:CA GUIDELINES FOR ELECTRICAL SAFETY WORK PRACTICES

,.0 INTRODUCTION

Progressive customers require potential project bidders to submit, as part of their bid proposal package, a copy of the bidder's company safety manual. These customers often also require the successful bidder to submit a copy of their company's site-specific safety and health procedures and action plans prior to starting any project work.

To assist electrical contractors in meeting Customer mandates, NECA has made available numerous safety publications that help address best practices for developing, implementing, and administrating company safety and total loss control programs, company manuals, and site-specific safety procedures and action plans - see Exhibit 14.1 on page 87.

This publication primarily focuses on inside electrical work. It does not cover electrical safety procedures for low-voltage & limited-energy, fiber optic, telecommunication, or communication tower construction activities. For guidance in developing electrical safety procedures covering these work activities, please refer to the *NECA's Voice-Data-Video Contractor Safety Compliance Manual.* In addition, this publication does not address compliance with OSHA's Construction Industry Subpart V - Power Transmission and Distribution Standards 29 CFR 1926.950 through 1926.960 or OSHA's General Industry Subpart R - Electric Power Generation, Transmission, and Distribution Standard 29 CFR 1910.269.

The *NECA's Guidelines for Electrical Safety Work Practices* has been developed to assist Site Superintendents, Safety Coordinators, and Foremen to address all actual and potentially hazardous phases of the Company's electrical work packages in order to safeguard Company employees, other site workers, and the Customer's assets. The guidelines cover task-specific electrical safety program principles, controls, procedures, and related medical and emergency rescue action plans.

2.0 OBJECTIVES

The four major objectives of this manual are to help:

- Comply with the Customer's project electrical safety contractual requirements.
- Identify significant national consensus electrical standards and federal or state OSHA 1910 & 1926 electrical safety standards with a look toward the most stringent standards.
- Establish the Company's project electrical safety programs, procedures, and action plans to provide electrically-safe work conditions for Company employees and site personnel.
- Define the Company's electrical accident rescue and emergency action planning requirements.

3.0 NATIONAL CONSENSUS ELECTRICAL SAFETY STANDARDS

National consensus standards are normally written by volunteers and published by standards developing organizations (SDO's). Some consensus standards are product-oriented. Others define testing requirements, cover design and installation criteria, or personal safety guidelines. Many national consensus standards become legally mandated by governmental organizations. Since national consensus standards are generally regarded as accepted engineering practices, these can be used for litigation purposes, when entered as evidence in legal proceedings. The SDO's, which follow, address various electrical safety guidelines.

1.1 NFPA 70 - NATIONAL ELECTRICAL CODE (NEC)

NFPA 70 is commonly called the National Electrical Code or the NEC. The NEC is currently adopted by more than 1,800 different governmental organizations in the U.S., and by several Latin American countries. These organizations include city, county or state governments. Some adopt the NEC as it is published by NFPA; others add or subtract requirements.

The NEC covers premise wiring involving interior and exterior wiring, including power, lighting, control and signal circuits along with all associated hardware. This extends from the service point from the utility or separately derived system to the outlet(s).

The focus of the NEC is to identify requirements used to control the probability of electrical fires and provide safe installation, when the system or equipment is operating normally. By itself, the NEC is a standard with advisory information offered for use in law and for regulatory purposes and is reviewed and revised on a three-year cycle. NEC is offered as a minimum standard, and therefore its requirements may have to be exceeded to meet functional necessities, sound engineering judgment, and improved safety.

The NEC covers four basic types of installations:

- Electric conductors and equipment within or on public and private buildings or other structures, including mobile homes, recreational vehicles, and floating buildings. This section also includes premises wiring for such facilities as yards, carnival lots, parking lots, and industrial substations.
- Conductors and equipment that connect to the supply of electricity.
- Other outside conductors and equipment on the premises.
- Optical fiber cable.

The NEC does not apply to ships, railway rolling stock, underground mine installations, railway generation, communications equipment under the control of communications utilities, and certain facilities under the control of electric utilities. The utility facilities that are excluded include the communications, metering, generation, transformation, transmission, and distribution in buildings or substations used specifically for that purpose. The NEC does include utility office buildings and other such public and commercial structures.

The NEC has become an engineering reference, an installation guide, a design standard, and a fire safety code all in one volume. *Always refer to the most recent edition of the National Electrical Code (NEC).*

3.2 NFPA 70B - RECOMMENDED PRACTICES FOR ELECTRICAL EQUIPMENT MAINTENANCE

The NFPA 70B, Recommended Practices for Electrical Equipment Maintenance, is a national standard, whose purpose is to reduce hazards to life and property that can result from failure or malfunction of industrial/commercial electrical systems/equipment. NFPA 70B addresses electrical safety and maintenance of industrial-type electric systems and equipment that are typical of those installed in commercial buildings, industrial plants, and large multi-family dwellings. It does not cover consumer appliances or home-type equipment and does not supersede the equipment manufacturers' recommended maintenance procedures.

