Gym Lighting Guidelines
Best Practices for Efficiency

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Drafted by

Benya Lighting Design

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Introduction

Gyms are a unique lighting problem. With ceiling heights of 20 to 30 feet or more, a gym is often a multipurpose space in which many activities are common. These demands can be extreme, complicating an otherwise simple lighting problem. When starting a gym lighting design, be sure to fully understand the intended uses. They will dramatically affect all lighting choices.

Advances in state-of-the-art lighting technology can significantly reduce energy use and costs while providing light levels and quality recommended by the Illuminating Engineering Society of North America. In order to ensure compliance with applicable energy codes, achieve typical lighting energy levels substantially less than the energy code allowance, and contribute to regional energy and demand management, the following guidelines for lighting are strongly recommended. Note that these guidelines generally provide substantial benefits from utility incentive programs and through LEED and other certification programs and may offer significant tax deductions and other benefits.

Facilities Affected

These Guidelines are intended to be used by contractors, architects, engineers, and others responsible for designing, specifying and/or building new lighting systems, including new buildings, tenant fit-out, remodeling, and/or energy-upgrade initiatives.

In general, these Guidelines should be applied to the following:

- Gymnasiums
- Ice rinks.
- Sports clubs
- Exhibition halls

In addition, some other multipurpose spaces may benefit from using these Guidelines.

Facilities Less Affected

These Guidelines are not necessarily intended to address any of the following space types.

- Exercise rooms
- Arenas
- Field Houses

However, these facilities have similarities, and principles of cost effective, energy efficient design expressed by these Guidelines should be employed in these or other space types whenever possible.

Implicit Considerations

These Guidelines were developed in consideration of applicable codes and standards in the U.S., including the following:

- Standards of the Illuminating Engineering Society of North America, including IESNA/ANSI RP-6, American National Standard for Sports Lighting. IESNA Standards apply in the USA, Canada and Mexico
- Standards of Underwriters Laboratories.

- Energy efficiency standards of the States of Connecticut, Massachusetts, and IESNA/ASHRAE/ANSI 90.1-2001.

General Design Requirements

All designs must comply with applicable codes and ordinances. Note that in general, the following requirements will result in lighting designs that demand less power (watts per square foot floor area) than mandated by the energy code. The energy cost savings realized by this practice will often pay back the incremental cost for the more efficient system within 3 years. Additionally, in many cases the first cost of lighting may be less than traditional designs because these Guidelines optimize the amount and type of lighting equipment than can be used.

Lighting Systems

General Requirements

A complete, hardwired lighting system must be installed that has an average power density of less than 1.0 watts per square foot. Areas with only audience seating shall not exceed 0.3 w/sf. Storage rooms and other back of house spaces including locker rooms, restrooms, storage rooms, locker rooms, and similar spaces shall not exceed a connected lighting power density of 0.6 watts per square foot.

Additional lighting, such as lighting for television or theatrical effects, may be installed gyms. Such systems are typically used infrequently, and are often exempt from energy code considerations. Whenever such systems are used, provisions must be made to prevent careless or inadvertent use.

Compliance Documentation

Designs shall be certified using COM-CHECK 3.1 release 1 or higher. For the Code to be used, select ASHRAE/IESNA 90.1-2004. If these guidelines are followed closely, the resulting designs should achieve approximately 25-35% better than 90.1-2004 and 40-50% better than 90.1-2001. NOTE: Achieving performance significantly better than these target values is very difficult and not recommended without design involving considerable expertise.

Principal Lighting Systems

The primary lighting system should provide between 40 and 60 footcandles of general lighting with a high degree of uniformity. This is suitable for most indoor sports without video. If cameras are used, they will work but image quality will not be ideal. For gyms requiring good quality video lighting, supplementary lighting systems will be needed. Keeping in mind that not all uses of the gym are for high speed sports, a lighting system capable of lower lighting levels for moderate exercise may be desirable.

