Audible/Visible Appliance Reference Guide

SYSTEM SENSOR®

Audible/Visible Appliance Reference Guide

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Introduction: The Need for an Audible/Visible Compliance Reference Guide

The installation and performance requirements for audible/visible appliances in general are addressed in three documents: 1.) ADAAG, 'Americans with Disabilities Act Accessibility Guidelines', a civil rights law prohibiting discrimination on the basis of disability; 2.) ICC/ANSI 117.1–1998 'Accessible and Usable Buildings and Facilities', a standard on accessibility designed to be adopted as part of a building code; and, 3.) NFPA72, the National Fire Alarm Code, 1999 edition, an installation standard for fire alarm systems normally not adopted directly into law, but referenced in a building code as the standard to be followed.

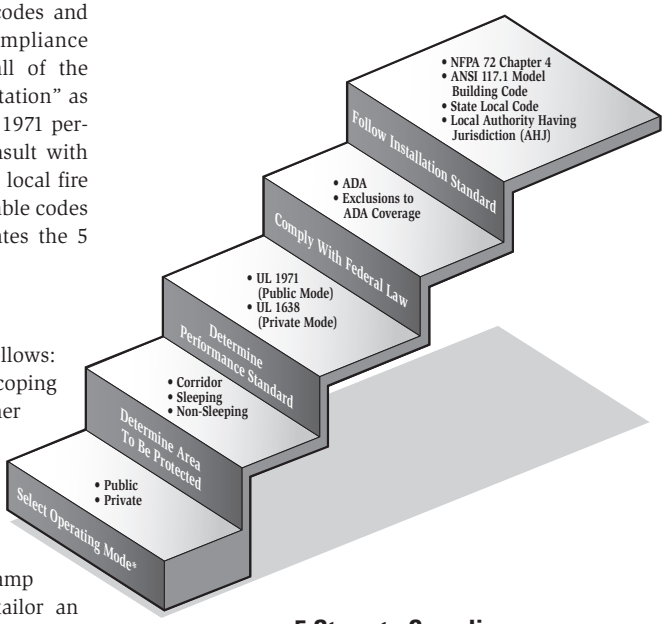
Currently, the NFPA72 and ICC/ANSI 117.1–1998 have been harmonized, and are consistent in regards to the type, visual intensity, and amount of visual alarm notification appliances, i.e. strobes, to use within a given space, as well as the mounting and placement of such appliances. However, the current ADAAG has not been updated since its initial publication in 1991 and does not reflect recent technological advances within the industry. As such, the current version of the ADAAG is not harmonized with the NFPA72, 1999 edition, and ICC/ANSI 117.1–1998. As a result, the ADAAG provides differing guidelines as regards strobe selection from those of the two harmonized codes.

On November 16, 1999, the Access Board, an independent Federal agency devoted to accessibility for people with disabilities, published a proposed rule in the Federal Register to change the ADA Accessibility Guidelines (ADAAG). These updated guidelines, if adopted by the Department of Justice after a period of public review and commentary, would be the first comprehensive update of the ADAAG since its initial publication in July 1991. However, until adopted, the current (1991) version of the ADAAG remains in effect.

System Sensor has prepared this Reference Guide in an effort to help promote understanding and awareness of the issues that affect specifying engineers, installers, and the enforcement authorities. We hope to increase the probability of proper installation and reduce the possibility of misapplication of audible/visible appliances in the commercial market place.

What Is Required To Comply?

Due to differing codes and standards, compliance entails meeting all of the ADA requirements or providing "equivalent facilitation" as well as adhering to NFPA 72 installation and UL 1971 performance standards. It is always prudent to consult with your Authority Having Jurisdiction (AHJ) and/or local fire marshal to ensure that you are meeting all applicable codes and standards. The diagram to the right illustrates the 5 steps to compliance.



5 Steps to Compliance

Equivalent Facilitation

Currently, equivalent facilitation is stated as follows: "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."

The Access Board advises that "...by varying lamp intensity and spacing, systems designers can tailor an installation to the physical conditions of the space being served." However, the Access Board goes on to caution that "it is impossible to provide specific guidance for the design of non-standard installations based upon the photometry calculations necessary to demonstrate equivalent facilitation."

In the proposed ADAAG, Equivalent Facilitation verbiage has been simplified and is more user friendly. Specifically, "Nothing in these guidelines is intended to prevent the use of designs or technologies as alternatives to those prescribed in this document, provided they provide equivalent or superior accessibility and usability."

What Is The ADAAG?

The Americans with Disabilities Act Accessibility Guidelines (ADAAG) are the official standards for accessible design under Title III of the ADA. They cover only new construction and alterations undertaken by facilities covered by the ADA. The ADAAG was written by the Architectural and Transportation Barriers Compliance Board, also known as the Access Board. The Access Board, in one of its information bulletins, states: "Because the ADA is civil rights law, compliance with and enforcement of its implementing regulations are not overseen by a local building code official, but are exercised through private suit or by specified federal agencies when discrimination—or the probability of discrimination on the basis of disability—is alleged."

A few states have adopted ADAAG as their accessibility code and implement its provisions through state and local building code officials in the same way as other applicable building regulations are applied, reviewed and enforced. Many jurisdictions are expected to submit their building codes and/or standards for review by the Department of Justice. Standards that meet or exceed the minimum accessibility requirements of the ADA will be certified. The model codes, including ANSI 117.1, have sought to coordinate accessibility provisions through informal review and technical assistance from DOJ.

ADA/ADAAG compliance does not relieve the designer from complying with the provisions of a state or local access code. "Where such a code contains more stringent requirements, they must be incorporated. Conversely, adoption of ADAAG or certification of the equivalence of a state/local code will not relieve covered entities of their responsibilities to meet the accessibility standards imposed by the ADA."

