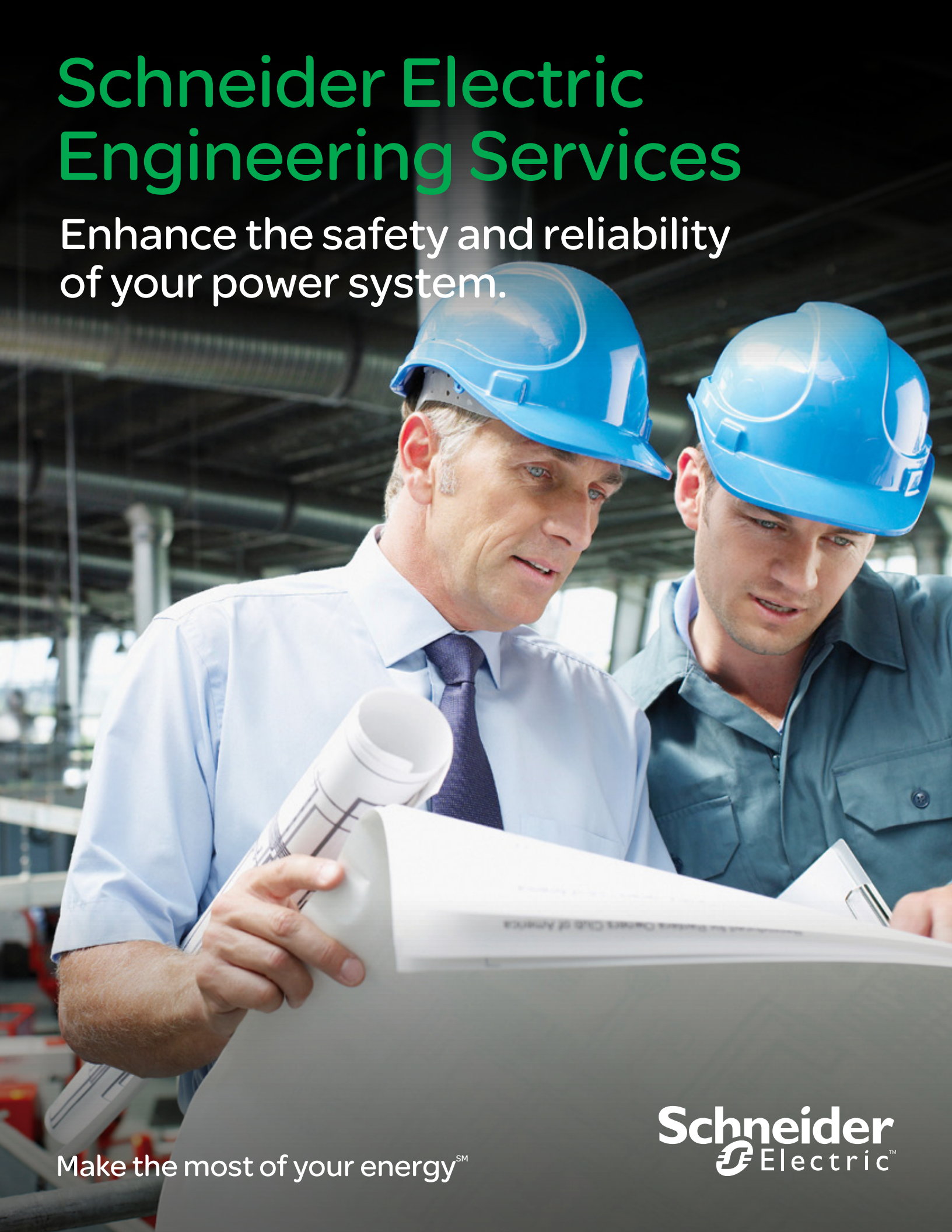
Schneider Electric Engineering Services

Enhance the safety and reliability of your power system.



Make the most of your energy℠

Schneider Electric™

Industry-Leading Expertise

to Address All of Your Power System Needs

For more than 40 years, Schneider Electric Engineering Services has completed over 10,000 power system assessments, studies, and designs for our customers, who include:

Automotive
- Chrysler
- Honda of America
- Toyota Motor Manufacturing
- Ford Motor Company
- General Motors Corp.