For most spaces, designers should employ either of the two pattern lighting layouts illustrated below. Spacing measurements are taken from the plan view center of the luminaire. Luminaires should be mounted at least 1/3 of the indicated mounting distance away from any ceiling-high partition.

Other Common Lighting Systems

Most associated spaces benefit from the use of simple, durable lighting systems employing modern fluorescent technology. Consult these and other Guidelines for suggestions for efficient

solutions. In general, do NOT use incandescent lighting, halogen lighting, or track lighting systems or monopoints of any kind or voltage of operation.

Special Situations

There are several common variations on gym design requiring special lighting consideration:

- Gyms are sometimes designed for large audience events like commencement ceremonies and community events.
- Occasionally, gyms are equipped with stages, or are designed to be converted to stages with a temporary proscenium arch.
- Gyms frequently have collapsible seating systems, which when opened cover parts of the gym floor, leaving exposed only the principal court.
- Gyms are often a social space used for parties, proms and similar standing events.

Under these conditions, special lighting systems or controls will be required.

Principal Lighting Systems

General

There are two primary choices: HID and high-bay fluorescent. In some cases, a third possible choice, induction, may be viable. Lighting systems must be direct or semi-direct, as indirect lighting in these spaces is inefficient.

HID Systems

Metal halide lamps have been used for decades to illuminate high bay spaces. Having good energy efficiency and acceptable color, for many years HID lamps presented the only economically viable alternative for big spaces. But in order to compete with fluorescent lighting systems, significant improvements were called for and recently have been made available.

Photo courtesy Holophane

Appropriate HID lighting systems employ state of the art, high color rendering metal halide lamps. In most cases, the ideal lamp watts are between 250 and 400. There are two types of suitable lamps: quartz pulse-start metal halide lamps (QMH), and ceramic metal halide pulse-start lamps (CMH). As a basic design guide, high color rendering index QMH lamps tend to favor high color temperatures (5000K+) while CMH lamps with high CRI favor low and neutral color temperature (3000 to 4000K).

In order to achieve the performance required by this Guideline, use of suitable electronic ballasts is required. In addition to less internal loss than magnetic ballasts, electronic ballasts significantly improve the lamp's lumen maintenance. This permits electronically ballasted metal halide lighting systems to operate at 20-30% less power than comparable magnetic systems, including pulse start. Note that the ballast must be matched to the lamp; CMH and QMH lamps operate at different frequencies.

Many current electronic ballasts have noteworthy built-in features including

- Dimming
- Relay for quartz auxiliary
- Switch selected lamp wattage (250-320-350-400)

Advantages of the HID system include superior luminaire appearance, better optical control, and reduced audience glare. The principal disadvantages are warm up, restrike and limited dimming range. HID systems are best in gyms where use is constant, there is little or no daylight, and supplemental lighting systems are provided for the alternative uses of the gym. A lens or cage is required to protect the lamp from errant flying objects.

Fluorescent Systems

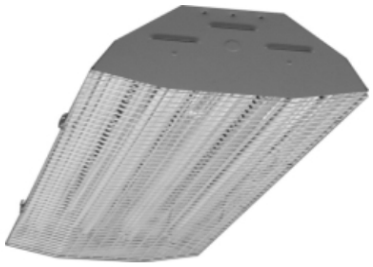


Photo courtesy 1st Source

Unlike foregoing fluorescent lamp products having peak light output at 25°C, the T5HO lamp was designed for peak performance in ambient air at 35° C. Mounted high in a gym, these lamps actually take advantage of thermal stratification to perform properly. Fluorescent lamps have superior lumen maintenance, starting and restarting qualities as compared to HID, and efficacy (mean lumens per watt) as good as or better than most metal halide lamps. When these features are combined with a high performance reflector, fluorescent high bay luminaires are a viable alternative to HID luminaires. Side benefits include simple multi level switching and redundancy to ease maintenance demands. Advantages of the fluorescent high bay system include immediate starting, instant restarting, simple multiple level circuiting, and full range dimming (with proper dimming ballasts). Disadvantages include luminaire size and appearance and reduced optical control.

