# Audible Visible Appliance Reference Guide

SYSTEM SENSOR®

# Audible Visible Appliance Reference Guide

## Contents



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

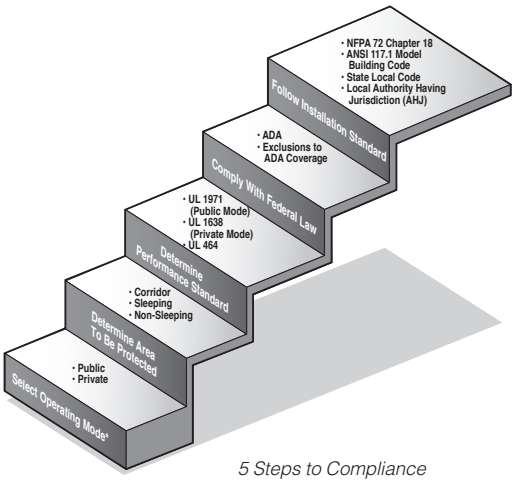
The installation and performance requirements for audible/visible appliances in general are addressed in three documents: 1. ADAAG, 'Americans with Disabilities Act Accessibility Guidelines', the Federal Civil Rights Law prohibiting discrimination on the basis of disability, 2. ANSI 117.1–2009 'Accessible and Usable Buildings and Facilities', a standard on accessibility designed to be adopted as part of a building code, and 3. NFPA 72, the National Fire Alarm Code and Signaling Code 2010 or 2013 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.

In the past audible/visible requirements of NFPA 72 differed from the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and other accessibility standards such as ANSI 117.1 2003 Accessibility and Usable Buildings and Facilities. Section 702.1 of ANSI 117.1-2009 reads "Accessible audible and visual alarms and notification appliances shall be installed in accordance with NFPA 72 listed in Section 105.2.2, be powered by a commercial light and power source, be permanently connected to the wiring of the premises electric system, and be permanently installed." Therefore, the standards 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. On Friday, July 23, 2010, Attorney General Eric Holder signed final regulations revising the Department's ADA regulations, including its ADA Standards for Accessible Design. As such, the 2010 edition of the ADA Standards have been harmonized with the latest editions of NFPA 72.

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.

Section 1
## What Is Required To Comply?

Compliance entails adhering to the adopted model building code NFPA 72, installation, and UL 1971, UL 1638, UL 464 product 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 below illustrates the five steps to compliance.




*5 Steps to Compliance*

Section 2
## What Is The ADAAG?

The ADAAG is the official standard for accessible design under Title III of the ADA. It covers only new construction and alterations made to the fire alarm system undertaken by facilities covered by the ADA. The ADAAG was written by 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."

Most 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 and the International Building Code, 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." NFPA 72, National Fire Alarm and Signaling Code provides guidance for equivalent facilitation to comply with ADA requirements. See Performance Based Alternative section 13.

### Exclusions to ADA Coverage:

- Individual employee offices and work stations. Arrangements should be made, however, 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 the Architectural 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).

Section 3
## 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 Commercial Facilities**
Enforced by: Department of Justice (DOJ)

**Title IV: Miscellaneous Provisions**

Section 4
## What Is "Public Mode" vs. "Private Mode" Operation?

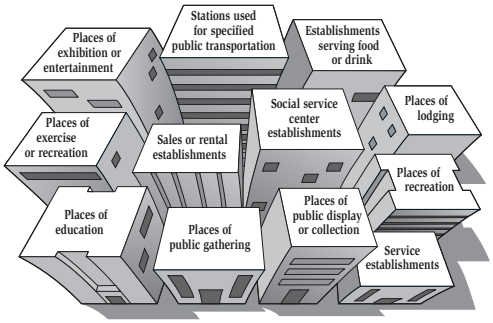
*"Private mode" applications* are those where a signal is known to be in place and where someone is trained to take additional action upon notification from the alarm signal. Examples include control rooms, nurses' stations and guard desks. These emergency signaling applications may not have to meet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




Section 5

## Where Should Strobes Be Located?

According to NFPA 72 2010 and 2013 Edition, Chapter 18 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. If the room configuration is not square, the size square that will encompass the entire room is to be used (see Figure 1).

