Making Safer Facilities

Increasing Safety And Productivity With Arc Flash Prevention And Thermal Imaging

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Introduction

Insurers serving the business and institutional market face a number of growing challenges.You need to reduce liability, fend off growing costs and cope with an environment which is increasingly litigious.

The good news? You're in a prime position to advise your policyholders and help them make their facilities and workforce safer. One way to accomplish this is to ensure policyholders are complying with the new (2012) requirements in NFPA 70E, the Standard for Electrical Safety in the Workplace. In this white paper, we'll focus on the heart of the updated 70E, **arc flash safety.**

A properly conducted arc flash survey can prevent accidents and save life and limb.

Arc flash can be deadly for employees and devastating to a facility. It occurs when electrical current jumps between two conductors, causing a massive discharge of heat and light. Temperatures can reach 35,000 degrees Fahrenheit, several times hotter than the surface of the sun, pushing material outward in a small explosion. A properly conducted arc flash survey can ensure procedures are followed which prevent the flash from occurring in the first place and, if one does occur, that employees have taken precautions that can save life and limb.

In the remainder of this paper, we'll examine how arc flash happens, how the new standards address it and why complying with 70E makes sense even if it's not required by authorities in your policyholder's area. Then we'll move on to the solution—the arc flash survey—giving an overview of how it works, what benefits it delivers, the cost savings and how combining it with thermal imaging can save even more money. Lastly, we'll focus on what to look for—and what to avoid—in an arc survey provider.

Too often, accidental contact from an electrical worker closes a circuit and produces an explosive arc flash.

How Arc Flash Happens

Whenever electrical current passes between two or more conducting materials through the air, we see an arc as the current produces light and plasma. We're all familiar with benign electric arcs, such as static when touching a door knob, or in welding applications.

The industrial arc flash is a different animal. It almost always occurs in systems running 480 volts or more and always occurs accidentally. Deteriorated equipment, corrosion, conductive dust, system parts that aren't rated for the power in the system, accidental contact or any number of other factors allow the electricity to short circuit. From the moment this short circuit is completed until an “upstream” safety device (such as a circuit breaker) cuts the power, the energy in the system is unconstrained, heating up the conductors and exploding out into the work environment.

What Arc Flash Does

An arc flash is essentially an explosion. The electricity in the circuit breaks loose, finding the path of least resistance and moving through a conductive plasma air path. This converts much of the energy in the arc to heat; in milliseconds the temperature can reach 35,000F, several times hotter than the surface of the Sun. Intense light—easily bright enough to cause permanent blindness—flares out from the arc. It covers the entire light spectrum from deep infrared to ultraviolet, and carries enough energy to cause severe burns, vaporize materials in the vicinity or set them on fire. The heat energy alone can cause fatal burns up to 10 feet away.

Arc flashes can reach 35,000F, several times hotter than the surface of the sun.

Like any dangerous explosion, an arc flash produces deafening noise and an expanding pressure wave. This is driven by two factors.

First, the conductors the arc is jumping between—and other nearby metals—are vaporized. As they change from a solid to a vapor, their volume increases enormously, over 67,000 times in the case of copper. Other metals are liquefied.

Second, the extreme heat causes air expansion, adding to the explosive force. The pressure wave expands, pushing plasma, debris, molten metal and loose objects outward with enormous force into nearby equipment and workers. Secondary fires will likely keep burning after the arcing power is cut off.

NFPA 70E: Why Comply?

Even if no local authority is requiring you or your policyholder to follow the arc flash hazard analysis requirement in National Fire Protection Association (NFPA) 70E, there are excellent reasons to do so. Here are three:

If an arc flash occurs, a proper survey can be the difference between a worker being fully protected or fatally vulnerable.

Safety

Of course, preserving the safety of employees must be the primary goal of insurer and insured. An arc flash survey will preserve and increase that safety by ensuring every worker interacting with high voltage systems is aware of the hazards in the specific equipment they're working with and is wearing the correct Personal Protection Equipment (PPE). The survey will also set approach boundaries for each piece of equipment designed to keep untrained or unprotected workers out of the area of a potential blast. If an arc flash occurs, these employees will be at a safe distance and escape harm.

