CASE STUDY

Auto Manufacturer—North America

Safer by Design: Protecting Industrial Personnel and Equipment From Arc-Flash Hazards

North America—In 2016, a global vehicle manufacturer well known for its world-class vehicle safety standards wanted to expand its U.S.-based manufacturing plant to accommodate a new vehicle model. The company was planning to install a state-of-the-art electric power system for the plant expansion that provided advanced levels of safety for personnel.

Prior to the expansion project, the company's manufacturing facility housed production lines for five vehicle models. The manufacturing floor was full of robotics, conveyors, and automated equipment, similar to that shown in Figure 1.

Figure 1—Robotic Manufacturing Equipment

To accommodate a new model production line and improve its manufacturing flexibility, the automaker decided to add 1.5 million square feet (or approximately 34 acres) to the facility. Once completed, the facility would be able to produce more than 300,000 vehicles per year. This new production line presented an opportunity to design an innovative electrical system that would provide reliable power and the flexibility to respond to shifts in market demand.

Responsible Design

The project's senior electrical engineer was strongly committed to safety. His background in the utility industry had given him a broad perspective on potential safety risks and a heightened awareness of arc-flash hazards. Tasked with creating a state-of-the-art power system for the new vehicle line, the engineer was determined to design the best solution possible to maximize safety for the plant's personnel. This meant choosing the best equipment to support his safety objectives.

Identifying Arc-Flash Hazards

The engineer identified one of his plant's most dangerous activities as the annual equipment maintenance, including the attendant risk of an arc-flash event. During this maintenance, in-house staff performed various nonroutine activities, such as switching medium-voltage circuit breakers, installing protective grounds, tearing down transformers, troubleshooting low-voltage circuit breakers, etc. Since they only performed these duties once a year, these less familiar tasks pose an increased risk for human error.

Adding to this risk, an outside agency typically performed relay and transformer testing. Human error could come into play because electrical personnel relatively unfamiliar with the plant and its design were preparing the power system for maintenance and performing the tests. Also, since the plant had to remain operational, it was common for the adjacent circuits to be energized while workers performed the maintenance. The senior engineer understood that this situation presented a potential arc-flash safety hazard.

Industry Data on Arc Flash

The consequences of an arc-flash event can be extreme, and unfortunately these events are common. According to the May 31, 2013 online issue of *Industrial Safety & Hygiene News*, 30,000 arc-flash incidents occur each year. Of these, 7,000 are burn injuries, 2,000 are hospitalizations, and 400 are fatalities. The publication notes that 80 percent of the electrical worker arc-flash-related fatalities are due to external burns. Industry data have also shown that the majority of arc-flash events occur late in the day or at the end of a shift, when workers are tired, rushing, or tempted to ignore safety protocols.

Arc-Flash Consequences

In *Understanding Arc Flash*, the Occupational Safety & Health Administration (OSHA) states: “Because of the violent nature of an arc flash exposure when an employee is injured, the injury is serious—even resulting in death. It’s common for an injured employee to never regain their past quality of life.”

Aware of these potential consequences, the engineer took arc-flash hazards very seriously. It was widely accepted within the organization that if an arc-flash event were to occur, not only would it be hazardous to personnel and equipment, the resulting process downtime could be extremely expensive. A single arc-flash event has the potential to release up to 35,000 degrees Fahrenheit—almost four times the surface temperature of the sun—and could potentially impact the plant’s electrical power system and limit production.

Standard Safety Measures—Focus on Effects

According to the OSHA, arc-flash events can be caused by “dust, dropping tools, accidental touching, condensation, material failure, corrosion, and faulty installation.” The three main factors that determine the severity of an arc-flash hazard injury are “proximity of the worker to the hazard, temperature, and time for the circuit to break.”

Historically, this vehicle manufacturer had deployed conventional industry solutions to provide a safe environment for personnel and minimize potential injuries. These measures focused on the effects of arc flash, including: (1) calculating the incident energy of exposure to establish arc-flash protection boundaries, (2) installing product safety signs and labels to communicate the risk areas, and (3) requiring the use of personal protective equipment and clothing (PPE), such as fire retardant suits and face shields.

While these typical measures are commonplace, the senior engineer was confident that more could be done. Based on his research and prior utility experience, he wanted to take advantage of the tremendous advancements in arc-flash protection technology that are available today.

In order to attain a higher level of safety for the new plant, the engineer focused his efforts on a simple, but effective strategy: using technology to physically remove personnel from harm’s way. He also wanted to reduce the time for the circuit to break, which would significantly lower the amount of incident energy resulting from an arc-flash event. He felt these two tactics were key to creating an optimal arc-flash safety strategy.