NFPA 72 requires strobes to be located so that the illumination can be seen regardless of the viewer's orientation, with maximum spacing between devices, not to exceed 100 ft. (see Figure 2).

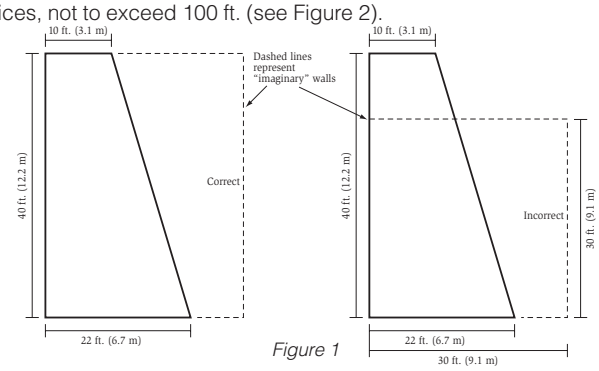



*Figure 1*

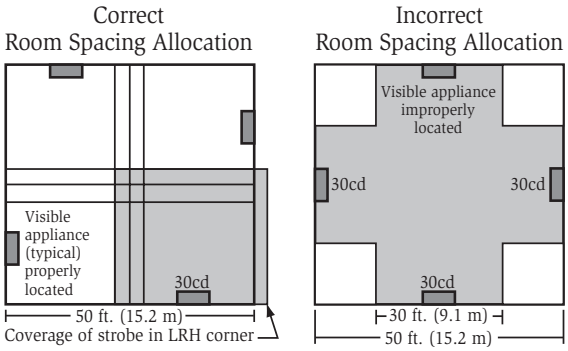



*Figure 2*

### Corridor Spacing for Visible Appliances

For ***corridors,*** NFPA specifies strobe location not more than 15 ft. from the end of the corridor, with a maximum separation of 100 ft.. Corridor spacing of strobes is specified as shown in Table 1 below. Typical corridor placement is shown in Figure 3.

### Table 1. 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´ | ■ | ■ | ■ | ■ | ■ | ■ |

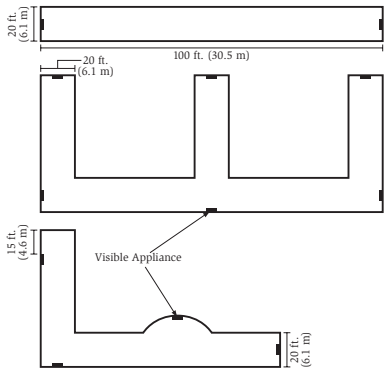



*Figure 3*

### Non-Sleeping Rooms

In non-sleeping areas NFPA requires that wall mount visible notification appliances be installed such that the entire lens is not less than 80 inches and not greater than 90 inches above the finished floor. Where low ceiling heights do not permit mounting at a minimum of 80 inches, visible appliances shall be mounted within 6 inches of the ceiling. (see 18.5.4.1 and 18.5.4.2) and for ceiling mounted strobes, no more than 30 ft. above the floor. Refer to the Annex of NFPA 72 for exceptions to these guidelines(A.18.5.4.3).

NFPA specifies varying minimum required light outputs for ***non-sleeping*** rooms (see Section 14 - Reference Material).

### Sleeping Rooms

In ***sleeping areas,*** where the mounting height is within 24 in. or less of the ceiling, the required intensity is 177 cd. When the distance would be more than 24 in. to the ceiling, light intensities of 110 cd may be provided (see Figure 4).

### Strobe Requirements for Sleeping Area

| Distance from Ceiling to Center of Lens | Intensity |
|---|---|
| Greater than or equal to 24 in. (610 mm) | 110 cd |
| Less than 24 in. (610 mm) | 177 cd* |

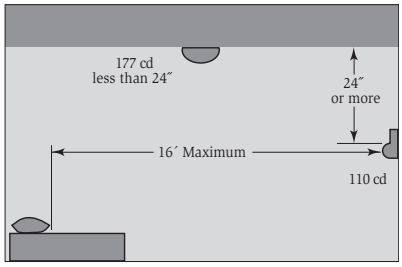



*Figure 4*

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

Section 6

## How Many Strobes Should Be Used?

NFPA 72 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 tables 18.5.4.3.1(a), 18.5.4.3.1(b) and figure 18.5.4.3.1 in this section of NFPA 72 2010 and 2013:

1. Use a single visible notification appliance.
2. Use two visible notification appliances located on opposite walls.
3. Two groups of visual notification appliances, where visual appliances of each group are synchronized, in the same room or adjacent space within the field of view. This shall include synchronization of strobes operated by separate systems.
4. More than two visible notification devices or groups of synchronized appliances in the same room or adjacent space within the field of view that flash in synchronization.

