Electrical Safety Addendum

1. WORK IN EXCESS OF 50 VOLTS

1. PURPOSE

Qualified and competent electrical workers are required to perform a variety of tasks with and around higher voltage electricity, electrical equipment, and apparatus. The nature of such work necessitates an understanding of applicable safety policy and rules.

Many electrical hazards and work practices are the same regardless of the voltage involved. However, due to the nature of high voltage work, there are many hazards and work practices that are specifically related to high voltage.

The following standards and sections provide information for repairing, servicing, construction, and maintaining electrical circuits and equipment that are supplied by systems of 50 Volts or more.

- 29 CFR 1910
- 29 CFR 1926
- ANSI/IEEE C-2, National Electrical Safety Code
- NFPA 70

2. RESPONSIBILITIES FOR SAFETY

This section provides safety guidelines and requirements for carrying out assigned job tasks. It is essential that each employee exercise sound judgment to perform assigned tasks safely. Safety is the responsibility of each employee.

3. WORKER

The greatest responsibility for a worker's safety lies directly with the worker. This means that all workers are responsible for performing their work in a manner that does not endanger themselves, their co-workers, or others in the area and for complying with safety rules and requirements. Workers should rely solely on the care exercised by another for their protection. Workers are encouraged to contribute to the safety program and bring to the attention of their supervisors or safety representative any condition they believe is unsafe.

Other safety responsibilities of workers include the following:

1. The worker should examine the work area for existing hazards and proceed in a safe manner.
2. When servicing energized electrical equipment, non conductive fiberglass ladders shall be used. In no case shall conductive ladders be used in or around energized electrical equipment.
3. Work place lighting shall be no less than five candle power. In the event of no lighting or poor lighting, head lamps and portable lights shall be utilized.
4. When seen in a dangerous situation, fellow workers should be warned in such a manner as to avoid confusing, startling, or suddenly alarming them.
5. Before climbing poles, ladders, or other such structures or before working on scaffolds, workers shall make a careful inspection to determine whether the structures are safe and are properly supported. Workers should not carry anything in their hands while ascending or descending ladders. Small objects or tools may be carried in pockets or pouches. Larger objects, however, should be raised or lowered by use of handlines or ropes and blocks. Others working nearby or below should remain out of line of the work in case anything should accidentally be dropped.
6. It is the responsibility of each worker to attend safety meetings. Workers should also make a practice of learning safety information made available to them that will help them perform their work safely.
7. The worker shall report to the supervisor and personal injury as defined by the facility as soon as possible.
8. The worker should exercise care and good judgment when lifting heavy material, obtaining help if the object is too heavy or awkward for one person to handle.

4. SUPERVISORS

Supervisors are responsible for knowing and implementing applicable safety policies and directives and taking action as required to provide for the safety of the personnel and operations they supervise. This includes; taking positive action to determine and reduce, as necessary, the hazards associated with their operations; instructing employees in safe work methods and associated requirements; allowing only those employees that are qualified for the work to perform the work; and ensuring that employees perform their work safely.

Supervisors shall be responsible for the safety of all employees under their supervision. They shall enforce the rules that apply to the hazards involved.

Supervisors shall make certain that each new or transferred employee is instructed in the safe practices pertaining to his or her work.

Supervisors shall ensure that the appropriate employees receive instruction in appropriate emergency techniques, such as CPR, first aid and confined space rescue, warranted by the employee's duties.

Other duties of supervisors include the following:

1. Provide instructions on safe practices for the crew and see that they are followed.
2. Periodically examine supervised employees on their knowledge of the safety rules and approved emergency techniques
3. Does not allow a worker to perform any task that cannot be performed safely or for which the worker is not qualified.
4. Report every injury in the established manner prescribed for the facility.
5. Be responsible for the care and proper use of all protective devices
6. Be responsible for proper posting of hazardous work areas as a safeguard to those supervised. Under no circumstances shall the supervisor allow work to continue if safety precautions are ignored.
7. Designate a qualified worker to be in charge of work during the supervisor's absence. The supervisor should not leave the job while dangerous work is in progress.
8. Coach and direct employees who are working near exposed, energized wires, equipment, or apparatus.
9. Prescribe, along with employees, the appropriate PPE when establishing safety related work practices.

2. TRAINING

1. EMPLOYEE TRAINING

Employees shall be trained in and familiar with the safety-related work practices, safety procedures, and other safety requirements in this section that pertain to their respective job assignments.

Employees shall also be trained in and familiar with any other safety practices, including applicable emergency procedures that are not specifically addressed in this section but are related to their work and necessary for their safety.

3. QUALIFIED EMPLOYEE TRAINING

Qualified employees shall be trained and competent in:

1. The skills and techniques necessary to distinguish exposed live parts from other parts of electrical equipment.

2. The skills and techniques necessary to determine the nominal voltage or exposed live parts.
3. The skills and techniques necessary to determine the minimum approach distances corresponding to the voltages to which they are exposed.
4. The proper use of the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment.

   Training may consist of a combination of classroom and on-the-job type.