Chemical
- Pfizer Inc.
- Union Carbide
- INVISTA
- INEOS
- Air Products

Commercial
- Disney® Corp.
- Home Depot
- Hyatt Regency®
- J.C. Penney
- Sears
- Kroger
- McDonald's Corp.
- Winn Dixie
- UPS® Corp.
- Food Lion
- Mercantile Stores

Communications
- AT&T
- Bell Telephone
- GTE
- Pacific Bell

Data Centers
- Lowe's
- M&T Bank
- The Hartford®
- Mayo Clinic
- Southern California Edison
- EMC®

Educational
- Duke University®
- Harvard University
- Kansas University
- Ohio State University
- Penn State® University
- Texas A&M
- Texas Tech
- University of Illinois
- University of Kentucky
- University of South Carolina

Educational (cont.)
- University of Texas®
- University of Washington
- Wichita State University
- Vanderbilt University

Food & Beverage
- Coca-Cola® Company
- General Foods
- Kraft Foods
- Nabisco Foods
- Pepsi® Cola
- Sara Lee®
- Nestlé®

Government
- Camp Pendleton
- FAA
- Ft. Campbell
- IRS
- Los Alamos National Labs
- Pentagon
- Social Security Admin.
- U.S. Federal Courthouse
- U.S. Postal Service™
- Wright Patterson AFB

Healthcare
- VA Hospital (various facilities)
- Massachusetts General Hospital
- Barnes Jewish Hospital

Manufacturing
- 3M™ Company
- Boeing Aircraft
- Caterpillar Inc.
- Martin Marietta
- Lockheed Martin
- Kimberly Clark Corp.
- Dell™ Computer Corp.
- IBM® Corp.
- Intel® Corp.
- Lucent Technologies
- Motorola
- Samsung
- Texas Instruments™
- Xerox® Corp.

Oil & Gas
- ExxonMobil™
- Shell
- BP
- OXY
- Chevron

Pharmaceutical
- AstraZeneca
- Johnson & Johnson
- Merck
- Pfizer
- GlaxoSmithKline
- Baxter Healthcare
- Wyeth
- Cordis
- DePuy

Utility
- Commonwealth Edison
- Northern States Power
- Southern Indiana Gas and Electric
- Sunflower Electric
- TVA
- Progress Energy
- Orlando Utilities

Water Treatment
- WWTP Columbus
- LTC WWTP Ph2
- Pelham WWTP Expansion
- Four Mile Creek WWTP

[Any brand. Any industry. Any time.]

Schneider Electric Engineering Services can address all of your power system requirements to help **ensure safe, reliable, and continuous power**.

We are focused on helping facilities manage their energy and solve complex power system issues that may involve equipment, automation, or the utility. Our capabilities include:

> **Solutions for OSHA and NFPA 70E Compliance**

> **Power System Design and Upgrades**

> **Power System Assessment Services**

> **Power System Analytical Studies**

Our value to you:

- We have over 150 strategically-located professional engineers who are **collectively registered in every state** of the U.S. to meet state licensing requirements
- Our professional engineers have in-depth knowledge of power distribution and control equipment with advanced expertise of calculation methods as well as industry codes and standards
  - Many of our engineers are leaders in IEEE, NFPA, and other power system standard-making organizations
- Our team has established standardized methodologies to complete studies, analyses, and assessments, along with uniform reporting standards nationwide
- We provide full-scope power system engineering support and solutions
  - Includes corrective action recommendations to mitigate future power system issues

Since 1966, we've **completed thousands of power system designs and analyses** for our customers throughout the U.S. You can count on us for consistent engineering studies and designs, thanks to our comprehensive Engineering Standards. These standards are in place so that all projects for your facilities are executed using the same processes and systems no matter how many locations you have.

Solutions for OSHA and NFPA 70E Compliance

Enhance the safety and reliability of your power system beginning with an arc flash risk assessment.

The Occupational Safety and Health Administration (OSHA) mandates that work on electrical equipment must be performed in a manner that does not expose the worker to undue risk of injury. OSHA enforces electrical workplace safety standards outlined in the National Fire Protection Association's NFPA 70E: Standard for Electrical Safety in the Workplace®.

Schneider Electric™ Engineering Services advocates compliance to NFPA 70E not only for worker safety, but also equipment productivity. An arc flash accident can render equipment unusable and place the facility in a costly downtime mode. Basic compliance is established with **a five-step process**; **a sixth step** assists the facility owner with fine tuning the electrical power system, both for safety and operability.

Fact:

Over the last ten years, more than 30,000 workers have been injured in workplace electrical accidents.

