



*Manufacturer of Industrial and
Environmental Solutions*

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Arc Flash and Grounding: Safety, Compliance, and Good Practices

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Arc Flash

What is Arc Flash?



Arc Flash

Arc Flash Is An Electrical Explosion That Emits:

- High Levels of Thermal Energy
- Vaporized Metal & Insulation
- Blinding Light
- Flames
- Concussion Shock Wave



Arc Flash

Arc Flash Occurs When You Have:

- An Electrical Short
- Massive Amount of Available Electrical Energy
- Inadequate Electrical Circuit Protection Devices



Arc Flash

Arc Flash May Cause:

- Death or Significant Personal Injury
- Blindness
- Skin & Facial Burns
- Lung Damage From Inhaled Super Heated Gases
- Bodily Injury From Flying Part Fragments



Arc Flash

Several Deaths and Severe Injuries from Arc Flash Related Accidents Have Caused:

- OSHA to Charter the National Fire Protection Association (NFPA) to Write Standards For Work Place Safety Involving Electrical Work.
- The Standard is: NFPA 70E, Standard for Electrical Safety in the Work Place.



Arc Flash - SCCR

Short Circuit Current Rating (SCCR) – What Is It?

- The SCCR of a Device Defines How Much Fault Current Can Be Tolerated With Out Causing Significant Damage to the Device or Creating a Hazardous Operating Condition.
- Assembly Ratings for Control Panels take into account all the components contained within the equipment.
- The SCCR marking for a control panel will be based on the lowest withstand rated component in the equipment, the weakest link. Using the UL508A Industrial Control Panel standard or product testing establishes the equipment SCCR.




Arc Flash - SCCR

NFPA And UL Define How SCCR Is Calculated

- Component Manufacturers Must Test Parts For SCCR.
- Control Panel Manufacturers Must Calculate The Control Panel SCCR Using UL Standards.
- UL Control Panels Must Be Marked With The SCCR Rating.



Arc Flash - SCCR



PANEL MODEL: LR4250PF-1-.5PS
SERIES CODE: NA
SERIAL NO: 12-10810

VOLTS: 230VAC PH: 1 HERTZ: 60


TOTAL AMPS (PANEL): 6.74

SHORT CIRCUIT CURRENT RATING: 15K AMPS RMS

PANEL IS TO OPERATE PUMP:
VSDPT 8-4
MOTOR: HP: 0.5 VOLTS: 230VAC PH: 1 FLA: 5.0


ENCLOSURE IS RATED: NEMA 4, UL TYPE 4

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Arc Flash - SCCR

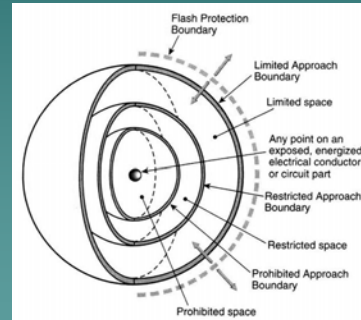
Why is SCCR so important?

- Safety, Safety, Safety, plus some liability protection for the equipment owner.
 - It's purpose is to properly warn workers of the hazard.
 - If the fault current is less than the device's SCCR, then the device should contain the fault energy.
 - The SCCR along with an Arc Flash rating which is based on the total available power to the equipment is used to determine the PPE (Personal Protective Equipment) to be worn when servicing the equipment.
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Arc Flash – Approach Boundaries

Approach Boundaries – What Are They?

- Define Personal Hazards Verses Distances From Arc Flash
- Flash Protection Boundary
- Limited Approach Boundary
- Restricted Approach Boundary
- Prohibited Approach Boundary



Arc Flash – Approach Boundaries

Why Are Approach Boundaries Important?

- They define who can work on the equipment and what Personal Protective Equipment (PPE) is required.
 - Only Authorized Maintenance Personnel
 - Gloves
 - Helmet
 - Eye Protection
 - Boots



Arc Flash – Approach Boundaries

**Approach Boundaries to Energized Electrical Conductors
or Circuit Parts for Shock Protection**
(All dimensions are distance from energized conductor or circuit part to employee.)

