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Electrical Hazards in Coal Mining
Programmed Instruction Book

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Programmed Instruction Series
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I. INTRODUCTION

This workbook is about the hazards of electricity in coal mining. It is designed to teach you to identify hazardous electrical conditions and describes safe procedures that you can take to prevent accidents. Appendix A contains a glossary of terms. If you do not know what a word means, look it up in the glossary before continuing. Appendix B contains some of the electrical regulations from Title 30 of the Code of Federal Regulations. These regulations affect every coal miner (not just electricians) and are included for your benefit.

This workbook is in a "programmed instruction" format. Three characteristics that distinguish programmed instruction from conventional textbooks are:

- The subject matter is broken down into a series of easily learnable small steps.
- Students are frequently given a quiz on the important points to be learned.
- Students can immediately check their responses for correctness.

Throughout each chapter and at the end of each, you will find questions covering what you have read. These questions will help you determine if you are learning the important concepts. Write your answer(s) to each question in the space provided. Then check your answers to see if they are correct. The answers are given following each set of questions.

The use of programmed instruction materials has proved to be an effective alternative to conventional textbooks if students respond to the questions and then check their answers. Therefore, it is important that you take the quizzes through each chapter and the self-check at the end of each chapter.

You are taking this course to learn about ways you can protect yourself from hazards to your health and safety. How much you learn and practice can mean how well you are protected.

To ensure that you learn as much as possible, always write your answer to a question before looking at the correct answer. This type of practice is important to you because it allows you to work with the new information you are learning under non-emergency conditions.

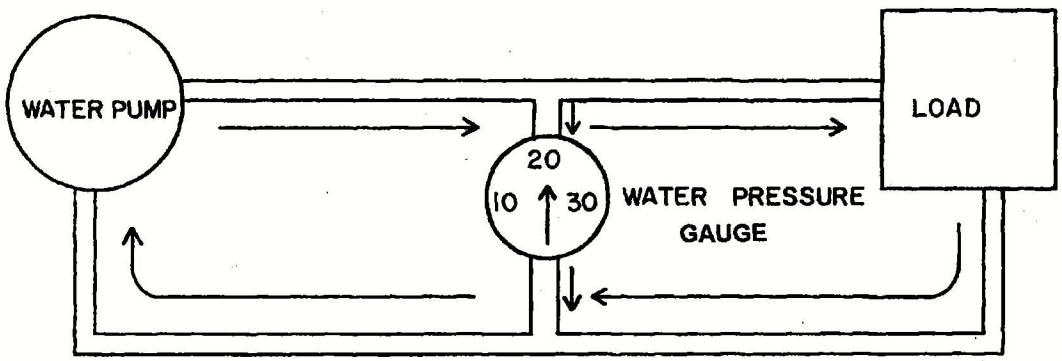
II. INTRODUCTION TO ELECTRICITY IN COAL MINING

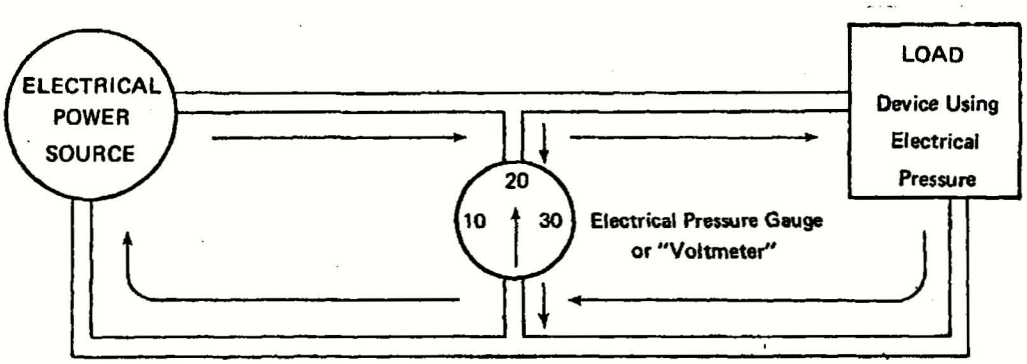
In this chapter, you will learn about the uses of electricity in mining. You will also learn the meaning of various mining terms and the names of and uses for various types of equipment.

VOLTAGE

Electricity can be compared to water. At one time or another, you probably have seen a water pressure gauge. Water pressure is usually called "pounds per square inch" or "pounds." Electrical pressure is called "voltage" or "volts."

The following diagram shows a simple closed water system. The water pump supplies the water pressure which forces the water through the main water pipe to the water pressure gauge and the device using water pressure, called the load. After being used by the load, the water flows through the water return back to the water pump. The water in the water return is not under pressure because the load has consumed the water pressure. The water pressure gauge monitors the difference in pressure between the main water pipe and the water return.

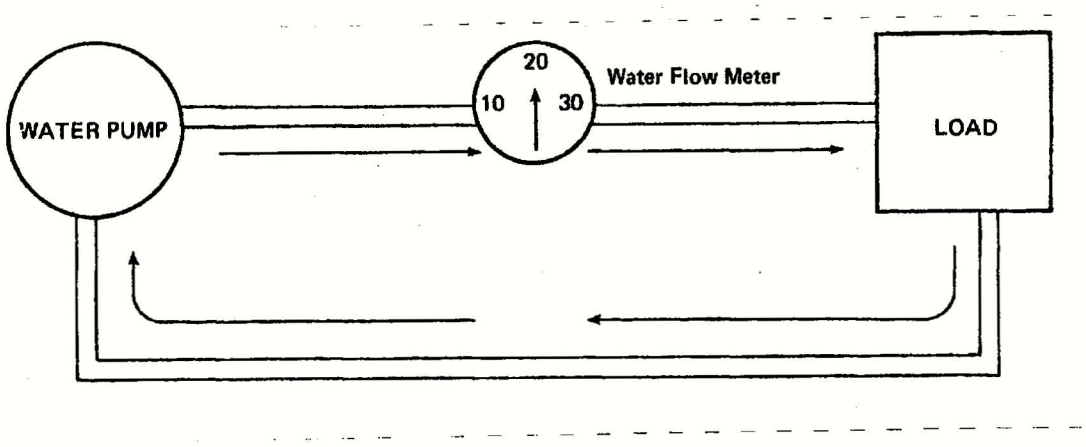




Electrical pressure is similar to water pressure. The electrical power source supplies the electrical pressure or "voltage" which forces electrons through the negative power lead to a voltmeter and load. The load is an electrical device that uses the effects of moving electrons and consumes electrical power. The electrons return to the electrical power source through the positive power lead. A voltmeter monitors the difference in voltage between the positive power wires and negative wires.

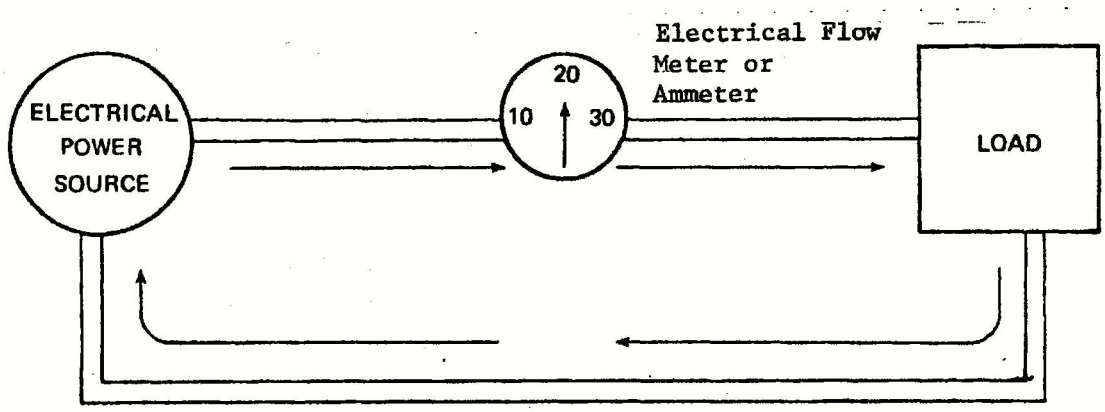
AMPERAGE OR AMPS

Now that we understand voltage as being the electrical pressure, as compared to the water pressure of the simple water system, let's discuss the electrical flow equivalent as compared to the number of gallons of flow in the water system.



The amount of water flowing through a pipe is often measured in "gallons per minute." A large amount of water flowing through a pipe would be many gallons per minute. The amount of water flowing through a pipe can be great or small even with the same water pressure supplied by the pump. If the water power used by the load increases, the number of "gallons per minute" flowing through the pipe will increase, but the water pressure supplied by the pump will stay the same unless the system is overloaded.

The amount of electrical current flowing through a wire is measured in "amperes" or "amps." Many or only a few amps can flow through a wire with the same voltage supplied by the electrical power source. If the electrical power used by the load increases, the number of "amps" flowing through the wire will increase, but the voltage supplied by the source will stay the same unless the system is overloaded. The diagram of a simple electrical system with an ammeter is shown in the following diagram.



Please complete the following quiz on Voltage and Amperage or Amps.

II-1 Electrical pressure is measured in terms of what unit or units? _____

II-2 A device used to measure voltage is called a _____.

II-3 The amount of electrical current or flow through a wire is measured in _____.

II-4 The _____ supplied by an electrical power source will remain the same no matter how many amps flow through the wire unless the system is overloaded.

II-5 If the _____ _____ used by an electrical load increases, the current flow will increase.

Please go to the next page to check your answers.

Answers to quiz on Voltage and Amperes or Amps

II-1 Volts or voltage

II-2 Voltmeter

II-3 Amperes or amps

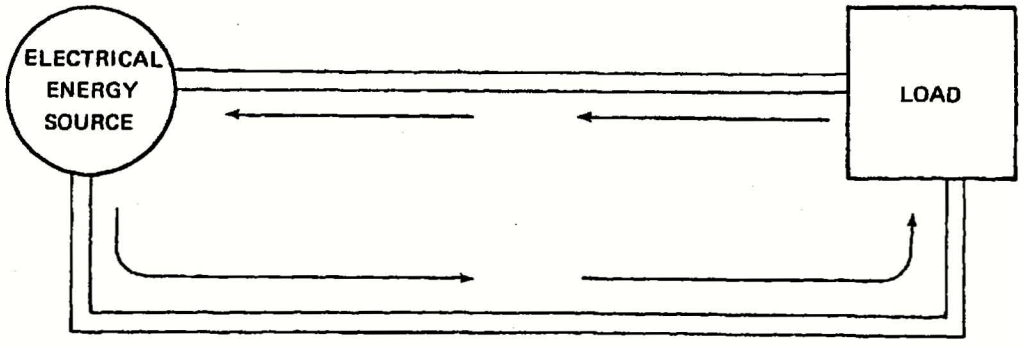
II-4 Voltage

II-5 Electrical power

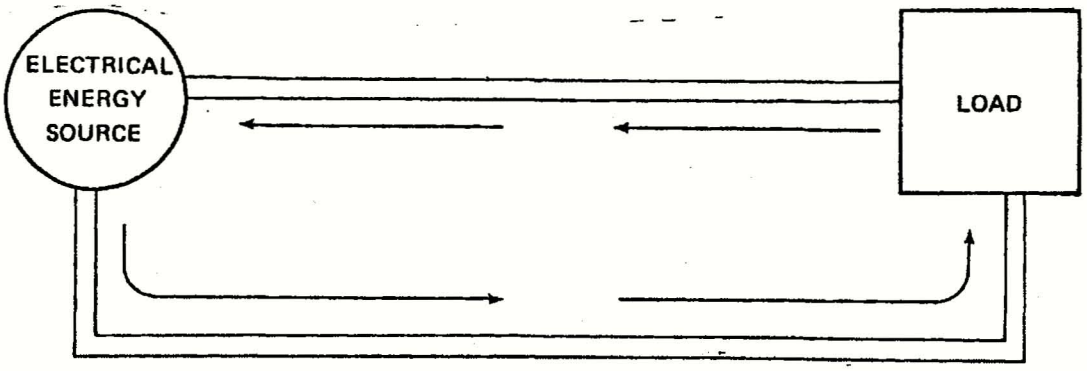
If you missed any of the questions, again review the sections until you are confident you understand the question and know the answer(s).