Source: *Electrical Safety Foundation International (ESFI)*

Step 1

Develop and Audit an Electrical Safe Work Practices (ESWP) Policy.

The ESWP policy includes topics such as lock out/tag out procedures, method of qualifying workers, selection and application of personal protective equipment (PPE), methods of establishing a safe work area, arc flash and shock protection calculations, and equipment labeling.

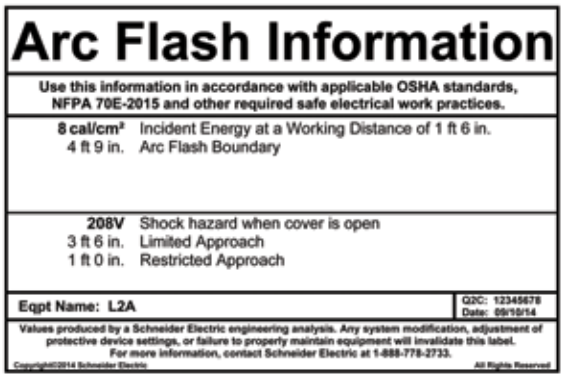
It also defines the requirements for safe work practices and requires audits on at least a three-year cycle. If audits determine that the principles and procedures of the electrical safety program are not being followed by the workers, appropriate revisions to the training program or to the procedures shall be made.

Step 2

Conduct an Arc Flash Risk Assessment to Determine the Present Degree of Arc Flash Hazards and Apply Associated Equipment Labeling.

An arc flash hazard analysis must be updated when a major renovation or modification takes place. At a minimum, it should be reviewed every five years because changes in the electrical distribution system could affect the calculated incident energy levels. Additionally, equipment that is likely to be examined, adjusted, serviced, or maintained while energized must be field-marked with a label containing specific information pertaining to shock and arc flash protection. The calculation method and data to support the information for the label shall be documented.

The methodology for conducting an arc flash analysis is outlined in IEEE 1584™ Guide for Performing Arc-Flash Hazard Calculations. Our power system engineering team is staffed with professional engineers and project managers to assure an effective arc flash risk assessment and labeling are performed with minimal intrusion to your processes.



▲ Arc flash label

Step 3

Ensure Adequate Supplies of PPE and Proper Tools.

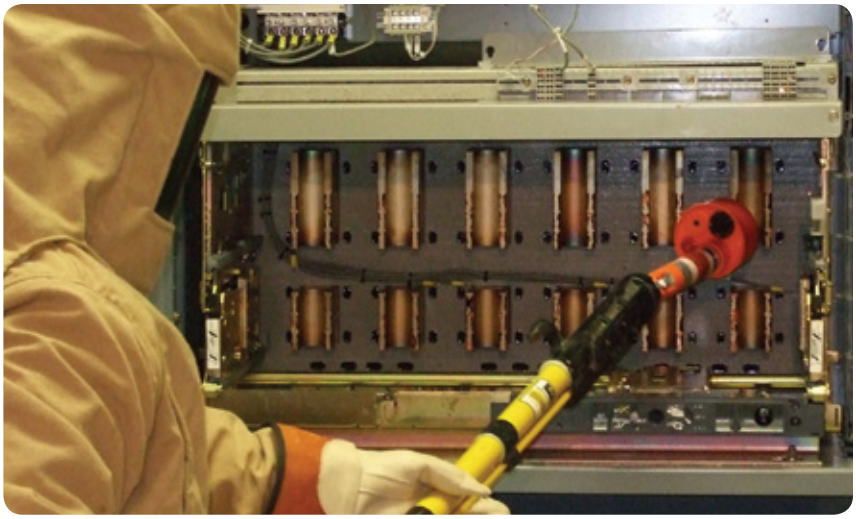
Employees working in areas where there are potential electrical hazards must be provided PPE that is appropriate for the specific parts of the body to be protected. Additional requirements include properly-rated equipment to test voltages and insulated tools for workers who perform testing and troubleshooting on energized equipment.

Step 4

Conduct Regular Safety Training and Employee Assessments.

Electrical workers are not considered to be qualified by OSHA until they have received safety training specific to the hazards of arc flash, arc blast, shock, and electrocution. Further, the employer must verify, through regular supervision or inspection (conducted at least on annual basis) that each worker complies with the safety-related work practices required by NFPA 70E.

Our training department is staffed with OSHA Authorized Outreach Trainers to help ensure your employees are formally trained and aware of electrical hazards per the regulatory requirements.



Step 5

Maintain All Electrical Distribution System Components.