* Field of view= 135˚

Section 7

## 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. ADA, a civil rights law prohibiting discrimination on the basis of disability; 2. IFC 2012 Edition/ ANSI 117.1–2009 'Accessible and Usable Buildings and Facilities', a standard on accessibility designed to be adopted as part of a building code; and, 3. NFPA 72, the National Fire Alarm and Signaling Code, 2010 and 2013 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, IFC 2006 Edition/ANSI A117.1–2009 and NFPA 72, 2010 and 2013 edition, both recognize ceiling-mount visual alarm appliances and describe the requirements for intensity, mounting, and placement for such appliances. The 1991 version of the ADAAG 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. Or, ask for a variance from the Authority Having Jurisdiction.

The definition of equivalent facilitation is provided within Chapter 1, Section 103 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 may not have been taken into account when the ADAAG was developed."*

### 2010 ADA Standards and Ceiling-Mount Visual Alarm Appliances

The 2010 ADA Standards for Accessible Design has great importance to members of the fire alarm industry because it is used as a reference to define the provisions for accessibility within the design and construction of accessible buildings. The 2010 ADA Standards for Accessible Design addresses ceiling-mounted audible/visible devices, in terms of installation and performance, in a manner that is consistent with the current versions of NFPA72 and ICC/ANSI A117.1.

### ANSI A117.1-2009 and NFPA 72 Harmonized

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 A117.1–2009 refers to NFPA 72 for the mounting locations, spacing allocations, and minimum effective intensities for ceiling-mounted devices. In the 2010 and 2013 Edition of NFPA 72, if ceiling heights exceed 30 feet, ceiling mounted visible notification appliances shall be suspended at or below 30 feet, or wall-mounted visible notification appliances shall be installed. Table 18.5.4.3.1(b) Room Spacing for (Ceiling-Mounted Visible Appliances) shall be used if the ceiling mounted visible notification appliance is at the center of the room. If the ceiling-mounted visible notification appliance is not located at the center of the room, the effective intensity (cd) shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size.

This standard (ICC/ANSI A117.1) "is available for adoption and use by jurisdictions internationally. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction's laws."

### Ceiling Mount

**Minimum Light Output by Room Size (Non-Sleeping)**

| | 20 ft.× 20 ft. | 30 ft.× 30 ft. | 50 ft.× 50 ft. | 70 ft.× 70 ft. |
|---|---|---|---|---|
| **10 ft. Ceiling** | 15 cd | 30 cd | 95 cd | 185 cd |
| **20 ft. Ceiling** | 30 cd | 45 cd | 95 cd | 185 cd |
| **30 ft. Ceiling** | 55 cd | 75 cd | 95 cd | 185 cd |

Where ceiling heights exceed 30 ft. the NFPA states, "Visible signaling appliances shall be suspended at or below 30 ft. or wall mounted." Candela requirements for ceiling strobes, presented in the table above, 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." For Ceiling mount devices over 30 feet, refer to Performance Based-Alternative in 18.5.4.5.

### Conclusion

From a building design and construction standpoint, ANSI A117.1, the building standard for accessibility, NFPA 72, the National Fire Alarm and Signaling Code and the 2010 ADA Standards for Accessible Design recognize ceiling-mount visual alarm appliances and describe the requirements for intensity, mounting, and placement for such appliances.

Section 8

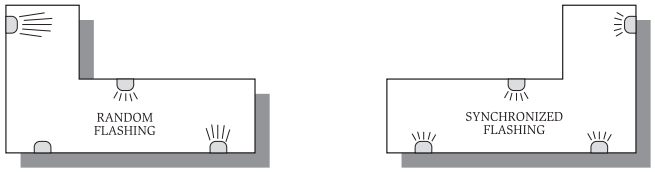
## What About Photosensitive Epilepsy and Strobe Flash Rates?

