



**Electrical Safety
Awareness Training**

**CFR 1910.301
NFPA 70E**

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Training Objectives

- Responsibilities
- Qualified Personnel
- Unqualified Personnel
- General Work Practices
- Energized Exposed Parts
- Effects on the Human Body
- Electrical Hazard Protections
- NFPA 70E – Approach Boundaries
- Safe work Practices
- Electrical Work Process Diagram
- Control Measures
- Monitor and Review
- Safe Limits of Approach Boundary Diagram
- Approach Boundary Procedures
- Summary

Responsibilities

- **Supervisor:**

- Review project carefully with your workers, unless they are routine assignments
- Emphasize safety practices and check employee's work practices to ensure compliance
- Train workers on area-specific policies & procedures
- Check the final product to ensure that no deficiencies exist
- Provide the appropriate disciplinary measures for poor electrical safety practices.

Responsibilities Cont.

- **Employee:**

- Review each project carefully with your supervisor
- Become thoroughly familiar with your assignments
- Only perform work in which you are trained
- If at all in doubt, ask questions
- Have your supervisor review your completed project
- Follow your supervisor's instructions

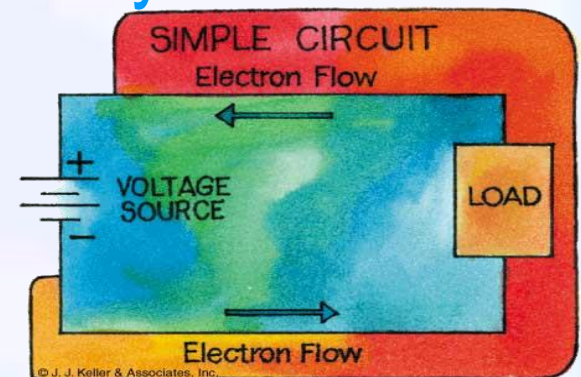
Responsibilities Cont.

- **Employee Cont.**

- Follow safe work practices
- Make sure lines are de-energized before your work on them
- Wear any required PPE
- Alert your co-workers to any unsafe work practices
- Report all problems to your supervisor
- Know what to do in the event of an emergency

Qualified Personnel

- Has specialized training to avoid electrical hazards when working on/near exposed energized parts
- Has skills and techniques necessary to distinguish exposed live parts from other parts of electrical equipment
- Has skills and techniques necessary to determine normal voltage of exposed live parts



Qualified Personnel Cont.

- Has knowledge, skills, and techniques to work safely around energized circuits
- Knows and applies safe work practices when working with electrical
- Has knowledge of proper use of personal protective equipment and insulated tools

Unqualified Personnel

- Has no training or with little in avoiding the electrical hazards that may be encountered while working on/near exposed energized parts.
- Do not permitted to work on or near exposed or potentially exposed electrical contacts.
- Can not recognize or differentiate energized and de-energized electrical contacts.
- Has general knowledge of electrical safety to aid in recognition of potentially unsafe conditions.

Electrical Hazards

- Electricity is easy to use and convenient, but it must also be remembered that electricity can be very **DANGEROUS**.
- Electrical accidents appear to be caused by a combination of three possible factors:
 - Unsafe equipment and/or installation.
 - Workplace made unsafe by the environment.
 - Unsafe work practices.



Electrical Hazards Cont.

- **SHOCK** - Occurs when the human body becomes part of the path through which current flows.
 - The **direct result** can be electrocution.
 - The **indirect result** can be injury resulting from a fall or movement into machinery because of a shock
- **BURNS** - Can result when a person touches electrical wiring or equipment that is energized.

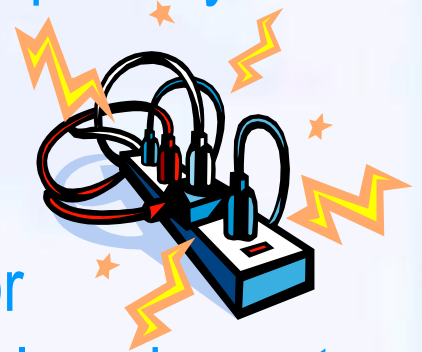
Electrical Hazards Cont.

