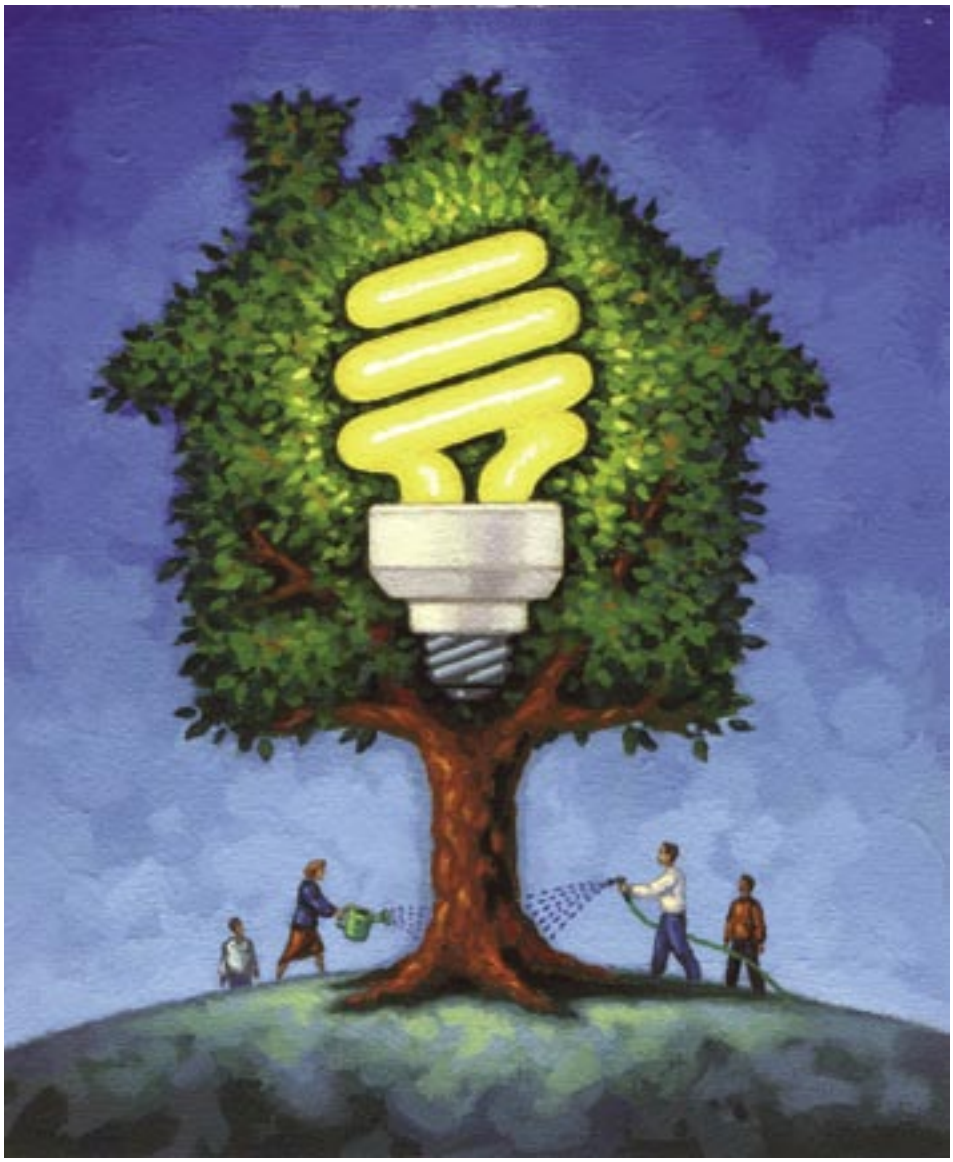
ELECTRICAL DESIGN LIBRARY

LEED: Make Lighting Green



NECA
NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Contents

Electrical Design Library (EDL) publications are prepared for architects, consulting engineers, and qualified electrical contractors, as well as owners, developers, investors, and their electrical construction specifying personnel. Issued periodically by the National Electrical Contractors Association (NECA), the publications provide factual explanations of the increasing variety of sophisticated electrical systems and the economics of their installation by professional electrical contractors. They are distributed by the Association's chapters, located in all sections of the United States. Photo on page 1 is courtesy of the U.S. Green Building Council.

