IMPLEMENTING THE NEW ELECTRICAL SAFETY REQUIREMENTS

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BACKGROUND

► Update to 29CFR1910 Subpart S Electrical Safety Standards
► First update since 1981
► Reliance on NFPA 70E, STANDARD FOR ELECTRICAL SAFETY REQUIREMENTS FOR EMPLOYEE WORKPLACES
NFPA 70E

Standard for Electrical Safety in the Workplace

2004 Edition
BACKGROUND

Areas to be addressed

- Electrical Installations
- Work Practices for working on live equipment
- Safety Related Maintenance Requirements
PRESENTATION OBJECTIVES

► Understand the revised electrical safety requirements and how they will impact the management and engineering control of electrical hazards in general industry.
PRESENTATION OBJECTIVES

► Describe the components of the revised Subpart S Electrical Safety Standard and illustrate the similarities and differences between the existing and new regulation.
Apply the revised requirements in the industrial setting.
PRESENTATION FORMAT

- Requirements Applying to both existing and new regulation.
- Additional requirements per NFPA 70E
- How companies are complying.
SAFETY REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
ELECTRICAL INSTALLATIONS

► General Requirements
  ▪ OSHA
    ► General Industry 1910.302-1910.308
    ► Construction 1926.402-1926.408
  ▪ NFPA:
    ► NFPA 70E, Chapter 4, Articles 400-450
ELECTRICAL INSTALLATIONS

► General Requirements
  ▪ OSHA & NFPA (similarities)
    ► Electrical Insulation
    ► Heating
    ► Arcing
    ► Marking
MARKING & IDENTIFICATION

Markings required by OSHA
Electrical Panel

- PNL Designation
- Circuit Breaker Identification
- Circuit Breaker Numbers
Marking of Wires

- Number of insulated wires
- Cable type (nonmetallic)
- Maximum voltage rating (600 volts)
- Wire gauge
ELECTRICAL INSTALLATIONS

► General Requirements
  ▪ OSHA & NFPA (Similarities)
    ► Workspace
      ▪ Requirements for ≤ 600 Volts
      ▪ Requirements for >600 Volts
Workspace about low voltage equipment

- Energized Parts
- Non-Energized Parts

Workspace about low voltage equipment

Guard (wood or plasterboard)
Workspace about low voltage equipment
Workspace-600 V
Workspace about high voltage equipment

- Energized Parts 6' Non-Energized Parts
  25,001 Volts-75kV

- Energized Parts 8' Non-Energized Parts
  >75 kV
Workspace-26 kV
## Elevation of Unguarded Energized Parts Above Workspace

<table>
<thead>
<tr>
<th>Nominal Voltage</th>
<th>Minimum Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>601-7500</td>
<td>8’ 6”</td>
</tr>
<tr>
<td>7501-35,000</td>
<td>9’</td>
</tr>
<tr>
<td>&gt;35 kV</td>
<td>9’+0.37”/kV above 35 kV</td>
</tr>
</tbody>
</table>
ELECTRICAL INSTALLATIONS

- General Requirements
  - OSHA & NFPA (Differences)
    - NFPA
  - Requirements for Interrupting Rating
    - Requirements for Circuit Impedance
ELECTRICAL INSTALLATIONS

- **Impedance**
  - **Impede**: to slow the movement.
  - Grounding conductor must have low impedance to trip a circuit or fuse.
Impedance Equations

\[ Z = R_{\text{Hot}} + R_{\text{Ground}} \]

Where: 
- \( Z \) is Impedance (Ohms)
- \( R_{\text{Hot}} \) is Resistance of Ungrounded Conductor (Ohms)
- \( R_{\text{Ground}} \) is Resistance of Grounding Conductor (Ohms)
Impedance Equations

\[ I = \frac{V}{Z} \]

Where: Z is Impedance (Ohms)
V is Voltage of System
I is Current (Amps)
A 120 V outlet has been rated at 0.25 ohm over the hot conductor but 5.75 ohm over the grounding conductor. A 30 amp circuit breaker has been installed on the circuit. Will the circuit breaker trip if it detects a problem?
Example 1 (Answer)

\[
Z = 6 \text{ Ohm} \\
I = 20 \text{ amps}
\]

Will the circuit breaker trip if it detects a problem?

