*The following article has been generously contributed by Bob Sheppard, President of the Arizona Power Quality Association.*

## *So, why all the concern about "Arc-Flash"?*

In the past few years, there has been a lot of buzz around the industry regarding "Arc-flash" So what is "Arc-Flash"? It's an event that takes place, when there is an electrical Arc, or Flash, typically while working on or around electrical equipment. This is not necessarily an electrocution, as this typically indicates direct contact with an energized conductor, but the effects of the "arc" or 'flash" event.

An arc fault occurs when an uncontrolled electric current flows through air between conductors from phase to ground, phase to neutral, and/or phase to phase. This arc is accompanied by ionization of the surrounding air, and vaporizing the conductive metal. Flash temperatures typically reach in excess of 35,000 degrees F in less than 1/1000 of a second, or roughly four times the temperature of the surface of the sun. In that amount of time, the flash heat can severely burn human skin and set clothing on fire.

These temperatures experienced in an arc-flash vaporize the conductors and change the state of the conductor from solid to vapor. Copper vapor expands to 67,000 times the volume of solid copper. Conductive vapors help sustain the arc and the duration of the arc is primarily determined by the time it takes for over-current protective devices to open the circuit. The clearing time can range from a couple cycles to several seconds depending upon the type of protective device and its size and settings.

The rapidly expanding vapor also produces a large shock wave that can blow personnel off their feet and cause concussive injuries. The other exposure risks to arcing faults include flying debris, severe sound waves, shock hazard due to touching energized conductors etc.

***Why is this important to you?*** It is estimated that on average, 10 arc-flash incidents take place every day in the United States. The average cost of medical service for each of those incidents is over 2 million dollars per occurrence, and does not address any lost wages or other damages or court costs.

**Is an Arc Flash Hazard Analysis Required?** The National Fire Protection Agency (NFPA) 70E *Standard for Electrical Safety in the Workplace* 2004 Edition Section 110.8(B)(1) requires that an electrical hazard analysis be performed to ensure that workers are properly protected whenever they work on or near equipment that is not in an "electrically safe condition". This type of hazard analysis is typically performed by a registered engineer, experienced in this type of study.

***How do I know if I am "Safe"?*** According to the NFPA 70E Section 130.3, the goal of arc flash hazard analysis is to identify:

- The arc flash-protection boundary, as *"an approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur."*
- based on the incident energy present at the working distance for the task to be performed, the proper PPE shall be selected

***Are there laws or regulations relating to Arc-Flash?*** The federal agency known as the Occupational Safety and Health Administration, or ***OSHA*** was established to mandate that employers provide a safe workplace for their employees. Part of their responsibility is the development of those standards that will assure that you are able to perform the function of your job duties in the workplace, in a safe environment. The codes or standards that are developed by OSHA are known as "Codes of the Federal Register" or "CFR's". Often the OSHA CFR's reference other industry standards such as the National Fire Protection Agency (NFPA) and others.

OSHA standard CFR Part 1910 promotes the safety of employees working on or near electrical equipment, and clearly define employers' responsibilities such as:

- Equipment must be de-energized before work is performed.
- If equipment cannot be de-energized prior to work, Employees must be properly protected, and the employer must provide the appropriate Personal Protective Equipment (PPE)
- Employers are responsible for performing a hazard assessment to identify the potential hazard so that the appropriate PPE can be determined.

**What is "incident energy" and how do I know if I have the right PPE?** Incident energy is a measure of thermal energy at a working distance from an arc fault. Incident energy is measured and identified as Calories per square Centimeter, or "cal/cm2. The threshold value of incident energy for 2nd degree burn of human skin is about 1.2 cal/cm2 (5 Joules/cm2). One cal/cm2 is equivalent to the amount of energy produced by a cigarette lighter in one second. It is assumed that a second-degree burn will be curable and will not result in death.

The working distance is the distance from where the worker stands to the flash location. The most common distance at low voltages (<1000V) for which incident energy has been determined in tests is 18 inches. After determining the incident energy, the value can be used to select the appropriate personal protective equipment.

There are various types of PPE with distinct levels of thermal protection capabilities termed "Arc Thermal Performance Exposure Values" (ATPV) rated in cal/cm2.

**News Flash!**: On February 13th, 2007, OSHA released a statement on their www.osha.gov website, regarding the adoption and updated standards as they effect the workplace. The adopted and revised general industry electrical installation standard found in 29 CFR Part 1910 draws heavily from the 2000 edition of the NFPA 70E, and the 2002 edition of the National Electrical Code (NEC). This final rule becomes effective on August 13, 2007.

In summary, I cannot obviously cover all of the in-depth discussions regarding Arc-Flash, and all of its technical and other ramifications. What I can say, is that with the recently adopted rules from OSHA, conformity with these new requirements no longer be voluntary. Arc-flash has been the subject of many Arizona Power Quality Association discussions, and will likely continue to be a major concern for workplace safety in the future.

I've had such a huge number of questions about this topic; I thought that I would follow up with a second part, and answer a few of the questions that I've been asked to address.