Unless adequate maintenance is performed, overcurrent protective devices may not function and the electrical system study and the arc flash analysis may not be a correct representation of the potential performance of the power system.

Our qualified field services personnel perform on-site preventive and predictive maintenance services for any manufacturer's electrical equipment. Upon completion, a detailed report is provided that identifies potential issues along with corrective recommendations.

Step 6

Follow Strategies to Reduce and Control Arc Flash Hazards.

This step is crucial in optimizing the safety and performance of the power system. The goal of arc flash mitigation is to reduce the arc flash energy, and thus the PPE, to a level that permits normal tasks to be performed on equipment.

Arc flash mitigation has been a rapidly developing area of research and development for Schneider Electric. We can help you choose the most cost-efficient alternative to reduce arc flash energy and improve worker safety.

Power System Design and Upgrades

Meet requirements for the most challenging design and upgrade projects.

Serving customers in every industry segment — from data centers to steel mills — our portfolio of design and construction projects includes:

- Substation solutions
- Switchgear modernization
- Control and protection system upgrades
- Generator backup design and construction
- Power factor correction and filter design
- High resistance grounding conversions

Projects can be customized from basic design consultation to feasibility studies to a complete turnkey solution.

Substation Solutions

Schneider Electric Engineering Services serves utilities and industrial facilities with industry-leading products and services. We have the resources to meet all aspects of your substation construction, remodeling, and/or expansion needs. Our dedicated design services team, staffed with professional engineers, has specialized expertise in all aspects of power equipment design and construction. By combining our design services with engineering analysis, we are able to provide you with a complete engineered solution.

Power System Design and Upgrades (cont.)

Our capabilities include:

- Physical layout and design of the installation
- Codes and standards evaluation
- Analytical studies
- Equipment installation and commissioning

Our capabilities include design and construction services up to 345 kV:

- Project management
- Substation layout, elevation drawings, oil containment
- Civil and structural
- Equipment sizing and specification
- Protection and control system design
- Control house design
- Conduit and trench design
- Power factor correction and harmonic filter design
- Grounding system design
- Utility coordination and regulatory approval
- Commissioning services
- Turnkey installation
- Substation service and repair

We also have significant experience in constructing multi-megawatt solar photovoltaic generating stations. Our approach to the design of the solar collector system, the DC distribution, and the associated grid-tie substation balances cost, reliability, and performance. The end result is an economically viable and productive renewable energy solution. Coupled with our proven project management experience, Schneider Electric provides complete engineering, procurement, and construction services for solar photovoltaic generating stations.

Switchgear Modernization and Upgrades

Modernization solutions from Schneider Electric will upgrade your existing switchgear or motor control centers to current technology. Our modernization and upgrade solutions are designed to minimize downtime, improve reliability, and extend the life of your equipment. In addition, our detailed scope of work helps to ensure the optimum solution for your facility and includes:

- On-site engineering assessment by a professional engineer
- Assessment of the existing maintenance and repair practices
- Evaluation of facility's present and future requirements
- Codes and standards compliance review
- Selection of equipment and upgrade options
- Bills of material, drawings, and specifications to facilitate procurement and installation
- Start-up and commissioning services

Protection, Control, and Automation

Our solutions to upgrade protective relaying and control systems are applicable to:

- Switchgear with electromechanical relays
  - » Digital microprocessor-based relays enhance functionality, simplify maintenance, and increase reliability
- Arc flash reduction technologies
  - » Includes addition of virtual main, light sensing relay technology, and zone selective interlock systems
- Risk Assessment — Identify vulnerabilities in critical power control systems and provide recommendations to mitigate risk.
- Preventive Maintenance — Validate operation of existing system, replace expired or obsolete components.
- Retrofit — Install intelligent controls in legacy switchgear.
- Commissioning Services — Develop sequence of operation, method of procedures, commissioning checklists.

As a turnkey offer, we take responsibility for the overall project including data collection, analysis, installation, and commissioning. The result is a well-designed and commissioned system that will deliver improved reliability and operational efficiency.

Generator Backup Design and Connection

Schneider Electric Engineering Services delivers turnkey generator connection solutions for both your normal and your emergency power systems. Permanent generators enhance power system reliability and are required in healthcare and critical operation facilities. Both new installation and upgrade solutions are available. Partner with us to maximize your return on investment.