Published by the National Electrical Contractors Association, 3 Bethesda Metro Center, Bethesda, Maryland 20814.

Index No.
3025114
Marketing
9K/10/05

Introduction

Though less than a decade old, the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) standards are already having a significant impact on the materials and systems that clients are demanding and architects and engineers are specifying.

Initially directed only toward new commercial construction, LEED standards now also target core-and-shell construction and interior build-outs as well as existing commercial construction. They are also expanding into residential construction and development.

Developers who seek to minimize their buildings' impact on the environment and maximize the comfort and well-being of building occupants use the clear guidelines and quantifiable goals in the standards.

LEED offers a point-based system and provides varying levels of certification—"certified," "silver," "gold," and "platinum." This system allows designers to balance the costs and benefits of specific products and construction practices.

What's more, many developers now turn to the LEED standards for guidance even when they have no intention of seeking LEED certification. Plus, building professionals from all disciplines are earning LEED accreditation to help their clients enact the standards' sometimes complex requirements.

As a significant contributor to energy bills and occupant comfort, lighting is addressed throughout the LEED standards. Specific guidelines include limiting exterior light pollution and allowing individual lighting controls.

Lighting is also included as part of larger goals, such as meeting the overall energy-use targets of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-1999, "Energy Standard for Buildings Except Low-Rise Residential Buildings."

Lighting manufacturers are responding with new lamps, fixtures, and controls to help designers and owners meet LEED efficiency and comfort targets.

Building team members with specific design questions should consult applicable LEED rating systems and referenced standards, along with LEED-accredited professionals. This publication provides a general overview of issues the building team should consider when designing and specifying lighting systems for LEED-compliant new construction, including:

- Interior and exterior lighting levels;
- Fixture and lamp specification;
- Control-system design; and
- Ongoing lighting-system maintenance.

Setting the Levels

Embedded in the LEED rating system for new construction is required compliance with ASHRAE/IESNA (Illumination Engineering Society of North America) Standard 90.1-1999. Standard 90.1-1999 is specified as a minimum; local energy codes, if stricter, should serve as a minimum performance criterion for buildings submitted for certification.

With this requirement, the rating system ensures that buildings meet a minimum, baseline efficiency standard. As of 2005, this LEED requirement is somewhat redundant, as—under U.S. law (Department of Energy regulations), all new buildings are now required to meet ASHRAE 90.1 guidelines.

Designers gain additional LEED credit for improving a building's energy performance beyond what would have been achieved through following the ASHRAE/IESNA standard. Documented energy simulations are required to determine the degree to which buildings meet or surpass baseline performance levels.

Required interior lighting levels are not specifically called out in the LEED system. That's because Standard 90.1-1999 incorporates highly detailed lighting power-density tables for a range of building types and areas. The goal here is two-fold: reduce the amount of energy consumed by lighting systems and reduce resulting cooling loads by cutting the amount of heat that lighting systems produce.

LEED guidelines provide more specific requirements for exterior lighting. These are intended to minimize the impact of outside illumination on the evening sky. In addition to referencing the IESNA's Recommended Practice Manual: Lighting for Exterior Environments, LEED's Light Pollution Reduction credit outlines some specific performance criteria, including:

- Exterior luminaires with more than 1,000 initial lamp lumens should be shielded.
- Exterior luminaires with more than 3,500 initial lamp lumens should meet IESNA's full-cutoff classification.
- The maximum candela value of all interior lighting should fall within the building, not shine out through windows.
- The maximum candela value of all exterior lighting should fall within the property.
- Luminaires within a distance of 2.5 times their mounting height from the property boundary should be shielded so that no light from them crosses the property boundary.

ASHRAE, IESNA & The NEIS

ASHRAE is the American Society of Heating, Refrigeration, and Air-Conditioning Engineers.

IESNA is the Illuminating Engineering Society of North America.

NEIS are National Electrical Installation Standards.

