Contents

ELECTRICAL SAFE PRACTICES, GENERAL

A. PURPOSE/SCOPE/RESPONSIBILITY

1. **Purpose, Scope, and Responsibility -** The WESTLAKE series of standards describe general safe practices and protective measures that should be followed in working on or near electrical circuits and equipment. Their purpose is to prevent accidents and all inadvertent contact with energized electrical circuit components. The guidelines listed in this document serve as basic expectations for performing electrical work safely in the WESTLAKE Lake Charles complex. Particular circumstances may require additional safety precautions not specifically outlined in this document. It is every employees responsibility to ensure that sufficient safety precautions are taken before performing energized work.

2. **Periodic Review -** Because personnel are constantly changing and because the electrical equipment and circuits are subject to constant change, it should not be assumed that any standard or procedure remains always valid. To maintain a safe work environment, safety-related standards and procedures should be routinely reviewed and updated to reflect current conditions.

3. **Specific Procedures -** It should not be assumed that all safe practices are included in the WESTLAKE series of standards. Additional, and possibly more detailed procedures, may be required to suit particular types of equipment, operation, area, or personnel situation. These procedures and practices should be established well in advance of any work assignment to prevent the necessity for "last-minute" decisions.

B. REFERENCES

NFPA 70E – Standard for Electrical Safety in the Workplace, the most current edition shall be used.

OSHA 1910.137, 1910.331 through 1910.335. The most current edition shall be used.

C. GENERAL

C.1. **Importance of Electrical Safe Work Practices -** Any work performed on or near electrical circuits or equipment requires careful planning and a high degree of caution if the work is to be performed safely. Failure to recognize and plan for the hazards that are present can result in a fatal or very serious injury. Electricity is silent and most energized components are generally located behind enclosures. This makes it difficult to recognize the hazard unless one has some familiarity with electrical circuits, electrical equipment, and the nature of electricity. The very low amount of current/voltage that can cause death or injury and the tremendous amount of energy/temperature present in an electrical fault underscores the necessity for developing a comprehensive electrical safety program. Some of the key factors in preventing incidents are: **organization, adequate procedures, trained personnel, job planning** and **auditing.**

C.2. **Management Framework -** One of the basics in designing, implementing and monitoring a high quality safety program is a management framework. The Joint Safety Committee Electrical Area Team has been formed at the Lake Charles complex to oversee our plant electrical safety program. However, the authority of the ESS does not relieve Line Management or the individual of their responsibilities regarding safety.

C.3. **Hazard Analysis –** An analysis of the potential electrical hazards shall be conducted before each job. This is discussed in more detail in sections D and H of this standard.

C.4. **Standard Procedures -** Procedures are another valuable tool that can be used to accomplish electrical work safely. It is imperative that adequate, up-to-date procedures exist governing all work on or near electrical circuits and equipment. These procedures would govern the requirements of **all crafts** whose duties necessitate work near electrical circuits or equipment.

C.5. **Visual Safety Indicators -** There are some other "safety tools" which are discussed throughout this standard and which should be used in implementing a site electrical safety program or in the planning and execution of various electrical jobs. Some of these "Safety Tools" are "Warning Signs" (see section J), "Schematic Diagrams" (see section K), and "Identification Labels" (see section J).

C.6. **Safety Planning -** Even with a management structure in place, and with all the "tools", procedures, and training present there are still several safety variables present. This is the reason planning and auditing are critical. These are discussed in more detail in section D - Safety Planning - of this standard.

D. SAFETY PLANNING

D.1. **Planning Overview -** The special hazards associated with electrical work intensify the need for thorough planning from a safety perspective. Each job should be analyzed carefully to assure that safe working conditions are secured. No work should be attempted until there is assurance that it can be done safely. Much of the work that is performed on any site is done by individual mechanics. Planning that work from a safety perspective should be done by that individual. However, there are many instances when a job is so extensive, such as an area shutdown or where several workers are involved, that a more formal approach may be required.

An Electrical Safety Team should be formed for the specific purpose of performing safety planning. This type of approach could also be used when contractors perform work on a site. In none of these cases does the formation of such a team remove the need of the individual to plan his own individual tasks from a safety perspective. Electrical work must be planned from two different perspectives - (1) the work to be accomplished - and (2) the safety considerations that must be in place to accomplish the work safely.

a. **Safety Planning Checklist -** The following checklist provides a good framework for planning any job:

1. **IDENTIFY:**
   What are the hazards?
   What voltage levels are involved?
   What skills are required?
   Is the equipment "high energy?"
   Unusual work conditions?
   Is the job a two man job?
   ...Determine hazard level of job.
   What PPE levels are required?

2. **ASK:**
   Can the equipment be de-energized for work?
   Is a standby person required?
   Are there any potential back feeds?
   Is an energized work permit needed?

3. **CHECK:**
   Job plan.
   Blueprints.
   Safety Procedures.
   Vendor Information.
   ...Is the information up-to-date?

4. **KNOW**
   What is the job?
   Who is in charge?
   Who else needs to know?
   ...Communicate with them.

5. **THINK:**
   About the "extra" event" ...the "what if..." the "unexpected"
   Lock - Tag - Test - Try.
   Test for voltage on known live source.
   Install grounds and remove grounds.
   Use right tools and equipment
   ...What else

6. **PREPARE** for an emergency...
   Standby person CPR trained?
   Are radio communications available?
   Where is the telephone?
   Where is the fire alarm?
   Extinguisher?
   Telephone number for Emergency Response? 5700
   What is the work location?
   How do I shut off the equipment in an emergency?
   Where is the emergency equipment?

...Is the equipment available?

DON'T BE AFRAID TO ASK AND ANSWER QUESTIONS ABOUT THE JOB!!!

D.2. **Determining Hazard Level** - One of the very first steps in planning a particular job is to identify and assess the hazard potential that is or may be present if something goes wrong. Once this is identified then steps shall be planned to remove, isolate or minimize the hazard. Once the hazard is identified - shock, explosion or burns - the intensity of the hazard shall be assessed. Some of the following factors can be used to make this determination:

a. Voltage level present
b. Energy level present
c. Integrity of the equipment upon which work is to be performed.
d. Actual task to be performed
e. Posted Arc Flash Information

D.3. **Standby Personnel/Two Man Job** - An additional factor that should be considered in planning a job is to determine if the job requires more than one person to execute the job safely. Should it be determined that the job requires two persons to execute the job safely, it would be helpful to make a distinction between a "two-person job" and a job requiring a "standby person". **A two-person job** requires that both parties have similar qualifications around electrical, e.g., high voltage phasing, where a job requiring a **"standby person"** may require that the second person need only have some knowledge around emergency response techniques, perhaps emergency notification, and/or how to de-energize the circuit if necessary. Generally speaking this last bit of information can be communicated to someone before beginning a job. As a general rule, 2 workers should be present during any energized work, as well as any de-energized high voltage (>600V) work.

