

# **Mine Foreman Training**

## **Electricity and Apparatus**

### **Unit 6**

**Power Point Program and Training**  
**Developed by Wayne Collett**  
**Office of Mine Safety & Licensing**  
**2005**



## **352.010 Definitions related to electricity**

**(c) "Approved" means that a device, apparatus, equipment, machinery, or practice employed in the mining of coal has been approved by the commissioner of the Department of Mines and Minerals;**

**(k) "Face equipment" means mobile or portable mining machinery having electric motors or accessory equipment normally installed or operated in by the last open crosscut in any entry or room;**



## **352.010 Definitions (continued)**

**(m) "Gassy mine." All underground mines shall be classified as gassy or gaseous**

**(n) "High voltage" means any voltage of one thousand (1,000) volts or more**

**(o) "Imminent danger" means the existence of any condition or practice which could reasonably be expected to cause death or serious physical harm before the condition or practice can be abated**



## **352.010 Definitions (continued)**

**s) "Low voltage" means up to and including six hundred sixty (660) volts;**

**(t) "Medium voltage" means voltages greater than six hundred sixty (660) and up to nine hundred ninety-nine (999) volts;**

**(y) "Permissible" means that any equipment, device, or explosive that has been approved by the United States Bureau of Mines, the Mining Enforcement and Safety Administration, or the Mine Safety and Health Administration meets all requirements, restrictions, exceptions, limitations, and conditions attached to the classification;**



## **352.010 Definitions (continued)**

**(ag) "Working face" means any place in a coal mine at which the extraction of coal from its natural deposit in the earth is performed during the mining cycle;**

**(ah) "Working place" means the area of a coal mine inby the last open crosscut;**

**(ai) "Working section" means all areas of a coal mine from the loading point to and including the working faces; and**

**(aj) "Workmanlike manner" means consistent with established practices and methods utilized in the coal industry**



# **Basic Electrical Information and Terminology**

**Voltage - a force caused by a difference in electrical charge. The unit of measurement is the volt and the electrical symbol is an E.**



**Current flow – the movement of electrons in a material from negative to positive. The unit of measurement is the ampere (amps) and the electrical symbol is an I.**



**Resistance – opposition to the flow of current. The unit of measurement is the ohm and the electrical symbol is an R.**





**Electrical power – the rate of doing work and the basic unit of electrical power is the watt. The electrical symbol for power is the letter P. Power is measured in kilowatts, a quantity equal to 1,000 watts. One horsepower =746 watts.**



**Direct current (D.C.) – an electrical current that flows in only one direction.**



**Alternating current (A.C.) – an electrical current that changes level and reverses direction at regular intervals, usually 60 cycles per second.**



**Voltmeter – an instrument that is used to measure voltage.**



**Ammeter – an instrument that is used to measure current flow in amperes.**



**Ohmmeter – an instrument that is used to measure resistance.**



**The formula for Ohm's Law is:**

$$\mathbf{E = I \times R \text{ or}}$$

**Volts = Current (Amps) x Resistance (Ohms)**



**Short circuit – occurs when current takes a path outside its intended circuit.**





**Overload – the operation of equipment in excess of normal, full-load current rating, or of a conductor in excess of its rated current-carrying ability.**



**Series circuit – an electrical circuit having only one path for current flow.**



**Parallel circuit – an electrical circuit having more than one path for current flow.**



**Single-phase power – a condition when only one current is alternating. This system requires two power conductors and a grounding conductor.**



**Three-phase power – three instantaneous currents are alternating. This system requires three power conductors, a grounding conductor, and usually a ground monitoring conductor. Three phase power is more efficient than single-phase power.**



**Low voltage – up to and including 660 volts.**



**Medium voltage – voltages  
from 661 to 999 volts.**



**High voltage – voltages  
greater than 1,000 volts.**





**When low or insufficient voltage is provided to electrical equipment, it will over heat, will not operate efficiently, and it's operating life will decrease.**



**Excessive line loss or current loss can be avoided by using conductors with ample current-carrying capacity.**



**Capacitor – a device that stores energy. Capacitors should be properly discharged before working on electrical circuits or equipment.**



**All approved electrical equipment must be maintained in its original condition unless approved changes have been made.**



**To perform electrical work at a coal mine you must meet the requirements for qualification and certification prescribed by state and federal law. The law requires you to have experience performing electrical work under the direct supervision of a qualified electrician and pass a series of written tests as prescribed by the department.**



## **KRS 351.109 Requirements for qualification and certification to perform electrical work**

**(1) An individual is a qualified and certified person, within the meaning of this chapter, to perform electrical work, other than work on energized surface, high voltage lines, if he has at least one (1) year of experience under direct supervision of a qualified electrician in performing electrical work underground in a coal mine,**



## **KRS 351.109 Requirements for qualification and certification (continued)**

**in the surface work areas of an underground coal mine, in a surface coal mine, in a noncoal mine, in the mine equipment manufacturing industry, or in any other industry using or manufacturing similar equipment, and he attains a satisfactory grade on each of the series of written tests administered by the department**



## **KRS 351.109 Requirements for qualification and certification (continued)**

**(2) The series of written tests shall include, but not be limited to, the following subjects:**

- (a) Direct current theory and application;**
- (b) Alternating current theory and application;**
- (c) Electric equipment and circuits;**
- (d) Permissibility of electric equipment;**
- (e) Requirements of both federal and state laws; and**
- (f) Pertinent sections of the National Electrical Code.**





## **KRS 351.109 Requirements for qualification and certification (continued)**

**(3) A score of at least eighty (80) percent on each of the written tests shall be deemed to be a satisfactory grade. Recognition shall be given to practical experience in that one (1) percentage point shall be added to an individual's score in each test for each additional year of experience beyond the one (1) year minimum requirement specified in subsection (1) of this section; however, in no case shall an individual be given more than five (5) percentage points for such practical experience.**



## **351.109 Requirements for qualification and certification (continued)**

**(4) An individual may, within thirty (30) days from the date on which he received notification from the department of his test scores, repeat those sections on which he received an unsatisfactory score. If further retesting is necessary after this initial repetition, a minimum of thirty (30) days from the date of receipt of notification of the initial retest scores shall elapse prior to such further retesting, whereupon the entire series of written tests shall be retaken.**



## **KRS 351.109 Requirements for qualification and certification (continued)**

**(5) An individual qualified and certified in accordance with this section shall, in order to retain qualification and certification, satisfactorily complete annually a retraining program approved by the department.**

**(Note: the approved program requires eight (8) hours of training each year.)**



## **352.050 Transportation of underground mining equipment.**

**(1) After June 16, 1972, no machinery powered by an internal combustion engine shall be placed in use in underground workings unless the equipment is rated 'permissible' as described in KRS 352.010 for underground use, and the use of the machinery is approved by the commissioner of the Department of Mines and Minerals**



## **352.220 Electricity in mines and surface installations.**

**For purposes of this section, "approved" means that a device, apparatus, equipment, machinery, or practice employed in the mining of coal has been approved by the commissioner of the Department of Mines and Minerals or accepted by a nationally or federally recognized testing laboratory or the Department of Labor Mine Safety and Health Administration;**



## **352.220 Electricity in mines and surface installations - continued**

**“Suitable” means a design, material, or installation that meets the requirements of its intended use or that is accepted by a nationally or federally recognized testing laboratory or the Department of Labor Mine Safety and Health Administration.**



# **352.220 Electricity in mines and surface installations - continued**

**(1) The following shall apply to underground installations: (a) Nonconductive or insulated materials shall be used when trailing cables or high voltage feeder cables are suspended; (b) Suitable circuit-interrupting devices shall be provided for all power circuits and equipment at the mine; (c) All power wires and cables shall be properly insulated and protected by proper installation or guarding;**