AC AND DC POWER

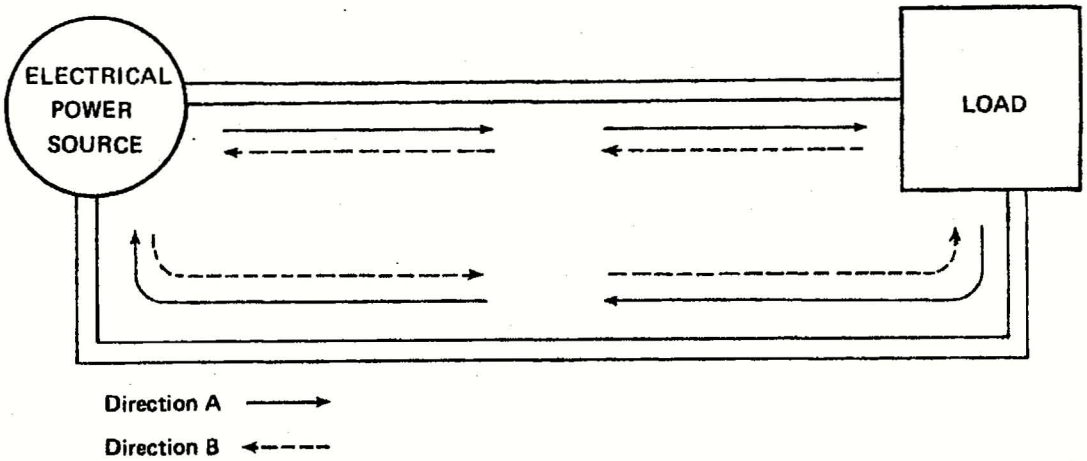
There are two types of electrical power used in mining – AC and DC. First, we will look at DC power. DC is an abbreviation for direct current. Direct current is electrical current which flows only in one direction.



In this diagram, the electrical current flows from the source, through the negative wire, through the load, through the positive wire, and back to the source. This is the only direction the electrical energy flows. Electrical current that always flows in one direction is called direct current or "DC." The batteries in a flashlight supply DC electrical power.



The electrical current in this diagram is flowing in the opposite direction. Although it flows in the opposite direction, the electrical current is still continuously flowing. It does not flow in one direction, stop flowing, and flow in the opposite. If electrical current continuously flows in one direction, no matter what the direction is, it is direct current power or "DC" power. So this diagram also shows "DC" power.



In this diagram the electrical current flows in direction A for a fraction of a second and then flows in direction B for a fraction of a second. The electrical current constantly alternates between flowing in direction A and direction B. This is called alternating current or "AC." The electrical power supplied to your home by the electric company is AC. The electrical energy used in your home and in mining changes direction many times each second.

Equipment that operates only on AC power must never be connected to DC power and equipment that operates only on DC power must never be connected to AC power. Severe damage to equipment can result from attempting to use the wrong type of electrical power.

Please complete the following True/False quiz on AC and DC Power.

II- 6 _____ DC stands for Direct Current.

II- 7 _____ Direct current or DC power always flows in only one direction.

II- 8 _____ Direct current always flows from left to right.

II- 9 _____ DC power always flows continuously in one direction.

II-10 _____ Electrical current that constantly changes direction of flow is called AC, or Alternating Current.

II-11 _____ A vacuum cleaner in your home that you plug into the wall socket operates on DC power.

II-12 _____ Equipment that requires AC power to operate may also operate on DC power, but the reverse is not true.

II-13 _____ The battery in your automobile is an example of a DC power source.

Please go to the next page to check your answers.

Answers to quiz on AC and DC Power

II-6 True

II-7 True

II-8 False

II-9 True

II-10 True

II-11 False

II-12 False

II-13 True

TROLLEY WIRES, TRAILING CABLES, AND TROLLEY NIPS

Trolley Wires

One way that DC power is brought into the mine is by using trolley wires. The trolley wire is a large bare wire suspended from the roof of the mine over the mine car tracks. The mine car track can be used as the other conductor. The trolley wire carries huge amounts of electrical energy and **because a trolley wire is usually bare, it is very dangerous.** Trolley wires carry only DC power.

Trailing Cables

A trailing cable is a large electrical cable which connects to a piece of mine equipment. These cables are strong and well-insulated with a heavy rubber-like covering. They carry large amounts of electricity and can be extremely dangerous. Therefore, **trailing cables should be kept in good condition and care should be taken that they are not run over or crushed by machinery.** Trailing cables are typically 500 feet long but may be longer depending upon size.

Trolley Nips

A trolley nip is used to transfer electrical power from a trolley wire to a trailing cable. On the same end of the trailing cable (as the trolley nip) are ground and return clamps which are connected to the mine track rail.

Hazards

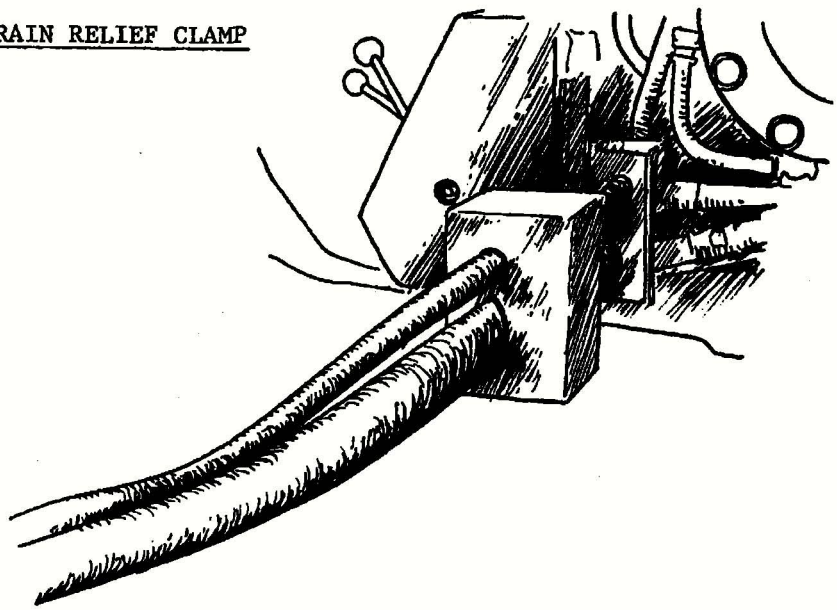
Cables and trolleys are the major causes of electrical arcs and burns that injure miners. The greatest problems with cables are usually defective splices and breaks in the insulation. Such defects are usually found when the cable is being handled, resulting in a shock or arc that burns the hands or eyes. The hands and eyes are the parts of the body most commonly injured in an electrical accident.

Many injuries are the result of arcing caused when making connections to trolley wires. These injuries occur when hanging nips or placing the trolley pole on the trolley wire. **These injuries are caused by not shutting off equipment prior to connecting it to the trolley.** A powerful and dangerous arc is created from the current drawn by the energized equipment. The suddenly energized equipment may also cause an accident as it begins to operate.

Another hazard that can occur with trolleys is the possibility of mine fires caused by the overheated trolley wires. Electrical faults can occur that do not draw enough current to trip the circuit breaker but will cause the trolley wire to overheat and soften. The softened wire can sag (increasing the possibility that someone will walk into it) or fall. If it falls on coal or something else combustible, a fire could result.

Strain Relief Clamp

STRAIN RELIEF CLAMP



The illustration on the previous page shows a strain relief clamp on a piece of mine equipment. Without the strain relief clamp, the pulling and tugging on the trailing cable could damage the trailing cable connections to the piece of mine equipment. The strain relief clamp protects these connections.

Please complete the following quiz on Trolley Wires, Trailing Cables, and Trolley Nips.

II-14 DC power is brought into the mine through trailing cables and _____ _____.

II-15 A trolley nip transfers electrical power in the trolley wire to a _____ _____ connected to the trolley nip.

II-16 A trailing cable may be _____ feet long.

II-17 _____ True or False -- The purpose of the strain relief clamp is to protect the connection of the trailing cable to the piece of mine equipment.

Please go to the next page to check your answers.

Answers to quiz on Trolley Wires, Trailing Cable, and Trolley Nips

II-14 Trolley Wires

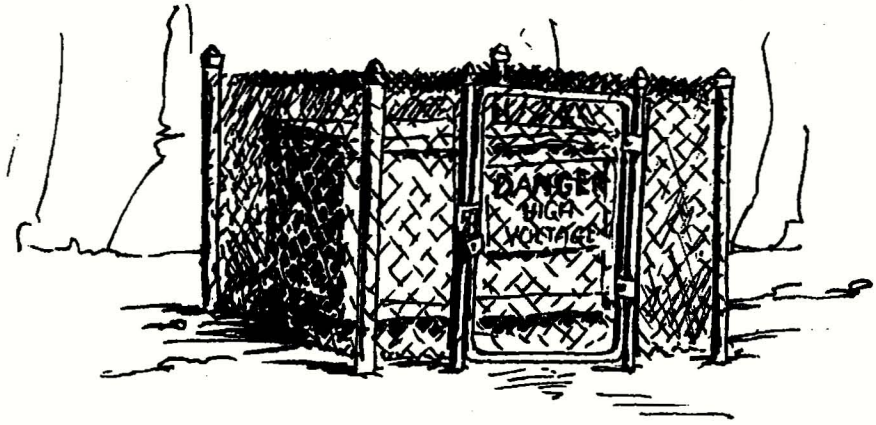
II-15 Trailing Cable

II-16 500

II-17 True

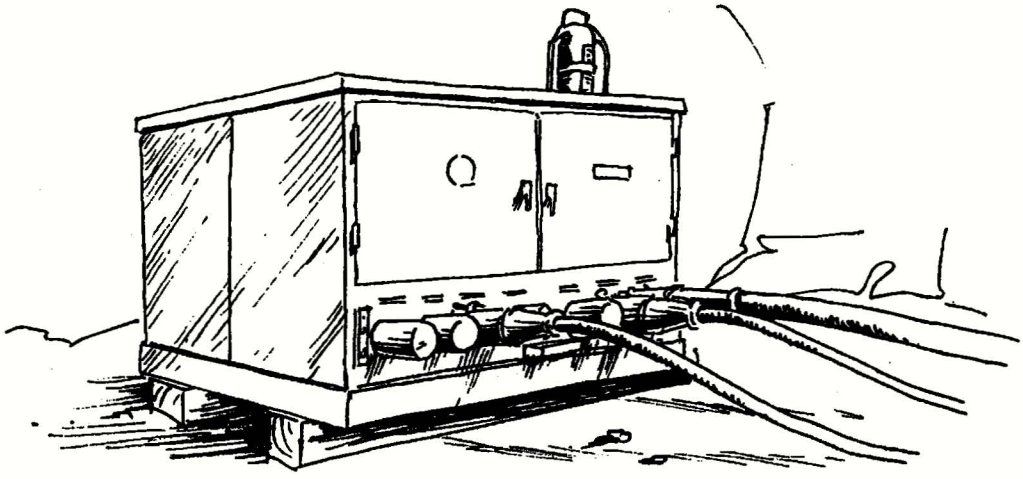
TRANSFORMER AND POWER DISTRIBUTION CENTER

AC power is brought to the mine by special cables. The voltage of the AC power in these cables is much too high to be used by mine machines. The AC power is fed through a transformer which lowers the voltage.