4. JOB BRIEFINGS

The employee in charge shall conduct a job briefing with the employees involved before the start of each job. The job briefing will at least cover the following subjects: hazards associated with the job, work instructions involved, special precautions, energy source controls, and personal protective equipment requirements.

If the work or operations to be performed during the work day are repetitive and similar, at least one job briefing shall be conducted before the start of the first job or each day or shift. Additional job briefings shall be held if significant changes, which might affect the safety of the employees, occur during the course of the work.

A brief discussion is satisfactory if the work involved is routine and if the employees, by virtue of training and experience, can reasonably be expected to recognize and avoid the hazards involved in the job. A more extensive discussion shall be conducted if the work is complicated or extremely hazardous, or the employee cannot be expected to recognize and avoid the hazards involved in the job.

An employee working along need not conduct a job briefing. However, the employee shall ensure that the tasks to be performed are planned as is a briefing were required.

5. PERSONAL PROTECTIVE EQUIPMENT & PROTECTIVE CLOTHING

Employees shall wear appropriate personal protective equipment (PPE) and protective clothing to protect them from hazards of high-voltage apparatus. Employees authorized or

required to work on high-voltage systems shall be completely familiar with the PPE and protective clothing they need for adequate protection while working on such systems.

1. **SHOES**

   Employees should wear shoes or boots that comply with the requirements of ANSIZ41. No metal parts shall be present in the sole or heel of the shoes where non-conductive shoes are required.

2. **HEAD PROTECTION**

   Workers should wear approved hardhats when working aboveground on poles, structures, or buildings or in trees per ANSIZ89.1 and 29 CFR 1910.135.

   Workers shall wear hardhats when working on the ground near poles, structures, buildings, or trees in which work is being done. Workers shall wear hardhats when visiting or observing in areas where overhead work is being done.

3. **EYE PROTECTORS**

   Whenever eyes are in danger of being injured, workers shall wear safety goggles or other eye protectors meeting ANSI standards. When the work being performed dictates, workers should wear nonmetallic and non-conductive eye protection.

4. **RESPIRATORS**

   Workers shall wear the appropriate respirator per 29 CFR 1910.134.

5. **WORK GLOVES**

   When insulated gloves suitable for high-voltage are not required, otherwise suitable work gloves should be worn while handling materials and equipment to prevent the possibility of slivers, cuts and skin irritation.

6. **WORK CLOTHES**

   Work clothes should be made of natural materials, such as cotton or wool, or fire resistant materials and should have full length sleeves. Sleeves should be rolled down for greatest protection.

   Workers shall not wear articles such as loose chains, keys, watches, or rings if such articles increase the hazards associated with inadvertent contact with energized parts or can become caught under or snagged while climbing off or on structures, equipment

or vehicles.

All clothing worn by affected workers should be considered part of the employees protective clothing system. This includes rain wear, cold weather wear and underclothing. Protective clothing should provide a good functional fit to increase the protection and comfort of the clothing. When required, protection can be increased by wearing single or multiple layers of flame resistant outer garments over non-melting clothing. Sleeves and shirts should be fully buttoned and appropriated neck, head, and hand covering provided.

6. ELECTRIC ARC HAZARDS PPE

Electric shock is a widely recognized hazard and involves current flow through or on the body. Burns from electric arcs are not as well recognized. There is no contact required and the burns can be severe if the clothing ignites or melts. The hazards to which the employee is exposed also include the clothing breaking open due to the arc pressure blast, the heat from the electric arc and subsequent secondary fires or explosions**.**

1. FIRE RESISTANT CLOTHING

29 CFR 1910.269(1)(iii) states, in part, "…each employee who is exposed to flames or electric arcs does not wear clothing that, when exposed to flames or electric arcs, could increase the extent of injury.

"**Note:** Clothing made from the following types of fabrics, either alone or in blends, is prohibited by this paragraph, unless the employer can demonstrate that the fabric has been treated to withstand the conditions that my be encountered or that the clothing is worn in such a manner as to eliminate the hazard involved: acetate, nylon, polyester, rayon."

GENERAL – All fire resistant fabrics comply with 29 CFR 1910.269(1)(iii). Untreated cotton and wool comply if the fabric will not ignite and continue to burn under the conditions to which the employee could be exposed. ASTM F1506-94 and 2 new ASTM provisional standards, outline the testing procedures to determine how various fabrics react in the presence of an electrical arc on an instrumented manikin or panel. The ASTM provisional standards provide testing procedures that expose these same fabrics to a vertical flame test.

Chemically dependent fire resistant fabrics are treated with flame retardant chemicals added to the fiber or treatments applied to the fabric. These treatments are activated by heat and produce gases that smother the flame. Typically, these fabrics have a

definite life as defined by the manufacturer. This is usually defined by the number of home or commercial washings the garment is exposed to.

Inherently fire resistant fabrics, by their composition, do not burn in air. The fire resistance of this fabric is not affected by washing.