OSHA and other regulatory compliance

Let's be clear: OSHA does not officially require compliance with the 70E standard and the agency has never officially adopted it as a regulation. However, 70E is a “consensus safety standard” and as such, is considered by OSHA and other agencies to be necessary for a safe workplace. The “general duty clause” of the Occupational Safety and Health Act requires employers to have a workplace “free from recognized hazards.”

You and your policyholders can be sure that if they're complying with all the requirements of 70E, they have complied with the general duty clause.

During enforcement actions, compliance with industry safety standards such as 70E “can be used as evidence of whether the employer acted reasonably,” according to OSHA. If you persuade your policyholders to comply with all aspects of 70E, you may just save them from hefty fines and regulatory hassles.

Cost reduction

Beside the substantial savings from preventing injuries or death in the first place, a proper survey can limit financial damage if an arc flash occurs. The care you or your policyholder took to ensure employee safety can prevent a lawsuit or reduce a settlement significantly. The typical cost for the discovery phase of a trial alone can far outstrip the cost of a proper arc flash survey.

A proper survey ensures workers wear the PPE they need.

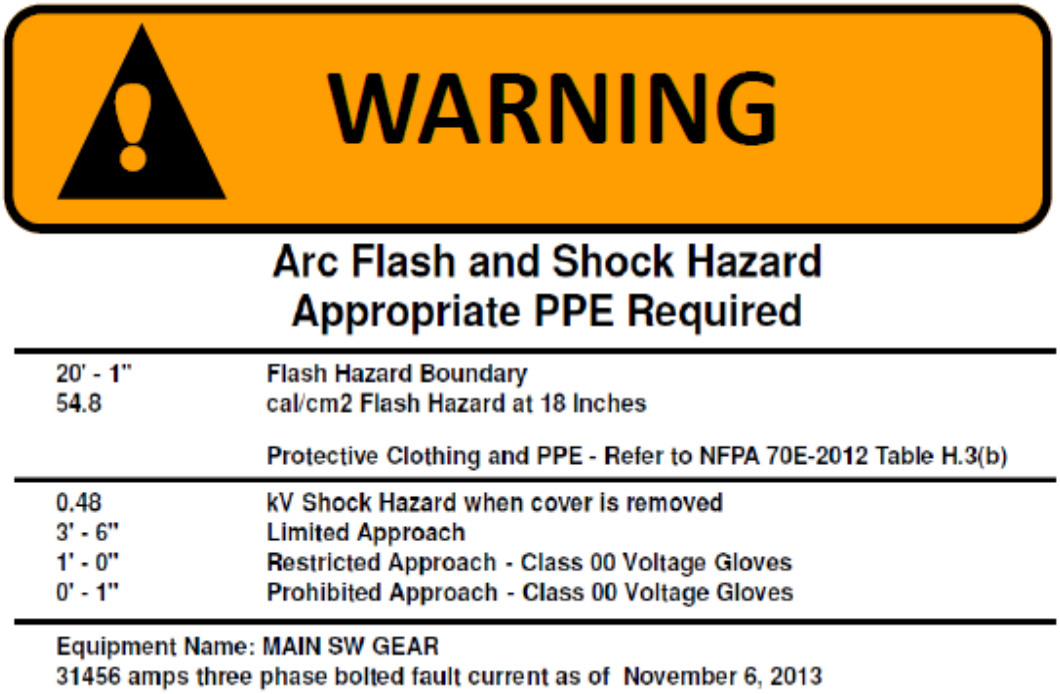
The Arc Flash Survey: How It's Done Right

The survey is an on-site evaluation (by a qualified electrical engineer) of a facility's systems, beginning with an identification of all equipment which might produce an arc flash. The system is mapped and each piece of equipment identified as a hazard is evaluated further. An electrical engineer uses specialized software to calculate how much energy would be released in an arc flash, using factors such as how much energy is present when that system is energized, how long the arc would exist before safety equipment “upstream” cut it off, etc.

