ELECTRICAL SAFETY

EM-385 SECTION 11
29 CFR 1926 Subpart K
NFPA-70 (NEC)
NFPA-70 E
NESC- National Electrical Safety Code

Governmental Safety Requirements 013526

SAFETY REQUIREMENTS PROTECTION OF PROPERTY PEOPLE
ELECTRICAL SYSTEMS

ELECTRICAL VOLTAGES
HIGH OVER 15,000
MED 601-15,000
LOW 600 VOLTS AND LESS

Most voltages on job sites are <600 V

Higher voltages usually worked by lineman
**WORKING WITH ELECTRICITY**

*Special training* is required for work on electrical equipment.

**ALL ELECTRICAL WORK SHALL COMPLY WITH APPLICABLE NATIONAL ELECTRICAL SAFETY CODE. (NESC), NATIONAL ELECTRIC CODE (NEC), OSHA AND USCG REGULATIONS**

EM-385 Section 11.A.01 Electrical work shall be performed by Qualified Personnel with *verifiable credentials* who are familiar with applicable code requirements. Verifiable credentials consist of State, National and/or Local Certifications or licenses that a Master or Journeyman Electrician may hold, depending on work being performed, and should be identified in the appropriate AHA
Qualified Person (Electrical): One who has received training in and has demonstrated skills and knowledge in the construction and operation of electrical equipment and installations and the hazards involved. This includes the skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment, to determine the nominal voltage of exposed live parts, the clearance distances and corresponding voltages to which the qualified person will be exposed.
ELECTRICAL SHOCK

DO YOU KNOW?

• Currents as small as 10 mA can paralyze or “freeze” muscles
  A Person cannot release tool
  – Tool is held even more tightly,
  – resulting in longer exposure
  – to shocking current

An electric power drills uses 30 times as much current as what will kill.
ELECTRICAL BURNS

• Most common shock-related, nonfatal injury
• Occurs when you touch electrical wiring or equipment that is improperly used or maintained
• Typically occurs on the hands
• Very serious injury that needs immediate attention
FALLS

• Electric shock can also cause indirect or secondary injuries

• Workers in elevated locations who experience a shock can fall, resulting in serious injury or death
SAFE WORK PRACTICES

BEFORE STARTING WORK…

• A sketch of proposed temporary power distribution systems to be accepted by GDA before power installed.

Sketch shows the location, voltages, means of protection of all circuits, including receptacles, disconnecting means, grounding, GFCI’s, and lighting circuits.

That is in COE 11.E
Working on energized circuits

ENERGIZED WORK REQUIRES COMMANDING OFFICER APPROVAL AND A COMPLETED ENERGIZED ELECTRICAL WORK PERMIT. SEE NFPA 70E

Lots of advance notice needed for this work!
An AHA and written work procedures must be prepared for unusual or complicated work activities or any activity identified by the QUALIFIED PERSON.

11.B ARC FLASH
11.B.01 Whenever it is necessary to work on energized parts greater than 50 volts to ground, a risk/hazard analysis/arc flash hazard analysis will be conducted in accordance with NFPA 70E. Either Appendices or Tables may be used to conduct analysis. The flash protection boundary, approach distances, hazard/risk category and PPE requirements shall all be identified. This AHA is separate, distinct and in addition to the AHA required in Section 01.
TEMPORARY ELECTRICAL POWER

• Temporary electrical & devices are to be checked for polarity, ground continuity & resistance before used & modification. GFCI shall be tested monthly & recorded & copy furnished to the GDA

Yep, right here in 11.A.03 and the ground resistance to be 25 Ohms or less
Ground Fault Circuit Interrupters (GFCI)

An unintentional electric path between a source of current and a grounded surface is referred to as a "ground-fault." Ground faults occur when current is leaking somewhere, in effect, electricity is escaping to the ground. How it leaks is very important. If your body provides a path to the ground for this leakage, you could be injured, burned, severely shocked, or electrocuted.