Power Factor Correction and Filter Design

Power quality correction equipment is typically justified on the basis of reducing power factor penalties charged by the utility. Our turnkey services include design engineering, procurement, and installation of power factor correction and harmonic filtering equipment from 480 V to 345 kV. Using power quality monitoring devices, our engineers will evaluate the harmonic and transient environment in your facility to ensure the equipment is properly sized and applied.

Our design services extend from the transmission line to the motors and equipment in your facility.

High Resistance Grounding (HRG) Conversions

Used in facilities with continuous, uninterrupted power requirements, HRG power systems may allow non-stop operation during a ground fault. Facilities with ungrounded (delta) electric power systems often experience equipment damage, excessive voltage transients, and high maintenance costs associated with ground faults. Converting to HRG can alleviate the damage caused by ground faults. Our power system engineers will assess, design, and apply power system conversions using component-based or packaged HRG systems.

Power System Assessment Services

Provide a roadmap to optimize future capital and operational expenditures.

Power Quality Analysis

Technologies such as variable speed drives (VSD) and robotic welders are designed to lower energy costs, but they also can give rise to unwanted harmonics and transients within an electrical system. Capacitor switching, motor starting, and ground faults within the utility infrastructure can also cause transients. The result may be only an annoyance or a shutdown that can cost hundreds of thousands of dollars. Any of the following can indicate a power quality issue:

- Variable speed drives tripping for no apparent reason or VSD damage
- Damage or disruption of the electronic network; noise or hum on communication/data circuits
- Control systems unable to hold a process
- Blinking lights concurrent with equipment disruption
- Simultaneous disruption or damage to equipment in different locations within the facility
- Damage or high counts on surge suppressors
- Premature lamp or ballast burnout
- Unknown power disturbances

Our registered professional engineers will document the symptoms, examine damaged equipment, assess the power and grounding in the area, collect data using temporary monitors, and develop a report of findings that identifies the most probable cause. The report will include cost-effective mitigation recommendations to prevent future occurrences of the problem.

Power System Grounding Evaluation

Lack of proper grounding translates into an increased chance of fire, data and equipment losses, process anomalies, plant shutdowns, and workplace safety hazards. Components of a grounding system are subject to corrosion due to electrochemical, electrolytic, or chemical reactions. In fact, if the system has been in place long enough, a ground grid can be completely consumed. Facilities that have sensitive electronic equipment are particularly vulnerable to disruptions.

Schneider Electric power system engineers will develop a scope of work to address your areas of concern, which may include the following evaluations:

1. Grounding system and the ground grid at the main switchyard including the switchgear room
2. Grounding system at the service entrance equipment, generators, generator panels, and automatic transfer switches (where used)
3. Grounding electrode system and bonding methods, including the structural metal used
4. Ground fault protection equipment
5. Lightning protection system (NFPA 780) and surge protection application
6. Sensitive equipment grounding requirements

Assessment services are customized based on your need to reduce risk to your facility from:

- reliability issues
- process disruptions
- code violations
- outdated workplace safety requirements

Power System Assessment Services (cont.)

Example of Impact to a Facility

The impact of a transformer loss serving a hospital's service area (kitchen, house-keeping, etc.) would be quite different — and a lower priority to restore — than the impact on critical care areas (operating rooms, ICU, emergency, etc.)

We will document the baseline condition of your grounding and surge protection systems. Corrective action recommendations are provided to improve the existing grounding systems and to comply with current electrical codes and standards.

Equipment Condition Evaluation, Risk Assessment, and Contingency Planning

Electrical distribution equipment is subject to degradation due to age, environmental stresses, and heat. Our professional engineers produce a basic* equipment condition evaluation by visually inspecting the equipment during a walk-through of the facility. For each non-optimum condition identified during the equipment condition assessment, a measure of risk can be defined.

Risk to the facility is determined by the combination of four factors:

1. The impact of the occurrence to key process elements
2. The safety hazard to electrical workers
3. The probability of an occurrence
4. The ability to respond quickly to correct the negative effects of the occurrence (vulnerability)

Results of the risk assessment are entered into a Hazard Vulnerability Analysis table, which prioritizes the findings according to the total risk to the facility.

A contingency plan identifies a power system's key components (major assets) and evaluates available alternatives, in case of a major asset loss. It also produces an action plan to be implemented should a major loss occur.

Equipment evaluation, risk analysis, and contingency planning are three separate assessment activities that may be combined.