D.4. **Routine Work/Job Planning Requirements -** Much of our daily work is routine in nature in that it involves work that is done on a repetitive basis. Work of this type may not require a formal written plan for accomplishing the task. However, experience shows that the majority of serious electrical incidents occur when work of this nature is being accomplished. It is generally worthwhile to periodically develop a formal written plan for this type of work. This may be done in an auditing framework to check the validity of past work habits or assumptions. However, on jobs where there can be exposure to voltages of 440 volts or over, large jobs where several people are involved, or where system shutdown work is involved, a specific written job plan should be developed.

a. Where shutdown procedures or plans are prepared, they should include specially marked-up electrical drawings or switching lists which detail the electrical circuits involved.

b. Once a job plan is developed it should be followed without deviation. If unusual or unforeseen circumstances arise during the course of the job that have not been anticipated or planned for they will usually compromise safety. In such cases, the work shall be stopped and the job re-planned before continuing. Review of that segment of the job should be done as if it were a new job. Don't be trapped by changing circumstances. By far, the greatest number of injuries occur because an individual either did not plan completely or else they went beyond the job plan written or unwritten.

D.5. **Review -** Safety items and methods shall be discussed each time a new job is started. Each person needs to be alerted to possible dangers, given an opportunity to review the job, and make suggestions on how to reduce accident potential.

D.6. **Safety Equipment -** All required safety equipment shall be inspected and tested, as appropriate, prior to beginning any work.

D.7. **Barricades -** Securing access to a work area is the responsibility of supervision and assigned mechanics. Unauthorized personnel should be kept away from potential hazards by installing barricades, placing signs, closing gates, and stationing personnel as necessary.

D.8. **Emergency procedures** - in case of an accident shall be defined and clearly understood. These should include designating two "escape" routes, if possible. Verify radio communication with associated control room, fire extinguishers, fire alarm boxes, and safety showers, recording emergency numbers, locating job site within plant coordinates, and locating applicable emergency equipment.

D.9. **Responsibility -** On jobs where several people are involved, a single person shall be in charge and this person's authority shall be well known by the work force. However each person has stop work authority if any hazards are recognized.

D.10. **Operating Department Personnel -** Appropriate operating department personnel shall be actively involved in the planning of electrical shutdown work. They need to be made aware of starting times, temporary feeds, equipment that is affected, and areas to be barricaded. Shutdown notices should be sent to all affected parties for their comments prior to the shutdown.

D.11. **Review Meetings -** A shutdown meeting with people involved may be appropriate to review the scope of work and safety requirements. Each worker shall be positive he has received and understands all safety instructions. Oral communications should be repeated by the person receiving them to verify correct interpretation. When sequence or rigid adherence to a plan (or both) is essential, written procedures should be developed. Written instructions, procedures, and prints shall be readily available to the workers for reference.

D.12. **Supervision Planning -** All of the above steps basically address the planning required by the people involved in the work. There is an element of planning that involves only supervision. Supervision must make certain that the person that is assigned to perform the work has the necessary qualifications to perform the work safely. Section E gives some guidance in making this determination.

D.13. **Auditing -** It is also the responsibility of supervision to audit the planning process as well as the execution of the job plan. Auditing of the planning process can be done by examining the job site and by asking questions similar to those listed in D.1.a.

E. PERSONNEL QUALIFICATIONS

E.1. **General Requirements -** Electrical work, as defined in section H falls into four categories - Hot Work - Proximity Work - Other Hazardous Work

- and Non-hazardous Work. Electrical work, as defined by this standard, shall be done only by qualified personnel who are properly authorized to do such work.

E.2. **Qualified Person** – A qualified person shall be trained and knowledgeable of the construction and operation of equipment or a specific work method and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.

a) Such persons shall also be familiar with the proper use of the special precautionary techniques, personal protective equipment, including arc-flash, insulating and shielding materials, and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others.
b) Such persons permitted to work within the Limited Approach Boundary of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:

(1) The skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment
(2) The skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts
(3) The approach distances specified in Table 130.2(C) of NFPA 70E and the corresponding voltages to which the qualified person will be exposed
(4) The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely

c) An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the *direct supervision* of a qualified person shall be considered to be a qualified person for the performance of those duties.

d) Tasks that are performed less often than once per year shall require retraining before the performance of the work practices involved.

e) Employees shall be trained to select an appropriate voltage detector and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the employee to understand all limitations of each specific voltage detector that may be used.

E.3. **Responsibility of Supervision** - It is the **responsibility of supervision** to determine a particular individual's qualification for performing a particular job. It is also the responsibility of supervision to make certain that each assigned individual obtains the training necessary to keep these qualifications current.

F. EQUIPMENT CONSIDERATIONS

F.1. **Space Requirements -** Sufficient space shall be provided and maintained around electric equipment to permit ready and safe operation and maintenance of such equipment (OSHA 1910-303).

a. The workspace shall be adequate to permit at least a 90-degree opening of doors or hinged panels.

b. Where energized parts are exposed, the minimum clear workspace shall not be less than 6 feet 6 inches high (measured vertically from the floor or platform), and less than 3 feet wide (measured parallel to the equipment). The depth shall be as required in Table 1, Page 26.

c. The minimum clear working space in front of electric switchboards, control panels, switches, circuit breakers, motor controllers, relays, and similar equipment shall not be less than specified in Table 1, Page 26.

d. Working space is not required in back of equipment such as dead-front switchboards or control assemblies where there are no renewable or adjustable parts, e.g., fuses, switches, etc., on the back and where all connections are accessible from locations other than the back.

e. Where rear access is required to work on de-energized parts on the back of enclosed equipment, a minimum working space of 30 inches horizontally shall be provided.

F.2. **Illumination** - Adequate illumination shall be provided for all working spaces around electric equipment (OSHA 1910-303).

F.3. **Unguarded live parts -** above working spaces shall be maintained at elevations not less than specified in Table 2, Page 27.

F.4. **Access** - At least one entrance, not less than 24 inches wide and 6 inches high, shall be provided to give access to the working space around electric equipment (OSHA) 1910-303).

a. On switchboards and control panels exceeding 72 inches in width or rated 1200 amperes or more, there shall be one entrance at each end (NEC 110-16).

b. Where bare energized parts, at any voltage, are located adjacent to such entrance, they shall be suitably guarded.

F.5. **Permanent ladders or stairways** - shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, mezzanine floors, or in attic or roof rooms or spaces (OSHA 1910-303).

F.6. **New Equipment** - A combination of guarding (see section G), labeling (see section J), and interlocking shall be provided, when equipment is purchased, to minimize the possibility of accidental contact with energized parts. A site philosophy, to be uniformly applied, should be adopted specific to the equipment and personnel involved. For instance, a general guideline might be adopted to require two distinct physical actions before contact with live parts is permitted. The following are some examples which illustrate this philosophy.

a. Removing a cover from a 480-volt switchgear compartment reveals an insulating barrier over the cable lugs with "Warning - 480 Volts"

stenciled on the barrier. Contacting the "hot" lugs would require removing this barrier also.

b. A high-voltage switch is a keyed interlock with the door to the downstream fuses. Contacting the fuses, while energized, would require (1) opening the door and (2) defeating the interlock. Placing a sign on a door stating that energized equipment was present and explaining the purpose of the interlock could also be a major factor in preventing injuries.

F.7. **Grounds** - Permanent equipment ground connections and conductors are necessary for protection of personnel and equipment. Inspection and testing should be done on a periodic basis, consistent with the environmental conditions, to ensure integrity of the grounding system.

F.8. **Demolition** - Abandoned wiring is a subject not generally described by standards and codes, but should be addressed by plant policy. Where possible, all abandoned wiring should be physically removed. Minimum safe practice should include disconnecting and identifying cables(s) on both ends indicating the location of the opposite end. Abandoned conductor ends shall be individually insulated.

