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Electrical Safety Management

Mike Doherty, Senior Member IEEE
Health & Safety Consultant
Infrastructure Health & Safety Association
Mississauga, Ontario, Canada

H. Landis Floyd II, PE, CSP, CMRP, Fellow IEEE
Principal Consultant
DuPont
Wilmington, Delaware, USA

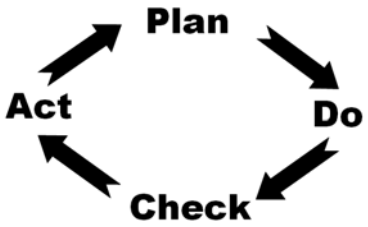
L. René Graves, CSP
Senior Environmental, Health & Safety Specialist
Texas Instruments
McKinney, Texas, USA

Background

This paper is based on the premise that the most effective design and implementation of an electrical safety program can best be achieved through a collaborative effort of a multidiscipline team. The breadth of expertise should include: electrical specialists expert in design, construction, operation, maintenance and demolition of electrical equipment and systems; safety professionals knowledgeable in safety management systems; financial managers responsible for bid assessment and purchase of equipment; and business managers responsible for goal setting, resource allocation, and business systems integration. This collaboration can help ensure proven safety management principles and practices applicable to any hazard in the workplace are appropriately incorporated in an electrical safety program. This paper discusses ANSI Z10-2005, *Occupational Safety & Health Management Systems* (harmonized with CSA Z1000-2006, *Occupational Safety & Health Management* and other internationally recognized safety management systems standards) as the framework for benchmarking existing programs and for designing and implementing a state of the art electrical safety program. It outlines the critical importance of incorporating within this framework the requirements of industry standards, such as NFPA 70E-2009, *Standard for Workplace Electrical Safety* and CSA Z462-2008, *Workplace Electrical Safety* and other recognized industry standards to achieve a comprehensive program based on proven safety management principles.

Introduction

The authors introduced the tutorial, "Electrical Safety Management" in St Louis, Missouri, at the 2009 Electrical Safety Workshop, sponsored by the Industry Applications Society of the Institute of Electrical and Electronics Engineers (IEEE). This annual forum is known for stimulating innovations in technology, work practices, and management systems essential for breakthrough improvements in workplace electrical safety. One of the important concepts included in the tutorial was the Deming Quality Management Model, "Plan-Do-Check-Act." This model, shown in Figure 1, is an essential element of modern business management and is central to internationally recognized standards for occupational safety and health management systems. The authors used this model to critique the 2009 tutorial to improve the quality and value of the tutorial materials for its second presentation at the 2010 IEEE IAS Electrical Safety Workshop held in Memphis, Tennessee, and identified the improvement opportunity to develop this paper as a concise and comprehensive take away from the tutorial.



A model for continuous and sustainable quality improvement

- **PLAN**: Design or revise business process components to improve results, establish goals, identify resources, establish responsibilities, identify measures of success
- **DO**: Implement the plan and measure its performance. This includes training, hazards assessments, work practices
- **CHECK**: Assess the measurements and report the results to decision-makers. This includes audits, skill and knowledge assessments, incident investigations
- **ACT**: Decide on changes needed to improve the process. Review progress with management, re-evaluate needs and gaps, re-establish management commitment

Figure 1. Elements of the Deming Quality Improvement Model

A management system is the framework of processes and procedures used by an organization to help assure it can fulfill all tasks required to achieve its objectives. Electrical safety management is about the effective integration of a multifaceted electrical safety improvement process into business management systems. This integration is primarily focused on safety management systems, but also includes project engineering and capital management systems, contractor management systems, material and equipment sourcing systems, workforce training and development systems, and other systems that may be unique to the business or industry. It is the authors' experience that electrical engineers and specialists involved in designing and implementing improvements to a workplace electrical safety program tend to focus on the technical aspects, including safe work practices, electrical system design, hazard analysis, and the performance of personal protective equipment, and may overlook some aspects of safety management systems. A practical example is an organization implementing the requirements of

NFPA 70E and incorrectly assuming this would constitute a comprehensive, effective, and sustainable electrical safety program. Figure 2 illustrates the limitations of applying the requirements of NFPA 70E or CSA Z462 alone. The fundamental foundations of safety management may be overlooked if the electrical safety program is delegated solely to the electrical experts.