## 352.220 - continued

**(d) Ground wires for circuits shall have a total cross-sectional area of not less than one-half (1/2) the power conductor; (e) Extra length or long trailing cables shall be spread out in long open loops or in a figure-eight configuration on a clean, well rock-dusted floor where the cable can be protected against mechanical injury, but cables suspended in long open loops shall be acceptable;**





## 352.220 - continued

**(f) One (1) temporary splice may be made in any trailing cable. No temporary splice shall be made in a trailing cable within twenty-five (25) feet of the machine except cable reel equipment. Splices in trailing cables shall be made in a workmanlike manner and shall be mechanically strong and well insulated. Splices made in cables shall provide continuity of all components;**



## 352.220 - continued

**(g) Three-phase alternating-current circuits used underground shall contain either a direct or derived neutral which shall be grounded through a suitable resistor at the power center, and a grounding circuit, originating at the grounded side of the grounding resistor, shall extend along with the power conductors and serve as a grounding conductor for the frames of all the electrical equipment supplied power from that circuit;**



## **352.220 - continued**

**(h) The frames of hand-held electrically driven tools shall be properly grounded or double-insulated by design. The frames of all pumps shall be properly grounded. Hand-held tools and all pumps shall be properly protected by suitable fuses, circuit breakers, or other no less effective devices to provide the minimum overload and short circuit protection required by the department;**



## 352.220 - continued

**(i) All underground high-voltage transmission cables shall be installed only in regularly inspected air courses and haulageways, and shall be covered, buried, or placed so as to afford protection against damage, guarded where men regularly work under or pass under them unless they are six and one-half (6-1/2) feet or more above the floor or rail, securely anchored, properly insulated, and guarded at ends, and covered, insulated, or placed to prevent contact with other circuits.**



## **352.220 - continued**

**Underground high-voltage cables used in resistance grounded systems shall be equipped with metallic shields around each power conductor, with one (1) or more ground conductors having a total cross-sectional area of not less than one-half (1/2) the power conductor, and with an insulated internal conductor not smaller than No. 10 (AWG) or an insulated external conductor not smaller than No. 8 (AWG) for the ground continuity check circuit. All cables shall be suitable for the current and voltage and shall be properly maintained;**



## 352.220 - continued

**(j) Power circuits shall have suitable disconnecting devices and short-circuit protective devices at or near the supply end of the circuit. Suitable disconnecting devices shall be provided at the beginning of all branch circuits; (k) Underground transformer stations, battery charging stations, substations, rectifiers, and water pumps shall be housed in noncombustible structures or areas or be equipped with a suitable fire suppression system.**



# 352.220 - continued

**1. When a noncombustible structure or area is used, these installations shall be: a. Ventilated with intake air that is coursed into a return air course or to the surface and that is not used to ventilate working places; or b. Ventilated with intake air that is monitored for carbon monoxide or smoke by an atmospheric monitoring system (AMS) installed and operated in a suitable manner. Monitoring of intake air ventilating battery charging stations shall be done with sensors not affected by hydrogen; or**



## **352.220 - continued**

**c. Ventilated with intake air and equipped with sensors to monitor for heat, carbon monoxide, or smoke. 2. The sensors used for monitoring shall de-energize power to the installation, activate a visual and audible alarm located outside of and on the intake side of the enclosure, and activate doors that will automatically close when any of the following occurs:**





## **352.220 - continued**

- a. The temperature in noncombustible structure reaches one hundred sixty-five (165) degrees Fahrenheit;**
- b. The carbon monoxide concentration reaches ten (10) parts per million above the ambient level for the area; or**
- c. The optical density of smoke reaches 0.022 per meter.**



## **352.220 - continued**

**3. At least every thirty (30) days, sensors installed to monitor for carbon monoxide shall be calibrated with a known concentration of carbon monoxide and air sufficient to activate the closing door, or each smoke sensor shall be tested to determine that it functions correctly.**



# 352.220 - continued

4. When a fire suppression system is used, the installation shall be:
  - a. Ventilated with intake air that is coursed into a return air course or to the surface and that is not used to ventilate working places; or
  - b. Ventilated with intake air that is monitored for carbon monoxide or smoke by an atmospheric monitoring system installed and operated in a suitable manner.



## **352.220 - continued**

- 5. All monitoring systems used to monitor intake air ventilating battery charging stations under subparagraphs 1. and 4. of this paragraph shall be done with sensors not affected by hydrogen.**



# 352.220 - continued

## 6. This paragraph shall not apply to:

- a. Rectifiers and power centers with transformers that either are dry type or contain nonflammable liquid, if they are located at or near the section and are moved as the working section advances or retreats;
- b. Submersible pumps;
- c. Permissible pumps, and associated permissible switchgear;



## **352.220 - continued**

- d. Pumps located on or near the section that are moved as the working section advances or retreats; or**
- e. Small portable pumps. Underground stations containing transformers or circuit breakers filled with flammable oil shall be provided with door sills or their equivalent, which will confine the oil if leakage or rupture occurs, and shall be of fireproof construction. Underground transformers purchased after June 16, 1972, shall be air cooled or cooled with nonflammable liquid or inert gas.**



## **352.220 - continued**

**Portable power centers, portable transformers, and distribution centers which are essentially fireproof are not required to be placed on separate splits of air but shall be stationed in well ventilated places outby the last open crosscuts;**



## **352.220 - continued**

- (l) Electrically powered locomotives shall be provided with suitable electrical protective devices;**
- (m) Suitable firefighting equipment shall be located at strategic points along the belt conveyor, and proper fire extinguishers shall be provided at the transfer points.**





## **352.220 - continued**

**The commissioner may prescribe any other safety measures for the prevention and combating of mine fires as they pertain to conveyor belts. Only approved flame resistant belting shall be taken into and used inside any mine, and all underground belt conveyors shall be provided with slippage and sequence switches and with start and stop controls at intervals not to exceed one thousand (1000) feet. The controls shall be properly installed and positioned so as to be readily accessible;**



## **352.220 - continued**

- (n) Communication wires and cables shall be adequately insulated and protected by proper installation or guarding;**
- (o) Telephone wires shall be provided with lightning arresters where the wires enter the mine and at the buildings on the surface;**
- (p) Insulating mats shall be placed in front of disconnecting devices and all electrical installations where required;**



## **352.220 - continued**

- (q) Ground wires in trailing cables shall be tested weekly for open circuit and high resistance;**
- (r) Power circuits in tipples, buildings, cleaning plants, etc., and all underground electrical circuits shall be deenergized when not in use over a long period;**
- (s) All underground power circuits and electrical equipment shall be de-energized before work is done on the circuits and equipment except when necessary for troubleshooting or testing.**



## 352.220 - continued

**When electrical work or major mechanical work is performed, a suitable disconnect providing visible evidence that the power is disconnected shall be locked open and a tag shall be posted by the individuals performing the work. Locks and tags shall be removed only by the persons who installed them, or if those persons are unavailable, by a person authorized by the operator. . Repairs or maintenance shall not be performed on machinery until the power is off and the machinery is blocked against motion, except where machinery motion is necessary to make adjustment;**



## **352.220 - continued**

- (t) Where electric circuits cross over or pass under belt conveyors the wiring shall be suitably protected; and**
- (u) Switch boxes, contactors, controllers, and all other similar devices shall be kept free of significant accumulations of combustible dust.**



## **352.220 - continued**

- (2) The following shall apply to trolley wires and trolley feeder wires:**
- (a) On all haulage roads, landings, and partings where persons are required to regularly work or pass under bare power wires placed less than six and one half (6-1/2) feet above the top of the rail, suitable protection shall be provided. This protection shall consist of channeling the roof, placing boards along the wires and extending below them, or the use of some other approved device that affords protection;**