- **Fires**

- Electricity is one of the most common causes of fire both in the home and workplace. Defective or misused equipment is a major cause, with high resistance connection being one of the primary sources of ignition.

- **Explosions**

- Electricity can cause electrical burns or electrocution, and overheated electrical equipment can cause fires. Also electrical sparks can cause explosions.



Electrical Hazards Cont.

- **ARC-BLASTS** - Occur from high-amperage currents arcing through the air. This can be caused by accidental contact with energized components or equipment failure. Three primary hazards associated with an arc-blast are:
 - Thermal radiation
 - Pressure Wave
 - Projectiles

General Work Practices

- Turn on a circuit breaker or disconnect, place hand on device, stand to the side, turn/flip switch
- Use of metal ladders near exposed electrical devices is prohibited
- Remove all metal jewelry such as watch, ring, necklace, etc. prior to work on or near exposed electrical.
- Work with one hand wherever possible (one hand behind back to prevent path to ground)



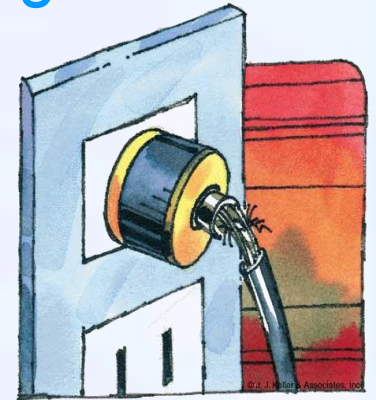


General Work Practices Cont.

- Do NOT touch anything electrical while standing in a wet area or with wet hands.
- Do NOT reach blindly into an area that could contain exposed electrical conductors.
- Do NOT overload specified circuit ratings.
- Do NOT use electrical equipment while touching metal or other conductors.
- Do NOT allow combustible or flammable materials near exposed energized electrical components.

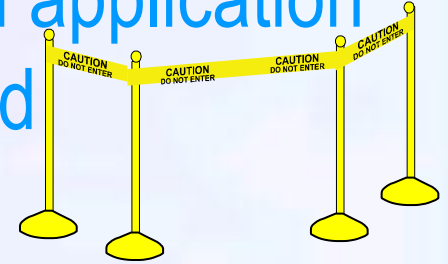
General Work Practices Cont.

- Never remove the third prong from plugs
- Use insulated tools properly
- Never string electrical cords together
- Keep all areas dry when working
- Make sure cords & ground conductors are in good condition
- Always use surge protectors
- Never pull the plug out by the cord



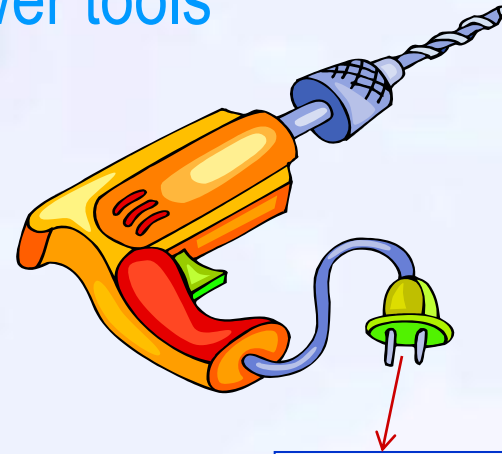
General Work Practices Cont.

- Use only 3-pronged plugs with cord application
- Follow approach distances specified
- Obey all warning signs
- Barricades (plastic yellow chains or caution tape) will be used to prevent access to areas with exposed energized electrical
- GFCI protection is **REQUIRED** to be used when using hand/portable power tools
- Insulated tools are **required** to be used when working on voltage exceeding 50 volts and will be provided by the immediate supervisor



General Work Practices Cont.