Summarizing some of the highlights of what I discussed previously, an arc fault occurs when an uncontrolled electric current flows through air between conductors from phase to ground, phase to neutral, and/or phase to phase. This arc is accompanied by ionization of the surrounding air, and vaporizing the conductive metal. Flash temperatures typically reach in excess of 35,000 degrees F in less than 1/1000 of a second, or roughly four times the temperature of the surface of the sun. in that amount of time, the flash heat can severely burn human skin and set clothing on fire. Most importantly, statistically it is estimated that on average 10 events happen every day!

**Q:** "*There is a chart in the 2004 NFPA 70e that indicates the type of Personal Protective Equipment (PPE) to use in various situations. Does this chart effectively tell the worker what to use in the various applications and voltages?"*
**A:** The short answer to this is "No". Most engineers involved with engineering studies related to identifying the "calories per square centimeter" (cal/cm2) will tell you that this chart is to used strictly as a guideline. Personally, if that chart is all you have to identify the PPE to wear, I would have to say that it is better than nothing. The true way to identify the cal/cm2 and the appropriate PPE, is to have a formal Arc/Flash engineering study performed by a registered engineer that is experienced with the type of calculations. There is a lot of liability to "guessing" what type of PPE to use for any application.

**Q**: *"As a facility manager, I intend to "hire" people to perform my energized electrical service work. This puts the responsibility on the contractor to identify the incident energy and proper PPE- doesn't it?"*

**A**: Absolutely NOT! If there is electrical equipment on your property, regardless of if you "hire services out" or perform our own service "in house" the liability remains the same- yours. This is one of the biggest misconceptions that I regularly come across. If you have electrical equipment at your facility, it is your responsibility to identify the hazard for all persons that may be exposed, provide the proper PPE, training and markings.

**Q**: "*What can I do to reduce the arc/flash hazard?"*
**A**: Of course the best way to reduce a hazard is to avoid it all together. Many times, an Arc/Flash hazard analysis identifies an excessive amount of energy due to the equipment installed at a facility. In some cases, we can change out equipment to reduce the levels to an amount that is more manageable.

**Q**: *"Why can't I find PPE with more than a 40 Calorie rating?"*
**A**: 40 calories is the maximum level that you will likely see in the market for a couple of different reasons. As I had mentioned previously about the rate that copper expands. This is the percussion part of the arc/flash (blast) and above the 40 calorie level, you will likely live through the electrical hazard, however you will likely not survive the blast.

**Q**: *"Since my employer doesn't want to buy a lot of different PPE, is it acceptable to just purchase a 40 Calorie suit and use it for every situation?"*
**A**: Actually, working with the improper PPE, in this case too much can put you in as much danger as using too light of PPE for the application. In case you have not seen a 40 Calorie suit, it would remind you a lot of the "Michelin Man" and with all that equipment on, it would make it very difficult to use tools or do much of anything. In fact, I believe you'd be more likely to "create" an arc/flash incident in the improper application. The best plan of action is to identify the proper PPE for the hazard, and yes this can sometimes mean purchasing various kinds of PPE.

**Q**: *"Surely the new Arc/Flash rules will only apply to "new" equipment- Won't they?"*
**A**: Actually, in this case it does not. According to the www.osha.gov web site, OSHA has been issuing fines and violations when an arc/flash incident has occurred, and there was evidence that there was improper or no use of PPE. Following some of the incident reports, some of the equipment has been newly installed, and others have happened with older existing equipment.

**Q**: *"Proper use, and maintenance of PPE is self explanatory isn't it?"*
**A**: It is important to have some sort of formal training and/or identification on how to use the PPE in the correct manner. The equipment can be very "pricy" and the more preventative care is taken, the longer it will last.

**Q**: *"Do I really need to have training on Arc/Flash specific to my facility?"*

**A**:  There is no “cookie cutter” arc/flash training.  Just about every facility has a different level of incident energy, PPE, site specific guidelines and company policies.  There are also a lot of different Arc/Flash labels that all look differently. The basic information is usually on the label, however if you are not familiar with the label, you may unintentionally wear the wrong equipment.

*As a side note*:  Engineers use the best recognized engineering methods and tools to their trade to identify the proper incident energy levels.  Much of the information used to identify the interruption time of a device such as a circuit breaker or switch is provided by the manufacturers in the form of time-current characteristic curves. These curves are critical to the engineering study. Hopefully, the equipment installed was tested to assure that the equipment works as designed, and the device actually will interrupt the fault as it was designed by the manufacturer.  This is equally as important that the electrical equipment is maintained and in good working order.  There are several various agencies that make recommendations for frequency of maintenance testing, but as a good “rule of thumb” this maintenance should take place at least every 3-5 years.  In other words, the engineering calculations are only as good as the equipment condition.  Older, non maintained equipment can have much slower reaction times, and cause a much higher incident energy level than calculated by the engineering study.

Arc-flash has been the subject of many safety meetings, trade associations meetings and with the concerns of equipment and human life, I am sure it will continue to be a top safety topic in the future.

If you have any comments or concerns regarding this or any other electrical topic, please feel free to contact me at 602-438-7500 or bob.sheppard@southwestenergysystems.com