People 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 72 and the proposed ADAAG. NFPA 72 makes it clear in Chapter 18, Section 18.5.4.3 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. The 2010 edition of NFPA 72 added that the strobe synchronization requirements of Chapter 18 do not apply where visible notification appliances located inside the building are viewed from outside of the building. In 1996 the NFPA changed its maximum acceptable strobe flash rate from 3 Hz to 2 Hz in an effort to reduce strobe flash rates in an individual's field of view.




Section 9

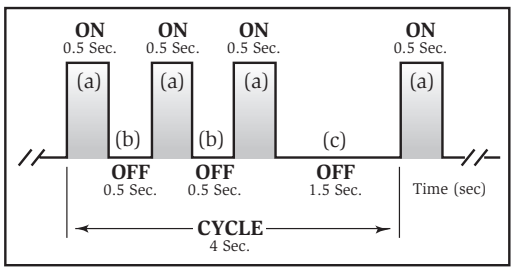
## Audibility Requirements

The focus of notification appliance code development over the last several years 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.
As defined by the NFPA, the location of a wall-mounted audible appliance shall have their tops not less than 90 in. above the floor and not less than 6 in. 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 audibility requirement adopted by 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 requiring 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, Chapter 18. Standard evacuation signal shall be synchronized within a notification zone.

### Public Mode Sound Level

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

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

### Private Mode Sound Level

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

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

### Sleeping Area Tone Requirement

NFPA 72 2010 edition, Chapter 18, Section 18.4.5, has introduced a new requirement that effective January 1, 2014, where audible appliances are provided to produce signals for sleeping areas, they shall produce a low frequency alarm signal that has a fundamental frequency of 520Hz +- 10% and shall be a square wave or provide equivalent awakening ability.

The code was developed based on studies that a low frequency tone, around 520 Hz, is more effective at waking sleeping individuals than a traditional 3KHz tone. The low frequency is also effective for occupants that have mild to severe hearing loss. This requirement is also in the 2013 edition of NFPA 72.

### Sleeping Area Sound Level

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

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

### General Requirements

An average ambient sound level greater than 105 dBA shall require the use of a visible notification appliances(s) for public or private mode applications.

NFPA's maximum dBA output is 110 dBA at the minimum hearing distance.

Section 10

## Audible Visible Appliances for ECS/MNS Applications

Emergency Communication Systems are a single control system or may serve as an interconnection of several control systems for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action. NFPA 72: 2010 and 2013, Chapter 24 defines the requirements for ECS systems that are integrated in a fire alarm system.

Where audible notification is provided, mass notification systems shall also provide visible notification information to serve the hearing impaired and for high noise areas. Strobe placement requirements are common per NFPA 72, Chapter 18.

There is distinction in regards to the standard compliance for ECS/MNS systems. In most cases for ECS/MNS applications the color of the lens can be something other than clear. In addition, if the color of the strobe is something other than clear then it is not required to be listed to ANSI/UL 1971 but the devices must be tested to meet the ANSI/UL 1971 polar light distribution.

** Colored lens products cannot be listed to ANSI/UL 1971 because the standard requires that the light be clear or white.*

Strobes used in combination systems, where the same strobe is used for both mass notification and fire notification shall be of clear lens and comply with ANSI/UL 1971 requirements.

Section 11

## Voltage Drop Calculations

Voltage drops occur in the wiring, causing the voltage at the end of the loop to be lower than the supply voltage. In laying out a circuit, it is important to prove that the voltage supplied to the last device on the loop is greater than its minimum operating voltage designated by UL testing.

The following should be taken into consideration when estimating the worst case voltage drop:

- The minimum possible voltage at which the particular power supply will operate as defined by UL testing.
- The minimum voltage supplied to the circuit.
- The total current drawn by the appliances on the circuit.
- The length of the circuit, from the power supply to the last device.
- The wire size.
- The total wiring resistance (determined from the length of the circuit and the wire size).

When calculating the voltage available to the last device, it is necessary to consider the voltage drop due to the resistance of the wire. The thicker the wire, the smaller the voltage drop. Generally, for purposes of determining the wire size necessary for the system, it is best to consider all of the devices as “lumped” on the end of the supply circuit to simulate worst case.

For the most accurate voltage drop calculations use the System Sensor voltage drop calculator available at www.systemsensor.com/volt.