Exclusions to ADA Coverage:

- Individual employee offices and work stations (however, arrangements should be made to comply with the provisions of Title I, which addresses providing reasonable accommodations; e.g., a visible signal for an employee who is deaf or hard of hearing).
- Religious entities and private clubs.
- Strictly residential private apartments and homes.
- Federal buildings (covered by theArchitectural Barriers Act of 1968 [ABA] and, currently, by the Uniform Federal Accessibility Standards [UFAS]), a corporation wholly owned by the government of the U.S. or an Indian tribe.
- Multi-family residential facilities (generally covered by the Fair Housing Amendments Act of 1988 [FHAA] and its related regulations and standards).

What is the Coverage and Enforcement of the ADA?

The ADA comprises four titles that define and prohibit discrimination on the basis of disabilities within specific areas. Fire safety signaling devices are addressed under Title III, which covers public accommodations and services, including transportation. Compliance is enforced by the Department of Justice, or the Department of Transportation in areas of public transportation.

Fire Safety Signaling Devices Are Covered Under Title III:

ADA – Americans with Disabilities Act

Title I **Employment**

Enforced by: Equal Employment Opportunity Commission (EEOC)

Title II **Public Services**

Enforced by: Department of Justice (DOJ), Department of Transportation (DOT)

Title III **Public Accommodations and Services**

Enforced by: Department of Justice (DOJ)

Title IV **Miscellaneous Provisions**

What Is "Public Mode" vs. "Private Mode" Operation?

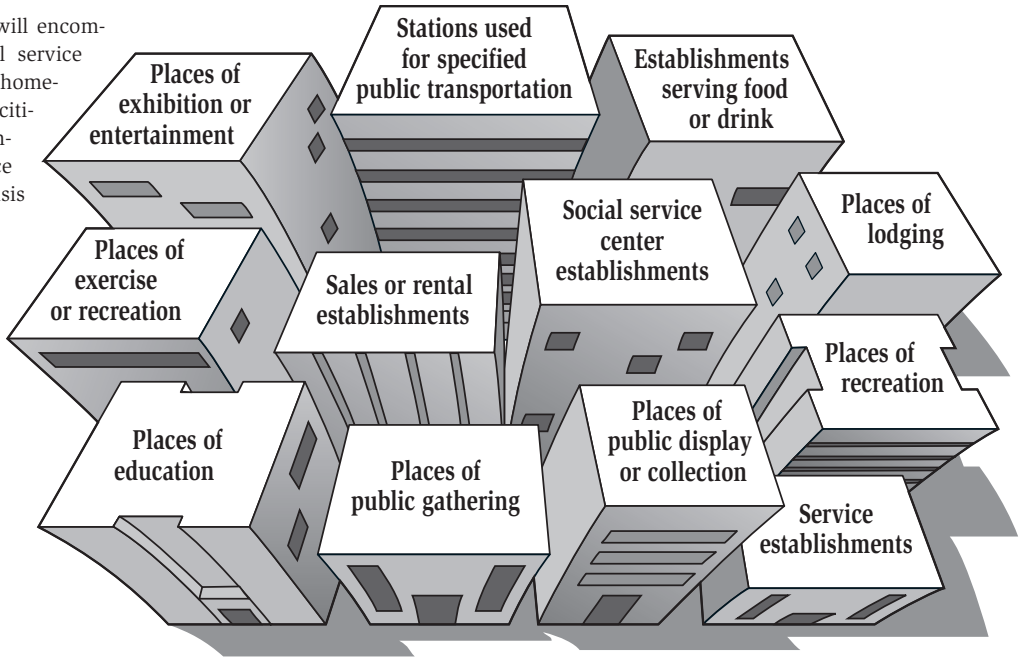
"Private mode" applications are those where a signal is known to be in place and where someone is trained to take additional action upon notification from the alarm signal. Examples include control rooms, nurses' stations and guard desks. These emergency signaling applications may not have to meet ADA requirements and may be satisfied through installation of UL 1638 appliances.

"Public mode" operation includes audible or visible signaling to occupants or inhabitants of the area protected by the fire alarm system.

The Americans with Disabilities Act, Section 301-7, defines a *public accommodation* as any facility that is privately operated, affects commerce with its operation, and falls into one of the 12 categories shown in the accompanying illustration.

These categories are fairly general and will encompass a wide variety of facilities. Social service facilities, for example, include not only homeless shelters, adoption agencies, senior citizen centers, food banks and day care centers, but also halfway houses, substance abuse treatment facilities and other crisis centers.