G. GUARDING ELECTRIC EQUIPMENT

G.1. **Guarding Requirements - Live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact (OSHA 1910-303).**

a. For voltages of 50 through 600 volts, this may be accomplished by any of the following means:

1. By location in an approved cabinet or enclosure.

2. By location in a room or vault that is accessible only to qualified persons.

3. By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts.

4. By location on a suitable balcony or platform so elevated and arranged as to exclude unqualified persons.

b. For voltages exceeding 600 volts, all of the provisions in G.1.a.1,2,3, and 4 apply. In addition, the following provisions also apply:

1. Installations that are open to unqualified persons shall be made with metal-enclosed equipment or shall be enclosed in a vault or in an area, access to which is controlled by a lock.

2. If metal-enclosed equipment is installed so that the bottom of enclosure is less than 8 feet above the floor, the door or cover shall be kept locked or securely fastened (see section J).

3. Electrical installations having exposed live parts shall be accessible to qualified persons only.

4. Electrical installations in a vault, room, closet, or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only. A wall, screen, or fence less than 8 feet in height is not considered to prevent access unless it has other features that provide a degree of isolation equivalent to an 8-foot fence.

5. The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 volts nominal shall be kept locked.

H. WORK INVOLVING ELECTRICAL HAZARDS

H.1. **Hazards Overview**

The preferred approach to work involving electrical hazards is to de-energize the equipment before work begins. This section provides guidance for work on or near energized equipment when the electrical hazards are present. This work is placed in four categories:

- **"Hot Work"**
- **"Proximity Work"**
- **"Other Hazardous Work"**
- **"Nonhazardous Work"**
- **"Troubleshooting"**

a. **Hazard Types -** There are four types of hazards associated with work on or near energized equipment:
   - Shock and burns due to physical contact
   - Arch Flash burns caused by high energy electric faults
   - Damage to equipment due to arcing or short circuited conductors
   - Upset or shutdown of an operating unit

b. **Personal and Other Protective Equipment**
Employees working in areas where electrical hazards are present shall be provided with, and shall use, personal protective equipment that is designed and constructed for the specific part of the body to be protected and for the work being performed.

c. **Signs and Barricades** shall be used when access to exposed energized parts is a concern. These signs and barricades are to be non-conductive and meet the requirements designated in NFPA 70E 130.7(E).

H.2. **"Hot Work"** is any work that requires physical contact with hands, jumper connectors or tools other than fuse pullers and hot sticks, or any exposed energized circuits above 50 volts ac or 100 volts dc to ground. "Hot Work" is the intentional contact with energized circuits for the purpose of loosening, changing, tightening, removing or relocating wires, cables or components, etc. (Voltage testing with approved instruments and test leads is not considered to be "Hot Work.")

a. **Approval -** The basic rule at WESTLAKE is that no one shall perform "Hot Work". However situations may arise that require "Hot Work". In such cases, specific approval shall be obtained as described in the current "Safety Rule Deviation" procedure, except for the case as stated in H.2.g. An Energized Electrical Work Permit shall be completed before any work is to begin. This permit will satisfy the safety deviation documentation requirement. This type work shall be performed only by qualified personnel who have adequate knowledge of the hazards involved. Specific procedures shall be developed for the work to be performed prior to beginning the work.

b. **High Energy Circuits -** "Hot Work" shall not be done on High Energy Circuits (see H.6). The explosive and heat energy released during potential fault conditions can be of such high value that Arc Flash personal equipment protection will not adequately protect the worker.

c. **Tools** - Approved tools for touching energized parts are voltage rated hot sticks and their attachments and fuse pullers used within their voltage rating. Approved tools include hand tools with voltage rated handles. All tools should be in accordance with NFPA 70E 130.7 D and should be inspected before each use. Also, see section L.

d. **PPE -** "Hot Work" always requires the person to wear the proper Arc Flash personal protective equipment. See Table 130.7(C)(9)(a) Hazard/Risk Category Classifications in NFPA 70E for proper Arc Flash PPE requirements while performing specific electrical tasks.

e. **Exemptions** - Work on chlorine cell circuits is exempt from this part of the standard. Changing brushes on generators is also exempt from this standard. See standard maintenance procedures for changing brushes on A Power and C Power generators.

f. **Requirements** - Work on energized equipment at the 120/240 VAC or 125/250 VDC level shall be allowed only if de-energizing the equipment would shut down a continuously operating process, or would cause or pose more hazard or risk than the proposed hot work. This type of hot work is acceptable only when approved by a qualified electrical supervisor.

g. **Standby Person -** "Hot work" should not be performed alone. A standby person shall accompany all "hot work."

H.3. **"Proximity Work"** is any work that requires working close to exposed and unguarded circuits or parts energized at voltage above 50 volts ac or 100 volts dc to ground. The distance limits which define "Proximity Work" are presented in Table 3. It is not the intent of "Proximity Work" to touch energized parts or circuits as in "Hot Work" and positive control must be provided to prevent inadvertent contact. (Voltage testing with approved instruments and test leads are not considered "Proximity Work".)

a. **Proximity Considerations** - Work near energized exposed and unguarded circuits or parts at voltages above 50 volts ac or 100 volts dc to ground that are outside the limits set in Table 3 but within the workman's reach may be classified as "Other Hazardous Work" (see H.4). Work at greater clearances should be given the same considerations as **"Proximity Work"** if, in the judgment of the personnel involved, unintentional contact with an unguarded energized part is possible.

b. **Precautions** - All "Proximity Work" should be avoided. If "Proximity Work" is required then an "Energized Electrical Hot Work Permit" must be filed out on any job on equipment rated at greater than 600 volts. Electrical shutdowns should be arranged whenever possible. Suitable barriers and barricades may be installed to prevent "Proximity Work" exposure. Adequate approval is necessary and specific instructions must be furnished. A standby person may be required.

c. **Worker Assurance** - Some work assignments routinely involve "Proximity Work" on 120 volt nominal control and lighting circuits. A person's safety must be assured by his knowledge of the potential hazards involved, his knowledge of good job practices and

procedures, and his wearing the recommended Arc Flash personal protective equipment.

d. **Precaution Variance** - The levels of approval and standby required may vary according to (a) the voltage level and the circuit energy level, (b) the type work being performed, (c) the type person performing the work, e.g., control mechanic, painter, etc.

e. **Rules of Approach** - No person shall be permitted to approach (or touch any conductive object without an approved insulating handle) closer to exposed energized parts than shown in Table 3 unless:

1. The person is wearing the proper Arc Flash personal protective equipment for the task as stated in Table 130.7(C)(9)(a) Hazard/Risk Category Classification in NFPA 70E, or
2. The energized part is insulated or guarded from the employee and any other conductive object at a different potential, or
3. The employee is isolated, insulated or guarded from any other conductive objects(s).

H.4. **"Other Hazardous Work"** is any work that exposes the employee to energized equipment or circuits where additional adequate safety procedures are required to limit employee exposure to electrical shock, arc flash burns and arc blasts. Some of this work will require that specific safety procedures shall be developed for each task and specific management approval obtained for same. Some "Other Hazardous Work" may be routine and blanket management approval may be obtained.

"Troubleshooting" is the use of voltage and/or current measurement tools to determine proper operation of electrical equipment and/or electrical components.

