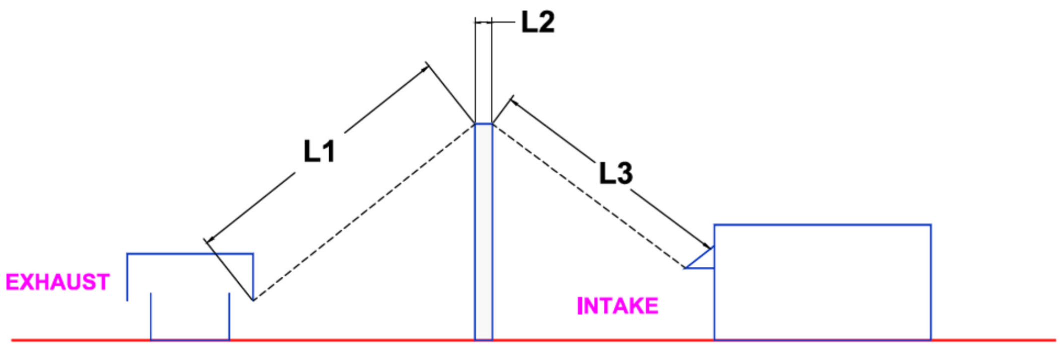


Figure B-1 Diagram showing how to calculate string distance, *L*. In the figure *L* = *L*1 + *L*2 + *L*3.

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:

$$d_{e,eff} = [\text{Exhaust Area} \times 4/\pi]^{0.5} \quad \text{(B-6)}$$

for louvered round or louvered rectangular exhaust (capped, horizontal, or vertical), an equivalent round stack diameter should be calculated using the following equation:

$$d_{e,eff} = [\text{Exhaust Area} \times \text{Open Fraction} \times 4/\pi]^{0.5} \quad \text{(B-7)}$$

for heated capped or heated horizontal exhaust (including louvered), the exhaust diameter prescribed in Section B.2.2.5 applies

β = 1 for uncapped stacks and 0 for capped or horizontal (including louvered) exhaust

Equation B-8a (I-P) or B-8b (SI) shall be used to determine whether the exhaust is considered heated:

$$T_c = 0.00626\left(\frac{v_s^{1/3}}{d_{e,\,eff}^{2/3}}\right)T_s \quad \text{(I-P) (B-8a)}$$

$$T_c = 0.0297\left(\frac{v_s^{1/3}}{d_{e,\,eff}^{2/3}}\right)T_s \quad \text{(SI) (B-8b)}$$

where

T_c = the crossover temperature difference in (K [R]); if $Tc < T_s - T_a$, the exhaust is considered to be heated

v_s = exhaust air discharge velocity (m/s [fpm])

$$v_s = \frac{Q_e}{d_{e,\,eff}}$$

If the exhaust is not considered heated, the exhaust temperature shall be equal to the ambient temperature. Both summer and winter design conditions shall be evaluated.

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 Section 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 on 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). 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 ±45 degrees away from the intake.

B2.2.1.2 Allowable Adjustments. Equations B-9 through B-11 shall be used to adjust the values in Section B2.1.

$$U_{H,pa} = V_e \quad \text{(B-9)}$$

$$\mathrm{DF}_{pa} = \mathrm{DF}/1.7 \quad \text{(B-10)}$$

$$L_{pa} = L/(1.75 \times d_e) \quad \text{(B-11)}$$

B2.2.2 Upblast Exhaust. For upblast exhaust (typically used for kitchen exhaust), the effective exhaust velocity is computed using the dimension "A" for d_e (see Figure B-2) and the exhaust volume flow rate along with Equation B-4.

B2.2.3 Downblast Exhaust. Downblast exhaust (e.g. "mushroom" exhausters) are treated the same as a capped exhaust stack. The input exhaust diameter is "A," as shown in Figure B-2.

Informative Note: If the downblast stack is heated, the method in Section 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 at a similar elevation as the exhaust and on a building sidewall. For hidden intakes, the minimum dilution factor from Table B-1 shall be divided by 2, as shown in Equation B-12:

$$\mathrm{DF}_h = \mathrm{DF}/2 \quad \text{(B-12)}$$

Informative Note: Typically, hidden intakes are located 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 plume rise due to buoyancy effects. For capped heated exhaust, Equations B-13 and B-14 shall be used to calculate the value of $F2$ in Equation B-2.

$$d_e = d_{e,capheat} = 10\ d_{e,eff} \quad \text{(B-13)}$$

$$\beta = 1 \quad \text{(B-14)}$$

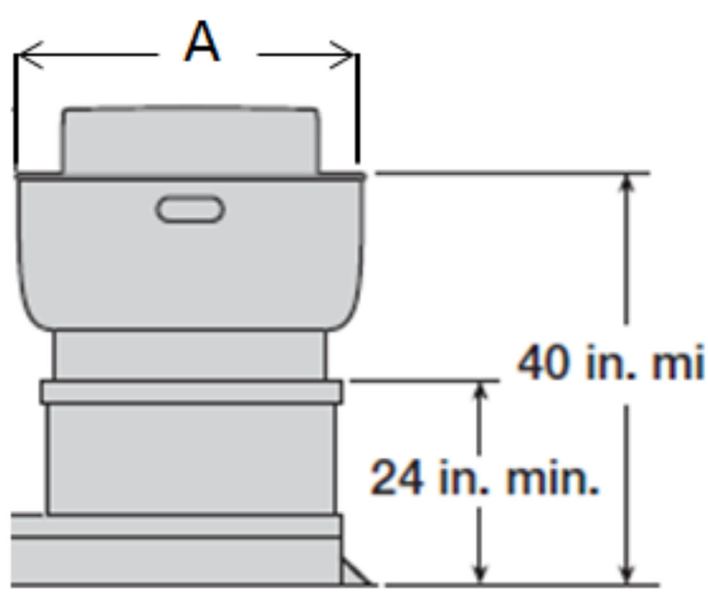


Figure B-2 Typical upblast exhaust.

Modify Informative Appendix P as follows.

		Section
[. . .]		
U.S. Environmental Protection Agency **1200 Pennsylvania Avenue, N.W.** **Washington, D.C. 20460** **(202) 564-4700; www.epa.gov**		
EPA-454/B-95-003B (1995)	User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Vol. 2: Description of Model Algorithms	Normative Appendix B
[. . .]		

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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