**Approximate wire resistance:**
18 AWG solid: 8 ohms/1000 ft.
16 AWG solid: 5 ohms/1000 ft.
14 AWG solid: 3 ohms/1000 ft.
12 AWG solid: 2 ohms/1000 ft.
NOTE: If Class A wiring is installed, the wire length may be up to twice as long as on non-fault tolerant circuits.

The total wiring resistance is determined by multiplying the ohms/foot of the wire being used by the total length of the wiring. The length of the circuit must be multiplied by two to get the total length of the wiring (to account for two conductors in the wire).

With this information the voltage drop in the wiring can be determined using the formula:

$$V_{DROP} = (\text{Total Current Draw}) \times (\text{Total Wiring Resistance})$$

The voltage at the end of the circuit is then determined by the formula

$$V_{EOL} = V_{SUPPLY} - V_{DROP}$$

The above calculations should be made using the minimum supply voltage specified by the manufacturer of the supply.

If the calculated result for $V_{EOL}$ is less than the minimum rated voltage of the appliances being used, then changes need to be made in the design of the circuit. Somewhat more favorable results may also be attained by analyzing the circuit in more detail, where the exact location of each appliance in the circuit is taken into account. This approach is most easily accomplished by using a computerized program, like the one on the System Sensor website.

### Example

Let’s go through a lump sum example. A 24-volt notification circuit needs to drive 12 appliances. Each appliance has a rated operating voltage range of 16 – 33 volts and draws 125 mA. The length of the circuit is 250 feet from the power supply to the last device. The proposed wire is 18 AWG solid copper. Will this system provide adequate voltage to the last device on the circuit?

From the wiring tables, the resistance of the wire is 8.08 ohms/1000 feet. The total length of the wire is 500 feet (250 feet of two wire cable). Therefore, the total resistance of the wire is

$$R_{WIRING} = 8.08 \times 500/1000 = 4.04 \text{ ohms}$$

The total current in the circuit is

$$I_{TOTAL} = 12 \text{ appliances} \times 125 \text{ mA/appliance} \times .001 \text{ amp/mA} = 1.5 \text{ amps}$$

Voltage dropped (or lost) in the wiring thus becomes

$$V_{DROP} = I_{TOTAL} \times R_{WIRING} = 1.5 \times 4.04 = 6.06 \text{ volts}$$

Voltage available at the end of the circuit is calculated by subtracting $V_{DROP}$ from the supply voltage. Assuming a worst case supply voltage 15% below nominal, the result is

$$V_{EOL} = 20.4 - 6.06 = 13.8 \text{ volts}$$

Since this voltage is less than the operating voltage of the appliances (16 volts), the circuit design is not acceptable. If we switch from 18 AWG wire to 16 AWG and repeat the calculations

$$R_{WIRING} = 5.08 \times 500/1000 = 2.54 \text{ ohms}$$
$$I_{TOTAL} = 12 \text{ appliances} \times 125 \text{ mA/appliance} \times .001 \text{ amp/mA} = 1.5 \text{ amps}$$
$$V_{DROP} = I_{TOTAL} \times R_{WIRING} = 1.5 \times 2.54 = 3.8 \text{ volts}$$
$$V_{EOL} = 20.4 - 3.8 = 16.6 \text{ volts}$$

Since the worst case voltage at the end of the circuit is now greater than the minimum voltage required for the appliances, this design would be acceptable.

Voltage drop calculations should be done during the planning stages of an installation, prior to installing any wiring or devices. There is no simple fix if it turns out that a fully installed system cannot meet the requirements of the appliances connected to it.

In designing the notification circuit, it is also important to make sure that the power supply is capable of supplying the appropriate voltage and current levels required by the appliances.