- Ground Fault Circuit Interrupters (GFCI) must be used in the following circumstances
 - Hand-held electric power tools
 - Extension cords
 - Temporary lighting
 - Damp or wet areas
 - Outside any building
 - Portable Power Generators
- Test the GFCI prior to use



Ground prong missing on three-prong plugs. Some tools are double insulated and won't have a ground prong. That's OK.

Energized Exposed Parts

- **Exposed parts**

- They are de-energized, but not locked/tagged are considered energized, exposed parts

- **Live or energized parts**

- If exposed live parts are not de-energized, other safety related work practices shall be used

- **De-energized parts**

- Live parts which an employee may be exposed shall be de-energized before an employee works on or near them

Effects on the Human Body

- 1.5 milliamps
 - Tingle, Slight shock
- 5 – 10 milliamps
 - Shock, inability to let go
- 10 – 50 milliamps
 - Painful, serious shock, respiratory difficulty
- Over 50 milliamps
 - Possible fatal, loss of muscle control, loss of breathing and heart functions

Electrical Hazard Protections

- **Personal Protective Equipment**

- Use, store and maintain your electrical PPE in a safe, reliable condition.
- Wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts.
- Wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.

Electrical Hazard Protections

- There are various ways of protecting people from the hazards caused by electricity.

These include:

- Insulation
- Guarding
- Grounding
- Electrical protective devices
- Safe work practices

Electrical Hazard Protections Cont.

- **Insulation**

- Conductors should be covered with some type of insulation. Insulators are any materials with high resistance that include:
 - **Glass, rubber, and plastic.**

Electrical Hazard Protections Cont.

- **Guarding**

- Live parts operating at 50 volts or more must be guarded against accident contact.
- A type of isolation that uses various structures to close off live electrical parts.
- These structures include:
 - Boxes
 - Screens
 - Covers
 - Partitions



Electrical Hazard Protections Cont.

- **Grounding**

- Effective grounding means the path to ground:

- Is permanent and continuous
 - Has ample current carrying capacity to conduct safely any currents to be imposed on it

Electrical Hazard Protections Cont.

- Electrical protective devices
- Foot protection
 - Footwear will be marked “EH” if it’s approved for electrical work.
 - EH = Electrical Hazard
 - Footwear must be kept dry, even if it is marked “EH”



Electrical Hazard Protections Cont.

- **Head protection**

- Hard hat (insulated - nonconductive)
- Class B & E.
- Always wear your hat with the bill forward.
- Do not store anything in the top of your hat while wearing it.



Electrical Hazard Protections Cont.

- **Hand protection**

- Rubber insulating gloves.
- Classified by the level of voltage and protection they provide.
- Should always be worn over rubber insulating gloves to provide the mechanical protection needed against cuts, abrasions, and punctures.



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NFPA 70E – Approach Boundaries

NFPA 70E Table 130.2(C) - Approach Boundaries to Live Parts for Shock Protection
 (All dimensions are distance from live parts to employee)