## **352.220 - continued**

- (b) All machine feed conductors shall be placed on suitable insulators which shall be so placed as to prevent the conductors coming in contact with combustible or conductive materials;**
- (c) When the machine or feed wires are carried in the same entry as the trolley wire, they shall be placed on the same side as the trolley wire, between the trolley wire and rib, and shall be protected from contact therewith. Positive feed wires crossing places where persons are required to travel shall be safely guarded or protected against persons coming in contact therewith, as required by paragraph (a) of this subsection;**



## 352.220 - continued

**(d) All trolley and positive feed wires shall be placed on opposite sides of track from refuge holes or necks of rooms when so ordered by the department, but wires, when protected as required by paragraph (a) of this subsection, may be placed across the necks of rooms. Switches or circuit breakers shall be provided to control the current at the mine and all important sections in the mine;**





## **352.220 - continued**

- (e) Where track is used for the return circuit, at least one (1) side shall be bonded to the full length of the trolley wire installation. Cross-bonds shall be installed not to exceed two hundred (200) foot intervals along the track; and**
- (f) All mine locomotives shall be fused or otherwise protected at the switch or at the nip.**



## **352.220 - continued**

- (3) The following shall apply to surface installations:**
- (a) High-voltage lines shall be at least twenty (20) feet above the ground where there is a possibility of contact by traffic passing underneath;**
  - (b) Electrical circuits, wires, and cables shall be supported on insulators except when cables, which are of a design that can be safely used without insulators, are used;**



## **352.220 - continued**

- (c) Lightning arresters shall be installed on all ungrounded, exposed power conductors and telephone wires entering a mine, regardless of voltage. Overload protection and disconnect switches of suitable sizes and ratings approved by the department shall also be provided, except that they shall not be required of telephone wires;**
- (d) Every metallic building in which electricity is used or connected with any circuit shall be effectively grounded;**



## **352.220 - continued**

- (e) All transformer tanks shall be effectively grounded;**
- (f) Switch boxes, contactors, controllers, and all other similar devices shall be kept free of significant accumulations of combustible dust that create a fire hazard;**
- (g) Surface transformer stations shall be housed or fenced in when lower than fifteen (15) feet above the earth, and the fences shall be a minimum of six (6) feet in height; and**



## 352.220 - continued

**(h) All surface power circuits and electrical equipment shall be de-energized before work is done on the circuits and equipment except when necessary for troubleshooting or testing. When electrical work or major mechanical work is performed, a suitable disconnect providing visible evidence that the power is disconnected shall be locked open and a tag shall be posted by the individuals performing the work.**



## 352.220 - continued

**Locks and tags shall be removed only by persons who installed them or, if those persons are unavailable, by a person authorized by the operator. Repairs or maintenance shall not be performed on machinery until the power is off and the machinery is blocked against motion, except where machinery motion is necessary to make adjustments.**



## **352.220 - continued**

**When disconnects for stationary low and medium voltage equipment that do not provide visual evidence that the power is disconnected are used, an adequately rated voltage detector shall be used to test each phase conductor or circuit part to verify they are de-energized before any work is performed. When practical, confirmation that the voltage detector is operating satisfactorily shall be made before each test.**



## **352.230 Use of electrical equipment**

**For purposes of this section, "approved" means that a device, apparatus, equipment, machinery, or practice employed in the mining of coal has been approved by the commissioner of the Department of Mines and Minerals or accepted by a nationally or federally recognized testing laboratory or the Department of Labor Mine Safety and Health Administration;**





## **352.220 Use of electrical equipment - continued**

**“Suitable” means a design, material, or installation that meets the requirements of its intended use or that is accepted by a nationally or federally recognized testing laboratory or the Department of Labor Mine Safety and Health Administration.**



## **352.230 - continued**

**(1) All electrical equipment and all other electric-driven equipment except intrinsically safe equipment which is taken into or used in by the last open crosscut and in return airways in underground mines shall be permissible. The commissioner or his authorized representative shall reject any modification to mining equipment which would endanger the health or safety of employees.**



## **352.230 - continued**

**(2) Headlights shall be properly installed and maintained in a workmanlike manner and working order on all mobile and face equipment at all times the equipment is in operation.**

**(3) Headlights shall be mounted to provide maximum illumination where it will be most effective and shall be protected from damage by guarding or locations.**

**(4) At all times when mining equipment is being used, it shall be maintained in safe working order. Electrical equipment and circuits shall be examined and tested in a suitable manner by certified electricians to ensure safe working order.**



## **352.230 - continued**

**(5) Combustible materials, grease, lubricants, or flammable liquids shall not be allowed to accumulate where they can create a fire hazard.**

**(6) All electrical equipment utilized in intake airways outby the last open crosscut shall be maintained in safe operating condition and in accordance with the manufacturer's instructions.**



## **352.232 Use of electrical face equipment**

**(1) No person shall be placed in charge of electrical face equipment in any mine unless he is a qualified person capable of determining the safety of the roof, face, and ribs of the working places and detecting the presence of explosive gas. Operators of electrical face equipment shall undergo an examination to determine their fitness to detect explosive gas and shall have a minimum of forty-five (45) days of actual mining experience before they are permitted to have charge of electric face equipment.**



## **352.232 Electrical face equipment - continued**

**Safety committeemen, shotfirers, and others whose duty may require them to make inspections for gas shall undergo and pass an examination or possess a mine foreman's certificate before using an approved multi-gas detection device underground. The examination shall be given by the mine inspector. Blank forms for the examination shall be furnished by the department. A copy shall be retained on file at the mine office and the original shall be sent to the department fully made out and signed by the applicant and approved by the mine inspector.**



## **352.232 Electrical face equipment - continued**

**(2) No electric face equipment shall be brought in by the last breakthrough next to the working face until the equipment operator has made an inspection for explosive gas using an approved gas detection device or instrument in the place where the equipment is to work unless the inspection is then made by some other competent person authorized and appointed for that purpose by the mine foreman. If any explosive gas in excess of one percent (1%) is found in the place, the electrical equipment shall not be taken in until the gas is removed.**



## **352.232 Electrical face equipment - continued**

**(3) While the electric equipment is operating at the face, an examination for gas shall be made at not more than twenty (20) minute intervals. If methane gas is found in excess of one percent (1%) at any time, the power shall be de-energized from the equipment and left de-energized until the gas is reduced to less than one percent (1%) and the place determined safe by a foreman.**





# Permissible Electrical Equipment

**Permissible electrical equipment means any equipment, device, or explosive that has been approved by the U.S. Bureau of Mines, The Mining Enforcement and Safety**

**Administration, or the Mine Safety and Health Administration and meets all requirements, restrictions, exceptions, limitations, and conditions attached to such classification.**



**“Explosion – proof” means an enclosure is so constructed that it will withstand internal explosions of methane – air mixtures:**

**(1) without damage to, or excessive distortion of, its walls or covers and**

**(2) without discharge of flame from inside to outside the enclosure or ignition of surrounding methane – air mixtures.**

