



# ADDENDA

**ASHRAE Addenda a, b, c, and d to  
ASHRAE Guideline 10-2011**

# **Interactions Affecting the Achievement of Acceptable Indoor Environments**

Approved by the ASHRAE Standards Committee on June 28, 2014, and by the ASHRAE Board of Directors on July 2, 2014.

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## FOREWORD

*This addendum combines the sections on lighting aspects for consistency with the rest of the guideline.*

**Note:** In this addendum, changes to the current guideline are indicated in the text by underlining (for additions) and ~~striketrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

### Addendum a to Guideline 10-2011

*Modify Sections 7 and 8 as follows.*

## 7. LIGHTING (DAYLIGHT)ILLUMINATION

Studies of illumination usually focus on the distribution of energy by intensity and sometimes by frequency in the visible portion of the electromagnetic spectrum. Energy in the non-visible portion of the electromagnetic spectrum, including both infrared and ultraviolet, can strongly affect occupants, materials, and even chemical, physical, and biological agents in a space. The main focus of most investigations of illumination is on the support provided for task visual performance. In some locations, especially regions more distant from the equator, the absence of daily exposure to bright light can cause seasonal affective disorder (SAD). Brief exposure to very bright lights has been used to counteract this effect (Lewy et al. 1985).

**7.1 Daylight Interactions.** Some studies have found that access to daylight or windows is associated with lower prevalence of SBS symptoms. However, it appears that an important contributor to the measured outcomes is access to views to the outside. In one study, researchers found that the larger the view available from occupants' desks, the fewer complaints the occupants had about all other ambient factors, regardless of objective measurements of those conditions (Heschong Mahone Group 2003).

**7.2 Daylight—Electrical Lighting Interactions.** Light from either an electric or a daylight source is necessary for use of most building spaces. The spectral distribution and intensity will affect people's responses to the light in a space. Light can affect mood and performance. Proper color rendition is necessary for artists and textile and other product designers, as well as medical diagnostics and many other tasks, including personal hygiene.

**7.3 Daylight—Acoustical Interactions.** When uninsulated single-pane glazing open windows or skylights are used to admit daylight, noise can enter and be a significant disturbance to occupants. Such noise may interfere with proper task performance. In addition, the hard resonant surfaces of large areas of glass may increase the reverberation time in a space and should be considered in acoustic design.

Some skylights can amplify the sound of rain and hail striking the panels.

Visual access to a noise source may increase, or reduce, its acceptability. Noises that do not have a clear source or cause may be more disturbing than those that are easily understood via visual cues. Thus, a view to the outside that includes the noise source may actually reduce disturbance from the noise. This is especially true of unpredictable noises, such as those from construction sites or emergency vehicles, that in the absence of further information might suggest danger.

**Implications:** Operable windows should be located away from outdoor noise sources and be provided with some means to dampen incoming noise when noise sources are unavoidable. Consider locating activities that require quiet environmental conditions away from outdoor and indoor noise sources.

## 8. LIGHTING (ELECTRIC)

**7.4 Electric Lighting (Electric)—Acoustical Interactions.** Electric lighting fixtures emit sound that can be audible and even loud enough to be annoying, especially light sources that depend on electromagnetic ballasts, e.g., gaseous discharge lamps such as fluorescent or metal vapor. In extreme cases, noise from electrical devices can interfere with proper task performance. Often the primary surface providing acoustical absorption within a room is the ceiling, since acoustical ceiling tile is generally the lowest-cost material available to control reverberation time within a room. Typical recessed luminaires (installed in the ceiling grid) tend to occupy approximately 15% of the ceiling surface, thus limiting the available space for the application of ceiling tile to control reverberation. It can be better to use pendant luminaires that do not occupy the ceiling plane and that, when used with highlight-reflectance ceiling tile, provide high levels of indirect lighting without substantial glare.

**Implications:** Designers should select light sources whose noise emissions are compatible with the functions of the space. For example, in a library, theatre, or study hall, especially quiet light sources are more appropriate. However, in a bar or nightclub, there will usually be many sources of noise besides the illumination; thus, quiet illumination sources are not as critical as in an office or conference room or classroom where verbal communication is critical to the use of the space. Guidance on appropriate noise levels in classrooms is available from the Acoustical Society of America's ANSI/ASA S12.60 for classroom acoustics (ASA 2002).