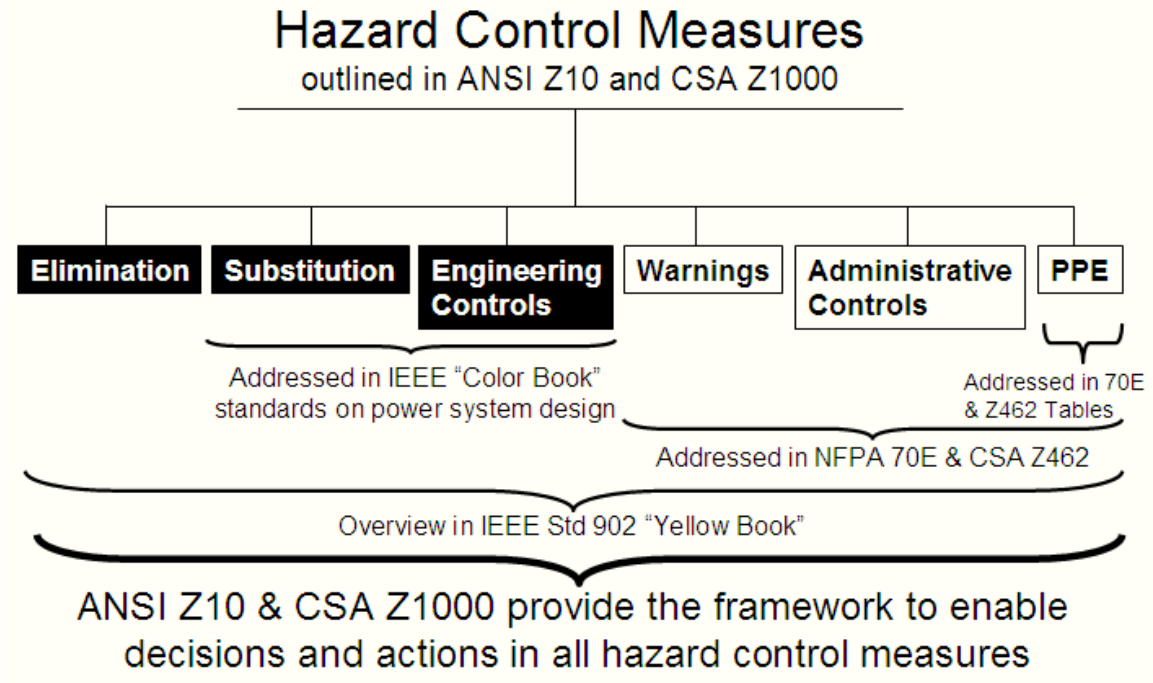


Figure 2. An illustration mapping the resources from several electrical safety related standards to the comprehensive control measures fundamental to occupational safety and health management systems standards (*Source:* Adapted from ANSO Z10 and CSA Z1000).

This paper provides a roadmap to guide critical analysis and planning, as well as a toolkit of ideas and resources that can help an organization achieve its potential in electrical safety performance. For someone with concern or responsibility for an organization's electrical safety program, exploring the answers to these questions may hold the key to enabling success:

- How familiar are you with ANSI Z10, *Occupational Health and Safety Management Systems*, or CSA Z1000, *Occupational Health and Safety Management*, or other globally recognized safety management systems standards?
- How do these standards align with the safety management systems in your organization?
- How effective have you been in selling electrical safety improvement initiatives to your management?
- How would you rate the collaboration and synergy among the safety professional, key members of management, and the electrical experts with respect to driving improvement in the electrical safety program in your organization?