Nominal System Voltage Range, Phase to Phase	Limited Approach Boundary		Restricted Approach Boundary; Includes Inadvertent Movement Adder	Prohibited Approach Boundary
	Exposed Movable Conductor	Exposed Fixed Circuit Part		
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.05 m (10 ft. 0 in.)	1.07 m (3 ft. 6 in.)	Avoid contact	Avoid contact
301 to 750	3.05 m (10 ft. 0 in.)	1.07 m (3 ft. 6 in.)	304.8 mm (1 ft. 0 in.)	25.4 mm (0 ft. 1 in.)



Arc Flash

OSHA Requires The Following When Working On Live Electrical Equipment:

- Only Properly Trained Maintenance Workers
- Approach Boundaries Must Be Followed
- Proper PPE Must Be Worn



Arc Flash – Circuit Breaker vs. Fuses

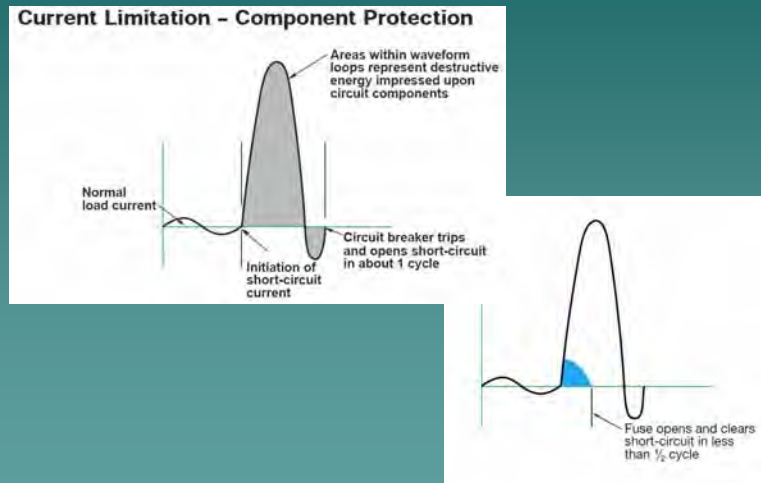
- Arc Flash and SCCR can be achieved by either Circuit Breakers or Fuses.
 - Circuit Breakers provide Type 1 protection.
 - Fuses provide Type 2 protection
- Type 1 protection allows considerable damage to contactor and overload relay, but damage contained within the panel with no danger to personnel. Replacement of components or a new starter may be needed.
- Type 2 protection does not allow any damage to the contactor or overload relay and no danger to personnel.



Arc Flash – Circuit Breaker vs. Fuses



Arc Flash – Circuit Breaker vs. Fuses



Arc Flash – Circuit Breaker vs. Fuses

- Panel should be equipped with low-peak dual-element fuses.
- Fuses interrupt large current surges that destroy equipment and cause an Arc Flash.
- Fuses accommodate current surges during motor startups.
- Fuses allow a higher SCCR rating for the control panels.
- Fuses allow the use of lower rated personal protection equipment



Arc Flash

How Does Arc Flash Affect You?

Site Owner Or Manager

- Install control panel equipment following the national electrical code and local regulations.
- Determine maximum potential electrical energy available to the control panel from the local power utility.
- Make Sure Control Panels Are Manufactured To UL Standards And Have The SCCR Rating Marked.
- Use Available Site Electrical Energy And Control Panel SCCR Rating To Determine Personal Protection Equipment (PPE) Required For Electrical Maintenance.



Arc Flash

How Does Arc Flash Affect You?

Site Owner Or Manager

- Prepare a Written Landfill Safety Program Addressing SCCR, Arc Flash Hazard, and PPE Policies.
- Implement Safety Training Program For All Affected Workers.
- Purchase, Provide, And Maintain The Required PPE.
- Document All Maintenance Activities.



Arc Flash

How Does Arc Flash Affect You?

