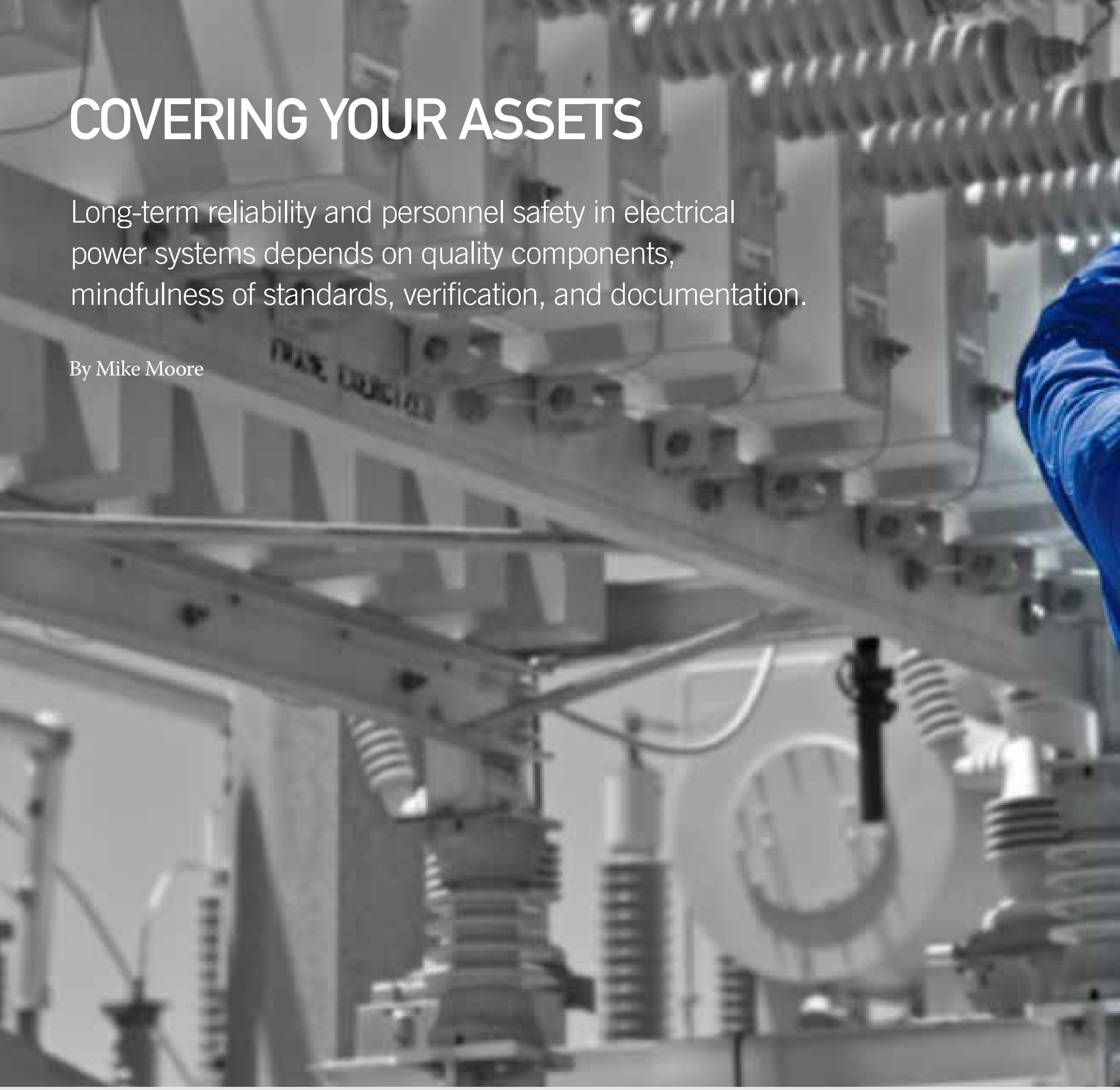
COVERING YOUR ASSETS

Long-term reliability and personnel safety in electrical power systems depends on quality components, mindfulness of standards, verification, and documentation.