In cooperation with IESNA, the National Electrical Contractors Association, develops and publishes several National Electrical Installation Standards.

NECA/IESNA 500-1998, Recommended Practice for Installing Indoor Commercial Lighting Systems (ANSI)

NECA/IESNA 501-2000, Recommended Practice for Installing Exterior Lighting Systems (ANSI).

NECA/IESNA 502-1999, Recommended Practice for Installing Industrial Lighting Systems; and

NECA/IESNA 504 - Standard for Installing Lighting Control Devices and Systems.

For additional information, see the NECA-NEIS web site at *www.NECA-NEIS.org/standards* and select "Lighting" from the menu at the left.

LEED Fact Sheet

LEED (Leadership in Energy and Environmental Design) Green Building Rating System is a voluntary standards and certification program that defines high-performance green buildings—which are more environmentally responsible, healthier, and more profitable structures. Developed by USGBC, it addresses a variety of buildings and building project types through individualized systems, including:

- New Construction (LEED-NC)
- Existing Buildings (LEED-EB)
- Commercial Interiors (LEED-CI)
- Core & Shell (LEED-CS)
- Homes (LEED-H)
- Neighborhood Development (LEED-ND)

In addition, application guides are available to provide information and instruction about applying LEED to market segments. Application guides include Campuses, Retail, Labs, Healthcare and Schools.

LEED rating systems are developed through a consensus process in USGBC committees. Each volunteer committee is composed of a diverse group of practitioners and experts representing a cross-section of the building and construction industry. Any USGBC member can serve on a committee, and all committee procedures and proceedings are available at *www.usgbc.org*.

Getting Certified

LEED-certified buildings have lower operating costs, higher lease rates, and happier and healthier occupants than conventionally-constructed structures. Certification under LEED validates to the market that your building is green and setting standards and measures for the building's performance.

There are four progressive levels of certification: Certified, Silver, Gold, and Platinum. To get certified, projects must be registered and submit completed LEED project documentation for review. Certification typically takes three months from submittal.

2005 Program Highlights

- 2,164 LEED registered projects.
- 285 LEED certified projects.
- Registered and certified LEED projects represent 300 million square feet.
- There are LEED projects in 50 states and 12 countries.
- LEED has been licensed for use in Canada by the Canada Green Building Council.
- LEED was first released for new construction (LEED-NC) in 2000.

Source: U.S. Green Building Council

Specifying Efficiency

As a performance-based system, LEED gives designers a good deal of freedom. Designs can incorporate whatever products a designer chooses, as long as total energy consumption doesn't exceed specified targets. Lighting-equipment manufacturers have responded to specifiers' needs for greater selection of energy-efficient products by developing a broad range of options.

What's most needed, at this point, are dimmable electronic ballasts—and lamps that perform as well as standard models, but which can be adjusted to meet the needs of varying tasks and ambient lighting levels. Though dimmable fluorescent and high-intensity discharge (HID) products have been available for several years, it's only recently that these offerings have begun to live up to their performance promises.

Fluorescent lighting has long been the technology of choice for many commercial applications. However, dimmable fluorescent ballasts and lamps have proven problematic in the past. Standard electronic ballasts could not dim fluorescents enough for some low-light applications, while specialized models designed to achieve special, architectural lighting effects were just too expensive.

New, more affordable models, however, allow lamps to be dimmed to as low as 5% of their potential light output, which should be low enough for most settings (such as conference rooms) requiring that level of flexibility.

Additionally, new T5 high-output (HO) fluorescent lamps are gaining favor in combination with dimmable control systems. These fluorescent systems are even replacing metal halide and other HID technologies in high-bay warehouse, big-box retail, factory and athletic-facility applications.

When used in highly reflective luminaires, T5HOs can operate more efficiently than comparable HID products. What's new (for fluorescents in these applications) is that they also provide lower lumen depreciation rates, better dimming options, virtually instant startup and restrike, and better color rendition. Further, these new lamps are significantly slimmer than older fluorescent models. This means the fixtures where they are used need less head room.