Transformers like this one can be on the surface or in the mine. Transformers are very dangerous because of the high voltage fed to them. Transformers can only be used with AC power.

After the AC power goes through a transformer, the voltage is still too high to be used by mine machinery. So it is fed to a power distribution center where the AC power is lowered again, through the use of another transformer, to a level which can be used by mine machinery.



Power distribution centers, like this one, have connectors to which trailing cables are connected. The trailing cable transfers the AC power from the power distribution center to a piece of mine machinery. Sometimes, part of the AC power is converted to DC power by a DC power supply inside the power distribution center. The DC power uses the same type of trailing cable connectors as the AC power.

Turning the power on for equipment is called **energizing**; a piece of equipment for which the electricity is turned on would be **energized**. Removal or turning off of electrical power is called **deenergizing**.

Please complete the following quiz on Transformers and Power Distribution Centers.

Circle the word or phrase that correctly answers questions or completes sentences.

II-18 Through which of the following equipment is AC power fed to lower its voltage?

A. Generators
B. Transformers
C. Strain relief clamps
D. Trolley wires

II-19 Transformers may only be used with _____.

A. AC power
B. DC power

II-20 AC power is transferred from a power distribution center to a piece of mine machinery through_____.

A. Transformers
B. Strain relief clamps
C. Trailing cables

II-21 What kind or kinds of power can be supplied by a power distribution center?

A. AC power only
B. DC power only
C. AC and DC power

Please go to the next page to check your answers.

Answers to quiz on Transformers and Power Distribution Centers

II-18 B. Transformers

II-19 A. AC power

II-20 C. Trailing cables

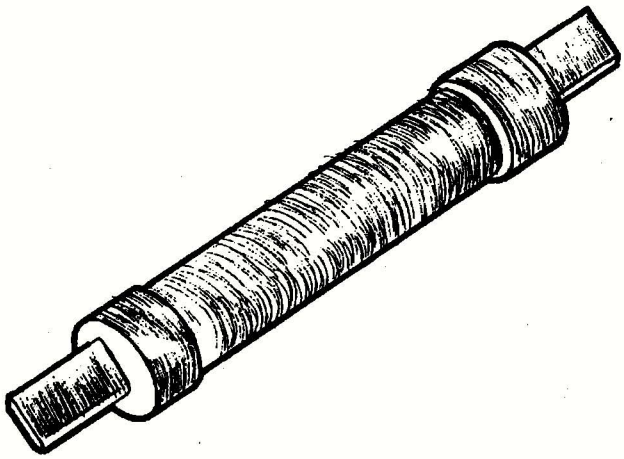
II-21 C. AC and DC power

CIRCUIT BREAKERS AND FUSES

If a piece of equipment malfunctions and excessive amounts of electrical current are fed through the machine, fires, explosions, or injury to a miner could be the result. To protect against excessive amounts of electrical current being fed to a machine, overload circuit breakers and fuses are used.

This is a circuit breaker. A circuit breaker will have a rating, such as 100 amps. If more than 100 amps flow through a breaker with that rating, a piece of metal inside the circuit breaker will quickly heat up and activate a spring. This spring throws the circuit breaker off and shuts down any machinery or equipment connected to it. A circuit breaker in this condition is called a "tripped" circuit breaker. When a circuit breaker trips, it does not

have to be replaced like a fuse. It is reset which means it is turned back on. A circuit breaker should only be reset if it is safe to do so. Circuit breakers are commonly used on power distribution centers.



Fuses also provide protection against an overload. A fuse will have a rating, such as 100 amps. If more than 100 amps flow through a fuse with this rating, the metal element inside the fuse will quickly heat up and burn open. This shuts down any machinery or equipment connected to the fuse. The fuse in this condition is called a blown fuse and must be replaced. Fuses and circuit breakers come in many ratings, both large and small. Fuses, like the one shown above, are often used in trolley nips.

Please complete the following True or False quiz on Circuit Breakers and Fuses.

II-22 _____ Excessive amounts of electrical current fed through mine equipment can cause fires, explosions, or injuries.

II-23 _____ To prevent excessive amounts of electrical current from being fed to a piece of mine equipment, circuit breakers and fuses are used.

II-24 _____ A circuit breaker with a 100 amp rating means that if less than 100 amps flow through the breaker, the breaker will shut down the piece of equipment.

II-25 _____ When a fuse blows, you should always reset it.

II-26 _____ When a circuit breaker trips, it must be replaced.

II-27 _____ Trolley nips often use fuses for overload protection.

II-28 _____ Energize means to turn power off.

Please go to the next page to check your answers.

Answers to quiz on Circuit Breakers and Fuses

II-22 True

II-23 True

II-24 False

II-25 False

II-26 False

II-27 True

II-28 False

BATTERIES AND CHARGING STATIONS

Some mining machinery and equipment need an electrical power source which does not use trailing cables. Batteries are used for this purpose. The miner's cap light uses a small rechargeable battery and some utility vehicles use batteries similar to the battery in your automobile, only much larger. These batteries are recharged at a place called a charging station. **The charging station requires special ventilation because the recharging process causes the batteries to give off highly explosive gases.**

Please complete the following quiz on Batteries and Charging Stations.

II-29 What is used to provide an electrical power source which does not need trailing cables or a trolley wire? _____

II-30 Where are batteries recharged? _____

II-31 What do batteries give off when they are being recharged?

_____ _____ _____

Please go to the next page to check your answers.

Answers to quiz on Batteries and Charging Stations

II-29 Batteries

II-30 Charging stations

II-31 Highly explosive gases

Electrical accidents are costly, not only monetarily but also in terms of injuries and lives. Some of the consequences of electrical accidents include:

- Death
- Sparks, explosions, fires
- Electrical shock
- Burns
- Blindness
- Miscellaneous physical injuries
- Equipment damage

Extreme care should always be taken when working with or around electricity in an effort to avoid electrical accidents. In the next section of this course, you will learn to recognize electrical hazards and unsafe acts.

Before we go to the next chapter, let's take the self-evaluation exercise to see how well you remember the important information given in this chapter. Answer all questions before checking your answers at the end of the exercise.

Self-Evaluation Exercise for Chapter II

II-1 Electrical pressure is measured in _____.

II-2 The amount of electrical current flowing through a wire is measured in _____.

II-3 If the amount of electrical power used by the load increases and the system is not overloaded, the number of amps will _____ and the voltage supplied by the source will _____.

II-4 Water pressure in a water system is similar to _____ in an electrical system.

II-5 "Gallons Per Minute" in a water system corresponds to _____ in an electrical system.

II-6 What is used to provide an electrical power source which does not need trailing cables and does not use a trolley wire? _____

II-7 Where are batteries recharged? _____

II-8 What do batteries give off when they are being recharged? _____ _____ _____.

II-9 A large bare wire suspended from the roof of a mine, over the mine car tracks, and used to carry DC power is called a _____ _____.

II-10 The device which protects mine machinery trailing cable connections from damage caused by pulling and tugging on the trailing cable is called a _____ _____.

II-11 High voltage AC power is lowered in voltage by a _____ before the AC power is fed to a power distribution center.

II-12 Why are trolley wires dangerous? _____

II-13 What is one method of transferring the DC power from the trolley wire to a trailing cable? _____

II-14 What is used to transfer electrical power from a power distribution center to a piece of mine machinery? _____

II-15 What kind of power can be used with transformers? _____

II-16 When AC power is used, the trailing cable is connected between a piece of mine machinery and a _____.

II-17 Why are transformers dangerous? _____
_____

II-18 What kind or kinds of power can be supplied by a power distribution center?
_____

II-19 Overload protection is provided by _____ and
_____.

II-20 Energize means to turn power _____.

II-21 Deenergize means to turn power _____.

II-22 When an overload occurs and a circuit breaker is thrown off, the circuit breaker has _____.

II-23 When an overload occurs and a fuse burns open, the fuse has _____.

II-24 Trolley nips use _____ for overload protection.

II-25 Power distribution centers use _____ for overload protection.

II-26 Do fuses and circuit breakers only come with 100 amp ratings? _____

II-27 After a circuit breaker has tripped, turning it back on is called
_____.

II-28 When a fuse blows, it must be _____.

II-29 Electrical current which flows only in one direction is called _____.

II-30 Electrical current which constantly changes direction of flow is called
_____.

Please go to the next page to check your answers.

Answers to Self-Evaluation Exercise For Chapter II

If you made any mistakes, correct your errors by reading the section(s) that corresponds to the question(s) missed.

II-1	Volts (or voltage)
II-2	Amps (or amperes)
II-3	Increase, stay the same
II-4	Voltage (or electrical pressure)
II-5	Amps (or amperes)
II-6	Batteries
II-7	Charging stations
II-8	Highly explosive gases (hydrogen)
II-9	Trolley wire
II-10	Strain relief clamp
II-11	Transformer
II-12	They are electrically "hot" and are bare
II-13	Trolley nip
II-14	Trailing cable
II-15	AC power
II-16	Power distribution center
II-17	Because of the high voltage AC power fed to them (Note: Low voltage power is also dangerous.)
II-18	AC and DC power
II-19	Fuses, circuit breakers
II-20	On
II-21	Off
II-22	Tripped
II-23	Blown
II-24	Fuses
II-25	Circuit breakers
II-26	No, fuses and circuit breakers come in many different ratings
II-27	Resetting
II-28	Replaced
II-29	DC or direct current
II-30	AC or alternating current

Now go to Chapter III, Recognizing Electrical Hazards and Unsafe Acts.

III. RECOGNIZING ELECTRICAL HAZARDS AND UNSAFE ACTS

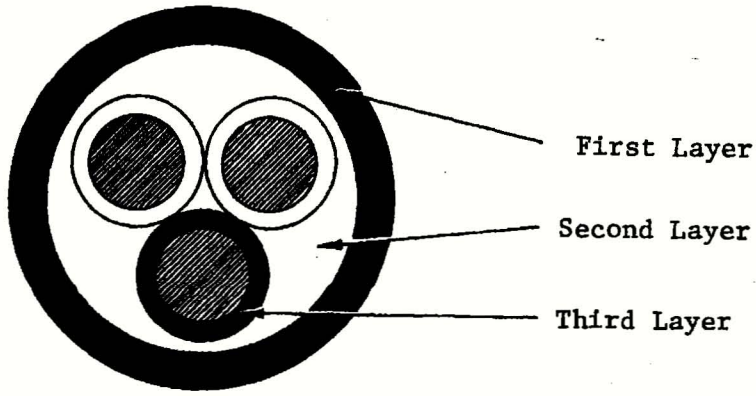
In this Chapter, you will learn how to recognize electrical hazards and unsafe acts, which some day may prevent injury to you or a fellow miner, or even save someone's life.