2. RUBBER GLOVES

The following requirements apply:

1. Rubber gloves shall be of appropriate voltage rating for the work performed. All rubber gloves shall meet the standards set forth in ANSI/ASTM D120.
2. Leather glove protectors shall be worn over rubber gloves except where leather protectors are not required.
3. Rubber gloves should be carried cuff down in a bag, box or container that is designed for this purpose.
4. Rubber gloves shall be visually inspected and field air-tested before use each day and at other times if there is cause to suspect damage.
5. Rubber gloves should be uniquely identified (i.e., serial number or other marking). The results of dielectric tests should be documented.
6. Rubber gloves shall be wired clean of any oil, grease, or other damaging substances as soon as possible.

3. RUBBER LINE HOSE, HOODS, COVERS, SLEEVES & BLANKETS

Linemen's rubber insulating sleeves are to be worn to provide protection from electrical shock and burn to the arm and shoulder areas. They are available in several different thicknesses, lengths, and designs, depending on the maximum voltage they are designed to protect against.

Insulating line hose (flexible hose) is used as an insulating cover for electric conductors to protect against accidental contacts. A lengthwise slit with overlapping sides permits the hose to be placed on conductors easily. It is available in various diameters, lengths, and compositions.

Insulating covers are used in conjunction with line hose to cover an insulator and the conductor attached to it for protection against accidental contact.

Rubber insulating blankets are molded sheets of insulating rubber or synthetic elastomer,

usually square or rectangular in shape, designed to cover energized electrical equipment to prevent direct accidental contact by electrical workers.

4. LIVE LINE TOOLS

A careful periodic inspection shall be made of equipment used for handling or testing energized lines or equipment. Such tools shall be examined before each use to make certain they are in good condition.

Particular attention shall be given to preserving the surfaces of wooden and fiberglass tools used around electrical equipment, including ladders, pike poles, switch sticks, live-line tools, and insulating platforms. Only colorless varnish or other appropriate transparent insulating preservative shall be used.

Insulated tools shall be stored in a dry location. Suitable containers or racks shall be provided to protect the tools from mechanical damage and warping.

7. STORAGE OF PPE

1. STOREROOM STORAGE

Since heat, light, oil, and distortion are natural enemies of rubber, rubber protective equipment should be guarded from these as much as possible. Rubber equipment shall not be stored near boiler rooms, steam pipes, or radiators and should be protected from exposure to direct sunlight.

Gloves should be stores in their natural shape in the leather protector. Keep sleeves flat with the inserts left in. Blankets should be stores flat, hung on pegs by the eyelet or rolled up. Line hose should be stored in its natural shape.

2. TRUCK STORAGE

The storing of rubber protective equipment on the truck should be planned. If possible, separate compartments should be provided for each class of equipment, and each compartment should be of sufficient size to allow the articles to lie in a natural position. Rubber gloves should be stored in glove bags and hung up. If stored in tool bags or inside boxes, nothing should be piled on top to cause distortion. Gloves should not be stored near vehicle heaters.

Sleeves should be stored flat with inserts rolled up lengthwise, or placed in a tube shaped bag. Nothing should be placed on top of sleeves or stored near vehicle heaters.

Blankets should be rolled up and placed in canisters or protective canvas holders. Do

not fold, hold together with tape, pile materials on top of, or store blankets near vehicle heaters.

3. PLACING OF INSULATING GOODS ON CONDUCTORS

When workers are about to begin work that requires the use of rubber goods, they should climb or raised the bucket to a position just below the first line of conductors. When climbing they should then determine their working position and what lines and other conductors should be covered. They should then request the required rubber goods. Before proceeding further, the workers shall put on the rubber gloves and leather protectors and make certain that they are in good order. Rubber goods shall be raised in a secure manner.

As the workers ascend to their working position, they shall cover all conductors which provide a hazard. This should be done from below whenever possible. At no time shall workers pass through energized equipment before it is covered with rubber goods (line guards). All conductors and grounds adjacent to working space shall be considered, including those near any possible change of position that may be necessary. When line hose is applied to vertical or sagging wires, it should be fastened to the line to prevent its slipping from position. When blankets are used for covering items such as dead ends, potheads, secondary racks, and transformers, they should be secured by wooden or plastic clamp pins or tie thongs. After the protective equipment has been placed, care should be taken to prevent damage to the rubber from tie wires, spurs, or other objects.

4. REMOVING INSULATING GOODS FROM CONDUCTORS

When the job is completed, the protectors should be removed in the reverse order of installation. Remote conductors are removed first and the wires nearest the workers last. After being detached, the equipment should immediately be lowered to the ground.

5. CLEANING AND INSPECTING

After rubber goods have been lowered to the ground, they should be cleaned and visually inspected before being placed in the carrier compartments of the truck.

8. PROTECTIVE GROUNDING OF LINES & EQUIPMENT

Grounding is the most effective way of protecting electrical workers from electric shock. That

is why it is important to ensure that all de-energized lines and equipment are grounded.

1. PURPOSE

This section provides information concerning protection for workers repairing, servicing, or working on high-voltage power lines.

2. REDUCE THE POTENTIAL VOLTAGE DIFFERENCE ACROSS THE WORKER

The primary function of personal protective grounds is to provide maximum safety for personnel while they are working on de-energized lines or equipment. This will be accomplished by making provisions that will reduce the potential voltage differenced at the work site to a safe value in the event that line or equipment being worked on is accidentally re-energized, voltages induced from other energized lines, an energized line falls on the line being worked, or there is a lightning strike near the line being worked.