(1)	(2)	(3)	(4)	(5)
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		
0 to 50	Not Specified	Not Specified	Not Specified	Not Specified
51 to 300	10 ft 0 in.	3 ft 6 in.	Avoid contact	Avoid contact
301 to 750	10 ft 0 in.	3 ft 6 in.	1 ft 0 in.	0 ft 1 in.
751 to 15 kV	10 ft 0 in.	5 ft 0 in.	2 ft 2 in.	0 ft 7 in.
15.1kV to 36kV	10 ft 0 in.	6 ft 0 in.	2 ft 7 in.	0 ft 10 in.
36.1kV to 46 kV	10 ft 0 in.	8 ft 0 in.	2 ft 9 in.	1 ft 5 in.
46.1kV to 72.5kV	10 ft 0 in.	8 ft 0 in.	3 ft 3 in.	2 ft 1 in.
72.6kV to 121kV	10 ft 8 in.	8 ft 0 in.	3 ft 5 in.	2 ft 8 in.
138kV to 145kV	11 ft 0 in.	10 ft 0 in.	3 ft 7 in.	3 ft 1 in.
161kV to 169kV	11 ft 8 in.	11 ft 8 in.	4 ft 0 in.	3 ft 6 in.
230kV to 242kV	13 ft 0 in.	13 ft 0 in.	5 ft 3 in.	4 ft 9 in.
345kV to 362kV	15 ft 4 in.	15 ft 4 in.	8 ft 6 in.	8 ft 0 in.