For those not fully comfortable with answers to these questions, opportunities may be found in the subtle but significant changes in two high profile standards driving change in workplace electrical safety in North America. Continuing its evolution since first published in 1979, the 2009 edition of NFPA 70E and the first edition of CSA Z462-2008 for the first time make reference to safety management systems standards. The referenced management systems standards focus on the strategic levels of management policy and implementation processes to help establish management commitment and support necessary for planning, implementing and assuring sustainable and continuous improvement in safety performance. Better understanding the role of safety management systems in planning and implementing changes in an electrical safety program may be one of the most critical factors in the success of the electrical safety program, no matter what its stage of implementation or its level of maturity. An organization just beginning to apply the requirements of NFPA 70E or CSA Z462, an organization that has a mature safety management system and electrical safety program, but hasn't assessed integration effectiveness, and the organization that has a mature integration of the electrical safety program may benefit from a critical review of its electrical safety program and safety management systems. This presents an opportunity to maximize the impact of the organization's efforts to improve electrical safety.

Opportunity to Maximize Impact

In today's challenging business environment, the most effective managers are always looking for an advantage over their competitors. Competitors can be found not only in different businesses but also within your company, as staff jockey for position, financial compensation, and job security. Unfortunately, many managers today still rely on old school approaches to the leadership required to maximize the impact they can have within their electrical safety programs. NFPA 70E and CSA Z462, for instance, have become the *de facto* tools for many to implement their electrical safety programs.

Unfortunately, even in the most sophisticated business units accountable managers, health and safety professionals and electrical maintenance staff often struggle with implementing their electrical safety programs in a simple and effective manner. This, more often than not, leads to wasted time, money and a loss of credibility for those attempting to execute its implementation. It could be said that the blinders have been on in regards to ensuring these two standards have the maximum impact, considering the resources available to those that are tasked with implementing a "quality" electrical safety program. While these standards are world class and leading edge, they were never designed with the concept that they could easily be deployed. Conversations, discussions, and brainstorming over the last few years have led to an "evolution of thought" where it is now recognized that "systems" are required to move forward in a businesslike manner, and to help assure sustainable continuous improvement.

Sports analogies are helpful in recognizing these opportunities within the electrical safety and business communities. Hockey in the old days was played with great intensity, fast skating, hard checking, and shooting. Work harder than the other team, and we win. Teams looking for an edge over their competitors started to develop "effective systems" designed to break down the other team and increase their chances to win. The left wing lock is a controlled forechecking "system" that was popularized by the Detroit Redwings in the late 1990s to the great dismay of those that played against them. The Red Wings were the dominant team of this time period. It would have been simply unheard of not very long ago to employ such an effective system. Now it

is commonplace for those that want to win. Imagine, if you will, the same thoughts applied to your electrical safety program. The opportunities abound for those willing to use a recognized health and safety "system" template to execute their electrical safety program. The Deming "Plan—Do—Check—Act" template accomplishes exactly that.

The Business Case

All too often the authors have heard the complaint, "How can I get management to support our efforts?" It is a management responsibility to establish goals, set priorities, and allocate resources to enable an organization's success. Sound decisions in a complex environment necessitate good information, or a business case, in order to make smart decisions. The business case for electrical safety involves legal, moral, and financial consequences. There is also an underlying power, or hidden value, that results from effective electrical safety management. Individuals who are knowledgeable or concerned about the state of the electrical safety program have an important role to engage management in a way to both inform and educate them on facts that can help assure informed and sound decisions to support an electrical safety improvement initiative. Here are some things to consider when developing the business case.