NOTE: Once operation of electrical equipment and/or electrical component(s) in question has been determined, the electrical circuit shall be de-energized before electrical equipment and/or electrical component(s) is removed or repaired.

a. **Voltage Testing** - All voltage testing of power and lighting circuits above 50 volts ac and 100 volts dc to ground is considered **"Other Hazardous Work"**. Voltage testing circuits during troubleshooting in enclosures sources should be avoided whenever possible or special procedures outlined in NFPA 70E must be instituted to protect employees from electrical shock and arc flash burn hazards. (Use proper recommended test equipment listed in table 6.)

1. The following are examples of **"Other Hazardous Work"**. (It should not be assumed that this list is complete.)

a. Insertion and removal of a plug-in element into and out of energized motor control centers and similarly functioning equipment (see P1.4G).

b. Troubleshooting and testing energized starters in motor control centers and substation equipment.

c. Operating power switches and/or breakers in substations, either primary or secondary.

d. Installation and removal of insulating barriers such as hoses, blankets, snakes, etc.

e. Installation and removal of safety grounds where energized circuits are nearby.

f. Phasing of electrical circuits utilizing the proper test equipment and methods.

g. Changing energized fuses (use approved insulating tools such as fuse pullers or hot sticks).

h. Work on high energy battery systems.

b. **Cable Tray Work** - Work in cable trays containing energized cable is classified as "Other Hazardous Work". The age, condition of cable insulation, type of cable construction and environmental conditions shall be considered in determining the degree of hazard of handling or contacting energized cables in cable trays or manholes. Walking, crawling, etc., on cables in cable tray shall not be permitted because of shock hazard to personnel and possibility of cable damage.

c. **High Energy Tasks -** The "Other Hazardous Work" category which includes "High Energy Tasks" must be performed by qualified persons using approved procedures and/or job plans. Power switching devices, e.g., disconnect switches and circuit breakers, including those in motor control centers, can fail with an explosive force releasing molten splatter and vaporized metal. The most likely time of failure to occur is when the device is being switched open or closed. This subjects operators and nearby personnel to an increased risk.

1. **Personal Stance** - Standing in front of a device while switching operations are being performed shall be avoided. Stand to the side that has the control mechanism, face away from the mechanism or device, and operate it with the hand closest to it. The person operating the switch should face the switch if he is wearing the proper Arc Flash personal protective equipment for a Hazard/Risk Category 0.

2. **Motor Starters** - Routine operation of the motor starter disconnect switch with the doors closed and latched does not require personal protection equipment other than that required by safety rules for persons working in the area. Where the motor control center does not comply with the physical construction requirements of A6-3101, and operation of energized substation breakers and switches (except medium voltage switchgear), where there is potential for electric arc flashes, requires personal protective equipment. A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the Arc Flash personal protective equipment that people within the Flash Protection Boundary shall use.

3. **CT's** - Testing energized substation control circuits that include protective relays is often required while they are in operation. The secondary circuits of current transformers (CTs)

will generate dangerously high voltages if open-circuited. This can result in electric shock to persons or failure of the CT (or both) and can propagate to a high-energy fault on nearby power conductors. For the purposes of this standard, this task category is classified "Other Hazardous Work". The task can be done safely provided:

a. The persons doing the testing are recognized as being qualified by the supervision responsible for the construction, testing and maintenance of the unit.

b. Arc flash personal protective equipment is worn when high energy components are exposed.

c. Extreme caution is taken to assure a low impedance path for the secondary current at all times. "Shorting screws" may be inserted in special "shorting" terminal strips to provide this path.

d. If these special terminal strips are not used, shorting jumpers may be used if they can be applied without opening the normal circuit.

e. **Caution:** The consequences of shunting out the current and losing the signal to metering and control devices should be evaluated. It may result in tripping of circuit breakers or temporary loss of fault protection.

H.5. **"Nonhazardous Work"** does not qualify for any of the three categories previously described and requires only that it be performed by qualified personnel. Example of this work is:

• Work on control circuits below 50 volts ac or 100 volts DC to ground. (Caution: The inadvertent shorting or grounding of these circuits may disrupt control power to operating units and cause production shutdowns.)

H.6. **Arc Flash Danger -** All four categories of work on or near energized equipment can involve "High Energy Tasks". Arcs in 480-volt motor starters can cause fatal burns at five feet. They can result in major burns at ten feet. Arc temperatures of 35,000°F are possible in high energy faults.

a. The heat produced by an electric arc is a function of the energy supplied to the arc. Dangerous arcs can be formed on voltages as low as 240 volts when the circuit is fed directly from a unit substation transformer with 240 volt secondary windings. Arc current is a function of the KVA rating of the unit substation transformer supply and the impedance of the conductors in the arc supply circuit. For this reason electrical equipment connected close to 480 volt unit substations is considered high energy devices (see H.6.4).

b. The temperature rise a person's skin experiences when exposed to an electric arc is a function of:

1. The surface area of the arc which is determined by the arc energy.

2. The distance the person is from the arc.

3. The time duration of the arc exposure.

4. The darkness of the person's skin or the cleanliness of the skin.

5. The heat radiated from metal surfaces behind the arc.

c. Many burns associated with arc flashes are the result of clothing ignition burning the person. Burning clothing temperature is about 1400°F and it can be next to a person's skin for sufficient time to cause third degree burns. Third degree burns can result from a skin temperature of 205°F for 0.1 second duration. Man-made fibers ignite easily and should be covered by designated Arc Flash personal protective equipment when persons are working near energized conductors or equipment.

d. Experience and engineering analysis has determined that the following energized facilities should be treated as potential sources of arc flash burns and work near them should be designated **"High Energy Tasks"** (see Figure 3).

1. All electrical distribution equipment operated at voltages above 600 volts.

2. Motor control centers and bus ducts.

3. Power panel boards fed directly from substation secondary breakers.

4. Other equipment fed directly from substation secondary breakers.

5. Any other equipment that an engineering analysis has determined has sufficient energy to cause arc flash burns.

e. As a general rule, Arc Flash personal protective equipment should be worn by persons working or standing by within the arc flash boundary of the exposed high energy parts. Opening enclosure doors for equipment inspection of high energy parts should be considered hazardous and should be limited to the maximum extent possible, and only as directed by NFPA 70E table 130.7(C)(9).

I. ISOLATING EQUIPMENT FOR WORK

I.1. **Procedure -** Electrical work on equipment and circuits that are connected to energized parts must be carefully planned and executed. All potential sources of voltage must be identified and plans made for positive control of all isolating devices. All of the following requirements for isolating electrical equipment for work must be satisfied:

a. Open isolating switches, breakers, or other isolating devices and visually check to verify they are open.

b. Lock the isolating devices in the open position (see I.2).