NO! 20 amps < 30 amps, therefore the circuit breaker will NOT trip.
ELECTRICAL INSTALLATIONS

- Wiring protection & design
  - OSHA & NFPA (Similarities)
    - Identification of conductors
    - Polarity of connections
    - Grounding Methods
      - System
      - Equipment
Ungrounded Conductor

Grounded Conductor

Grounding Conductor
Equipment Grounding Conductor
ELECTRICAL INSTALLATIONS

► Wiring Protection & Design
  ▪ OSHA & NFPA (Differences)
    ► NFPA
      ▪ GFCI protection for personnel in
        ► Bathrooms
        ► Rooftops
        ► Kitchens
GFCI
ELECTRICAL INSTALLATIONS

- Wiring Protection & Design
- OSHA & NFPA (Differences)
  - NFPA
  - Outlet devices shall not have an ampere rating less than the load to be services.
Example 2

A receptacle is rated at 20 amperes. The circuit is rated at 15 amperes. Are we in compliance with the requirements for outlet devices?

No
ELECTRICAL INSTALLATIONS

► Hazardous Locations
  ▪ OSHA & NFPA (Similarities)
    ► Class I-Flammable Liquids
    ► Class II-Combustible Dusts
    ► Class III-Combustible Fibers
ELECTRICAL INSTALLATIONS

Hazardous Locations

- OSHA & NFPA (Similarities)
  - Division 1-Conditions will be present
  - Division 2-Conditions may be present
Class I, Division 1
Example 3

What is the Proper Classification for a storage room, which will contain closed drums of chemical product containing Acetone and Isopropyl Alcohol (OSHA Classification)?
Example 3 (Answer)

Class: I
Division: 2
ELECTRICAL INSTALLATIONS

- Hazardous Locations
  - OSHA & NFPA (Differences)
    - NFPA now reclassified Class I divisions into “zones”
ELECTRICAL INSTALLATIONS

▶ Class I, Zone O

- Ignitable concentrations of flammable gases and vapors are present continuously

- Examples:
  - Tanks which contain flammable liquids
  - Spraying or coating enclosures
  - Open vessels containing flammable liquids
Class I, Zone 0 (inside tank)
ELECTRICAL INSTALLATIONS

► Class I, Zone 1

- Ignitable concentrations of flammable gases and vapors are likely to be present under normal operating conditions
- May exist because of repair or maintenance or because of leakage
- Locations adjacent to Class I, Zone 0
ELECTRICAL INSTALLATIONS

► Class I, Zone 1

- Examples:
  - Areas where flammable liquids are transferred from one container to another
  - Adequately vented drying rooms
Class I, Zone 1 (outside tank)
ELECTRICAL INSTALLATIONS

Class I, Zone 2

- Ignitable concentrations of flammable gases and vapors are NOT likely to be present under normal operating conditions
- Flammable liquids are normally confined to closed containers
- Locations adjacent to Class I, Zone 1 locations
ELECTRICAL INSTALLATIONS

► Class I, Zone 2

Examples:

► Flammable liquids or flammable gases are used, but would become hazardous only in the event of an accident or unusual operating condition
Example 4

What is the Proper Classification for a storage room, which will contain closed drums of chemical product containing Acetone and Isopropyl Alcohol (NFPA Classification)?
Example 4 (Answer)

Class: I

Zone: 2
ELECTRICAL INSTALLATIONS

 ► Hazardous Locations
   ▪ OSHA & NFPA (Differences)
   ► Equipment Operating Temperature Requirements for Class I equipment
Temperature Classification of Class I Equipment