Legal

Legal issues abound within the realm of electrical injury and incidents. Probability low but a consequence high is the often-quoted concept that can be applied to the legal risk issues. Companies must be aware of legal requirements and the law of the land. Workers' rights must be respected, as well as those items are contained in the health and safety legislation of the authorities having jurisdiction (AHJs). Regulators assign responsibilities to employers for a safe workplace. It's the law. Employers must establish the electrical safety programs. Employers must also ensure that their employees follow the electrical safety program. Employees must follow the programs as set out by their employers. Using contractors, of course, does not absolve owners from their legal health and safety accountabilities. NFPA 70E and CSA Z462, for example, require that an electrical safety program be established for contractors as well. Cutting-edge recent legislation in the Province of Newfoundland in Canada has clearly defined the requirements for the establishment of a health and safety managed system. An excerpt from the Newfoundland and Labrador Regulation 70/09, Occupational Health and Safety Regulations, 2009 under the Occupational Health and Safety Act (O.C . 2009-233) is provided below:

> *Occupational Health and Safety Program*
>
> *12. (1) An occupational health and safety program required under section 36.1 of the Act shall be signed and dated by the employer and by the person or persons responsible for the management of the employer's operations in the province and shall include:*
>
> *(a) a statement of the employer's commitment to cooperate with the occupational health and safety committee and workers in the workplace in carrying out their collective responsibility for occupational health and safety;*
> *(b) a statement of the respective responsibilities of the employer, supervisors, the occupational health and safety committee and workers in carrying out their collective responsibility for occupational health and safety;*
> *(c) procedures to identify the need for, and for the preparation of written safe work procedures to implement health and safety practices, including practices required by the Act and the regulations, or as required by an officer;*

(d) written work procedures appropriate to the hazards and work activity in the workplace;
(e) a plan for orienting and training workers and supervisors in workplace and job-specific safe work practices, plans, policies and procedures, including emergency response, that are necessary to eliminate, reduce or control hazards;
(g) a system for the recognition, evaluation and control of hazards that includes:
(i) evaluation and monitoring of the workplace to identify potential hazards and the associated risks,
(ii) procedures and schedules for regular inspections by management and committee members,
(iii) procedures for the identification, reporting and control or correction of hazards,
(iv) procedures for the prompt investigation of hazardous occurrences to determine the cause of the occurrence and the actions necessary to prevent a recurrence,
(v) identification of the circumstances where the employer is required to report hazards to the committee and the procedures for doing so, and
(vi) measures for the accountability of persons responsible for the reporting and correction of hazards;
(h) a plan for the control of biological and chemical substances handled, used, stored, produced or disposed of at the workplace and where appropriate, the monitoring of the work environment to ensure the health and safety of workers and other persons at or near the workplace;
(i) a system to ensure that persons contracted by the employer or for the employer's benefit comply with the program developed under this section and the Act and regulations;
(j) an emergency response plan;
(k) maintenance of records and statistics, including occupational health and safety committee minutes, reports of occupational health and safety inspections and investigations, with procedures to allow access to them by persons entitled to receive them under the Act; and
(l) provision for monitoring the implementation and effectiveness of the program.

It is clear that regulators are starting to demand health and safety "systems" and not just general, unorganized pieces of safety process in the workplace. Many of the requirements of this legislation are embedded within ANSI Z10 and CSA Z1000.

Moral

The moral costs in a significant electrical incident are suffered by the supervisors, managers, owners and executives who were in charge and control of the worksite where a worker(s) was injured on their watch. Being challenged in a court of law by aggressive lawyers wanting to know what they were doing to protect those under their care can be a debilitating experience for those in charge. The guilt suffered is only compounded if the injured worker is a friend, colleague or young worker. The classic story of knocking on the door to tell the spouse of a tragic incident is a moral cost that no one ever wants to endure. The moral costs can also seriously affect the culture in your organization that can really affect the financial bottom line as well.

Financial

The financial side of an electrical incident involves direct and indirect costs and can be a disaster for the company involved. Damage to process equipment, lost production, environmental cleanup and legal costs, as well as the reputation of the company in the local community, can all be factored in. Fines from regulators, root cause investigations, insurance premium increases and the

displacement of staff from regular duties add up very quickly. Contractors who must maintain an exemplary safety record to bid on jobs can be devastated very quickly, from an economic point of view very. The costs of hospitalization can be very significant for electrical burn victims running up into the millions of dollars and can continue for years after the event. If your financial controllers were more aware of the business risks and the costs involved with not having a world-class electrical safety program, there would be far more of them in use.

