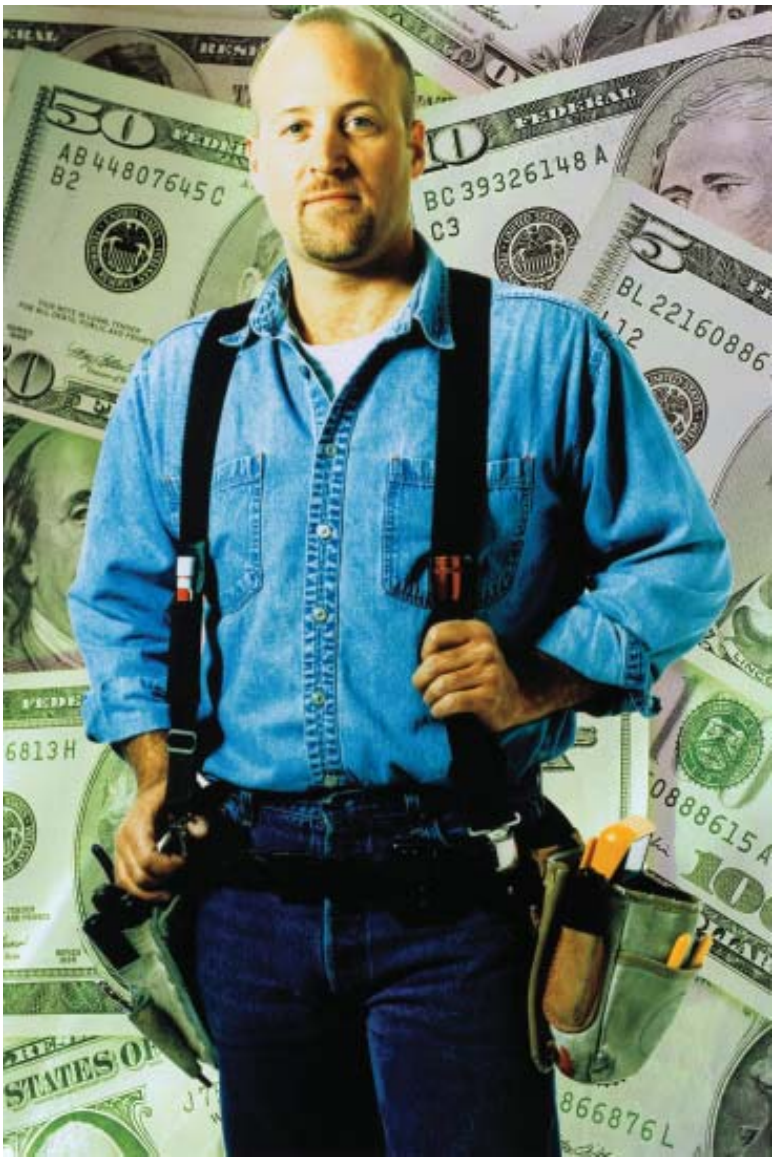
ELECTRICAL DESIGN LIBRARY

Electrical Maintenance Pays Dividends



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. This EDL is the result of ongoing research being sponsored by The Electrical Contracting Foundation, Inc. into electrical service contracting by The University of Kansas.

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Electrical Maintenance Concerns

Since most building power distribution systems are radial, the failure of any downstream component will interrupt all upstream loads. Such power disruptions usually result in lost production and sales, events that directly impact the bottom line.

Building power distribution systems are no different than other building systems. Over time and with use, the components that make up a power distribution system degrade and need to be maintained or replaced.

However, other building systems offer an advantage. They usually fail gradually—for example, small leaks through the ceiling, which allows you to take corrective action—replace or repair a roof—before catastrophe occurs. With power distribution systems, wear or system failure is rarely immediately visible—out of sight and out of mind.

Regular maintenance programs are key to getting advance notice of impending power distribution failure. They reveal problems such as discolored insulation or overheated conductor terminations that allow you to take early corrective action. They also increase the chances that uninterruptible power supplies (UPSs) will actually operate properly in an emergency.

Further, poor electrical maintenance is expensive. It causes unnecessary equipment replacement, preventable repairs, avoidable service disruptions, and prolonged downtime.

This Electrical Design Library discusses issues to consider when creating an effective electrical maintenance program.