By Mike Moore



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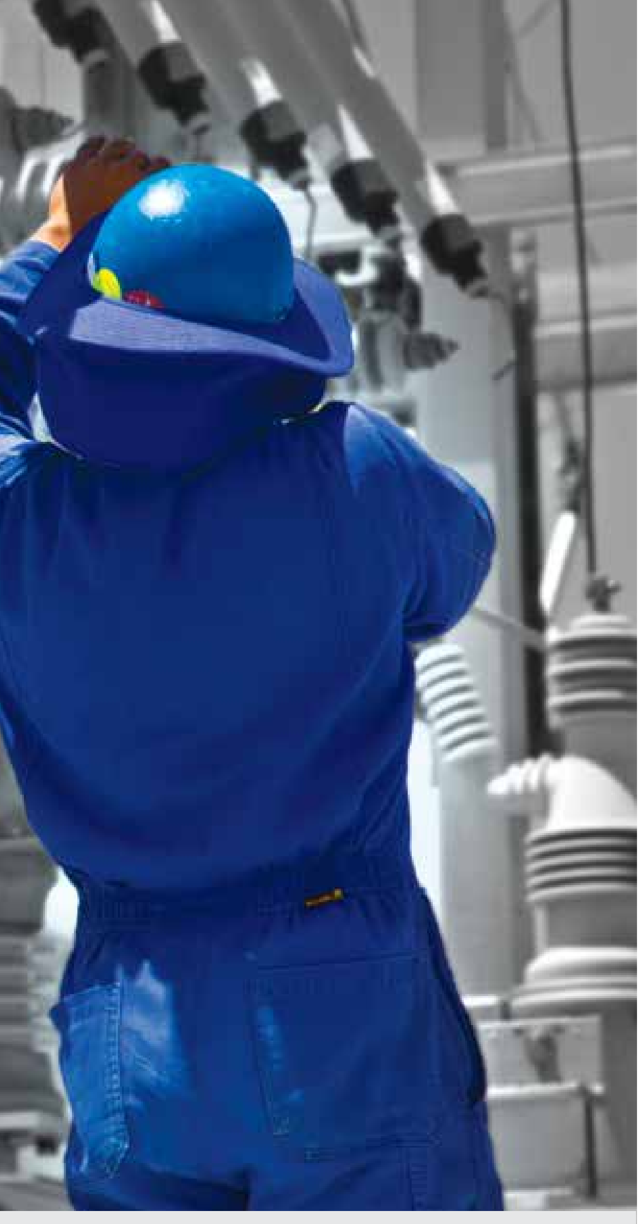
THE PLANNING AND PERFORMANCE of any reliability based maintenance program has always created challenges regarding methodology and frequency of test, contractor qualifications and selection, as well as regulatory and standards interpretation and implementation. Debate also revolves around the effectiveness of on-line predictive maintenance strategies and preventative programs that impact uptime.

With this said, one of the hardest line items to justify in the budget "prove up" is electrical system maintenance and its impact on the reliability to the wind plant. Many components of these electrical systems, including the turbines, were not designed for the ease of maintenance programs. This can be complicated when third-party engineering review and acceptance testing is not included in the development process. Many electrical projects, whether for normal equipment service or even for safety related maintenance, can come with unplanned costs that exceed budgets and create havoc with project cash flow. Additionally, simple test methodology and contractor selection errors as well as poorly implemented maintenance strategies create costly and possibly catastrophic outages. So what do you do? You have to build a "Cover



Your Assets" strategy that protects the electrical equipment and systems, the electrical workers as well as the other stakeholders.

This article is the first of an occasional three-part series that will offer the wind plant owner, designer, developer, and operator some fresh insight—through the eyes of a field-savvy, NETA accredited third party electrical maintenance organization and an EASA-qualified machine repair facility—on how a safety- and reliability-driven electrical protection plan can be developed, documented, and implemented. Each article will be centered wind industry specific challenges:

Part 1—Wind farm electrical specification and installation practices that impact long term reliability and personnel safety.

Part 2—Wind farm electrical practices that impact the turbine and its related components. Not to include the collector system or substation.

Part 3—Wind farm electrical practices that impact the balance of plant to include collector system, substation and the interconnect substation.

FACING REALITY

If the safe, reliable operation of a newly-installed electrical power system and related components is to be achieved, several key components are required:

1. The power system and components must be designed and engineered correctly by a qualified firm that considers maintenance practices, personnel safety and long term reliable operation during the specification and planning process.
2. Only proven quality, design tested and defect free electrical equipment should be specified and procured.
3. The installation must meet all applicable codes and standards and be performed by qualified contractors and vendors.
4. Verification of all of the above should be performed through an independent, third-party inspection process, especially in the absence of AHJ personnel.
5. All information should be documented and archived for future engineering, repair, replacement, upgrade or expansion needs.