The Underlying Power of an Effective Electrical Safety Program

In addition to the obvious legal, moral, and financial aspects of the business case described above, there may be a "hidden" value to the business or enterprise. Business and commerce are dependent on electrical technology for energy, control, data, and communications essential to its operations. An organization that manages its electrical safety program as an asset, rather than a cost, will likely find opportunities to derive benefits across a broad set of business performance parameters. When mishaps occur in critical energy and control systems, a more likely consequence than injury is disruption of the operations served by the electrical systems. Whether it is a chemical plant, financial institution, medical facility, mass transportation or almost any other component of our modern society, an incident resulting in disruption to electrical systems critical to operations can have very significant financial losses. For example, an incident resulting in disruption of electrical energy or control to a hazardous chemical process could result in a process safety event, waste of raw materials, loss of production, and damage to facilities and equipment. A similar incident in a credit-card transaction processing center can impact millions of dollars in banking transactions.

Environmental, Safety and Health Management Systems

The development of industry standards for safety management has usually been included under the broader umbrella of environment, health, and safety management systems (ESHMS). An ESHMS standard provides the blueprint, or framework, to help enable effective, robust and sustainable programs to manage occupational safety and health risks. Where and when industry standards did not provide consensus standards, some companies developed proprietary safety management standards that align with or go beyond industry standards that have since emerged.

The first industry consensus standard addressing these needs appeared in 1995, with the publication of ISO 14001, *Environmental Management Systems*. In 1999, a collaboration of international safety organizations published OHSAS 18001, *Occupational Safety and Health Management Standard*. A similar standard, *ILO Guidelines for Occupational Safety and Health Management Systems* was published by the International Labour Organization in 2001. Implementation of these standards includes rigorous certification processes, similar to the ISO 9000 quality certification process. More recently, ANSI Z10, *Occupational Health and Safety Management Systems*, and CSA Z1000, *Occupational Health and Safety Management,* were first published in 2005 and 2006, respectively. These two standards are well harmonized with each other and with the aforementioned safety management standards, but can be applied without vigorous certification.

These safety management systems standards are based on quality management principles popularized by W. Edwards Deming. The Deming quality improvement model, Plan—Do—Check—Act, as shown in Figure 1, is central to safety management systems, maintenance and reliability systems, as well as any quality continuous improvement process. These standards are

also well harmonized on the comprehensive hazard control measures shown in Figure 3. In addition, they are harmonized in how these equally important measures are ranked in descending order of relative effectiveness in helping assure worker safety. The top three measures are well aligned with maintenance and reliability concepts of re-engineering systems and equipment to eliminate defects and causes of failure. As illustrated in Figure 2, NFPA 70E and CSA Z462 currently focus on the bottom three control measures and do not address the top three, except through reference to safety management systems standards.

Figure 3. Hierarchy of hazard control measures (*Source:* ANSI Z10)

Creating Collaboration and Synergy

In applying an environmental, safety and health management system, as in any other process, it is important to establish a system and method that will allow for effective implementation. When applying to electrical safety, an established system will make provisions for a team of individuals whose purpose is to develop an electrical safety program. A discussion of the process for bringing together a team of professionals who will provide an effective, cohesive plan and successfully execute this plan follows.

Establishing Your Team

In *The 7 Habits for Managers: Managing Yourself, Leading Others, Unleashing Potential*, Stephen R. Covey defines a team as a group of individuals coming together to achieve a common goal. In order for a team to be successful they must establish:

(a) goals and objectives;
(b) deliverables;
(c) actions/items from the team; and
(d) a method to evaluate the success of the team.

