A UTC Fire & Security Company

Handbook of Visual Notification Appliances for Fire Alarm Applications

A practical guide to regulatory compliance

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Foreword

As traditional boundaries between building systems become blurred by advances in integrated approaches, it becomes increasingly important for everyone concerned with building design and construction to have a thorough understanding of life safety equipment application. Now that security and access control functions are sharing resources with life safety systems, it is no longer possible to design and install building systems in isolation of one another. Today unified building control requires a broad base of knowledge that encompasses a wide range of building control functions.

Whether your background is in life safety, security, or access control, the success of every building system installation will ultimately rest on the effectiveness of the building's emergency warning system. Yet the application of life safety notification appliances is one of the least understood elements of building system design and installation today.

These devices hold a special place because they are not only subject to the requirements of building codes and life safety standards; they are subject to federal laws as well. Complicating matters further, these laws address signaling from entirely different points of view. Life safety standards are written in the context of fire alarm application, while accessibility laws are enacted to make buildings (and their emergency signals) accessible to all building occupants, regardless of the physical challenges they face. Much of the confusion that surrounds the application of notification appliances lies where these standards and laws converge.

This handbook will help system designers and installers identify those points of convergence in order to gain an understanding of how the requirements fit together. It will bridge the gap between legislation and practice. And it will provide readers with an overview of the changing nature of notification appliances and the laws that govern their application.

At Edwards we believe that the best notification appliances are the ones that are applied to provide the most efficient means of warning and installed to deliver the greatest level of performance. We also recognize that competitive bidding is essential to achieving these goals. This handbook will demonstrate that, despite the inherent complexities, it is possible to apply life safety notification appliances so that they are effective, efficient, economical, and compliant with all the prevailing legislation.

Contents

1. The Legislative Landscape

No compliance strategy for visual notification appliances can be effectively formulated without a solid understanding of the principles that underlie visual signaling and the laws that govern their application. This chapter provides an overview that provides the basis for further discussion on visual signaling application in the context of current standards and regulations.

What are visual notification appliances?

Visual notification appliances are fire alarm devices that provide visual notification of a life safety system event. Generally speaking, there are two kinds of directly viewed visual notification appliances: those that operate in private mode and those that operate in public mode.

Private mode signaling is intended to alert and inform only those who are directly involved with the response to an emergency situation. Such individuals include firefighters, security personnel, and others who are familiar with the operation of the fire alarm system. Private mode visual signaling is generally not intended to compensate for hearing impairment or high ambient noise conditions.

Public mode signaling is intended to provide building occupants with adequate warning of danger so that they can exit the premises safely. Public mode signaling appliances serve a very different purpose from their private mode counterparts. In the public mode, signals must be unambiguous, easily recognizable by people who have little or no knowledge of fire alarm systems, and able to reach all occupants of the building. Visual signals were developed primarily as a means to provide emergency warning to individuals who would not normally hear audible signals such as a horns, bells, or speakers.

The function of a visual notification device is accomplished by means of a strobe set to flash at a prescribed frequency, or flash rate. Strobe devices are usually marked with the word "FIRE", or a pictogram communicating the purpose of the device, and are frequently found in combination with audible signals. This handbook focuses on the standards and codes governing the application of visual notification appliances, also referred to as visual signals, operating in the public mode.

Why are visual notification appliances needed?

An estimated one in 125 Americans suffers from profound hearing loss (i.e.: they can hear little or no sound).[1] This is a significant portion of the population that would certainly benefit from alarm strobes in the event of an emergency.

But hearing loss doesn't have to be absolute to render audible signals ineffective. Today, one in 11 Americans suffers some form of hearing impairment. Even partial hearing loss can interfere with the ability to identify an audible signal.[2] Making audible signals louder to accommodate hearing-impaired individuals is not a reasonable option because doing so could result in signals that produce sound pressure levels that cross the pain threshold and that could cause permanent damage to the hearing of people who suffer no impairment.

While visual notification appliances find their justification among the statistics of America's hearing impaired today, it's highly unlikely that we'll find any relief in those statistics in the years to come. Quite the opposite is true. It's no secret that hearing acuteness decreases with age. In fact, we all lose a decibel of hearing acuity each year past the age of 35.[3] As the percentage of our population reaching their senior years continues to swell over the next two decades, so too will the proportion of those who find it increasingly difficult to hear audible signals.

[1] "Self Help for Hard of Hearing People," Hearing Loss Journal, http://codi.buffalo.edu/graph_based/.demographics/.statistics

[2] Ibid.

[3] Ibid.

Hearing impairment is not the only factor that establishes a need for visual signals. Industrial and other settings with high ambient noise levels affect the ability of even those with no impairments to hear emergency signals. Factories, warehouses, even nightclubs and theatres frequently have sound levels that conspire to render audible signals ineffective. Workers wearing sound attenuating headsets or ear plugs risk missing audible alarm signals, not only because the headsets cut down on the sound reaching their ears, but also because their work conditions make them likely candidates for noise-induced hearing loss, which when coupled with sound attenuating headsets makes it even more difficult to hear audible warnings.

How long have visual notification appliances been in use?

While audible signals have been required by codes and standards for nearly one hundred years, visual signals are a relatively recent development. It was not until 1980 that requirements for visual signals made their first appearance in building codes. Early requirements stipulated the use of flashing lights at exit signs. This limited their usefulness to points of exit and routes along the way, doing little to alert people who weren't already on the move that danger was imminent.

In 1990 President Bush signed the Americans with Disabilities Act (ADA), watershed legislation that provides comprehensive civil rights protection to individuals with disabilities. This had an enormous impact on the way buildings are designed and opened the door for significant changes in the way alarm systems are required to operate. The ADA moved the use of visual notification appliances from the relative obscurity of a handful of accessibility codes to the forefront of alarm system design practically overnight. With it came the prescribed use of the now-familiar xenon strobe that is a fixture of buildings throughout America.

What types of buildings are subject to ADA requirements?

The ADA applies to buildings characterized as either Commercial Facilities or Public Accommodations.[4] Commercial Facilities include offices, factories, and other buildings housing private entities that affect commerce. Public Accommodations include facilities that are privately operated and fall within one or more of the following 12 categories:

[4] Code of Federal Regulations, Department of Justice, 28 CFR Part 36 (Rev. July 1, 1994), 36.104.

1) Places of lodging (e.g., inns, hotels, motels) (except for owner-occupied establishments renting fewer than six rooms);
2) Establishments serving food or drink (e.g., restaurants and bars);
3) Places of exhibition or entertainment (e.g., theaters, concert halls, stadiums);
4) Places of public gathering (e.g., auditoriums, convention centers, lecture halls);
5) Sales or rental establishments (e.g., bakeries, grocery stores, hardware stores, shopping centers);
6) Service establishments (e.g., laundromats, dry-cleaners, banks, barber shops, beauty shops, travel services, shoe repair services, funeral parlors, gas stations, offices of accountants or lawyers, pharmacies, insurance offices, professional offices of health care providers, hospitals);
7) Public transportation terminals, depots, or stations (not including facilities relating to air transportation);
8) Places of public display or collection (e.g., museums, libraries, galleries);
9) Places of recreation (e.g., parks, zoos, amusement parks);
10) Places of education (e.g., nursery schools, elementary, secondary, undergraduate, or postgraduate private schools);

11) Social service center establishments (e.g., day care centers, senior citizen centers, homeless shelters, food banks, adoption agencies); and
12) Places of exercise or recreation (e.g., gymnasiums, health spas, bowling alleys, golf courses).

Given this broad range of facilities, a building designer would be hard-pressed to find an application to which ADA requirements don't apply. It's safe to say then, that nearly every building that goes up in America today is subject to the obligations set out in the ADA.

Where in these buildings must visual notification appliances be installed?

Despite its all-encompassing requirements, the ADA does not specify the areas within a Commercial Facility or Public Accommodation that must be covered by visual signals. It merely states that where an emergency warning system is provided, it must have a visible component and that this visible component meet the standards set out in the ADA Accessibility Guidelines (ADAAG) drafted by the Architectural and Transportation Barriers Compliance Board, also known as the Access Board.[5]

The Accessibility Guidelines require that wherever an emergency warning system is provided, equivalent warning must be provided to all occupants and potential occupants of common spaces such as washrooms, hallways, classrooms, lobbies, meeting rooms, and other areas where occupancy cannot be predicted.[6] This means that, even though people who suffer no hearing impairments may generally occupy a common space, the potential for a person to be in one of these areas, especially if there is a chance they will be unaccompanied, necessitates the use of visual signals.

[5] ADA Accessibility Guidelines for Buildings and Facilities, U.S. Architectural and Transportation Barriers Compliance Board, 4.1.3 (14).

[6] ADA Accessibility Guidelines for Buildings and Facilities, U.S. Architectural and Transportation Barriers Compliance Board, 4.28.1.

Whether or not any particular building requires a fire alarm system generally falls under the responsibility of your local Authority Having Jurisdiction (AHJ). AHJs include fire marshals, building inspectors and other state and local agencies that administer regulations concerning building construction or renovation. Local and national building codes may require both audible and visible signaling in buildings that are outfitted with fire alarm systems.

All Public Accommodations and Commercial Facilities as defined in the ADA require some form of life safety protection. So it's a pretty safe bet that if you're designing a new building that meets the criteria for a Commercial Facility or Public Accommodation, or if you're planning an addition or renovations to an existing one, you'll have to include visual signals as part of its life safety system.

In addition to AHJs, insurance companies underwriting the building may have life safety requirements as well. These requirements sometimes exceed those of the local AHJ.

Note: Any requirement for an emergency warning system, whether it stems from your AHJ or not, automatically triggers ADA compliance with respect to visual signals.

If my AHJ approves the system, does that mean it complies with ADA?

Not necessarily. Your AHJ should be well versed in the requirements of ADA and will no doubt enthusiastically point out any deficiencies that are apparent. But the ADA is a federal statute based in civil law and as such transcends local regulations. The building owner is still exposed to litigation as a result of deficiencies in ADA compliance – even if the life safety system meets local building code requirements.[7]

Some local jurisdictions have adopted local laws with the same language as the ADA. This allows them to essentially enforce the text of the ADA as any

[7] Based on civil law, the ADA is enforced by means of litigation, not prosecution. Courts may levy civil penalties only in cases brought by the Department of Justice, not private litigants. Civil penalties of $55,000 for the first offense and $110,000 for subsequent offenses may be levied. (source: http://www.ada.gov/julsep07.pdf)

other code. Similarly, the model codes have sought to bring themselves into alignment with the ADAAG. Additionally, equivalent facilitation can only be determined by a Federal trial after the system is installed. However, most designers have used NFPA 72, *National Fire Alarm Code* as equivalent facilitation to comply with the ADA.

Where the ADA is violated, the United States Department Of Justice (DOJ) will prosecute the offenders on behalf of the plaintiff. Penalties can be as much as $50k to $100k, therefore, owners have a great incentive to comply with the ADA.

Where are visual signals not required by ADA?

Visual signals are not required where occupancy can be predicted. That is, in private areas intended for the use of specific individuals who are known not to suffer from hearing impairment.[8] Such areas include single offices and workstations, mechanical rooms, kiosks and control booths that are not for common use. However, the ADA requires that any of these private use spaces that are occupied by individuals known to have hearing impairments must accommodate their disability by means of visual warning signals.[9]

Special provision has also been made in the Accessibility Guidelines for hospital settings, specifically wards and patient rooms.[10] The Access Board acknowledges that, where a supervised emergency evacuation plan is in place, it is usually not desirable to install alarms in patient rooms. It is reasoned that emergency signals in these settings could cause distress and threaten the well-being of the occupants, especially those who should not attempt to exit their rooms without assistance. Instead, private mode alarm systems alert caregivers to an emergency and they are responsible for ensuring patients are moved to a safe location if necessary.

In addition to the special circumstances described above, the ADA specifically exempts private clubs (unless they cater to the patrons of a Public

[8] "Visual Alarms," U.S. Architectural and Transportation Barriers Compliance Board Bulletin #2, December 1992.

[9] The Americans with Disabilities Act (ADA) requires employers to make reasonable accommodation for a qualified individual with a known physical or mental disability. (ADA: Section 1630.2(o) Reasonable accommodation).

[10] ADA Accessibility Guidelines for Buildings and Facilities, U.S. Architectural and Transportation Barriers Compliance Board, 4.1.3 (14).

[11] Code of Federal Regulations, Department of Justice, 28 CFR Part 36, (Rev. July 1, 1994), 36.104.

[12] ADA Accessibility Guidelines for Buildings and Facilities, U.S. Architectural and Transportation Barriers Compliance Board, 4.1.6.

Accommodation), religious entities and public entities. Several applications are exempt from ADA requirements because they fall under the influence of other accessibility legislation. These include: federal buildings including the Postal Service (Architectural Barriers Act and Rehabilitation Act); public housing facilities administered by the Housing and Urban Development program (Fair Housing Act), and; railroads (Federal Railroad Safety Act).[11] Aircraft, correctional facilities and military installations are not subject to ADA Accessibility Guidelines. Nor are private single-unit dwellings.

Are building renovations subject to ADA requirements for visual signals?

If renovations involve the alteration or upgrading of all or part of the fire alarm system, then visual signals are required in all affected areas.[12] Replacing a defective detector or circuit card is not a retrofit. Nor is any activity normally associated with routine maintenance. But if fire alarm components are upgraded, replaced, or relocated to accommodate a change in use or floor plan, then provision must be made to include visual signals. Similarly, if the AHJ orders a retrofit of an existing system to meet local building codes, then visual signals must be part of that retrofit, whether or not they are an explicit part of that order.

If only a small part of the system has been changed, it's not required that the entire building's life safety system be retrofitted to include visual signals. At a minimum, only the areas affected by the renovations need to be brought into compliance with the ADA Accessibility Guidelines – as well as adjacent escape routes that would normally be used during an emergency situation.