Shifting the Safety Focus—Reduce Energy Levels by Upgrading to SEL

The engineer knew about Schweitzer Engineering Laboratories (SEL) from using SEL transformer differential relays to mitigate arc-flash hazards in the manufacturer’s 480 V substation. SEL had impressed him with its product performance and reliability as well as its strong level of customer and technical support.

He was also acquainted with SEL from participating in the training courses offered by the company's training department, SEL University. While attending a course on The SEL Real-Time Automation Controller (RTAC), the engineer began to piece together how his company could automate his new power system to achieve a world-class level of safety.

While OSHA and NETA requirements are helpful, the senior engineer wanted to go beyond what was required. He realized that he could surpass these standards by using an SEL communications-assisted tripping scheme, shown in Figure 2, to reduce arc-flash risk. By utilizing an SEL Real-Time Automation Controller (RTAC) and MIRRORED BITS® communications tripping scheme, arc-flash time functions could be cut to approximately 10 milliseconds—significantly reducing hazardous arc-flash incident energy levels.

The incremental cost of SEL arc-flash mitigation was minimal compared to the expected improvement in safety and equipment protection: "I was amazed at how affordable that system really was," said the engineer. "When I looked at the tremendous gains to personnel safety and protection of equipment, I was convinced."

Transitioning to Increased Safety

Although SEL technology is widely respected by electric utilities worldwide, it is less known among industrial operators and was relatively unknown to individuals within this automaker. The manufacturing company's design engineers, equipment manufacturing engineers, and electrical contractor needed to be convinced that switching to SEL would be worthwhile. In particular, the company's electrical contractor balked at the notion of changing their electrical protection scheme. Nobody was willing to take responsibility for the integration and programming of a system they didn't already understand.

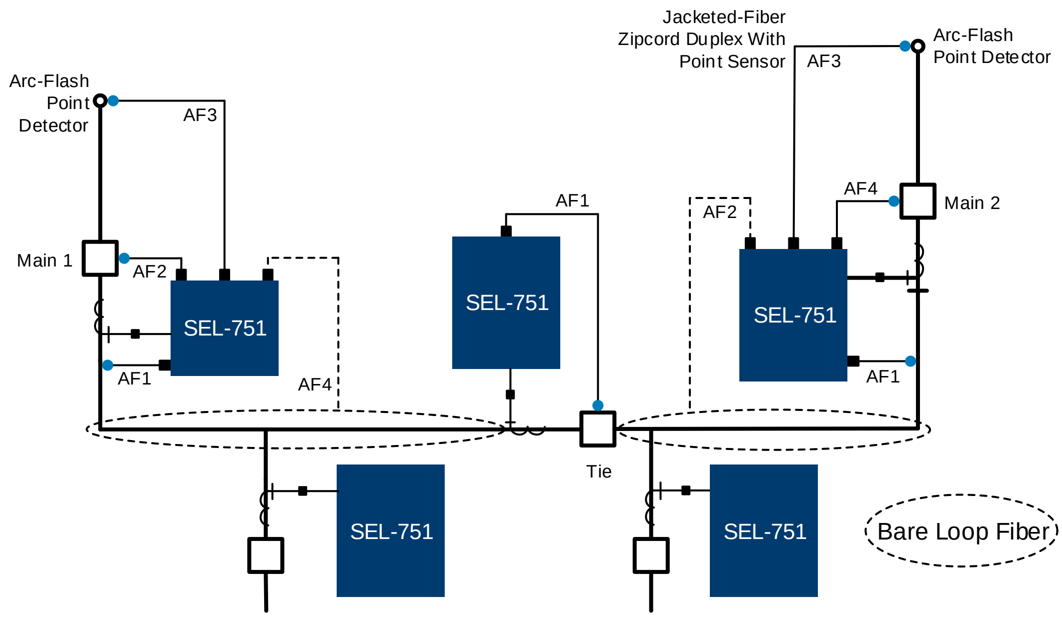

Figure 2—Arc Flash Detection Scheme

Despite the multiple benefits of adopting the new technology: improved quality, lower cost, simplicity, faster sampling speed, greater data storage capacity, added equipment protection and improved personnel safety, the proposed technology was new and there were concerns about how to properly configure and operate the equipment.