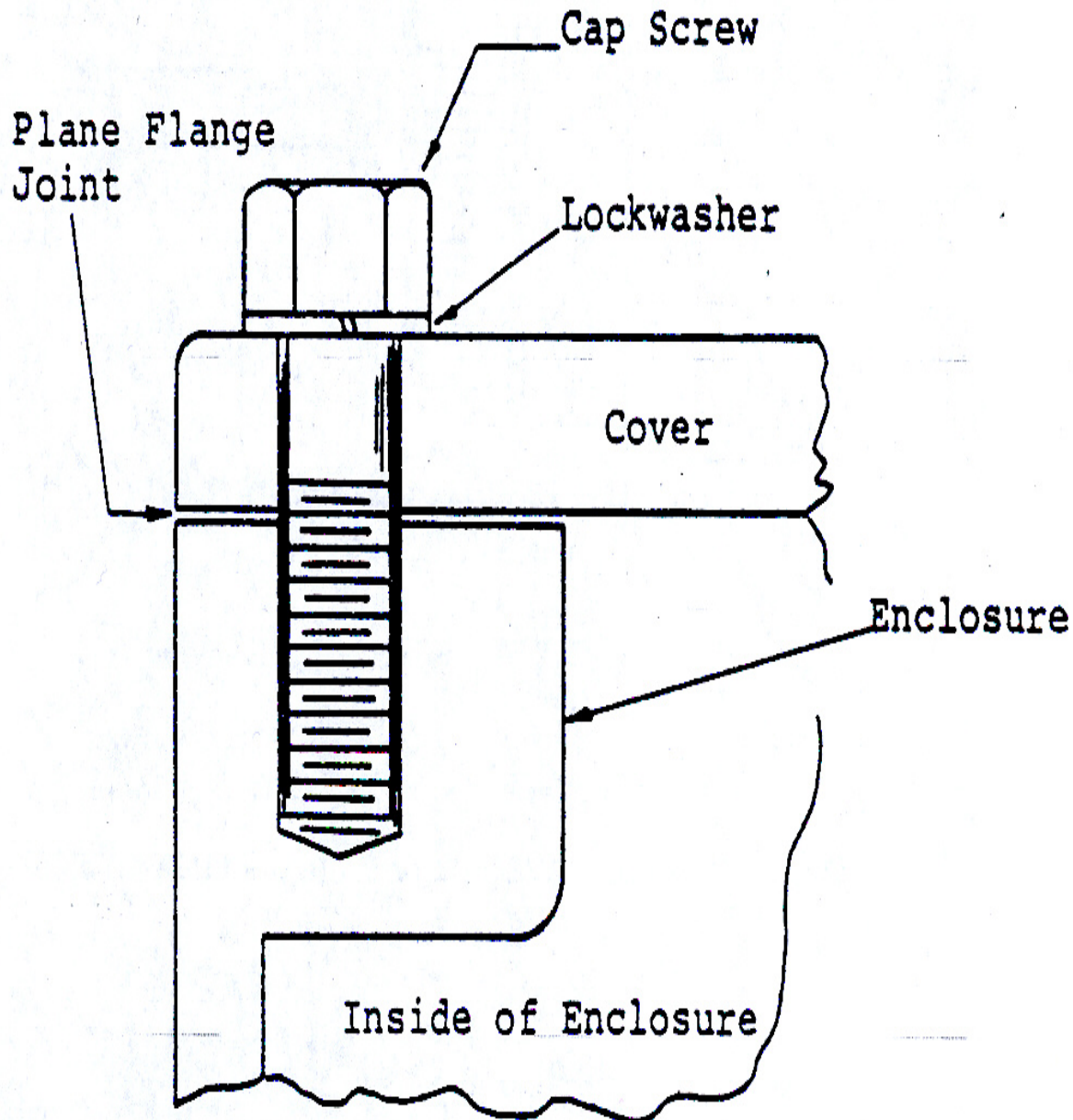


**The danger of an explosion from operating electrical equipment may be minimized by the use of permissible electrical equipment that is maintained in permissible condition.**



**Lids or covers on electrical boxes must be designed and maintained so that electrical arcs cannot escape from within the enclosures and become ignition sources in the underground mine atmosphere. The equipment is deemed “permissible” when it is designed and maintained in this manner.**