For example, a wall has been opened up in a small office building in order to create a meeting room where two offices once were. The Fire Marshal determines that the new room needs to be fitted with smoke detectors. He concludes that the horn in the adjacent hallway provides a strong enough audible signal to serve the new meeting room. Because the alarm system has been modified to accommodate the change in occupancy, the renovation is subject to ADA requirements. This means that suitable visual signals need to be installed in the meeting room, the adjacent hallway, and the adjoining reception area, which provides the primary means of escape from the building.

Your AHJ does not need to wait for renovations to order the installation of visual signal appliances. Depending on local codes and ordinances, visual signals may be required by local authorities before they are mandated by the ADA. Regardless of the means by which the visual signals were required, however, once they have been ordered, they must meet ADA requirements as well as those outlined in any other standards and codes referenced by building regulations.

What standards specifically govern the use of visual signals?

The ADA addresses visual signals through its Accessibility Guidelines. These guidelines are a set of requirements drafted by the Access Board that cover the placement, spacing, and coverage of strobes. Requirements also cover technical issues such as flash intensity and duration. The Accessibility Guidelines must be met in order to achieve ADA compliance.

In addition to the ADA, there are four standards commonly referenced in local building codes and ordinances. By referencing all or part of a standard, the AHJ makes the provisions of the standard mandatory in that jurisdiction. Each of these standards has overlapping interests in visual signals. Each one serves a different purpose and has its own unique characteristics.

The *National Fire Alarm Code* (NFPA 72) covers the application, installation, performance and maintenance of fire alarm systems and their components. NFPA 72, *National Fire Alarm Code* does not dictate the use of occupant notification. Visible notification appliances are often required by other codes such as NFPA 101, *Life Safety Code* and local building codes, and insurance requirements. By law, all fire alarm systems and components

– whether required by local authorities or not – must meet its requirements.[13] Chapter Seven of the 2007 edition of NFPA 72 outlines the requirements for notification appliances. Most of this chapter is devoted to describing the requirements for visual signals, their placement, application, and performance. Similar requirements are outlined in the ADA's Accessibility Guidelines.

Accessible and Usable Buildings and Facilities (ANSI 117.1), is an accessibility standard administered by the American National Standard Institute and currently published by the International Code Council. First published in 1961, this standard was the first to establish comprehensive guidelines for accessible buildings. The importance of ANSI 117.1 has been somewhat eclipsed by the enactment of the ADA and the requirements of its associated guidelines. But ANSI 117.1 remains the accessibility standard of choice in many jurisdictions. Like NFPA 72 and ADA, this standard describes the placement, performance, and application of visual signals, and when referenced in local building codes, its requirements are also mandatory.

Standard for Safety Signaling Devices for the Hearing Impaired (UL 1971) is a performance standard published by Underwriters Laboratories. UL 1971 sets out performance criteria for fire alarm strobes. UL then tests products submitted by manufacturers in controlled settings to determine whether they meet the criteria prescribed by the standard. If they do meet those criteria, the product is listed to that standard. NFPA 72 and ANSI 117.1 have adopted UL 1971 strobe performance specifications in their entirety. These specifications are accepted as the standard by which effective strobe installations are judged. UL 1971 specifies requirements for minimum light output for both sleeping and non-sleeping areas, minimum horizontal and vertical light output dispersion and minimum sustained light output. Strobes not listed to UL 1971 may perform adequately for the application, but in the absence of quantifiable evidence to support such a claim, your AHJ will probably not allow their use.

[13] Wayne D. Moore and Lee F. Richardson, National Fire Alarm Code Handbook, NFPA 2007.

Standard for Safety for Visible Signaling Appliances – Private Mode Emergency and General Utility Signaling (UL 1638) is a performance standard similar in intent to UL 1971 that deals with visual signals operating in the private mode and signals intended for outdoor use. Private mode signals are intended to reach only those directly concerned with the implementation of emergency action. These signals are usually found in areas not in common use as defined by the ADA, and therefore are not subject to its requirements – unless the usual occupant of the area is known to suffer a hearing impairment. While the bulk of UL 1638 does not apply to public mode signaling, the measurement of light output it outlines does. UL 1971 derives much of its measurement criteria from the private mode standard.

How do I know whether a fire alarm system requires visual signals?

While all fire alarm systems must meet NFPA 72 requirements, NFPA 72 doesn't mandate visual signals, except in high noise areas (over 105 dBA). Local and national building codes will determine what occupancy types or use groups require fire alarm signals. The ADA doesn't require the use of notification appliances. But it does require visual signals wherever an audible emergency warning system is in place. From this you can draw the following corollary for buildings subject to ADA requirements:

> If you have a fire alarm system, it must meet NFPA requirements.
> If it meets NFPA requirements, it must have an emergency notification component.
> If it has an emergency notification component, it must meet ADA requirements.
> If it meets ADA requirements it must have visual signals.
> Therefore, if you have a fire alarm system it must have visual signals.

Fire alarm applications in jurisdictions that reference ANSI 117.1 are obliged to comply with that standard as well as NFPA 72 and the ADA Accessibility Guidelines. Furthermore, because NFPA and ANSI 117.1 have accepted UL 1971 as the standard by which effective strobe installations are judged, it can also be said that all fire alarm systems must have UL 1971-listed visual signals.[14]

[14] NFPA 72, National Fire Alarm Code, 7.5.3, 2007 Edition requires all visible signaling appliances used for occupant notification to comply with the polar dispersion requirements of ANSI/UL 1971, Standard for Safety Signaling Devices for Hearing Impaired, or equivalent.

What are the requirements for visual signals?

NFPA 72, the ADA Accessibility Guidelines, and ANSI 117.1 all include requirements that address the following:

- **Signal characteristics.** The operating characteristics of visual signals determine how room occupants will see them. These characteristics include the color of the light, how bright it is, how long each flash lasts, and the period of time between flashes.
- **Signal placement.** The placement of visual signals is the key to effective signaling. Not surprisingly, a central requirement among all the standards is that visual signals be visible. Simply installing strobes wherever audible signals would normally be placed is not sufficient. Unlike audible signals, output from visual notification appliances cannot pass through walls or doors. Where a horn installed in a hallway can be heard in adjacent rooms, a strobe would be invisible behind a closed door. This makes it necessary to provide more comprehensive strobe coverage than is necessary with audible signals.
- **Signal Coverage.** The flash intensity and the spacing of strobes need to be finely balanced to provide adequate signaling throughout the coverage area. All three standards require that the flash from a strobe raise the light level in the protected area sharply, but not to the point

where the intensity is unsafe. Flashes that are too bright or long in duration could temporarily blind room occupants. Flashes too distant or weak could go unnoticed, especially in brightly lit or sunny rooms. This makes the choice of strobes and their placement critical factors, particularly in large rooms and hallways.

- **Room use.** Sleeping rooms such as hotel rooms and dormitories have different performance requirements for visual signals. This is because a visual signal in a sleeping room must be of sufficient intensity to awaken the occupant.

Are visual signaling requirements the same in all three standards?

In a perfect world they would be. But our world is far from perfect. It must be understood, however, that NFPA 72 serves a very different purpose from the ADA Accessibility Guidelines and ANSI 117.1. It was developed in the context of fire alarm system application and performance. The two accessibility standards, on the other hand, were written to address the needs of people with disabilities. This is not to say that the two kinds of standards work at cross-purpose to one another, merely that they focus on different aspects of building construction.

It is generally acknowledged that NFPA 72 provides the most definitive and effective means of providing visual signaling with regard to signal characteristics, placement, coverage, and room use. In fact, the latest revision of ANSI 117.1 brings itself in line with NFPA 72, and the ADA Accessibility Guidelines are currently in revision. It is expected that they will adopt similar, if not identical, requirements to those specified in NFPA 72.

In the meantime however, there remains some disparity among the three standards. And while it may seem as if across-the-board compliance is an elusive goal, by following the guidelines in this handbook it is easily achievable.

Is it possible to comply with all these standards even though they have different requirements?

Yes. The paradox of conflicting standards is undone by the magic of equivalent facilitation. Equivalent facilitation is a caveat to the ADA that acknowledges there may be better ways of doing things than those outlined in the standard.

While ANSI 117.1 does not explicitly deal with equivalent facilitation, it does reference NFPA 72 as an authoritative source of supplementary information regarding the location of visual signals, thereby acknowledging that the fire alarm code may be used to satisfy ANSI requirements where those requirements fall short.

Given the fact that NFPA 72 is widely regarded as the most comprehensive standard covering visual signals, and that ADA is likely to harmonize itself with NFPA 72 in the near future, it makes good sense to plan a compliance strategy that focuses on the *National Fire Alarm Code*. Equivalent facilitation makes this the wisest course of action in both the short and the long term.

Also, keep in mind that when reconciling any applicable standards the most stringent requirement applies.[15] For example, if ADA specifies a maximum flash rate of three per second, but NFPA 72 says two per second is the most it will allow, then NFPA 72, being the most stringent standard in this respect, prevails.

[15] Code of Federal Regulations, Department of Justice, 28 CFR Part 36 (Rev. July 1, 1994), 36.103.

2. A comparison of standards requirements

Understanding the three prevailing standards, and working effectively within their bounds, requires a solid familiarity with the terms and concepts they use. Though the standards are not difficult to read on their own, certain points they raise call for explanation beyond what is found in the texts themselves. This is especially true when dealing with NFPA 72, ANSI 117.1, and ADA as a single set of requirements that affects the placement of visual notification appliances. This chapter summarizes key elements of the three prevailing standards and offers a method for reconciling what sometimes appear to be contradictory requirements among them.

The table on the following page is an overview of current and proposed standards that affect public mode strobe application. It is important to note that at the time of this writing, the ADA is in the final stages of revision, and public comment. When public hearings are completed in the recommendations of the Access Board will begin their final journey into law. While every indication points to a set of guidelines that is harmonized with NFPA and ANSI, until the recommendations are enacted by Congress, current ADA requirements must be considered valid and binding.

Shaded areas in the chart below represent requirements that prevail because they are the most stringent or comprehensive. Heavily shaded areas (requirements affected by the ADAAG's 75 cd requirement) represent the remaining issues to which equivalentfacilitation commonly applies.

Summary of Standards: Public Mode Strobe Application

	NFPA 72	ANSI 117.1	Proposed ADA Guidelines	Current ADA Guidelines
2.1 Photometric Features				
2.1.1 Lamp type	Xenon (UL 1971)	Xenon strobe type or equivalent		
2.1.2 Light characteristics	Clear or nominal white			
2.1.3 Maximum flash rate	2 flashes per second			3 flashes/ second
2.1.4 Minimum flash rate	1 flash per second			
2.1.5 Maximum pulse duration	0.2 seconds			
2.1.6 Maximum duty cycle	40 per cent			
2.2 Flash Intensity				
2.2.1 Minimum flash intensity (non-sleeping rooms)	15 cd (effective)			75 cd (at 50 feet maximum)
2.2.2 Minimum flash intensity (sleeping rooms)	110 cd (effective) if the strobe is more than 24” from ceiling 177 cd (effective) if the strobe is less than 24” from ceiling			75 cd (at 50 feet maximum)
2.3 Vertical Placement (wall mounted strobes)				
2.3.1 Min. height above floor	80 inches			80” above floor 6” below ceiling
2.3.2 Max. height above floor	96 inches			
2.4 Corridors (maximum 20 feet wide)				
2.4.1 Maximum distance between strobes	100 feet			
2.4.2 Minimum flash intensity	15 cd (effective)			75 cd (at 50’ max.)
2.4.3 Maximum distance from each end of corridor	15 feet			Not specified
2.4.4 Minimum distance between strobes	Not specified	50 feet (details on page 21)		
2.5 Room Spacing				
2.5.1 Wall-mounted	See Allocation Table 2.5.1			Maximum 50’ from any point in room
2.5.2 Ceiling-mounted	See Allocation Table 2.5.2			
2.5.3 Sleeping Rooms	Maximum 16 feet from the pillow	Maximum 16 feet from the head of the bed		Maximum 50’ from any point in room

Legend: Prevailing Requirement | Equivalent (see p. 20)

In order to fully understand the effects that code requirements have on strobe placement and application, it's important to be familiar with the terms and concepts they use to describe these requirements. The following explanations detail the necessary framework for proper interpretation.

2.1 Photometric features

	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.1.1 Lamp type	Xenon (UL 1971)	Xenon strobe type or equivalent		

The xenon strobe specified by the ADA Guidelines and ANSI 117.1 refers to the familiar flash strobe in common use today. This strobe comprises a clear glass tube filled with xenon gas that illuminates quickly and brightly when an electrical current is applied. The effect is similar to a camera flash.

	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.1.2 Light characteristics	Clear or nominal white			

All three standards specify clear or nominal white light. Research sponsored by the Access Board found that white light was most visible. Colored flashes, particularly red, are judged to be ineffective at high intensities. Therefore, only white light is acceptable.[16]

[16] "Visual Alarms," U.S. Architectural and Transportation Barriers Compliance Board Bulletin #2, December 1992.

Flash rates	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.1.3 Maximum flash rate	2 flashes per second			3 flashes/ second
2.1.4 Minimum flash rate	1 flash per second			

The flash rate represents the number of times per second that the strobe fires. It is also expressed as hertz (Hz). A strobe that fires once per second has a flash rate of 1 Hz. The flash rate of strobes used in emergency signaling applications is an important factor because if the rate is too high, it could cause epileptic seizures among individuals sensitive to rapid bursts of light.

2.1.5 Maximum pulse duration	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
	0.2 seconds			

Pulse duration refers to the length of time the flash lasts. It's not hard to forget the days of cameras with the old-style flash bulbs and how, as photographic subjects we were frequently blinded by spots before our eyes for a period after the photograph was taken. This blinding was the result of a flash duration that lasted long enough for our pupils to contract in response to the bright light. Obviously, alarm signals cannot be allowed to blind room occupants during an emergency, so flash durations are strictly limited to periods short enough to have no significant effect on visual acuity.