Hey, check it out! lots of GFCI information!!
ALL GFCI RECEPTACLES HAVE A TEST BUTTON
• All bulbs protected by guards.
• Not suspended by wires
• Empty sockets/broken replaced
• Confined spaces 12 volts or less.
• Temporary lighting circuits to be separated from receptacles.
Circuits labeled "Lights only"
Tool circuits “Tools only”
TEMPORARY LIGHTING

Wire holding fixture from bldg.
TEMP. LIGHTING VIOLATION
ELECTRICAL SAFETY QUESTION

AS YOU WALK AROUND THE JOB SITE YOU NOTICE THE LIGHTS GET DIMMER JUST AS A WORKER STARTS UP HIS ELECTRIC SAW. IS THE A PROBLEM? WHY?
SAFE WORK PRACTICES

Vertical clearance for temporary wiring 600V less:

10 ft (3m) above finished grade, sidewalks, or from any platform.

12 ft (3.6m) over vehicular traffic other than truck traffic.

15 ft (4.5m) over areas for truck traffic.

18 ft (5.4m) over public streets, alleys, roads, and driveways.

We need to raise these power lines and then re-submit our temporary power sketch too!
WHAT IS THE CLOSEST DISTANCE A CRANE CAN BE USED NEXT TO HIGH VOLTAGE LINES?
SAFE WORK PRACTICES

DANGER
DO NOT OPERATE
WITHIN 10 FT. OF
POWER LINES
SAFE WORK PRACTICES

WET LOCATIONS

A receptacle in a wet location to be contained in a weatherproof enclosure the integrity of which is not affected when an attachment plug is inserted.

LOOK IN COE 11.D.04 THE NEXT SLIDE HAS SOME GREAT PHOTOS TOO!
WET LOCATIONS

POWER CORD IN USE

COVER IN PLACE
SAFE WORK PRACTICES

Remove all conductive articles: jewelry and clothing, watchbands, bracelets, rings, key chains, necklaces, metal, cloth with conductive thread, or metal headgear.
TESTING OF A CIRCUIT

Verify system is de-energized.

Operate controls to verify equipment cannot be restarted.

Use test equipment to verify the circuits and electrical parts for voltage and current.
TESTING OF A CIRCUIT

Test the test equipment, usually a voltmeter, on a known source of power of same rating, to insure the test equipment is working.

Test the test equipment always before you verify the circuit to be worked on, then test the equipment again after!!
WHAT IS A MANDATORY REQUIREMENT BEFORE ANY WORK ACTIVITY CAN BE DONE ON ANY OVERHEAD POWER LINES?
WHAT IS AN ARC FLASH?

A short circuit through the air when insulation or isolation between conductors is breached or can no longer withstand the applied voltage.

Workers on or near energized conductors or circuits, movement near or contact with the equipment or failure of the equipment may cause a fault resulting in Arc Flash
ARC FLASH SAFETY

Temperatures 5000 F.
Explosions
Hot Gases
Melting Metal
Radiation Burns
Severe Eye Damage
Death
WORK OVER 50 VOLTS ON ENERGIZED PARTS:

ARC FLASH HAZARD ANALYSIS IAW NFPA-70E TO DETERMINE SAFE BOUNDRY FROM HAZARD

SYSTEMS 600 VOLTS AND LESS MINIMUM BOUNDRY IS 4 FEET

SPECIAL TRAINING

SPECIAL PPE FOR WORKERS

50 Volts is not very high voltage
ARC FLASH SAFETY

SPECIAL PPE

ARC FLASH COVERALLS ARE BASED ON ANTICIPATED HAZARD RATED IN CALORIES OF HEAT
TRAINING CERTIFICATE FOR WORKER

Note: This ARC flash suit is rated at 11 Calories per square centimeter
FLEXIBLE CORDS

Size & number of wires
Insulation type printed on the cord!

(UL) 12/3 SJTW
FLEXIBLE CORDS

Where does a person find information about the letters that would indicate types of insulation for "Hard Usage and Extra Hard Usage" requirements?
FLEXIBLE CORDS

HARD SERVICE CORD & EXTRA HARD SERVICE

S, SE, SEO, SO, SOO, ST STO, STOO, SJ, SJE, SJEO SJO, SJOO, SJT, SJTO SJTOO

A complete list of all can be found in NEC Art. 400
FLEXIBLE CORDS

IS THIS CORRECT USE OF A FLEXIBLE CORD?
FLEXIBLE CORDS

Inspected before use:
Loose parts, missing pins
Damage to insulation & outer jacket
Properly protected at the jobsite
Protected by bushings or fittings if passing through holes