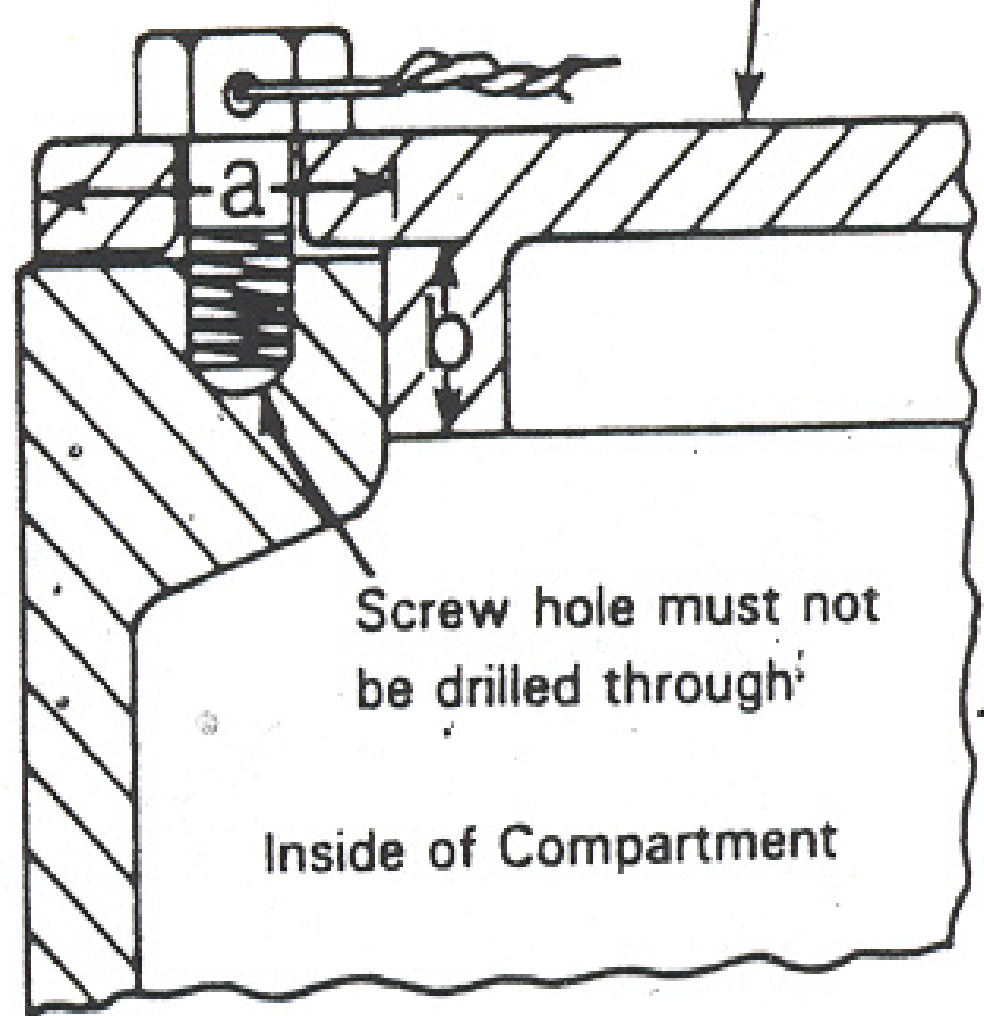




**This is a plane flange joint that can have a maximum clearance of only .004 inch.**

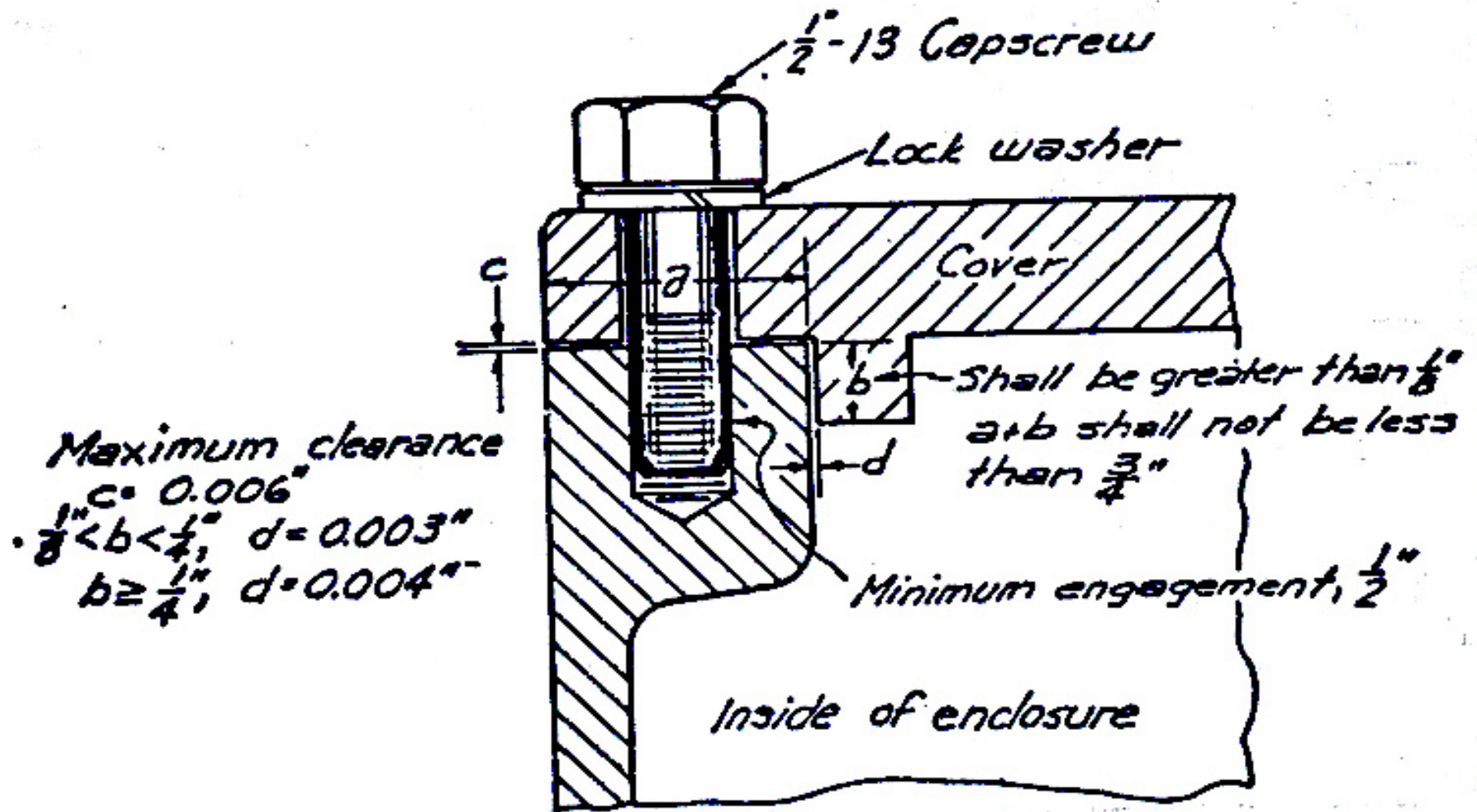


**This is a step flange joint that can have a maximum clearance of only .006 inch**



**STEP FLANGE JOINT  
C**

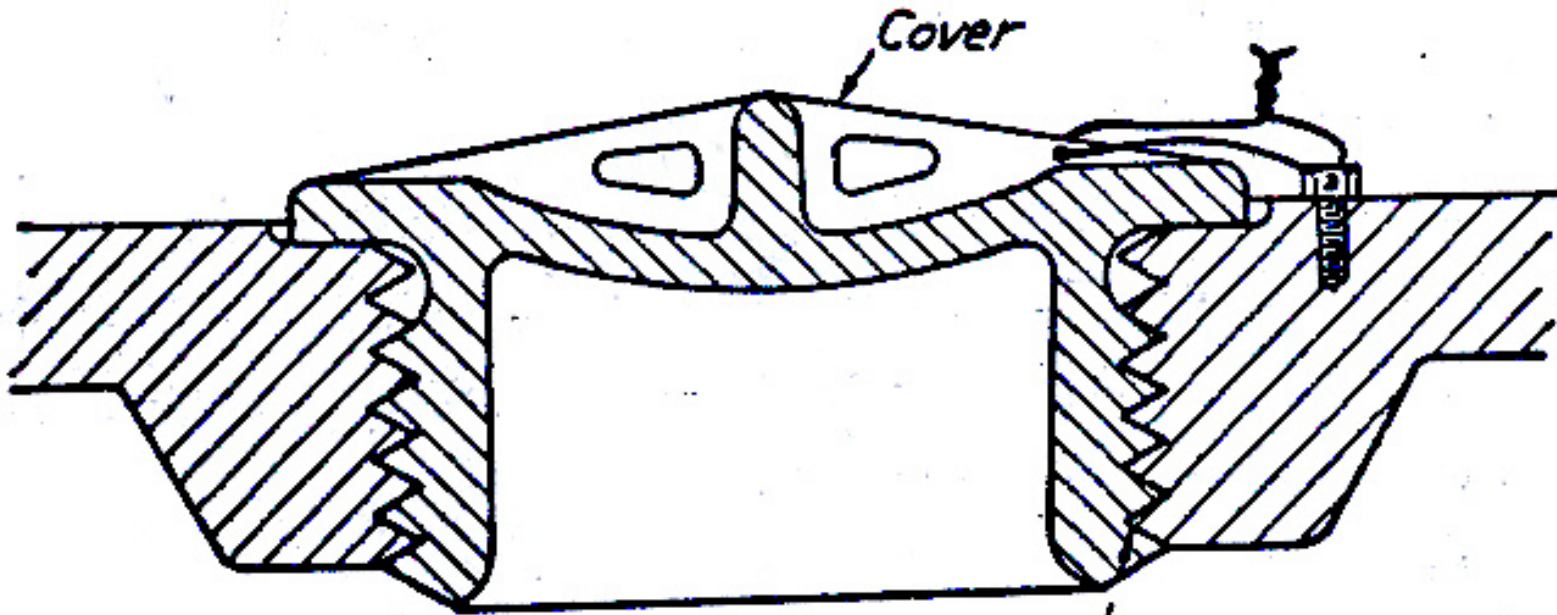




TYPICAL COMBINATION JOINT



# Threaded Joint



THREADED JOINT

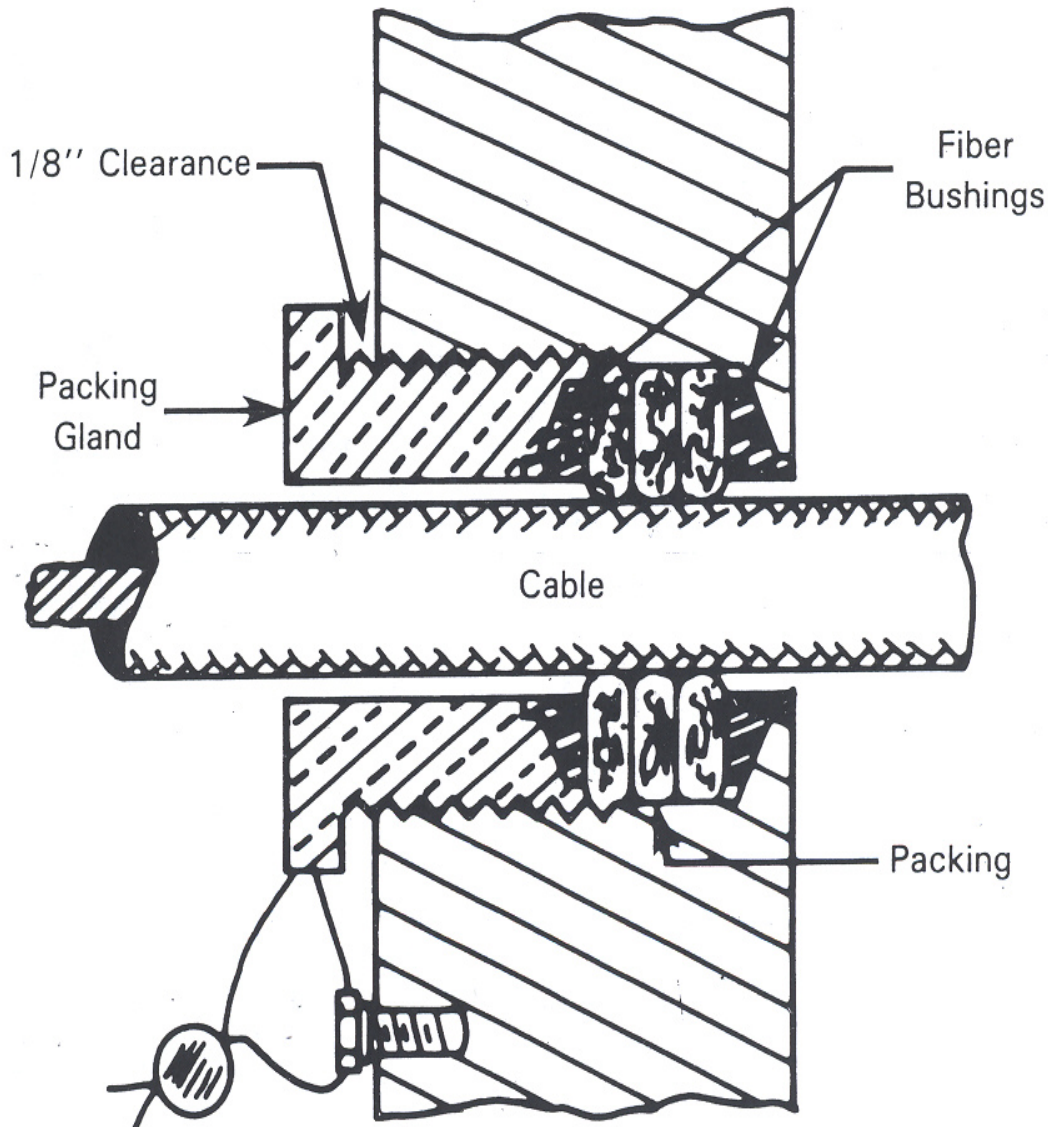
Figure 7

Total developed length  
to conform to  
18.31 (a) (6) - Class 1 fit





# A correctly packed gland for cable entrance



**When the cable gland has been properly packed, the gland nut still has a clearance distance of 1/8 inch or more.**



**The maximum clearances for joints are as follows:**

**Plane flange joint - .004 inch**

**Step flange joint - .006 inch**



**ORAL REVIEW**  
**of**  
**Electricity & Apparatus**



**When a device, apparatus, a piece of equipment or machinery, or a practice has been approved for use in the mining of coal, who must give the approval?**



**Answer: The Commissioner of  
the Office of Mine Safety and  
Licensing (OMSL)**



**Are all underground mines in  
Kentucky classified as “gassy?”**



**Answer: yes**



**What is high voltage?**





**Answer: voltage of  
1,000 volts or more**



**What is an imminent  
danger?**



**Answer: 'Imminent danger'**  
means the existence of any  
condition or practice which  
could reasonably be expected to  
cause death or serious physical  
harm before the condition or  
practice can be abated.



# What is low voltage?



**Answer: Low voltage  
means up to and  
including 660 volts**



# What is medium voltage?



**Answer: Medium voltage means voltages greater than six hundred sixty (660) and up to nine hundred ninety-nine (999) volts;**



**What does permissible  
mean?**





**Answer: "Permissible" means that any equipment, device, or explosive that has been approved by the United States Bureau of Mines, the Mining Enforcement and Safety Administration, or the Mine Safety and Health Administration meets all requirements, restrictions, exceptions, limitations, and conditions attached to the classification;**



**What does “workmanlike manner” mean?**



**“Workmanlike manner”  
means consistent with  
established practices and  
methods utilized in the  
coal industry.**



**What is the unit of measurement for voltage and what is its electrical symbol?**



**Answer: volts and the symbol for voltage is E.**



**What is the unit of measurement for current flow and what is its electrical symbol?**



**Answer: ampere (amps)  
and the electrical symbol  
for current is I.**



**What is the unit of measurement for resistance and what is its electrical symbol?**





**Answer: ohm and the electrical symbol for resistance is R.**



**Which electrical current flows in only one direction?**



**Answer:**  
**Direct current (D.C.)**



**Which electrical current changes level and reverses direction at regular intervals, usually 60 cycles per second?**



**Answer:**

**Alternating current (A.C.)**



# True or False

**An ammeter is used to measure voltage.**



**Answer:**

**False: an ammeter is used to measure current flow.**



**Which instrument is used to measure voltage?**





**Answer:**

**Voltmeter**



**Which instrument is used to measure resistance?**



**Answer:**

**Ohmmeter**



**A series circuit has how many paths for current flow?**



**Answer:**

**One**



**Which electrical current  
has more than one path for  