** A more detailed evaluation, which is performed by removing equipment covers, is most economically accomplished during the data collection phase of an arc flash study.*

Sample: Hazard Vulnerability Analysis for a Hospital

Finding	Location	Equipment	Deficiency	Action	Patient Impact	Safety Hazard	Probability	Vulnerability	Risk Hazard Grade	Cost
1	Basement	MSB, MSB1, T1, T2, and generator	Fire/explosion in switchgear room will cause loss of power for days	Portable generator with temp wiring to emergency loads	5	4	3	5	300	$40,000
2	Basement	Transf T1	Transformer near end of life	Replace transformer before failure	5	3	4	5	300	$60,000
3	Basement	Transf T2	Transformer near end of life	Replace transformer before failure	5	3	4	5	300	$60,000
4	Basement	SF6 switches	LOTO danger tag improperly applied	Replace with operating tags	2	5	5	5	250	$0
5	Basement	Transf T3	Excessive dust (potential failure)	Clean and test	4	3	4	5	240	$2,000
6	Basement	Transf T4	Excessive dust (potential failure)	Clean and test	4	3	4	5	240	$2,000
7	Penthouse	MTS1	High dirt level (potential fault)	Clean buses, switches; inspect	4	3	4	4	192	$1,500
8	Penthouse	MTS2	Wiring unknown	Document wiring	4	3	4	4	192	$500
9	Third floor	LP3 Bus plug	Insulation abrasion and improper bend radius	Replace conductor	3	4	4	3	144	$2,000

A Hazard Vulnerability Analysis provides valuable information to help facility management plan future capital and operational expenditures.