From his own experience with SEL and from talking to industry peers, the electrical engineer was confident that SEL customer service and technical support would help the company design their system to their specifications, and help them configure it properly. If any questions came up, SEL had a track record of providing timely technical support, including onsite visits to help them over the learning curve. “I wasn’t going to pass up an opportunity to utilize the latest technology available [from SEL],” said the engineer, “just because nobody had installed it before. I knew that I could implement a safer power system that was both reliable and maintenance-friendly.” After they discussed the benefits, the company consensus was that using the newer technology from SEL would result in significantly improved arc-flash hazard mitigation vs. using “traditional” time-current coordination protection schemes.

The SEL Solution—Employ All the Benefits of Today’s Technology

The SEL safety solution designed for this global auto manufacturer utilized SEL-751A Feeder Protection Relays, devices specifically tailored to quickly detect and interrupt arc flashes. These relays can remotely isolate a fault and disengage a system so personnel do not have to approach a panel, but instead can use SCADA to perform their operations remotely.

In addition to the SEL-751A feeder protection relay, other components of the SEL solution included SEL-735 Meters, an SEL-3555 Real-time Automation Controller, an SEL-2407® Satellite-Synchronized Clock, and an SEL-387 Current Differential Relay.

Overall, the solution provided arc-flash detection technology, fast bus tripping, an intelligent electronic device (IED) failure backup protection scheme, a breaker failure backup tripping scheme, breaker remote control to trip and close via HMI (effectively allowing the removal of personnel from in front of the switchgear and increasing their safety), and an HMI cabinet, which housed an RTAC, a touchscreen monitor, keyboard, and incoming fiber-optic communications.

By adding an SEL RTAC, advanced fiber-optic communications could be used, which simplified wiring and significantly improved data bandwidth, data quality, and collection speed. To increase reliability, interconnected wiring was replaced with fiber optics cabling. After doing this, instead of 110 copper wires, there were only 11 fiber-optic cables.

“The fiber-optic communications provide us greater flexibility,” said the engineer. “Future changes can be made quickly in software, versus the expensive and time-consuming cable runs that were previously needed. Fiber-optic cabling also offers improved reliability versus traditional copper wiring.”

To design the same functionality with traditional copper wire for a medium-voltage switchgear lineup would have meant much more time implementing the design and greater risk for errors.

“Fifteen years down the road we could have problems with the wires,” said the engineer. “Any time we remove wires, there’s a chance of damaging them, and then there’s also the troubleshooting time. Instead of running copper wire, we are running fiber to an HMI cabinet. All the messages, data, control signals—it’s all going on at a communications level, and we’re getting much more data than we would have had otherwise.”

The higher quality data and improved data access provided by the RTAC will help the auto manufacturer's staff make better decisions and optimize their resources efficiently. The changes introduced now can be retrofitted to the company's 20-year old switchgear, to support continued modernization of their plant power system. Finally, an SEL RTAC field specialist will be available to provide onsite assistance to help the manufacturer customize the RTAC to fit their application requirements.

Conclusion

While the risks associated with arc-flash hazards are relatively well known, many industrial organizations are unaware of the latest advancements in electrical protection technology. Communication-assisted protection technology, widely used by utilities, can significantly reduce the incident energy associated with arc-flash events. Other industrial plants can benefit from integrating specialized arc-flash mitigation technology into their electrical design. The technology exists and is easily accessible to quickly detect and mitigate arc-flash events within a fraction of a second—before dangerous levels of incident energy can develop.

The most effective way to increase arc-flash safety is to remove the human element from the equation as much as possible. By utilizing state-of-the art technology to work remotely versus directly in front of equipment, personnel greatly decrease their risk of arc-flash exposure.

Over the next several years, the manufacturer plans to upgrade to SEL intelligent electronic devices (IEDs) and implement this same communications-assisted protection and control scheme in other parts of its facility. These IEDs will be connected over a site-wide SEL fiber communications network and will replace the existing system and provide exceptional protection, control, and power quality metering functions.

For the senior engineer, deploying this new power protection and automation technology enabled him to achieve his safety goal: "The medium-voltage switchgear associated with this project will be the safest and most reliable switchgear in any of this manufacturer's facilities anywhere in the world."

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About SEL

Schweitzer Engineering Laboratories, Inc. (SEL) has been making electric power safer, more reliable, and more economical since 1984. This ISO 9001:2000-certified company serves the electric power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, control, and monitoring. For more information, please contact SEL at 2350 NE Hopkins Court, Pullman, WA 99163-5603; phone: +1.509.332.1890; fax: +1.509.332.7990; email: info@ selinc.com; website: www.selinc.com.

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