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GUIDING *the* LIGHT

Understanding and applying evolving commercial lighting energy codes and standards

Energy codes — many designers and builders view them as a "necessary evil" or just another set of requirements that must be dealt with in order to obtain a building permit. This situation can be further complicated by the multiple variations of energy codes that are enforced by individual states and local jurisdictions.

Playing a big part in these standards, lighting has become more of an issue for many designers because of recent changes in the requirements found in nationally adopted codes. To help make sense of the current commercial lighting energy requirements, it's important to understand where they come from, how they are applied, and the differences that exist from state to state.

Basis for energy code requirements. Title III of the Energy Conservation and Production Act (ECPA), as amended by the Energy Policy Act (EPAct) in 1992 and 2005, requires states to adopt commercial building energy efficiency requirements that meet or exceed the stringency of the ASHRAE/IESNA Standard 90.1-1999, jointly developed by the American Society of Heating and Refrigeration Engineers (ASHRAE) and the Illuminating Engineering Society of North America (IESNA). However, it does not dictate the adoption of a specific set of requirements. This drives state legislatures to adopt or develop some sort of energy code or standard to meet the EPAct ruling.

A few states, such as California, Florida, Oregon, and Washington, have developed their own energy codes, but most choose to adopt a nationally available code or standard such as ASHRAE 90.1 or the International Energy Conservation Code (IECC) developed by the International Code Council. Even though faced with this federal mandate, several states have yet to adopt a code, and others have one on the books that's not quite up to the required level of stringency.

For those states that have adopted some code or standard — and depending on when this occurred — the applicable code may be based on one of many versions of ASHRAE 90.1 or IECC, including ASHRAE 90.1-1989, -1999, -2001, -2004 or IECC 2000, 2001, 2003, 2004, 2006. As the ASHRAE 90.1 and IECC documents evolve and states adopt newer codes, there is some convergence toward a more consistent set of requirements. For example, the IECC references ASHRAE 90.1 as an alternative compliance standard. However, there's still lot of potential variety out there that can make compliance confusing when working on projects in more than one state. A list of the currently adopted state codes is available on the Web at http://www.energycodes.gov/implement/state_codes/index.stm.

To help make sense of the current commercial lighting energy code requirements, this article focuses on two common energy standards or codes: ASHRAE 90.1-2004 and IECC 2003. By comparing these two documents, you can see what an owner, general contractor, and you will likely need to address in regard to lighting energy requirements.

Scope of lighting requirements. ASHRAE 90.1-2004 and IECC 2003 include requirements for interior and exterior building lighting in new construction, additions, and alterations for all commercial buildings, including residential structures with four or more stories above grade. Note: Changes recently proposed to ASHRAE 90.1-2004 regarding lighting are scheduled to be evaluated in September 2006 for possible inclusion in the 2007 IECC Supplement.

The application of the codes to alteration type projects has been mixed in the past, but as energy codes become more commonplace in states and local jurisdictions, these projects will be required to comply as well. The requirements for alterations are effectively the same as for new construction or additions in that the replacement of lighting systems, and any new or replacement control devices must comply. The ASHRAE 90.1 standard (1999 through 2004) provides an exception for spaces where less than 50% of the luminaires in the space are replaced, *and* there is no increase in the lighting

Photo courtesy of Spectrum Engineers (photographer: Michael Northrop)

Houses of worship like St. John the Baptist Catholic Church at Skaggs Catholic Center in Draper, Utah must also conform to lighting power density requirements as noted in these codes.

Photo courtesy of Spectrum Engineers (photographer: Michael Northrop)

The energy codes and standards discussed in this article also provide limits and/or efficiency requirements for exterior building lighting in places such as the Cedar Center Library in the Park, located in Cedar City, Utah.

power density (LPD). The requirements refer to the replacement of "lighting systems;" therefore, component replacements (lamps and/or ballasts) alone do not constitute an alteration.

Mandatory individual space control. The energy codes require at least one lighting control for each room or space enclosed by ceiling-height partitions. These must generally be readily accessible to occupants, but remote location is allowed to accommodate areas where safety or security is a concern. Both ASHRAE 90.1 and IECC require that controls to turn off permanently installed and switched receptacle lighting in hotel or motel guest rooms be placed at room entrances (IECC 1998 through 2006 exempts bathroom lighting).

The ASHRAE 90.1 standard (1999 through 2004) also requires individual control of display or accent lighting, case and task lights, and nonvisual and demonstration lighting. The 2004 version also adds requirements for occupancy sensor controls in some classrooms, conference rooms, and employee break rooms. The IECC (1998 through 2006) includes a "bi-level" switching requirement for all spaces with the capability to uniformly reduce the connected load by 50% with some exceptions.