Although it sounds pretty simple, these steps often don't happen on an electrical construction project, especially one that is at a remote location.

STANDARDS AND RECOMMENDED PRACTICES

Consensus technical standards and recommended practices are usually developed to establish uniform engineering criteria and practices that help with compatibility, reliability, and safety. The utilization of these standards helps ensure proper design and construction. Some of the applicable standards and regulations that should be considered are listed below, but there are many others.

OSHA—Occupational Safety and Health Administration (OSHA) was established to "assure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance". The agency is also charged with enforcing these regulations.

NFPA—The National Fire Protection Association (NFPA) creates and maintains standards and codes for use and adoption by local governments that cover a wide range of topics from model building codes to the firefighting equipment.

Especially crucial for wind plant maintenance consideration is the NFPA 70B, which explains the importance of electrical equipment maintenance, as well as the 70E, which addresses arc flash and the electrically safe working environment.

Current NFPA Standards:

- NFPA 70 — National Electrical Code
- NFPA 70B — Recommended Practice for Electrical Equipment Maintenance
- NFPA 70E — Standard for Electrical Safety in the Workplace
- NFPA 72 — National Fire Alarm and Signaling Code
- NFPA 101 — Life Safety Code
- NFPA 704 — Standard System for the Identification of the Hazards of Materials for Emergency Response
- NFPA 921 — Guide for Fire and Explosion Investigations
- NFPA 1001 — Standard for Fire Fighter Professional Qualifications
- NFPA 1123 — Code for Fireworks Display
- NFPA 1670 — Standard on Operations and Training for Technical Search and Rescue Incidents
- NFPA 1901 — Standard for Automotive Fire Apparatus

NEC—The National Electrical Code (NEC), while having no legally binding regulation as written, can be and often is adopted by states, municipalities and cities in an effort to standardize their enforcement of safe electrical practices within their respective jurisdiction.

AHJ—The authority having jurisdiction (AHJ) is the governmental agency or sub-agency which regulates the construction process where the site is located. They often have their own standards that should be considered during the system design process.

NESC—The National Electrical Safety Code (NESC) or ANSI Standard C2 is a United States standard of the safe installation, operation, and maintenance of electric power and communication utility systems including power substations, power and communication overhead lines, and power and communication underground lines. It is published by the Institute of Electrical and Electronics Engineers (IEEE).

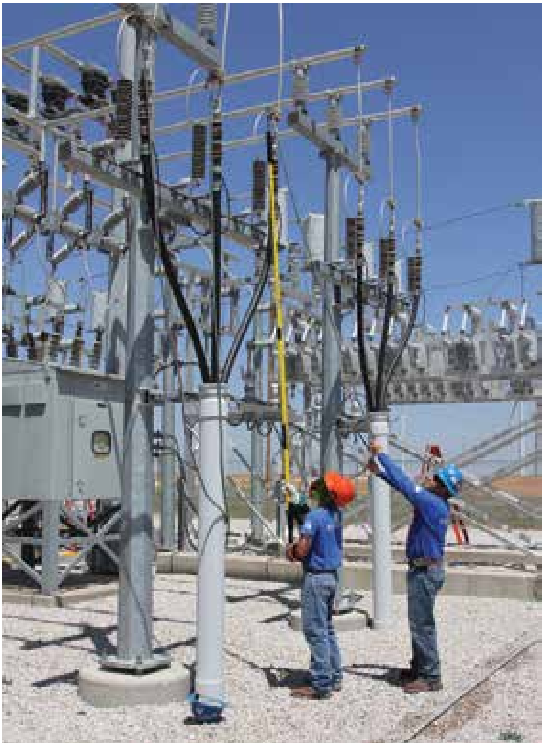
PLANNING FOR MAINTENANCE

Maintenance planning of the electrical equipment and systems should begin at the inception of the project. Consideration should be given to crucial elements such as logistics, access, and equipment configuration, as well as ease of electrical and mechanical isolation. Often the question is asked, "Why test 'new' electrical equipment?" Since the protection of both personnel and the electrical systems is so critical at startup of the plant, verification of proper operation is required. Third-party electrical acceptance is the best manner of confirming the safe performance of the electrical system and its specific components. The test data also provides baseline information that is important to a good maintenance regime. Two general categories of tests are useful. The first—acceptance testing—verifies that all is well at startup. Maintenance testing is used periodically to assure continued reliability, regardless of the operation methodology chosen for the wind plant. The International Electrical Testing Association (NETA) defines these categories as ATS and MTS.

