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The Underlying Power of an Effective Electrical Safety Program

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Abstract

Modern industry and commerce are nearly completely dependent on electrical technologies for energy, control, data management and communications. While a worker's mishap in these critical systems has the implication of injury to the worker, with much greater frequency a mishap or incident includes the consequence of significant disruption to the enterprise's operations. This paper discusses the broad implications of incidents in electrical systems critical to business and commerce, and serves to help justify measures and investments in electrical safety programs to prevent injury to workers.

Introduction

Many businesses and organizations today are pursuing performance goals that are defined in terms of operational excellence. In a broad sense, operational excellence is about improving business and operating processes that enhance product or services quality, achieves higher yields, uses less energy, results in less waste, and increases uptime.

Beginning in the late 19th century and continuing today, electrification, or the displacement of other technologies with electrical technology, has transformed all aspects of our modern society. Energy generation and distribution, heating, lighting, transportation, food production and storage, medical diagnostics, and financial transactions are just a few examples in which electrical technology has displaced previously used technologies to enable extraordinary advancements and conveniences. In celebrating the beginning of the 21st century, the National Academy of Engineering identified electrification as the most significant engineering achievement of the 20th century. The implications of having such dependence on electrical technology, combined with increasing initiatives in pursuit of operational excellence, makes the elimination of errors and failures in electrical systems of paramount importance. Today, it is difficult to imagine our world without the convenience and productivity made possible by electricity and application of electrical technology. Virtually every aspect of our society, including transportation, leisure activities, business and commerce, food production and distribution, and medical services are dependent on electricity for energy and control. 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 transactions processing center can impact millions of dollars in banking transactions. The hierarchy of hazard control measures in ANSI Z10 Occupational Safety and Health Management Systems [1], coupled with the electrical safety requirements in NFPA70E, Standard for Electrical Safety in the Workplace [2], serve to prevent incidents that can result in unscheduled disruption of critical electrical systems, thus provide the foundation for operational excellence.

Electrical Safety and Collateral Consequences

Whenever there is interaction between people and electrical systems, there is always the possibility for an unexpected or undesirable event to occur. These events have results ranging from serious injury and death to disruptions of some aspect of operations. Electrical injuries occur at a relatively low frequency, as compared to injuries from other hazards in the workplace. Cawley and Homece noted that electrical hazards are the sixth leading cause of occupational fatalities, but account for only 0.2% of lost time injuries [3]. This shows that electrical injuries are low frequency but high consequence in nature. The low frequency of lost time injuries could cause an organization to overlook the need for, and the opportunities in additional benefits of, implementing an effective electrical safety program. It is the author's experience that most mishaps in electrical systems do not involve injury, but almost all have undesirable collateral consequences. These disruptions range from annoying with little consequence, to very serious and costly, but with no direct injury. In an earlier paper, the author noted that an organization desiring to improve performance of electrical systems critical to business operations may find improving the implementation of an effective electrical safety program may have more benefits than in investing in capital projects or additional preventive maintenance [4]. Aeiker et al identified collateral consequences to include process safety, fire safety, and avoidable maintenance and operating costs [5]. Below are examples the author has gleaned from newspaper accounts and incident reports provided by professional colleagues.

Six Hour Outage in San Francisco Bay Area

A task sequence error resulted in an electric utility crew failing to remove protective safety grounds before re-energizing a section of the utility system that had been de-energized for maintenance. The error resulted in a six hour power outage in the San Francisco Bay area, impacting millions of customers. Although there was no injury to the workers directly involved in the re-energization tasks, there was a report of an automobile accident death at a street intersection with a non-functioning traffic light.

Millions in Northeast without Power
An operator error in a power generating station was attributed as a cause to a power outage in August 2003 impacting millions of customers in the eastern US and Canada.

Delmarva Peninsula Blackout
A wiring error in the modification of a protective control circuit was attributed to causing a power outage lasting for several hours to all customers in the Delmarva Peninsula area on the eastern shore of the Chesapeake Bay.

Hospital Power Outage
One contractor was burned in an arc flash incident and a hospital was without normal and standby power for four hours. Modifications were being made to the hospital back up power transfer system. A job that was planned to avoid disruption to the hospital electrical systems actually resulted in an extended outage impacting patients dependent on electrical power for critical care.

Chlorine Release due to Power Outage
During routine functional testing of the utility power protection systems, an unexpected equipment failure resulted in complete loss of power to a chemical manufacturing plant. Backup power generators failed to start and the plant shutdown generated a chlorine release. By chance, wind blew the chlorine cloud off shore and the surrounding community was not impacted.

In these examples, all had the potential for injury to the workers directly involved, however only one did involve worker injury. All resulted in highly undesirable and costly collateral impact. Widespread loss of power carries the potential of creating dangerous situations for people far removed from the immediate activity at the root of the incident. The chlorine release could have resulted in danger to the community. Table 1 summarizes business performance parameters potentially impacted by incidents involving electrical energy, control, communication and data systems critical to most operations.

Employee safety	Capital effectiveness
Process safety	Environmental releases
Fire safety	Raw material utilization
Energy utilization	First pass yield
On time delivery	Operation uptime

Table 1. Business Performance Parameters Impacted by Mishaps in Electrical Systems

An Effective Electrical Safety Program

Widely recognized occupational safety management standards, including ANSI Z10, Occupational Safety and Health Management Systems and CSA Z1000, Occupational Safety and Health Management are well harmonized regarding the hazard control measures shown in Table 2. In addition, they are harmonized in how these equally important measures are ranked in descending order with regards to relative effectiveness in helping assure worker safety.

1. Elimination of the hazard 2. Substitution of less hazardous equipment or materials 3. Engineering controls to reduce exposure or severity 4. Warnings, signs, and other communications 5. Administrative controls, including safe work practices 6. Personal protective equipment

Table 2. Hierarchy of Hazard Control Measures Described in ANSI Z10

NFPA70E, Standard for Electrical Safety in the Workplace, provides specific requirements unique to the hazards of electrical energy, however this standard by itself does not constitute a comprehensive and effective electrical safety program. The current edition of NFPA70E focuses on control measures 4, 5, & 6 in Table 2, and does not effectively address the first three. An organization desiring to design and implement an electrical safety program that includes a comprehensive set of control measures must look beyond the requirements in NFPA70E.

Kolak describes a compliant electrical safety program as one that meets minimum OSHA requirements (i.e. the requirements in NFPA70E), and an effective electrical safety program as one that also includes the application of safety management principles [6]. An effective application of the requirements in NFPA70E can be achieved if implemented within the framework of a recognized safety and health management system standard. ANSI Z10 provides comprehensive guidance on the elements of an effective safety and health management system. It is harmonized with other internationally recognized occupational safety and health management standards, including CSA Z1000, ISO 14001, and OSHAS 18001. Some companies and organizations may have proprietary safety and health management systems that are aligned with the key elements of ANSI Z10.

Capelli-Schellpfeffer et al emphasized that the most effective design and implementation of an electrical safety program can best be achieved through a joint effort involving electrical subject matter experts and safety professionals knowledgeable in safety management systems. This collaboration can help assure proven safety management principles and practices applicable to any hazard in the workplace are appropriately incorporated in the electrical safety program [7].

Conclusion

Business and commerce is 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. The approach outlined in this paper will help assure sustainable improvement in preventing injury, and provide the basis for gains in operational excellence.

References

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