OSHA & Arc Flash Hazard Analysis

Presented by
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OSHA & ARC FLASH HAZARD ANALYSIS

Impact of Revisions to the OSHA Electrical Safety Regulations

Presented by: John J. Kolak, MS, CSP
Introduction

• Important Definitions
• Understanding OSHA
  – Applicable standards
  – Integrating OSHA with Consensus standards
  – When to exceed minimum standards
• Overview of OSHA revisions…
• Next Steps…

You, before this webinar…

You, after this webinar…
Important Definitions

• **Voltage (Phase to Phase vs Phase to Ground)**
  – i.e. 120v/240v or 7,200v/12,470v
  – *This becomes important when using Arc Flash Hazard Analysis (AFHA) software!*

• **Fault Current or Short-Circuit Current**
  – *Bolted Fault Current vs Arcing Fault Current*

• **Incident Energy (cal/cm²)**

• **Arc Flash Hazard**

• **Flame Resistant vs Arc Rated**
UNDERSTANDING OSHA...
Why OSHA Was Created

1. The development and enforcement of Health and Safety standards
   • Consensus Standards
   • How CFR’s and Consensus Standards Relate...

2. Establishing both employer and employee responsibilities regarding safety
   ▪ General Duty Clause {section 5(a)(1)} of the OSHAct...

3. Establishing record keeping requirements
### OSHA Standards

**Utilization Standards**
- 29 CFR 1910.302 - .308 *Design Standards*
- 29 CFR 1910.331 - .399 *Safe Work Practices*
- 29 CFR 1926.400-.449 *Construction*

**Supply Standards**
- 29 CFR 1910.269 *Utility Maintenance, Std*
- 29 CFR 1926.950-.959 *Construction Industry T&D standards*

### Consensus Standards

**Utilization Standards**
- National Electrical Code (NFPA 70)
- NFPA 70E
- NFPA 70B

**Supply Standards**
- National Electrical Safety Code (ANSI C2)
OSHA Home Page...
Select “Regulations”...
Regulations Page...
The List of Standards Appears Here...

OSHA Law & Regulations

Welcome to OSHA's Law and Regulations page. This page contains links to all current OSHA standards, provides information on the rulemaking process used to develop workplace health and safety standards, and includes links to all Federal Register notices that are currently open for comment. This page also provides links to the Occupational Safety and Health Act of 1970 (OSHA Act) and other relevant laws. Finally, this page includes resources to explore the Federal Register, the Code of Federal Regulations, and RegInfo.gov - the federal government's public portal for all agency regulatory information.

Under the OSHA Act, employers are responsible for providing a safe and healthful workplace. OSHA's mission is to assure safe and healthful workplaces by setting and enforcing standards, and by providing training, outreach, education and assistance. Employers must comply with all applicable OSHA standards. Employers must also comply with the General Duty Clause of the OSHA Act, which requires employers to keep their workplace free of serious recognized hazards.

Find an OSHA standard:

- General Industry
- Construction
- Maritime
- Agriculture
- Recordkeeping
- State Plans
- All

1910 Full Table of Contents
Top 10 Viewed
Important Standards...

- 1910.147 - The control of hazardous energy (lockout/tagout).
- 1910.147 App A - Typical minimal lockout procedures

1910 Subpart S - Electrical
- 1910.301 - Introduction.
- 1910.302 - Electric utilization systems.
- 1910.303 - General.
- 1910.304 - Wiring design and protection.
- 1910.305 - Wiring methods, components, and equipment for general use.
- 1910.306 - Specific purpose equipment and installations.
- 1910.308 - Special systems.

- 1910.269 App C - Protection from Step and Touch Potentials.
OSHA & Arc Flash Safety…

• There have been no substantial changes to Subpart S related to Arc Flash Hazards (AFH)…

• The Utility Maintenance Standard (29 CFR 1910.269) included the most substantive changes…
  – 1910.269 (g)(8): Personal Protective Equipment (Fall Arrest systems)
  – 1910.269 (l): Work On Energized Parts
  – Appendix E: Protection From Flames & Electric Arcs

• The most significant changes relate to High Voltage (>600v) systems (this can be Supply OR Utilization systems)

• The changes to OSHA do not precisely align with some of the Consensus standards (i.e. 2.0 cal/cm² vs 1.2 cal/cm²)
1910.269(l)(8): Work On Energized Parts

- All PPE must also meet the requirements of Subpart I (1910.132)...
- 1910.269(l)(8): Employers must assess the workplace for arc hazards...
  - Identify tasks that expose workers to arc flash hazards
  - Estimate Incident Energy
- Ensure employees don’t wear clothing that will melt...
- The outermost layer must be FR at a minimum & Arc Rated (AR) if exposed to electrical arcs...
- Workers must wear AR clothing if exposed to >2 cal/cm²
- Hand protection not needed if wearing rubber gloves & arc exposures <14 cal/cm² (Let’s talk about what to do if > 14 cal/cm²)
- Head protection need not be AR if <5 cal/cm², 3-phase
- Foot protection need not be AR (if they are constructed of heavy leather) for any IE level
- The requirement to ensure employees exposed to arc hazards wear AR clothing commences in April 1, 2015
• Employer requirements:
  1. Assess flame & arc hazards
  2. Estimate IE exposures
  3. Ensure employees don’t wear clothing that will melt
  4. Ensure employees wear properly-rated FR or AR clothing

• Identify sources of flame & arc exposures
• Determine the Probability that an arc will occur
• READ THE FOOTNOTES to the Tables!
  • Things like “rubber glove approach distances or Live-Line work distances”
    don’t apply to most locations…
  • Single-phase vs Three-phase faults

• OSHA allows broad-estimates of IE exposures (be careful here…)
• Remember what an Arc Thermal Protective Rating (ATPV) rating means…
### Selecting An AF Calculation Method...