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## FOREWORD

*This addendum adds a practical example of indoor air quality acoustical environment interaction.*

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### Addendum b to Guideline 10-2011

*Modify Section 6.6 as follows.*

**6.6 Indoor Air Quality—Acoustical Environment.** The primary ways to achieve IAQ include the use of ventilation, either mechanically with equipment or passively through window openings. Mechanical ventilation is often accompanied by the noise of fans, airflow through duct elbows and branches, mixing boxes, dampers, and diffusers or even the sounds of air leakage from the ductwork or other system components. This HVAC noise will generally be dominated by

low-frequency sound, which may in extreme cases even induce secondary vibration in walls, floors, and other surfaces (in addition to that caused by improperly isolated or mounted equipment). See *Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning* (ASHRAE 2009a) for a more detailed discussion.

If ventilation equipment is noisy, it may not be used as intended by the designer. For example, teachers tend not to operate noisy unit ventilators in their classrooms, resulting in reduced outdoor air ventilation and increased indoor source pollutants. Home occupants tend not to operate noisy bathroom or kitchen fans, resulting in a buildup of moisture, combustion gases, or other products and by-products of activities conducted in the home. Because of this interaction, Standard 62.2 requires quiet fans to achieve its IAQ objective.

Passive control of IAQ is often attempted with the use of operable windows. Opening windows to “get some fresh air” may not be an option where noise enters a space from outdoors. In busy urban areas or areas adjacent to highways, railways, airports, playgrounds, or factories, the ambient noise levels can deter people from opening windows. But it should be recognized that the primary purpose of a window is to let daylight in while providing visual relief by making it possible for occupants to see outside. It is not necessary to use operable windows to allow outdoor air entry; an acoustical plenum or acoustical louvers can be used in conjunction with a window (above, below, or to the side) to allow outdoor air entry without allowing noise to enter.

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## FOREWORD

*This addendum adds new wording indicating that minimizing an exposure is typically but not necessarily always the best control.*

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### Addendum c to Guideline 10-2011

*Modify Section 4.11 as follows.*

**4.11 Control of Interactions by Limiting Exposures.** The magnitude of the effects of the interactions among the environmental components can be much reduced by limiting the extent to which each component departs from its optimum

level. For example, cancer can be caused by single environmental agents or by combinations of agents. Two substances that are both carcinogenic to the same target organ can result in a larger effect than the two separately. The importance of minimizing the concentrations of both pollutants is evident: doing so will minimize both their individual effects and their harmful interaction. It is also possible for a nontoxic substance to increase the risk of cancer from a known carcinogen so that even low-level exposure to the carcinogen can be potentially far more hazardous.

It follows that minimizing all pollutants or other environmental stresses (total environmental load) ~~will~~ may reduce the likelihood of interactions that result in an unacceptable indoor environment. This advice applies to air pollutants (chemical, physical, and biological), lighting-related issues (glare, luminance distribution, and color issues), noise (loud and/or unpleasant sounds), and thermal conditions that are far from the central range of thermally acceptable conditions. Whenever one factor is emphasized to create a high-performance or interesting indoor environment, its interactions deserve additional scrutiny. However, the desired impact may not occur if the interaction is antagonistic, as described in Section 4.7. The type of interaction (per Section 4.7) will determine whether minimizing is appropriate.

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## FOREWORD

This addendum simplifies definitions by removing non-definition text, and adds definitions for the four primary factors with which this guideline is concerned.

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### Addendum d to Guideline 10-2011

Modify Section 3 as follows.

## 3. DEFINITIONS

**acceptable indoor environment:** an environment that has been determined to be acceptable according to the process that defines acceptability and the individuals involved in this process. Acceptability of an indoor environment is the determination of any affected party that the environment is suitable for the purposes of the intended occupancy. It should be noted that acceptability is not identical with the satisfaction of most or all occupants, which would generally require a somewhat higher level of environmental quality. Ultimately, acceptability defined by the process used to determine it as well as by the individuals who make the evaluations, assessments, or judgments that are part of the process. These individuals decide what is acceptable for them, whether they are occupants, operators, owners, or visitors. This guideline recognizes that individual acceptability is often dependent on context and on cultural expectations.

