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The Importance of Electrical Equipment Maintenance and CSA Z462 Workplace electrical safety Standard

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Overview

- With the development of the new CSA Z462 Workplace electrical safety Standard the electrical hazard of arc flash now has an identity and is being proactively quantified by industry by having engineering based Arc Flash Hazard Analysis completed based on IEEE 1584.
- Essential to minimizing the potential thermal energy released if an abnormal condition occurs on energized electrical equipment that could lead to an arcing fault and arc flash is detecting and clearing the fault as quickly as possible.
- Essential to ensuring detection and clearing times are optimized is the requirement for review and maintenance of electrical protection equipment.

Overview

- Electrical equipment maintenance although practiced has not been prioritized with a focus on minimizing the arc flash hazard.
- The CSA Z462 Workplace electrical safety Standard places emphasis on arc flash hazard analysis and relies on electrical protection equipment to operate to specifications.

Agenda

- The CSA Z462 Workplace electrical safety Standard
- The “Arc Flash Triangle”
- Arc flash, what is it?
  - Videos
- Engineering Arc Flash Hazard Analysis, IEEE 1584
- Fault detection and clearing time
- Role of electrical equipment maintenance in minimizing arc flash incident energy
  - CSA Z462 Annex B Safety-related electrical maintenance
- The future of electrical equipment maintenance, CSA Z463
- Concluding remarks

The CSA Z462 Workplace electrical safety Standard

- Published December 28, 2009.
- Over 10,000 copies sold in 2009 across Canada.
- Adaption/adoption of NFPA 70E-2009 Standard for Electrical Safety in the Workplace.
- Comprised of six (6) Clauses and supporting Annexes.
- Requires that Arc Flash & Shock Hazard Analysis be completed for energized electrical work. Energized electrical work must be justified.
- Identifies that electrical equipment maintenance is critical to ensuring the energy released by an arc flash is minimized. Annex B Safety-related electrical maintenance.

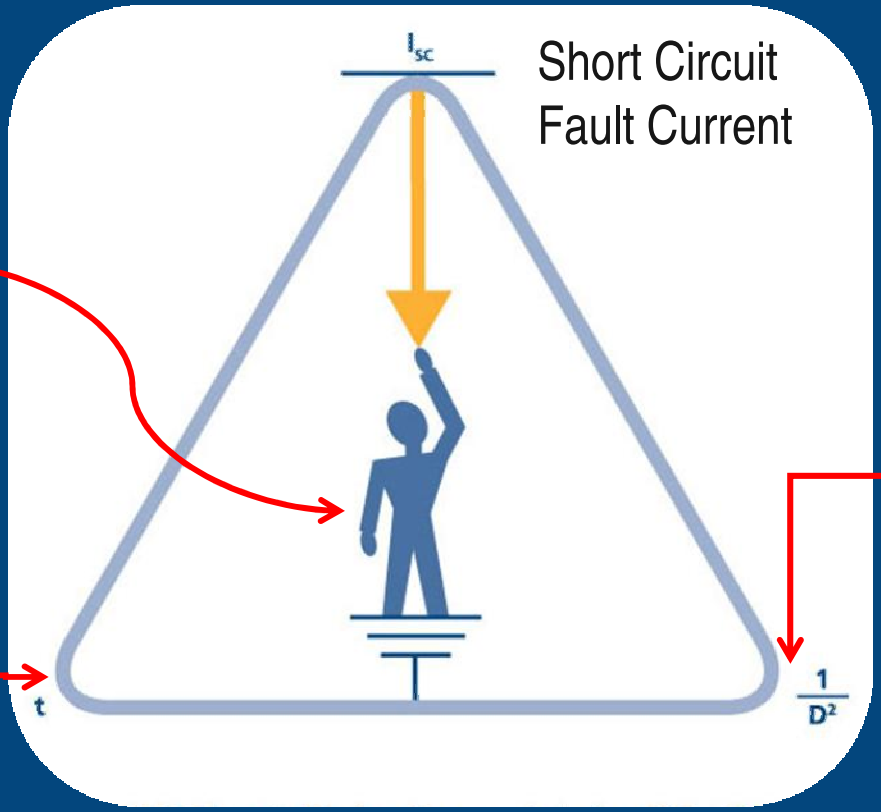
The CSA Z462 Workplace electrical safety Standard

- Two methods of Arc Flash Hazard Analysis:
  - Method 1 – Table Method, use Tables 4, 5, and 6 in Z462
  - Method 2 – Engineering based incident energy analysis
- Both methods rely on electrical equipment protection to operate as intended and to original specifications.
- Defines “Incident Energy” as “The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units used to measure incident energy is calories/cm^2.” At an exposure level of 1.2 calories/cm^2 a worker can have the onset of a second degree burn.