Section 12
## Power Supply Considerations

Because of the relatively high currents drawn by fire alarm strobe lights, and the current surges associated with them, the choice of an appropriate power supply is critical to the proper operation of the overall system. Before beginning the layout of the NAC wiring, it is important for the designer to verify that the proposed power supply, or fire panel, will meet the needs:

- It must be compatible with the notification appliances that will be used
- It must be capable of providing enough current for all of the appliances on the circuit.
- It must be a compatible regulated power supply

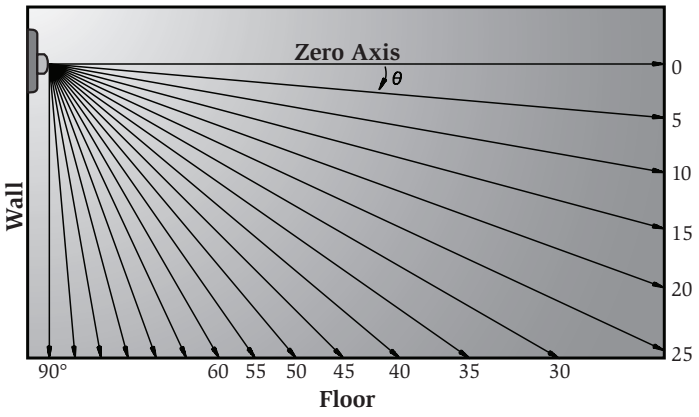
It is important to understand the operating characteristics of the power supplies chosen for use in any fire system. The characteristics of every power supply model vary and these characteristics determine the number of notification appliances that will effectively operate on a power supply's loop. Underwriters Laboratories standards UL 1971 & 464 require that operating current measurements are made using RMS (root mean square) instead of peak or average values. RMS measurements more accurately predict the power consumption of a device since they take into account the entire current draw profile including surge, repetitive surge, and peak values.

The published RMS current is the maximum operating current of that device within its operating voltage range. This current maximum may or may not occur at the endpoints of the voltage range. The UL revisions standardize how operating currents are measured.

Section 13
## What is Meant by Polar Light Distribution?

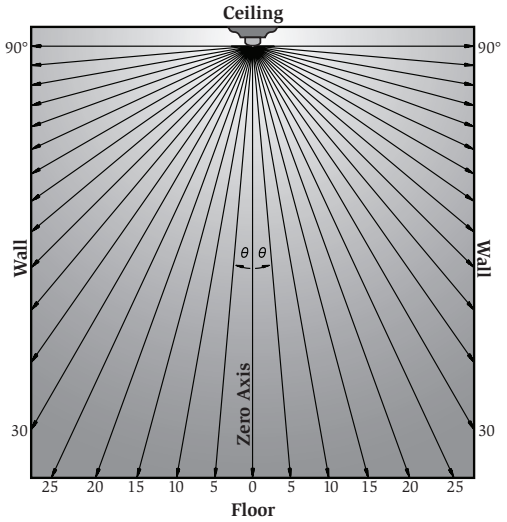
UL 1971 requires a polar light distribution pattern to enhance the likelihood of alerting hearing impaired individuals throughout an area. Polar refers to the way the standard measures light intensity —both horizontally and vertically—at viewing angles ranging from 0 to 180 degrees. The following diagrams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

**Light Output –**
**Vertical Dispersion, Wall To Floor**

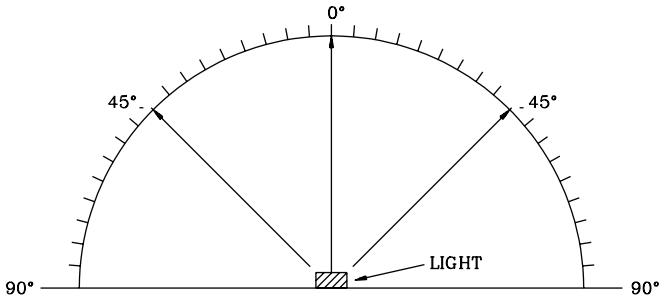



| Degrees | Percent of Rating |
|---|---|
| 0 | 100 |
| 5-30 | 90 |
| 35 | 65 |
| 40 | 46 |
| 45 | 34 |
| 50 | 27 |
| 55 | 22 |
| 60 | 18 |
| 65 | 16 |
| 70 | 15 |
| 75 | 13 |
| 80 | 12 |
| 85 | 12 |
| 90 | 12 |

**Light Output –**
**Vertical Dispersion, Ceiling To Walls And Floor**




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




*Light output - horizontal dispersion*

| 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 |
| Compound 45 to the right | 24 |
| Compound 45 to the right | 24 |

## Performance- Based Alternative

Equivalent facilitation is the concept of utilizing innovative solutions and new technology, design or materials in order to satisfy the guidelines. These alternative solutions provide equal access and take advantages of new developments, but may differ technically from specific guidelines.