Strobe pulses are represented by graphs that map the intensity of a single flash over time. The plot takes the shape of a bell, with the signal peaking about half way through its duration. For the purpose of calculating pulse duration, NFPA 72 does not consider the first 10 per cent or the final 10 per cent of the signal to be strong enough, so pulse duration is based only on the 80 per cent of the signal that remains. Thus, NFPA 72 defines pulse duation as "the time interval between initial and final points of 10 per cent of maximum signal."[17]

[17] NFPA 72, National Fire Alarm Code, 7.5.2.3, 2007 Edition.

2.1.6 Maximum duty cycle	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
	40 per cent			

Maximum duty cycle is a logical extension of the pulse duration calculation where only 80 per cent of the signal is considered. If the signal rises and falls in a nice smooth path, then the pulse would peak at 40 per cent of its cycle measured from the time it crossed the 10 per cent threshold.

2.2 Flash intensity

	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.2.1 Minimum flash intensity (non-sleeping rooms)	15 cd (effective)			75 cd (at 50 feet maximum)

Flash intensity is a measure of brightness. Emergency warning strobes must have a flash intensity great enough to be noticeable over ambient light conditions. Bright room lights or strong sunlight can render weak flashes ineffective.

The brightness of a strobe flash is measured in units called candela (cd), formerly referred to as candlepower. The source intensity of a flash is measured, as the term implies, at its source. Source intensity is an absolute value: a 15 cd flash generates 15 candela of light output regardless of its location with respect to the viewer or the duration of the flash.

Flash brightness, for the purposes of all three standards however, is expressed as effective intensity. This is the measure by which strobes are rated to UL 1971. It is well known that a flash of relatively long duration can easily be perceived as being brighter than a stronger flash that doesn't last as long. Effective intensity overcomes this by expressing the perceived brightness of the flash given its source intensity and duration. The result is a measure of brightness that can be specified by standards-setting bodies.

Flash intensity requirements have been at the center of debate since the ADA guidelines were first drafted. While both NFPA 72 and ANSI 117.1 require minimum effective intensities of 15 cd for some applications, current ADA Guidelines specify 75 cd at 50 feet for all applications. Because the most stringent requirement prevails, the 75 cd rule would need to be followed in order to meet ADA requirements to the letter.

But 75 cd is more light output than many rooms require. The 75 cd requirement often results in wasted output and unnecessarily high power requirements. Putting 75 cd strobes in corridors or rooms less than 40 feet wide does not offer any practical advantages over the placement of one or more 15 cd strobes that combined, achieve an equivalent light output across the same area.

Using equivalent facilitation, it is possible to circumvent the 75 cd rule while still meeting all the code requirements. ADA Guidelines, in allowing for equivalent facilitation, acknowledge that …

Departures from particular technical and scoping requirements of this guideline by the use of other designs and technologies are permitted where the alternative designs and technologies used will provide substantially equivalent or greater access to and usability of the facility.[18]

[18] ADA Accessibility Guidelines for Buildings and Facilities, U.S. Architectural and Transportation Barriers Compliance Board, 2.2.

This means that if "alternative designs" can be demonstrated to achieve "substantially equivalent" or better results, they can be used in place of the requirements set out in the guidelines.

Illumination holds the key to this puzzle. This is the measure of light reaching an object expressed in units called lumens per square foot (foot-candles). By calculating the illuminance resulting from both minimum requirements, we can demonstrate that 15 cd at 20 feet is not only substantially equivalent to 75 cd at 50 feet, but that it results in slightly greater illumination:

The formula…	Effective Intensity	Divided by	Distance²	=	Illuminance
ADA…	75	Divided by	(50 x 50)	=	0.0300 lumens/ft²
NFPA/ANSI…	15	Divided by	(20 x 20)	=	0.0375 lumens/ft²

Based on this equivalency, strobe manufacturers have strobes listed to UL 1971 that are rated at 15 cd and can also satisfy the ADA requirement of 75 cd at 50 feet. This means the same strobe can satisfy NFPA/ANSI standards, as well as current ADA Guidelines.

Despite this equivalency, the Access Board held steadfastly to the notion that the application of multiple strobes should be avoided at all costs and "strongly discourages" the use of equivalent facilitation to lower the minimum flash intensity threshold.[19] The board reasons that multiple strobes firing at random in a single field of view would result in aggregate flash rates that put

[19] "Visual Alarms," U.S. Architectural and Transportation Barriers Compliance Board Bulletin #2, December 1992.

people who suffer from photosensitive epilepsy at risk. Photosensitive epilepsy is a well-documented condition, particularly prevalent among children, that causes seizures triggered by rapidly flashing lights.

Since the Access Board first made this determination in 1992, however, advances in strobe technology have resulted in devices that synchronize strobe flash rates. This is often accomplished by means of a module that contains the synchronizing circuitry. The module resides on the notification appliance circuit and provides a timing mechanism for the signals on the circuit.

In light of these developments, the Access Board has softened its attitude towards equivalent facilitation. In the ADAAG Manual, released by the Access Board in 1998, the practice of placing relatively low intensity strobes closer together is merely “discouraged” rather than “strongly discouraged.”[20] In the recommendations put forward in the manual, the ADAAG concedes that the use of synchronized strobes will effectively overcome the risk of photo epileptic seizures.

For its part, NFPA 72 acknowledges the danger posed by random flashing lights and requires that one of four alternatives be used to address the issue:[21]

1. Use only one signal in a protected area;
2. Where two signals are used, locate them on opposite walls;
3. Two groups of visible notification appliances, where visual appliances of each group are synchronized, in the same room or adjacent space within the field of view. This includes synchronization of strobes operated by separate systems;
4. More than two visible notification appliances or groups of synchronized appliances in the same room or adjacent space within the field of view that flash in synchronization.[22]

NFPA 72 thus recognizes that synchronized strobes provide an effective means of mitigating the risk of triggering photo epileptic seizures in applications employing the use of multiple strobes. By doing so, it lends credence to

[20] ADAAG Manual, a guide to the Americans with Disabilities Act Accessibility Guidelines, U.S. Architectural and Transportation Barriers Compliance Board, July 1998, p. 99.

[21] NFPA 72, National Fire Alarm Code, 7.5.4.3.2, 2007 Edition.

[22] The proposed ADA (702.3.4.1) standard specifies a viewing angle of no more than 135 degrees. As this is a more specific viewing angle than NFPA 72, it should take precedence.

the practice and establishes synchronized strobes as an alternative technology that falls under the umbrella of the Access Board's equivalent facilitation guideline. Therefore, it is not only acceptable to use 15 cd strobes to satisfy the signaling requirements of spaces smaller than 30 feet square, it is also acceptable to use multiple higher intensity strobes in larger spaces – as long as their flashes are in synchronization.

	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.2.2 Minimum flash intensity (sleeping rooms)	110 cd (effective) if the strobe is more than 24" from ceiling 177 cd (effective) if the strobe is less than 24" from ceiling			75 cd (at 50 feet maximum)

Sleeping rooms, (i.e.: places of public accommodation such as hotel rooms and hostels) warrant special consideration when determining the application of visual signaling devices. NFPA 72, ANSI 117.1, and the proposed ADA standard require higher intensity strobes in sleeping rooms when strobes are mounted near the ceiling. This is because smoke, being lighter than air, will obscure more of the flash the closer the strobe is to the ceiling. To offset this effect, the standards specify the use of higher intensity strobes if their placement is to be less than 24 inches from the ceiling.[23]

The 110 cd minimum strobe intensity is an extra measure to ensure sleeping occupants will be awakened in the event of an emergency. In these locations it is widely believed that the flash intensity should be sufficient, not only to alert an active and aware occupant, but also to awaken and alert a sleeping one. In fact, research conducted by Underwriters Laboratories concluded that 100 cd is the minimum flash intensity that would be required to awaken 90 per cent of sleeping individuals.

However, the Access Board reasons that "because guest rooms sizes are not large, it is required only that the signal, which is intended to alert persons who are awake, be visible in all areas of the room or unit."[24] Nonetheless, because the 110 cd minimum is more stringent than current ADA guidelines, the higher intensity specification prevails.

[23] NFPA 72, National Fire Alarm Code, 7.5.4.6.2, 2007 Edition.

[24] ADAAG Manual, a guide to the Americans with Disabilities Act Accessibility Guidelines, U.S. Architectural and Transportation Barriers Compliance Board, July 1998, p. 100.

2.3 Vertical placement (wall mounted strobes)

Vertical Placement	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.3.1 Min. height above floor	80 inches			80” above floor 6” below ceiling
2.3.2 Max. height above floor	96 inches			

The vertical placement of strobes needs to be finely balanced to achieve maximum effect. Flashes from strobes placed too high up on a wall will not be easily seen. Strobes placed too low can be obscured by room furnishings or may present an obstacle if they protrude from the wall. Both NFPA and ANSI specify a minimum height of 80 inches and a maximum height of 96 inches above the finished floor. Both documents require the entire lens of the appliance to be within this range.

Current ADA requirements specify 80 inches above the floor or six inches below the ceiling, whichever is lower. The Access Board has determined that this height, which is optimal for 75 cd strobes, can be measured to either the bottom edge, or the centerline of the device. However, the board has also determined that the NFPA/ANSI mounting heights of 80 and 96 inches “show only nominal differences and can be practically considered to be equivalent.”[25]

NFPA 72 sets slightly different vertical mounting requirements for audible devices, such as horns and speakers. However, the fire alarm code also specifies that combination devices, i.e.: horn-strobes and speaker-strobes, must be mounted in accordance with the requirements established for strobes.[26]

[25] ADAAG Manual, a guide to the Americans with Disabilities Act Accessibility Guidelines, U.S. Architectural and Transportation Barriers Compliance Board, July 1998; p. 99.

[26] NFPA 72, National Fire Alarm Code, 7.4.7.3, 2007 Edition.

2.4 Placement in corridors

Illuminance in Corridors	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.4.1 Maximum distance between strobes	100 feet			
2.4.2 Minimum flash intensity	15 cd (effective)			75 cd (at 50' max.)

Corridors and hallways are considered to be passages no more than 20 feet wide. Areas that exceed this maximum width should be considered as rooms for the purpose of compliance with the standards.

Generally, corridors and hallways less than 20 feet wide are not subject to the same 0.0375 lm/ft^2 rule that room spaces are. Illuminance requirements are lower because people in corridors are usually moving and alert.[27] They are more aware of their surroundings than, for example, people in office cubicles focused on computer monitors. Corridors also tend to be windowless, which makes flashing strobes even more noticeable.

[27] Wayne D. Moore and Lee F. Richardson, National Fire Alarm Code Handbook, NFPA 2007

In corridors and hallways, 15 cd strobes are accepted by ANSI 117.1 and NFPA 72 to provide sufficient illuminance when spaced no further apart than 100 feet. Calculating the illumination for this spacing of 15 cd strobes reveals light output of 0.006 lm/ft^2, far short of the 0.0375 lm/ft^2 target for rooms (see page 19 for an explanation of this calculation).

Current ADA guidelines only specify that strobes be placed so that no point in the corridor is more than 50 feet from a strobe.[28] This puts the maximum distance between strobes at 100 feet, the same requirement stipulated by NFPA and ANSI 117.1.[29] While current ADA requirements remain silent on strobe intensity in corridors, it is generally accepted that 15 cd is sufficient for this application. Nonetheless, strobe intensity requirements for corridors are open to interpretation. Check with your AHJ for acceptable specifications in your jurisdiction.

[28] Code of Federal Regulations, Department of Justice, 28 CFR Part 36 (Rev. July 1, 1994), 4.28.3.

[29] NFPA 72, National Fire Alarm Code, 7.5.4.4.5, 2007 Edition.

Placement in Corridors	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.4.3 Maximum distance from each end of corridor	15 feet			Not specified
2.4.4 Minimum distance between strobes	Not specified	50 feet (details on page 20)		

The proposed ADA requirements, along with current ANSI 117.1 and NFPA 72 specifications, require that strobes be placed no further than 15 feet from each end of the corridor. They also require the minimum distance between strobes to be 50 feet. When considered individually, both these requirements are achievable. But surprisingly, when considered together, they are unattainable for corridors between 30 and 50 feet in length.

A corridor less than 30 feet in length can be served by a single strobe at its mid-point. In this case, it would be no more than 15 feet from each end of the corridor. Because there is only one device, minimum and maximum spacing between strobes is not an issue. Likewise, corridors more than 50 feet in length can be served by a strobe within 15 feet of each end of the corridor, plus as many strobes as are necessary to maintain spacing of 50 to 100 feet between strobes.

But corridors between 30 and 50 feet in length cannot be accommodated by the standards the way they are now written. A 45-foot corridor with strobes placed within 15 feet of its ends would have these devices closer together than the 50-foot minimum allows. The same corridor with a single device placed at its mid-point would not have any strobes within 15 feet of the ends of the corridor.

This placement paradox will no-doubt be addressed as the standards are updated. In the meantime, if you are placing strobes in corridors between 30 and 50 feet in length, it would be prudent to ask your AHJ for guidance. Careful planners would also ask that this guidance be provided in writing.

Where changes in corridor direction or elevation occur, each area must be treated as a separate corridor. Additionally, new requirements found in NFPA 72 additionally require more than two corridor strobes in a field of view to flash in synchronization.

2.5 Room spacing

	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.5.1 Wall-mounted	See Allocation Table 2.5.1			Maximum 50' from any point in room

Strobe placement in rooms can take full advantage of equivalent facilitation in order to reconcile current ADA guidelines with the NFPA and ANSI standards. Table 2.5.1 below represents spacing allocation requirements specified by both NFPA 72 and ANSI 117.1. By working out the lumens per square foot (provided in parentheses), we can demonstrate that these spacing allocations are substantially equivalent to the 0.0300 lm/ft^2 required by ADA's 75 cd/50-foot specification (see description of equivalent facilitation on page 20).