ADA Public Accommodations



Visible Signaling Appliance Requirements

REQUIREMENT	AREA TO BE PROTECTED	ADA CURRENT	ADA ANTICIPATED	UL 1971	ANSI 117.1	NFPA 72
LIGHT DISTRIBUTION		No Specific Requirement[1]	Per UL 1971	"Polar" Distribution[2]	Per UL 1971	Per UL 1971
INTENSITY	**Non-Sleeping Area**	75 cd (50´ spacing)	15 cd Minimum[5,6]	15 cd Minimum[5,6]	15 cd Minimum[5,6]	15 cd Minimum[5,6]
	Sleeping Area	75 cd (50´ spacing)	110 cd (wall) 177 cd (ceiling)	110 cd (wall)[3] 177 cd (ceiling)	110 cd (wall)[3] 177 cd (ceiling)	110 cd (wall)[3] 177 cd (ceiling)
	Corridor Area	75 cd (50´ spacing)	15 cd (100´ spacing)	15 cd	15 cd (100´ spacing)	15 cd (100´ spacing)
FLASH RATE		1 to 3 Hz[4]	1 to 2 Hz[4]	1/3 to 3 Hz[4]	1 to 2 Hz[4]	1 to 2 Hz[4]
MOUNTING and PLACEMENT	**Non-Sleeping & Corridor Area**	Lower of 80˝ above floor or 6˝ below ceiling	Wall: 80˝ to 96˝ above floor, 6˝ min. below ceiling. On ceilings less than 30´[6]	No Specific Requirement	Wall: 80˝ to 96˝ above floor, 6˝ min. below ceiling. On ceilings less than 30´[6]	Wall: 80˝ to 96˝ above floor, 6˝ min. below ceiling. On ceilings less than 30´[6]
	Sleeping Area	Lower of 80˝ above floor or 6˝ below ceiling	110 cd required if greater than or equal to 24˝ below ceiling; 177 cd required if less than 24˝ below ceiling	110 cd required if greater than or equal to 24˝ below ceiling; 177 cd required if less than 24˝ below ceiling	110 cd required if greater than or equal to 24˝ below ceiling; 177 cd required if less than 24˝ below ceiling	110 cd required if greater than or equal to 24˝ below ceiling; 177 cd required if less than 24˝ below ceiling
	Placement	Wall Only	Wall or Ceiling	Wall or Ceiling	Wall or Ceiling	Wall or Ceiling

Notes:
[1] UL 1638 does not stipulate a minimum light output requirement "on-axis" (directly in front of device).
[2] UL 1971 requires specific light intensities at viewing angles ranging from 0 to 90 degrees off axis.
[3] If detector and visible device are in same sleeping room intensity is required to be 177 cd.
[4] 1/3 Hz equals 20 flashes per minute; 1 Hz equals 60 flashes per minute; 3 Hz equals 180 flashes per minute.
[5] Intensity dependent upon room size.
[6] Where the ceiling strobe is not located in the center of the room, the candela level shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size.

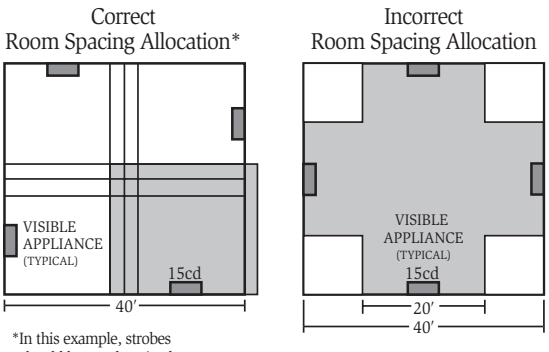
According to the ADAAG, "ADA compliant visual alarms are not required in *alterations,* except where an existing fire alarm system is upgraded or replaced, or a new fire alarm system is installed." The ADAAG goes on to define an alteration as "A change to a *building* or *facility* that affects or could affect the usability of the *building* or *facility* or part thereof. *Alterations* include, but are not limited to, remodeling, renovation, rehabilitation, reconstruction, historic restoration, changes or rearrangement of the structural parts or elements, and changes or rearrangement in the plan configuration of walls and full-height partitions. Normal maintenance, re-roofing, painting or wallpapering, or changes to mechanical and electrical systems are not *alterations* unless they affect the usability of the *building* or *facility."*

Where Should Strobes Be Located?

According to NFPA 72 1999, Chapter 4 and its appendices, specific installation, spacing and location of strobes is dependent upon the size and configuration of the area to be protected. Requirements are based on square room size. (See page 6) If the room configuration is not square, the size square that will encompass the entire room is to be used.

NFPA requires strobes to be located so that the light can be seen regardless of the viewer's orientation, with maximum spacing between devices (like the ADA), not to exceed 100′.

Non-Sleeping Rooms



*In this example, strobes should be synchronized.

In non-sleeping areas the NFPA requires that wall mount visible notification appliances be installed 80″ to 96″ above the floor (6″ minimum below the ceiling) and for ceiling mounted strobes, no more than 30 above the floor. In sleeping areas a 110 cd strobe must be placed more than 24″ below the ceiling or a 177 cd strobe must be placed less than 24″ below the ceiling. In either case the strobe can be no more that 16′ from the pillow.

The NFPA specifies varying minimum required light outputs for *non-sleeping* rooms (shown in the table below).

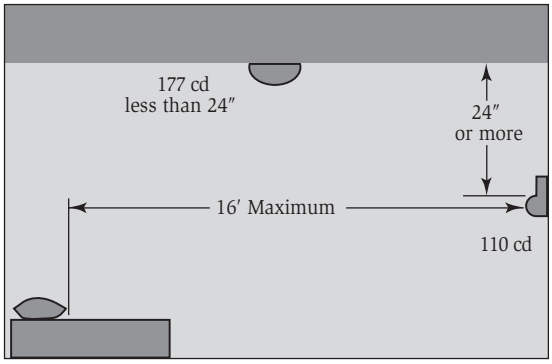
Sleeping Rooms

In *sleeping areas,* where the mounting height is within 24″ or less of the ceiling, the required intensity is 177 cd. When the distance would be more than 24″ to the ceiling, light intensities of 110 cd may be provided.*

Strobe Requirements for Sleeping Area

Distance from Ceiling to Top of Lens	Intensity
Greater than or equal to 24″ (610 mm)	110 cd
Less than 24″ (610 mm)	177 cd

*NOTE: If the room is larger than 16′ × 16′, the appliance shall be located within 16′ of the pillow measured horizontally.