After you complete this section, you will be able to recognize general types of electrical hazards. You will know what action to take if you observe an electrical hazard. You will also know the differences between permissible and non-permissible electrical equipment. In addition, you will know under what conditions electrical equipment is required to be permissible.

Finally, when you master this section, you will be able to recognize safe and unsafe acts of other miners. You will learn the general electrical safety rules you should follow, and the reasons for these rules.

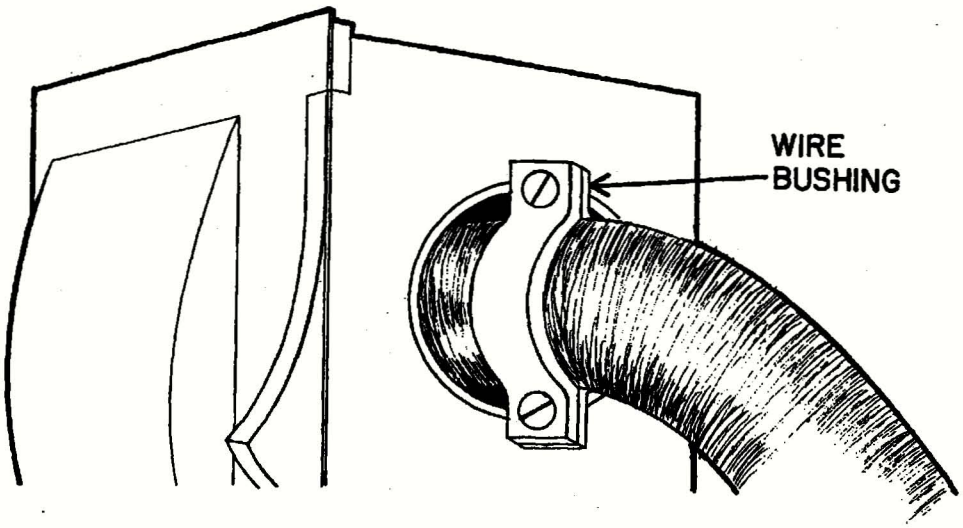
WIRES AND CABLES

The most important way of preventing electrical accidents in mining is to learn to recognize potential electrical hazards. Many of the wires and cables which carry electricity to the machines are dangerous. Some of the wires are dangerous because they are bare wires. Trolley wires are usually bare; that is, they have no covering or insulation which would make them safe to handle. Other wires are insulated, of course, but they too may be dangerous because the insulation is damaged or worn. An insulated wire is one which has a rubber-like covering. Cables, such as trailing cables, have several wires and each wire is separately insulated.



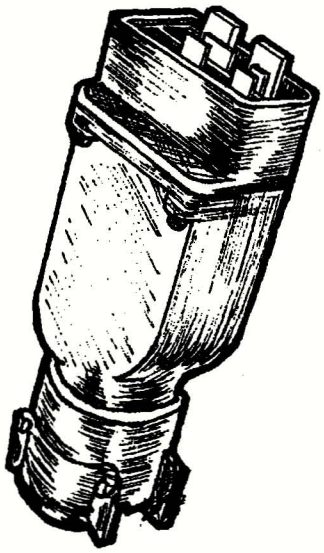
This illustration is a trailing cable showing each wire and each layer of insulation. If any bare wires are showing, or if any insulation is damaged, the wire or cable is a hazardous condition. Any wire or cable which has uninsulated, exposed wires is hazardous and can cause an electrical shock; a physical injury, such as a burn; death; or an explosion. In addition to uninsulated wires, any wire that is hot, smoking, or sparking is dangerous. These wires can also cause the same results – shock, injury, burns, death, or an explosion.

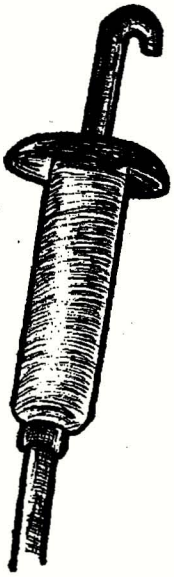
One way wires and cables can be damaged is in the way they are connected to switch boxes and fuse boxes. The hole in the box that the wire or cable goes through has sharp edges which could cut or scrape the insulation. A device called a wire bushing is used to protect the insulation from being cut or scraped.



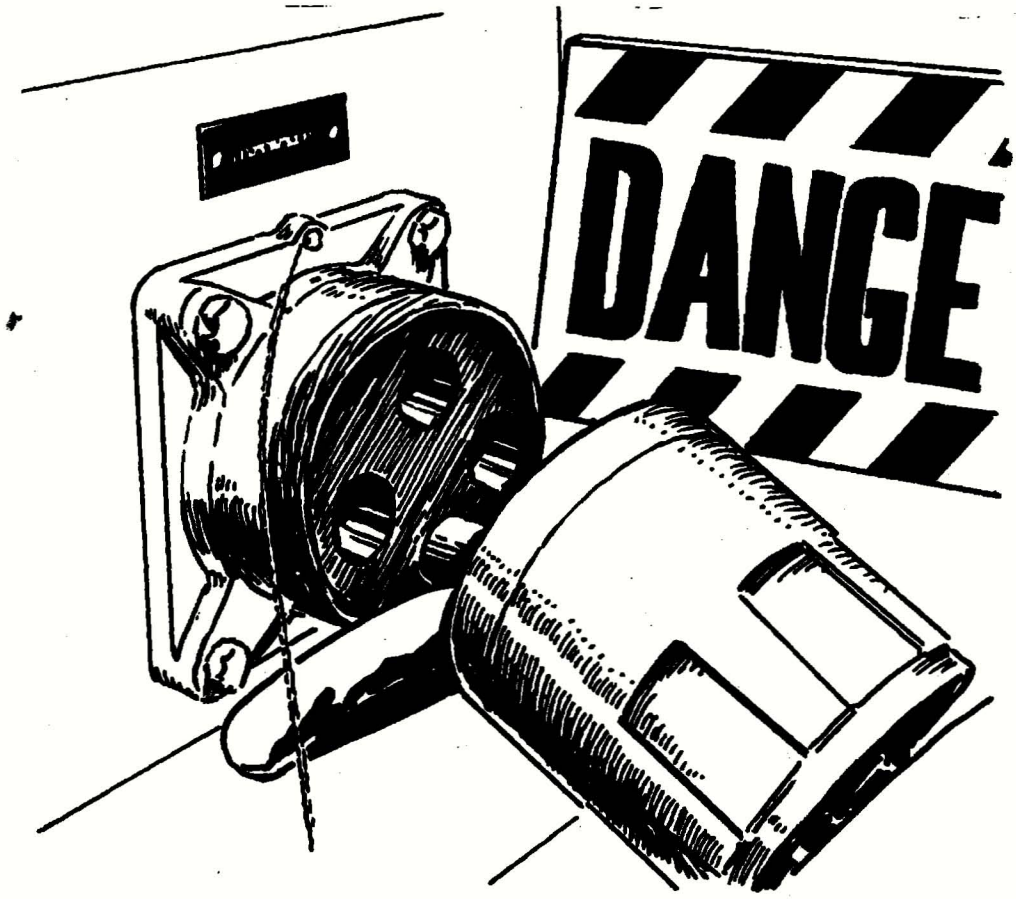
Here you see how a wire bushing protects wires from damage. The wire bushing holds the wire tightly in place and shields it from the sharp edges of the box. Any switch box or fuse box which is missing one or more wire bushings is an electrical hazard.

Trailing cables that are not properly connected are also a hazard. There are two types of trailing cable connections.



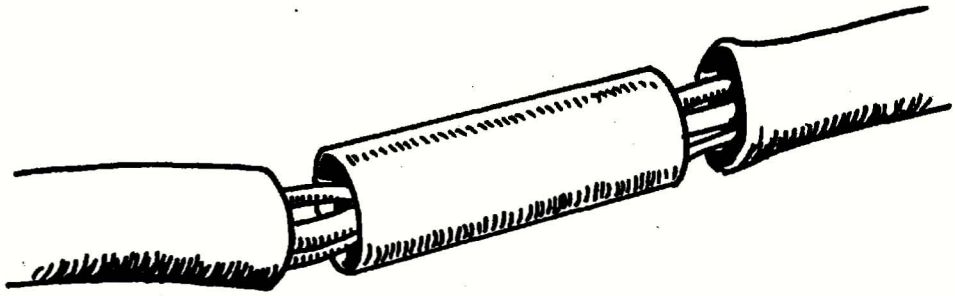


The illustrations on the previous page show the two types of trailing cable connectors. The one on the right is used to connect power cables to trolley wires. The one on the left is used to connect trailing cables to power distribution centers. Improperly connected trailing cables like the one shown in the next illustration can also cause serious injury or even death. Failure to use proper procedures in making connections can cause explosions, damage to equipment, electrical burns, and blindness. An improperly connected trailing cable can be very hazardous. (Note the bent pin in this illustration.)



When cables become damaged or worn, they are repaired by cutting out the damaged part and splicing the cable together. These splices are another possible source of electrical hazards. If a wire or cable splice is not adequately insulated and watertight, the splice is an electrical hazard. Permanent splices must be (1) mechanically strong with adequate electrical conductivity and flexibility; (2) effectively insulated and sealed so as to exclude moisture; and (3) vulcanized or otherwise treated with suitable materials to provide flame-resistant qualities and good bonding to the outer jacket.

If a splice has bare wire showing, it is, of course, an electrical hazard. But a splice may be a hazard even though it does not have bare wires showing. A splice that is not solidly constructed, watertight, or well-insulated could cause a miner to be severely injured or killed. Here you see an example of such a splice.



Please complete the following quiz on Wires and Cables.

True or False

III-1 _____ Trolley wires are usually bare.

III-2 _____ Trailing cables contain several wires which are not insulated.

III-3 _____ Any wire that is not insulated is hazardous and can cause injury.

Complete this sentence:

III-4 A device used to protect wires from damage is called a _____.

III-5 Which of the following would be a characteristic of improperly made permanent splicing?

A. Mechanically strong with adequate electrical conductivity and flexibility
B. Flame-resistant and good outer jacket bonding
C. Contains bare wires showing
D. Effectively insulated and sealed

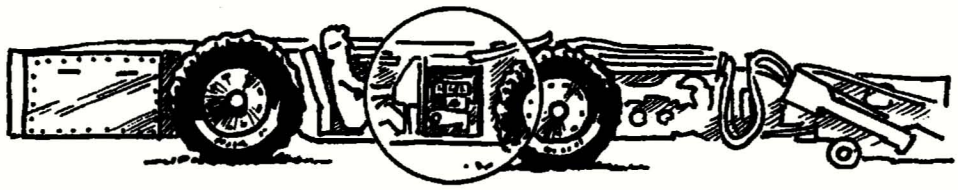
Please go to the next page to check your answers.