500kV to 550kV	19 ft 0 in.	19 ft 0 in.	11 ft 3 in.	10 ft 9 in.
765kV to 800kV	23 ft 9 in.	23 ft 9 in.	14 ft 11 in.	14 ft 5 in.

Safe Work Practices

• Working Clearances

- The dimension of working space in the direction of access to live parts operating at 600 volts or less and likely to require examination, adjustment, servicing or maintenance while energized.
- Nominal Voltage to Ground (OSHA Table S-1)
 - 0-150 volts 3 Feet clear space
 - 151-600 volts 4 Feet clear space

Safe Work Practices Cont.

De-energized Parts

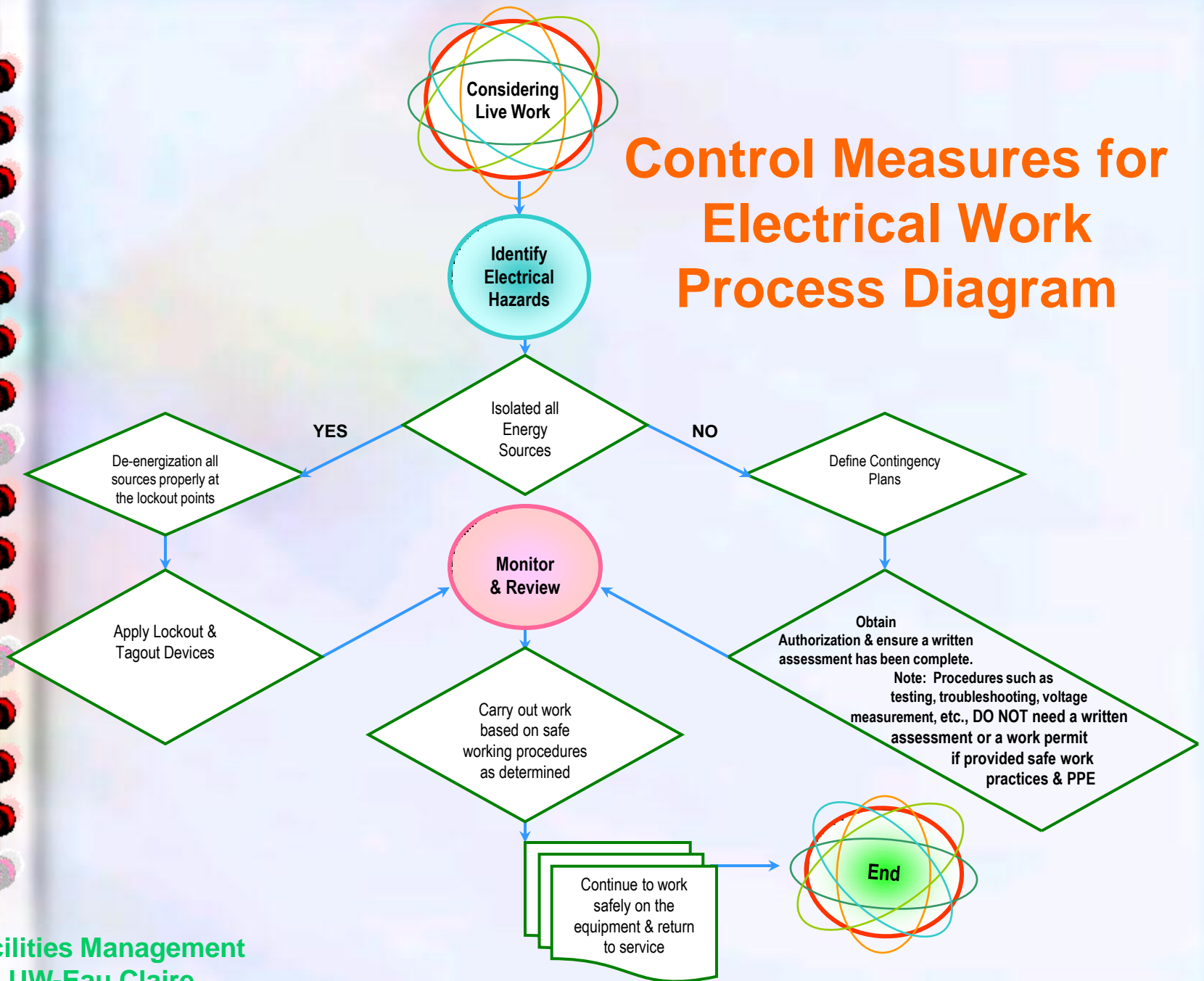
- Live parts to which an employee may be exposed will be de-energized before an employee works on or near equipment unless:
 - The de-energizing creates hazardous situation.
 - The equipment, by design, cannot be shut down.
- Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.