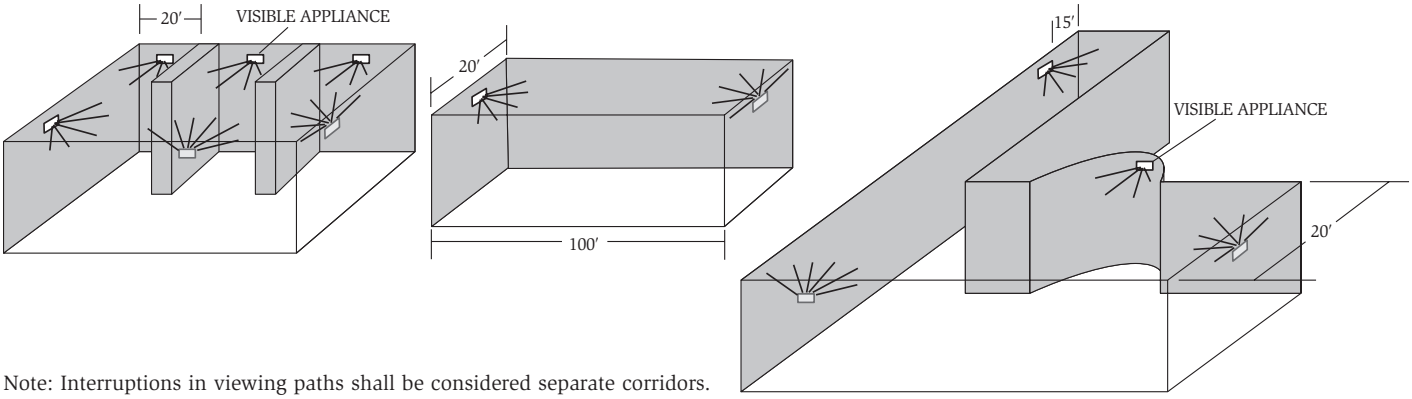


Minimum Number of 15 cd Strobes by Corridor Length

Corridor Length	Number of Strobes					
	1	2	3	4	5	6
0–30′	■					
31–130′	■	■				
131–230′	■	■	■			
231–330′	■	■	■	■		
331–430′	■	■	■	■	■	
431–530′	■	■	■	■	■	■

For *corridors,* NFPA specifies strobe location not more than 15′ from the end of the corridor, with a maximum separation of 100′. Corridor spacing of strobes is specified as shown in the table to the right. Typical corridor placement is shown below.

Recommended Placement for Strobes in Corridors and Elevator Areas (NFPA 72 Appendix A-4-4.4.2, 1999 Edition)



Note: Interruptions in viewing paths shall be considered separate corridors.

How Many Strobes Should Be Used?

The NFPA is very specific with respect to strobe count and spacing using room size as the determining variable. Four different strobe count and spacing solutions are offered in conjunction with the tables in this section:

1. Use a single visible notification appliance.
2. Use two visible notification appliances located on opposite walls.
3. In rooms 80′ × 80′ or greater where there are more than two visible appliances in any field of view*, they shall be spaced a minimum of 55′ from each other.
4. When using more than two visible notification appliances, that the appliances flash in synchronization.

* Field of view = 135°

Wall Mount

Minimum Light Output Per Strobe by Room Size (Non-Sleeping)

	20′ × 20′	30′ × 30′	40′ × 40′	50′ × 50′	60′ × 60′	70′ × 70′	80′ × 80′	90′ × 90′	100′ × 100′	110′ × 110′	120′ × 120′	130′ × 130′
One Strobe	15 cd	30 cd	60 cd	95 cd	135 cd	185 cd	240 cd	305 cd	375 cd	455 cd	540 cd	635 cd
Two Strobes	Not Allowable	15 cd	30 cd	60 cd	95 cd	95 cd	135 cd	185 cd	240 cd	240 cd	305 cd	375 cd
Four Strobes	Not Allowable	Not Allowable	15 cd	30 cd	30 cd	60 cd	60 cd	95 cd	95 cd	135 cd	135 cd	185 cd

Usage of Ceiling-Mounted Visual Alarm Appliances as Prescribed by Key Standards, Laws, and Codes

The installation and performance requirements for audible/visible appliances in general are addressed in three documents: 1.) ADAAG, 'Americans with Disabilities Act Accessibility Guidelines', a civil rights law prohibiting discrimination on the basis of disability; 2.) ICC/ANSI 117.1–1998 'Accessible and Usable Buildings and Facilities', a standard on accessibility designed to be adopted as part of a building code; and, 3.) NFPA72, the National Fire Alarm Code, 1999 edition, an installation standard for fire alarm systems normally not adopted directly into law, but referenced in a building code as the standard to be followed.

From a building design and construction standpoint, ICC/ANSI A117.1–1998 and NFPA72, 1999 edition, both recognize ceiling-mount visual alarm appliances and describe the requirements for intensity, mounting, and placement for such appliances. The current version of the ADAAG (1991) does not. While compliance with all three is generally required, the only method to satisfy the requirements of ANSI A117.1/NFPA 72 and the ADAAG, and thus to be able to install ceiling-mounted appliances, is to claim equivalent facilitation. The definition of equivalent facilitation is provided within Chapter 2, Section 2.2 of the ADAAG, which states the following:

> "Alternatives to specific requirements that provide equal or greater access are permitted. This provides flexibility for new technologies and innovative design solutions that many not have been taken into account when the ADAAG was developed."

The ADAAG and Ceiling-Mount Visual Alarm Appliances

The ADAAG has great importance to members of the fire alarm industry as it used as a reference to define the provisions for accessibility within the design and construction of accessible buildings. However, the ADAAG has not been updated since 1991 and does not reflect recent technological advances within the industry. These advances have served to improve the ability of fire alarm devices, in general, and audible/visible devices, in particular, to provide notification of a fire condition and the need to evacuate a given area. Since the introduction of the ADAAG, the industry has made significant advances in the design of audible/visible appliances, specifically in the area of ceiling-mounted devices, which are not addressed by the current ADAAG.