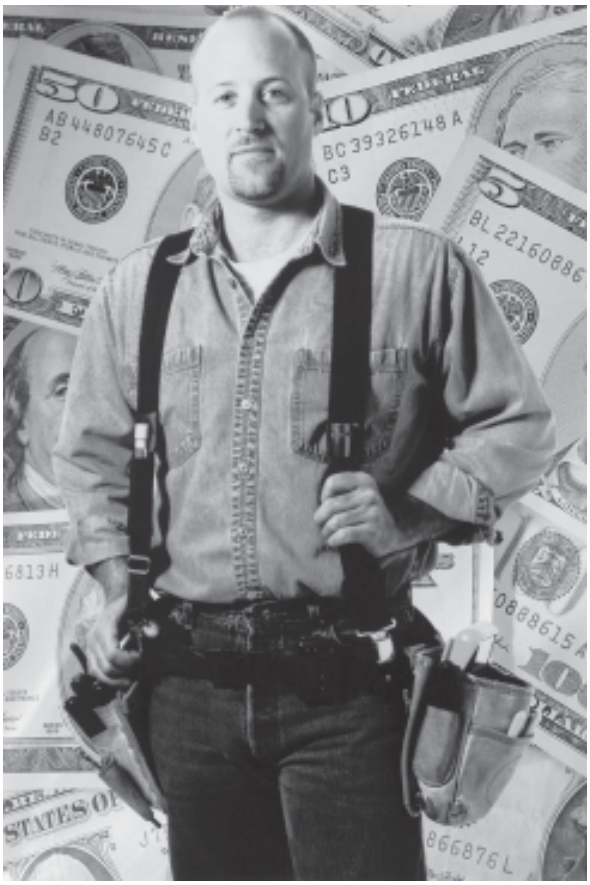
Environmental Concerns

Effective electrical maintenance should address both the electrical environment and the physical environment where equipment operates.

Motor and transformer life expectancy decreases significantly when the equipment is operated for a short period of time at temperatures only moderately above the rated insulation temperature. Excessive heat causes insulation failure and internal short circuits.

Excessive heat may be generated when transformers and motors operate in unconditioned and nonventilated spaces, ventilation openings are blocked, ventilation fans are inoperable, or dirty air filters don't get replaced.

Similarly, exposing distribution equipment to dust and moisture it is not designed to handle will shorten its life. Dust and moisture can lead to arcing and insulation failure. Further, dust buildup reduces the ability of equipment to rid itself of excess heat, which leads to insulation failure.



Poor electrical maintenance is expensive; it leads to avoidable disruptions and prolonged downtime

Electrical equipment must be selected and rated based on the environment where it will be placed. After installation, the equipment needs to be inspected and cleaned regularly

so that corrective action can be taken and premature failure of the equipment can be avoided.

Other Concerns

Age and use are not the only things that impact the reliability of a building's power distribution system.

Few people would install a new piece of production equipment in a building without first checking to make sure that the structure could handle it.

However, new and different loads are added to building power distribution systems each day without anyone questioning whether or not the system can handle them, how the loads will affect the operation of other system loads, or how reliable power distribution system components are.

Managing power distribution is complicated enough day-to-day—with mechanical and production equipment cycling on irregular schedules—to not take into account the effects of changing load characteristics and power quality requirements as electronic data processing, communications, and control equipment are added to the system.

If everything is sized properly, overloads and short circuits will be cleared by the circuit breaker or fuse protecting the circuit. Still, repeated overloads and short circuits weaken system components over time and result in premature equipment failures.

In addition, every time that a feeder or branch circuit is opened due to an overload or short circuit, the systems fed by that circuit are down until the problem is identified and corrected.

Further, system conditions such as harmonics, voltage imbalance, chronic low voltage, and system transients often go undetected by circuit breakers and fuses. They can, however, be detected and corrected through an ongoing maintenance program.

Why is this important?

If undetected, these conditions can result in overheating and insulation failure of distribution system components that will result in a short circuit and power interruption.

Exposure to dust and moisture is one sure way to shorten the useful life of electrical equipment.

Power Distribution System Service

When putting together an effective power distribution maintenance program, consider the types of maintenance required in your facility. Power distribution system service can be divided into the following three categories:

- Demand Service
- Scheduled Service
- Programmed Service

Demand Service

Demand service refers to service that responds to your immediate need. Typically, demand service occurs when your system or piece of equipment has failed or is operating at a significantly reduced capacity and is affecting your ability to carry on day-to-day business.

Demand maintenance is often the result of a run-to-failure (RTF) mentality. Unexpected failure of electrical equipment can never be eliminated. There will always be equipment that fails unexpectedly or fails for reasons other than just wear and tear, such as accidents and acts of God.

However, ongoing inspection and maintenance can identify problems in advance and help avoid sudden failures. By identifying potential problems in advance, you can plan corrective maintenance around your operations with scheduled service. Programmed service is designed to reduce the amount of demand service you need.