1. Exempt Cases Where Owner's Locks Are Not Required

- Owner's permission through a safe work permit must be received before beginning any electrical work.
- For work on single lock point 110 volt circuits the employee(s) performing the work shall control all job related energy sources.
- 240 volt and below breakers may be installed or removed from lighting panels by qualified employees (Service Mechanic Electrician/Contract Electrician) as outlined in OSHA 1910-303-308 and .332.
- Other exceptions for work on circuits 480v and below, the employee(s) performing the following work shall control all job related energy sources. These include:
  1. Lighting circuits
  2. Welding machines
  3. HVAC systems
  4. Temporary power
  5. Swapping motor rotation where work is performed within arm's reach and line-of-sight of the breaker.

c. Place "Danger - Do Not Operate" tag.

d. Verify that the correct isolating device has been opened by trying to operate electrically operated breakers, contactors and motor starters (see I.3). It is important that precautions be taken to ensure the safety of other personnel if in fact the equipment being "tried" actually starts due to incorrect lock-out.

e. When grounding a system for work to be done refer to document 2305-EL-2037, Temporary Grounding Procedure.

f. If the work involves exposure to any power or control wiring above 50 volts ac or 100 volts dc to ground, the circuits shall be tested (see I.4) and grounded as required (see I.5 and I.6).

g. Voltage testing energized circuits is classified as **"Other Hazardous Work"** and it involves working on parts not electrically isolated from power sources. Troubleshooting energized motor control center starters has been proven very hazardous and should be controlled by site procedures.

   1. The only exceptions to these requirements shall be specific jobs that have been approved for **"Hot Work"**.

h. All lockouts with multiple lock points are considered group lockouts and must also comply with WESTLAKE lockout procedure #4301-06-306.

I.2. **Visual Verification** - In order to properly lock-out equipment the fundamental rule is before locking out an isolating device, the device must be checked visually to verify the circuit is open. Several circumstances require extra precautions to ensure visual verification of an open circuit.

a. At **lighting panels** that have not been provided with manufacturer's lock-out provisions, a breaker must either be locked with an

individual breaker locking device (Brady 51252 or similar), or the breaker shall be turned off, voltage checked, circuit wire removed, and breaker tagged.

b. Where possible, **disconnect switches** shall be inspected to assure that all blades are in the full open position before locking. Some type switches in motor control centers have switch blades covered. In these circumstances, the fuses must be removed. **Caution:** Before removing the fuses, they must be tested for absence of voltage (see I.4).

c. **Draw-out switchgear** shall be withdrawn until a POSITIVE BREAK with the LINE and LOAD stabs occurs. The disconnect device and/or cubicle shall be locked in such a way as to prevent the disconnect device from being reconnected to the circuit. In some cases to obtain this POSITIVE BREAK may require removal of the device from the cubicle. In other cases this break may be assured by observation of the shutter position. If the circuit breaker remains in the cubicle, then it shall be operated to the DISCONNECT position rather than the TEST position. Note: In some cases withdrawal of this type of equipment from the cubicle subjects the equipment to moisture absorption which affects the safety and reliability of the equipment. Special consideration for equipment protection, such as space heaters, should be considered.

d. Some types of **oil circuit breakers** cannot be withdrawn. This type of equipment generally has isolating switches that can be opened and locked. In the case of single hook-operated switches, the method of locking out may require special procedures such as use of insulated chains, fuse removal, or use of insulated hot sticks with special features. **Caution:** On this type of equipment the circuit breaker must be open before opening or closing the isolating switches.

e. **Control circuit** locking does not provide the safeguards required for isolating equipment for electrical work and thus is not a valid locking method. In most cases the requirement that a visual disconnecting device be checked is not satisfied. Most electrically operated circuit breakers are equipped with a manual closing device which bypasses the electrical circuits. Control circuit failures can cause operation of motor starts, relays, and other contactors.

I.3. **"Trying" a circuit** means to operate a control device, after locking out the circuit, to verify that the power to the equipment through the starter, circuit breaker or other isolating device has been locked out.

When this step is performed, it is recommended to have a schematic diagram of the control circuit on hand to assure that the test is a positive one. It is possible that the equipment under consideration did not operate because of the position of some interlock and not because the correct power device has been locked out.

a. Caution: In the case of draw-out circuit breakers, it is possible for the circuit breaker to close and not operate the equipment. Before reinserting this type of equipment upon completion of the work, a visual inspection should be made to make certain the device is open before racking back in.

I.4. **Verification of De-energization -** All circuits shall be considered energized until positive verification by a voltage test with an

approved voltage tester (see section M and Table 6). The appropriate level of PPE must be used (see section L).

i. In order to limit the exposure time to potentially energized circuits or parts, a voltage tester shall be at the work place prior to removing any cover, door, barrier, or guard from uninsulated conductors or equipment.

j. Testers shall be functionally tested on a known source of the same voltage magnitude immediately prior to and after use to verify that the tester has not failed to operate properly.

k. In the case of multi-phase systems, verification of a de-energized circuit shall be made by measuring both phase-to-phase and phase-to-ground voltages.

I.5. **Safety Grounds -** Absence of voltage when testing for voltage should be taken at face value, i.e., there was no voltage at time of the test. Visible, adequate, maintenance grounds are to be properly applied to provide an assurance that conductors tested de-energized remain de-energized.

a. There are a number of ways voltage can reappear on a "de-energized" system.

1. Back-feeds from potential transformers
2. Undocumented alternate source(s)
3. Missed lockout(s)
4. Equipment not operating at time of test
5. Lightning
6. Induced voltage
7. Energized line contacting a de-energized line
8. Insulation failure (extension cord, etc.)

b. Maintenance grounds are required as final protection against back-feeds during all personnel contact with the conducting parts on the following electrical components:

1. All substation switchgear buses.

2. All feeders from substations. The grounds may be installed on the feeder load end with **"Proximity Work"** or **"Other Hazardous Work"** would be required to install the grounds in the substation switchgear compartments.

3. All open wire lines (on both sides of the work place).

c. All motors equipped with power factor correction capacitors must be grounded before motor work begins. All motor circuits above 600 volts using shield cable shall be grounded before motor work begins. Motor power leads (T_1, T_2, T_3,) are often difficult to ground. In these instances, "Temporary" maintenance grounds should be applied and then removed prior to beginning motor work. This will "drain" any residual stored energy from the circuit.

d. All grounds should be applied as if the circuit were energized, i.e., use appropriate tools and protective equipment. (The reason for this is that insulated cables can retain a capacitive charge

after they are de-energized. Some circuits, particularly open wires, can have an induced potential present.)

e. The ground conductor of a grounding cluster shall always be connected first and removed last.

f. Stored energy equipment, e.g., capacitors, may require grounding through properly sized resistors before applying safety grounds.

I.6. **Special Cases -** There are some special cases where grounding is required and special arrangements must be considered.

a. On an ungrounded system, one phase of an energized conductor may be grounded without any visible effect other than a small arc, provided there are no other existing ground faults on the system. For this reason, special steps must be taken to assure safety.

1. Use a test device that is designed for use on ungrounded systems to test for voltage prior to applying grounds. Any test device that measures voltage phase-to-phase rather than phase-to-ground is suitable. Generally, noncontact devices and single contact devices, i.e., hot-or-nots, **are not reliable** for ungrounded systems.

2. Check the source of the system to make certain there are no existing ground faults. These are generally detected by an installed ground detection system.

3. Verify that the ground detection system is working.

4. When maintenance grounds are applied, observe the ground detection system to make certain no change takes place. This observation should take place when the first conductor is grounded. No other conductors should be connected until there is verification that no change takes place on the ground detection system.

b. When work involves cutting medium voltage distribution insulated cables, the following special precautions should be taken:

9. Ground both ends of the cable, where practical.

10. Use a "spiking" tool to penetrate the insulation at the point of cut if the cable cannot be visibly traced from the point of cut to one of the two ends. An approved "spiking" tool is A. B. Chance Company cable penetrator tool set, Catalog No. C600 - 1625.