NFPA 70B chapters cover maintenance fundamentals, how to plan a preventive maintenance program, detailed maintenance techniques, and expected results for switchgear, circuit breakers, cables, motor control centers, rotating equipment, wiring devices, and other such electric equipment. It also provides the specifics for electrical testing in areas such as insulation resistance, protective device testing, infrared, fault-gas analysis, and many other such modern testing procedures. Still other chapters cover the maintenance of equipment, which is subject to long intervals between shutdowns and methods to be used for de-energizing equipment in such a way that maintenance personnel are protected. The appendices include information on walk-through inspections, instruction techniques, symbols, diagrams, and a variety of recommended test sheets and forms to be used for maintenance programs.

3.3 NFPA 70E- ELECTRICAL SAFETY REQUIREMENTS FOR EMPLOYEE WORKPLACES

The NFPA 70E standard focuses on protecting people and identifies requirements that are considered necessary to provide a safe workplace. NFPA 70E is intended to address conditions that exist, may exist, and in abnormal conditions, where people can become involved. The NFPA 70E states that:

- Electrical hazards include shock, arc flash and arc blast.
- The best way to avoid injury or incident is to establish an electrically-safe work condition prior to beginning the work.
- Procedures and training are extremely important, if injury is to be avoided.

When OSHA's electrical standards were first developed, these were based on the National Electrical Code. As OSHA focused more on all aspects of electrical safety, the need resulted for a consensus document in preparing electrical safety requirements for protecting individuals working on or near electrical equipment. Many parts of the current OSHA regulations 29 CFR 1910 Subpart S were derived from NFPA 70E.

NFPA 70E Standard for Electrical Safety Requirements for Employee Workplace is revised every three years and therefore attempts to reflect the best practices on the subject of electrical safety, especially in the area of safe work practices, and identifies the requirements for enhanced worker safety. The current edition of NFPA 70E at the time of publishing these NECA guidelines is the 2000 edition. *Always refer to the most recent edition of the NFPA 70E as well as other documents referenced in this NECA guideline document for specific information.*

3.4 NESC - NATIONAL ELECTRICAL SAFETY CODE

The National Electrical Safety Code (NESC) is an ANSI standard that is written and published by the IEEE. This standard is intended to identify requirements that apply to outdoor electrical transmission, distribution, and communication systems, equipment, and associated work practices, as opposed to premises wiring, addressed in the NEC. The NESC addresses the utility industry and provides information intended to protect the general public from hazards associated with the transmission and distribution of electricity. NESC does not cover installations in mines, ships, railway rolling equipment, aircraft, automotive equipment, or utilization wiring, except in certain cases. The NESC is the base standard providing the starting point for OSHA, when 29 CFR 1910.269 was being written.

The NESC rules cover supply and communication lines, equipment, and associated work practices used by both public and private electric supply, communications, railway, or similar utilities and systems, which are under the control of qualified persons. Co-generation plants, industrial complexes, or utility interactive systems are covered by the standard. The code has three general rules as follows:

- All electric supply and communication lines and equipment shall be designed, constructed, operated, and maintained to meet its requirements.
- The utilities, authorized contractors, or other entities, as applicable, performing design, construction, operation, or maintenance tasks for electric supply or communication lines or equipment covered by the NESC are held responsible for meeting the applicable requirements.
- For all particulars not specified in the NESC, construction and maintenance should be done in accordance with accepted good practice for the given local conditions.

The NESC covers five major areas in numerous parts. The following sections describe each of the major areas of coverage and lists the type of information included in each. The information provided in the following sections is intended to be general information only. Always refer to the most recent edition of the NESC for specific information.

- GROUNDING METHODS FOR ELECTRIC SUPPLY AND COMMUNICATIONS FACILITIES. This section covers the methods to implement protective grounding for electric supply and communications facilities. The information is technical in nature and includes topics, such as, the point of connection, the composition of the grounding conductor, the means of connection, grounding electrodes, and many other grounding topics.
- RULES FOR INSTALLATION AND MAINTENANCE OF ELECTRIC SUPPLY STATIONS AND EQUIPMENT. This section covers those parts of the electrical supply system and associated structural arrangements, which are accessible only to qualified personnel. It also covers the conductors and equipment employed primarily for the utilization of electric power, when such conductors and equipment are used by the utility in the exercise of its function as a utility. Protective arrangements in electric supply stations, illumination, installation and maintenance of equipment, rotating equipment, storage batteries, transformers and regulators, conductors, circuit breakers, switchgear and enclosed metal bus, and surge arrestors are included in this section.