The personal protective grounds should provide a low-impedance path to ground to ensure prompt operation of the circuit protective devices.

3. APPLICATION

Certain methods and steps should be exercised when placing grounds and loads to protect workers from high-voltage hazards.

- DEENERGIZED LINES – When an energized line or equipment in excess of 600 V is removed from service to be worked on, it shall be treated as energized until it is de-energized, tagged, locked if necessary, tested, and grounded.
- NEW CONSTRUCTION OR DISMANTLING OF FACILITIES – If isolating devices are not in place and energization is impossible from any source, single-phase grounding is appropriate, acceptable, and safe. If energization is possible by the closure of a jumper or isolating device, shorts or grounds shall be used unless conductor handling activity makes this impractical or impossible because of line design or construction process.
- MINIMUM APPROACH DISTANCE FROM UNGROUNDED CONDUCTORS The minimum approach distances shall be maintained from ungrounded conductors at the work location. The ground may be omitted if the making of the ground is impractical or the resulting conditions are more hazardous than working

on the lines or equipment without grounding. However, all work shall be done as if the line or equipment were energized.

- VISIBLE THREE-PHASE SHORT & GROUND REQUIRED – Visible three-phase short circuiting may be accomplished through conductive parts such as guy wires and unpainted metal tower members, but shall not be effected through a grounding mat or other concealed conductors.

  GROUND CIRCUIT – No power disconnect switch, power circuit breaker, transformer, wave trap, or fuse shall be part of the protective grounding circuit.

4. GROUNDING EQUIPMENT

The grounding of high-voltage lines and equipment will provide workers with additional protection from electric shock if grounds are sized, selected, and installed properly. Aluminum cables shall not be used for personal grounds.

AVAILABILTY - Grounding cables shall be available for use when work is being done on de-energized lines or equipment.

APPROVED CAPACITY - Grounding cables shall accommodate the maximum fault current to which the cable or equipment might be subjected.

GROUNDING CABLES & HARDWARE - Personal protective grounding cables consist of appropriate lengths of suitable copper grounding cable, with electrically and mechanically compatible ferrules and clamps at each end. In addition, appropriate hotsticks are required for installing and removing the conductor-end clamps to the conductors. Hotsticks are required for attaching ground-end clamps if the grounded system and the worker are at different potentials. Cluster bars provide a low-resistance means of connecting the ground-end clamps.

GROUNDING CABLES - Most of the grounding cables in use today are actually manufactured for another purpose-principally as welding cable. These extra-flexible copper cables with jackets are manufactured according to appropriate ASTM standards for both cables and jackets, and can be expected to perform satisfactorily as grounding cables.

- **STRANDING** – There are several classes of flexible cable with various stranding in the sizes normally used for grounding cables.
- **JACKETS** – Welding cables are nominally insulated at 600 volts. When used as grounding cable, the insulation or jacket serves primarily for mechanical protection of the conductor. The flexible elastomer or thermoplastic jackets are manufactured, applied, and tested according to ASTM standards. Black, red, and yellow jackets are usually neoprene rubber compounds, while clear jackets are ultraviolet-inhibited polyvinyl chloride (PVC). All jackets should have the

American Wire Guage (AWG) size stamped or printed repeatedly along the length of the cable. The clear jacket allows easy visual inspection of the conductor for strand breakage, but becomes stiff and hard to handle at low temperatures. The clear jacket will split or shatter at very low temperatures.

- **FERRULE** – Ferrules should be threaded-stud copper base compression type. Ferrules should have the filler compound vent hole at the bottom of the cable so that employees can visually check that the cable is fully inserted into the ferrule. Compound should be used with crimped ferrules. The ferrules should be crimped with ferrule manufacturer's recommended die. The press shall have enough pressure to completely close the die.
- The area covering the inserted cable jacket should not be compressed at shrink or springs should be installed over a portion of the ferrule to minimize strand breakage caused by bending. In all cases, the manufacturer's recommendations should be followed.
- **HANDLING OF GROUNDING CABLE** – Personal protective grounds are usually handled and lifted by the cable. However, continuous flexing eventually breaks the conductor strands beneath the jacket. Therefore, employees should minimize the use of sharp bends in the cable.
- **SIZE OF GROUNDING CABLE** – The size of the grounding cable must be selected to handle the maximum calculated fault current of the power system or specific portion thereof. The minimum size that shall be used for grounding cables is #2 (AWG) flexible copper. In larger substations, the maximum available fault current may require larger cables. If larger cables are not available, parallel cables may be used.

  Most manufacturers and suppliers of grounding cables publish tables to assist the user in selecting the proper cable size for a given fault current. These tables show the maximum fault current capability for several sizes of copper grounding cables.
- **GROUNDING CABLE LENGTH** – Excessive cable lengths should be avoided. Therefore, slack in the installed cable should be minimal to reduce possible injury to workers. Resistance in the cable increases with cable length, and excessive length could exceed the tolerable voltage drop across the body. Longer than necessary cables also tend to twist or coil, which reduces the effectiveness of the cable.
- **GROUNDING CLAMPS** – Grounding clamps are normally made of copper or aluminum alloys; sized to meet or exceed the current-carrying capacity of the cable; and designed to provide a strong mechanical connection to the conductor, metal structure, or ground wire/rod

CLAMP TYPES – Clamps are furnished in, but not limited to, three types according to their function and methods of installation.