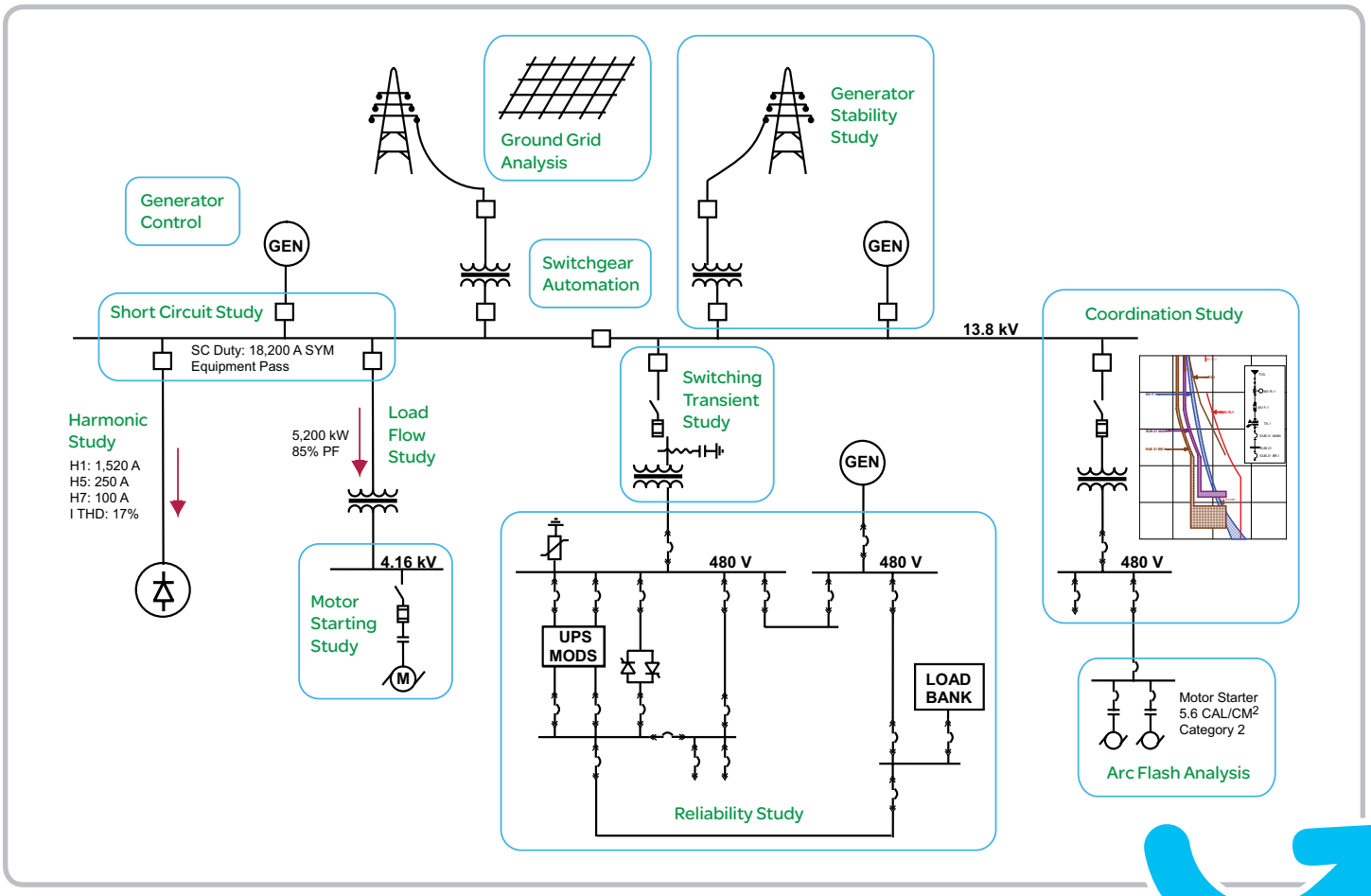
Power System Analytical Studies

Fine-tune your electrical system for optimal operation.

There's more to managing an electrical system than troubleshooting problems. It also involves identifying potential issues and either eliminating or mitigating their effects. The analysis and diagnosis of any engineered system guards against improper system operation and the possibility of catastrophic losses. Managing an electrical system and the energy it delivers requires:

- A comprehensive understanding of the system's normal and abnormal operation
- Knowledge of a wide variety of equipment
- The successful application of industry codes and standards

Our analytical studies help ensure your electrical system operates as it was designed and intended. Each study includes a detailed report of findings along with corrective recommendations to help maximize the reliability and operational efficiency of your system.



▲ The production of a modern power system study includes a data collection phase, power system modeling, analysis, and the development of the engineering report. Schneider Electric Engineering Services offers a broad range of power system studies.

Power System Analytical Studies (cont.)

Protective device time-current coordination analysis

The goals of a protective device time-current coordination analysis are to:

- Provide power equipment with the required protection
- Minimize service interruption under overload or short circuit conditions

This analysis evaluates an electrical system's protective devices, including relays, fuses, and circuit breakers, and the equipment to which they are applied.

The final report includes suggested settings for all adjustable devices. Composite log-log characteristic curves illustrating the resulting protection and system coordination are also provided.

Benefits

- Minimizes system downtime and nuisance device operations
- Increases system protection and reduces equipment damage
- Isolates faulty circuits without loss of power to other parts of the system
- Optimizes the protective device setting for reliability and arc flash protection

Short circuit analysis

This analysis calculates the fault current levels throughout the electrical network. The interrupting duties of the devices being analyzed are compared with the available fault currents. Where underrated equipment is identified, recommendations are provided to help you comply with industry codes and standards.

The final report includes tables comparing short circuit levels to the rating of the equipment with recommendations for improvements. A computer-generated single-line diagram of the distribution system is also provided.

Benefits

- Reduces system downtime
- Addresses concerns about underrated or misapplied equipment
- Minimizes or eliminates equipment damage
- Promotes electrical workplace safety

Load flow analysis

A load flow analysis addresses present electrical system deficiencies or identifies system requirements to meet future demand. Specifically, it:

- Optimizes loading of the electrical distribution equipment
- Establishes reactive power flows needed to stabilize bus voltages
- Determines transformer tap settings

Our load flow experts translate design load data or field measurements into an accurate system model. Key system parameters are then calculated and the results of various scenarios are distilled into easy-to-understand tabulations.

Benefits

- Minimizes downtime by stabilizing system voltages
- Prevents (or corrects) overloaded transformers and conductors
- Optimizes equipment utilization by evenly distributing plant load
- Prevents load-related nuisance tripping
- Improves power factor and avoids power factor penalties from utility

Harmonic analysis

Harmonics cause power quality problems that can reduce system efficiency and increase operating costs. Found traditionally in industrial processes, harmonics are now present in both commercial and industrial facilities due to the proliferation of non-linear loads (power electronic equipment, variable speed drives, and switched-mode power supplies).

The harmonic analysis results are presented in easy-to-understand tables. Explanations are provided to highlight the issues uncovered.

Benefits

- Prevents equipment overheating
- Allows seamless interaction between loads and generators
- Reduces or eliminates undesirable voltage distortion levels
- Complies with IEEE 519 harmonic limits

Motor starting analysis

Starting large motors across the line can cause severe disturbances to the motor and any locally connected loads. The most significant effect is the voltage sag, which extends the acceleration time of the motor being started and causes additional thermal and mechanical stresses. Voltage sags also impact other loads connected to the power system, particularly electronic loads.

