5.4 Lighting

Lighting accounts for 25% of the electricity used in the Federal sector. If advanced lighting technologies and designs were implemented throughout the Federal sector, electricity use for lighting would be cut by more than 50%, electrical demand dramatically reduced, and working environments significantly improved. Lighting power densities of 2.5 watts per square foot (typical for many office buildings) can be reduced to 1 watt per square foot or even less in new buildings and major renovation by (1) optimizing the use of natural daylighting; (2) installing modern, efficient luminaires; (3) replacing ballasts and lamps with modern components; (4) replacing incandescent lamps with compact fluorescent lamps (CFLs); (5) replacing mercury vapor lamps with metal halide or fluorescent lamps (including new T-5s); (6) implementing task lighting strategies; and (7) installing state-of-the-art lighting controls.

Opportunities

Consider making it a very high priority to retrofit the lighting system whenever undertaking renovations or new additions. Even reconfiguring workspaces (adding partitions, for example) provides an opportunity to upgrade the ceiling lighting system and add task lighting where appropriate. If the HVAC system is being upgraded or replaced, that presents another opportunity to upgrade the lighting system—in fact, the reduced cooling loads that can be achieved with state-of-the-art lighting may enable significant downsizing of chillers and even pay the full first-cost of the lighting improvements while ensuring dramatic savings in ongoing energy use. Whenever possible, incorporate daylighting strategies into a building (new or existing) and integrate the electric lighting system appropriately (see *4.1.2 – Daylighting Design*). Replacing incandescent wall sconces, downlights, decorative pendants, and exit sign lighting with CFL units (or, in the case of exit signs, with light-emitting diode [LED]-lit units) will not only save a considerable amount of energy, it will also significantly reduce labor costs associated with relamping.

Technical Information

LIGHTING DESIGN ASSISTANCE

Designing a lighting system that provides visual comfort at low energy cost is more of an art than generally thought. Hire a lighting designer for both new building design and lighting retrofit projects. The designation "LC" after a consultant's name indicates "lighting certified" by the National Council for the Qualification of Lighting Professionals—a certification program supported by DOE. With lighting retrofit projects, the lighting designer should inventory the age and type of lighting equipment, examine visual tasks in the building and changes that have occurred (such as increased use of computers), and interview workers about their satisfaction with the lighting.

DESIGN STRATEGIES FOR IMPROVED LIGHTING

- Refer to the *IESNA Lighting Handbook – 9th Edition* (2000) for lighting quality and quantity recommendations—match lighting to tasks. An inexpensive light meter (less than $200) can help determine whether needs are being met in existing work spaces.
- Consider brightening interior surfaces—the perception of spaciousness and the relative "cheeriness" of spaces is directly related to wall and ceiling brightness.
- Use a combination of direct and indirect lighting to minimize harsh contrasts, which can be uncomfortable and tiring.
- Consider reducing ambient light levels (or relying on natural daylight) and supplying task lighting where the light is needed.

LIGHTING EQUIPMENT SELECTION

- Choose fixtures (luminaires) that efficiently deliver light and are well suited to the expected tasks (see *5.4.1 – Linear Fluorescent Lighting* for more on fixture selection).
- Depending on the ceiling fixtures selected, some additional illumination on walls and ceilings may be needed to achieve adequate *vertical surface brightness*. This is particularly important with parabolic fixtures (see *Section 5.4.1*). Wall and ceiling illumination can be provided with luminaires that deliver some of their light upward, wall-wash sconces, and daylighting.

- Select fluorescent lamps with a high color rendering index (CRI) and color temperature well suited to the space and tasks.
- Install lighting control systems that will dim or turn off lights when the illumination is not needed—either because people have left the space or because of adequate daylighting. Provide manual dimming control, especially in small offices.

TOOLS TO ASSIST IN LIGHTING DESIGN AND PRODUCT SELECTION

(see References for information on accessing the Building Energy Tools Directory)

- **Commercially available software tools**, including *Lumen-Pro, Radiance,* and *LightScape,* are a tremendous help in lighting design.
- **FEMP's Federal Relighting Initiative** is a program that provides facility managers with lighting evaluation tools and lighting retrofit information.
- **Lighting Technology Screening Matrix (LTSM)** software evaluates different lighting technologies on a per-fixture basis. The algorithms are based on lumen equivalents, but the user can adjust for areas that are overlit or underlit. The LTSM program is primarily a financial tool that generates a list of potentially cost-effective lighting retrofits.
- **Lighting Systems Screening Tool (LSST)** software allows managers to evaluate system retrofits on a facility-wide basis. It can either make assumptions about existing lighting for a first cut or allow more precise evaluation using actual data entered for the facility.
- **The Federal Lighting Expert (FLEX)** is an expert system that can assist facility managers in optimizing lighting retrofit projects. It is user-friendly, can be used by nonexperts, and has a product database with performance specifications and cost information.
- **The Master Specifications (Version 2.03)** is a generic specification for energy-efficient lighting systems targeted at Federal facilities. It addresses lamps, ballasts, reflectors, and luminaires. Parts of the specification can be copied verbatim to assist in the preparation of technical specifications for specific projects.

Mercury is present in all fluorescent and mercury vapor lamps, and polychlorinated biphenyls (PCBs) are in many older fluorescent ballasts. These materials can be extremely hazardous to human health and the environment and should be disposed of only through specialized recycling or hazardous disposal facilities. Never discard lamps or ballasts that do not carry labels "No PCBs" with ordinary waste.

References

Advanced Lighting Guidelines, Report Number DOE/EE–0008, NTIS Order Number DE94005264, U.S. Department of Energy, Washington, DC, 1993. Provides acceptable lighting levels for various applications.

ASHRAE Standard 90.1, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta, GA; www.ashrae.org.

IESNA Lighting Handbook – 9th Edition, Illuminating Engineering Society of North America, New York, NY, 2000; (212) 248-5000; www.iesna.org.

Contacts

The FEMP Help Desk at (800) DOE-EREC (363-3732) has information about the Federal Relighting Initiative, training courses devoted to lighting technologies and techniques, and software; see also the lighting information on the Web at www.eren.doe.gov/femp/.

ProjectKalc software is available from the EPA Green Lights Hotline: (202) 775-6650.

DOE's Building Energy Tools Directory offers information on over 200 software tools covering lighting and other topics. Many of these tools are free or accessible online; www.eren.doe.gov/buildings/tools_directory.

The National Lighting Product Information Program (NLPIP) of the Lighting Research Center at Rensselaer Polytechnic Institute offers independently evaluated product information, including manufacturer-specific test results on thousands of lamps, fixtures, ballasts, and controls; www.lrc.rpi.edu.

Association of Lighting and Mercury Recyclers, 2436 Foothill Blvd., Suite K, Calistoga, CA 94515; (707) 942-2197.