Look at the examples on the next few slides!!
FLEXIBLE CORD VIOLATIONS
FLEXIBLE CORD VIOLATIONS
HAND-HELD ELECTRIC TOOLS

Potential danger due to continuous contact with hands:
To protect from shocks, burns & electrocution tools required to have following:

3 wire cord, with ground plugged into GFCI receptacle or be double insulated or powered by low voltage transformer

So what do I look for now?
HAND-HELD ELECTRIC TOOLS

DOUBLE INSULATED ELECTRIC DRILL

DOUBLE INSULATED MARKING
A worker is using a double insulated drill. Since it is double insulated does he have to plug into a GFCI protected circuit?
Non-conductive side rails
At least 10 feet away from all electric lines
PERSONAL PROTECTIVE EQUIPMENT

HARD HATS
  Class "E" high voltage work
  Special High Voltage gloves

EYE PROTECTION
FOOT PROTECTION
HIGH VOLTAGE GLOVES

A hole, tear, puncture, or cut ozone cutting or ozone checking the cutting action produced by ozone on rubber under mechanical stress into a series of interlacing cracks

Special PPE & special testing too!
Lock-out / Tag-out

Control of Hazardous Energy
Lock-out / Tag-out
Control of Hazardous Energy

• References

EM 385-1-1 Section 12 Control of Hazardous Energy
– 29 CFR 1926.417 – Lockout and Tagging of Circuits
– 29 CFR 1910.147 – Control of Hazardous Energy
– UFGS 013526 – Governmental Safety Requirements
– ANSI Z244.1 – Personnel Protection - Lockout/Tagout of Energy Sources
– ANSI A10.44 - Control of Energy Sources (Lockout/Tagout) for Construction and Demolitions Operations
Control of Hazardous Energy

• Direct causes of mishaps:
  – Lack of notification prior to re-energizing.
  – Not verifying de-energized state.
  – Failure to adequately bleed pressurized system before disassembly.
  – Unauthorized work
  – Lack of communication between workers.
  – Worker ignoring safety procedures.
Control of Hazardous Energy

• Indirect causes of mishaps:
  – Lack of Lock-out/tag-out program.
  – Workers not adequately trained or supervised.
  – Approved safety plan not implemented.
  – Regular site safety inspections not performed.
  – Lack of safety equipment and/or use.
Control of Hazardous Energy

• 12.A.03 – When contractor work involving hazardous energy will be performed on a Government Operated Facility, the following coordination must occur:

• a – The GDA and the Contractor shall fully coordinate all control activities with one another throughout the planning and implementation of these activities.

• b – When contractors are planning the use of Hazardous Energy Control procedures, they shall submit their Hazardous Energy Control Plan to the GDA for acceptance. Implementation of the Hazardous Energy Control Procedures shall not be initiated until the Hazardous Energy Control Plan has been accepted by the GDA.
Control of Hazardous Energy

• 12.A.04 – Systems with energy isolating devices that are capable of being locked out shall be locked out. If an energy isolating device is not capable of being locked out, the Hazardous Energy Control Procedures shall use tag out providing full personnel protection. See 12.A.11.c

• 12.A.05 – Locks must always be used when the clearance involves equipment that is accessible to the public.

• 12.A.07 – A preparatory meeting and inspection with the GDA and Contractor personnel shall be conducted to insure that all affected employees understand the energy hazards and the procedures for their control. This meeting/inspection shall be Documented.

• 12.A.08 – Lock-out and Tag-out shall be performed by only Authorized employees.

• 12.A.09 – All employees affected by Lock-out/Tag-out shall be notified, before and upon completion of the application and removal of locks and tags.
Hazardous Energy Control Program

• 12.A.12 – Hazardous Energy Control Program

• 12.A.12.a – HEC Procedures shall be developed in the Hazardous Energy Control Plan.

• 12.A.12.b – The Hazardous Energy Control Plan shall clearly and specifically outline the scope, purpose, authorization, responsibilities, rules and techniques to be used for the control of hazardous energy.

• To include:
Control of Hazardous Energy
12.A.12.b cont...