<table>
<thead>
<tr>
<th>Temperature Class</th>
<th>Max. Surface Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>≤450 °C</td>
</tr>
<tr>
<td>T2</td>
<td>≤300 °C</td>
</tr>
<tr>
<td>T3</td>
<td>≤200 °C</td>
</tr>
<tr>
<td>T4</td>
<td>≤135 °C</td>
</tr>
<tr>
<td>T5</td>
<td>≤100 °C</td>
</tr>
<tr>
<td>T6</td>
<td>≤85 °C</td>
</tr>
</tbody>
</table>
# Electrical Installations
## NFPA vs. OSHA

<table>
<thead>
<tr>
<th></th>
<th>OSHA</th>
<th>NFPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>1910.301-308</td>
<td>NFPA 70E, Chapter 4</td>
</tr>
<tr>
<td>Markings &amp; Identification</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Workspace</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Impedance requirements</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Polarity &amp; Grounding</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>GFCI for restrooms &amp; rooftops</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Hazardous Locations</td>
<td>Class I “Divisions”</td>
<td>Class I “Zones”</td>
</tr>
</tbody>
</table>

52
What companies are doing for compliance (Electrical Installations)

► Ensure equipment installation complies with NFPA 70E
► Ensure equipment modification complies with NFPA 70E
SAFE WORK PRACTICES
SAFETY RELATED WORK PRACTICES

► General Requirements
  ▪ OSHA
    ► General Industry 1910.331-1910.360
    ► Construction 1926.415-1926.417
  ▪ NFPA:
    ► NFPA 70E, Chapter 1, Articles 100-130
SAFETY RELATED WORK PRACTICES

► Working on or near energized electrical parts
  ▪ OSHA & NFPA (similarities)

► Employees may work with on live energized electrical equipment IF it meets the following criteria:
Increased or additional hazards include interruption of life support equipment, deactivation of emergency alarms, shutdown of hazardous location ventilation systems, or removal of illumination for an area.
Because of infeasibility due to equipment design or operational limitations including testing of electrical circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous industrial process that would otherwise need to be completely shut down in order to permit work on one piece of equipment.
WORKING ON LIVE PARTS
(OSHA & NFPA)

- Employer can demonstrate the de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.
SAFETY RELATED WORK PRACTICES

- Working on or near energized electrical parts
  - OSHA & NFPA (similarities)
- Qualified Person: ones familiar with the construction and operation of the equipment and hazards involved
SAFETY RELATED WORK PRACTICES

► Working on or near energized electrical parts
  ▪ OSHA & NFPA (similarities)

► Qualified Persons shall be trained in the following:
QUALIFIED PERSON TRAINING

- The skill necessary to distinguish exposed energized parts from other parts of electrical equipment
- The skills necessary to determine the nominal voltage of exposed energized parts
- Approach distances
- Personnel Protection
What companies are doing for compliance (Training)

► Classroom training on specific requirements of the standard
  ▪ Personnel protection
  ▪ Flash protection boundaries

► On the job training specific to job duties
SAFETY RELATED WORK PRACTICES

►► Working on or near energized electrical parts
  ▪ OSHA & NFPA (Differences)
►► Approach Boundaries
  ▪ OSHA Applies to when qualified persons are working in the vicinity of overhead lines
  ▪ NFPA applies to all work on live parts
  ▪ Employer must perform a Flash Hazard Analysis
APPRAOCH BOUNDARIES
## Approach Limits

<table>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50 V to 300 V</td>
<td>3.5 ft</td>
<td>3.5 ft</td>
<td>Avoid Contact</td>
<td>Avoid Contact</td>
</tr>
<tr>
<td>301 to 750 V</td>
<td>3.5 ft</td>
<td>3.5 ft</td>
<td>1 ft</td>
<td>1 in</td>
</tr>
<tr>
<td>751 to 15 kV</td>
<td>5 ft</td>
<td>5 ft</td>
<td>2 ft 2 in</td>
<td>7 in</td>
</tr>
<tr>
<td>15.1 kV to 36 kV</td>
<td>6 ft</td>
<td>6 ft</td>
<td>2 ft 7 in</td>
<td>10 in</td>
</tr>
<tr>
<td>36.1 kV to 46 kV</td>
<td>8 ft</td>
<td>8 ft</td>
<td>2 ft 9 in</td>
<td>1 ft 5 in</td>
</tr>
</tbody>
</table>
Flash Hazard Alerting

WARNING

Arc Flash Hazard.
Appropriate PPE Required.
Failure To Comply Can Result in Death or Injury.
Refer to NFPA 70 E.