Appropriate fluorescent lighting systems employ luminaires with 4 to 6 T5HO lamps. There are a number of fixtures on the market with differing appearance, but in general most of them use high efficiency reflectors to direct the light in the desired direction. The principal advantage of T5HO lamps over T8 and T12 is the ability to employ these reflectors in a practical-sized luminaire. In choosing a luminaire, be certain to provide some type of lens or cage to protect the lamps. Each fixture will use at least 2 ballasts making multi-level lighting systems easy and inexpensive without requiring dimming ballasts. Program start, instant start and dimming ballasts are available – choose the type that best matches the operations of the facility. Instant start ballasts use the least power but if frequently switched, can reduce lamp life. In addition to using the most efficient ballast, be sure to address the ballast's operating temperature and rating.

Induction Systems

There is a growing interest in the use of induction lamps in high bay applications. Historically, high costs of lamp and ballast systems have been an impediment, but recent advances have suggested that induction systems might compete.

Induction lamps are a form of fluorescent lamp that uses RF induction, rather than an electric arc, to excite the internal gas and emit light. Induction lamps offer many of the advantages of other fluorescent lamps, including instant starting, instant restriking, and dimming. By far their biggest advantage is lamp life – induction lamps are rated at 100,000 hours. However, the key limitation to induction lamps is that while both lamp and fixture are efficient, it is difficult to control the candlepower, risking glare to audiences as well as players. Note: even under ideal conditions, induction lighting systems not more efficient than the HID or fluorescent systems described above. When evaluating induction lighting options, make certain that the advantages of induction lighting are called for.

Lighting Patterns

Pattern 1: the HID Solution

To meet this guideline, design the high bay metal halide lighting system as follows:

- High efficiency luminaire, preferably with qualities that reject dirt accumulation. An open, ventilated fixture with an internally protected (P rated) lamp and exclusionary socket is strongly recommended. Anti-static glass reflectors are generally the best choice.
- Proper candlepower shape for the space. For glare control commensurate with retail, the spacing criterion should be less than 1.4. Luminaire efficiency at least 75% with CU = 0.80 at RCR = 2.0 and reflectances 80/50/20.
- High CRI QMH lamp with high frequency electronic ballast, or high CRI CMH lamp with low frequency electronic ballast
- Choice of lamp between 250 and 400 watts (with appropriate ballast) matching the lamp+ballast input power to a lighting power density of about 0.9 watts per square foot. See Table A for approximate spacing recommendations,

Pattern 2: the High Bay T5HO Fluorescent Solution

To meet this guideline, design the high bay fluorescent lighting system as follows:

- High efficiency luminaire, preferably with qualities that reject dirt accumulation. Luminaires designed to manage lamp and ballast case temperatures should be selected.

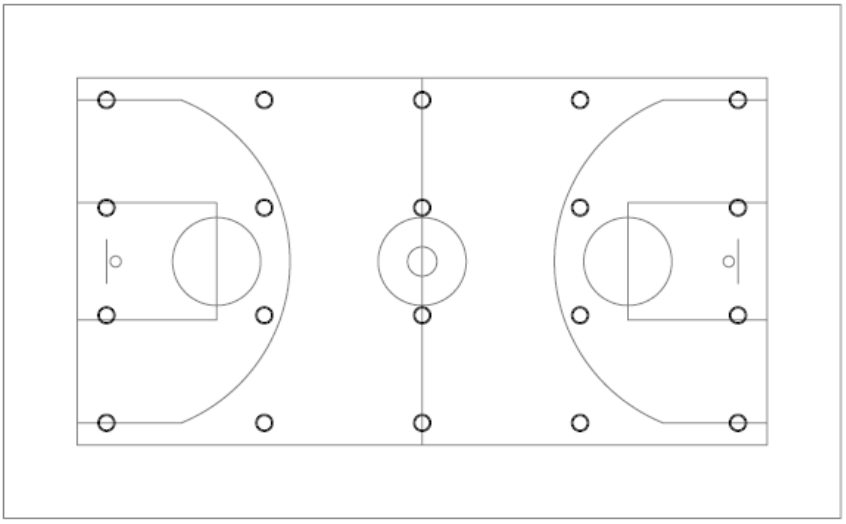
- Proper candlepower shape for the space. For glare control, the spacing criterion should be less than 1.4.
- T5HO non-amalgam lamps
- Luminaire efficiency of at least 75% with a minimum CU of 0.80 at RCR = 2.0 with reflectances 80/50/20.
- Electronic ballasts matching project conditions. Instant start ballasts are the most efficient and least costly, but can negatively affect lamp life if switched more than 2-3 times per day. Program start ballasts offer good lamp life with a power penalty of about 1.5 watts per lamp. Dimming ballasts are more expensive, but allow greatest flexibility.