1. Type I clamps, for installation on de-energized conductors, are equipped with eyes for installation with removable hotsticks.
2. Type III clamps, for installation on permanently grounded conductor or metal structures, have T-handles, eyes and/or square-or-hexagon-head screws.
3. Other types of special clamps are designed for specific applications, such as cluster grounds, underground equipment grounding, and so on.

CLAMPS JAWS – Bus clamps should be furnished with smooth jaws for installation on copper, aluminum, or silver-plated bus work without marring the surface. Conductor or metal structure clamps should be furnished with serrations or cross-hatching designed to abrade or bite through corrosion products on surfaces of the conductor or the metal structure being clamped. Several styles of conductor and ground-end clamps have jaws that can be replaced when the serrations have worn. Self-cleaning jaws are recommended for conductor-end clamps used on aluminum or aluminum conductor steel reinforced (ACSR) conductors. Several styles of ground-end clamps are designed with a cup-point set screw which should be tightened with a wrench (after the serrated jaws have been securely tightened) to break through paint, rust, galvanized coating, or corrosion on the surface that is to be clamped.

A typical grounding cable for transmission line work used by line crews consists of a 2/0 (AWG) copper cable with an insulating jacket, terminated with an all-angle, self-cleaning aluminum conductor clamp at one end, and a flat-faced clamp with a GROUNDING CLUSTER BAset screw at the other end for connecting to a tower leg or ground wire/rod

- **GROUNDING CLUSTER BAR** set screw at the other end for connecting to a tower leg or ground wire/rod.
- **RS** – When climbing wood-pole structures, workers may use a grounding cluster bar to connect the phase cables to the pole ground wire, if the ground wire has sufficient capacity to carry the fault current. Cluster bars must have an attached bonding lead. If there is no pole ground wire, the cluster bar for each pole is connected to a common driven or screw-in ground rod with a grounding cable (or cables). In substation grounding, a copper bar is sometimes used to connect the three-phase cables and a fourth cable to a riser from the station ground mat. When installing personal grounds on wood structures from a bucket, the ground cables

may be connected between the overhead ground wire (OGW), and the phases without the use of cluster bars provided that an electrical bond or sufficient current carrying capacity exists between the OGW and the structure ground.

- **TEMPORARY GROUND RODS** – Some typical examples of temporary ground rods used for grounding ungrounded structures or mobile equipment, or during conductor splicing operations, are either:
- A minimum 5/8-inch diameter bronze, copper, or copper-weld rod at least 6 feet lone, driven to a depth of at least 5 feet; or

  A 6-foot, screw-type ground rod, consisting of a minimum 5/8-inch diameter copper-weld shaft with a bronze auger bit and bronze T-handle, screwed to a depth of at least 5-feet (preferred). The T-handle must be tightly connected to the rod.

  If a temporary rod cannot be driven or screwed to a depth of 5 feet, additional rod(s) should be driven or screwed so that a total of at least 5 feet of rod is buried. These rods shall be bonded together with grounding cables prior to installing phase grounds. The rods should be placed 6 to 8 feet apart; however, the 10-foot clearance from the rods should be maintained. OGWs may be used at any time to bond the conductors provided that these wires are electrically bonded to the structure ground, either permanently or be personal grounds.

  Groundmen should stay clear (at least 10 feet where feasible) of items such as down guys, ground rods, maintenance vehicles, and structure legs or ground wires while they are bonded to protective grounds which are in place. When it is absolutely necessary to work on or near these features, employees should used bonded conductive or insulated platforms, or approved insulated shoes to minimize the hazard from step and touch potentials.

5. TESTING BEFORE INSTALLING GROUNDS

Before grounds are installed, the de-energized line or equipment shall be tested for voltage. Appropriate testers for the nominal voltage involved (audio or visual) should be used. They shall be tested immediately before and after used to verify that they are in good working condition.

6. ATTACHING & REMOVING GROUNDS

Employees attaching or removing grounds shall comply with the following:

- Grounding equipment should be visually inspected and all mechanical connections checked for tightness before each use.

- The surface to which the ground is to be attached should be clean before the grounding clamp is installed or a self-cleaning clamp shall be used.
- No ground shall be removed until all personnel are clear of the temporary grounded lines or equipment. When the grounding set is removed, it shall be disconnected from the line or equipment end first with an approved hot-line tool and moved to a point clear of the energized conductors before the ground end is disconnected.

7. GROUNDING METHODS & LOCATION OF GROUNDS IN ORDER OF PREFERENCE

Employees installing grounds shall install them using the information given in the following sections.