In revisiting the ESHMS process and its relationship to the Deming model, it is noted here that the process will identify the plan, work the plan, check the plan, and then make any modifications to ensure continuous improvement of the plan. When beginning the team selection process, it is important to consider the criticality of selecting individuals that can assist in the development and implementation of your program. Consider the following:

(a) ensuring management support for electrical safety program;
(b) selecting engineer(s) or electrical specialist(s) who design, construct maintain or demolish the electrical systems;
(c) being seen by peers as a "go-to" person and believing that a safe and healthy work environment is critical to the electrical safety program; and
(d) selecting a safety professional who is committed and congruent with others regarding electrical safety.

The safety professional team member is the individual who assists in promoting and delivering this program to an organization and company. The unique knowledgebase this select team possesses facilitates an effective and successful implementation of an electrical safety program. Key aspects of the team are illustrated in Figure 4.

The Knowledge Set

There are professionals involved in ESHMS who would state that the selection process for the first team member also involves selection of a person who possesses a mindset with critical conviction for the program. The management team member(s) provides the program with financial commitment that ensures necessary funding, thereby lending support to a program. The management team member(s) provides position power, thereby allowing for other team members (e.g., engineer, technician, and safety professional) to effectively perform their work functions. The management team member understands hazards and risk associated with performing energized electrical work. This team member is familiar with the regulatory requirements, as well as the training requirements, and will provide the financial support to ensure appropriate PPE and equipment necessary to perform work functions safely. A management team member will also designate an individual to review and authorize energized work permits.

The next team member(s) selected will be an individual(s) who provides electrical expertise for the team. This team member will be knowledgeable of:

(a) regulatory requirements;
(b) industry codes and standards;
(c) local electrical codes;
(d) training requirements;
(e) site-specific electrical hazards;
(f) site-specific electrical programs;
(g) energized electrical work;
(h) how the company manages energized electrical work;

(i) how to calculate fault currents;
(j) personal protective equipment (PPE) and incident energy available at each source; and
(k) electrical short circuit study for the area(s) of their responsibility.

The electrical team member will be familiar with the site-energized work process should they be called upon to administer such permit. In the event that a company would not have an employee to provide team membership as an electrical technician, the team member with electrical expertise would also be the “go to” team member and a leader within an electrical department. This team member will be knowledgeable of:

(a) safe work practices;
(b) different codes that effect their work;
(c) training requirements; and
(d) electrical design, installation, demolition or equipment purchase.

This team member possesses personal power among those they work and interact with in the work environment.

The team member selected as a safety professional will also be familiar with regulations, codes and standards, but it is not necessary for this team member to be as well versed in the details as the electrical team member. The safety professional team member will be familiar with electrical hazards, and will be prepared to help lead the team in risk assessments, hazard analysis, and auditing processes. The safety professional team member will be knowledgeable about the site-specific process for an energized work permit to the extent that they could perform this process if called upon to do so. There are liabilities for every member in the team. To reduce the liabilities, the group will need to work as a team and collaboratively create a successful process thereby building a roadmap for success.