The "Arc Flash Triangle"

- The Arc Flash Triangle below emphasizes three critical components related to an arcing fault and resulting arc flash, available electrical fault current, clearing time and worker distance. Clearing time is critical.

Contact or proximity to exposed energized electrical conductors or circuit parts to ground



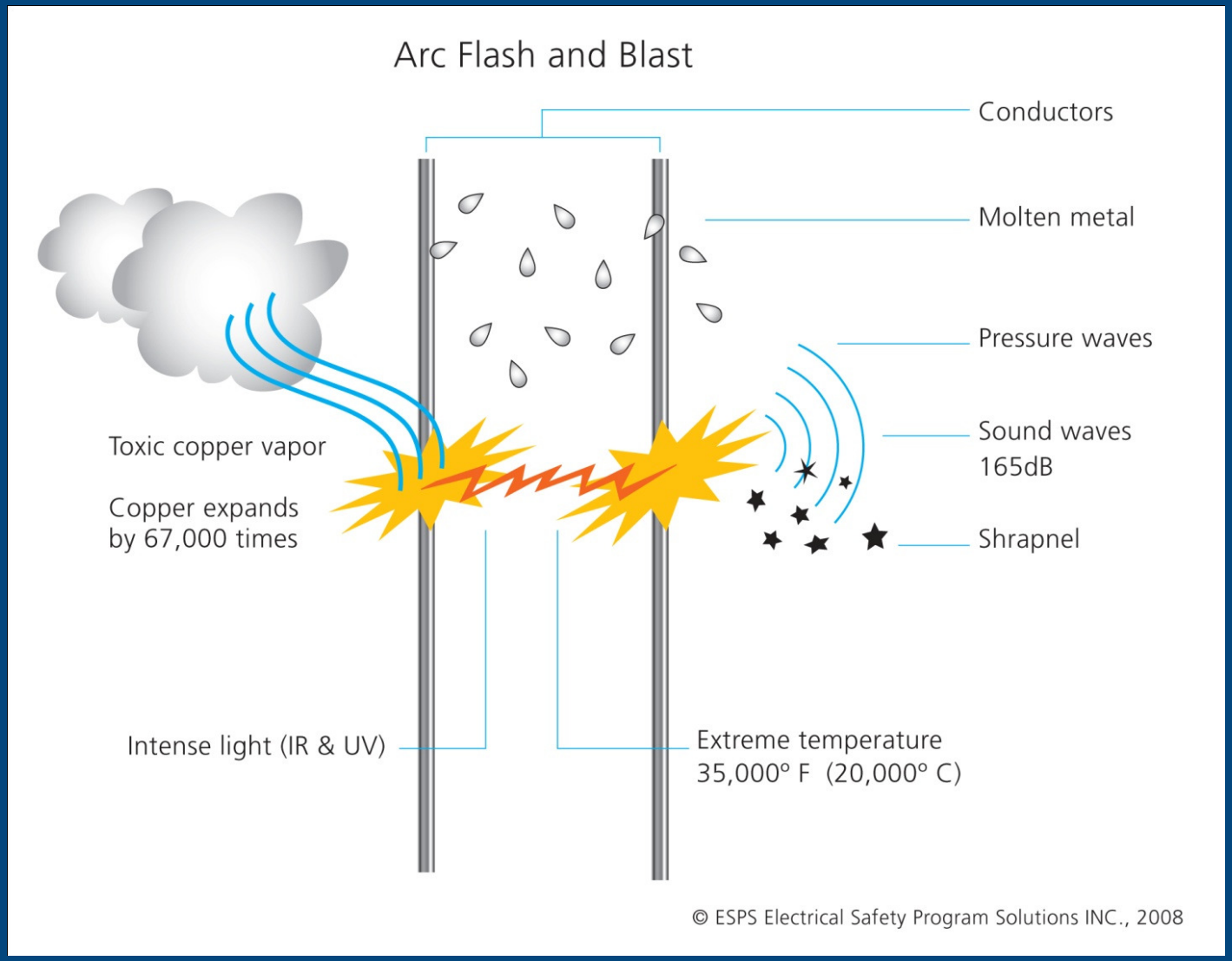
Distance the Worker is from the arcing fault and arc flash

Protective Device Clearing Time

Note: 1.2 cal/cm², 2nd Degree Burn

What is an Arc Flash?
Low Voltage Disconnect. Cotton Clothing.