- **WORK LOCATION** – Grounds should be installed at the work location with all grounded parts of different potential bonded together (on wood poles, all down guys, overhead ground wire, neutral conductor, and pole ground). The cluster bar assembly should be installed below the working area and jumper to the ground point or the neutral conductor and the phase conductor, a method of grounding termed “equipment potential” grounding. It provides the greatest margin of safety for the lineworker by placing everything at equal potential, eliminating the possibility of the lineworker getting in series to ground.
- **MULTIPLE WORK LOCATIONS & SINGLE-PHASE GROUNDING AT WORK LOCATION** – If work is to be performed at more than one place in a line section, the line section shall be grounded at one location and the conductor be grounded at each work location to reduce the potential voltage difference across the work site.
- **OTHER LOCATIONS** – Grounds shall be placed at work location or at each side of the work location and as close as practical to it.

  TESTING WITHOUT GROUNDS – Grounds may be temporarily removed when necessary for testing. Each employee shall use insulating equipment and be isolated from any hazard involved. Additional measures may be necessary to protect each exposed employee is case previously grounded lines or equipment become energized.

  GROUND PERSONNEL – In cases where ground rods or pole grounds are used for personal protective grounding, personnel working on the ground shall either maintain a safe distance from such equipment or use the appropriate equipment designed to prevent touch-and-step potential hazards. The term “touch potential hazard” refers to the difference in voltage measured between the grounding

equipment and a worker in contact with the grounding equipment at the time it is accidentally energized. The term “step potential hazard” refers to the difference in voltage measured between each foot of the worker standing or walking in an electrical field created by high voltage brought to earth.

9. INSTALLING OR REMOVING CONDUCTORS

Employees installing or removing conductors should follow certain guidelines to ensure safety.

1. WORKING ON ENERGIZED LINE OR EQUIPMENT

Employees working on energized lines or equipment should comply with the following.

- Work on electrical equipment and circuits other that electrical utility lines and equipment, operating a 50 V or more ground, should be worked on following the guidelines.
- Line or equipment carrying an ac voltage in excess of 600 V phase-to-phase should be worked on with rubber gloves or live line tools. All other necessary protective devices such as line hose, hoods, covers, sleeves, and rubber blankets should be used.
- Energized lines should be worked on from below whenever possible. When working energized lines or equipment carrying 600 V or more to ground, there shall be two qualified workers performing the work. Work shall not be performed on energized lines or equipment during rain, snow, sleet, fog, and other damp conditions, except in extreme emergencies if in the opinion of supervision and line crews it can be done safely.
- While working on the same pole, workers shall not work simultaneously on wires that have a difference of potential.
- Rubber gloves of appropriate voltage rating shall be worn when working within reach of a fellow employee who is working on or within reach of wires or equipment carrying voltage in excess of 600 V.
- Insulated tongs or disconnect sticks shall be used to open or close plugs or fuses or to disconnect blades.

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2. STRINGING OR REMOVING DEENERGIZED CONDUCTORS

Employees stringing or removing de-energized conductors should follow certain safe work practices. Consideration should be give to the following:

- When it is necessary to conduct any work on poles or structures carrying more that one circuit and where there is not safe working clearance between circuits, the conductors not being worked on shall be either:
  - United and separated with proper clearance from the pole or structure,
  - De-energized and grounded, or
  - Covered with the necessary protective devices.
- Prior to stringing operations, a job briefing shall be held setting forth the plan of operation and specifying the type of equipment to be used, grounding devices to be used and instructions to be followed, crossover methods to be employed, and clearance authorization required.
- Where there is a possibility that the conductor will accidentally contact an energized circuit or receive a dangerous induced voltage buildup, to protect the employee from the hazards of the conductor, the conductor being installed or removed shall be grounded or provision made to insulate or isolate the employee.
- If the existing line is de-energized, proper clearance authorization should be secured and the line grounded on both sides of the crossover, or the line being strung or removed should be considered and worked on as energized.
- When workers cross over energized conductors, rope nets or guard structures shall be installed unless provisions are made to isolate or insulate the workers or the energized conductor. Where practical, the automatic re-closing feature of the circuit-interrupting device should be made inoperative. In addition, the line being strung should be grounded on either side of the crossover or considered and worked on as energized.
- Conductors being strung or removed should be kept under positive control by the use of adequate tension reels, guard structures, tie lines, or other means to prevent accidental contact with energized circuits.
- Guard structure members should be sound, or adequate dimension and strength, and adequately supported.
- Catch-off anchors, rigging, and hoists should be of ample capacity to prevent loss of lines.
- The manufacturer’s load rating should not be exceeded for stringing lines, pulling

lines, sock connections, and all load-bearing hardware and accessories.

- Pulling lines and accessories should be inspected regularly and replaced or repaired when damaged or when their dependability is doubtful.
- Conductor grips should not be used on wire rope unless designed for this application.
- While the conductor or pulling line is being pulled (in motion), workers should not be permitted directly under overhead operations, nor should any employee be permitted on the crossarm.
- A transmission clipping crew should have a minimum of two structures clipped between the crew and the conductor being sagged. When working on conductors, clipping crews should install grounds at the work location. The grounds should remain intact until the conductors are clipped in, except on dead-end structures.
- Except during emergency restoration activities, work from structures should be discontinued when adverse weather (such as high wind or ice on structures) makes the work hazardous.
- Stringing and clipping operations should be discontinued during an electrical storm in the immediate vicinity.
- Reel-handling equipment, including pulling and braking machines, should have ample capacity, operate smoothly, and be leveled and aligned in accordance with the manufacturer's operating instructions.
- Reliable means of communication between the reel tender and pulling rig operator should be provided.
- Each pull should be snubbed or dead-ended at both ends before subsequent pulls.