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Mandatory automatic shutoff. Automatic lighting shutoff of all building lighting is required in both ASHRAE 90.1 (1999 through 2004) and IECC (2001 through 2006) for buildings larger than 5,000 square feet. This can be done with time-scheduling devices, occupant-sensing devices, or a similar signal from another control or alarm system that indicates the area is unoccupied. IECC 2000 only requires this in spaces larger than 250 square feet.

There are also requirements for occupants to be able to override the

automatic shutoff control for not more than 2 hours (IECC 2003 through 2006) or not more than 4 hours (ASHRAE 90.1, 1999 through 2004). There are exceptions to the entire automatic shutoff requirement that include lighting for 24-hour operation (ASHRAE 90.1, 1999 through 2004), patient care spaces and areas with safety or security concerns (ASHRAE 90.1-2004), and corridors, storerooms, restrooms, public lobbies, and guest rooms (IECC 2004).

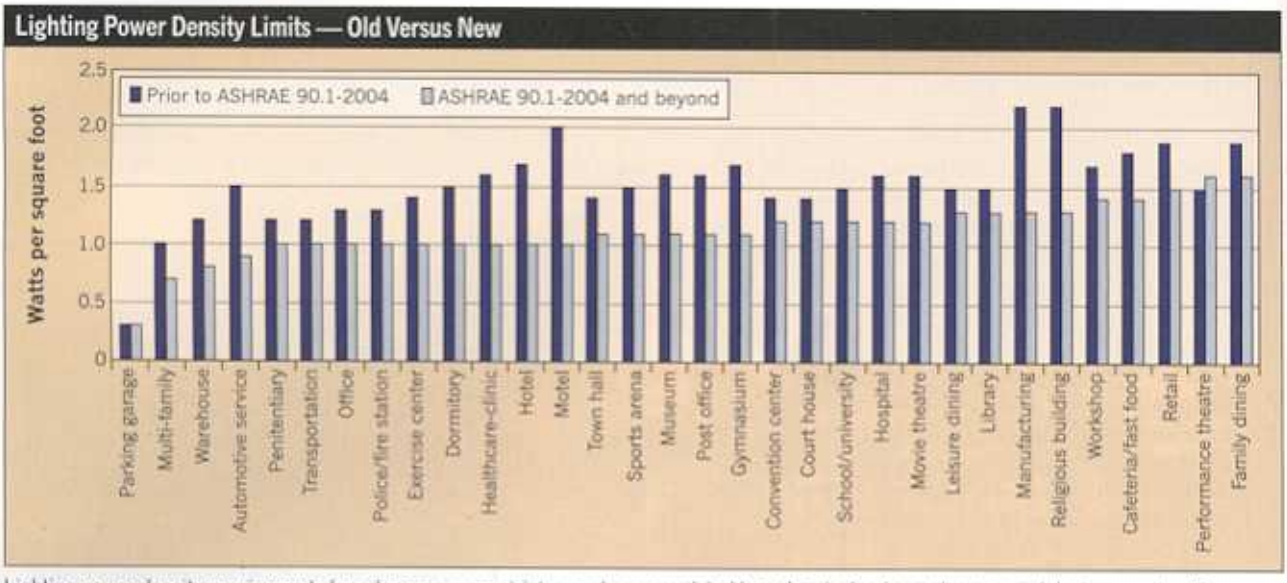
Mandatory exterior lighting control. Exterior building lighting must be controlled using photocells (for dawn-to-dusk lighting) or seven-day/seasonal programmable controls with astronomic correction and 4-hour battery backup. ASHRAE 90.1 (1989 through 2004) exempts covered vehicle entrances and exits from buildings or parking structures where lighting is required for safety, security, or eye adaptation.

In addition, ASHRAE 90.1 requires tandem wiring of fixtures when single-lamp magnetic ballasts are used. Limits are also placed on exit signs with a limit of 5 watts per face for most of the codes.

Interior lighting power limits. The mandatory requirements cover a lot of items that can affect building design, but that's only half the story. The other major requirement in the energy codes is the limitation of lighting power. These limits vary by building or space type and can be complied with in more than one way. One method is the performance option where the proposed building is modeled for all energy use (heating, cooling, water heating, and lighting). If the modeled building meets a target energy use based on that expected of the same building built to the code, the proposed building complies. This method involves the use of detailed, whole-building software and is typically used for buildings with highly complicated systems or unusual design elements.

Most buildings comply with the simpler prescriptive-tradeoff method for lighting, which compares the actual interior LPD (watts per square foot) to the LPD allowance. The compliance process starts with determining the installed lighting wattage for entire lighted space(s) in watts. This must include all interior lighting designed for general, ambient, or task illumination with exceptions. The codes also provide some guidance on how certain fixture-type wattages are calculated. This includes the maximum labeled wattage for screw-in-type fixtures and a minimum of 30 watts per foot of line-voltage track lighting.