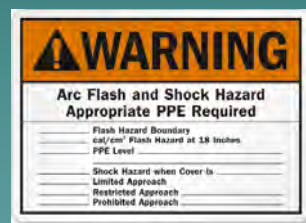
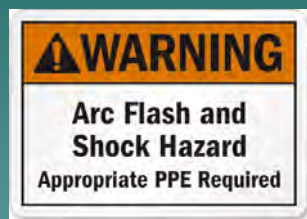
Electrical Maintenance Worker

- Understand Incoming Electrical Power Feed.
- Read And Understand Control Panel Labeling And Type Of PPE Required.
- Implement And Follow Safety Training Program.
- Understand How To Use And Maintain The Required PPE.
- Use Required PPE When Working on Control Panels.
- Document All Maintenance Activities.



Arc Flash

Sample Arc Flash Warning Labels



Arc Flash

References – Arc Flash, SCCR, And National Safety Standards

1. National Fire Protection Association – NFPA 70E Standard for Electrical Safety in the Workplace, 2012 Edition.
2. National Electrical Code – NEC, 2011 Edition.
3. Underwriters Laboratory – Industrial Control Panels.
4. National Fire Protection Association – NFPA 70E Standard for Electrical Safety in the Workplace, 2012 Edition, Approach Boundaries Table 1.30.2 And Arc Flash Protection Boundary Section 130.3.A.
5. National Fire Protection Association – NFPA 70E Standard for Electrical Safety in the Workplace, 2012 Edition, Limits of Approach Figure C.1.2.4, Annex C.
6. National fire protection association – NFPA 70e HANDBOOK for Electrical Safety in the Workplace, 2009 Edition, by e. William Buss, Mark W. Earley, and Ray A. Jones.



Grounding

Purpose

- Ensure Personnel Safety
- Protect Process Equipment
- Protect Data and Telecommunication Equipment
- Provide Low Level of Electrical Noise
- Act as a “Zero” Reference Point for Equipment and Instrumentation



Grounding

NEC Definition of a Ground

"A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth or some conducting body that serves in place of the earth."

Types of Grounds

- Earth Ground
- Equipment Ground



Grounding

Earth Grounds

- Protect from Super-imposed Voltages (Lightning & Power Surges)
- Prevent Build Up of Static Charges
- Establish a Zero Voltage Reference Point for Electronic and Communication Equipment



Grounding

Equipment Grounds

- Protect personnel from Electrocution
- Provide a Common Link to All Electrical Components

The Electrical Power Research Institute state that "better than 80% of all electronic failures that are attributed to power anomalies are actually the result of electrical wiring or grounding errors."



Grounding

NEC Section 250-51 says an Effective Grounding Path Shall:

- Be permanent and continuous.
- Have the capacity to safely conduct any fault current imposed on it.
- Have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of protective devices in the circuit.



Grounding

- NEC Requires 25 OHMs of Resistance or Less
- ISA Recommends 1 OHM of Resistance or Less
- The effective ground resistance needs to be as low as possible to quickly and safely dissipate the fault current.



Grounding

Several factors should be considered in the initial design of the grounding system.

- The area available for installation of the grounding system. This could lead to the requirement and utilization of chemical rods, or wells.
- Water table and seasonal changes to it.
- Soil resistivity is the key element in determining effectiveness. Moisture content, mineral content, soil type and contaminants are factors that determine resistivity.



Grounding

- Available fault currents (i.e., three (3) phase, line-to-ground, and line-to-line-to ground, etc.).
- NEC and ANSI/IEEE requirements of the process equipment to be installed.
- Consideration of the number of lightning strikes and thunder storm days per year.
- Utility ties and/or service entrance voltage levels.
- Utilization of area where ground system is to be installed, (i.e., do not install under paved parking lot).



Grounding

Ground Resistance Meter designed to test a system ground.

This meter measures the current traveling through the ground wire.

Think of it as a "super accurate" clamp-on meter measuring current (amps).



Grounding - Examples



Grounding - Examples



Good installation
except...

Ground placed in new
construction area.



Grounding – Case Study #1

A landfill in NE Pennsylvania had been experiencing a high failure of submersible level sensors in the leachate wells and load calls at the scale house.

This landfill site is on the side of a mountain and experiences a high number of electrical storms each year.

During a meeting with their design engineers, the suggestion was made to find a wet spot outside one of the cells, or use a monitoring well that was not needed and make it the ground point.

Several small piezometer wells were drilled, which became the ground points and gas condensate sumps for different cells.