What is an Arc Flash? Toxic!!



What is an Arc Flash? Food Processing Plant 13,800V SWGR.

Engineering based Arc Flash Hazard Analysis, IEEE 1584

- For most industrial installations, IEEE 1584-2002 provides formulas for calculating:
  - Incident energy at assumed working distance.
  - Arc Flash Protection Boundary, distance where worker can get onset of 2nd Degree burn or 1.2 calories/cm2 (5 joules/cm^2) of incident energy.
- Formula for incident energy, E, arcing time has major impact:
  - $E = 4.184\ C_f\ E_n\ (t\ /\ 0.2)\ (610^x\ /\ D^x)$
    - E = incident energy
    - C_f = calculation factor
    - E_n = incident energy, normalized
    - t = arcing time, seconds
    - D = distance from the arc to the person (assumed working distance)
    - X = distance exponent

Fault detection and clearing time of an arcing fault

- With respect to an arcing fault that leads to an arc flash clearing the arcing fault and ensuring the arc flash event is minimized is “critical” to minimizing incident energy.
- CSA Z462 Method 1 for Arc Flash Hazard Analysis using CSA Z462 Tables 4, 5, and 6 assumes that electrical protection operates to original specifications.
- CSA Z462 Method 2 for Arc Flash Hazard Analysis in most industrial facilities uses the IEEE 1584 formulas. These formulas assume that the electrical protection operates to original specifications.
- There are no factors for aging, operating environment impacts and lack of maintenance.

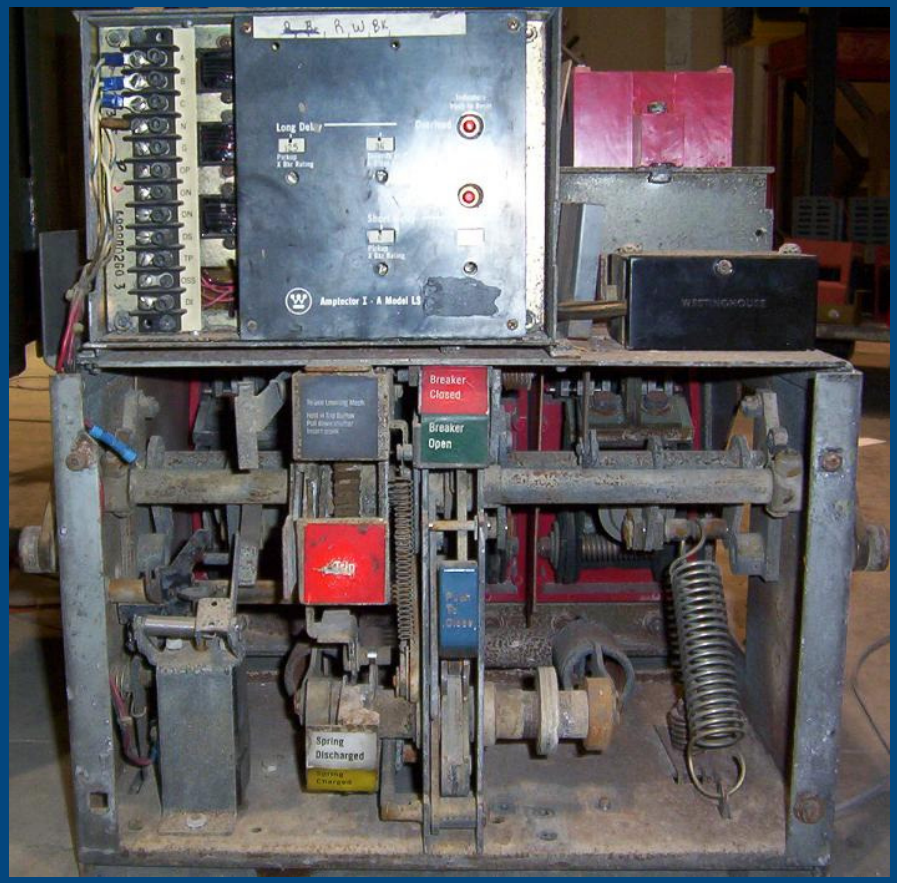
Role of electrical maintenance in minimizing arc flash incident energy