1) Statement of intended use of the procedure;
2) Means of coordinating and communicating HEC activities;
3) Procedural steps for shutting down, isolating, blocking, and securing systems to control hazardous energy;
4) Procedural steps and responsibilities for the placement, removal, and transfer of lockout and tagout devices;
5) Procedural steps, responsibilities and a means of accounting for placing and removing personal protective grounds;
6) Procedural steps, responsibilities and requirements for testing the system to verify effectiveness of isolation, lockout/tagout devices;
7) Procedural steps and responsibilities for transfer of clearances when and if necessary;
8) Procedures steps and responsibilities for Multi-Shift Safe Clearances;
9) A description of any emergencies that may occur and procedures for safely responding to those emergencies;
10) The means to enforce compliance with the procedures.
Lock-Out/Tag-Out

• Breaker LO/TO

• Switch Box LO/TO
3.2 PRE-OUTAGE COORDINATION MEETING

• Contractors are required to apply for utility at least 15 days in advance.
• Once approved and prior beginning, work contractor must attend a pre-outage coordination meeting with the Contracting Office [and the] [installation representative] [Public Utilities representative] to review the scope of work and the lock-out/tag-out procedures for worker protection. No work will be performed on energized electrical circuits unless proof is provided that no other means exist.

3.3 SAFETY LOCKOUT/TAGOUT PROCEDURES

Contracting Officer will, at the Contractor’s request, apply lockout/tagout tags and take other actions that, because of experience and knowledge, are known to be necessary to make particular equipment safe to work on.
3.3.1 TAG PLACEMENT (3rd paragraph)

When it is required that certain equipment be tagged, the Government will review the characteristics of the various systems involved that affect the safety of the operations and the work to be done; take the necessary actions, including voltage and pressure checks, grounding, and venting, to make the system and equipment safe to work on; and apply such lockout/tagout tags to those switches, valves, vents, or other mechanical devices needed to preserve the safety provided. This operation is referred to as “Providing Safety Clearance”
3.3.2 TAG REMOVAL

When any individual or group has completed its part of the work and is clear of the circuits or equipment, the supervisor, project leader, or individual for whom the equipment was tagged shall turn in his signed lockout/tagout tag stub to the Contracting Officer. That group’s or individual lockout/tagout tags on equipment may be removed on authorization by the Contracting Officer.
• 12.B – Training

• 12.B.01 – Training shall be provided to ensure that the purpose and function of the Hazardous Energy Control procedures are understood by employees and that employees possess the knowledge and skills required for the safe application, usage and removal of Hazardous Energy Control Devices.
  
  –a. Authorized Employee Training ……
  –b. Each affected employee……
  –c. All incidental personnel shall be informed………
  –d. When only tagout systems are employees shall be trained in the limitations of tags.

12.B 02 Employee retraining requirements.
12.B.03 The supervisor shall certify and document all training and retraining.
Periodic Inspections
12.C

12.C.01 – Daily inspections **shall** be conducted to ensure that all requirements of the Hazardous Energy Control procedures are being followed.

12.C.02 – **Periodic** Inspections **shall** be documented and **shall** specify the system where the Hazardous Energy Control procedures were inspected, the date of the inspection, the names of employees performing and included in the inspections and any deficiencies in complying with the Hazardous Energy Control procedures.
Lock It and Tag It Before Servicing

- Lock Out Safety
- Lock Out and Tag Out
WORK AREA SAFETY

NO work on energized electrical parts without adequate illumination.

If there is an obstruction that prevents seeing your work area or if you must reach blindly into areas which may contain energized parts.
CIRCUIT IDENTIFICATION

DISCONNECTS FOR MOTORS & APPLIANCES
Legibly marked to identify

SERVICE, FEEDER & BRANCH CIRCUITS &
Disconnecting means or over-current device to be
legibly marked to indicate its purpose.
Pull and junction boxes and fittings must have approved covers

Unused openings must be closed (no missing knockouts)

That is easy to spot!!!
WHAT IS THE CLOSEST DISTANCE THAT A MOBILE CRANE CAN BE SET-UP NEXT TO HIGH VOLTAGE POWER LINES?
This photo a violation of OSHA, EM-385 and/or NEC
This photo a violation of OSHA, EM-385 and/or NEC
This photo a violation of OSHA, EM-385 and/or NEC
ELECTRICAL PROBLEMS

This photo a violation of OSHA, EM-385 and/or NEC
This receptacle was mounted inside a soap bottle. It was used by a homeowner as an extension cord while floating around in a pool so he could save batteries while watching a portable television.

Photo taken of an example of a "stupid persons" ingenuity