On November 16, 1999, a proposed update of the ADAAG was published in the Federal Register for public comment. The intent is to harmonize the ADAAG with the model codes and the national standard, as well as to reflect technological developments, such as ceiling-mounted devices, that have occurred since the current 1991 version, while continuing to meet the needs of people with disabilities. The proposed version of the ADAAG addresses ceiling-mounted audible/visible devices, in terms of installation and performance, in a manner that is generally consistent with the current versions of NFPA72 and ICC/ANSI A117.1. However, the proposed update has not been adopted into law, and until such time the current ADAAG (1991) remains in effect, and equivalent facilitation must be demonstrated in order to use ceiling-mounted devices in those installations requiring compliance with the ADAAG.

ANSI A117.1 'Accessible and Usable Buildings and Facilities' and Ceiling-Mount Visual Alarm Appliances

The American National Standards Institute Document ANSI A117.1, since its introduction in 1961, has served to present the criteria for accessibility for building design. **The current version of the standard, ICC/ANSI A117.1–1998, does recognize and allow for the installation of ceiling-mounted visual alarm appliances in Chapter 7 – Communication Elements and Features.** The mounting locations, spacing allocations, and minimum effective intensities for ceiling-mounted devices stated within this chapter are identical to those found in NFPA 72:

> **ICC/ANSI A117.1–1998 Accessible and Usable Buildings and Facilities**
> Chapter 7. Communication Elements and Features
> 702 Alarms
> 702.3.3.2 Ceiling-Mounted Appliances.
> Appliances shall be on the ceiling. Where ceiling height exceeds 30 feet, appliances shall be suspended from the ceiling to a height of 30 feet maximum above the floor or ground.

This standard, in past (CABO/ANSI A117.1 - 1992) and current (ICC/ANSI A117.1- 1998) versions, is "intended for adoption by government agencies and by organizations setting model codes to achieve uniformity in the technical design criteria in building codes and other regulations". As such, the four major building codes governing construction within the United States reference the current version (1998) of the ICC/ANSI A117.1 standard for accessibility requirements, and thus all recognize ceiling-mount devices:

1.) **International Building Code / 2000** – Appendix E 'Supplementary Accessibility Requirements'
Section E1101.2 Design. Technical requirements for items herein shall comply with this code and ICC/ANSI A117.1.

2.) **The BOCA® National Building Code / 1999** – Chapter 11 'Accessibility'
Section 1101.1 Scope: The provisions of this chapter shall control the design and construction of facilities for accessibility to physically disabled persons. Facilities that comply with this chapter and ICC A117.1 listed in Chapter 35 shall be considered accessible.

3.) **Standard Building Code, SBCCI, 1997** – Chapter 11 'Accessibility for People with Physical Disabilities'
1101.1.4 Details, dimensions, and construction specifications for items herein shall comply with the requirements of CABO/ANSI A117.1.

4.) **1997 Uniform Building Code™, Volume 1** – Chapter 11 'Accessibility'
Section 1101 – Scope
1101.3 Design. The design and construction of accessible buildings and building elements shall be in accordance with this chapter and CABO/ANSI A117.1–1992. For a building to be considered accessible, it shall be designed and constructed to the minimum provisions of this chapter and CABO/ANSI A117.

Conclusion

From a building design and construction standpoint, ANSI A117.1, the building standard for accessibility and NFPA72, the National Fire Alarm Code, both recognize ceiling-mount visual alarm appliances and describe the requirements for intensity, mounting, and placement for such appliances. As noted, the current version of the ADAAG (1991) does not. While compliance with all three is generally required, the only method to satisfy the requirements of ANSI A117.1/NFPA 72 and the ADAAG, and thus to be able to install ceiling-mounted appliances, is to claim equivalent facilitation.

Equivalent facilitation, as defined in the current ADAAG Section 2.2, states that "alternatives to specific requirements that provide equal or greater access are permitted". The ADAAG further states that equivalent facilitation "provides flexibility for new technologies and innovative design solutions that may not have been taken into account when ADAAG was developed". Equivalent facilitation, in the instance of visual alarm appliances, may be used to demonstrate that any proposed substitute will deliver the minimum illumination (or light intensity) requirements. The use of ceiling-mounted visual alarm appliances in lieu of wall-mounted appliances, as supported by a demonstration of equivalent facilitation, requires the approval of the appropriate authority having jurisdiction (AHJ).

Ceiling Mount
Minimum Light Output by Room Size (Non-Sleeping)

	20′ × 20′	30′ × 30′	40′ × 40′	50′ × 50′
10′ Ceiling	15 cd	30 cd	60 cd	95 cd
20′ Ceiling	30 cd	45 cd	80 cd	115 cd
30′ Ceiling	55 cd	75 cd	115 cd	150 cd

Where ceiling heights exceed 30′ the NFPA states that "visible signaling appliances shall be suspended at or below 30′ or wall mounted." Candela requirements for ceiling strobes, presented in the table to the right, assume location of the strobe in the center of the room. "Where it is not located in the center of the room, the candela level shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size."

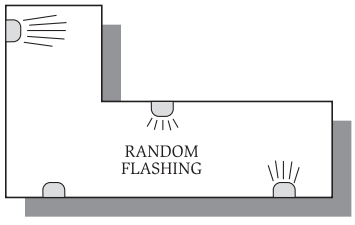
What About Photosensitive Epilepsy and Strobe Flash Rates?