Each piece of equipment is labeled with a customized warning unique to that component. The label makes it clear what must be done to interact with the system in a safe manner.

Anatomy of the label

Let's take a look at a typical warning label, line by line:



Flash Hazard Boundary—Also known as the Flash Protection Boundary, this is the distance at which a worker would be exposed to 1.2 calories per square centimeter of thermal energy. Why is that level of energy significant? It's the amount which will cause second degree burns or worse unless the worker is wearing PPE.

Incident Energy Level—This is expressed as the amount of calories per cm^2 at 18 inches, or roughly arm's length.

PPE Level—This section details the minimum protection equipment required by anyone working on the electric component or working in the immediate area while it's being serviced. It can range from cotton or flame resistant shirts to full body kits rated at 100 calories/cm2. The label may also note the Hazard Risk Category (HRC) on a scale from 1 to 4, with a higher number indicating greater danger. Some labels also indicate the type of gloves required

Shock Hazard—Indicates the voltage exposed when the cover to the equipment is removed or opened.

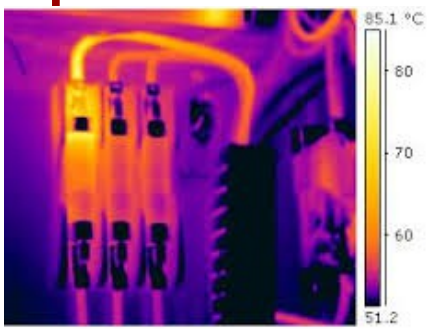
The next portion of the label describes a series of boundaries (expressed as distances from the live equipment), each of which has specific safety procedures assigned to it. These are arguably the most important part of the survey, because they build in an extra level of protection for the workers.

Limited Approach Boundary—Unprotected workers must remain outside this line and may only cross when wearing proper PPE and escorted by a worker who is qualified on the procedure being performed.

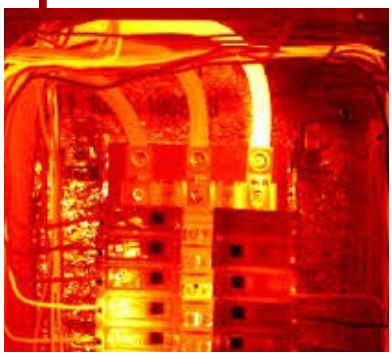
Restricted Approach Boundary—Only workers who are qualified on the procedure being performed can cross this boundary. They must have proper PPE, a permit to perform the work and a written work plan detailing how they will avoid having any body parts or conductors cross the Prohibited Approach Boundary.

Prohibited Approach Boundary—Because of high voltage making an arc possible, passing closer than this boundary is the equivalent of direct contact with the live parts. Only non-conductive materials should be closer to the circuit than this and any part of the worker's body that passes through the boundary must have PPE rated high enough for direct contact.

Increased Safety, Reduced Cost
What is the simple takeaway from the complex details of the survey process? Properly analyzed and labeled equipment will leave workers with no doubt what they should be doing and wearing or who should be nearby. Arc flash will be less likely to occur. If it does occur, fewer workers will be affected and those who are will be protected from the explosion by the best available safeguards.



Thermal imaging allows technicians to see into the infrared part of the spectrum...


...and detect overheated equipment that might otherwise be missed.

Reducing Costs Further With Thermal Imaging

Thermal imaging cameras allow technicians to inspect equipment from a distance and without opening casings or covers. By revealing hot spots which would otherwise be missed, they can detect failing motors, faulty or clogged cooling equipment, overload conditions, corrosion, loose connections and even short circuits.

Today's sophisticated cameras can even display the images in a picture-in-picture or blended format, making it easy to pinpoint the exact location of a fault.

During an arc flash hazard survey, technical staff will already be studying the facility's equipment, so combining thermal inspection with the survey will avoid duplication of work and save time. Thermal inspection during the survey has other benefits as well:

Increased safety from early detection—A failing motor can catch fire or come apart violently. A loose connection can cause electrocution. But none of that can happen if the thermal consequences of the fault are detected long before an accident occurs.