- CSA Z462, Annex B Safety-related electrical maintenance emphasizes the critical nature of electrical arcing fault clearing time.
- Also identifies that some statistics are available for service aged circuit breakers, 22% malfunctioned and 10.5% did not operate at all during maintenance testing.

B.1 General

Regularly scheduled electrical maintenance is a critical part of any electrical safety program. Improper equipment operation can drastically increase the risk of worker exposure to electrical hazards. Studies by the Electrical Safety Authority of Ontario indicate that 66% of safety incidents can be attributed to maintenance-related issues. A survey performed by the InterNational Electrical Testing Association (NETA) in October 2007 indicated that 22% of service-aged circuit breakers had some type of malfunction and 10.5% did not operate at all during maintenance testing.

Role of electrical maintenance in minimizing arc flash incident energy



- This breaker has not been adequately maintained.
- The environment it was operating in has compromised its integrity
- Lack of maintenance for this breaker has led to a condition where it would have a longer clearing time or may not operate at all.

Role of electrical maintenance in minimizing arc flash incident energy

- CSA Z462, Annex B Safety-related electrical maintenance emphasizes the critical nature of electrical arcing fault clearing time and provides a specific example.

B.2 Risk categories and the need for maintenance

Incident energy levels and associated risk categories depend on the operating times of protective devices such as fuses, relays, and circuit breakers. The hazard/risk category method of Table 4 requires careful attention to the clearance times specified in the notes to Table 4. A detailed arc flash hazard analysis method determines the arc flash protection boundary and incident energy based on the operating time of the existing circuit-protection devices.

Figure B.1 shows a typical power system time–current curve used in determining arc flash hazard levels. In Figure B.1, a circuit breaker instantaneous setting has been changed from 5X to 4X, reducing the operating time during an arc flash event from 1.5 to 0.04 s. This lowers the incident energy from 33.5 to 1.1 cal/cm^2 and reduces the hazard/risk category from 4 to 0. However, these curves are based on manufacturer's data for equipment in as-new condition. If the protective device's graph does not correspond with how the breaker actually performs in the field, a dangerous situation exists, as these devices are typically slower than indicated in the manufacturer's performance specifications.

In some cases the devices do not operate at all. Lengthening the operating time will vastly increase the incident energy values, arc flash boundaries, hazard risk categories, and PPE requirements. Operating times with relaying and circuit breakers can increase when regularly scheduled maintenance practices are not followed.

It is vitally important to this process to ensure that the entire system functions properly, including the current sensors, relays, and trip circuits. Ensuring that power fuses follow a replacement-in-kind procedure is also an important part of this maintenance process. Assuming that electrical power distribution equipment will operate as designed without verifying the operating condition can result in an unexpected increase in the level of hazard.

The future of electrical equipment maintenance CSA Z463

- Currently there is no specific guidance in Canada provided on electrical equipment maintenance (e.g. what maintenance is required and at what frequency).
- A new CSA Standard CSA Z463 has been proposed that should provide guidance on requirements for electrical equipment maintenance with a focus on electrical safety.
- A CSA Z463 Technical Committee is being constituted and this new Standard would be available by 2012 – 2013.
- Other Standards are available, NFPA 70B Recommended Practice for Electrical Equipment Maintenance.

Concluding Remarks

- It is clear that electrical equipment maintenance is critical to eliminating or minimizing the electrical hazard of arc flash.
- The impact of aging, operating environment and lack of maintenance will lead to a higher probability of an arc flash occurring in electrical equipment and higher incident energy release when an arc flash event occurs.
- Critical electrical equipment must be maintained in order to minimize arc flash incident energy.

Thanks!

- Thank you for your time!
- QUESTIONS?

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