The second part of the process is to determine the allowed wattage for the building. This is done on a whole



Lighting power density requirements have become more strict as codes are updated based on technology advances and design practice. For example, the whole-building lighting power density for museums has decreased from 1.6 watts per square foot to 1.1.

building (one LPD value for the building type) or space type (LPD values for each different space type) basis. In either method, the appropriate LPD(s) are chosen from the whole building (32 in ASHRAE 90.1, 26 in IECC) or space type (91 in ASHRAE 90.1, 28 in IECC) tables. These values are multiplied by their matching square footage, and the results are summed to determine the allowed lighting power in watts. If the calculated installed watts is less than or equal to the total allowed watts, the project is in compliance. The whole building method uses one value for each building type, which makes the calculation simpler but limited in flexibility. The space-type method requires more calculations but also allows more flexibility and can provide more allowed wattage.

There is a large difference in stringency of whole-building and space-type values between previous and current versions of the codes and standards. The most stringent set exists in the ASHRAE 90.1-2004 and IECC 2003 through 2006.

There is a large difference in stringency of whole-building and space-type values between previous and current versions of the codes and standards. The most stringent set exists in the ASHRAE 90.1-2004 and IECC 2003 through 2006. Previous publications of ASHRAE 90.1 and IECC contain similar listings of building and space types but with less stringent LPD values. The **Figure** above shows the difference between previous and

current sets of whole-building LPDs in the ASHRAE standard.

The LPD values in the current codes and standards were not chosen by simple consensus or other limited selection processes. Instead, they were developed using an extensive space-type modeling process that incorporates the latest light-level recommendations, current energy-efficient product characteristics, applicable light-loss factors, and designer input on quality design metrics. To view details on the process as well as a list of the values in the ASHRAE 90.1-2004 standard, visit the IESNA Web site at http://12.109.133.232/cgi-bin/lpd/lpdhome.pl.

To ensure that the codes can accommodate the quality and art components in a wide variety of lighting designs, the codes provide additional lighting power allowances. These are use-it-or-lose-it allowances and must be used only for the designed purpose — not for general illumination.

In addition, these allowances can only be applied if using the space-type method. The allowances prescribe additional wattage for decorative lighting at 1.0 watts per square foot, lighting specifically designed to meet the IESNA computer screen glare guidelines at 0.35 watt per square foot, and retail display lighting at 1.6 watts per square foot of display area, or 3.9 watts per square foot for fine merchandise display.

The ASHRAE 90.1-2004 and IECC 2006 have extensive power limits based on square footage of illuminated area or perimeter for all expected exterior applications such as entrances and exits, facades, building grounds, parking lots, and walkways.

Exterior lighting power limits and efficiency. Finally, the codes and standards provide limits and/or efficiency requirements for exterior building lighting. The ASHRAE 90.1-2004 and IECC 2006 have extensive power limits based on square footage of illuminated area or perimeter for all expected exterior applications such as entrances and exits, façades, building grounds, parking lots, and walkways. These requirements are split into

Photo courtesy of Henderson Engineers

Office buildings such as this Garmin International Phase III Expansion Projects offer great opportunity for energy savings through use of efficient lighting systems.

tradable vs. non-tradable applications.

The tradable applications work like the interior lighting limits in that it is the total wattage for all of these compared to the total allowance that is important. Non-tradable applications are specific limits to that lighted feature and cannot be combined with others. Earlier codes and standards have less involved requirements, including shorter sets of applications or simple lighting efficiency requirements.

Energy code compliance. Compliance with energy codes is typically a combination of documenting the proposed energy features of the building and passing related inspections. Many jurisdictions require documentation of the proposed design before issuing building permits. The form of documentation will depend on what the local jurisdiction requires.

One compliance documentation method used by most states is the COM*check* software tool, provided free by the U.S. Department of Energy's Building Energy Codes Program via its Web site, http://www.energycodes.gov. COM*check* provides a flexible way to demonstrate compliance with minimal input.

The lighting section enables you to quickly determine if your lighting design meets interior-lighting power limits. COM*check* supports several codes including various versions of IECC and ASHRAE 90.1, documents mandatory requirements, and includes a printable compliance certificate. The software is also supported with accompanying users guides, videos, training materials, and compliance manuals at no cost.

The U.S. Department of Energy's Building Energy Codes Program Web site provides a wealth of technical resources to lighting designers, engineers, architects, code officials, building inspectors, and others involved in creating code-compliant energy-efficient buildings. The site, which receives more than 3.5 million hits a month, offers free compliance tools, technical support, articles on code issues, and extensive connections to other resources.

Remember, with energy code compliance, the final application and interpretation rests with the local building official in your jurisdiction. To obtain a copy of ASHRAE 90.1, go to www.ashrae.org; to obtain a copy of the IECC, go to www.iccsafe.org. **EC&M**

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