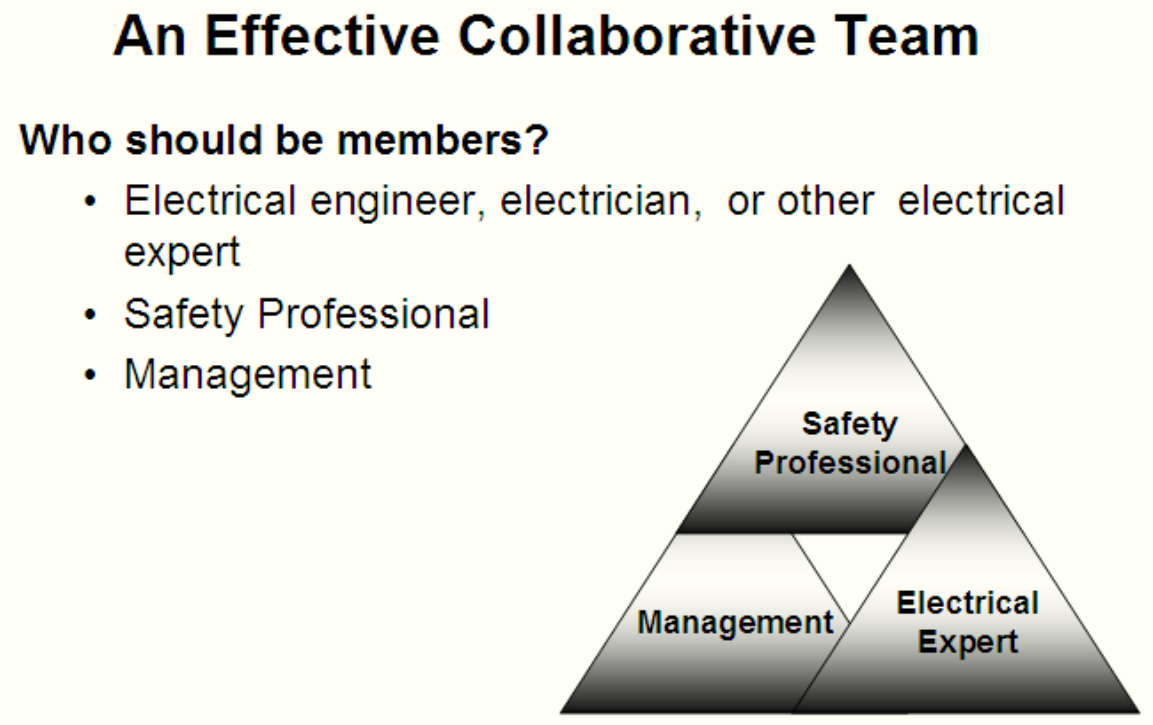


Figure 4. Illustrating the collaboration of electrical and other technical experts, management and safety professionals that can lead to mutual optimization of electrical safety and maintenance & reliability objectives.

Continuous and Sustainable Improvement

Benjamin Franklin once said "For every minute spent organizing, an hour is earned." The other side of the same coin obviously is true as well. For those not well-organized, you will be wasting time and money. As illustrated in Figure 5, using the synergy and leadership models of an ESHMS as your template brings all of the three stakeholders into the equation. The beauty of an ESHMS-based electrical safety program is that it can be defined as a model of continuous improvement. It really doesn't matter where you are today, as long as you don't stand still or go backwards.

The other key concept is the word sustainability. Those that will open their eyes to the possibilities of the expert knowledge available in these systems will have the potential for a continually improving and sustainable electrical safety program. A key to sustainability involves leadership within the program. Quality organizations do more than the status quo; they go the extra mile, and that's where great leaders come in. Interestingly, great leaders in your electrical safety program can come from anywhere in the organization. It might be the health and safety manager with no electrical background, but who understands the system of continual improvement and how to get all the accountable stakeholders working together. It might be the experienced electrician who is given the opportunity to design a world-class electrical safety program using recognized standards, and has the backing of a wise manager who understands that great leaders need effective people to execute the task.

Sustainability requires effective individuals who are empowered by great leaders. The sustainability model needs a process to build a program that is important and enduring. Sustainability in your programs requires that you see the world differently. This would include alignment of your electrical safety program to facilitate, rather than hinder, achievement. The system will inspire trust amongst your staff that will allow them to make the best use of time, money and resources. Using a health and safety managed system as the skeleton and framework of your electrical safety program will clarify its purpose, establish metrics for achievable goals and, most important for sustainability, will demonstrate to individuals that their work is contributing the goals of a world class sustainable electrical safety program.