Answers to quiz on Wires and Cables

III-1 True
III-2 False
III-3 True
III-4 Wire bushing
III-5 C. Contains bare wires showing

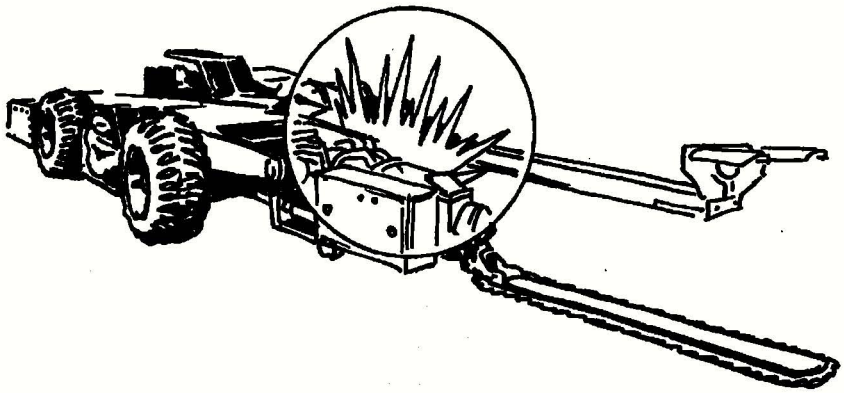
MINE MACHINERY AND TRANSFORMERS

Now let's discuss electrical hazards involving mine machinery and equipment. Many mine machines have cover plates over the electrical components of the machinery. These cover plates provide access for repairs. Machines with missing cover plates should not be operated because a missing cover plate would expose the operator to live electrical parts and the live electrical parts could serve as an ignition source for explosive gases.



Here you see a machine missing a cover plate. This machine should not be used in this condition.

Another possible hazard with mine machinery is arcing between two pieces of machinery.



Here you see two machines with arcing occurring between them. Whenever arcing occurs, both pieces of machinery should be deenergized (disconnected from power distribution source) immediately. Arcing is a signal that something is wrong with one of the two machines. One has an electrical charge on its outside surface. If the two machines are not deenergized, someone could receive a severe electrical shock. The arcing could also serve as an ignition source for explosive gases. An electrician will find out which machine is causing the trouble and repair the defective machine.

Transformers on the surface are kept in a locked room or enclosed by a fence to keep miners from getting too close. Transformers have high voltage on them and, if a miner accidentally got too close, the miner could receive a severe electrical shock that would probably result in his/her death. If a transformer enclosure is left unlocked, an electrical hazard exists. Transformer enclosures should always be kept locked.

Please complete the following quiz on Mine Machinery and Transformers.

True or False

III-6 _____ Mine machinery or equipment may be operated with missing cover plates.

III-7 _____ If arcing occurs between two mine machines, both machines should be immediately deenergized.

III-8 Transformer enclosures should always be kept locked/unlocked (Circle your answer).

Please go to the next page to check your answers.

Answers to quiz on Mine Machinery and Transformers

III-6 False
III-7 True
III-8 Locked

SIGNS

Danger signs and other warning signs are used to prevent accidents. A warning sign that is covered, damaged, or too dirty to be readable isn't preventing any accidents; but it may cause one. Any warning sign that is partially or completely unreadable should be replaced immediately, because a miner who can't read or see a warning sign may unknowingly allow himself/herself to be placed in a hazardous situation.

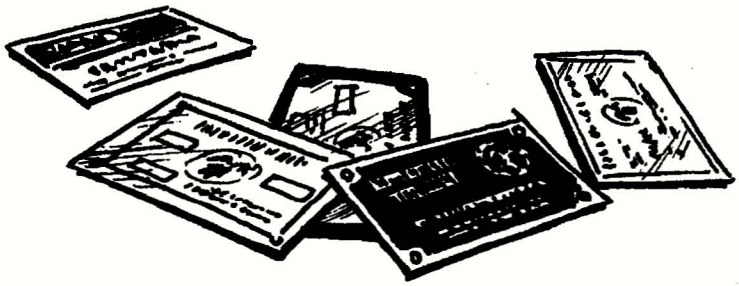
Also, failure to post warning signs when and where they are needed can result in accidents. Warning signs should be posted whenever a hazardous situation is observed and whenever performing repairs on powered machinery and equipment.

PERMISSIBLE AND NON-PERMISSIBLE EQUIPMENT

The area of a mine called the face, where coal is being removed from the ground, has some special requirements. Removing the coal from the ground often releases significant amounts of explosive gases. Because of this, one of the special requirements for the face is that all electrical equipment must be "permissible." An electrical device is permissible only if it has been approved by the Mine Safety and Health Administration (MSHA) and is maintained in good condition.

Before a piece of electrical equipment is approved by MSHA, it is put through a series of tests. These tests ensure that the equipment will not ignite explosive gases when operated, and, when installed in an explosion-proof enclosure, will withstand internal explosions of methane/air mixtures without damage to, or excessive distortions of, its walls or cover, and without ignition of the surrounding methane/air mixture or discharge of flame from inside or outside the enclosure. When a piece of equipment passes these and other extensive testing, MSHA allows the manufacturer to put an approval plate on the equipment.

All electrical equipment which has been approved by MSHA has an approval plate.



In addition to the approval plate, all electrical equipment must be maintained in safe condition to be permissible. Any equipment that is damaged or in a hazardous condition is not permissible.

All electrical motors, lights, and other electrical devices on permissible equipment are contained in explosion-proof housings. These explosion-proof housings prevent any heat, sparks, fires, or explosions inside the housing from igniting any explosive gases present at the face. The following is an illustration of an explosion-proof housing.

If an explosion-proof housing is damaged, improperly assembled, or missing any nuts, bolts, or washers, the piece of electrical equipment that the explosion-proof housing is mounted on becomes non-permissible. Also, any permissible equipment becomes non-permissible if it has any other unsafe equipment conditions.

Please complete the following quiz on Permissible and Non-Permissible Equipment.

True or False

III- 9 ____ All lights, electrical motors, and other electrical devices on permissible equipment are contained in explosion-proof housings.

III.10 ____ Equipment that is slightly damaged electrically may be considered permissible.

Please go to the next page to check your answers.

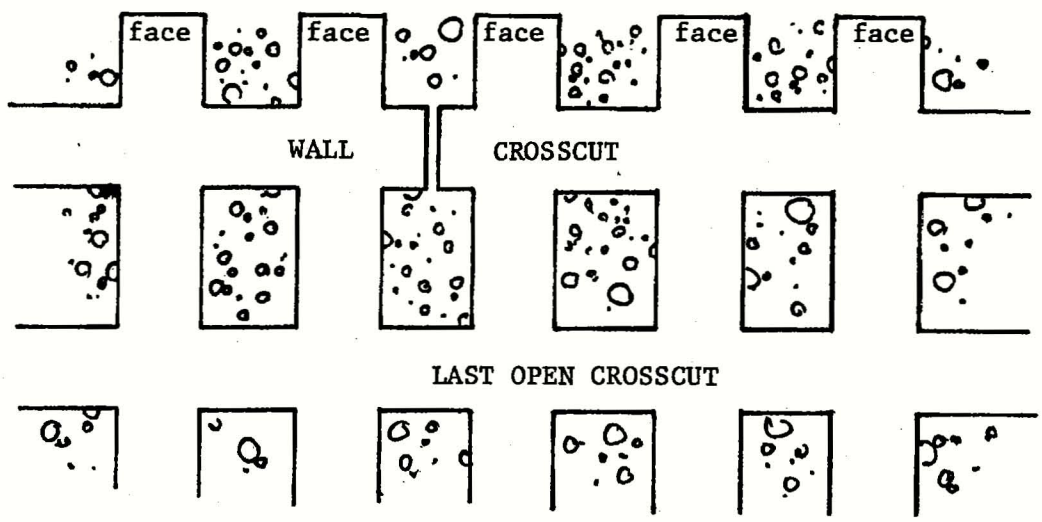
Answers to quiz on Permissible and Non-Permissible Equipment

III- 9 True
III-10 False

Locations Where Permissible Equipment is Required

Because of the danger of igniting explosive gases, Federal law prohibits use of non-permissible equipment inby (on the side toward the face) the last open crosscut. Electrical equipment that is not permissible is called non-permissible. Non-permissible electrical equipment cannot be used at the face, or in areas where unsafe air is being circulated out of the mine (return air). Non-permissible equipment could ignite any explosive gases that are present and cause a violent explosion. Any electrical equipment that is used inby the last open crosscut must be permissible. This includes large mining machines and small equipment like a miner's cap light.

The last open crosscut refers to the crosswise tunnels cut in the room-and-pillar method of mining. Room-and-pillar mining is the most common method of mining. In this method, tunnels are dug through the coal seam and pillars of coal are left between the tunnels to support the roof. Every so often, a cut is made through the pillars to form tunnels running crosswise. These crosswise tunnels are called crosscuts. This illustration shows a plan for a room-and-pillar mine with crosscuts.



What is the last open crosscut depends on how the mine is ventilated. All active working places must be ventilated by a current of air. Fresh air is constantly flowing through the mine tunnels and crosscuts and carrying out the contaminated air. If the crosscut is blocked by a curtain or a wall as is the top crosscut on the left in the above plan, it is no

longer considered open. Inby the last open crosscut, the methane gas is more heavily concentrated and the area is more dangerous. Therefore, only permissible equipment is allowed in this area. However, on the outby side (away from the face) of the last open crosscut, the air is less contaminated and, therefore, non-permissible equipment is allowed here because of less danger of an explosion.

SAFETY RULES

There are some general electrical safety rules that all miners must obey. These rules, if they are obeyed, will help you protect yourself and other miners from physical injury.

If you are operating a piece of equipment and you observe an electrical hazard, you should first remove power from the hazardous equipment. After removing power, place a warning sign on the appropriate switch or connecting device. Then you should notify your foreman or supervisor of the hazard. Remember these three steps:

1. Remove power
2. Post a warning sign
3. Notify your foreman or supervisor

Failure to perform these three steps in the correct order can result in injury or death to you or someone else. For example, if a miner observed an electrical hazard, shut off power and left the area to notify his foreman of the hazard without posting a warning sign, another miner could turn the power back on and cause someone to be injured or killed. You must notify your foreman or supervisor of the hazards. If you only tell a miner working near you about the hazard, your foreman or supervisor wouldn't know about it and could not arrange to have the hazard corrected.

Performing Electrical Repairs

Another general electrical safety rule concerns performing electrical repairs. Do not try to perform these repairs yourself. Only qualified electricians should repair electrical equipment. The electrician has been trained to repair electrical equipment safely and correctly. Unqualified miners have caused themselves and other miners to be injured by attempting to perform electrical repairs.

If you become a qualified electrician and have to perform any repairs or maintenance on electrical equipment, there are some things you should do to protect yourself. If power is coming from a power distribution center or a switchbox, you should deenergize the circuit with the switch or circuit breaker, visibly disconnect the cable from the power distribution center or switchbox, lock out the disconnecting device, and place a warning tag on the disconnecting device. This will prevent someone from applying power to the equipment you are working on.

If you find a disconnecting device locked out and tagged, do not try to connect the trailing cable to the power distribution center or switchbox. Only the person who placed the lock and tag on the disconnecting device should remove them.

If you must work on equipment that receives its electrical power from a trolley wire, which is only done in emergency situations, you should first remove the trolley nip or tap from the trolley wire. Then you should disassemble the trolley nip and keep the parts in your possession. This will prevent someone from accidentally applying power to your equipment while you are working on it. After disassembling the trolley nip, you should post a warning sign at the trolley nip location. This will help ensure that no one applies power to your equipment.