NEIS Standards Offer Maintenance Guidance

While all NEIS are created to make electrical and datacom system maintenance easier and less expensive over a building's life, many of these installation standards specifically deal with maintenance. In each case, a short PDF is available—free—which contains the individual document's table-of-contents and scope.

Some sample standards and Web URLs for downloading of the PDFs:

NECA 400—Recommended Practice for Installing and Maintaining Switchboards
(www.necanet.org/store/pdf_toc/ACF48.pdf).

NECA 408—Recommended Practice for Installing and Maintaining Busways
(www.necanet.org/store/pdf_toc/ACF23D6.pdf)

NECA 230—Standard for Selecting, Installing, and Maintaining Electric Motors and Motor Controllers
(www.necanet.org/store/pdf_toc/NECA230TOC.pdf)

Many other standards specifically mention (and are titled with) maintenance. For a complete list, see the menu at left on www.neca-neis.org/standards. A PDF with basic document info is available on each; ordering information is included online, with electronic ordering available.

Scheduled Service

Scheduled service refers to service that is planned and scheduled in advance with the customer. Scheduled service can include moves, adds, and changes (MACs or MAXs) to an existing system to better meet needs.

Scheduled service can also involve the repair of noncritical or redundant systems or equipment that have failed or are running at reduced capacity. Scheduled service can also occur when a system or piece of equipment is suspected to be near failure.

Programmed Service

Programmed service includes both pre-scheduled and trigger-point service.

Pre-scheduled service includes preventive maintenance that occurs on regular intervals. These intervals are determined by a parameter such as

Reduce Electrical System Operation & Maintenance

Construction industry research shows that the up-front investment in a building—the total cost, from conception to delivery, including design, installation, materials procurement, and contractor costs—is roughly 1% or less of total building lifetime operating cost.

Can the up-front investment be made more effective? That's the question owners and developers ask. Not too long ago, the nation's top electrical contractors asked themselves a related question: How can owners, developers, and their architect and engineer representatives better define "effective" when it comes to electrical and datacom systems?

Those discussions led to the inception of the *National Electrical Installation Standards (NEIS)*. The first quality and performance standards for electrical construction, *NEIS* are designed to be referenced in plans and specifications for electrical construction projects. Here's what that means, along with answers to some frequently asked questions.

What About The NEC?

NEIS supplement and extend the minimum requirements of the National Electrical Code. They were created to "start" where the NEC "leaves off," if you will. The NEC is an electrical safety code, not a performance standard. When it comes to installation, the Code commands that it be done in a "neat and workmanlike" manner—and stops right there! What does "neat and workmanlike" mean, anyway? That's the major question that the *NEIS* seek to answer.

Why Go Beyond The Code?

Building electrical and datacom systems designed, installed, and inspected "to Code" should be safe. Building occupants won't be harmed; building contents won't be damaged. But electrical and communications systems built to Code won't necessarily function in an optimal manner that meets customer expectations. For that, you need standards that specify how power and communications systems are intended to function after their initial installation—NECA's *National Electrical Installation Standards*.

Nothing in the *NEIS* contradicts the NEC. But, in many cases, *NEIS* go beyond the safety requirements of the Code to specify a higher level of system performance and reliability.

True Industry Standards

Many *National Electrical Installation Standards* are jointly written with other expert groups, such as engineering societies and specialty trade associations. All are voted upon by a broad cross-section of industry,

and approved by the American National Standards Institute (ANSI), coordinating body for U.S. standards developers. These two facts make the *NEIS* true industry standards that can be relied upon by engineers, contractors, facility managers, and inspectors.

Is Proper Installation Worthwhile?

What can systems designed to *NEIS* standards do for building owners, developers, and tenants?

Design process: Inclusion of these standards in a specification allows architects and engineers to gain unprecedented control over electrical system installation. Additionally, the *NEIS* library—now at more than 25 documents—covers many key electrical products and systems s (with more to come).

Construction: If construction documents don't clearly specify how building systems are to be installed, communication between owner, architect, engineer, general contractor, subcontractor, and others can become confused. Use of *NEIS* makes things clear. Misunderstandings are reduced or eliminated.

Installation & inspection: NEIS include many details that can be inspected on a job site; they provide additional guidance that electrical inspectors—and others—can use when evaluating electrical installations. Some state governments have adopted NEIS for regulatory use. Electrical inspectors can use an NEIS standard in evaluating an installation—as can others.

Liability: By improving levels of detail and instruction for electrical installers, use of *NEIS* may well reduce or eliminate potential liability. Of course, with clear communication on electrical and datacom system installation (referenced above), there should also be a reduction in lawsuits arising from the electrical construction process.