Table 2.5.1: Spacing – Wall Mounted Strobes

Maximum Area	Minimum Required Light Output (cd, effective)		
	One Light	Two Lights	Four Lights
20' x 20'	15 (0.0375 lm/ft^2)	Not allowed	Not allowed
28' x 28'	30 (0.0375 lm/ft^2)	Unknown	
30' x 30'	34 (0.0375 lm/ft^2)	15	
70' x 70'	185 (0.0378 lm/ft^2)	95	
40' x 40'	60 (0.0375 lm/ft^2)	30	15
45' x 45'	75 (0.0370 lm/ft^2)	Unknown	19
50' x 50'	94 (0.0375 lm/ft^2)	60	30
54' x 54'	110 (0.0377 lm/ft^2)	Unknown	30
55' x 55'	115 (0.0380 lm/ft^2)	Unknown	28
60' x 60'	135 (0.0375 lm/ft^2)	95	
63' x 63'	150 (0.0378 lm/ft^2)	Unknown	37
68' x 68'	177(0.0383 lm/ft^2)	Unknown	43
70' x 70'	184 (0.0376 lm/ft^2)	95	60
80' x 80'	240 (0.0375 lm/ft^2)	135	60
90' x 90'	304 (0.0377 lm/ft^2)	185	95
100' x 100'	375 (0.0375 lm/ft^2)	240	95
110' x 110'	455 (0.0376 lm/ft^2)	240	135
120' x 120'	540 (0.0375 lm/ft^2)	305	135
130' x 130'	635 (0.0376 lm/ft^2)	375	185

	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
2.5.2 Ceiling-mounted	See Allocation Table 2.5.2			Maximum 50' from any point in room

Spacing allocation specifications set for ceiling-mounted strobes by NFPA and ANSI can likewise be considered equivalent to the ADA requirements. Table 2.5.2 below represents spacing allocation requirements specified by both NFPA 72 and ANSI 117.1. By working out the lumens per square foot (provided in parentheses), we can demonstrate that these spacing allocations are substantially equivalent to the 0.0300 lm/ft^2 required to meet ADA's 75 cd/50-foot specification (see description of equivalent facilitation on page 20).

Table 2.5.2: Spacing – Ceiling Mounted Strobes

Maximum Area	Minimum Required Light Output (cd, effective)	
	Maximum Ceiling Height	One Light
20’ x 20’	10 feet	15 (0.0375 lm/ft²)
30’ x 30’		30 (0.0333 lm/ft²)
40’ x 40’		60 (0.0375 lm/ft²)
50’ x 50’		95 (0.0375 lm/ft²)
53’ x 53’		110 (0.0392 lm/ft²)
55’ x 55’		115 (0.0380 lm/ft²)
59’ x 59’		135 (0.0388 lm/ft²)
63’ x 63’		150 (0.0378 lm/ft²)
68’ x 68’		177 (0.0383 lm/ft²)
70’ x 70’		185 (0.0378 lm/ft²)
20’ x 20’	20 feet	30
30’ x 30’		45
44’ x 44’		75
46’ x 46’		80
50’ x 50’		95
53’ x 53’		110
55’ x 55’		115
59’ x 59’		135
63’ x 63’		150
68’ x 68’		177
70’ x 70’		185
20’ x 20’	30 feet	55
30’ x 30’		75
50’ x 50’		95
53’ x 53’		110
55’ x 55’		115
59’ x 59’		135
63’ x 63’		150
68’ x 68’		177
70’ x 70’		185

2.5.3 Sleeping Rooms	NFPA 72	ANSI 117.1	Proposed ADA	Current ADA
	Maximum 16 feet from the pillow	Maximum 16 feet from the head of the bed		Maximum 50' from any point in room

In sleeping rooms the focus of strobe placement is on the bed. Current and proposed standards require placement to be such that the device is no more than 16 feet from head of the sleeping person. While NFPA uses the pillow as the basis for this measurement, ANSI 117.1 and the proposed ADA standard both specify the head of the bed. These are substantially equivalent points of reference, but the head of the bed, being the more specific of the two, should take precedence.

2.6 Summary

They key to trouble-free compliance is reconciling the requirements of the three prevailing standards. By carefully employing the principle of equivalent facilitation, strobe application can satisfy all the requirements.

The synchronized strobe is the cornerstone to overcoming the differences between current ADA requirements and the other two standards. When properly placed, they ensure that flash frequency in any one field of view will be no greater than two flashes per second, thus significantly reducing the risk of inducing seizures among those sensitive to random or rapidly flashing lights.

The Access Board's current position that a single high-intensity strobe is better than several relatively low intensity flashes in the same field of view is predicated on the assumption that more than one strobe will produce aggregate flash rates and increase the risk to photosensitive individuals. But synchronized strobes have been demonstrated to mitigate this risk, and Access Board objections to multiple strobes don't carry as much weight today as they did when the standard was written, before the widespread use of synchronized strobes.

Today synchronized strobes, along with equivalent facilitation, create a level playing field with respect to the three standards. They give installers the opportunity to reduce costs by economizing on power requirements and by simplifying parts inventories.

It is important when selecting strobe devices to look for models that operate most efficiently with the power supply installed with the life safety system. With the right strobe, a well-matched power supply, and the proper use of equivalent facilitation, it will soon become apparent that compliance with the law and low-cost installations are not necessarily mutually exclusive propositions.

3. Strobe Application

In a perfect world – at least from a life safety system designer's point of view – all building spaces would be perfectly square with walls that differ in measurement only by 10-foot increments. In such a world, strobe placement would be as simple as playing tic-tac-toe. Thankfully, architects are continually finding new ways to make our built spaces more interesting. This does, however, present challenges to determining proper strobe placement in the context of regulatory compliance.

This chapter addresses practical concerns and issues that arise when spaces are less than ideal for strobe placement. It also highlights proper placement practices, tips, and pointers for achieving successful visual alarm system installations.

3.1 Vertical placement (non-sleeping areas)

Determining the best height a strobe should be mounted off the floor is an important consideration. Fortunately, the three prevailing standards prescribe specific requirements that call for little interpretation.

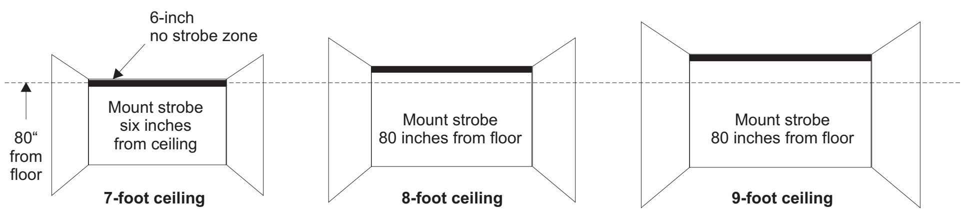
Strobes placed too high on a wall will lose their effective intensities over distance. This is because the forward horizontal plane of the device provides the greatest illumination, and is dramatically reduced as the viewing angle is increased. Strobes placed too low on the wall, on the other hand, can be easily blocked by furniture and equipment. When placed too low, strobes can also present a hazard to travel and can become damaged or knocked off the wall inadvertently. Most building codes do not allow such protrusions below a certain height.

When it comes to the standards affecting strobe application, NFPA 72, ANSI 117.1, and the proposed ADA standard all agree that no wall mounted strobe should be located more than 96 inches above the floor or less than 80 inches above the floor measured to the bottom of the strobe lens. It is important to note that combination audible/visual devices, such as horn/strobes and speaker/strobes, should be mounted vertically on the wall in accordance with the standards set for strobe placement – not those set for audible devices.[30]

[30] NFPA 72, National Fire Alarm Code, 7.4.7.3, 2007 Edition

However, while the proposed ADA standard will bring all three standards in line with one another with respect to vertical placement, current ADA specifications set height requirements at 80 inches above the floor or six inches below the ceiling, whichever is lower.

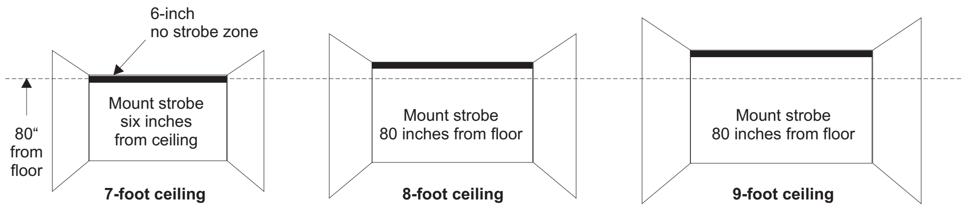
Figure 3-1: Current ADA Vertical Spacing Requirements



The illustration above demonstrates that, except for ceilings seven feet and lower, the current ADA requirement sets the prescribed height of all wall-mounted strobes at 80 inches off the floor. As this is more stringent than the NFPA and ANSI requirements, current ADA specifications should prevail. But the ADAAG admits that there is no appreciable difference between its requirement for vertical spacing and the heights set by NFPA and ANSI, and has ruled that either specification is acceptable.[31] This leaves somewhat more latitude for strobe placement, as illustrated in the following figure.

[31] ADAAG Manual, a guide to the Americans with Disabilities Act Accessibility Guidelines, U.S. Architectural and Transportation Barriers Compliance Board, July 1998, p. 99.

Figure 3-2: NFPA/ANSI and Proposed ADA Vertical Spacing Requirements



While allowed by the standards, it is not good practice to mount strobes with the top of their lenses less than six inches from the ceiling. Consult your AHJ when ceiling heights are less than 92 inches (7' 8"). Below this height, good practice could come into conflict with the standards.

3.2 Strobe Spacing

The goal of proper strobe placement is to achieve illuminance of at least 0.0375 lm/ft^2 in all areas in the room.[32] Lower levels of illumination will result in installations that are out of compliance with the prevailing standards, while excessive illumination can prove hazardous to occupants and unnecessarily costly to install.

[32] NFPA 72, National Fire Alarm Code, A.7.5.4.5, 2007 Edition.

3.2.1 Square rooms

Proper placement of strobes in regularly shaped rooms depends largely on the length of the longest wall. Many rooms are sufficiently small in size as to require no more than one signal, provided the signal is installed at the horizontal center point of the wall.

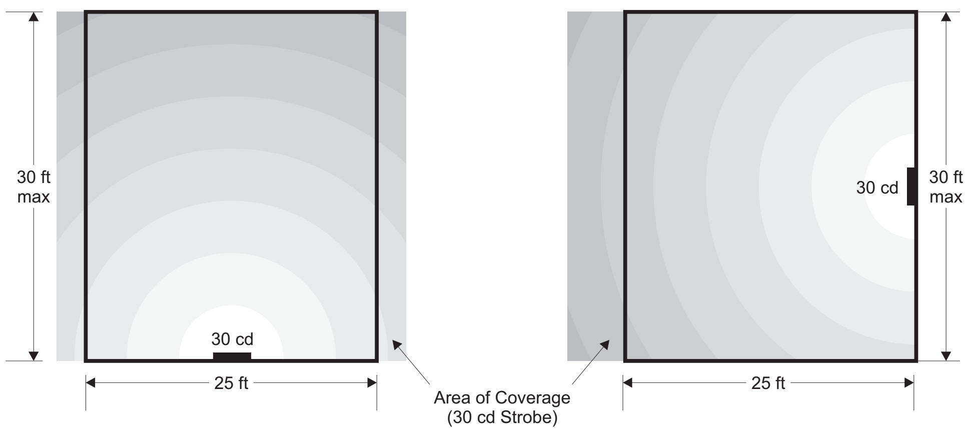
In such cases, and when the room is perfectly square, the effective intensity of the strobe is simply measured to the opposite wall. For example, following Allocation Table 2.5.1, a 20-foot square room would require a single 15 cd strobe centered on any of the four walls. Because the room is square, and UL 1971-listed strobes distribute their light through a 180-degree arc, the effective intensity is considered to be essentially the same at the opposite wall as it is at the adjacent walls.

3.2.2 Rectangular rooms

Generally speaking, when a room is small enough for a single strobe to provide sufficient illumination, the longest wall should be used to determine effective intensity. In rectangular rooms, the effective intensity is measured to either the farthest wall, or double the distance to the farthest adjacent wall, whichever is greater.[33] Applying this rule to Figure 3-3, we can see that a single 30 cd strobe may be placed on any of the four walls, as long as the strobe is centered horizontally along the wall. Placing it on either of the two shorter walls will allow it to be 2½ feet off-center in either direction and still maintain sufficient intensity at both adjacent walls. Notice that no such margin exists when the strobe is placed on either of the longer walls. Anything short of the center point there would require a higher-intensity signal.

[33] NFPA 72, National Fire Alarm Code, 7.5.4.3.4, 2007 Edition.