Thomas & Betts Catalog No. LB94913

New for 2002 NEC Article 110.16 Flash Protection
Switchboards, panelboards, industrial control panels and motor control centers that are subject to servicing or maintenance while energized, shall be field marked to warn of potential arc flash hazards. OSHA recognizes all NEC standards. Refer to NFPA 70 E.

Order Thomas & Betts P/N LB94913
Flash Hazard Alerting

WARNING

Flash and Shock Hazard
Proper PPE Required

Available Fault Current: 53,792 Amps - Sym.
Flash Protection Boundary: 74"
Cal/cm² Flash Hazard at 18": 20 Cal/cm²
Minimum PPE Required: Level 3 PPE
Shock Hazard Present: 480Y/277 Volts
(With covers removed)
Limited Approach Boundary: 42"
(For Shock Protection)
Restricted Approach Boundary: 12" - Class 0 Gloves
Prohibited Approach Boundary: 1" - Class 0 Gloves

Level 3 PPE
100% Cotton Under Garments (including Crew Neck Tee Shirt)
FR Long Sleeve Shirt - ATPV 6.0
FR Long Pants - ATPV 6.0
and
6.5 oz. Nomex III Coveralls
Safety Glasses with Side Shields (Nonmetallic Frame)
16 Calorie Flash Hood
Electrically-rated Hard Hat
Hearing Protection
Electrically-rated Safety Shoes
Leather Protectors over Rubber Gloves

Copyright 2002 TMK and Associates, Inc.
Power Distribution Panel DS-1
Example 5

What is the flash protection boundary requirement when working on a live 120 V system?
Example 5 (Answer)

3.5 feet
What companies are doing for compliance (Flash Protection Boundaries)

- Set-up flash protection boundaries based on the equipment nominal voltage
- Place flash protection boundary requirements in written program and equipment specific procedures
- Enforce flash protection boundary requirements
What companies are doing for compliance (Flash Protection Boundaries)

Flash Protection Boundary: __________
Limited Approach Boundary: __________
Restricted Approach Boundary: __________
Prohibited Approach Boundary: __________
PPE Hazard Level: ________
SAFETY RELATED WORK PRACTICES

- Working on or near energized electrical parts
  - OSHA & NFPA (Similarities)
- Personnel Protection
  - OSHA refers to Subpart I requirements which refer to ANSI & ASTM standards
  - NFPA also refers to applicable ANSI & ASTM standards
Voltage Protection Gloves
Lineman Sleeves
Voltage Rated Tools
Personal Protective Equipment

► OSHA & NFPA (Differences)
  - NFPA gives direction according to risk hazard categories
  - Risk Hazard Categories for protective apparel is dependant on the arc thermal protection value of the garment
    - HRC 0 - ATPV = N/A
    - HRC 1 - ATPV = 5 cal/cm2
    - HRC 2 - ATPV = 8 cal/cm2
HAZARD RISK CATEGORY CLASSIFICATIONS

Hazard Risk Category Classifications: Panelboards Rated 240 V and below

<table>
<thead>
<tr>
<th>Task (assumes equipment is energized &amp; work is being done within the flash protection boundary)</th>
<th>Hazard/Risk Category</th>
<th>V-Rated Glove</th>
<th>V-Rated Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove/Install CBs or fused switches</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Removal of bolted covers (to exposed bare, energized parts)</td>
<td>1</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>
# Protective Clothing & Equipment

<table>
<thead>
<tr>
<th>Hazard/Risk Category Number</th>
<th>Protective Systems for Hazard/Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

## Natural Fiber

- T-Shirt (short sleeve)
- Shirt (long sleeve)
- Pants (long)
Example 6

A qualified person will perform install circuit breakers on a 208 Volt panel board?