If you find a trolley nip that has been disassembled and tagged, do not try to reassemble the nip or remove the tag or use the tap. Only the person who disassembled and tagged the trolley nip should reassemble the nip and remove the tag.

When an electrical machine is initially energized, the circuit breakers on the machine and on the power distribution center must be reset. If a circuit breaker immediately trips after it is initially reset, do not try to reset it again. When the circuit breaker trips, it is a signal that something is wrong. A warning sign should be posted on the circuit breaker and the foreman or supervisor should be notified.

Some circuit breakers have adjustments on them. These adjustments should only be changed by a qualified electrician. If other miners change these adjustments, the circuit breaker may allow excess amounts of electrical power to be delivered.

When a fuse blows, it should be replaced with a fuse with the proper rating. Replacing a fuse with one of an improper or different rating can allow excess amounts of electrical power to be delivered. This can result in fires, explosions, and injury or death for a miner.

Please complete the following quiz on Safety Rules.

III-11 Who is responsible for repairing electrical equipment? _____

III-12 Name the four steps a qualified electrician takes before performing maintenance on electrical equipment.

_____

_____

_____

_____

III-13 What do you do if a circuit breaker trips immediately after it has been reset?

_____

_____

III-14 Who is the only person responsible for adjusting circuit breakers?

_____

Please go to the next page to check your answers.

Answers to quiz on Safety Rules

III-11 Qualified electricians

III-12

- Set circuit breaker to off
- Disconnect cable from power distribution center or switchbox
- Post warning sign on breaker or switch
- Lock out disconnecting device

III-13 Post a warning sign on the breaker and notify the foreman or supervisor

III-14 Qualified electricians

PROTECTIVE EQUIPMENT

Now let's consider some of the safety aspects of protective equipment. An electrician should wear insulated shoes and protective gloves whenever he/she is working on energized wires or cables. Repair work on energized wires and cables, except for testing and troubleshooting, is prohibited by law. Energized trolley wires are the only exception to the law; a properly trained person may repair energized trolley wires. Failure to use protective equipment can result in death.

Before an electrician uses his/her insulated shoes and protective gloves, he/she should inspect them for defects. Protective gloves which have cracks or holes don't offer much protection.

At some places where miners operate switches and circuit breakers, insulating mats and platforms are provided. If the miners stand on them, these protect miners from receiving an electrical shock if they accidentally touch a live part of the switch or circuit breaker. This protective equipment must be kept in place and in good condition. Any defect or absence should be reported to the foreman or supervisor.

Fire extinguishers are provided on electrical machines, power distribution centers, and other places in a mine. **A defective, empty, missing, or wrong type of fire extinguisher should be reported to the foreman or supervisor immediately**. If a fire extinguisher is not designed for extinguishing electrical and coal fires, it is the wrong type. A label on the front of the fire extinguisher will tell you what kinds of fires it can be used on. If a fire extinguisher is missing, inoperative, or the wrong type and a fire occurred, another fire extinguisher would have to be found before the fire could be extinguished. This delay could cause extensive equipment damage or injury to a miner.

Machinery that is known to be in an unsafe condition should not be used until it is repaired. Operating such machinery can result in injury or death for a miner. If an unsafe condition is detected, it should be reported to the foreman or supervisor and the machine should not be used.

Before you go to the next section, take the self-evaluation exercise and see how well you remember the important information in this chapter. Answer all questions before checking your answers at the end of the exercise.

Self-Evaluation Exercise for Chapter III

III-1 A rubber-like covering on a wire or cable is called _____.

III-2 What kinds of wires are hazards? _____ _____

III-3 Which of the following trailing cable conditions are hazardous?
a. Sparking trailing cable
b. Smoking trailing cable.
c. Hot trailing cable
d. Improperly connected trailing cable
e. All of the above

III-4 What are three possible consequences of using an improperly connected trailing cable? _____ _____ or _____

III-5 The fuse box is a hazard when it has a missing _____.

III-6 Why should trailing cables be kept out of water?
_____

III-7 Mine equipment which is missing a _____ should not be operated.

III-8 If arcing occurs between two machines, both machines should be _____ immediately.

III-9 Transformer enclosures should always be kept _____.

III-10 A partially unreadable _____ should be _____ immediately.

III-11 Warning signs should be posted whenever _____ and whenever _____ on powered equipment.

III-12 Which one of the following statements is the correct definition of permissible electrical equipment?
a. Electrical equipment that is properly maintained in a safe condition
b. Electrical equipment that has an MSHA approval plate mounted on it, and has a damaged cover plate
c. Electrical equipment that has an approval plate from MSHA and is properly maintained in a safe condition

III-13 Why can't non-permissible equipment be used at the face?

a. A miner may receive an electrical shock
b. Dangerous gases may overcome a miner
c. Explosive gases may be ignited
d. Non-permissible equipment is illegal in any part of the mine

III-14 Which of the following equipment conditions would cause an approved piece of electrical equipment to be non-permissible?

a. Approval plate is badly scratched
b. Missing lock washer on explosion-proof housing
c. All electrical components are enclosed in explosion-proof housings
d. Miner is operating machine too fast

III-15 If MSHA has approved a piece of electrical equipment as being permissible, the equipment will have an _____ on it.

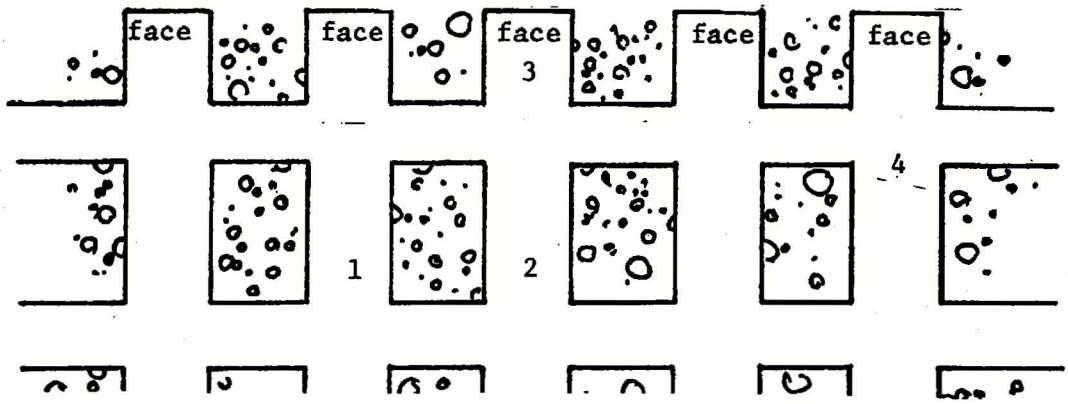
III-16 Where can permissible equipment be used in the mine? _____

_____

III-17 Where can non-permissible equipment be used in the mine?

_____

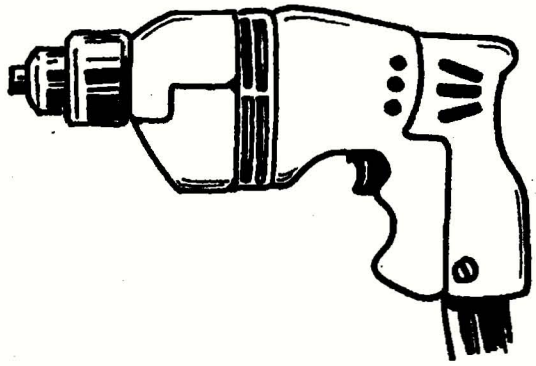
III-18 At which of the four numbered locations in this diagram is it required that permissible equipment be used?



For the following questions, answer "yes" or "no" and briefly explain your answer. Base your answers on what you can see.

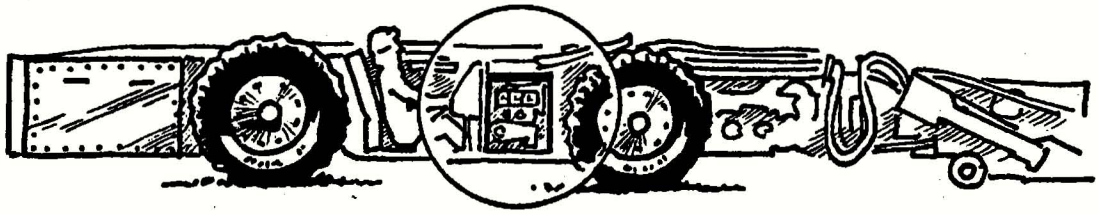
III-19 Is this hand drill permissible?

_____



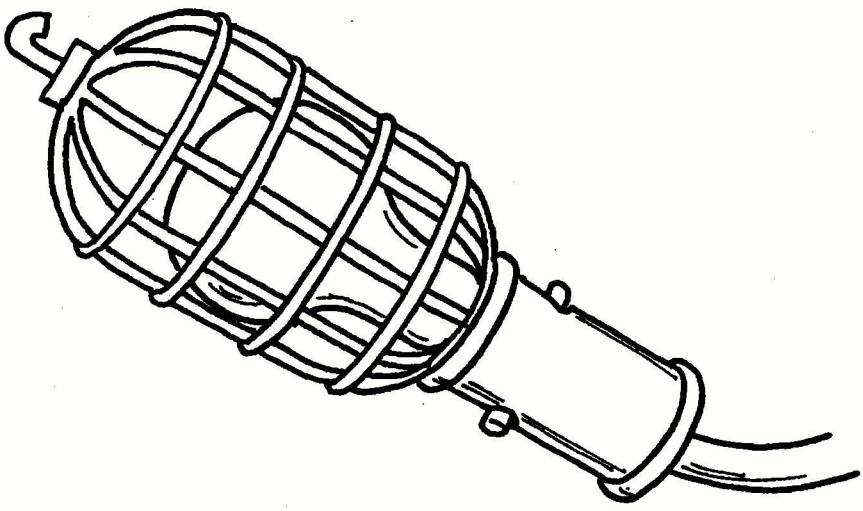
III-20 Is this loader permissible? _____

_____



III-21 Is this trouble light permissible? _____

_____



Fill in the blanks.

III-22 What are the steps you should take when you spot an electrical hazard while operating a piece of equipment?

_____

_____

_____

III-23 The only miner who may perform electrical repairs is a _____.

III-24 A miner reassembled a trolley nip which had been disassembled by another miner and removed the tag. Was this a safe act? ____ If not, why?

_____

_____

III-25 A miner, at the start of his shift, found that the circuit breaker on a power distribution center tripped. He did the following: 1) He set the circuit breaker to off; 2) he locked and tagged it; 3) he checked to see that the trailing cable was still connected to the power distribution center. Is this the proper procedure? _____ If not, what was done wrong?

_____

_____

III-26 A fuse blew on the trolley tap line and the electrician, not having one of the same size, found a slightly larger one but decided against using it. Did he do the proper thing? _____ Why?

_____

_____

III-27 Who should change the adjustment on a circuit breaker for a continuous miner?

a. A miner experienced in operating the equipment
b. An electrician
c. A foreman or supervisor

III-28 Before using safety clothing, they should be _____.

III-29 A miner who is operating a switch should stand on a/an _____ or _____.

III-30 What should you do if a fire extinguisher is missing?

_____

_____

III-31 How can you tell if the fire extinguisher is the proper kind for putting out electrical fires?