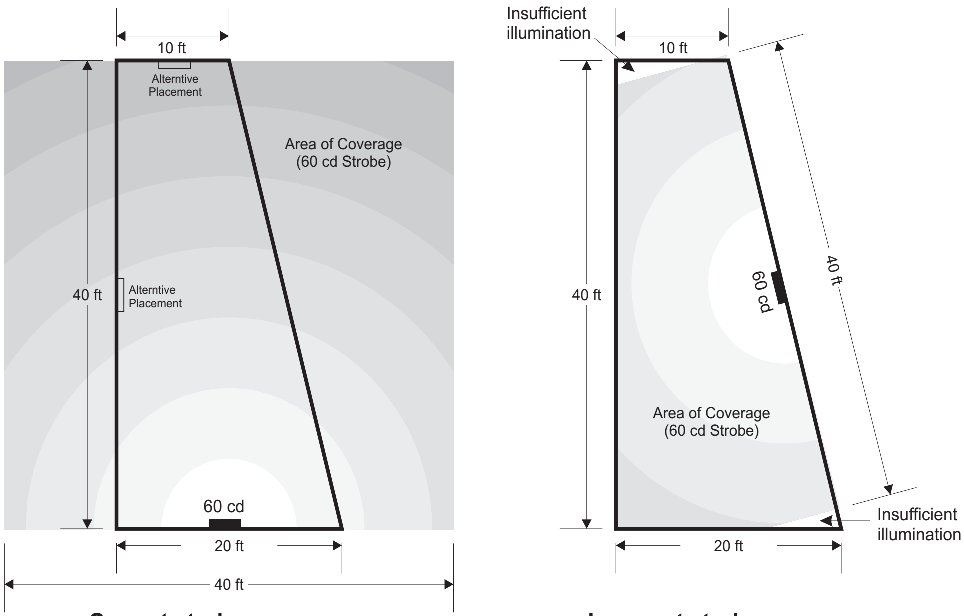
Figure 3-3: Strobe Coverage Area



3.2.3 Irregular rooms

Determining strobe placement for rooms of irregular shapes employs much the same technique used for rectangular rooms. Figure 3-4 illustrates both proper and improper strobe placement for irregular spaces. In this example, a 60 cd strobe would serve equally well at the center point of any of the three shorter walls, but would provide inadequate coverage if placed on the longer one.

Figure 3-4: Strobe Placement in Irregular Shaped Rooms



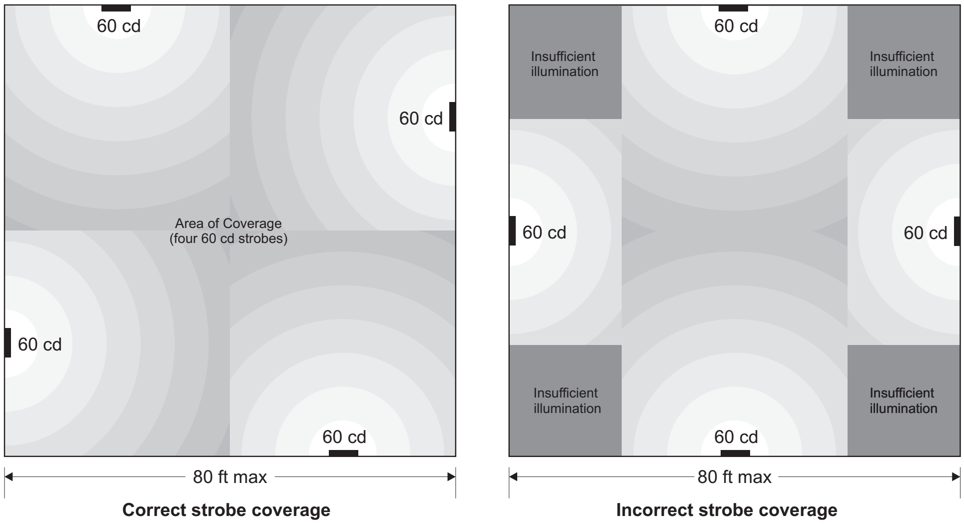
Correct strobe coverage **Incorrect strobe coverage**

3.2.4 Large rooms

Rooms measuring between 30 and 70 feet along the longest wall can be served by either one strobe of sufficient intensity to meet the 0.0375 lm/ft^2 requirement, or two strobes on opposite walls that achieve the same effect (see Table 2.5.1).

Rooms measuring more than 80 feet square may employ the use of one relatively high-output strobe, two strobes on opposite walls, or four strobes. Where more than one strobe is used, it is important to place synchronized strobes so that all areas in the room receive sufficient illumination. Figure 3-5 illustrates correct and incorrect strobe placement.

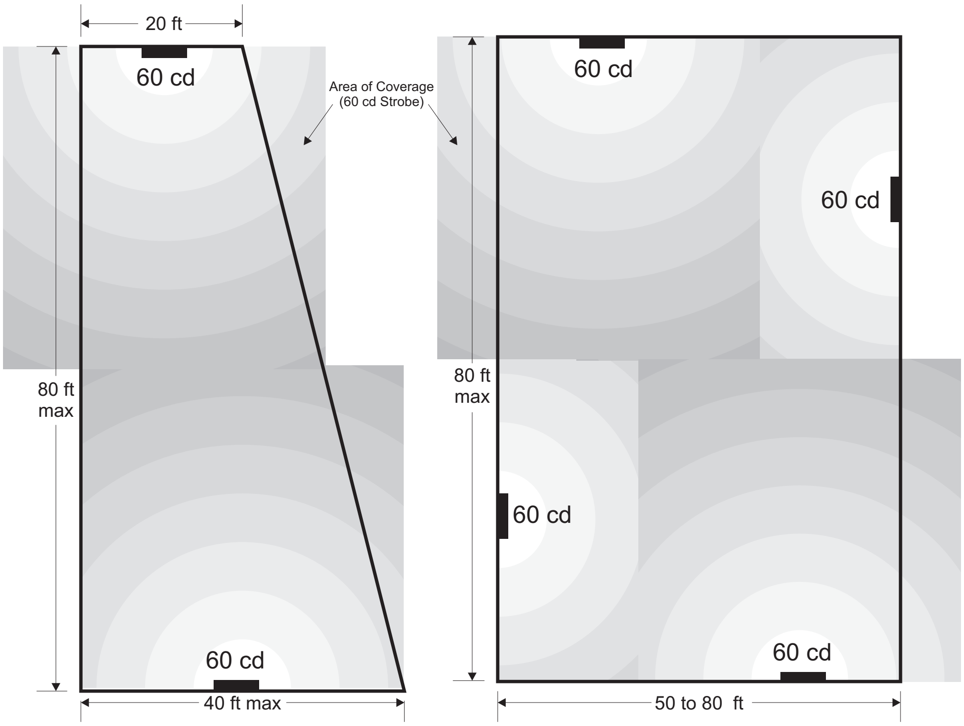
Figure 3-5: Multiple Strobe Placement in Large Square Rooms



This configuration divides the room into squares, each one served by a different strobe asif the individual areas of coverage were independent spaces.[34] The same technique should be used for rectangular and irregular spaces as shown in Figure 3-6.

[34] NFPA 72, National Fire Alarm Code, Figures A.7.5.4.3(c) and A.7.5.4.3(d), 2007 Edition.

Figure 3-6: Multiple Strobe Placement in Large Irregular and Rectangular Rooms



Note: Where more than one strobe is placed in any single field of view, only devices that flash in synchronization should be used. Failing to do so can result in aggregate flash rates high enough to trigger photoepileptic seizures among a portion of the population.

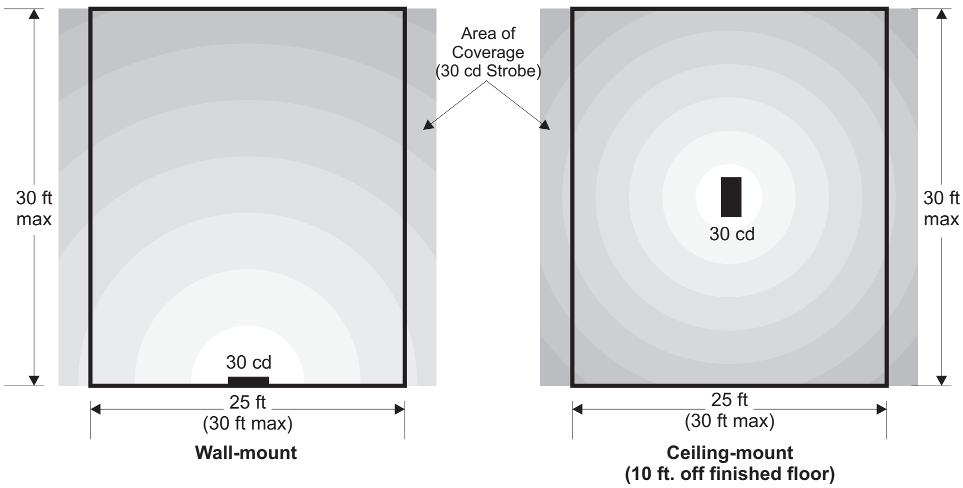
Many large spaces can be accommodated by four signals, one on each wall. For very long rooms, more than one strobe can share a single wall as long as their flashes are synchronized. For maximum economy, strobes should be placed no closer together than the room size given for the strobe intensities indicated in Table 2.5.1. Very large square areas may best be served by ceiling mounted strobes or a combination of ceiling and wall-mounted strobes.

3.3 Applications for ceiling-mounted strobes

Note: Because light distribution demands for ceiling-mounted strobes are radically different from wall mounted signals, strobes used in ceiling-mount applications must be UL 1971-listed specifically for this purpose. It is not acceptable to use strobes intended for wall-mount applications in their place.

In rooms where the ceiling is 10 feet or less above the finished floor, ceiling mounted strobes offer a performance-neutral alternative to wall-mounted devices. For example, a 15 cd ceiling-mounted strobe provides the same 20-foot square of coverage as a wall-mounted signal of equal intensity. Similarly, when mounted in the center of the room, 30 cd, 60 cd, and 95 cd ceiling mounted strobes perform essentially the same as their wall-mounted counterparts. The figure below illustrates this point.

Figure 3-7: Comparison of Wall and Ceiling Strobe Placement in Small Rooms



However, this similarity ends when the ceiling is more than 10 feet above the finished floor.[35] At 20 feet it takes a 30 cd ceiling mounted strobe to cover a 20-foot square area, but at ceiling heights of 30 feet it takes a 55 cd strobe to cover the same area. Where ceiling heights are greater than 30 feet,

[35] NFPA 72, National Fire Alarm Code, Table 7.5.4.3.1(b), 2007 Edition.

strobes should be either wall-mounted or suspended at or below 30 feet above the finished floor.[36] When this arrangement isn't practical, consult your AHJ.

[36] Ibid. NFPA 72, National Fire Alarm Code, Table 7.5.4.3.1(b), 2007 Edition.

Large areas benefit most when served by a combination of ceiling and wall-mounted devices. Because the inherent cost of installing strobes can rise exponentially with the effective intensity they deliver, it usually makes more sense from a cost point of view to keep intensities to a minimum while maintaining the largest coverage possible. The two examples in the figure below illustrate how cost-savings can be achieved by employing the use of ceiling and wall-mounted strobes.

The prescriptive requirements found in NFPA 72 are based on extensive research and are intended for more traditional applications found in commercial applications such as office buildings, small retail establishments, and other similar occupancies. Prescriptive requirements also apply to residential applications and hotel rooms. But big box retail stores present a unique challenge for the designer. Racks and piled storage displays can, and often do, interfere with the signal produced by the strobes. Treating each aisle as a corridor will necessitate mounting of strobes on the racks at the ends of aisles, which may result in damage by forklifts or the movement of stock.

Recent studies have proven that installing ceiling mounted strobes over aisles is an effective approach to providing a good signal to noise ratio at the floor. However, racks are frequently relocated, which will adversely affect the signal. Locating strobes over main aisles and checkout areas may mitigate this effect, but many areas will be adversely affected. Therefore, a prescriptive approach may not always be the best approach to this application.

A performance-based approach will generally result in both direct and indirect signaling. Figure 3-9 provides an example of direct and indirect signaling in a big box application. Many strobes will not be installed directly over aisles, but indirect signaling will result in occupant notification. In other words, some areas will not achieve a high signal to noise ratio. However, occupants generally move about and will probably see strobes in other areas or will receive indirect signaling from other strobes.

Figure 3-8: Comparison of Wall and Ceiling Strobe Placement in Large Rooms

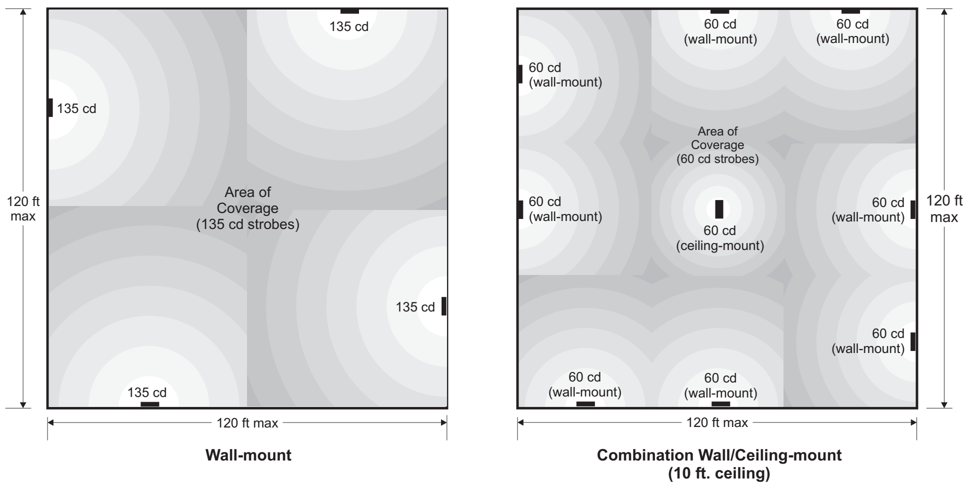
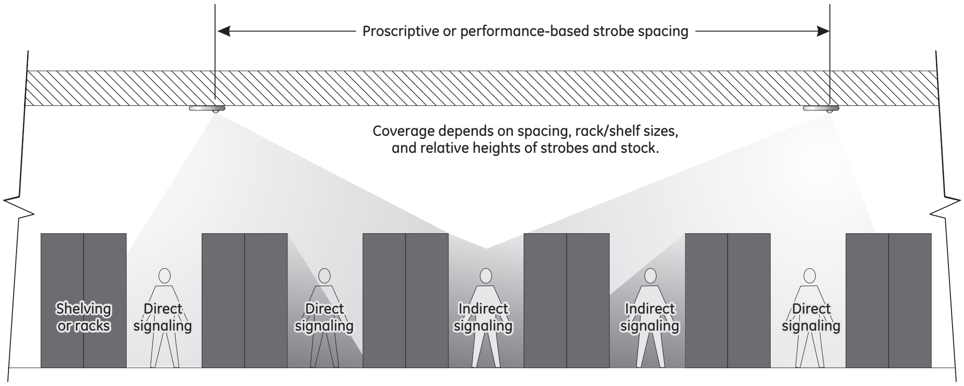


Figure 3-9: Direct and Indirect Signaling from a Performance-Based Approach



Adding the cd values in each example to arrive at a total candela output for a room of this size reveals that the two configurations are identical. This will result in more or less equal power requirements. But a word with your local supplier may reveal that the cost of four 135 cd strobes is significantly higher than the cost of nine standard 60 cd devices, even when the extra wiring is taken into account.