Safe Work Practices Cont.

- **Energized Parts** - If exposed live parts are not de-energized or isolated, use other safety related work practices such as:
 - Identify exposed live parts that could become live while using test instruments.
 - Use only approved insulated tools, testing probes, and isolation barriers to isolate all employees from contact with exposed conductive parts that could become live during testing.
 - Conduct periodic review of the situation to ensure that no new hazards are created during the process.

Control Measures for Electrical Work Process Diagram



Control Measures

- Work is done very carefully and in an un-hurried, considered manner.
- Safe working procedures are followed.
- All exposed conductors/equipment are assumed to be live.
- Work practices that are used shall be suitable for the conditions under which the work is to be performed.
- Safe working distances shall be used.



Control Measures Cont.

- Visual inspection, possibly in combination with an appropriate drawing and equipment manual.
- Ensure a written assessment has completed and determined how the work can be done safely.
- **Note:** Procedures such as testing, troubleshooting, voltage, measurement, etc., DO NOT need a written assessment or a work permit if provided safe work practices & PPE.

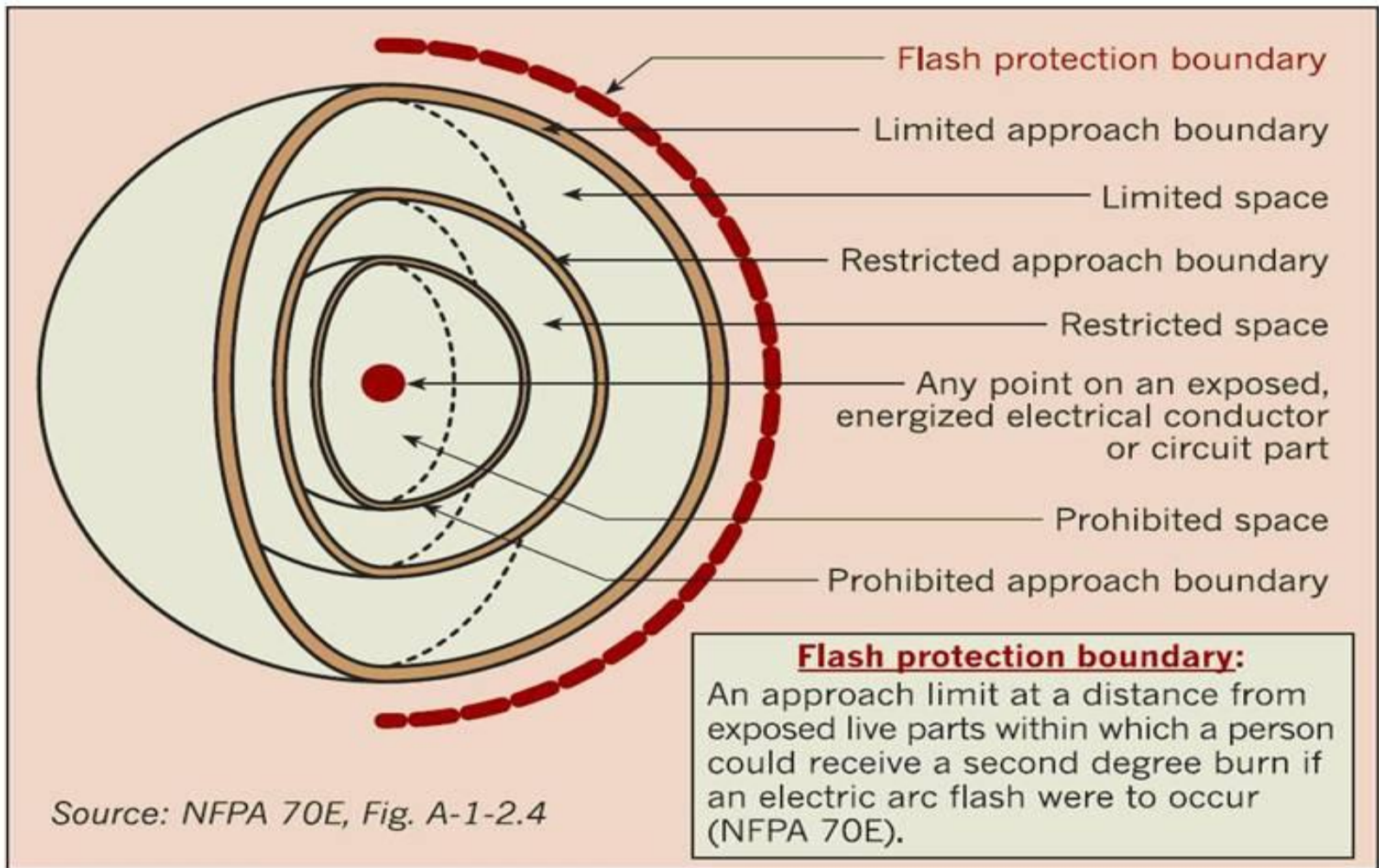
Control Measures Cont.

- Obtain authorization from immediate supervisor or a person who has more knowledge in control of the premises.
- Ensure that safe work practices and control measure have been implemented, as planned.
- Carry out work based on safe working procedures as determined.

Monitor and Review

- Evaluate electrical hazard controls during inspections, routine maintenance, and other activities to a safe condition.
 - Ensure that safe work practices and control measure have been implemented, as planned.
 - Ensure that safe work practices and control measure are being used correctly.
 - Ensure that all electrical hazards are eliminated or adequately reduced.
 - Carry out work based on safe working procedures as determined.
 - Continue to work safely on the equipment and return it to service.