_____

III-32 Should machinery which is tagged be used? _____ If not, why not?

_____

Please go to the next page to check your answers.

Answers to Self-Evaluation Exercise on Chapter III

If you make any mistakes, correct your errors by reading the section(s) that corresponds to the question(s) missed.

III-1 Insulation
III-2 Bare wires and wires with damaged insulation or poorly-made splices
III-3 E – All of the above
III-4 Electrical shock, blindness, burns, death, explosions, or equipment damage
III-5 Wire bushing
III-6 The insulation may be damaged and the miner can be killed by simply stepping in water
III-7 Cover plate
III-8 Deenergized
III-9 . Locked
III-10 Warning sign, replaced
III-11 A hazard exists, repairs are being performed
III-12 C – Electrical equipment that has an approval plate from MSHA and is properly maintained in a safe condition.
III-13 C – Explosive gases may be ignited.
III-14 B – Missing lock washer on explosion-proof housings
III-15 Approval plate
III-16 Anywhere in the mine
III-17 On the outby side (away from the face) of the last open crosscut
III-18 Permissible equipment must be used at location #3 because it is beyond the last open crosscut.
III-19 No, it does not have an approval plate
III-20 No, it has a missing cover plate
III-21 No, it does not have an approval plate
III-22 Remove power, post a warning sign, notify the supervisor about the hazard
III-23 Qualified Electrician
III-24 No, the person who disassembled the trolley nip and tagged the machine should reassemble the nip and remove the tag.
III-25 No, he should have visibly disconnected the cable from the power distribution center, after he locked out and tagged the breaker.
III-26 Yes, if a fuse blows it should be replaced by one with the same rating.
III-27 B – An electrician
III-28 Inspected
III-29 Insulated mat or platform
III-30 Report it to a foreman or supervisor
III-31 By reading the label
III-32 The tag means it's unsafe. Using it can cause death or injury.

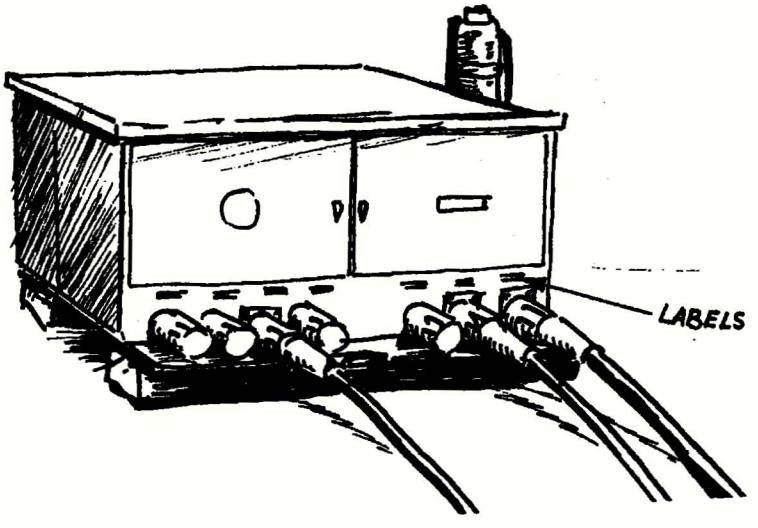
Now go to Chapter IV, The Power Distribution Center and Charging Station

IV. THE POWER DISTRIBUTION CENTER AND CHARGING STATION

In this chapter you will learn to distinguish between safe and unsafe power distribution center conditions and locations, the ideal placement of the unit, and hazardous conditions associated with its components.

You will also learn the special safety requirements for charging stations and the reasons for them, such as their ventilation needs.

Let's begin with the power distribution center. Power distribution centers supply electrical power to many different kinds of mining equipment. Power distribution centers in unsafe condition can cause accidents with severe consequences. Here you see a typical power distribution center.



There are several factors that influence the location of a power distribution center. The power distribution center location must be high, dry, well rock dusted, safe from roof and rib falls, free of debris and combustible materials, and in intake air outby the last open crosscut.

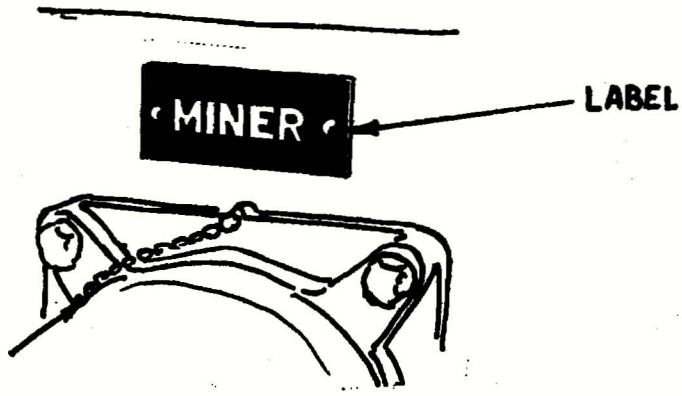
- The location must be high and dry so moisture doesn't get into the power distribution center and cause it to malfunction.
- The location must be well rock dusted so sparks don't cause a coal dust explosion or fire.
- The location must be safe from roof and rib falls because a roof or rib fall could damage the power distribution center and cause a fire or explosion.
- The location must be free of debris and combustible material because a power distribution center malfunction could ignite the debris or combustible material.

- The location must be in intake air outby the last open crosscut so the power distribution center doesn't ignite explosive gases that could be present inby the last open crosscut or in exhaust air.

Any power distribution center location that doesn't meet all of these requirements should be reported to the foreman or supervisor so corrective action can be taken.

Power distribution centers have a high-voltage switch. If this switch is in the off position, do not turn it on yourself. Notify your foreman or supervisor of your problems. Below, you will see a power distribution center high-voltage switch.

Power distribution center connectors and circuit breakers must be clearly labeled, as shown below. If the connectors and circuit breakers are not clearly labeled, electrical power could be accidentally connected to or disconnected from the wrong machine. This could result in a machine suddenly being energized or deenergized and injuring a miner.



If a power distribution center has two or more circuit breakers with different ratings, each connector must be made so that it is physically impossible to connect a trailing cable to the wrong connector. Connectors like this are commonly called "idiot proof" connectors. If a power distribution center has two or more circuit breakers with different ratings and connectors that are not idiot proof, a trailing cable could be connected to the wrong connector with a circuit breaker that has a different rating. The circuit breaker could then allow excess amounts of electrical power to be delivered. This could result in fires, explosions, injuries, and deaths.

There are several power distribution center safety practices you should be aware of: The first is that **all connections to a power distribution center must be tight.** A loose connection could result in overheating of the connection or sparking. The result could be fires or burns.

The second safety practice is **BEFORE making any connections to a power distribution center, the machine being connected should have all power switches and circuit breakers turned off.** Also, all the **machine controls should be in a neutral position** and the **power distribution center circuit breaker should be off.** If these switches and circuit breakers are not off when a connection to a power distribution center is made, an arc, which is a bright flash, could occur and burn or blind the miner making the connection. Also, the machine could suddenly energize and injure a miner who is near it.

At the start of each shift, be sure to find out where the power distribution center you are working with is located. If a malfunction or emergency situation occurs, you may need to quickly turn off the power distribution center circuit breaker for a machine. You won't have time to search for the power distribution center.

Please complete the following quiz on the Power Distribution Center.

IV-1 ____ True or False – Power distribution centers only supply power to face equipment.

IV-2 Which of the following conditions are wrong regarding the location of a power distribution center?

a. The location must be high and dry
b. The location must be in a return air zone
c. The location must be free of debris and combustible material
d. The location must be well rock dusted

IV-3 Any power distribution center location that does not meet all safety requirements should be:

a. Reported to the foreman or supervisor
b. Moved immediately by you and your fellow miners
c. Reconditioned annually
d. Used only in an emergency

IV-4 Why must a power distribution center be located in intake air outby the last open crosscut?

a. So that roof falls cannot damage it
b. So that it doesn't ignite explosive gases that could be present inby the last open crosscut or in exhaust air
c. So that it is free of combustible materials and debris
d. None of the above

IV-5 _____ True or False – Never turn on the high-voltage switch of a power distribution center.

IV-6 _____ True or False – A hazardous condition exists if power distribution center connector and circuit breakers are not clearly labeled.

IV-7 List three power distribution center safety practices.

1. _____
2. _____
3. _____

Please go to the next page to check your answers.

Answers to quiz on the Power Distribution Center

IV-1 False

IV-2 b – The location must be in a return air zone.

IV-3 a – Reported to the foreman or supervisor

IV-4 b – So that it doesn't ignite dangerous gases that could be present inby the last open crosscut or in exhaust air.

IV-5 True

IV-6 True

IV-7 Any 3 of the following:

1. All connections must be tight.
2. All power switches and breakers of the machine being connected should be "OFF".
3. Machine controls should be in neutral.
4. Power distribution center breakers should be "OFF".

Now let's discuss battery charging stations. Charging stations are where batteries are recharged. When batteries are being recharged, they give off hydrogen gas which is extremely explosive. Because of the explosive hydrogen gas, it is very important that the charging station has adequate ventilation.

Now, let's review the materials in this chapter by taking a self-evaluation quiz. Answer all questions before checking your answers at the end of the exercise.

Self-Evaluation Exercise for Chapter IV

IV-1 Why is a power distribution center location required to be high and dry?

IV-2 Why is a power distribution center location required to be well rock dusted?

IV-3 Why is a power distribution center location required to be safe from roof and rib falls?

IV-4 Why is a power distribution center location required to be free of debris and combustible materials?

IV-5 Why is a power distribution center location required to be in intake air outby the last open crosscut?

IV-6 What should be done if a power distribution center high-voltage switch is found in the off position?

IV-7 Why should power distribution center connectors and circuit breakers be clearly labeled?

IV-8 Why must a power distribution center with two or more circuit breakers with different ratings have "idiot proof" connectors?

IV-9 Why are loose power distribution center connections hazardous?

IV-10 What should be done before a trailing cable is connected to a power distribution center?

_____

_____

IV-11 Why should miners check to see where the power distribution center is located at the start of each shift?

_____

_____

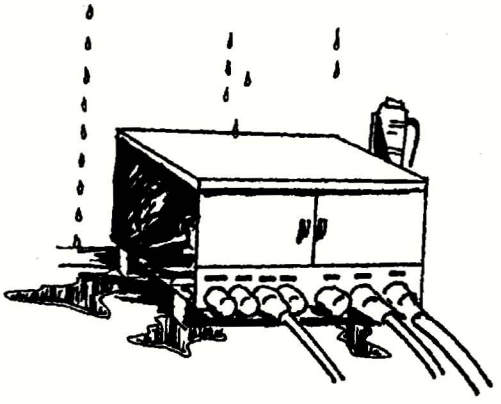
IV-12 Why is adequate ventilation so important in charging stations?

_____

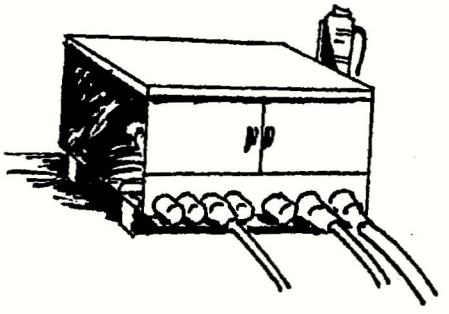
_____

IV-13 Identify any hazardous power distribution center conditions shown in the following illustrations. State why they are hazardous.

a. _____
b. _____
c. _____
d. _____
e. _____



A.