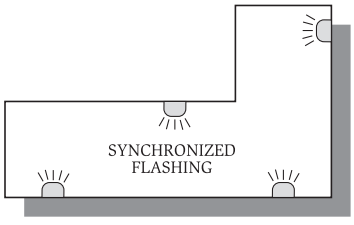
Those persons who are vulnerable to photosensitive epilepsy have voiced concern over the cumulative effect of seeing multiple flashing strobes in the field of view.

An example of this would be an individual standing at the cross-point of an "L" shaped corridor that contains multiple strobes. During an alarm or test of a system, the person could be exposed to a cumulative flash rate that might increase the probability of seizure and photosensitive response.

Although aggregate strobe flash rates in a fire alarm system and their relationship to those persons with photosensitive epilepsy are not directly referenced in any current law or standard, it is an issue that should be addressed with diligence when installing and/or upgrading fire alarm systems.

Although one solution involves synchronized (simultaneous flashing) strobes, other options have been outlined by NFPA and the proposed ADAAG. The NFPA makes it clear in Chapter 4, Section 4-4.4.1.1 that synchronization is only one of several installation configurations that the systems designer can use to minimize multiple strobes flashing in an individual's field of view. These four options are outlined on page 6. Also, in 1996 the NFPA changed its maximum acceptable strobe flash rate from 3 Hz down to 2 Hz, again, in an effort to reduce strobe flash rates in an individual's field of view.





Audibility Requirements

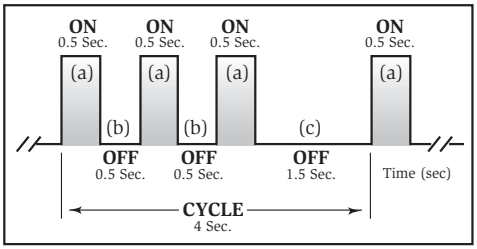
The focus of notification appliance code development over the last several years has centered around the visible portion of the devices to aid hearing impaired individuals during a fire emergency. Even with this focus it is important to remember that there are code requirements for the audible portion of the device as well. Although the ADA has audibility requirements, NFPA 72 Chapter 4 has the more stringent set. Therefore, the highlights of NFPA's notification appliance audibility requirements are outlined below.

As defined by the NFPA, the location of an audible appliance shall be not less than 90″ above the floor and not less than 6″ below the ceiling. This requirement is superseded by strobe location requirements when an audible appliance is installed in combination with a strobe.

Temporal Evacuation Signal

The most recent audibility requirement to be adopted by the NFPA is the Temporal Code. This code was developed to establish a universal evacuation signal to lessen confusion as to whether an alarm represents an emergency requirnig complete evacuation of the building.

This tone pattern is a 0.5 second on phase, followed by a 0.5 off phase for three successive on phases, followed by an off phase of 1.5 seconds. The pattern is then repeated for a minimum of 180 seconds.



Key:
Phase (a) signal is "on" for 0.5 sec ± 10%
Phase (b) signal is "off" for 0.5 sec ± 10%
Phase (c) signal is "off" for 1.5 sec ± 10% [(c) = (a) + 2(b)]
Total cycle lasts for 4 sec ± 10%

*Note: The temporal evacuation signal is a system requirement and is addressed in NFPA 72, 1999 Edition, Chapter 3, Section 3-8.4.1.2.

Public Mode Sound Level

NFPA's minimum public mode dBA output is the highest of three possible scenarios measured 5′ above the floor.

- 75 dBA at 10′
- 15 dBA above average ambient sound
- 5 dBA above the maximum sound level with a duration of at least 60 seconds.

NFPA's maximum public mode dBA output is 120 dBA anywhere.

The ADA's public mode audibility requirements are the same as NFPA's except the ADA does not require 75 dBA at 10′ as a minimum.

Private Mode Sound Level

NFPA's minimum private mode dBA output is the highest of three possible scenarios measured 5′ above the floor.

- 45 dBA at 10′
- 10 dBA above average ambient sound
- 5 dBA above the maximum sound level with a duration of at least 60 seconds

NFPA's maximum private mode dBA output is 120 dBA anywhere.

Sleeping Area Sound Level

NFPA's minimum sleeping area dBA output is the highest of three possible scenarios measured 5′ above the floor.

- 70 dBA at 10′
- 15 dBA above average ambient sound
- 5 dBA above the maximum sound level with a duration of at least 60 seconds

NFPA's maximum sleeping area dBA output is 120 dBA anywhere.

Mechanical Equipment Room Sound Level

The NFPA states that 85 dBA, as opposed to 75 dBA, is the minimum acceptable ambient sound level to use for design guidance.

Average Ambient Sound

Ambient sound levels are referred to on the previous page of this guide as well as all notification appliance codes. The table below shows examples of what average ambient sound levels may be dependent upon the application. The table shown below is taken from NFPA 72's Appendix A-4-3.2. Keep in mind that the table only represents examples and should not be used as a substitute to taking actual on-site measurements. In the same appendix, the NFPA states the following regarding the measurement of average ambient sound:

Average Ambient Sound Level According to Location

Locations	Average Ambient Sound Level
Business occupancies	55 dBA
Educational occupancies	45 dBA
Industrial occupancies	80 dBA
Institutional occupancies	50 dBA
Mercantile occupancies	40 dBA
Piers and water-surrounded structures	40 dBA
Places of assembly	55 dBA
Residential occupancies	35 dBA
Storage occupancies	30 dBA
Thoroughfares, high density urban	70 dBA
Thoroughfares, medium density urban	55 dBA
Thoroughfares, rural and suburban	40 dBA
Tower occupancies	35 dBA
Underground structures and windowless buildings	40 dBA
Vehicles and vessels	50 dBA

"When surveying the ambient sound levels to establish the increased level at which a notification appliance will properly function, the sound source needs to be averaged over a longer period of time. Moderately priced sound level meters have such a function, usually called 'L_{eq}' or 'equivalent sound level.' For example, an L_{eq} of speech in a quiet room would cause the meter movement to rise gradually to a peak reading and slowly fall well after the speech is over."