The Access Board, also known as the Architectural and Transportation Barriers Compliance 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.

NFPA 72:2010 and 2013, provides guidance for how to comply with equivalent facilitation by using the performance based alternative. Section 18.5.4.5 defines performance-based alternative for the placement of notification appliances. It specifically states that any design that provides a minimum of 0.0375 lumens/sq. ft (0.4036 lumens/sq. meters) of illumination at any point within the covered area at all angles specified by the polar dispersion planes for wall-or-ceiling-mounted visual appliances per ANSI/UL 1971 or equivalent, as calculated for maximum distance from the nearest visual notification appliances shall be permitted in lieu of requirements of 18.5.4(requirements for appliance location), excluding 18.5.4.6.

The following documentation needs to be provided to the AHJ for this alternative method:

- Inverse square law calculations using each of the vertical and horizontal polar distribution angles in ANSI/UL 1971 or equivalent
- The calculations shall account for the effects of polar distribution using one of the following:
  - The percentages from the applicable tables in ANSI/UL 1971 or equivalent
  - The actual results of laboratory tests of the specific appliance to be used as recorded by the listing organization

The equivalent facilitation calculator can be found at systemsensor.com/efc

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.

Section 14

# Reference Material

## Visible Signaling Appliance Requirements

| REQUIREMENT | AREA TO BE PROTECTED | NFPA 72 (PRESENT ADA REQUIREMENT) | UL 1971 | ANSI 117.1 |
|---|---|---|---|---|
| **Light Distribution** | | Per UL 1971 | "Polar" Distribution [1] | Per UL 1971 |
| **Intensity** | **Non-Sleeping Area** | 15 cd Minimum [4,5] | 15 cd Minimum [4,5] | 15 cd Minimum [4,5] |
| | **Sleeping Area** | 110 cd (wall) [2]<br>117 cd (ceiling) | 110 cd (wall) [2]<br>117 cd (ceiling) | 110 cd (wall) [2]<br>117 cd (ceiling) |
| | **Corridor Area** | 15 cd (100 ft. spacing) | 15 cd | 15 cd (100 ft. spacing) |
| **Flash Rate** | | 1 to 2 Hz [3] | 1 to 2 Hz [3] | 1 to 2 Hz [3] |
| **Mounting and Placement** | **Non-Sleeping & Corridor Area** | Wall: 80 in. to 96 in.: above floor, 6 in. min. below ceiling. On ceilings less than 30 ft. 5 | No Specific Requirement | Wall: 80 in. to 96 in.: above floor, 6 in. min. below ceiling. On ceilings less than 30 ft. 5 |
| | **Sleeping Area** | 110 cd required if greater than or equal to 24 in. below ceiling; 177 cd required if less than 24 in. below ceiling | 110 cd required if greater than or equal to 24 in. below ceiling; 177 cd required if less than 24 in. below ceiling | 110 cd required if greater than or equal to 24 in. below ceiling; 177 cd required if less than 24 in. below ceiling |
| | **Placement** | Wall or Ceiling | Wall or Ceiling | Wall or Ceiling |

Notes:

[1] UL 1971 requires specific light intensities at viewing angles ranging from 0 to 90 degrees off axis.

[2] Replace existing text with the following. Where the appliance is mounted less than 24 in. (610 mm) from the ceiling, it must have a minimum 177 cd effective rating because it might be in a smoke layer at the time it is called upon to operate. If the appliance is 24 in. (610 mm) or more from the ceiling, it is permitted to be rated 110 cd effective or more. (see A.18.5.4.6.2)