Alternate Solution: Induction Lighting

Induction lamps have limitations, but also offer tremendous potential. In the pattern shown below, to meet this guideline use high efficiency luminaires and modern high wattage induction lamps. Evaluate luminaires using both the round globe-style induction lamps and the square loop tubes as shown in the illustration above..

TABLE A –Lighting Systems

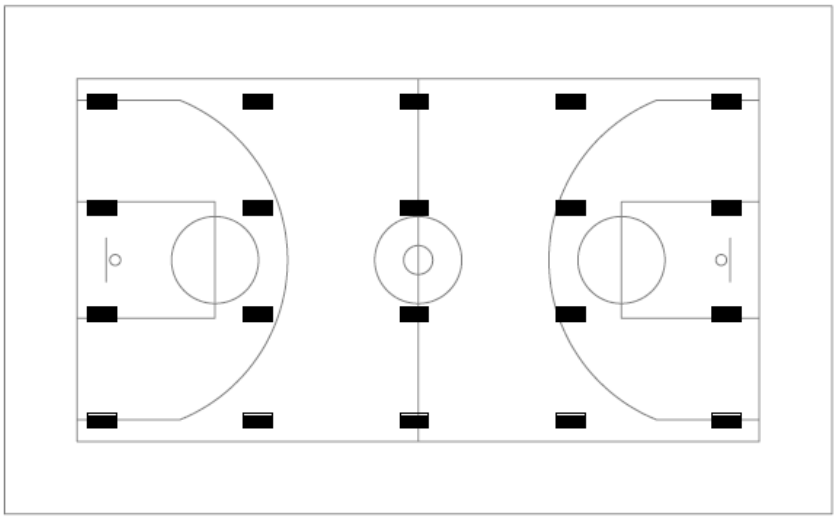
Applications	*Lighting Systems*	*Lamp Watts (Fixture input watts)*	*Spacing Area (approx grid)*	*Note*
PATTERN 1 HID Lighting	CMH or QMH metal halide lamp with proper electronic ballast. Note: high frequency electronic for QMH, and low frequency electronic for CMH	250 (275) 320 (345) 350 (370) 400 (425)	306 (17’ x 18’) 383 (19’ x 20’) 411 (20’6” x 20’) 472 (21’6” x 22’)	Mounting height at least 20’ AFF Set lamp height for proper spacing criterion (<1.1)
PATTERN 2 High Bay Fluorescent T5HO	T5HO with high bay reflector system and ballast designed for at least 60 degree C ambient temperature and 80 degree C case temperature in a properly designed luminaire with spacing criterion of <1.3	(4) T5HO with BF=1.0 IS ballast (226 watts) (6) T5HO with BF=1.05 IS ballast (344 watts)	251 (16’ x 15’9”) 382 (19’ x 20’)	Mounting height at least 20’ AFF Choose reflector for proper spacing criterion (<1.1)
OPTIONAL Induction lighting system (2 – 150 watt lamps)	Induction fluorescent lamp in high bay luminaire. NOTE: this is evolving technology that has a minimum of experience and installed base. Check proposed product literature and testing data carefully.	2 Icetron lamps @150w (312) (1) QL lamp @ 165w (165)	346 (18’ x 19’3”) 183 (13’6” x 13’6”)	Mounting height as recommended by manufacturer