"L_{eq} readings can be misapplied in situations where the background ambient noises vary greatly during a 24-hour period. L_{eq} measurements should be taken over the period of occupancy."

It is increasingly important, with the advent of ADA, UL 1971 and NFPA 72, Chapter 4, that a voltage drop calculation be made during the layout or retrofit of indicating circuits to determine if the indicating appliances will operate within their specifications.

Voltage Drop Calculations

A quick estimate of voltage drop at the last device in the circuit can be done by using Ohm's Law:

V= IR (Voltage= Current × Resistance)

To accomplish this, you must know the following about the circuit you are about to design.

- Total current draw of all appliances on the indicating circuit
- Wire size
- Length of circuit
- Resistance of the wire

The resistance of conductors can be found using the information provided in the National Electrical Code (NFPA 70), Chapter 9, Table: Conductor Properties. A portion of this table is shown below.

With this information, the voltage drop at the last device can be determined by using the formula:

$$V_{drop} = \text{(total current draw of appliances)} \times \text{(resistance of the wire)}$$

Some manufacturers recommend that circuits be designed so that no greater than a 10% voltage drop is experienced. This would mean less than 2.4 VDC for a 24 VDC system (to 21.6 VDC) and less than 1.2 VDC for a 12 VDC system (to 10.8 VDC). Refer to the manufacturer of the equipment you are using for specific device requirements.

Conductor Properties

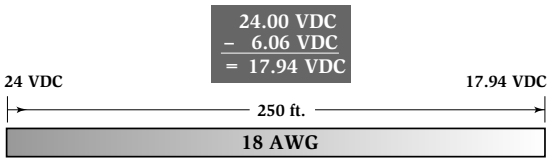
Size AWG/ kcmil	Area Cir. Mills	Conductors: Stranding Quant.	Stranding Diam. in.	Overall Diam. in.	Overall Area in.²	DC Resistance at 75°C (167°F): Copper Uncoated ohm/kFT	Copper Coated ohm/kFT	Aluminum ohm/ kFT
18	1620	1		0.040	0.001	7.77	8.08	12.8
18	1620	7	0.015	0.046	0.002	7.95	8.45	13.1
16	2580	1		0.051	0.002	4.89	5.08	8.05
16	2580	7	0.019	0.058	0.003	4.99	5.29	8.21
14	4110	1		0.064	0.003	3.07	3.19	5.06
14	4110	7	0.024	0.073	0.004	3.14	3.26	5.17
12	6530	1		0.081	0.005	1.93	2.01	3.18
12	6530	7	0.030	0.092	0.006	1.98	2.05	3.25

Example

What is the voltage at the last device of a 24 VDC system that uses 12 notification appliances (each drawing 0.125A and having an operating voltage range from 20 VDC to 30 VDC) with 250' of 18 AWG (solid copper, two conductor) cable? From NFPA 70, we find that 18 AWG solid copper wire has a resistance of 8.08 ohms per 1,000 feet. Therefore, the resistance of 500' of wire (250' of two conductor cable) is:

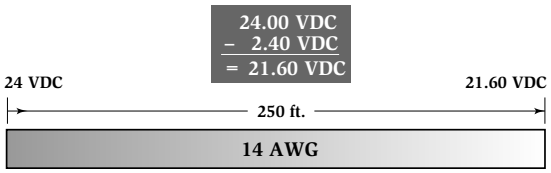
wire length / 1,000 × ohms / 1,000 =
0.50 x 8.08 = 4.04 ohms

$$V_{drop} = (12 \times 0.125) \times 4.04 = 6.06 \text{ VDC}$$



The voltage at the last device would be 17.94. Obviously, this is not within the range for the notification appliance to function properly. If 14 AWG solid copper wire is used instead of 18 AWG, the voltage drop changes to:

$$V_{drop} = (12 \times 0.125) \times 1.6 = 2.4 \text{ VDC}$$



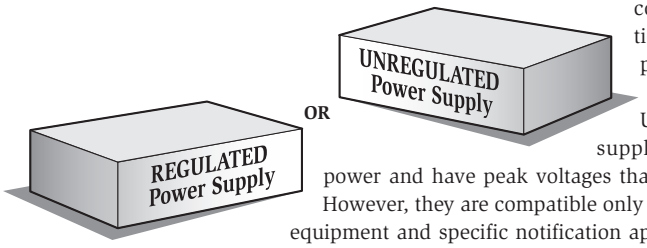
The voltage at the last device will be 21.6 VDC which is within the operating range of the devices used and satisfies the minus 10% rule mentioned above. Remember, it is still necessary to ensure the power supply is capable of supplying the necessary electrical current for the notification appliances.

This quick estimate of voltage drop is simple to perform and should be done in the planning stages, before devices are installed, to eliminate problems later.

Power Supply Considerations

Because of the relatively high current draw of UL 1971 strobes, the choice of an appropriate power supply is critical.

There are two proper power supply alternatives: regulated and unregulated. Regulated power supplies provide filtered and regulated DC power, are compatible with fire protective signaling panels, and are designed for use with any compatible notification appliance of the proper voltage.



Unregulated power supplies provide DC power and have peak voltages that may be very high. However, they are compatible only with specific control equipment and specific notification appliances. It is therefore important to verify with the fire panel manufacturer or power supply vendor that their supply can handle the number and type of strobes you intend to install.