The payback based on a reduction of sensors replaced was just over two years. If they would have added in up time of the gas plant, it would have been less than one year.



Grounding – Case Study #2

A landfill in Florida complained that they had not been getting correct flow meter rates and totals.

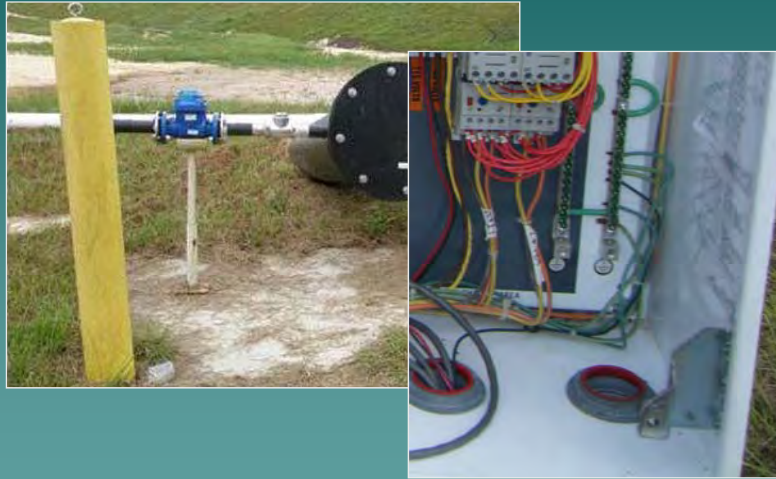
It was found that their flow meters, which had been installed in plastic pipe, did not have grounding rings installed.

The electrical contractor stated that the meters had a third grounding electrode within the flow tube.

Upon inspection, this was found not to be the case. There was no ground wire connection in the junction box. Grounding rings were added to the piping and were wired to the earth ground. No incorrect flow meter readings have been documented since.



Grounding – Case Study #2



Grounding – Case Study #3

A landfill in western United States complained that the pump would stop and after a period of time restart.

The pump was powered by a generator and controlled by a load monitor with a built-in timer.

Testing showed that the pump was not running dry, and the discharge line was not clogged.

The supply voltage was tested and was found to vary. There was no sound of surging in the generator and the speed was steady.



Grounding – Case Study #3

Upon closer inspection, it was found that the generator was not grounded to the earth and there was a loose connection for the motor lead at the junction box.

Because there was no system ground, the load monitor had no ground reference at the times it sensed that the circuit was under loaded and shut the pump off.



Summary

Arc Flash

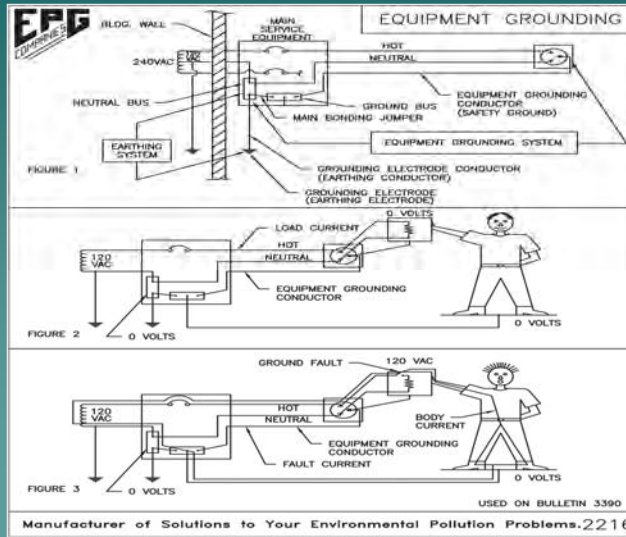
- Required to protect individuals working on electrical systems.
- Details the level of PPE for workers.
- Prepare a Written Landfill Safety Program Addressing SCCR, Arc Flash Hazard, and PPE Policies.
- UL Listed Panels with clearly marked SCCR ratings.

Grounding

- Required to protect individuals, equipment, and data.
- Ground resistance needs to be as low as possible to quickly and safely dissipate the fault current.



Summary



GOOD

BAD



Questions?