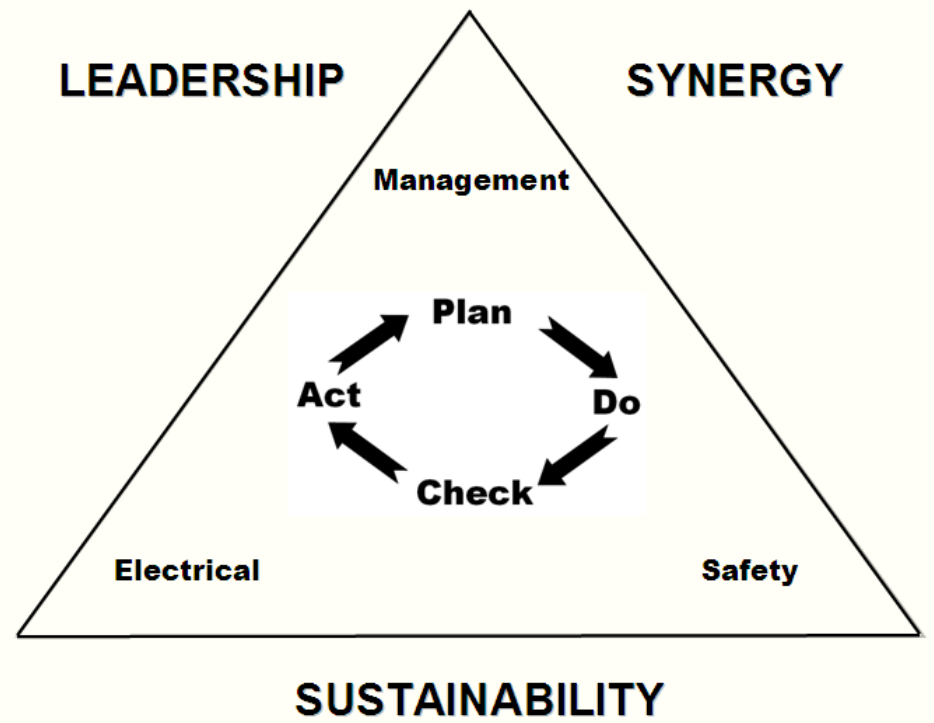


Figure 5. Bringing together the synergy of a collaborative team using the Plan–Do–Check–Act improvement model

Resources

Designing and implementing an effective electrical safety program involves more than one standard. There are organizations that can provide additional resources for environmental safety and health management systems. These organizations (i.e., Occupational Safety and Health Administration (OSHA), American National Standards Institute (ANSI), National Fire Protection Association (NFPA), and Canadian Standards Association (CSA)) will also serve as resources in program development as well as education for your employees. In addition, there are electrical codes and standards to assist in the safe design, installation, and maintenance of electrical equipment. These codes and standards include, but are not limited to: (1) National Fire Protection Association NFPA 70 *National Electric Code* as well as NFPA 70E, *Standard for Electrical Safety in the Workplace*; (2) American National Standards Institute Z10-2005 *Operational Safety and Health Management Systems*; (3) Canadian Standards Association Z462-2008 *Workplace*

Electrical Safety, and *Canadian Electrical Code*; (4) Institute of Electrical and Electronics Engineers (IEEE) Standard 1584 *Guide to Performing Arc Flash Hazard Calculations* and IEEE Standard 902 *Guide for Maintenance Operation and Safety of Industrial and Commercial Power Systems*, IEEE /ANSI C2 *National Electric Safety Code,* and CAN/ULC-S801-10, *Standard on Electric Utility Workplace Electrical Safety for Generation, Transmission, and Distribution.* Other resources are listed in the bibliography.

Conclusion

The authors believe the most effective design and implementation of an electrical safety program can best be achieved through a collaborative effort of a multidiscipline team. The attributes of this team should include: electrical specialists expert in design, construction, operation, maintenance and demolition of electrical equipment and systems; safety professionals knowledgeable in safety management systems; financial managers responsible for bid assessment and purchase of equipment; and business managers responsible for goal setting, resource allocation, and business systems integration.

An effective electrical safety program goes beyond compliance and is built on guidance and requirements from a wide resources base of electrical safety specific codes, standards, regulations, and recognized best practices that are integrated within the framework of a safety management system. Continuous improvement should be one of the objectives of your electrical safety program and the Deming Plan—Do—Check—Act model provides a widely accepted methodology. Establishing a sound business case is necessary for assuring management support and involvement to enable both short-term and long-term success. The underlying goal should be zero electrical incidents and injuries.

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