2. STRINGING ADJACENT TO ENERGIZED LINES

Employees stringing adjacent to energized lines should follow certain safe work practices.

Consideration should be given to the following:

- When performing work from structures, clipping crews and all others working on conductors, sub-conductors, or overhead grounding conductors should be protected by individual grounds installed at every work location.
- When workers are stringing adjacent to energized lines, the tension-stringing method or other methods that prevent unintentional contact between the lines being pulled and any worker should be used.
- All pulling and tensioning equipment should be effectively grounded.

- A ground should be installed between the tensioning reel setup and the first structure to ground each bare conductor, sub-conductor, and overhead grounding conductor during stringing across or adjacent to energized lines.
- During stringing operations, each bare conductor, sub-conductor, and overhead grounding conductor should be grounded at the first tower adjacent to both the tensioning and pulling setup and at appropriate intervals. The grounds should be left in place until conductor installation is completed. Except for moving-type grounds, the grounds should be placed and removed with a hot stick.
- Conductors, sub-conductors, and overhead grounding conductors should be grounded at all dead-end or catch-off points.
- A ground should be located at each side and within 10 feet of working areas where conductors, sub-conductors, or overhead grounding conductors are being spliced at ground level. The two ends to be spliced should be bonded to each other. It is recommended that splicing be carried out on either an insulated platform or on a conductive metallic grounding mat bonded to both grounds. When a grounding mat is used, it should be roped off and an insulated walkway provided for access to the mat.

10. SPECIAL TOOLS

Lineworkers shall be familiar with special tools that are used for climbing, such as climber gaffs, climber straps, and body belts shall properly store and maintain such equipment.

1. LINEWORKER'S CLIMBING TOOLS

Employees should apply the following:

- All climbers should be inspected frequently by the worker using them.
- Climber gaffs should be kept sharp.
- A climber shall not be used when its gaff becomes shorter than 1-1/4 inch inside measurement.
- Climber straps that are worn or otherwise defective shall be replaced.

2. BODY BELTS & SAFETY STRAPS (Limited Usage)

Note: The use of a full body harnesses with positioning rings will be used whenever possible.

Employees using body belts and safety straps (work positioning equipment) should apply the following:

- All body belts and safety straps shall be inspected before each use by the employee who uses them. Workers shall use their body belts and safety straps when doing any work involving danger of falling.
- Body belts and safety straps should not be stored with unguarded sharp tools or devices.
- Heat, sharp bends, and over stressing of body belts and safety straps should be avoided as they are injurious to leather. Wet leather should be dried slowly at moderate temperatures.

3. TOOL BAG & EQUIPMENT

Tools, small equipment, and materials should be raised and lowered in a tool bag. The tool bag should be inspected before each use to see that it contains no broken glass or other material (sharps) on which the employee could cut his or her hand or rubber gloves. Tool bags should not have any metal in their construction.

4. TAPES & RULERS

Workers should not use metal measuring tapes or tapes having metal strands woven into the fabric, brass bound rules, or metal scales when working near electrical equipment or conductors.

5. SPOON & SHOVELS

Tools of this type, especially those having long wooden handles, shall not be used when the handles are cracked, split, or broken.

6. PIKE POLES

Pike poles shall comply with the following:

- Cracked, broken, or slivered pike poles should not be used;
- Pike poles should not be thrown; and
- When not in use and loaded on the truck, the points should be protected so that they will not injure anyone.

7. HAND AXES & SHARP TOOLS

Hand axes and sharp tools shall comply with the following:

- Hand axes should not be used on overhead work; and
- When not in use, sharp tools should be protected by the suitable guards or containers.

8. HANDLINE & TAGLINES

Use high quality, non-conductive hand-lines and tag-lines. Keep them stores in a clean, dry location and protected from damage and contamination. Wear clean gloves when handling hand-lines and tag-lines to avoid contaminating the rope. Remove wet, dirty, or damaged rope from service.

11. UNDERGROUND

Underground work requires a means of safe entrance and exit from the workspace. Employees should follow the guidelines given in the following subsections to ensure safety in entering and leaving such work spaces.

1. WORKING IN MANHOLES, UTILITY TUNNELS & VAULTS

Manholes, utility tunnels, and vaults may be considered confined spaces and shall comply with the following:

- Employees who enter manholes shall be trained in the hazards of the confined spaces, confined space entry procedures, and confined space emergency and rescue procedures.
- When opening a manhole, employees shall completely remove the manhole cover from the opening. Manhole covers should be removed before the cable is rodded or installed and removed.
- Open manholes shall be barricaded and protected by flags or guards as required.
- Before the pit is entered, it shall be tested for oxygen content and the flammable-gas explosive limit. Workers shall not smoke or use open flame while tests for an explosive mixture of gas are being made.
- If the oxygen level is less than 19.5% or greater that 21%, the pit shall be ventilated and retested before any work begins.