- SAFETY RULES FOR THE INSTALLATION AND MAINTENANCE OF OVERHEAD ELECTRIC SUPPLY AND COMMUNICATIONS LINES. This section applies to overhead lines, associated structural assemblies, and extension of such lines into buildings. Typical examples of topics included in this part are inspection and tests of lines and equipment, grounding of circuits, arrangements of switches, relations between various classes of equipment, joint use of structures, clearances, grades of construction, line insulation, and other such topics.

- SAFETY RULES FOR THE INSTALLATION AND MAINTENANCE OF UNDERGROUND ELECTRIC SUPPLY AND COMMUNICATION LINES. This part is similar to the previous part, except the equipment it includes, is underground equipment. Topics address general requirements applying to underground lines, underground conduit systems, supply cable, underground structures, direct buried cable, risers supply cable terminations, and installations in tunnels.

- RULES FOR THE OPERATION OF ELECTRIC SUPPLY AND COMMUNICATIONS LINES AND EQUIPMENT. This final part of the NESC discusses rules for the operation of supply and communications lines and equipment. The first major section provides operational rules for both communications and supply employees. Personnel general precautions, general operating routines, overhead line operating procedures, and underground line operating procedures are also included. The second major section has additional rules which pertain to communications workers. Approaching energized conductors, joint-use structures, surface attendants at joint-use manholes, and sheath continuity rules are included.

Industrial facilities frequently require uninterrupted electrical service by contract. Work rules, as contained in the NESC, are intended to afford protection for utility workers as they go about their tasks of maintaining systems, while the lines are energized as is frequently necessary to maintain uninterrupted service. The attempt to provide uninterrupted service effectively defines the working environment for many utilities.

3.5 NEMA - NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

The National Electrical Manufacturers Association (NEMA) is a nonprofit standards-developing organization made up of manufacturers of electrical products. Many of NEMA's standards are accepted as ANSI standards.

The primary objective of a NEMA standard is to promote interchangeability among products. As in all electrical standards, the objective of NEMA standards is to provide for minimum acceptable safety.

NEMA has many standards on electrical products and systems and often serves as a basis for Underwriters Laboratories' (UL) safety standards. Both NEMA and UL standards are designed as consensus standards and are considered as minimal requirements.

3.6 UL- UNDERWRITERS LABORATORY

Underwriters Laboratory® (UL) is a nonprofit organization, whose prime reason for existence, is testing the safety of products to protect the general public. In many cases, the UL standard is accepted as an ANSI standard. The objective of a UL standard is to determine, if a product will perform a function, as defined by the protocol or standard.

There are other consensus standards developing organizations that function similarly to UL. For example, Factory Mutual produces testing standards. Although the organizational objective is different from UL, the standards "products" have a similar objective.

3.7 IEEE- INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

The Institute of Electrical and Electronics Engineers (IEEE) has over 300,000 members from approximately 150 countries around the world that focus on electrical engineering interests. The IEEE is a membership society composed of electrical engineers and technicians working in computer engineering, biomedical technology, telecommunications, electric power, aerospace, and consumer products. The IEEE holds more than 300 meetings annually, which allow engineers and technicians to exchange information.

The IEEE is responsible for approximately 20 percent of the world's published literature in electrotechnology including published papers, textbooks, technical journals, and other documents. The Color Book Series by the Institute of Electrical and Electronic Engineers (IEEE) provides recommended practices and guidelines that go beyond the minimum requirements of the NEC, NEMA and UL standards.

When designing electrical power systems for industrial and commercial facilities, consideration should be given to the design and safety requirements of the following IEEE recommended practice color books:

Red	-	Electrical Power Distribution for Industrial Plants
Green	-	Grounding of Industrial and Commercial Power Systems
Gray	-	Electrical Power Systems in Commercial Buildings
Brown	-	Power System Analysis
Buff	-	Protection & Coordination of Industrial and Commercial Power Systems
Orange	-	Emergency & Standby Power Systems for Industrial & Commercial Applications
Gold	-	Design of Reliable Industrial and Commercial Power
White	-	Electrical Systems in Health Care Facilities
Bronze	-	Electrical Conservation & Cost-Effective Planning in Industrial Plants
Emerald	-	Powering and Grounding Sensitive Electronic Equipment
Yellow	-	Maintenance, Operation and Safety of Industrial & Commercial Power Systems
Blue	-	Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

3.8 ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI does not develop standards. Instead, ANSI monitors the development of standards by other organizations and focuses on how the standard was developed. If the standards developing process meets criteria developed and published by ANSI, the standard can be accepted as an American National Standard.