Said to be the fastest-growing lamps in the fluorescent category, the efficiency of T5HO lamps is a big factor in their growth thus far. While HID fixtures typically perform at a peak of approximately 70% efficiency, capturing and redirecting about 70% of lamp light, new computer-designed fluorescent fixtures with engineered curves and highly reflective surfaces are now seeing efficiencies `up to the high 90% range.

DALI: A Sketch

One big issue faced by those specifying control systems is the proprietary nature of most building-control products. Industry participants seem to be addressing this concern with open-protocol systems—such as BACnet and LonWorks—that enable users to mix and match products from different manufacturers.

Ballast and lighting-control makers are now exploring a similar approach with the **digital addressable lighting interface**, or DALI. Though it's still a relatively new concept, DALI-based ballasts and controls are becoming more available.

In addition to its mix-and-match capabilities, DALI enables building owners and managers to program—and reprogram—large numbers of ballasts either as a group or individually. An example: Banks of fluorescent fixtures can be dimmed as a whole, and office space can be easily reconfigured—without having to remove and replace individual lighting fixtures to meet new needs.

DALI also enables remote monitoring of individual ballasts, making for easy identification of failed units. The system also can help managers and owners verify related lighting-energy savings, which could contribute to meeting the measurement and verification goal called out in Credit 5 of the LEED rating system.

Controlling & Harvesting Light

Energy efficiency in the 2000s has been a major enabler, making possible the increasing sophistication of today's building-control systems. Lighting controls play a big part in LEED-certified designs, both in meeting minimum Standard 90.1-1999 requirements and in improving building energy performance beyond baseline levels.

Lighting control technologies also play a role in meeting LEED's indoor-comfort guidelines, allowing occupants to have greater control over their work environment.

As a baseline, Standard 90.1 requires use of occupancy sensors or lighting-control panels to turn lights off when a space isn't being used. LEED's rating system takes that guideline a step further in Credit 6.1 ("Controllability of Systems: Perimeter Spaces") and Credit 6.2 ("Controllability of Systems: Non-Perimeter Spaces"), both under the Indoor Environmental Quality heading.

To qualify for the perimeter-space credit, buildings need to average at least one lighting control zone per 200 square feet for all regularly occupied areas within 15 feet of a perimeter wall. Non-perimeter spaces need controls for at least 50% of all individuals in regularly occupied areas.

Individual control requirements can be met by task lighting, in many cases. Providing lower overall lighting levels along with user-controlled task lights can be especially useful in computer-intensive environments, where higher light levels can cause glare on monitors.

Real energy savings can kick in when occupancy and daylight sensors are combined with lighting controls to ensure lights are only on when and where they are needed.

Improvements in dimmable ballasts are finally enabling daylight-harvesting schemes that designers have been encouraging for years. In these plans, photosensors are tied to dimming controls, so that fixtures are turned down when available daylight levels are high. Conversely, controlled lamps become brighter as daylight decreases.

One result: Today's integrated building designs incorporate plenty of low heat-gain glazing to optimize daylight harvesting without increasing building heat loads.

Designers, contractors, and owners need to recognize the importance of calibration and commissioning in successfully implementing any sensor technology. If these systems aren't properly adjusted from the start, building occupants will simply override the automatic controls, eliminating any possible savings.

Daylight sensors, especially, must be carefully tested and adjusted to related lighting controls to ensure the balance of natural and artificial light remains comfortable for area occupants.

Spotlight on Dimming Systems

Although performance of fluorescent dimming systems has improved greatly over the last decade, some researchers feel that we still don't know enough about how to design these systems for maximum reliability.

In response, the Lighting Research Center (located at Rensselaer Polytechnic Institute in Rensselaer, N.Y.) has begun a study designed to provide the basis for possible future standards to ensure consistent reliability.

Long-term testing of linear fluorescent lamps on a wide range of dimming ballasts is planned for the three- to five-year study. More than 850 systems will be tested.

Researchers note that these lamps were originally designed to work in a steady state—fully-on or fully-off. The study will explore the operational parameters of dimmed lamps to minimize performance problems that may appear over time and to develop a scientific basis for new dimming-system standards.

Maintaining the Savings

LEED's rating system covers the initial construction/renovation process, not ongoing maintenance. However, a strong lighting maintenance program is one of the best ways facility owners and managers can ensure promised energy savings are actually realized.