**TABLE 3: SELECTING A REASONABLE INCIDENT-ENERGY CALCULATION METHOD**

<table>
<thead>
<tr>
<th>Incident-energy calculation method</th>
<th>600 V and Less</th>
<th>601 V to 15 kV</th>
<th>More than 15 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1Φ</td>
<td>3Φa</td>
<td>3Φb</td>
</tr>
<tr>
<td>NFPA 70E-2012 Annex D (Lee equation) ...</td>
<td>Y-C</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Doughty, Neal, and Floyd .........................</td>
<td>Y-C</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>IEEE Std 1584b-2011 ...............................</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>ARCPRO .................................................</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

**Key:**

- **1Φ:** Single-phase arc in open air.
- **3Φa:** Three-phase arc in open air.
- **3Φb:** Three-phase arc in an enclosure (box).

- **Y:** Acceptable; produces a reasonable estimate of incident heat energy from this type of electric arc.
- **N:** Not acceptable; does not produce a reasonable estimate of incident heat energy from this type of electric arc.
- **Y-C:** Acceptable; produces a reasonable, but conservative, estimate of incident heat energy from this type of electric arc.
Arc Flash Calculation Methods on Low Voltage Systems...

Variable Fault Current for 480 volts in Air, 18" Work Distance
1.25" Arc Gap, 2.4 Cycle Clearing Time

Current in kA

Level 3
Level 2
Level 1
Level 0

Van Geem, N. & Blackley, W., 2005
Arc Flash Calculation Methods On High Voltage Systems

Variable Voltage 50 kA Arc, 18" Work Distance, Arc Gap Varied with Voltage as per IEEE 1584

Van Geem, N. & Blackley, W., 2005
## Flash Hazard Approach Distances

### Table 4: Selecting a Reasonable Distance from the Employee to the Electric Arc

<table>
<thead>
<tr>
<th>Class of Equipment</th>
<th>Single-phase arc mm (inches)</th>
<th>Three-phase arc mm (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable</td>
<td>&quot;NA&quot;</td>
<td>455 (18)</td>
</tr>
<tr>
<td>Low voltage MCCs and panelboards</td>
<td>NA</td>
<td>455 (18)</td>
</tr>
<tr>
<td>Low-voltage switchgear</td>
<td>NA</td>
<td>610 (24)</td>
</tr>
<tr>
<td>5-kV switchgear</td>
<td>NA</td>
<td>910 (36)</td>
</tr>
<tr>
<td>15-kV switchgear</td>
<td>NA</td>
<td>910 (36)</td>
</tr>
<tr>
<td>Single conductors in air (up to 46 kilovolts), work with rubber insulating gloves</td>
<td>380 (15)</td>
<td>NA</td>
</tr>
<tr>
<td>Single conductors in air, work with live-line tools and live-line barehand work</td>
<td><em>(MAD - (2 x kV x 2.54))</em></td>
<td><em>(MAD - (2 x kV/10))</em> t</td>
</tr>
</tbody>
</table>

**IMPORTANT:** IE can be calculated at different distances than listed in this table…
TABLE 6- INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES
ARCS IN OPEN AIR ONLY * † ‡ RUBBER INSULATING GLOVE EXPOSURES INVOLVING PHASE-TO-GROUND

<table>
<thead>
<tr>
<th>Voltage range (kV) **</th>
<th>Fault current (kA)</th>
<th>Maximum clearing time (cycles)</th>
<th>4 cal/cm²</th>
<th>5 cal/cm²</th>
<th>8 cal/cm²</th>
<th>12 cal/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 to 15.0 ..........</td>
<td>5</td>
<td>46</td>
<td>58</td>
<td>92</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>18</td>
<td>22</td>
<td>36</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>10</td>
<td>12</td>
<td>20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>6</td>
<td>8</td>
<td>13</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>28</td>
<td>34</td>
<td>55</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>15.1 to 25.0 ..........</td>
<td>10</td>
<td>11</td>
<td>14</td>
<td>23</td>
<td>34</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Convert cycles to seconds by dividing the “Clearing Time” cycles by 60
Next Steps For Those w/Supply Systems…

• Consult the National Electrical Safety Code as well as the NFPA 70E
• Carefully consider whether arcing faults will likely result in phase-to-phase or phase-to-ground faults. Then, ensure the software you use will accurately-evaluate that type of fault…
• High Voltage work requires the use of insulated sticks which results in greater Working Distances than listed in the 1910.269 tables…
• Know & understand the limitations of whichever type of Arc Flash Hazard Analysis software you use!
• EXCEED minimum standards when non-standard conditions exist!
Next Steps For Those w/Utilization Systems

• If you have High Voltage systems, follow the 1910.269 guidelines for those systems
• If you have “Utility type equipment” *, follow the 1910.269 guidelines
• KNOW the requirements of Supply AND Utilization systems & follow the most protective standard…
• Following the requirements in the NFPA 70E-2015 will usually result in the best protection…
• Know & understand the limitations of whichever type of Arc Flash Hazard Analysis software you use!
• EXCEED minimum standards when non-standard conditions exist!
Closing Thoughts...

• Remember that OSHA or Consensus standards are only MINIMUM requirements!
• Know ALL the standards that relate to your location & follow the most protective one…
• Become intimately-familiar with your arc flash software…
• Use AFHA to MITIGATE arc exposures, not just to select AR PPE!
Questions?