From a performance point of view, the example above on the right provides more even light distribution and has a greater chance of being seen in a modern office environment where cubicles, bookcases, and sunny windows can interfere with the transmission of light from strobes. A greater number of relatively low intensity strobes also ensures that should one or more devices fail, there are others nearby that will continue to provide visual signaling in the event of an emergency.

3.4 Corridors

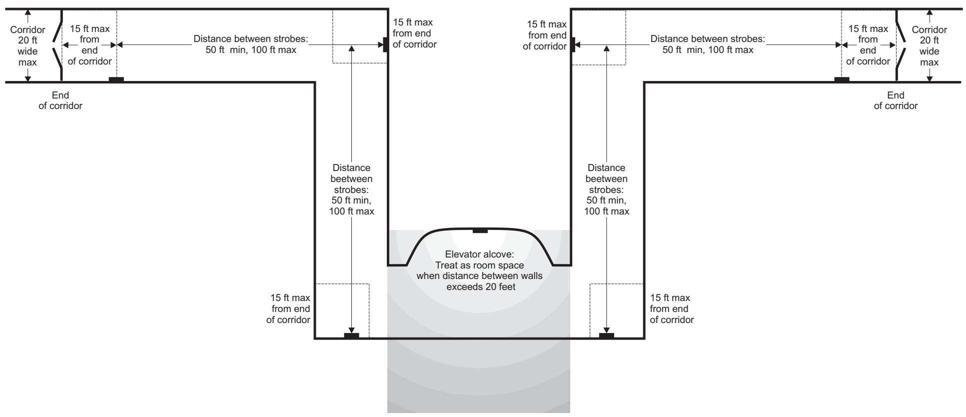
Placement of strobes in corridors warrants special consideration because these areas take on shapes and dimensions not found elsewhere in a typical building. Furthermore, it is generally acknowledged that effective intensity in corridors does not have to be as great as that achieved in rooms because occupants of hallways tend to be moving and alert and therefore more likely to notice strobe flashes.

All three prevailing standards set the maximum width for a corridor at 20 feet. Passageways wider than 20 feet, such as those commonly found in shopping malls and airport terminals, constitute room spaces for strobe placement purposes.

Corridor length is consideed to span from one end to the other. Changes in elevation or direction constitute a new hallway for strobe placement purposes, as does any interruption of the concentrated viewing path, such as fire doors.[37]

[37] NFPA 72, National Fire Alarm Code, 7.5.4.4.6, 2007 Edition.

Figure 3-10: Strobe Placement in Corridors



Distance between strobes should be no less than the prevailing requirement of 50 feet, and signals should not be placed more than 100 feet apart. Furthermore, the standards require that strobes be placed no less than 15 feet from the end of the corridor. The figure above illustrates the optimum placement of 15 cd strobes. Corridors between 30 and 50 feet in length present a special circumstance because the standards are unclear (see details on page 25). Consult your AHJ for an interpretation of how strobes should be placed in corridors of this length.

Where there are more than two strobes in a field of view in a corridor, NFPA 72 requires them to be synchronized. This requirement applies regardless of the distance between strobes.

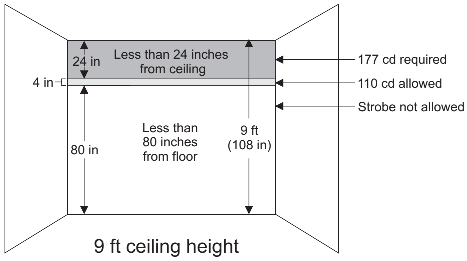
3.5 Sleeping areas

Unlike corridors, which do not require as much light output as rooms, sleeping areas require more light output from visual signals. This is because sleeping individuals must be aroused by the flashing light, as well as alerted by it. Research conducted by Underwriters Laboratories has concluded that a minimum of 100 cd is required to awaken 90 per cent of sleeping individuals.

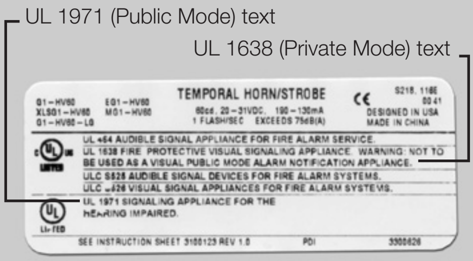
Based on these findings, NFPA 72 and ANSI 117.1, as well as the proposed ADA guidelines, specify that sleeping areas require strobes with an intensity of at least 110 cd. The standards further specify that strobes mounted with less than 24 inches between the ceiling and the top of the strobe lens must have an effective intensity of at least 177 cd. This is because smoke tends to rise towards the ceiling, and strobes mounted high up the wall need the extra intensity to overcome the potential for obscuration from this effect.

Sleeping rooms withceilings higher than nine feet can be served by a 110 cd strobe if it is mounted no lower than 80 inches from the floor and no higher than 24 inches from the ceiling. The following figure illustrates this requirement.

Figure 3-11: Vertical Strobe Placement in Sleeping Rooms



Sleeping areas must have one or more strobes placed within view of all parts of the room. Sleeping areas with any linear dimension greater than 16 feet must have a wall or ceiling mounted strobe within 16 feet of the head of the bed.[38] If that strobe is visible from all pats of the room, then only the one device is required. Combination devices, such as horn-strobes and speaker-strobes should be mounted in accordance with standards established for visual notification appliances.[39]

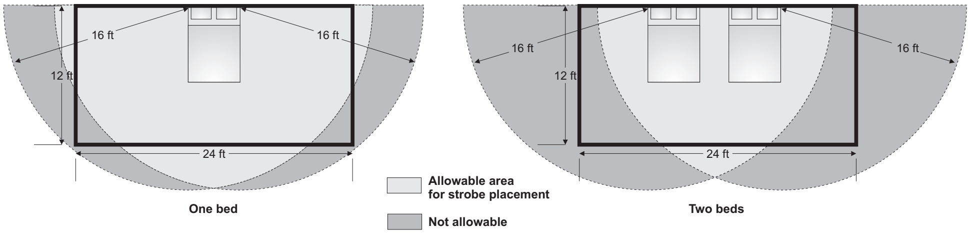


Strobes listed to both UL 1971 and UL 1638 must bear a label that includes the required text for each applicable standard, even if that text seems self-contradictory. Despite the fact that the ULC 1638 text on the label above says the device is not for public mode signaling, because it is also listed to UL 1971, it is in fact listed for this purpose.

[38] ANSI A117.1 stipulates the head of the bed (702.3.6.1), while NFPA 72, National Fire Alarm Code, 7.5.4.6.3, 2007 Edition uses the pillow to measure the required distance to the strobe. As the head of the bed is more stringent, is it considered the prevailing requirement.

[39] NFPA 72, National Fire Alarm Code, 7.5.4.6.1, 2007 Edition. 7.4.7.4 requires appliances that are an integral part of a smoke detector, smoke alarm, or other initiating device to be located in accordance with the requirements for that device. The proposed ADA Guidelines (702.3.3.1) concurs that these devices should be located between 4 and 12 inches from the ceiling.

Figure 3-12: Horizontal Strobe Placement in Sleeping Rooms



For the examples shown in Figure 3-12, the best placement for the strobe is on the wall directly opposite the bed.

3.6 Strobes in harsh and hazardous environments

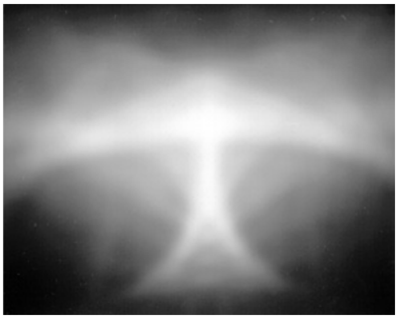
Strobes are not specifically mandated by code for outdoor applications. However, local authorities frequently require their use at building entrances as a means of preventing people from entering the building while an alarm is in progress. Signals installed outdoors must be weatherproof and specifically listed to UL 1638 for outdoor use. If they are intended for public mode signaling, they must be listed to UL 1971 as well as UL 1638. Mounting and wiring must also be in accordance with the National Electrical Code as it applies to outdoor installations.

Outdoor strobes are also frequently used in settings that are not strictly outdoors, but that present similar conditions. Parking garages and sub-basements are considered indoor enclosed spaces and are therefore subject to placement requirements set by prevailing standards. In these settings, strobes rated for outdoor use will provide the necessary extra durability and may be required by local authorities.

In hazardous locations, such as flour mills and refineries, where potentially explosive or corrosive atmospheres are found, hazardous location strobes (explosion proof) are required. These must meet hazardous classification standards established by the National Electrical Code, they must be UL 1971 listed for use as visual signals for the hearing impaired, and placement must be in accordance with applicable codes and standards.

3.7 Summary

The greatest challenge to proper strobe placement is for the designer to strike an effective balance between adequate flash coverage and cost-effective installations. Strobe installations with little regard for economy will, if applied properly, provide sufficient flash coverage, but could result in unnecessary expense. Conversely, strobe installations with too much emphasis placed on cost-cutting measures could result in design flaws that put the installation outside the bounds of compliance.



Light output from strobes using specular reflectors (shown above) is characterized by uneven light distribution. Changes to UL 1971 test methods are forcing manufacturers to seek more efficient designs.

The best strategy for achieving effective visual signaling is for the system designer to carefully weigh all the elements that affect strobe placement for each area of the building. Avoid the temptation to take shortcuts that save time at the planning stage. These seldom pay off. Devising a well thought-out plan that considers the unique aspects of each building area will ensure that your installation provides the best life safety protection at the lowest possible cost.

4. Strobe Selection Guide

Selecting the right strobe for any job requires some planning and careful consideration of the needs and objectives of the application. This chapter provides background on some of the key factors that ultimately determine strobe selection.

4.1 Listing Agencies

In many respects listing agencies make the selection of strobes an easy task. Most if not all jurisdictions require life safety equipment to be independently tested and certified by at least one recognized agency. Listing is a non-partisan seal of approval that ensures the listed device is designed, engineered, and manufactured to deliver minimum levels of operational performance. Because life safety devices fill such a vital role in times of crisis, agency listings are tightly controlled and rigorously applied.

Performance standards, such as the ones published and administered by Underwriters Laboratories (UL), set benchmarks for the durability, effectiveness, and electrical integrity of life safety systems and devices. Unlike prescriptive standards, such as NFPA 72, ANSI 117.1, and ADA, performance standards do not explicitly deal with strobe application or system design. Instead, they set out criteria against which devices are judged. Manufacturers wishing to have their devices listed must submit product samples to the listing agency. The agency then runs a battery of strictly controlled tests to determine whether or not the product meets the established performance criteria.

For visual notification appliances, these tests typically deal with the way the product is constructed and include close examination of enclosures and their ventilation openings, the level of corrosion protection provided, the integrity of field wiring connections, and the durability of the device's components such as circuit boards and internal wiring. Listing agencies also test the performance of the device by measuring its signal strength and frequency, its output and synchronization accuracy, as well as its ability to withstand vibration, circuit overloads, transients, extreme temperatures, and a range of other factors that could lead to equipment failure.

UL is one of several listing agencies to which life safety device manufacturers in America submit products. UL listed strobes are considered acceptable in all jurisdictions, although some jurisdictions specify additional listings.

There are two UL performance standards that figure prominently in the world of strobe application: UL 1638 (Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling), and UL 1971 (Signaling Devices for the Hearing Impaired).

UL 1638 is concerned primarily with private mode signaling. Private mode signaling is intended for individuals directly concerned with emergency action, such as firefighters, security personnel, and building maintenance staff. Signaling requirements are significantly different for private mode applications compared with public mode applications. For example, private mode flash rates are not restricted to a steady beat. Instead, they can follow the temporal pattern of audible devices. This can lower system battery requirements.

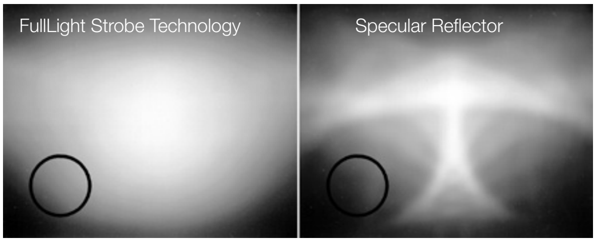
Products listed only to UL 1638 are not intended for public mode operation where the device is used to alert the general population of the building. Nor are such devices intended to provide warning to individuals who are hearing impaired. That task is left to UL 1971.

UL 1971 is the most important standard when it comes to the performance of strobes operating in the public mode. This

The mask-and-cavity design employed by Genesis™ wall and ceiling strobes from Edwards eliminates bulky specular reflectors and significantly reduces the size of the strobe while at the same time providing more even light distribution.

standard is the yardstick against which all strobes intended for the hearing impaired are measured. It not only sets out operational criteria for strobes, but also rates the performance of devices in terms of their minimum candela output and light dispersion properties.