NETA ATS—Acceptance tests are not manufacturer's factory tests. They comprise those tests necessary to determine that the electrical equipment has been selected in accordance with the engineer's requirements, installed in accordance with applicable codes and installation standards, and perform in accordance with their design and setting parameters. The ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems assists designers, specifiers, architects, and users of electrical equipment and systems in requesting the required tests on newly installed power systems and apparatus—before energizing—to ensure that the installation and equipment comply with specifications and intended use as well as with regulatory and safety requirements.

NETA MTS—Maintenance tests help determine if electrical equipment is suitable for safe and continued service. When dealing with service-aged equipment, many criteria are used in determining what equipment is to be tested, as well as the intervals and extent of the testing. Ambient conditions, availability of down time, and maintenance budgets are but a few of the considerations that go into the planning of a maintenance schedule. The owner must make many decisions each time maintenance is considered. It is the intent of the ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems to list a majority of the field tests available for assessing the suitability for continued service and reliability of the power distribution system.

Some suggested sources for maintenance strategies are the IEEE STD 902-1998 (Yellow Book): IEEE Guide for Maintenance, Operation and Safety of Industrial and Commercial Power Systems; NFPA 70B: Recommended Practice for Electrical Equipment Maintenance; or NETA MTS-2011: Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems. The NETA testing standard also offers guidelines for the frequency of maintenance tests within "Annex B" of the document.



ENGINEERING, MAINTENANCE & SAFETY

In recent years, the wind industry has expanded at a rapid pace. These are exciting—and often chaotic— times for the electrical construction contractor and the new generation of wind farm electrical workers. Many of these workers have never been exposed to the hazards that the wind turbine and collector system present, and most of them still have very little knowledge of the toxicity of electricity. In the last several years the wind industry has found the value of proper engineering on the front end of a project, including acceptance testing and commissioning prior to initial energizing. Additionally, many studies have shown that routine maintenance, including testing of electrical distribution equipment, has increased reliability and minimized downtime for commercial and industrial facilities; these same philosophies hold true for wind farms.

The same can be said about protecting electrical workers who operate or service energized electrical equipment, as we now can calculate that the incident energy produced by an arcing fault is proportional to its operating time. This aspect of incident energy means that proper maintenance and testing of the over-current protective devices (OCPD) is not only an operational issue, but is also a safety issue.

The very nature of maintaining an operational wind farm in a remote, outdoor and often windy environment also presents unique hazards typically not found in the commercial or industrial workplace.

REGARDING CONTRACTORS

The introduction of third-party contractors to the work site is one of the biggest exposures to liability and risk for either the plant owner or the contractor. How do you ensure the use of a contractor that has the desired safety culture as well as technical depth and talent? Before any work takes place, you should qualify the company to make sure their safety goals align with yours. You should then qualify the electrical workers to ensure that they can safely perform their services for your customer and livelihood, as well as safely interact with your electrical workers.

DATA COLLECTION

Specifying the collection and delivery format of the initial technical data is a must. Quality equipment performance data is extremely vital to trend and track the electrical equipment and system performance for the long term planning for any eventual modification of testing methodologies or frequencies of maintenance to equipment throughout the electrical equipment's extended years of service.

CONCLUSION

To assure the owner that his electrical assets are safe and reliable, the contracting officer should always confirm the qualifications of the testing company prior to awarding any contract. Certification requirements are placed in bid documents to protect the consumer. Nationally-recognized certification agencies and technicians with these certifications have a proven level of competency. The consumer is assured that the technician has a well-rounded knowledge of electrical testing.

All good testing and maintenance stratagems are designed to ensure the profitability of the operation. Periodic electrical testing, vibration testing, and alignment of the drive train are time consuming operations and are sometimes difficult to perform on a regular basis. However, the cost of unplanned outages including cranes, staffing and emergency generator repairs can also dramatically affect the bottom line. Good planning, proper testing, and clear decisions regarding the condition of the equipment will always pay off with reduced overall maintenance costs.