I.7. **Other general precautions** that should be observed when isolating circuits or equipment for work are listed below:

l. Disconnect, by removing fuses or racking out, all auxiliary devices such as potential transformers.

m. Account for and remove all grounds that were intentionally applied for protection prior to re-energizing.

n. Be aware of "other" voltage sources when isolating motor starter circuits.

J. LABELING, MARKING, AND IDENTIFICATION

J.1. **Purpose -** A uniform system of labeling, marking, and identification can significantly enhance safety. Some marking is required by OSHA (see J.2). This section also identifies some other steps that have proved very beneficial (see J.3 - J.7).

J.2. **Required Markings -** OSHA Part 1910 - Subpart S requires certain markings as follows.

o. Entrances to rooms and other guarded locations containing exposed live parts 600 volts or less shall be marked with conspicuous **warning** signs **forbidding** unqualified persons to enter {OSHA 1910 - 303(g)(2)(iii)}.

p. Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment rated over 600 volts shall be marked with appropriate **caution** signs {OSHA 1910 - 303(h)(2)(ii)}.

q. Where arc flash potential exists, equipment shall be labeled in accordance with NFPA 70E 130.7 E1.

r. Building services over 600 volts **warning** signs indicating the presence of high voltage shall be posted where other than qualified employees might come in contact with live parts {OSHA 1910 - 304(d)(2)(ii)}.

s. Covers of pull boxes and junction boxes containing circuits over 600 volts shall be permanently marked "High Voltage". The marking shall be on the outside of the box cover and shall be readily visible and legible {OSHA 1910 - 305(b)(3)(ii)}.

t. Termination enclosures for portable cables over 600 volts shall be suitably marked with a high voltage hazard **warning** {OSHA 1910 - 305(h)}.

u. The operating voltage of exposed live parts of transformer installations shall be indicated by **warning** signs or visible markings on the equipment or structure {OSHA 1910 - 305(j)(5)(ii)}.

v. Isolation or disconnect switches for capacitor banks that have no interrupting rating shall either be interlocked with the load-interrupting device or shall be provided with prominently displayed signs to prevent switching load current {OSHA 1910 - 305(j)(6)(ii)(a)}.

w. **"Danger"** labels shall be attached to induction and dielectric heating equipment and shall be plainly visible even when doors are open or panels are removed from compartments containing voltages of over 250 volts ac or dc {OSHA 1910 - 306(g)(2)(iv)}.

J.3. **Labels to Facilitate Switching -** When switching procedures and shutdown procedures are prepared, confusion can be avoided if all circuit breakers, switches, and starters are identified. This identification

should be attached (or painted) on the device and also included on all applicable single line and schematic diagrams (see section K).

J.4. **Multiple Sources of Power -** When starters contain external sources of power, it is required that warning signs be installed indicating that there is an external source.

J.5. **Underground Cable -** Identification marks should be attached to cables located in manholes. If practical, circuit identification tags should be attached to direct-buried power cables every 30 feet. This should be done at time of installation.

J.6. **Compartment/Cover Labels -** Compartment identification on the rear covers and on the floor will eliminate confusion regarding which cover to remove when the unit is one in a long line of equipment.

K. PRINTS AND DRAWINGS

K.1. **Importance -** It is usually difficult (and frequently impossible) to visibly trace electric power system and equipment circuits to assure the accuracy and completeness of circuit or equipment lockout. For this reason, each site **must maintain accurate and up-to-date single-line drawings and wiring diagrams.**

K.2. **One Line Diagrams -** Typically, design installation drawings are more complex than necessary for isolation lockout planning. Single-line drawings should be simple, legible, and up to date (see J.5).

K.3. **Accessibility -** Drawings must be readily accessible by authorized personnel. Distribution one-line diagrams are required to be posted in all MCC's.

K.4. **Troubleshooting -** Accurate schematic diagrams are necessary during troubleshooting activity. It is helpful if the applicable schematic drawings are referenced on the cover of motor starters.

L. WORK CLOTHES AND PERSONAL PROTECTIVE EQUIPMENT

L.1. **Importance -** The choice of appropriate work clothes is an important aspect in performing the job in a safe manner. All persons working around energized high energy equipment shall wear Arc Flash rated clothing if the tasks involve potential exposure to arc flash hazards. PPE provides a second line of defense against inadvertent contact with energized parts or burns resulting from electrical arcs. Work plans must include the personal protective equipment to be worn.

L.2. **PPE Selection -** The choice of personal protective equipment varies depending upon the type of work to be performed. However, there are certain particular requirements that should be observed when working around energized electrical equipment. The protection used shall be determined by the energized work permit (See H2.a.) or in NFPA 70E based on the task being performed.

A chart of tasks and corresponding PPE level can be found in Table 130.7(C)(9)(a), and PPE corresponding to PPE level can be found in Table 130.7(C)(10). These charts can also be found posted at the entrances of switchgear rooms.

Because the energized work permit is based on equipment specific parameters, the PPE described in the energized work permit shall supersede the PPE outlined in the general task requirements found in NFPA 70E. At the Lake Charles complex, the choice has been made to wear level 4 clothing for level 3 and level 4 tasks.

L.3 **Insulated Gloves -** Insulated gloves shall be worn any time contact or potential for contact is made with energized conductors. This includes the use of insulated tools. Insulated gloves shall be rated at or above the voltage present and shall be within testing compliance as defined in NFPA 70E 130.7.6 and OSHA 1910.137.

L.4 **Personal Item Precautions -** The following personal items shall not be worn while doing **"Hot Work"**, **"Proximity Work"**, or **"Other Hazardous Work":**

1. Metal jewelry such as rings, bracelets, necklaces, watches (metal band and/or body) tie clips, etc.
2. Key chains.
3. Ear muffs with metal frame or connecting strip.
4. Conductive objects in pockets that may fall into energized circuitry.

M. TOOLS AND TEST EQUIPMENT

M.1. **Proper Use -** All **"Hot Work"**, **"Proximity Work"**, and **"Other Hazardous Work"** shall be done with approved tools and test equipment. There are certain types of tools and equipment that should not be used around electric equipment due to the increased risk of contact with energized parts. These are shown in Table 4, Page 29. Each job must be analyzed for special guarding and tool requirements.

M.2. **Voltage Rated Tools -** Voltage rated tools are the only tools to be used for hot work. Never depend on plastic-dipped tool handles for electrical insulation. Plastic-dipped handles are for comfort and a firmer grip. They are not intended for protection against electric shock.

M.3. **Isolation of Nearby Hazards -** If the nature of a specific job involves handling conductive materials near energized parts, isolation of the hazard should be considered with properly inspected electrician's rubber goods or insulating barricades. These precautions should also be used when the exposure time of the job is such that attention of the work force may be diverted from the direct task of avoiding the hazard.

M.4. **Testing Device Inspection -** Voltage testers and multimeters with obvious defects (cracked case, broken switch, defective leads, etc.) must never be used. Only recommended voltage testers are to be used (see Table 6, Page 30). Solenoid type voltage testers are prohibited.