**Informative Note:** The meaning of *acceptability* depends on the criteria and the process that is applied to perform the determination. This is influenced by the individuals involved in this process (e.g., occupants, building operators, owners, and visitors) along with relevant health and other standards. These different individuals may render diverse determinations. Acceptability of an indoor environment is the determination of any affected party that the environment is suitable for the purposes of the intended occupancy.

It should be noted that acceptability is not identical to the satisfaction of most or all occupants, which would generally require a somewhat higher level of environmental quality. Ultimately, acceptability is defined by the process used to determine it, as well as by the individuals who make the evaluations, assessments, or judgments that are part of the process. This guideline recognizes that individual acceptability is often dependent on context and on cultural expectations.

**acoustic environment:** the sound and vibration conditions in a space.

**aspect:** the components that make up an environmental factor.

**enthalpy:** the integrated representation of the dry-bulb and wet-bulb condition of the air that describes the total energy content of the air. Enthalpy may also be defined as the thermodynamic quantity equal to the sum of the internal energy of a system plus the product of the pressure-volume work done on the system.

**factor:** the major features aspects of the indoor environment that affect its acceptability as addressed in this guideline are termed *factors*. This guideline identifies four factors—indoor air quality (IAQ), thermal environment, mechanical energy (especially sound and vibration), and electromagnetic radiation (especially light)—as the major categories that classify or characterize different elements of the indoor environment. Separate aspects of the environment may combine to form perceptions of the light, air quality, acoustic, and thermal conditions of the indoor environment.

**illumination:** nonionizing radiation in the visible portion of the electromagnetic spectrum.

**indoor air quality:** the measurable physical, chemical, and biological composition of air in a space compared with reference values for its components, the acceptability of the air to occupants, and the total composition of the air whether detectable or not.

**indoor environment:** the conditions that exist inside an enclosed, non-industrial building intended for human occupancy.

**interaction:** the combined effect on a building occupant of two or more environmental factors or their aspects.

**pollutant:** as defined in this guideline, a pollutant is any unwanted environmental component that is present in an occupied building space. For example, loud sound (music, speech, motors, etc.) that interferes with a desired function of a space such as conversation, a lecture, or other activity with audible content essential to its success is considered *sound pollution* (usually referred to as *noise*). However, what may be perceived as noise by one person may be considered desirable by another, as in the case of music where taste and personal preferences differ for loudness (sound intensity). Both disability glare (lighting that interferes with occupants' ability to see) and discomfort glare (lighting that causes discomfort for the occupants) could be considered undesirable components in the built environment. Here, too, individual preferences can be important. Contaminants in air are commonly referred to as *air pollutants*. No equivalent concept exists for thermal conditions inside buildings, but thermal pollution of water occurs at power plants where cooling water is released into a water body and adversely affects aquatic life.

**Informative Note:** What is “unwanted” will vary with the use of a space and the individual users. For example, loud sound (music, speech, motors, etc.) that interferes with a desired function of a space, such as conversation, a lecture, or other activity with audible content essential to its success, is considered sound pollution (usually referred to as *noise*). However, what may be perceived as noise by one person may be considered desirable by another, as in the case of music, where taste and personal preference differ for loudness (sound intensity). Differences in auditory acuity will also affect perceptions of acoustic conditions as visual acuity.

olfactory sensitivity, and tolerance or preference for thermal conditions will affect perceptions of thermal comfort.

Both disability glare (lighting that interferes with occupants' ability to see), discomfort glare (lighting that causes discomfort for the occupants), and color spectrum could be considered undesirable components in the built environment. Here, too, individual preferences can be important. Contaminants in air are commonly referred to as *air pollutants*. No

equivalent concept exists for thermal conditions inside buildings, but thermal pollution of water occurs at power plants where cooling water is released into a water body and adversely affects aquatic life.

***thermal environment***: the combined effect of the temperature, humidity, air movement, and thermal radiation in a space.



## **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.