Strobes intended for use in the public mode in harsh environments, or strobes intended for both public and private mode use must be listed to both UL 1971 and UL 1638. Such devices must also be labeled in accordance with the labeling requirements of both standards.



FullLight™ strobe technology, an element of EST's mask and cavity design, delivers smooth light output throughout the strobe's protected area. The pattern shown to the right is from a popular line of strobes and reveals dark spots resulting from their uneven light distribution — a typical drawback of old-style specular reflectors. Notice how the black circle is clearly visible on the FullLight side, but partially obscured by the void left by the specular reflector. In a real-life situation, this difference puts lives at risk.

NFPA 72 does not specifically mandate the use of UL listed strobes. But it does state that one way of determining product acceptability from a performance point of view is to ensure that all devices are listed to UL 1971.[40] While this sounds more like a recommendation than a requirement, in reality, few if any jurisdictions would permit the installation of strobes used in the public mode that are not listed to UL 1971.

[40] NFPA 72, National Fire Alarm Code, 7.5.3, 2007 Edition.

Like all such standards, UL 1971 is continually revised and updated to keep pace with technological developments and improved understandings of relevant issues. Recent changes to the standard have affected the performance criteria of strobes, depending on when they were manufactured and when they achieved their listing.

Strobes installed before the changes were implemented are "grandfathered" by most jurisdictions. In other words, unless your AHJ insists, there will be no need to replace existing strobes that fall short of the new requirements. That notwithstanding, it would be good practice to check with your equipment supplier before purchasing new strobes to ensure that they meet the most current UL requirements. The label on the back of the device displays the listings that have been granted to the manufacturer for that device. The label usually includes a date code showing when it was manufactured. Check with your equipment supplier for a proper interpretation of that code.

Effective November 1, 2000, two changes to UL 1971 resulted in different standards of measurement being applied to strobes submitted by manufacturers for testing. The first change involves an adjustment to the test that measures the light dispersion. Under the new procedures strobes will no longer be tested strictly across their horizontal and vertical planes. Instead, vertical testing will also include compound angles down and 45 degrees down to the left and down to the right of the device.

The reason for this change lies in the fact that most strobe devices do not disperse light in a smooth arc. Instead, light dispersion from strobes employing specular reflectors is characterized by spikes and valleys that trace a jagged path. This results in uneven light distribution that may deliver inadequate illumination to areas that do not lie directly in the path of either the horizontal or vertical planes. The change to UL 1971 puts greater demands on manufacturers to engineer strobes that produce a smooth dispersion pattern and full light coverage to all parts of the protected area.

The second change that was effective in November 2000 tightened up the synchronization requirements for strobes placed in a shared field of view. It has been known for some time that individuals susceptible to photosensitive epilepsy may suffer convulsions in the presence of random flashing lights. Strobes that are synchronized to flash in unison are generally accepted as the preferred means of overcoming this risk. As of November 1, 2000, synchronized strobes that meet UL 1971 are required to flash in unison within

10 milliseconds of each other over a two-hour period.[41]

In addition to checking the currency of the listing, it is important that all strobes are rated by the listing agency for their intended use. A look at the label on the back of the device should answer the following questions and determine the suitability of the device for nearly any given application.

Is it rated for indoor or outdoor use?

Is it rated for wall or ceiling application?

Is it intended for public mode signaling or private mode signaling?

Is it appropriate for use as a signaling appliance for the hearing impaired?

What is the rated candela output?

What is the flash rate?

Is the flash synchronized with other strobes on the same circuit?

Special listings are also required where devices are to be installed in potentially hazardous locations such as chemical refineries, flour mills, gas plants, etc. Where hazardous locations are found, only devices specifically listed to the type and class of that environment may be installed. Hazardous classifications are defined in the several building codes and standards including the *National Electrical Code*, NFPA 497M, NFPA 70, and the UL Hazardous Location Equipment Directory.

In addition to UL, your installation may require that signaling devices be listed with other agencies. For example, in New York strobes may also require listing to Material Equipment Acceptance (MEA), and in California they may also require listing to California State Fire Marshall (CSFM). Both these agencies operate at the state level and give authorities there the opportunity to test and approve devices that meet their specific needs. It is always wise to check with local authorities to determine the listing requirements of a particular jurisdiction or application.

Some insurers may also require that fire alarm components, including signaling devices, be listed with other agencies such as Factory Mutual (FM).

[41] UL Standard for Safety for Signaling Devices for the Hearing Impaired, Underwriters Laboratories Inc., 1971, April 26, 1999; 27A.2.

While not stipulated by legislation, such requirements may be specified by building architects, engineers, or owners.

Internationally, while UL is widely accepted, other listings are frequently referenced in legislation governing the application of life safety systems. In Canada, Underwriters Laboratories of Canada (ULC) listings, or more recently the cUL mark, are required. In Europe, the Loss Prevention Certification Board (LPCB) is given responsibility to testing and certification of life safety systems and components. Also in Europe, the CE (Conformité Européenne) mark is required on any products that have a bearing on, among other things, safety, public health, and consumer protection. In China and elsewhere, national bodies take up the reigns when it comes to testing and approvals.

4.2 New Technologies

Listing agencies only establish minimum operating parameters. The range of devices now on the market varies widely in quality and features, even within the listings framework. Selecting the best signal for any application still requires a good measure of system designer and buyer savvy.

Visual notification appliances today are available in a wide range of configurations that include individual strobes, as well as strobes in combination with horns or speakers. They come in a variety of shapes and sizes, depending on the manufacturer. Nearly all strobes employ specular reflectors, mirror-like structures behind the flash tube that reflect light in a manner that achieves the desired light distribution pattern.

Recently on the market is a generation of wall and ceiling strobes that departs from specular reflectors. This technology employs a mask-and-cavity design that channels and conditions light to produce a highly controllable distribution pattern. Because no bulky specular reflector is required, these devices are much smaller in size and do not suffer the drawbacks commonly associated with conventional reflective approaches.

Standard specular reflectors typically produce light output patterns characterized by spikes and valleys. This results in portions of the coverage area not adequately illuminated by the strobe flash. Agency testing only gauges the light that falls on set points within a test chamber, so most strobes manufactured today make it to market even though their light distribution patterns leave blind spots and holes in the coverage area.

Strobes employing mask-and-cavity technology achieve even light distribution across the entire coverage area; there are no blind spots or gaps in the coverage.

Another feature to look for when selecting strobes is multi-candela capabilities. Advanced strobes today allow the installer to select the strobe intensity, usually by means of a switch inside the device. This allows the same device model to be used in a number of different locations, and reduces the inventory of items required to be stocked and carried to the site.

4.3 Understanding Current Draw

One of the most important considerations when selecting strobes is the cost of running them once they are installed. Strobes that draw heavily on system resources require more power to operate. This can result in greater costs associated with batteries and power supplies.

Current draw is the gauge by which strobes are commonly measured in this respect. Strobes that draw relatively high current tend to require more system resources. Those that draw relatively low current will generally result in the most efficient use of resources. However, absolute current draw is not the only consideration. Operating current characteristics (i.e.: filtered, non-filtered, full-wave rectified, etc.) also play a significant role in the overall efficiency of the circuit, and these characteristics should suit the strobes used.

Manufacturers tend to engineer compatibility among their strobes and power supplies, which is why strobes designed and tested to operate with specific power supplies will often perform better and more efficiently than strobes that have a lower current rating but are installed with a power supply from a different manufacturer.

The installation of the signal circuit wiring also has an effect on the efficiency of strobes. Installers face a myriad of obstacles, running wire over doorways, around ventilation ducts and through ceilings. In many cases the laws of physics – not the strobe's current rating – determines how many strobes can be accommodated on a single circuit: Ohm's Law determines the resistance inherent in all wire; the longer the wire, the greater the resistance. This puts a limit on the distance strobes can be separated from one another and still function properly. In applications typical of modern buildings, system designers will frequently run out of wire before they fully load the circuit with strobes. Good designers don't load circuits to their maximum rated value. They always leave a few milliamps in reserve for that particularly tricky wiring maneuver that takes a few more feet of wire than anticipated. In fact, many designers specify a maximum circuit loading of 80% to allow for future expansion of the circuit.

4.4 Summary

When selecting visual notification appliances for Public Mode applications …

- Choose only UL 1971 listed devices;
- Make sure the listings are up to date;
- Check with your AHJ to determine if any other listings are required
- Install strobes with the power supplies they were tested and designed to work with and follow the manufacturer's recommended circuit capacity;
- Consider how Ohm's Law will affect the placement of strobes on any given circuit; and,
- Don't load signal circuits to their maximum rated value – always hold a few milliamps of current in reserve for extra long wiring requirements.

5. Proposed ADA Accessibility Guidelines (ADAAG)

The following is an excerpt from the proposed revisions to the ADA Accessibility Guidelines (ADAAG), which lays out the ADA requirements for visual notification appliances. These proposed guidelines are almost identical to those published under ANSI 117.1. At the time of this writing, the ADAAG is in the final stage of revision. For updates on the progress of the revision process, and for full-text versions of the proposed guidelines, visit http://www.access-board.gov/ada-aba/status.htm on the World Wide Web.

CHAPTER 7:
COMMUNICATION ELEMENTS AND FEATURES

701 General

701.1 Scope. Communications features and elements required to be accessible by Chapter 2 shall comply with the applicable provisions of this chapter.

702 Fire Alarm Systems

702.1 General. Fire alarm systems required to be accessible shall have audible alarms complying with 702.2 and visual alarms complying with 702.3.

EXCEPTION: Fire alarm systems in medical care facilities shall be permitted to be modified to suit standard health care alarm practice.

702.2 Audible Alarms. Audible alarms shall produce a sound that exceeds the prevailing equivalent sound level in the room or space by 15 dBA minimum or exceeds any maximum sound level with a duration of 60 seconds by 5 dBA, whichever is louder. Sound levels for alarm signals shall not exceed 110 dBA.

702.3 Visual Alarms. Visual alarms shall comply with 702.3.

702.3.1 Light Pulse Characteristics.

702.3.1.1 Type. The lamp shall be a xenon strobe type or equivalent.

702.3.1.2 Color. The color shall be clear or nominal white.

702.3.1.3 Flash Rate. The flash rate for an individual appliance shall be 1 Hz minimum and 2 Hz maximum over its rated voltage range.

Advisory 702.3.1.3

Flash rates that exceed five flashes per second may be disturbing to persons with a photosensitivity, particularly those with certain forms of epilepsy. Multiple, unsynchronized visual signals within a single space may produce a composite flash rate that could trigger a photoconvulsive response in such persons. Therefore, installations that may produce a composite rate in excess of 5 Hz should be avoided by decreasing the number of fixtures and raising the intensity of lamps they contain, by decreasing the flash rate of multiple lamps, or by synchronizing the flash rates of multiple fixtures.

702.3.1.4 Pulse Duration. The maximum pulse duration shall be two-tenths of one second with a maximum duty cycle of 40 percent. The pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.

702.3.2 Dispersion. Light dispersion of wall installed appliances shall comply with Table 702.3.2.1. Light dispersion of ceiling installed appliances shall comply with Table 702.2.2.

Table 702.3.2.1 Light Dispersion for Wall-Installed Visual Alarm Appliances

Vertical Dispersion		Horizontal Dispersion	
Degrees from Horizontal	Percent of Rated	Degrees from Vertical	Percent of Rated
0	100	0	100
5 to 30	90	5 to 25	90
35	65	30 to 45	75
40	46	50	55
45	34	55	45
50	27	60	40
55	22	65	35
60	18	70	35
65	16	75	30
70	15	80	30
75	13	85	25
80	12	90	25
85	12		
90	12		

702.3.3 Location. Appliances shall be located in accordance with 702.3.3.1 or 702.33.2.

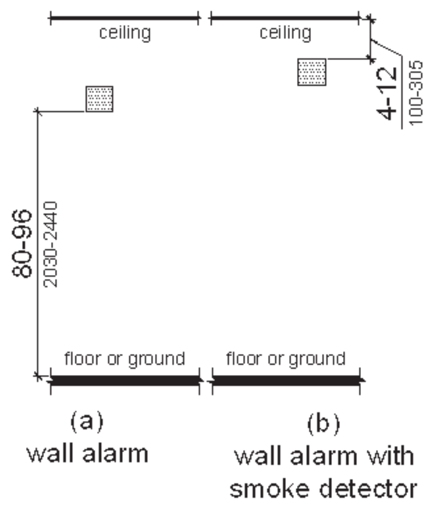
Table 702.3.2.2 Light Dispersion for Ceiling-Installed Visual Alarm Appliances

Degrees from Vertical	Percent of Rated
0	100
5 to 25	90
30 to 45	75
50	55
55	45
60	40
65	35
70	35
75	30
80	30
85	25
90	25

EXCEPTION: Appliances in guest rooms shall comply with 702.3.6.

702.3.3.1 Wall Installed Appliances. Appliances shall be located 80 inches (2030 mm) minimum and 96 inches (2440 mm) maximum above the finished floor or ground measured to the bottom of the appliance.

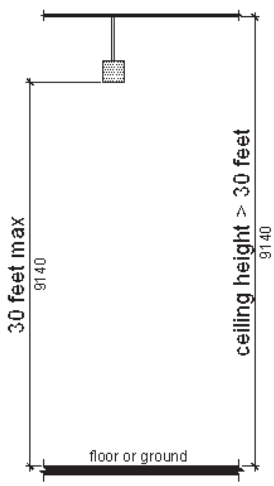
Figure 702..3.1



EXCEPTION: Wall installed appliances which are part of a smoke detector shall be located 4 inches (100 mm) minimum and 12 inches (305 mm) maximum below the ceiling measured to the top of the smoke detector.

702.3.3.2 Ceiling-Installed Appliances. Appliances shall be on the ceiling. Where ceiling height exceeds 30 feet (9140 mm), appliances shall be suspended from the ceiling to a height of 30 feet (9140 mm) maximum above the finished floor or ground.