M.5. **Absence of Voltage Test -** Good electrical safety practice requires that all electrical conducting parts in operating electrical equipment be tested for absence of voltage before the part is considered de-energized. When the absence of voltage test is being done, the task is considered **"Other Hazardous Work"** for voltage levels above 50 volts ac and 100 volts dc to ground. An approved voltage tester must be used to test for presence or absence of voltage. Table 6 lists various types of test equipment and their recommended applications. The following

general principles should serve as guidelines when using test equipment.

a. Retractable, insulated tip, test leads are recommended.

b. Conduct periodic training in the proper use of test equipment. This training should include all the safety considerations to be followed. Some test equipment is used on energized equipment and can develop lethal voltages that require special safety precautions in use.

c. All high voltage testers shall be visually inspected before each use and tested immediately before and after each use on a known source. They shall be tested for insulation integrity as outlined in NFPA 70E 250.2.

M.6. **Safety Grounds -** Safety grounds shall be inspected for integrity before each use and tested and stored in accordance with NFPA 70E 250.3.

N. GENERAL PRECAUTIONS

N.1. **Emergency Action Permission -** In an emergency, any knowledgeable person may open circuits or stop moving equipment without authorization.

N.2. **Chemical Hazards -** Chemical hazards may be associated with electrical work. Check appropriate reference information as needed (see Table 5, Page 29). Analyze each job for injury potential. Check MSDS sheets for more information.

N.3. **Stored Energy -** Some electric equipment, e.g. switches and circuit breakers, contain stored energy mechanical devices. This always presents a hazard when performing normal maintenance overhauls. Vendor literature should be consulted before attempting any work of this type.

N.4. **Fuses -** A fuse gap should never be bridged with metal except in the grounded phase, or if used as an isolating device. A fuse rated higher than the capacity of the circuit should never be used in an ungrounded leg.

N.5. **Re-energization Precautions -** After a circuit is de-energized by a circuit protective device, the circuit may not be manually re-energized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or re-energizing circuits through replaced fuses is prohibited. If it can be determined from the design of the circuit and the over current devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is re-energized.

N.6. **Rotating Equipment -** Rotating equipment should normally not be operated without all guards in place. There are some occasions when this is necessary to obtain test data. When this occurs, a knowledgeable person should approve a temporary arrangement. The machine should be properly barricaded. Persons who will be exposed should not wear anything that could become entangled in any rotating part. This includes such items as jackets with loose tails, ties, rings, key

chains, etc. The safety precautions required during the changing of generator brushes while online is outlined in their own SMP.

N.7. **Motor Lead Disconnection -** When motor power leads are disconnected in the motor terminal box prior to motor removal, the motor leads must be protected from mechanical damage. The motor power leads (T Leads) from the starter should be bolted together with the ground and taped.

O. OTHER CONSIDERATIONS

O.1. **CPR** - It is recommended that all personnel who work around electric equipment be trained in cardiopulmonary resuscitation (CPR). This training should be kept current.

O.2. **Training** - Ongoing training of electrical personnel in electrical safety is imperative. Potential hazards should be reviewed between electricians and supervision prior to starting jobs that occur infrequently such as maintenance of power system components.

O.3. **Management of Change** – The modification of equipment can have serious impacts on the safety of personnel and facility equipment. Every form of equipment modification, other than replacement in-kind or like-kind, must be approved through the management of change (M.O.C.) process before being returned to service. It is the responsibility of every employee to verify that such an MOC exists before returning modified equipment to service. This includes, but is not limited to, any temporary installations, jumpers, deviations from established safety procedures, or equipment modification other than in-kind or like-kind. Refer to 2305-L-1 for more information.

TABLE 1 - MINIMUM DEPTH OF CLEAR WORKING SPACE IN FRONT OF ELECTRIC EQUIPMENT {OSHA 1910 - 303(h)(3)(i)}

	Conditions[2] (ft)		
Nominal Voltage to Group*	(a)	(b)	(c)
601 to 2,500	3	4	5
2,501 to 9,000	4	5	6
9,001 to 25,000	5	6	9
25,001 to 75kV[1]	6	8	10
Above 75 kV[1]	8	10	12

*See NEC Table 110 - 16A for 0-600 volt working clearances

Notes:

1. Minimum depth of clear working space in front of electric equipment with a nominal voltage to ground above 25,000 volts may be the same as for 25,000 volts under conditions (a), (b), and (c) for installations built prior to April 16, 1981.

2. Conditions (a), (b), and (c) are as follows: (a) exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on

both sides effectively guarded by suitable wood or other insulating materials. Insulated wire, or insulated bus bars operating at not over 300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces. (c) Exposed live parts on both sides of the workspace not guarded as provided in condition (a) with the operator in between.

TABLE 2 - ELEVATION OF UNGUARDED ENERGIZED PARTS ABOVE WORKING SPACE {OSHA 1910 - 303(h)(3)(iii)}

Nominal Voltages Between Phases	Minimum Elevation
480 to 7,500	8 ft 6 inches(1)
7,501 to 35,000	9 ft
Over 35 kV	9 ft + 0.37 in. per kV above 35 kV

Note:

1. Minimum elevation may be 8 ft 0 in. for installations built prior to April 16, 1981 if the nominal voltage between phases is in the range of 480-6,600 volts.

TABLE 3 - MINIMUM SAFE APPROACH DISTANCES TO UNGUARDED ENERGIZED UNINSULATED PARTS FOR PERFORMING ELECTRICAL OR NONELECTRICAL OPERATIONS

Nominal Voltage		Minimum Safe Approach Distance	
		Electrical Operation (2) (3) (4)	Nonelectrical Operation (3) (4)
Line to Line	Line to Ground	Ft.-In.	Ft.-In.
300V or Less		Avoid Contact	10 - 0
Over 300 Less Than 750V		1 - 0	10 - 0
Over 750 Less Than 2,000V		1 - 6	10 - 0
Over 2,000 Less Than 15,000V		2 - 0	10 - 0
Over 15,000 Less Than 37,000V		3 - 0	10 - 0
Over 37,000 Less Than 87,500V		3 - 6	10 - 0
Over 87,500 Less Than 121,000V		4 - 0	10 - 8
Over 121,000 Less Than 140,000V		4 - 6	11 - 0

Notes:

1. For intermediate voltage, use distances for next higher nominal voltage.
2. Minimum safe approach distance for work by qualified electrical personnel performing electrical operations unless protected in accordance with H.3e(1), (2), or (3).
3. Minimum safe approach distance for any unprotected part of a worker's body or for any conducting object being handled by the worker (see Figure 1 for example).
4. An energized work permit must be filled out for proximity work on energized equipment rated greater than 600 volts.