Over time, age and dirt accumulation lead to a steady drop in light output from even the most efficient lamps, even as those lamps consume the same amount of energy. In fact, lighting output can drop by up to 50% before lamps actually fail. And, as overall lighting levels drop, occupants may be tempted to bring in their own, less-efficient light sources. A facility- or area-wide replacement process, which also incorporates simultaneous fixture cleaning, can help maintain both lighting levels and efficient performance.

Determining the right interval for completing group relamping depends on a number of factors, including:

- types of lamps and ballasts used (electronic ballasts generally last longer than magnetic models);
- the products' rated lifetimes;
- how many hours lighting operates in an average year; and
- how clean or dirty the affected area typically is.

Lamps and ballasts should be replaced when they reach 70% of their rated lives, according to U.S. Environmental Protection Agency recommendations—whether the lamps are still operating or not. Group relamping is more efficient than changing lamps one by one as they fail, and the practice helps maintain consistent light levels across a facility.

The "green building" movement, as expressed in the LEED rating system, helps building owners and those who serve them to ensure the design of new buildings (and the retrofit of existing structures) is done with energy-efficiency and environmental impact uppermost in mind.

Lighting design is an important piece of "green building" goals and hoped-for accomplishments. This document has but scratched the surface of the potential embedded in LEED and the referenced regulations.

Web Resources & References

The following websites offer additional information regarding the U.S. Green Building Council's LEED rating systems, and high-efficiency lighting designs and products:

ASHRAE—*www.ashrae.org*

Building Codes Assistant Project—*www.bcap-energy.org*

Energy Design Resources—*www.energydesignresources.com*

Energy Star Program (US EPA)—*www.enerystar.gov*

IALD (International Association of Lighting Designers)—*www.iald.org*

IESNA (Illuminating Engineering Society of North America)—*www.iesna.org*

LEED specifics (U.S Green Building Council)—*www.usgbc.org*

Lighting Research Center—*www.lrc.rpi.edu*

NEIS (National Electrical Installation Standards)—*www.neca-neis.org*

Case Study: LEED in Commercial Interiors

Thanks to LEED for Commercial Interiors (LEED-CI), the U.S. Green Building Council (USGBC) headquarters in Washington, D.C., is now green on the inside. "The USGBC is now able to experience, in our own offices, the kind of change we're making in the world. It's exciting to see LEED coming full circle," said Rick Fedrizzi, president and CEO of the USGBC.

A Case for Green Building

Building green was a natural for USGBC. As a tenant, USGBGC hasn't been able to pursue LEED certification for prior years' expansions because LEED for New Construction (LEED-NC) didn't address the particular needs of tenant improvement and interior renovation projects.

But this time, a new rating system—tailored *to commercial interiors*—was making its debut. The availability of the LEED-CI pilot program, combined with the pressing need to expand available work space to make room for new staff, gave USGBC its first opportunity to build green.

Project Goals and Results

Goals were to create a green headquarters space that would showcase LEED-CI, serve as a learning space, and give the USGBC's staff its first green workspace. At the project's outset, preexisting walls were removed to give everyone access to natural light and views. All of the doors and lighting fixtures were either set aside for reuse or returned to the building owner for use in other renovations.

The resulting office is drastically different. "The first day we moved in, there was an immediate positive reaction to the daylighting and the open floor plan," commented Pegi Shriver, vice president of marking and development. Benefits accrue outside of the newly renovated space, as well. A dramatic reduction in watts-per-square-foot was achieved by removing excess lighting fixtures, which results in energy savings for the building owner.

Text and photo courtesy of the U.S. Green Building Council.

EDL Order Form

The following monographs are $4.00 each for NECA members and $10.00 for nonmembers. Prices for bulk quantities will be quoted upon request.