Increased safety from distant inspection—Being able to inspect equipment through covering materials and at a distance saves workers from having to deal with the equipment in an “up close and personal” way, reducing exposure to dangerous conditions.

Increased inspection effectiveness—Thermal inspection can be performed while equipment is charged and running, and may catch problems which would be missed if the system was shut down.

Reduced inspection costs—Because workers won't need to spend time on safety precautions or stripping equipment down for inspection, a thermal survey will reduce the amount of man-hours spent on inspection. There will also be no loss in productivity from shutting off systems—or whole production lines.

Reduced repair costs—Replacing a component after it fails often costs far more than it would have cost to replace beforehand. Because the replacement can be scheduled for normal working hours, there may be a savings in overtime.

Increased productivity—Knowing about a failure in advance allows facilities to schedule repairs during downtime instead of losing production when the component fails.

No arc flash survey "do-overs"—It often makes sense to replace a failing component with a better version. However, this may change the characteristics of the system enough to change the results of the arc flash analysis. If failing components are identified with thermal imaging and replaced prior to the conclusion of the arc flash survey, this redundant work will be avoided.

Additional finds—Thermal inspection may uncover problems in other areas, such as missing or damaged insulation or clogged piping.

6 Things To Look For In A Survey Provider

In recent years, a number of companies have entered the market to offer this service. The problem? Some will provide a survey that does little to make employees safer and reduce exposure. Here are six things to check (or advise your policyholder to check) before hiring a firm for a survey:

Are they an established firm? Not every company new to the field is a fly-by-night outfit, but a complex system-wide survey should be accomplished by a company with a deep knowledge base and years of industrial and institutional experience. Companies which have entered the market recently (especially those that only do arc flash surveys) may be run by "entrepreneurs" cashing in on a change in regulations.

Choosing a firm that offers an experienced team, detailed surveys and plenty of training assistance...

Who will accomplish the survey? A proper arc flash hazard survey will require an electrical engineer and a fully qualified electrician at a minimum.

What level of detail do they offer? Companies hoping to accomplish surveys on the cheap will often classify equipment in broad risk categories and not provide the service needed for a full survey. This will often be reflected in their labeling: Instead of detailed information, they may simply place mass-produced labels on components reading "HRC 2 PPE" or some similar generic warning. This can make a huge difference in safety and can even increase the number of victims in an arc flash incident. With an improper label, workers who wouldn't even be allowed past the approach boundaries established by a proper survey could remain in the area affected by the blast.

...can ensure the safety of thousands of workers and equipment worth millions.

How does their cost compare with the industry? A sure sign of a less-qualified and less careful survey provider is a bid substantially below that quoted by other providers. They may be using fewer or less qualified personnel, providing a lower level of detail or both. Make sure you're comparing apples to apples.

Can they provide thermal imaging as part of their services? As we've discussed previously, a thermal imaging survey can improve the safety of your workers, reduce lost productivity and prevent equipment damage. It should be a part of every provider's bid.

Can they assist in establishing proper training and procedures in the workplace? Will the contractor be able to assist in designing a program meeting strenuous OSHA and NFPA requirements? Find a company that can be a partner in technical safety efforts, rather than a vendor slapping stickers on equipment and moving on.