The ANSI objective is to ensure a complete and open process for organizations that produce standards. ANSI ensures that rules associated with due process have been followed. ANSI is a voluntary, not-for-profit organization and is not directly associated with government. However, the National Institute of Standards and Technology (NIST) has identified ANSI as the official U.S. representative to international standards' efforts. ANSI serves four important functions:

- Coordinates voluntary standards activities.
- Approves American National Standards.
- Represents US interests in international standardization.
- Provides information on and access to world standards.

3.9 ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS

The ASTM has more than 130 standards writing committees, which write standards in such diverse areas as metals, paints, plastics, textiles, petroleum, construction, energy, the environment, consumer products, medical services and devices, computerized systems, and electronics. The ASTM headquarters has no technical research or testing facilities, because such work is done voluntarily by more than 30,000 technically-qualified ASTM members located throughout the world. The ASTM develops six principal types of full consensus standards including test method, specification, practice, terminology, guide, and classification. A list of ASTM procedures for electrical protective equipment is provided in Section 11.0 - see page 69.

3.10 IEC - THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

The International Electrotechnical Commission (IEC) standards are an attempt within international communities to reach a consensus on standard requirements. The IEC develops and promotes electrotechnical standards with national committees from more than 40 countries. Many of the European governments have mandated standards systems. The European Union (EU) encourages further consensus among affected nations.

In many instances, protection schemes embraced in the IEC differ from those in the U.S. For example, in the U.S., nationally-recognized testing laboratories are used to perform standardized third party product testing. Products meeting the testing standard are marked, identifying the testing laboratory. Many products meeting international safety requirements for installation in Europe require certification to testing standards and must bear a CE mark. The CE mark applies to certain Directives within European Union countries. The intent is to provide a safe product that is acceptable to all of the EU countries.

In regard to personnel safety, the IEC standards address protection from electrical shock more directly than U.S. standards. For instance, IEC standards generally recognize that degrees of exposure vary.

3.11 NECA - NATIONAL ELECTRICAL INSTALLATION STANDARDS (NEIS)

While other industries in the construction field have published standards that define acceptable quality, the electrical construction industry never has. Rather than having different and competing building codes like other construction trades, the electrical industry has one strong code: the National Electrical Code. But as important as the NEC is to electricians and contractors, the Code is a safety standard that does not specify all the details needed for quality electrical installations.

In 1996, the National Electrical Contractors Association embarked on a multi-year project to develop a series of National Electrical Installation Standards (NEIS). The primary purpose was to establish quality standards for electrical construction, over and above the minimum safety requirements of the National Electrical Code. In short, the NEIS are intended to define what is meant by installing electrical products and systems in a neat and workmanlike manner. Although this requirement appears in NEC in section 100-12 and six other places, it has never been defined.

Working with industry expert groups is NECA's preferred method of developing National Electrical Installation Standards. The results are more technically accurate standards, making the ANSI approval process easier, and the final publish documents have better acceptance from designers, builders, inspectors, and users of building electrical systems. All NEIS are submitted for approval by the American National Standards Institute (ANSI). This is a higher level of approval that improves acceptance by all parties in the building industry.

Standards developed and approved under ANSI procedures have the status of official U.S. standards. Generally speaking, state and local governments will only adopt American National Standards for regulatory use. Hence, the importance of ANSI approval for documents like the National Electrical Code and National Electrical Safety Code, which are written specifically with regulatory use in mind.

Likewise, many architects and consulting engineers prefer to reference ANSI standards in their specifications for construction projects. For this reason, NECA submits all National Electrical Installation Standards to the ANSI approval process.

National Electrical Installation Standards are the first "reliability" standards for electrical construction. They establish requirements for installing electrical products and systems that go beyond the minimum safety rules of the National Electrical Code (NFPA 70). The NEIS are organized as a series of installation manuals for electrical products and systems. They are intended to be referenced in bid documents and project specifications for electrical construction.

A list of National Electrical Installation Standards is shown as 14.2 on page 88. To order, contact the NECA Order Desk at 301-215-4504 (telephone), 301-215-4500 (fax), www.neca-neis.org or orderdesk@necanet.org. Provide your name, company, and mailing address and NECA member number, where applicable. All nonmember orders must be prepaid by check or credit card.

4.0 OSHA STANDARDS FOR ELECTRICAL WORK

OSHA standards are made available to the general public on OSHA's web site at www.osha.gov. A glossary of electrical terms used in the OSHA standards - see Exhibit 14.3 on page 90.