	Date	Title	Index No.
❑	8/99	Energy Savings Performance Contracting—A New Frontier	302597
❑	6/00	National Electrical Installation Standards	302599
❑	12/00	Intelligent Building Distributed Networks	3025100
❑	6/01	The Essentials of Quality Power	3025102
❑	9/01	Specifying Integrated Building Systems	3025103
❑	12/01	Guide to Energy Efficiency Options: Using Today's Electrotechnologies	3025104
❑	12/02	Guide to Quality Electrical Installations	3025105
❑	12/02	Quality Lighting Design and Installation	3025106
❑	4/03	Tips for Ensuring "Best Quality" Voice-Data-Video Installations	3025107
❑	9/03	Aspects of Electrical Testing	3025108
❑	12/03	Lighting Trends: Energy Rules and Technology Rolls	3025109
❑	12/03	Should Owners Use—Or Break—the Electrical Equipment Supply Chain?	3025110
❑	10/04	Electrical Maintenance Pays Dividends	3025111
❑	11/04	Concerns About Critical Facilities	3025112
❑	12/04	Sustainable Design: Turning Theory into Reality	3025113
❑	10/05	LEED: Make Lighting Green	3025114

Please send me the EDL(s) checked above. I have enclosed a check in the amount of $_____ for these copies.

Name _____

Address _____

City _____ State _____ Zip _____

Please mail this EDL Order Form and your check (made payable to NECA) to:

National Electrical Contractors Association, P.O. Box 79148, Baltimore, MD 21279-0148.

NECA Chapter Locations

The National Electrical Contractors Association, Inc., was founded in 1901. It represents the electrical contracting industry and is organized into independent, local chapters throughout the United States, Australia, Canada, and New Zealand. The headquarters office is located at 3 Bethesda Metro Center, Suite 1100, Bethesda, MD 20814-5372. Field service regional offices are located in Covington, LA, Glendale, WI, Novato, CA, and Wakefield, RI. For help in locating a qualified electrical contractor in your area or for more information concerning this publication, contact the NECA Chapter Office nearest you.