PATTERN 1 GYM

APPROX. 8000 SF

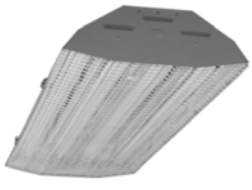
(20) 320 WATT CERAMIC METAL HALIDE FIXTURES
PRISMATIC GLASS WITH ALUMINUM SHROUD
ELECTRONIC BALLAST
50 FOOTCANDLES MAINTAINED AT 0.86 W/SF
60 FOOTCANDLES MAINTAINED ON COURT



PATTERN 2 GYM

APPROX. 8000 SF

(20) GYM-RATED FLUORESCENT HIGH BAY FIXTURES
EACH WITH (6) F54T5HO LAMPS
(2) OR (3) ELECTRONIC BALLAST TOTAL 360 WATTS
60 FOOTCANDLES MAINTAINED AT 0.90 W/SF
70 FOOTCANDLES MAINTAINED ON COURT



:Lighting Controls

Significant energy savings can be realized by using controls in the gym. Specific recommendations include:

- When using fluorescent systems, consider motion sensing. Use a number of sensors in parallel to prevent inactivity in one end of the gym from affecting the rest of the space. Be sure to use sensors designed for high bay use.
- If skylights are employed, use daylight sensors. Dimming ballasts are preferred, but multi-level switching daylight sensing can also be employed. With skylights, open loop control systems are generally recommended.
- If the gym has a predictable schedule, employ a programmable time control system.
- Whenever possible, make it possible for light levels to be lowered when full lighting levels aren't required.

When other lighting systems are also used (see below), consider interlocking controls so that lighting systems can only operate as intended, and to prevent simultaneous use of lighting systems not intended to be used together. This can be as simple as a selector switch, or as complex as a programmable control system.

Other Lighting Systems

The most common additional lighting systems are:

a. A dimmable house lighting system. Consider, for example, a grid of halogen downlights designed to produce 3-5 footcandles for use in seating areas and as a general "party" lighting system for most of the room. Provide layouts and controls zoned for the typical configurations of the gym including audience seating for sports, general seating for staged programs and other events, and as the basic lighting for social activities.

   Here's a good example. The multi-purpose rooms of this school, which is a lower grades facility for students with special needs, is a combination of gymnasium, commons and social space, theater, and In the photo at upper right, the general lighting system provides 40-50 footcandles at about 1.0w/sf as described above. Automatic daylighting controls are provided as this space has both extensive windows on the north façade and skylights towards the south wall (not visible in picture).

   In the lower photo, the general lighting system is off, and a dimmable downlighting system using 60 watt IR PAR38 downlights is being used. The maximum average lighting level is about 7-8 footcandles, and the system is interlocked to prevent being used when the general lighting system is on. The connected power is about 0.8 w/sf. *(Photos: Chartwell School, Monterey, CA courtesy of Benya Lighting Design)*

b. Television lighting for the principal sports area. With emphasis on the side(s) where cameras will be used, provide metal halide lighting systems designed to achieve 50-100 vertical footcandles.

c. Theatrical lighting for staged events. These may be temporary provisions, or permanent lighting equipment.

In the photo at right, recessed permanent lighting and removable theatrical lighting are both provided. The recessed lighting can illuminate the lectern and tables where shown on the front of the stage. For other events, including relatively full use of the stage area behind the curtain, theatrical lighting can be installed on pipe rails and plugged into receptacles connected to the lighting control system. The lighting control system is a preset architectural system with provisions for plugging-in a stage console either backstage or in the control room. *(Photo: Smith Memorial Student Union, Portland State University, Benya Lighting Design).*

Emergency egress lighting for a gym is very important. When using metal halide systems, an alternative lighting system will be required, such as quartz auxiliary lamps in some of the luminaires, or transfer to another system capable of being turned on immediately.