Power Limiting Issues

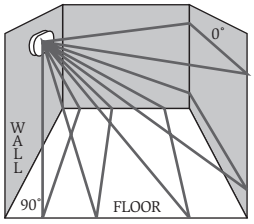
UL's power limiting requirements have made newer power supplies far more sensitive to fold back and notification appliance circuit shut down. Therefore, it is important to understand the operating characteristics of the power supplies chosen for use in any fire system. The characteristics of every power supply model vary and these characteristics determine the number of notification appliances that will effectively operate on a power supply's loop.

Whether to use average, peak or in-rush currents when sizing a notification appliance circuit will vary by manufacturer and power supply model. It is therefore recommended that system designers confirm the best method of sizing a notification appliance loop with the power supply or panel manufacturer prior to notification circuit design.

What Is Meant By Polar Light Distribution?

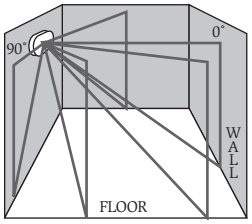
UL 1971 requires a polar light distribution pattern to enhance the likelihood of alerting hearing impaired individuals throughout an area. Polar refers to the way the standard measures light intensity —both horizontally and vertically—at viewing angles ranging from 0 to 180 degrees. The adjacent diagrams show the values required for wall mounted and ceiling mounted units.

Wall Mount Vertical Distribution



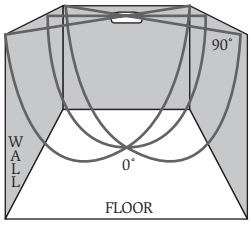
Degrees	Percent of Rating
0	100
5-30	90
35	65
40	46
45	34
50	27
55	22
60	18
65	16
70	15
75	13
80	12
85	12
90	12

Wall Mount Horizontal Distribution



Degrees	Percent of Rating
0	100
5-25	90
30-45	75
50	55
55	45
60	40
65	35
70	35
75	30
80	30
85	25
90	25

Ceiling Mount Horizontal Distribution



Degrees	Percent of Rating
0	100
5-25	90
30-45	75
50	55
55	45
60	40
65	35
70	35
75	30
80	30
85	25
90	25

Glossary

Access Board See Compliance Board.

ADA The Americans With Disabilities Act. An act of Congress intended to ensure civil rights for physically challenged people.

ADAAG The Americans With Disabilities Act Accessibility Guidelines. Developed as "rules" to help people comply with the ADA.

ANSI American National Standards Institute. Develops guidelines and standards, often incorporating NFPA standards for the installation and maintenance of fire safety equipment in buildings. Developed ANSI 117.1–Accessible and Usable Buildings and Facilities.

Average Ambient Sound The average sound level measured in a given area over the period of occupancy.

BCMC Board for Coordination of Model Building Codes.

CABO Council of American Building Officials.

Candela (cd) Unit of light intensity.

Compliance Board The United States Architectural and Transportation Barriers Compliance Board. The body responsible for developing the ADA Accessibility Guidelines (ADAAG) and interpretive instructions on the ADA and ADAAG in "Bulletins." Bulletin #2 focuses on visible signaling; Bulletin #5 focuses on using ADAAG.

EFA Epilepsy Foundation of America.

Footcandle Illuminance of a 1 candela source measured 1 foot away from the source.

Lumen Amount of light emitted by a 1 candela source passing through a specified area in space.

NEMA Signaling Section National Electrical Manufacturers Association. Body of manufacturers who design, develop, manufacture and distribute visible and audible signaling devices as well as other components of fire alarm systems.

NFPA National Fire Protection Association. Develops guidelines and standards for the installation and maintenance of fire safety equipment.

NFPA 72 Chapter 4 The chapter of the National Fire Alarm Code detailing installation standards for notification appliances for fire alarm systems.

Ohm's Law Voltage = Current × Resistance

"On Axis" A way of describing the "plane" of or uni-directional light generated from a strobe light. Often used to describe certain UL Standard 1638 strobe lights which send their light out primarily in front of the device.

Polar Way of describing light output in 2-dimensional space. Plotted as output in candela vs. angle.

Private Mode Applications where the signal is known to be in place and where someone is trained to take additional action upon notification from the signal.

Public Mode The mode of operation for both visible and audible where the signal is intended to alert anyone in the protected area whether aware or unaware of its presence.

Temporal Code A universal fire evacuation sound pattern adopted by NFPA in 1996. This tone pattern is a 0.5 second on phase followed by a 0.5 second off phase for three successive on phases followed by an off phase of 1.5 seconds. The pattern is then repeated for a minimum of 180 seconds.

UL Standard 1638 The UL standard governing private and general mode signaling applications as of April 1, 1994. A performance standard. Tests light output and distribution per manufacturer's specifications when the device is intended for emergency signaling. (Note: devices may also be tested for only fire and shock hazard for non-emergency signaling.) Minimum flash rate of ⅓ to 3 flashes per second. Listed device is "not to be used as an evacuation signal for the hearing impaired."

UL Standard 1971 The UL standard governing all public mode fire applications as of April 1, 1994. A performance standard. Includes specific light output and distribution requirements to ensure illumination throughout an area defined by NFPA 72. Minimum flash rate of ⅓ to 3 flashes per second. Categorizes minimum light intensities by area: non-sleeping (15 cd), corridor (15 cd) and sleeping areas (110 cd (wall) or 177 cd (ceiling).

Voltage Drop The decrease in voltage from the beginning of a circuit to the end of a circuit due to resistance.

NOTE: System Sensor does not approve, inspect, or certify any installations, procedures, equipment, or materials. In determining the acceptability of installations or procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items. The information in this guide has been provided in an attempt to assist in making this decision and should in no way be construed as a formal approval or certification.

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