circuit flow?**



**Answer:**

**Parallel circuit**



**What is the circuit called  
in which its current takes a  
path outside its intended  
circuit?**





**Answer:**

**Short circuit**



**What is the term used for a piece of equipment or cable that is being used in excess of its normal, full-load current rating?**



**Answer:**

**Overload**



**What device is used to store energy and must be properly discharged before work is done on electrical circuits or equipment?**



**Answer:**

**Capacitor**



# True or False

**According to law, changes can be made to approved electrical equipment after it is taken and used underground, if deemed necessary by the licensee.**



# Answer:

**False, all approved electrical equipment must be maintained in its original condition unless approved changes have been made.**



**What are the requirements  
for being qualified and  
certified to work on  
electrical equipment?**





**Answer:**

**You must successfully complete a series of tests and have at least one (1) year of approved practical electrical experience.**



**What percent on each written electrical test shall be deemed to be a satisfactory grade?**



**Answer:**

**Eighty (80) percent**



**What type of materials must be used for hanging or suspending trailing cables or high voltage feeder cables?**



**Answer:**

**Nonconductive or insulated materials.**



**What devices must be provided for all power circuits and equipment at the mine?**



**Answer:**

**Suitable circuit-interrupting devices.**



**How shall all power wires and cables be protected?**





**Answer:**

**By proper installation or  
guarding.**



**State law requires that all ground wires are to have a cross-sectional area of:**



**Answer:**

**$\frac{1}{2}$  the cross-sectional area of  
the power conductor.**



**How shall extra length or long trailing cables be spread out or stored underground?**



## **Answer:**

**In long open loops or in a figure-eight configuration on a clean, well rock-dusted floor, where the cable can be protected against mechanical injury, but cables suspended in long open loops shall be acceptable.**



**How many temporary splices  
are allowed in trailing cables?**



**Answer:**

**Only one (1) temporary splice is allowed in a trailing cable.**



**Other than cable reel  
equipment, how close can a  
temporary splice be made to  
the machine?**





**Answer:**

**To within 25 feet of the  
machine.**



# Fill in the blanks

The law requires that splices  
in trailing cables be made in a  
workmanlike manner,  
mechanically strong and \_\_\_\_\_  
\_\_\_\_\_ •



**Answer:**

**Well insulated.**



**How shall three-phase  
alternating current circuits  
used underground be  
grounded?**



**Answer:**

**By a direct or derived neutral which shall be grounded through a suitable resistor at the power center.**



# Fill in the blanks

According to law, if hand-held electrically driven tools are not double insulated by design, they must be \_\_\_\_\_  
\_\_\_\_\_.