1. What is the Hazard/Risk Category?
2. One type of protective clothing needed?
3. Are V-rated gloves needed?
4. Are V-rated tools needed?
Example 6 (Answer)

1. What is the Hazard/Risk Category? 1

2. One type of protective clothing needed? 
   Natural Fiber Long Pants ATPV = 5 cal/cm²

3. Are V-rated gloves needed? Yes

4. Are V-rated tools needed? Yes
What companies are doing for compliance (PPE)

► Perform risk hazard analysis according to NFPA standards
► Place PPE requirements in written program and equipment specific procedures
► Enforce use of PPE when entering flash protection boundary
OSHA & NFPA (Differences)

- NFPA 70E Electrical Safety Program

- The employer shall implement an overall electrical safety program that directs activity appropriate for voltage, energy level, and circuits.

- Establish Energized Electrical Work Permit System
ELECTRICAL SAFETY PROGRAM

▶ Components
  - Maintenance of Electrical Hazards
  - Control of Electrical Hazards
  - Procedures
ELECTRICAL SAFETY PROGRAM

► Maintenance of Electrical Hazards
  ▪ Methods of inspection
  ▪ Maintenance of electrical system integrity
  ▪ Assessment of employees ability to perform work
ELECTRICAL SAFETY PROGRAM

Control of Electrical Hazards

- Training
- Identification of tasks to be performed on or near energized parts
- Use and identification of precautions appropriate for environment
ELECTRICAL SAFETY PROGRAM

► Procedures
  - Approach limits
  - PPE to be used
  - Insulating tools and equipment to be used
What companies are doing for compliance (Written Program & Procedures)

► Equipment specific procedures
► Establish energized electrical work permit program
► Establish Energized Electrical Work Permit System
**ENERGIZED ELECTRICAL WORK PERMIT**

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Date:</th>
<th>Work to be performed:</th>
<th>Electrical PNL #</th>
</tr>
</thead>
</table>

Qualified Persons Involved: 1. _______________________________________________________
2. _______________________________________________________
3. _______________________________________________________
4. _______________________________________________________

<table>
<thead>
<tr>
<th>a. Purpose of task</th>
<th>b. Qualification and number of employees involved.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flash Protection Boundary: __________</td>
</tr>
<tr>
<td></td>
<td>Limited Approach Boundary: __________</td>
</tr>
<tr>
<td></td>
<td>Restricted Approach Boundary: __________</td>
</tr>
<tr>
<td></td>
<td>Prohibited Approach Boundary: __________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c. Approach limits.</th>
<th>d. Other safe work practices, which will be used.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Qualified Person Minimum Working Distances</td>
<td>PPE Hazard Level: 0 1 2 3 4</td>
</tr>
<tr>
<td>2. Flash Protection Boundaries</td>
<td>Voltage Rated Gloves: 00 0 1 2 3 4</td>
</tr>
<tr>
<td></td>
<td>Voltage Rated Tools: Y N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>e. PPE to be used.</th>
<th>f. Insulating materials/tools to be used.</th>
</tr>
</thead>
</table>

| g. Electrical diagrams. | |
|-------------------------| |
## Safety Related Work Practices
### NFPA vs. OSHA

<table>
<thead>
<tr>
<th>Reference</th>
<th>OSHA</th>
<th>NFPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>1910.331-360</td>
<td>NFPA 70E Chapter 4</td>
</tr>
<tr>
<td>Working on Live Parts</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Qualified Person/Training</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Approach Boundaries ALL work</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Personal Protective Equipment</td>
<td>Refers Subpart I</td>
<td>Risk Hazard According to Voltage</td>
</tr>
<tr>
<td>Electrical Safety Program</td>
<td></td>
<td>√</td>
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<tr>
<td>Energized Electrical Work Permit</td>
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