- If the flammable-gas content is more than 10% of the lower explosive limit, the pit shall be ventilated and retested before any work begins. When testing indicates that a manhole contains either a mixture or explosive gas and air richer than safe working limits or flammable liquids, corrective measures shall be taken before work in the manhole is allowed to proceed.
- When nitrogen is used in manholes or confined areas, approved atmosphere testing devices shall be placed in operation where they can be observed by people in the manhole. When the testing device shows a deficiency of oxygen, all personnel shall leave the manhole until the proper atmosphere is restored.
- The manhole shall be ventilated continuously when occupied.
- An attendant is required topside with the means to summon help without leaving his or her station. The attendant shall be capable of instituting a rescue without entering the manhole. The attendant on the surface is responsible for the safety of the persons in the manhole.
- The topside attendant can perform other duties outside of the enclosed space if these duties do not distract the attendant from monitoring employees within the space. All manholes over 4 foot deep should be entered with the use of a ladder as required.
- Workers should open all entrance bars or chains on the topside of manhole guards before entering or leaving a manhole. All chains or bars should be closed at all other times, except when raising or lowering tools or materials.
- Operations involving chemical cleaning agents, solvents, volatile chemicals, cutting and welding equipment, and other hazardous agents or tools require additional consideration. Consultation with and concurrence of appropriate industrial safety and industrial hygiene personnel are required.
- The employees shall enter or leave a manhole by means of a ladder. The employer shall not use a cable, cable hanger, or manhole rack as a support for climbing. A manhole ladder should never be removed while a worker is in the manhole unless absolutely necessary. In the instance of a ladder being removed to make it easier to rescue a worker, the topside attendant shall fully devote his or her attention and efforts to instituting a rescue using the worker's body harness and lifeline if necessary. The ladder shall be replaced as soon as practical.
- Materials, tools, and equipment should be kept at a sufficient distance from the entrance to the manhole to avoid any hazard to the occupant from falling objects or from hot metal or spilled creates additional hazards.
- Blowtorches and furnaces should be ignited before being lowered into manholes unless this creates additional hazards.

- Rags, tape, refuse, and combustible and flammable materials should not be allowed to accumulate in a manhole.
- Instrumentation shall be calibrated per manufacturer's instructions. A record of calibration should be maintained.
- Ground-fault circuit interrupters (GFCIs) shall be used for 120-V ac power unless such power is supplied by a portable or vehicle-mounted two-wire, single-phase generator rated not more than 5 kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces.
- All cables and insulated wires that do not have grounded conducting sheaths or shielding should be treated as bare conductors. They shall be considered energized unless approved methods have been used to determine that they are de-energized. Barricade or cover these conductors with protective equipment or devices that will be within reach of a worker's position.
- Where multiple cables are present the cable to be worked on shall be identified by electrical means unless its identity is obvious. Where cable has one or more abnormalities that could be an indication of an impending fault, the defective cable shall be de-energized, except when service load conditions and a lack of feasible alternatives require that the cable remain energized. In that case, employees may enter the manhole if they are protected by the affects of the failure by flash blankets or other devices capable of containing the adverse effects of the fault.

12. WORKING ON ENERGIZED UNDERGROUND CABLES

In general, work should be performed on energized underground cables. However, strictly external work, not requiring an appreciable change in location of the cable, may be performed under direct supervision.

1. TERMINALS OF UNDERGROUND CABLES (POTHEADS)

   Before work is started, the overhead line connections to a cable terminal upon which work is to be performed should be either:

   - De-energized and grounded or
   - Disconnected and covered with protective equipment.

13. FERRO-RESONANCE

Ferro-resonance can generate over-voltages of up to 12 times line-to-ground source voltage upon opening of a single-phase device or a poorly synchronized three-phase device. Violent failure can occur, exposing personnel to the high-voltage failure and accompanying

conditions. Ferro-resonant conditions can result in damage to lightning arresters, switching devices, buried cable, transformers, and associated equipment.

Ferro-resonance can be initiated when all of the following elements are present and the switching means at dip point or takeoff is either a single-phase device or an unsynchronized three-phase device that does not operate all phases within ½ cycle.

- System grounded at the source but with no ground at the transformer bank, such as a transformer or transformer bank connected delta on a grounded-wye system.
- Shielded cable or overhead conductor length sufficient to create the capacitance necessary.
- Transformer size that permits saturation of the iron core at the operation voltage.
- Transformer unloaded or very lightly loaded.

Prevention or control of ferro-resonance may be accomplished by any of the following measures:

- Using a wye-wye transformer connection with both neutrals grounded and tied to the system's neutral.
- Using only phase-to-neutral (not phase-to-phase) transformer connections for single-phase transformers.
- Limiting length of underground cable between transformers and single-pole or poorly synchronized three-pole switching devices.
- If single-pole or poorly synchronized switching devices must be used, ensuring that transformer and underground cable are loaded in excess of 2% resistive load of the transformer capacity.
- If transformer primary is ungrounded-wye, temporarily grounding the neutrals of the transformers being switched.
- Installing close-coupled, high-speed, three-pole switching devices to minimize the duration of the single-phase condition during opening and closing of the circuit.