Conclusions

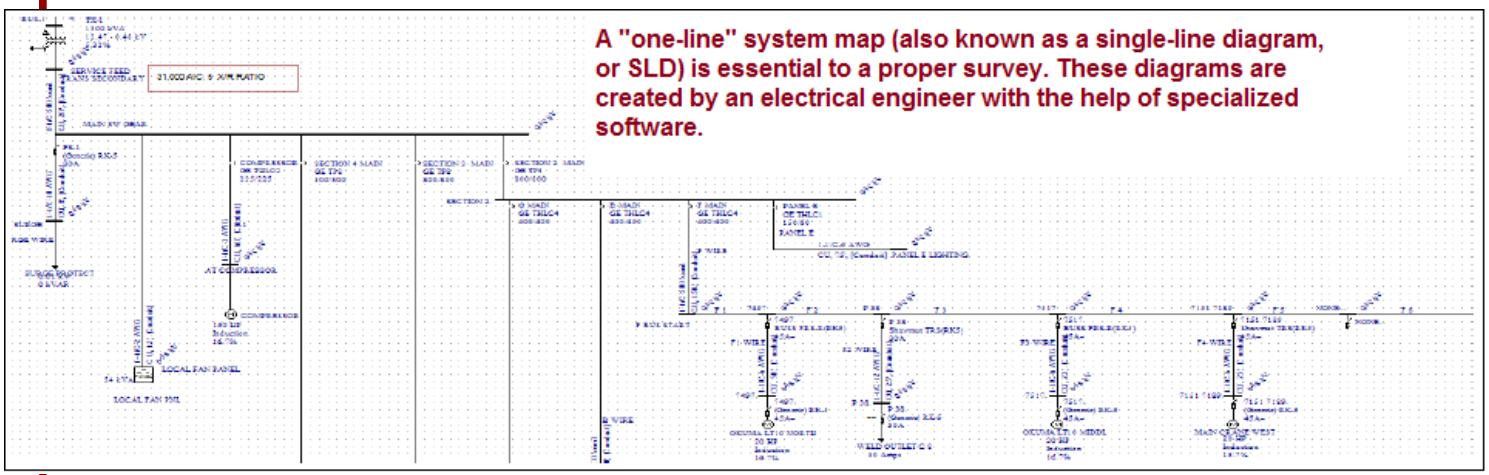
We've covered a number of diverse subjects, so let's review making facilities safer and more productive with arc flash hazard surveys and thermal imaging:

Arc flash occurs when a short circuit develops in a high energy electrical system, allowing the energy in the circuit to break loose in what is essentially a small explosion. It produces a blinding flash and heat several times hotter than the surface of the sun while throwing plasma, molten metal, debris and loose tools throughout the nearby work area.

Arc flash hazard surveys are an important part of NFPA's 70E standard. A properly conducted arc flash survey can ensure procedures are followed which prevent the arc from occurring in the first place. But, if one does occur, employees will have taken precautions that can save life and limb.

In addition to increasing safety, complying with the 70E standard ensures OSHA compliance and reduces cost and risk for both policyholders and insurers.

The arc flash survey involves a careful inspection of the high voltage systems in a facility by a qualified electrical engineer. One feature of a proper survey is establishing boundaries keeping untrained and/or unprotected workers away from equipment which might produce an arc flash.



A "one-line" system map (also known as a single-line diagram, or SLD) is essential to a proper survey. These diagrams are created by an electrical engineer with the help of specialized software.

Combining thermal imaging with the arc flash survey can increase safety and productivity while reducing costs by identifying failing components well before they break down.

When choosing a survey provider, facility owners should look for established firms using an electrical engineer and a qualified electrician (at a minimum) backed up by calculation software to accomplish the survey. They should be providing a high level of detail and be a partner in establishing a full electrical safety program.

You can provide a valuable service to your company or policyholders by helping them comply with 70E and conduct an arc flash hazard survey.

Next Steps

If you would like to know more about arc flash hazards and protection, please contact:

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About Ballard

Ballard Companies is committed to provide the best electrical services, design, engineering, communication technology and energy systems.

Founded in 1954 as a provider of residential wiring, Ballard has evolved into a family of companies—Ballard Electric, Ballard Engineering and Pro Com Systems—providing commercial, industrial and institutional electrical contracting, integrated control systems, power generation, co-generation and internal communication systems.

As safety standards change, Ballard continually upgrades equipment and capabilities to ensure customers are receiving the best available service. We have extensive experience assisting customers with safety and regulatory compliance. This broad experience and safety focus has resulted in Northern Illinois and Southern Wisconsin customers relying on us for many years for arc flash hazard studies and labeling, reducing their insurance exposure and making a safer work place.