A motor starting analysis must be made if the motor's size > 30% of the supply transformer's base kVA rating. Studies are also recommended if several smaller motors are started together or if the power source is a local generator.

This analysis calculates the electrical parameters (voltage and current) and the accelerating torque of the motor during the starting process.

Benefits

- Extends motor life by reducing starting thermal stresses
- Prevents the negative effects of voltage sags on other equipment
- Eliminates undesirable interactions between motors and generators
- Complies with the utility's motor starting requirements

Switching transient modeling and analysis

Normal or abnormal switching and circuit breaker operations cause transient conditions in power systems. Though transients have a brief time span, the resulting voltages may damage insulation or make sensitive electronic devices malfunction. Large magnitude currents can cause equipment overheating and even melt fuse links. Switching transient analyses are commonly employed to evaluate:

- The effect of switching of vacuum circuit breakers that supply power transformers
- Power factor correction capacitor switching issues
- Transient recovery voltages produced when a circuit breaker clears a fault

Results are presented in an easy-to-understand format. Recommendations are provided to mitigate the effect of transients

Benefits

- Determines stresses that system components are exposed to
- Identifies alternatives to reduce system stresses, which may include:
  - » Alternative switching schemes
  - » Addition of components
  - » Changes in power system configuration

Reliability analysis

A reliability analysis quantifies the probability that a system or component will operate as intended. Without performing this analysis, the task of evaluating alternative systems and components is left to the engineer's intuition.

Reliability studies are typically performed for mission-critical power systems such as data centers and Critical Operations Power Systems, as defined in the National Electrical Code®. However, the principles of a reliability analysis can be applied to any power system in order to optimize the selection and arrangement of the power distribution components.

Reliability indices are presented in an easy-to-understand format. Discussions are provided on the potential failure modes of the system.

Benefits

- Provides an understanding of the relative effectiveness of different power distribution schemes and/or component selections
  - » Offers recommendations to improve reliability
- Creates indices for cost/benefit analysis at the design stage
- Identifies potential modes of failure in an existing power distribution system

Substation ground grid analysis

Metallic components such as structural steel, electrical equipment enclosures, and fencing in an industrial or utility switchyard are directly or indirectly connected to ground. Under normal operating conditions, these components are at the same potential as the surrounding earth. However, during a ground fault, voltage gradients are generated along the substation walking surfaces and between metallic components and the earth.

The grounding grid analysis shows the existing design and the modifications being recommended. The study results graphically demonstrate the final touch and step potentials in the switchyard.

Benefits

- Optimizes grid geometry
- Evaluates high-risk areas of the switchyard
  - » Identifies opportunities for risk mitigation

Stability analysis

A stability analysis evaluates various power system scenarios corresponding to switching actions or the initiation of a fault. Stability studies are typically applied to facilities that utilize large generators. The goal is to determine conditions for prolonged voltage fluctuations that would cause the system to become unstable. By changing the parameters of the system and running alternate scenarios, opportunities are evaluated to correct the deficiency.

The final report provides a description of the conditions that cause the power system's instability as well as alternative equipment and system arrangements.

Benefits

- Minimizes downtime by providing an understanding of the system's response to abnormal conditions
- Allows better preparation for the development of a contingency plan
  - » Comparing alternative scenarios enables mitigation of stability issues through improved system protection or switching

The bottom line:

Electrical systems are serious business. You need serious professionals who can provide solid advice and recommendations to promote safety and to help ensure reliable and continuous power.

Why Choose Schneider Electric Engineering Services?

Get industry-leading expertise to address all of your power system needs.

For more than 45 years, Schneider Electric Engineering Services has completed over 10,000 power system assessments, studies, and designs for our customers. Our professional engineers, many of whom are leaders in standard-making bodies such as IEEE, have established a proven project management system that streamlines data collection activities to help minimize any impact on your operations. You will receive consistent engineering designs, studies, and analyses due to our comprehensive engineering standards.

Schneider Electric has established regional engineering operations, located strategically throughout the U.S. These operations are staffed by professional engineers who are licensed in the local jurisdiction and have the full support and capabilities of Schneider Electric worldwide. Having a power system engineer close by assures familiarity with authorities having jurisdiction, local codes and standards, utility systems, and operations.

[Any brand. Any industry. Any time.]

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