**Answer:**

**Properly grounded.**



**Are the frames of all pumps  
required to be properly  
grounded?**





**Answer: Yes**



**Where must high voltage  
cables be installed?**



**Answer: in regularly inspected air courses and haulageways.**



**How shall they be protected  
against damage?**



**Answer: covered or placed so as to afford protection against damage.**



**When men regularly work or travel under high voltage cables, they must be guarded if they are not at least \_\_\_\_\_ feet above the ground.**



**Answer:  $6 \frac{1}{2}$**



**Are the frames of all  
underground electrical  
equipment operated by men  
required to be grounded?**





**Answer:**

**Yes**



**What devices must be installed  
at or near the supply end of  
power circuits?**



**Answer:**

**Suitable disconnecting devices and short-circuit protective devices.**



**What must be provided at the beginning of all branch circuits?**



**Answer:**

**Suitable disconnecting devices.**



**The law requires underground transformer stations, battery charging stations, substations, rectifiers, and water pumps to be housed in noncombustible structures or areas. If this is not done, what must be provided?**



**Answer:**

**A suitable fire  
suppression system.**



**When these electrical units are housed in a noncombustible area, how shall the installations be ventilated?**





## **Answer:**

**They shall be ventilated with intake air that is coursed into a return air course or to the surface and not used to ventilate working places; or**



**(continued)**

**they shall be ventilated with intake air that is monitored for carbon monoxide or smoke by an atmospheric monitoring system (AMS)**



# True or False

**Monitoring of intake air used to ventilate battery charging stations shall be done with sensors not affected by hydrogen.**



**Answer: True**



**How often shall carbon monoxide and smoke sensors be calibrated?**



**Answer: At least every 30 days.**



**Are portable power centers,  
portable transformers, and  
distribution centers which are  
essentially fireproof required to  
be placed on separate splits of  
air?**



**Answer:**

**No, but they must be stationed in well ventilated places outby the last open crosscuts.**





**What must be located at strategic points along the beltline?**



**Answer:**

**Suitable firefighting equipment shall be located at strategic points along the belt.**



**What must be provided at transfer points along the beltline?**



**Answer:**

**Proper-type fire extinguishers**



**What three devices must be provided with all underground belt conveyors?**



**Answer:**

**Slippage and sequence switches  
and start and stop controls.**



**At what intervals must start and stop control devices be provided?**



**Answer:**

**At intervals not to exceed 1,000 feet.**





**Are lightning arrestors required to be installed on telephones?**



**Answer:**

**Yes, they must be installed where the wires enter the mine and at the buildings on the surface.**



**Where are insulating mats  
required to be installed?**



**Answer:**

**In front of disconnecting devices  
and all electrical installations  
where required.**



**What tests are to be conducted weekly on ground wires in trailing cables?**



**Answer:**

**For open circuit and high  
resistance**



**What does the law require when power circuits in tipplers, buildings, cleaning plants, etc., and all underground electrical circuits are not in use over a long period of time?**



**Answer:**

**They shall be de-energized.**





**The law requires that all underground power circuits and electrical equipment be de-energized before work is done on the circuits and equipment.  
When is the exception?**



**Answer:**

**When necessary for  
troubleshooting or testing.**



**Before electrical work or major mechanical work is performed, what must be done?**



## **Answer:**

**A suitable disconnect providing visible evidence that the power is disconnected shall be locked open and a tag shall be posted by the individuals performing the work.**



**When can repairs or  
maintenance be performed on  
machinery?**



**Answer:**

**Not until the power is off and the machinery is blocked against motion, except where machinery motion is necessary to make adjustment.**



**What precaution must be taken  
when electrical circuits cross over  
or under belt conveyors?**



**Answer:**

**The wiring shall be suitably protected.**





**Switch boxes, contactors,  
controllers, and all other similar  
devices shall be kept free of  
significant accumulations of  
what?**



**Answer:**

**Combustible dust**



**How high above the ground must high-voltage lines be installed on the surface where there is a possibility of contact by traffic?**



**Answer:**

**20 feet**



**What device shall be installed on all ungrounded exposed power conductors and telephone wires entering a mine regardless of voltage?**



**Answer:**

**Lightning arresters.**



**What other devices shall also be provided?**



**Answer:**

**Overload protection and disconnect switches of sizes and ratings approved by the department.**





**Are all metal buildings where electricity is being used required to be effectively grounded?**



**Answer:**

**Yes**



**Are all transformer tanks  
required to be effectively  
grounded?**



**Answer:**

**Yes**



**Switch boxes, contactors,  
controllers, and all other similar  
devices shall be kept free of  
what?**



**Answer:**

**Combustible dust.**



**Surface transformer stations shall be housed or fenced in when lower than how many feet above the earth?**



**Answer:**

**15 feet.**





**When surface transformer stations are fenced in, how high must the fence be?**



**Answer:**

**A minimum of six (6) feet.**



**What does the law require of all electrical equipment except intrinsically safe equipment which is taken in by the last open crosscut and in return airways?**



**Answer:**

**It must be permissible.**



**Who is authorized to reject any modifications to mining equipment which would endanger the health or safety of employees?**



**Answer:**

**The commissioner or his  
authorized representative.**



**Are headlights required on all mobile and face equipment at all times when in operation?**



# Answer:

**Yes, and they must be properly installed and maintained in a workmanlike manner and in working order to provide maximum illumination and be protected from damage by guarding or locations.**





**When mining equipment is being operated, how shall it be maintained?**



**Answer:**

**In a safe working order.**



**By law, who is permitted to examine and test electrical equipment and circuits?**



**Answer:**

**A certified electrician.**



**Is it against the law to allow combustible materials, grease, lubricants, or flammable liquids to accumulate where they can create a fire hazard?**



**Answer:**

**Yes**



**All electrical equipment utilized in intake airways outby the last open crosscut shall be maintained in safe operating condition and in accordance with whose instructions?**



**Answer:**

**The manufacturer.**





**Who, according to the law, can be placed in charge of electrical face equipment?**



## **Answer:**

**Only a qualified person capable of determining the safety of the roof, face, and ribs of the working places and detecting the presence of explosive gas and that person must have a minimum of 45 days of mining experience.**



**How is the fitness of an electrical  
face equipment operator  
determined?**



## **Answer:**

**They shall undergo an examination to determine their fitness to detect explosive gas and they must have a minimum of forty-five (45) days of actual mining experience before they are permitted to have charge of electrical equipment.**



**What must be done before electric face equipment can be brought in by the last open crosscut?**



## **Answer:**

**The equipment operator must make an inspection for explosive gas using an approved gas detection device or instrument in the place where the equipment is to work.**



**If any explosive gas in excess of one (1) per cent is found in the place, what must be done?**



**Answer:**

**The electrical equipment shall not be taken in until the gas is removed.**





**While the electrical equipment is operating at the face, when must examinations for gas be made?**



**Answer:**

**At not more than 20 minute intervals.**



**If methane gas is found in excess of one percent (1%) at any time, what must be done?**



## **Answer:**

**The power shall be de-energized from the equipment and left de-energized until the gas is reduced to less than one percent(1%) and the place determined safe by a foreman.**



**What is the effect on electrical equipment of voltage that is too low?**



**Answer:**

**Inefficient operation, abnormal heating, and decreased operating life.**



**How shall approved electrical equipment be maintained?**



**Answer:**

**In its original condition unless approved changes have been made.**





**What is the most common cause of electrical accidents in coal mines?**



**Answer:**

**Failure to open, lock-out, and tag electrical circuits and equipment before working on equipment.**



**Who is authorized to perform electrical work on circuits or equipment?**



## **Answer:**

**Only those persons who are qualified and have been certified by the Office of Mine Safety and Licensing as electricians, or trained persons working under direct supervision of a certified electrician.**