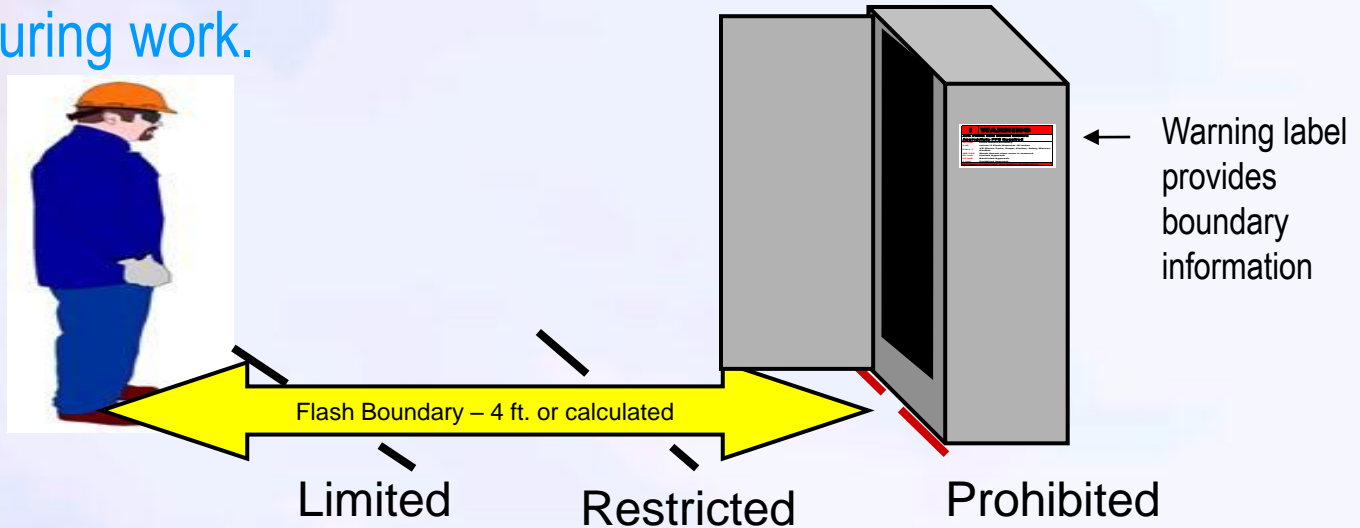
NFPA 70E Approach Boundaries



Approach Boundary Procedures

- **Flash Protection Boundary:**

- Voltage levels at 600 volts and below, the flash protection boundary shall be 4.0 feet.
- Voltage levels higher than 600 volts, this boundary must be increased for specific conditions.
- The qualified worker is responsible for ensuring physical barriers are in place and all approach boundaries are enforced during work.



Approach Boundary Procedures

- **Limited Approach Boundary:**
 - Unqualified person shall remain at a safer distance from open, energized conduction.
 - Qualified person shall advise the unqualified person of the possible hazards and ensure the unqualified person is safeguarded if there is a need for an unqualified person to perform a minor task.

Approach Boundary Procedures Cont.

- **Restricted Approach Boundary:**

- Under no circumstances shall an unqualified person be permitted to cross the restricted approach boundary.
- To cross this restricted boundary, the employee must:
 - Be a “qualified person” and have a approved plan.
 - Use PPE suitable for working near exposed live parts.
 - Position his/her body in a way that minimizes of inadvertent contact.



Approach Boundary Procedures Cont.

- **Prohibited Approach Boundary:**

- To cross the prohibited approach boundary, the qualified person must:
 - Have specified training to work on energized conductors or circuit parts.
 - Have a documented plan with proper written procedures and justifying the need to work inside the prohibited approach boundary and perform a written risk analysis.
 - Have a documented plan and written risk analysis above approved by immediate supervisor.
 - Use PPE appropriate for working near exposed live parts and rated for the voltage and energy level involved.

Summary

- Electricity will try to reach ground even if it means going through a person
- Always inspect power tools and cords before each use and do not use them if damaged
- Do not attempt to repair electrical equipment unless you are trained and qualified
- Always use lockout/tagout procedures to de-energize electrical systems

Summary Cont.

- Use electrical tools and equipment that are protected by a GFI
- Review your assignments with your supervisors
- Utilize correct PPE
- Report all problems to your supervisors
- If at all in doubt, ask questions

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Any Questions



Please visit FM Website

(<http://www.uwec.edu/facmgt/safety/traininglist.htm>)

for additional information.