ALABAMA: Mobile (251-479-9534)
ALASKA: Anchorage (907-561-1958)
ARIZONA: Phoenix (602-263-0111), Tucson (520-323-1622)
ARKANSAS: Little Rock (501-758-2224)
CALIFORNIA: Bakersfield (661-325-5937), Dublin (925-828-6322), Fresno (559-263-9683), Los Angeles/Pasadena (626-792-6322), Martinez (925-372-3222), Menlo Park (650-328-3100), Orange (714-634-8777), Petaluma (707-765-1050), Sacramento (916-376-8980), Salinas (831-751-2080), San Bernardino (909-824-7050), San Diego (858-571-6322), San Francisco (415-703-8333), San Jose (408-288-6100), Santa Maria (805-348-1200), Stockton (209-478-8105)
COLORADO: Denver (303-937-3900), Colorado Springs (719-636-3901)
CONNECTICUT: Hamden (203-287-1444)
DELAWARE: Philadelphia, PA (215-732-1444)
DISTRICT OF COLUMBIA: Annandale, VA (703-658-4383)
FLORIDA: Jacksonville (904-636-0663), Miami (305-828-9918), Orlando (407-426-9050), Tampa (813-253-0887)
GEORGIA: Atlanta (770-454-6400), Atlanta [Southeastern Line Constructors] (770-969-9209), Augusta (706-262-6322), Savannah (912-355-1252)
HAWAII: Contact NECA Marketing Services in Bethesda, MD (301-215-4525)
IDAHO: Boise (208-322-4744)
ILLINOIS: Chicago (630-876-5360), Joliet (815-729-2288), Northeastern Illinois (630-876-5360), Peoria (309-673-6900), Rockford (815-874-8400), Quad Cities (563-322-5371), Springfield (217-585-9500)
INDIANA: Evansville (812-422-3259), Indianapolis (317-846-5680), Michigan City (219-872-3151)
IOWA: Des Moines (515-278-2341)
KANSAS: Wichita (316-265-7067)
KENTUCKY: Louisville (502-893-2713)
LOUISIANA: Baton Rouge (225-752-7970), Monroe (318-387-4411), New Orleans (504-733-9370), Shreveport (318-686-9541), Westlake (337-436-0886)
MAINE: Boston, MA (617-969-2521)
MARYLAND: Baltimore (410-590-1189)
MASSACHUSETTS: Boston (617-969-2521), Springfield (413-785-1337), Worcester (508-752-6422)
MICHIGAN: Detroit (248-355-3500), Lansing (517-372-3080)
MINNESOTA: Duluth (218-722-8115), Minneapolis (952-591-1800), St. Paul (651-224-3377)
MISSISSIPPI: Jackson (601-373-1623)
MISSOURI: Kansas City (816-753-7444), Kansas City [Southwestern Line Constructors] (816-891-8570), Kansas City [Missouri Valley Line Constructors] (816-891-9066), St. Louis (314-644-3030)
MONTANA: Helena (406-442-8330)
NEBRASKA: Omaha (402-397-5105)
NEVADA: Las Vegas (702-876-7860)
NEW HAMPSHIRE: Boston, MA (617-969-2521)
NEW JERSEY: Mountainside (908-654-5770), Mt. Laurel (856-722-6777)
NEW MEXICO: Albuquerque (505-883-6677)
NEW YORK: Albany (518-785-5876), Binghamton (607-723-8824), Finger Lakes, NY (315-451-4278), Hudson Valley (845-928-3575), Long Island (631-462-0490), New York City (212-481-0534), Potsdam (315-742-1060), Rochester (585-292-5190), Scarsdale [Northeastern Line Constructors] (914-723-2527), Western NY State (716-810-1664)
NORTH CAROLINA: Richmond, VA (804-672-2234)
NORTH DAKOTA: Fargo (701-293-1300)
OHIO: Akron (330-384-1242), Cincinnati (513-791-8777), Cleveland (216-398-8440), Columbus (614-224-4408), Dayton (937-299-0384), Toledo (419-666-6040), Vandalia [American Line Builders] (937-898-5824), Youngstown (330-726-5525)
OKLAHOMA: Tulsa (918-749-9449), Oklahoma City (405-848-8621)
OREGON: Portland (503-233-5787), Springfield (541-736-1443)
PENNSYLVANIA: Philadelphia (215-732-1444), Pittsburgh (412-432-1155)
RHODE ISLAND: Providence (401-785-2990)
SOUTH CAROLINA: Richmond, VA (804-672-2234)
SOUTH DAKOTA: Fargo, ND (701-293-1300)
TENNESSEE: Chattanooga (423-894-4357), Memphis (901-366-9010), Nashville (615-885-4441)
TEXAS: Amarillo (806-373-0281), Arlington (817-633-3332), El Paso (915-778-4295), Houston (713-977-2522), San Antonio (210-226-6331), Wichita Falls (940-761-6020)
UTAH: Salt Lake City (801-486-6900), Midvale [Western Line Constructors] (801-566-8600)
VERMONT: Springfield, MA (413-785-1337)
VIRGINIA: Richmond (804-672-2234)
WASHINGTON: Everett (425-258-2644), Seattle (206-284-2150, Spokane (509-328-9670), Tacoma (253-584-4095)
WEST VIRGINIA: Charleston (304-346-1331)
WISCONSIN: Madison (608-221-4650), Milwaukee (414-778-0305)
WYOMING: Casper (307-234-8142)

INTERNATIONAL CHAPTERS
AUSTRALIA: NECA National Office [Australia] (61-3-9645-5566), New South Wales (02-9744-1099), Queensland (7-3251-2444), South Australia (61-8-8272-2966), Western Australia (618-9321-8637)

Thinking "Best Value?"

For Integrating Power, Light and Building Systems, NECA Contractors Define "Best Value."

Experts in the design, specification, installation management and integration of all electrical and specialty systems.

- **Power distribution**
- **Data and communications**
- **Safety and security**
- **Automated control systems**

Integration can make all the difference—in managing costs, delivering the best value and making sure that all power, light and sophisticated specialty systems perform as they should for years to come. With experience in all aspects of electrical contracting and staff trained in the most advanced installation and maintenance techniques, a NECA contractor can assume full accountability for all electrical contracting projects of any size or scope. To find NECA contractors, contact your local NECA chapter or visit www.necanet.org.

Think Best Value. Think NECA Contractors.

NECA