Maintainability: Finally, *National Electrical Installation Standards* created with a building's lifetime in mind. After all, when it comes to electrical systems, most building owners want to avoid replacement. If a system is installed so as to make maintenance difficult, it will be troublesome for a long, long time. On the other hand, a building with initial specs that included NEIS will be relatively easy to maintain—with an impact that extends for decades!

For More Information

For more information and a complete list of current standards (as well as those under development), see *www.neca-neis.org*. Individual *NEIS* are available as printed documents; there are also discounts available on logical groupings of printed standards (such as the three-volume Lighting series).

NEIS are also available in ready-to-use electronic format. A quarterly CD-ROM subscription service is available; each CD contains newly issued standards, an updated and complete library of existing NEIS—and drafts of new standards in the review process.

calendar time for continuously running equipment, running time for equipment whose running hours are monitored, or some other activity-based parameter.

Some examples of pre-scheduled service include visual inspection, cleaning, bus adjustments and tightening, switch and breaker inspection, and breaker and relay testing.

Trigger-point service or predictive maintenance involves monitoring key system or equipment parameters. If a parameter falls outside of preset tolerance limits, service is triggered to identify the cause and correct the problem. Service offerings under this category include both preventive and predictive maintenance.

Examples of trigger-point or predictive maintenance include electrical load monitoring, power quality analysis, infrared thermography, ultrasonic scanning, vibration analysis, grounding system integrity, and other non-invasive monitoring and testing.

Service Agreements

Service agreements can be tailored to your needs. Service agreements may cover anything from payment by the service call or an all-encompassing service contract.

Service calls typically involve demand service when there is a problem that needs to be corrected as soon as possible. Individual service calls can also be used for scheduled maintenance.

Individual service calls can be expensive when compared to a service contract. In addition, without a service contract, there is no guarantee that service will be provided when you need it.

Service contracts are agreements with an electrical contractor to provide clearly defined service for a fixed period of time for a set price. Provisions can include maintenance of all or part of the system, defined response time, a number of service hours per month, loan of equipment, and named technicians.

Advantages of service contracts are that they allow owners and maintenance staff to outsource electrical service needs when required technical personnel are not available in-house.

Additionally, they provide a way for owners and maintenance staff to budget for defined periods and control maintenance costs; shift risk to the electrical contractor; and result in improved system reliability and availability, improved safety, and reduced insurance premiums.

Harmonics, voltage imbalances, chronic undervoltage and system transients often are not detected by breakers and fuses.

Where Do I Turn for Electrical Maintenance Information?

How do you decide what to test, how to test, and when to test?

- **NFPA 70B-1998**, *Recommended Practice for Electrical Equipment Maintenance* provides such information. It is designed *to reduce hazards to life and property that can result from failure or malfunction of industrial-type electrical systems and equipment*. NFPA 70B covers a variety of equipment that is common to both industrial and commercial facilities, including transformers, substations and switchgear, motors and motor control, and uninterruptible power supplies (UPSs). (See *nfpa.org* for more information on the NFPA.)
- Other NFPA codes specify testing requirements for critical building systems. For instance, **Article 700 of the *National Electrical Code*** (*NEC*) requires full-load testing of emergency and legally-required standby systems in Articles 700 and 701, respectively.
- **NFPA 101, the *Life Safety Code*,** requires battery operated emergency lighting units to be tested every 30 days for a minimum of 30 seconds and annually for 1-1/2 hours.
- Similarly, **NFPA 72, the National Fire Alarm Code,** has specific requirements regarding how a building's fire alarm system should be tested and maintained and who can perform the required testing and maintenance.
- ***Maintenance Testing Specification,*** published by the InterNational Electrical Testing Association (NETA), helps ensure that equipment performs satisfactorily, downtime is minimized, and equipment life expectancy is maximized. The specification covers electrical equipment common to commercial, industrial, and institutional (CII) facilities. (See *netaworld.org* for more information on NETA.)
- Supplementing all of these sources are **equipment manufacturers and insurance companies.** Manufacturers often have recommendations about how and when to perform testing and maintenance on their equipment. Always follow requirements regarding testing and maintenance to ensure proper equipment operation and to avoid voiding the manufacturers' warranty and to maintain insurance.

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 Techology Rolls	3025109
❑	12/03	Should Owners Use—Or Break—the Electrical Equipment Supply Chain?	3025110
❑	10/04	Electrical Maintenance Pays Dividends	3025111

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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, Schaumburg, IL, Syracuse, NY, and Oakland, CA. 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.

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