Figure 70.3.3.1



702.3.4 Spacing Allocation and Minimum Intensity. Spacing and minimum effective intensity for appliances shall comply with 702.3.4.

EXCEPTIONS:

1. Appliances in corridors not more than 20 feet (6100 mm) in width shall comply with 702.3.5.
2. Appliances in guest rooms shall comply with 702.3.6.

702.3.4.1 General. The signal provided by the appliance or appliances shall be visible either by direct view or by reflection from all parts of the covered area. Multiple appliances within an area are permitted only where size, shape, building construction or furnishings prohibit total coverage by a single appliance. Where multiple appliances are provided in a single area to provide total area coverage, the appliances shall comply with one of the following: a maximum of two appliances located on opposite walls; the appliances shall have synchronized flashes; or, in rooms 80 feet (24 m) by 80 feet (24 m) or greater in size, more than two appliances located such that all appliances in any 135-degree field of view are spaced a minimum of 55 feet (17 m) from each other.

702.3.4.2 Wall Installed Appliances. Spacing and minimum effective intensity for wall installed appliances shall be in accordance with Table 702.3.4.2 provided the appliance is located at the midpoint of the longest side of the area served. Where the appliance is not located at the midpoint, the minimum effective intensity shall be based on a maximum area of coverage equal to the distance to the opposite side of the area served or double the distance to the farthest adjacent side of the area served, whichever s greater.

Table 702.3.4.2 Spacing Allocation for Wall-Installed Visual Alarm Appliances

Maximum Area of Coverage	Minimum Required Light Output (Eff. Intensity) (candela)		
	One Light per Area	Two Lights per Area	Four Lights per Area
20 X 20 (6.1 X 6.1 m)	15	Not Permitted	Not Permitted
30 X 30 (9.14 X 9.14 m)	30	15	Not Permitted
40 X 40 (12 X 12 m)	60	30	Not Permitted
50 X 50 (15 X 15 m)	95	60	Not Permitted
60 X 60 (18 X 18 m)	135	95	Not Permitted
70 X 70 (21 X 21 m)	185	95	Not Permitted
80 X 80 (24 X 24 m)	240	135	60
90 X 90 (27 X 27 m)	305	185	95
100 X 100 (30 X 30 m)	375	240	95
110 X 110 (34 X 34 m)	455	240	135
120 X 120 (37 X 37 m)	540	305	135
130 X 130 (40 X 40 m)	635	375	185

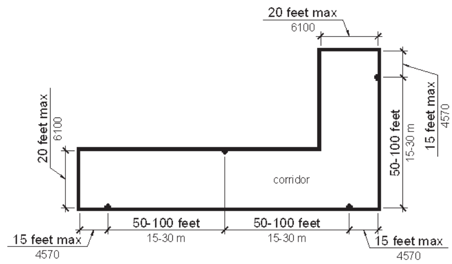
702.3.4.3 Ceiling Installed Appliances. Spacing and minimum effective intensity for ceiling installed appliances shall be in accordance with Table 702.3.4.3 provided the appliance is located at the centerpoint of the area served. Where the appliance is not located at the centerpoint, the minimum effective intensity shall be based on a maximum area of coverage equal to two times the distance from the appliance to the farthest side of thearea served.

Table 702.3.4.3 Spacing Allocation for Ceiling-Installed Visual Alarm Appliances

Maximum Area of Coverage	Minimum Required Light Output (Effective Intensity) (candela)	
	Maximum Ceiling Height	One Light
20 X 20 (6.1 X 6.1 m)	10 (3050 mm)	15
30 X 30 (9.14 X 9.14 m)	10 (3050 mm)	30
40 X 40 (12 X 12 m)	10 (3050 mm)	60
50 X 50 (15 X 15 m)	10 (3050 mm)	95
20 X 20 (6.1 X 6.1 m)	20 (6100 mm)	30
30 X 30 (9.14 X 9.14 m)	20 (6100 mm)	45
40 X 40 (12 X 12 m)	20 (6100 mm)	80
50 X 50 (15 X 15 m)	20 (6100 mm)	115
20 X 20 (6.1 X 6.1 m)	30 (9140 mm)	55
30 X 30 (9.14 X 9.14 m)	30 (9140 mm)	75
40 X 40 (12 X 12 m)	30 (9140 mm)	115
50 X 50 (15 X 15 m)	30 (9140 mm)	150

702.3.5 Corridor Spacing Allocation and Minimum Intensity. Appliances in corridors that are 20 feet (6100 mm) maximum in width shall comply with 702.3.5. Corridors exceeding 20 feet (6100 mm) in width shall comply with 702.3.4.

Figure 702.3.5



702.3.5.1 Appliance Spacing. Appliances shall be located 15 feet (4570 mm) maximum from each end of the corridor and shall be located 50 feet (15 m) minimum and 100 feet (30 m) maximum apart along the corridor. Interruptions to the concentrated viewing path by doors, elevation changes or other obstructions shall constitute the end of a corridor for purposes of this section.

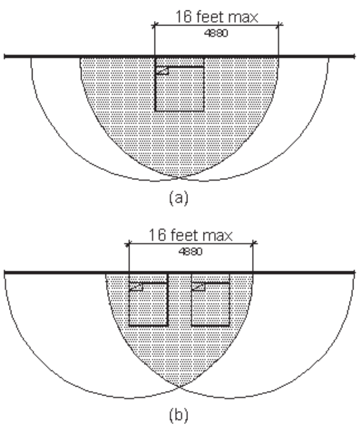
702.3.5.2 Minimum Effective Intensity. Appliances shall have a minimum effective intensity of 15 candela.

702.3.6 Guest Rooms. Guest rooms required to have visual alarms shall comply with 702.3.6.

702.3.6.1 Activation. Where single or multiple-station smoke detectors are provided in the sleeping room or suite, a visual alarm that is activated upon activation of the smoke detectors shall be provided within the room or suite. Where a building fire alarm system is provided, a visual alarm that is activated upon activation of the building fire alarm system shall be provided within the room or suite. The signaling line or channel between the activating device of the appliance and the building fire alarm system shall be monitored for integrity by the building fire alarm system. Where the same appliance is used for visual notification of smoke detector and fire alarm system activation, activation of the room or suite smoke detectors shall not activate the building fire alarm system.

702.3.6.2 Location. In sleeping rooms or suites, appliances shall be permanently installed at a location where alarm signals shall be visible, directly or by reflection, in all parts of the room or suite. In sleeping rooms the appliance shall be located 16 feet (4880 mm) maximum from the head end of the bed location, measured horizontally. Where a suite contains more than one sleeping room, an appliance shall be provided in each sleeping room.

Figure 702.3.6.2



702.3.6.3 Minimum Effective Intensity and Mounting Height. Wall installed appliances located 24 inches (610 mm) minimum below the ceiling shall have a minimum effective intensity of 110 candela. Ceiling installed appliances and wall installed appliances located less than 24 inches (610 mm) below the ceiling shall have a minimum effective intensity of 177 candela.

6. Glossary

ADA Accessibility Guidelines (ADAAG): A set of guidelines drafted by the Access Board and adopted by the Departments of Justice and Transportation as the ADA standard for new construction and alteration.

Agency Listings and Approvals: Standards to which the equipment and operation conforms, as set by the applicable standards/approvals agency.

Alarm Condition: The state of an alarm control indicator that has been activated by fire or other emergency situation.

Alarm Signal: An audible or visual signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

American National Standards Institute (ANSI): A national organization that administers and coordinates the private sector voluntary standardization system in the United States.

Americans with Disabilities Act (ADA): A Federal act to ensure that individuals with disabilities will be reasonably accommodated. Relevant sections of this Act detail the requirements for audible and visual indicating appliances and mounting heights for manual pull stations.

Architectural and Transportation Barriers Compliance Board (Access Board): The federal agency that develops minimum guidelines and requirements for standards issued under the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA).

Audible Notification Appliance: A notification appliance that alerts by the sense of hearing.

Authority Having Jurisdiction: The government body, organization, office, or individual having the power to enforce and/or interpret laws, codes and rules. Also responsible for approving equipment, installations or procedures (e.g.: Fire Marshal, building inspector).

Average ambient sound level: A weighted sound pressure level measured over a 24-hour period.

Candela: The SI (metric) unit of measure for the luminous intensity of a light or strobe.

Coded Signals: An audible or visual signal conveying discrete information. Coded notification signals might be numbered strokes of an impact-type appliance or numbered flashes of a visual appliance.

Fire Alarm Signal: A signal whose initiation by a device such as a manual fire alarm box, automatic fire detector, water-flow switch, or other device, indicates the presence of a fire or fire signature.

Fire Alarm System: A system or portion of a combination system consisting of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.

General Alarm (GA): Evacuation alarm signal.

Listed: Indicates that the equipment, material or service meets identified standards or has been tested and found suitable for a specified purpose and therefore appears on a list that is published and maintained by a standards organization.

Listing: A list of tested equipment or materials published by a standards organization acceptable to the local Authority Having Jurisdiction and concerned with product evaluation and periodic inspection of production of listed equipment or materials. Listing agencies verify that appropriate standards of testing have been met for equipment applied in specified uses. The criteria for evaluation and identification of approved equipment vary from organization to organization. Some of the major listing agencies include UL, FM, ULC, and CSA.

Local Alarm: An alarm which, when activated, makes a loud noise at or near the protected area or floods the site with light (or both).

National Fire Protection Association (NFPA): An organization that is internationally recognized as a definitive authority on fire protection. The NFPA publishes and administers the development of codes, standards, and other materials concerning all aspects of fire safety for the United States.

Notification Appliance: A component of a fire alarm system such as a horn, bell, strobe, speaker, or text display that provides audible, tactile, or visible outputs, or any combination thereof.

Notification Appliance Circuit (NAC): A supervised signal output circuit connected to strobes, bells, horns, sirens, buzzers, chimes, electronic tones, speakers, etc. to alert the building occupants of an alarm condition.

Public Mode Signaling: Audible or visual signaling to the occupants of an area that is protected by a fire alarm system.

Private Mode Signaling: Audible or visual signaling intended to alert and inform only those who are directly involved with the response to an emergency situation. Such individuals include firefighters, security personnel, and others who are familiar with the operation of the fire alarm system. Private mode visual signaling is not intended to compensate for hearing impairment or high ambient noise conditions.

Strobe: A signaling device that produces a bright flashing high-intensity light signal.

Visual Notification Appliance: A notification appliance that alerts by the sense of sight.

Visual Signal: A device used to visually indicate the actuation of the fire alarm system such as a strobe, beacon, or flashing light.

7. Bibliography

Standards and Guides

ADAAG Manual: A Guide to the Americans with Disabilities Act Accessibility Guidelines; US Architecture and Transportation Barriers Compliance Board, July 1998.

National Fire Alarm Code Handbook, National Fire Protection Association, fifth edition, 2007.

Code of Federal Regulations Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities, 28 CFP Part 36; Department of Justice, Revised July 1, 1994.

ICC/ANSI A117.1-2003, Accessible and Usable Buildings and Facilities, International Code Council, 2003.

UL Standard for Safety for Signaling Devices for the Hearing Impaired, UL 1971; Underwriter's Laboratories, Inc., third edition, Revised May 19, 2006.

UL Standard for Safety for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling, UL 1971; Underwriter's Laboratories, Inc., second edition, Revised November 7, 1990.

Web Resources

Americans with Disabilities Act (ADA)

ADAAG Review Advisory Committee Final Recommendations
http://www.access-board.gov/adaag/html/adaag.htm

Americans with Disabilities Act Handbook
http://www.nwosu.edu/stdserv/handbook/ADA%20Handbook.pdf

U.S. Access Board (Architectural Barriers Access Compliance Board)
http://www.access-board.gov

Department of Justice: ADA Page
http://www.usdoj.gov/crt/ada/

Codes, Standards and Listing Agencies

American National Standards Institute (ANSI)
http://www.ansi.org

American Society for Testing and Materials (ASTM)
http://www.astm.org

Canadian Standards Association (CSA)
http://www.csa.ca

International Organization for Standardization (ISO)
http://www.iso.org/iso/home.htm

National Institute for Occupational Safety and Health (NIOSH)
http://www.cdc.gov/niosh/homepage.html

National Institute of Standards and Technology (NIST)
http://www.nist.gov/welcome.html

Underwriters Laboratories Inc. (UL)
http://www.ul.com

National Fire Protection Association (NFPA)
http://www.nfpa.org

Government

Department of Energy: ES&H Technical Services
http://www.tis.eh.doe.gov

Department of Energy: Technical Information Services
http://www.tis.eh.doe.gov/techstds

Department of Justice: ADA Page
http://www.usdoj.gov/crt/ada

Associations and Interest Groups

American Fire Sprinkler Association (AFSA)
http://www.sprinklernet.org/index.html

American Society of Civil Engineers (ASCE)
http://www.asce.org/asce.cfm

Automatic Fire Alarm Association (AFAA)
http://www.afaa.org

International Code Council (ICC)
http://www.iccsafe.org

Institute of Electrical and Electronics Engineers (IEEE)
http://www.ieee.org

National Burglar and Fire Alarm Association (NBFAA)
http://www.alarm.org

National Fire Protection Association (NFPA)
http://www.nfpa.org

8. Index

Handbook of Visual Notification Appliances for Fire Alarm Applications

A practical guide to regulatory compliance

Notification appliances hold a special place in the life safety industry because they are not only subject to the requirements of building codes and life safety standards; they are subject to federal laws as well. Much of the confusion that surrounds the application of notification appliances lies where these standards and laws converge.

This handbook will help system designers and installers gain an understanding of how the requirements fit together. It will bridge the gap between legislation and practice. And it will provide readers with an overview of the changing nature of notification appliances and the laws that govern their application.

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