**What types of work require locking-out and tagging a visible disconnecting device when work is to be performed on electrical circuits and equipment?**



**Answer:**

**All types of work including electrical, mechanical, and hydraulic.**



**When disconnecting devices have been locked-out and tagged, who should remove the locks and tags?**



**Answer:**

**The person who installed the lock should remove it. In that person's absence, only an authorized person may remove it.**





**How often shall electrical equipment and wiring be inspected by a qualified electrician?**



**Answer:**

**As often as necessary to ensure safe operation.**



**What are some of the dangers associated with the transmission of electricity into a mine?**



**Answer:**

**Electrical shock, fire, and ignition of explosive gases.**



**What is the purpose of the belt slip switch?**



**Answer:**

**To open the control circuit if the belt hangs, stalls, or breaks.**



**What shall be done with power circuits on idle days and shifts?**



**Answer:**

**All power circuits not in use shall be de-energized.**





**What must be kept in place at all switchboards, power-control switches, and other areas where shock hazards exist?**



**Answer:**

**Suitable insulating mats.**



**What precaution should be taken when electrical circuits are no longer in use?**



**Answer:**

**The power should be disconnected  
and the wiring removed.**



**What action shall be taken when a potential hazard is found on electrical equipment?**



**Answer:**

**The equipment shall be removed from service and tagged-out until the unsafe conditions are corrected.**



**Why should transformer and distribution enclosures be locked?**



**Answer:**

**To prevent unauthorized entry.**





**What type of explosive gas is liberated from charging batteries?**



**Answer:**

**Hydrogen.**



**What precaution must be taken before an ohmmeter is used to check a circuit?**



**Answer:**

**The circuit must be de-energized.**



**What action should be taken by a mine foreman when he observes electrical protective devices “bridged” out or “blocked” in?**



**Answer:**

**The power should be disconnected immediately and the circuit returned to its safe, intended state.**



**For what is a “tic-tracer” used?**



## **Answer:**

**A “tic-tracer” is used to test for the presence of voltage without physically touching the conductor or equipment that is being tested.**





**What precaution shall be taken before removing or replacing fuses?**



**Answer:**

**The circuit shall be de-energized.**



**What tools shall be used when fuses are removed or replaced?**



**Answer:**

**Fuse tongs or hot-line tools.**



**What electrical equipment must be properly labeled and identified?**



**Answer:**

**Disconnecting devices and circuit protective devices.**



**What procedures must be used  
when mobile equipment travels  
over trailing cables?**



**Answer:**

**The cables must be properly bridged or otherwise protected.**





**Why is running over trailing cables considered a poor practice?**



**Answer:**

**Heavy loads damage the insulation, often resulting in short-circuits and electrical shock hazards.**



**What are the most common causes of abnormal heating of conductors?**



**Answer:**

**Insufficient current-carrying capacity, poor connections, low voltage, and overloads.**



**How shall trailing cables be clamped to machines?**



**Answer:**

**In a manner to protect the cables from damage and to prevent strain on the electrical connections.**



**What precaution must be taken before attempting to repair a trailing cable?**



## **Answer:**

**The circuit shall be disconnected by a visible disconnecting device and locked-out and tagged by the electrician who is to do the work. The conductors of high-voltage cables should be disconnected and discharged of any stored capacitive charge by shorting them to each other and to ground.**





**What are the dangers associated with poorly made splices in trailing cables?**



**Answer:**

**Electrical shock, fire, and ignition of explosive gas mixtures.**



**How should power wires be connected to stationary equipment?**



**Answer:**

**By using suitable connectors and proper strain protection.**



**How must splices in trailing cables be made?**



## **Answer:**

**In a workmanlike manner, mechanically strong, electrically efficient and effectively insulated and sealed to exclude moisture. Splices should provide mechanical strength and electrical conductivity as near as possible to the original condition of the cable.**



**What type of device should be used to splice electrical conductors?**



**Answer:**

**Suitable connectors.**





**How shall splices be made in high-voltage cables?**



**Answer:**

**Only permanent splices shall be made in accordance with manufacturers' specifications.**



**How should circuits coming from a power center be protected?**



**Answer:**

**By visible disconnects, proper circuit-protective devices and suitable strain protection.**



**How should electrical equipment  
be protected against overloads?**



**Answer:**

**By properly rated circuit-protective devices (circuit breakers or fuses) and overload relays.**



**How does the proper use of  
circuit breakers or fuses afford  
protection?**



**Answer:**

**By automatically opening the circuit when a short-circuit or current-overload condition occurs.**





**What type of fuses should be used to provide both short-circuit and overload protection?**



**Answer:**

**Dual-element fuses.**



**Against what hazards shall  
power lines and telephone  
circuits be protected?**



**Answer:**

**Short-circuits and lightning.**



**How should telephone circuits be protected from lightning and contact with high voltage lines?**



**Answer:**

**By the use of lightning arrestors and proper guarding of telephone wires that are installed near high voltage wires.**



**What is the purpose of the ground-check circuit?**



**Answer:**

**To continuously monitor the continuity and connections of the grounding conductor in a cable.**





**How shall all metal-enclosed or encased electrical circuits be protected?**



**Answer:**

**By proper grounding or equivalent protection.**



**What type protection shall be provided for metal fencing and metal buildings enclosing transformers and switchgear?**



**Answer:**

**Metal fencing and metal buildings shall be effectively grounded.**



**When shall continuity and resistance of grounding circuits be tested?**



**Answer:**

**Immediately after their installation  
and at regular intervals thereafter.**



**How must single-phase  
alternating current 120 and 240  
volt equipment be grounded?**



**Answer:**

**By the use of a third wire connected to the grounded center-tap of the transformer.**





**How shall three-phase circuits supplying power to portable or mobile equipment used on the surface be protected?**



## **Answer:**

**By a direct or derived neutral which shall be grounded through a suitable resistor at the power center, and a grounding circuit originating at the grounded side of the grounding resistor which shall extend along with the power conductors and serve as a grounding conductor for the frames of all electrical equipment powered by that circuit.**



**Do all electrically powered water pumps need to be frame grounded?**



**Answer:**

**Yes. Frame grounding is required by state law.**



**What portable electrical  
equipment should be grounded?**



**Answer:**

**All portable electrical equipment shall be grounded, except approved hand-held tools with double insulation.**



**For what conditions should ground wires in trailing cables be checked at periodic intervals?**



**Answer:**

**They should be checked for open circuits and high resistance connections or splices.**





**What are the requirements for grounding the frames of small electrical tools and devices?**



**Answer:**

**All metal parts on power tools, other than double-insulated hand-held tools, shall be grounded.**



**An insulated tool or switch that is meant to be held in hand or supported against the body will not be approved with a nameplate rating exceeding how many volts?**



**Answer:**

**300 volts AC or DC.**



**Each hand-held tool shall be provided with a two-pole switch of the type that must be held closed by hand and will open when hand pressure is released. What is this type of switch called?**



**Answer:**

**“Dead-man” control type.**



**What is the maximum separation of a plane flange joint tolerated for permissibility?**



**Answer:**

**.004 in.**





**What is the maximum separation of a step flange joint tolerated for permissibility?**



**Answer:**

**.006 in.**



**Why must cables entering a compartment on permissible equipment be properly packed?**



**Answer:**

**To prevent flames from escaping from the compartment in the event of an ignition within it.**



**On permissible equipment, how much packing must be used under a packing nut along a conductor?**



**Answer:**

**At least 1/2 in. of compressed packing material must extend around the conductor.**



**How much clearance must be maintained between a packing gland and stuffing box?**



**Answer:**

**At least  $1/8$  in.**





**The temperature of external surfaces of mechanical or electrical components shall not exceed what temperature under normal operating procedures?**



**Answer:**

**302°F.**



# End of Unit 6