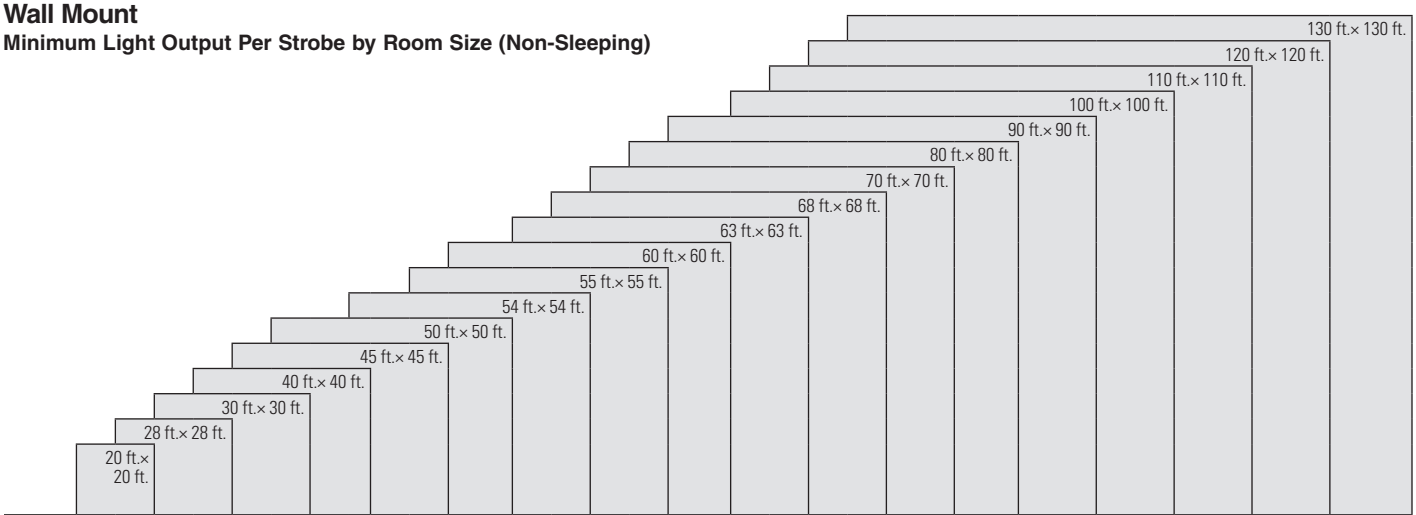
[3] 1/3 Hz equals 20 flashes per minute; 1 Hz equals 60 flashes per minute; 3 Hz equals 180 flashes per minute.

[4] Intensity dependent upon room size.

[5] Where the ceiling strobe is not located in the center of the room, the candela (cd) level shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size. In accordance with 18.5.4.3.6 - If ceiling heights exceed 30 ft (9.14 m), ceiling mounted visible notification appliances shall be suspended at or below 30 ft (9.14 m) or at the mounting height determined using the performance-based alternative of 18.5.4.5, or wall mounted visible notification appliances shall be installed in accordance with Table 18.5.4.3.1(a).

## Wall Mount

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




| | 20 ft.× 20 ft. | 28 ft.× 28 ft. | 30 ft.× 30 ft. | 40 ft.× 40 ft. | 45 ft.× 45 ft. | 50 ft.× 50 ft. | 54 ft.× 54 ft. | 55 ft.× 55 ft. | 60 ft.× 60 ft. | 63 ft.× 63 ft. | 68 ft.× 68 ft. | 70 ft.× 70 ft. | 80 ft.× 80 ft. | 90 ft.× 90 ft. | 100 ft.× 100 ft. | 110 ft.× 110 ft. | 120 ft.× 120 ft. | 130 ft.× 130 ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **One Strobe** | 15 cd | 30 cd | 34 cd | 60 cd | 75 cd | 94 cd | 110 cd | 115 cd | 135 cd | 150 cd | 177 cd | 184 cd | 240 cd | 304 cd | 375 cd | 455 cd | 540 cd | 635 cd |
| **Two Strobes** | Not Allowable | Unknown | 15 cd | 30 cd | Unknown | 60 cd | Unknown | Unknown | 95 cd | Unknown | Unknown | 95 cd | 135 cd | 185 cd | 240 cd | 240 cd | 305 cd | 375 cd |
| **Four Strobes** | Not Allowable | Not Allowable | Not Allowable | 15 cd | 19 cd | 30 cd | 30 cd | 28 cd | 30 cd | 37 cd | 43 cd | 60 cd | 60 cd | 95 cd | 95 cd | 135 cd | 135 cd | 185 cd |

Section 15
# 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, which are incorporated as regulation is in many regional, state, local and model building codes. and refers to NFPA 72 for accessible audible and visual alarms and notification appliances within a building. 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.

**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 18**
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. 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 1⁄3 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. A performance standard. Includes specific light output and distribution requirements to ensure illumination throughout an area defined by NFPA 72. Minimum flash rate of $^1/_3$ 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.

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