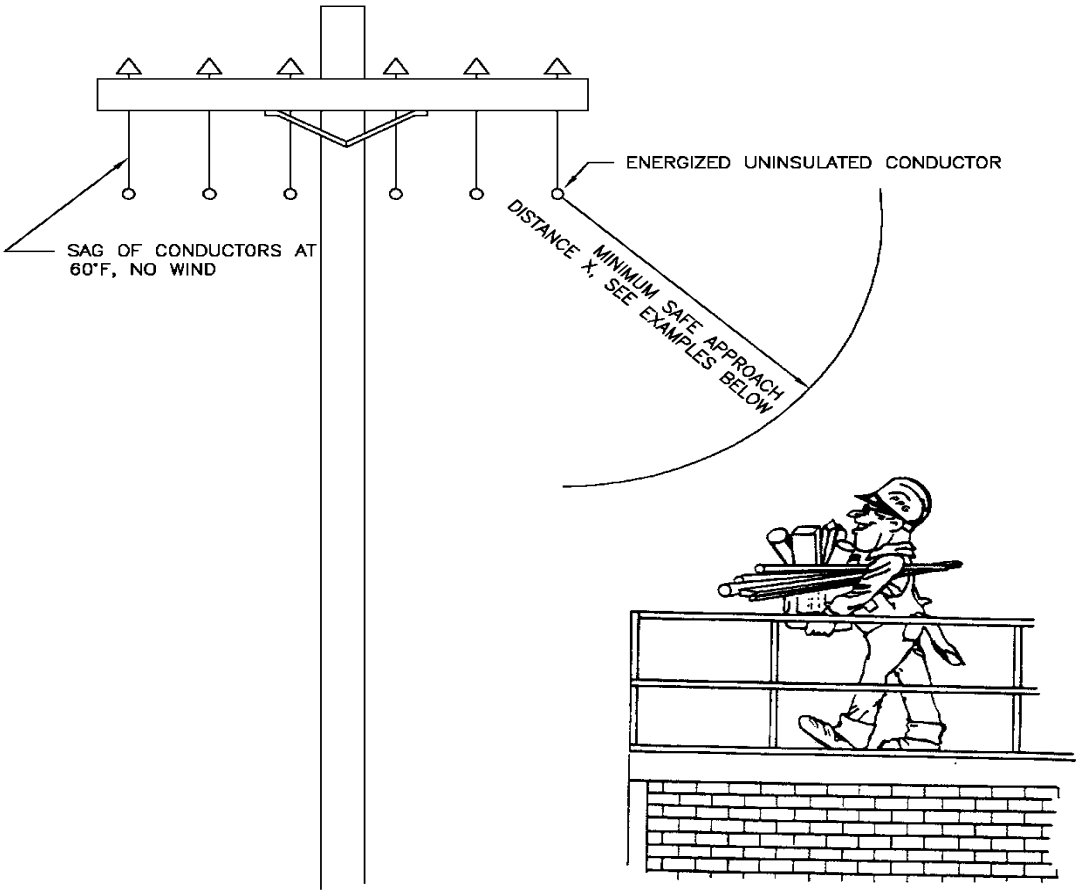

FIGURE 1 MINIMUM SAFE APPROACH DISTANCE(X)FOR NON ELECTRICAL WORK (See Table 3)

TABLE 4 - TOOLS FOR USE AROUND ELECTRIC EQUIPMENT

Prohibited	Acceptable Alternate
Metal ladders	Fiberglass or wood
Metal rules	Folding wood, 100 percent cloth, or plastic
Cloth rules with metal strands	Folding wood, 100 percent cloth, or plastic
Metal flashlights	Plastic or rubber cased flashlights

TABLE 5 - LIQUID HAZARDS AROUND ELECTRIC EQUIPMENT

Class of Hazard	Injury Potential	Reference Standards
Battery systems	Chemical burns from acid Explosive gases Electrical flash burns Electrical shock	See Related MSDA Information
Cleaning solvents	Fire and explosion	See Related MSDA Information
Insulating oil	Fire	See Related MSDA Information
Polychlorinated biphenyls (PCBs)	Toxic exposure Environmental impact	See Related MSDA Information

TABLE 6 - RECOMMENDED TEST EQUIPMENT

TASK	EQUIPMENT TYPE	MANUFACTURER/MODEL
Voltage testing	Multimeter	Fluke 87 or equivalent

Other tasks involve specialized test equipment and shall be approved by electrical supervision.

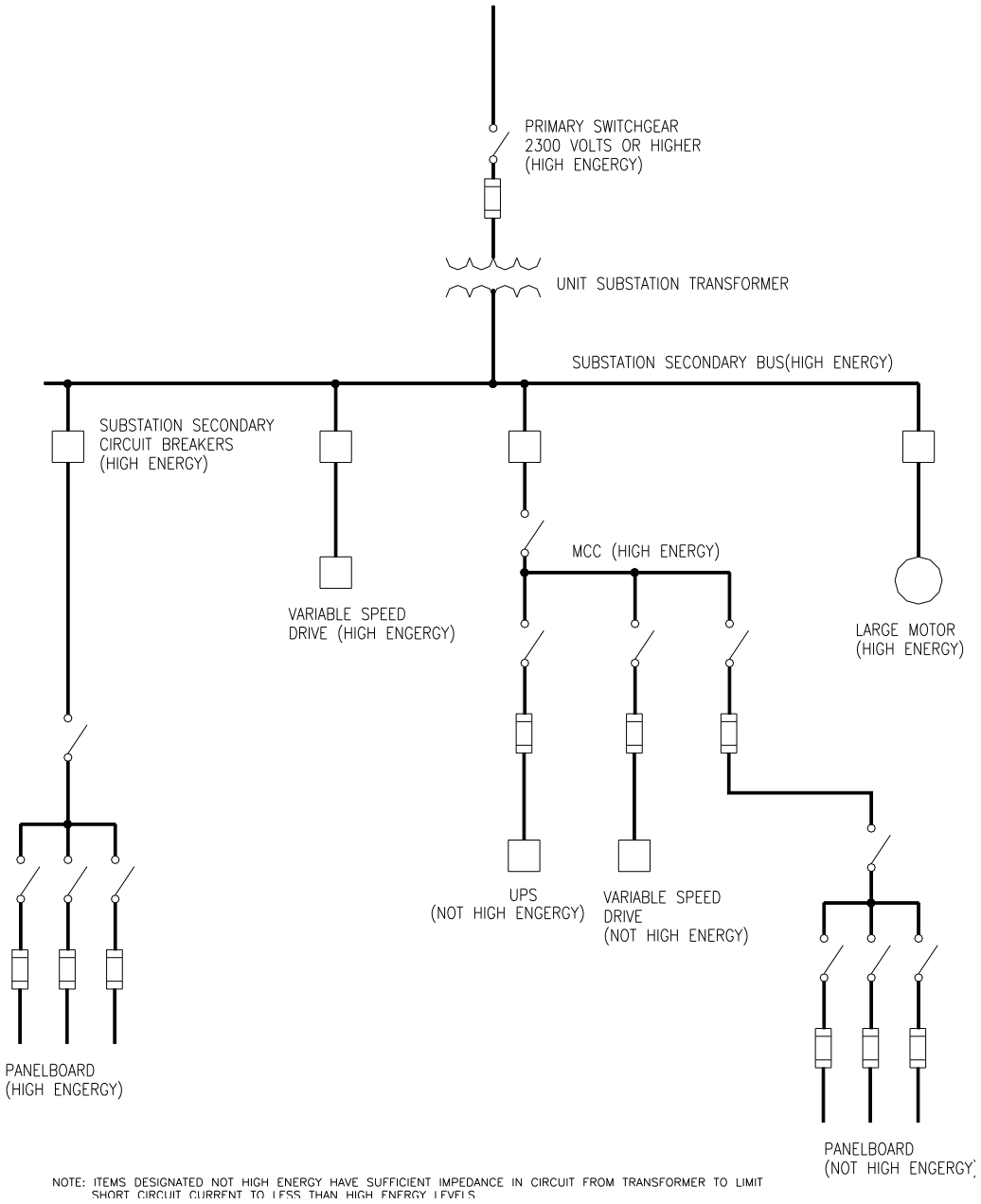

FIGURE 2 - TYPICAL HIGH ENERGY EQUIPMENT