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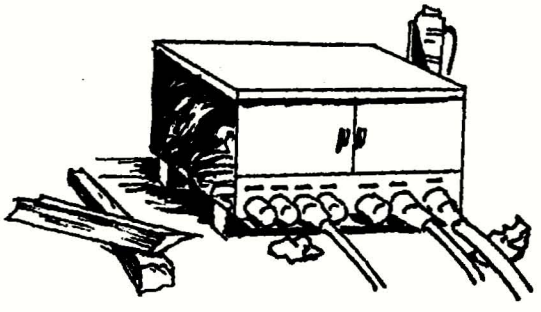

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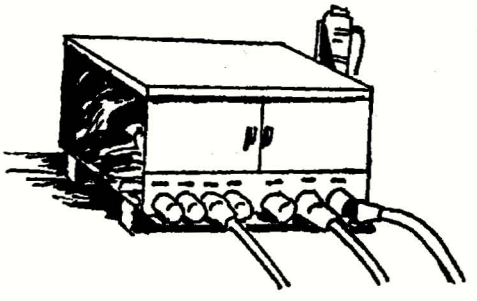
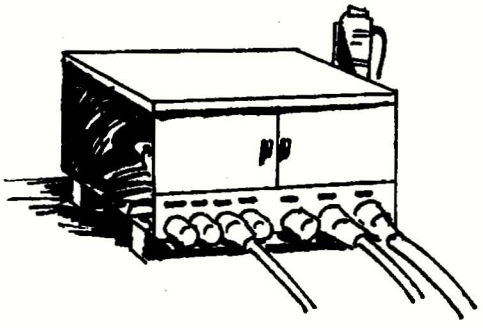


D.



E.

Please go to the next page to check your answers.

Answers to Self-Evaluation Exercise for Chapter IV

IV-1 So moisture doesn't get into the power distribution center and cause it to malfunction.

IV-2 So sparks don't cause a coal dust explosion or fire.

IV-3 Because a roof or rib fall could damage the power distribution center and cause a fire or explosion.

IV-4 Because a power distribution center malfunction could ignite the debris or combustible material.

IV-5 So the power distribution center doesn't ignite explosive gases that could be present inby the last open crosscut or in exhaust air.

IV-6 The miner should not turn it on himself/herself. He/she should notify his/her foreman or supervisor about this problem.

IV-7 So electrical power is not accidentally connected to or disconnected from the wrong machine.

IV-8 So a trailing cable cannot be connected to a connector with a circuit breaker that has an improper rating.

IV-9 Because the connection could overheat or spark.

IV-10 The machine being connected should have all power switches and circuit breakers turned off. Also, all the machine controls should be in a neutral position and the power distribution center circuit breaker should be off.

IV-11 Because if a malfunction or emergency situation occurs, a miner may need to quickly turn off the power distribution center circuit breaker. He/she wouldn't have time to search for the power distribution center.

IV-12 Because of the explosive hydrogen gas given off by the batteries.

IV-13 a. The power distribution center has water dripping on it. Water could get into the power distribution center and cause it to malfunction.

b. The power distribution center has unlabeled connectors and circuit breakers. Electrical power could accidentally be connected to or disconnected from the wrong machine.

c. The power distribution center has debris lying around it. A power distribution center malfunction could ignite the debris.

d. The power distribution center has a loose connector. The loose connection could overheat or spark.

e. This power distribution center has a safe location and is in a safe condition. No hazards are present.

Now that you can distinguish between safe and unsafe power distribution center conditions and locations, and you are aware of the special safety requirements for charging stations, you are ready to move on to Chapter V, Trolley Wires and Nips.

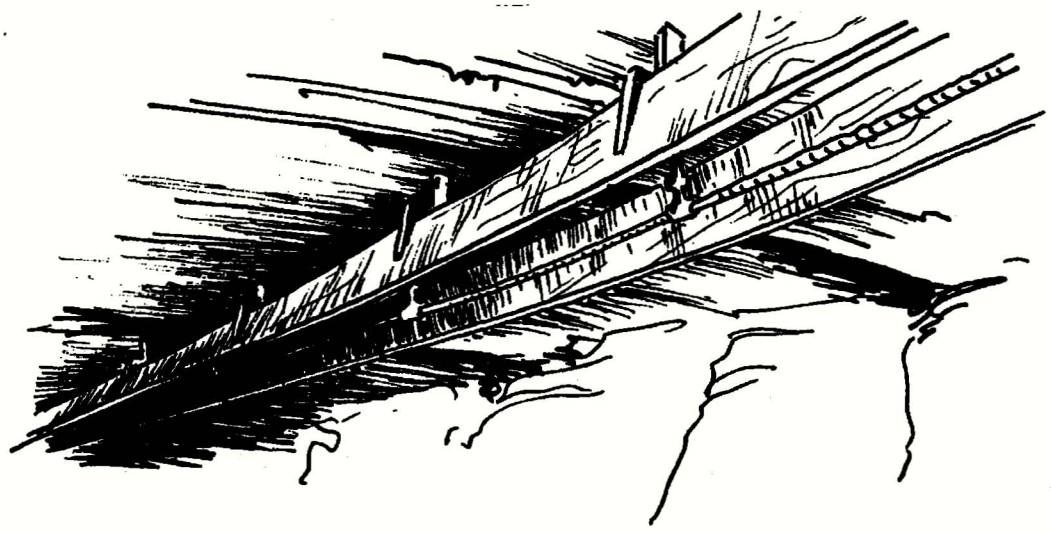
V. TROLLEY WIRES AND NIPS

In this chapter you will become familiar with some of the hazards associated with trolley wires and nips. You will discover that, while there are devices to protect you against the hazards produced by trolley wires, the main factor in ensuring your safety is **your own behavior**. While safety devices will protect against accidentally committing an unsafe act, they will not prevent you from deliberately committing such an act. It is, therefore, essential that you learn to recognize the unsafe acts pointed out in this section so that you can deliberately avoid them and work safely in the mine.

If you recall our earlier mention of trolley wires, you will remember that these are large bare wires suspended from the roof of underground mines. These wires supply the power needed for electrical locomotives to haul workers and coal through the mine, and also help power some auxiliary machines.

To power equipment such as electric locomotives, quite a large amount of current is running through trolley wires. When you add the fact that these wires must not be insulated, so that they can make contact with trolley poles, you can see the dangers of a trolley wire.

Because trolley wires are bare and carry large amounts of current, a miner accidentally touching these wires may receive a severe electrical shock that could injure or kill him/her.



For this reason, at certain places in a mine, trolley wire guards, like this one, must be installed to help protect miners from accidentally touching the trolley wire. Look at the trolley wire guard. Is it still possible to touch the bare trolley wire? Yes, it is! The

trolley wire can **still** be easily touched even with the trolley wire guard in place. Trolley wire guards only help protect you from **accidentally** touching the wire.

To be effective in preventing accidental contact with trolley wires by miners, two conditions must be met. The first of these is that trolley wire guards must be properly installed and maintained. What this basically means is that the guard must be installed so that a wire does not protrude above or below it. If a trolley wire guard does not extend above and below the trolley wire on both sides, that guard is not doing its job. It is defective. If you see a defective trolley wire guard, report this problem to your foremen or supervisor immediately.

The second condition which ensures miners are safe from accidental contact with trolley wires involves positioning of trolley wire guards. Trolley wire guards must be in the right places in addition to being in good shape.

Where are the proper places to locate trolley wire guards? Trolley wire guards are required at:

- all work areas
- all places where miners have to regularly walk under a trolley wire
- places called man trip stations, where miners get on and off cars which carry the miners in and out of the mine

Trolley wire guards will help keep you safe from the hazards of trolley wires, but you can still be hurt by trolley wires even when they are guarded – unless you are careful.

One example of how this can happen again involves the man trip station. At a man trip station the trolley wire will be hung over one side of the cars which will carry you into the mine (man trip cars). This allows you to enter the cars safely from one side, but presents a danger if you enter from the side over which the wire is hung.

Never board a man trip car from the trolley wire side! Your chances of being injured or killed go up tremendously when you do so. Many injuries and deaths have occurred when miners have attempted to board man trip cars from trolley wire sides.

Please complete the following quiz on Trolley Wires and Nips.

V-1 Safety devices protect you against
- a. Deliberately committing unsafe acts
- b. Every possible danger
- c. Accidentally committing unsafe acts

V-2 How well you avoid hazards associated with trolley wires depend most on
- a. Your foreman
- b. Other miners
- c. Safety devices
- d. Yourself

V-3 The main function of trolley wires is to power
- a. Haulage machinery
- b. Continuous miners at the working face
- c. Auxiliary fans
- d. Supply power to all the belt drive motors

V-4 Which of the statements below **best** describes a trolley wire?
- A. An insulated wire carrying large amounts of electrical current
- B. A bare wire carrying small amounts of electrical current
- C. A bare wire carrying large amounts of electrical current
- D. An insulated wire carrying small amounts of electrical current

V-5 _____ True or False – A deliberate attempt to touch a trolley wire can succeed despite a trolley wire guard.

V-6 _____ True or False – A trolley wire guard which has holes or gaps in it, but extends above and below the trolley wire, is not defective.

V-7 Trolley wire guards must be in good _____ and be in the correct _____ in order for them to be effective in preventing miners from touching bare trolley wires.

V-8 _____ True or False – Just before you enter a car which will take you down into the mine, if you look up at the trolley wires, you should notice guards around those wires.

V-9 _____ True or False – Trolley wire safety guards make it safe to board or leave a man trip car from the trolley wire side.

Please go to the next page to check your answers.

Answers to the quiz on Trolley Wires and Nips

V-1 c – Accidentally committing unsafe acts

V-2 d – Yourself

V-3 d – Supply power to all the belt drive motors

V-4 c – A bare wire carrying large amounts of electrical current

V-5 True

V-6 False

V-7 Shape (or "repair"), places (positions)

V-8 True

V-9 False

As a general rule in dealing with trolley wires, it is simply best to stay as far away from them as is practical. Keep in mind that staying away from these wires means keeping not only your body away from them but also your tools. If you are moving through an area where trolley wires are located, use extra caution in watching where you are going.

Trolley wires are held up by hangers attached to the roof at appropriate intervals. When trolley wire hangers are spaced too far apart, or if one comes loose from the roof, the trolley wire can hang below the guards and thus set up a hazardous situation. Another reason for trolley wires sagging is an electrical overload. Under this condition, the heat generated could soften the trolley wire and cause it to fall. In addition to being a potential source of injury, a wire falling on coal or other combustible material could cause a fire.

Trolley wires which are poorly hung can be extremely dangerous. If you see a sagging trolley wire, or notice a hanger pulling out of the roof, notify your foreman right away. Otherwise, you or another miner may just run into that sagging wire.

As you know, the main use of trolley wires is in haulage. However, occasionally, the trolley line will be tapped to provide power to a small piece of machinery on a temporary basis, or in an emergency.

Even though you will not be dealing directly with making trolley taps, you should be aware of some of the dangers involved.

Several of these dangers involve trolley "nips" (the section which actually attaches to the trolley wire). For example, if the nip is not clearly labeled as to what machine it is connected to, the wrong nip might be placed on the trolley wire, thus starting up a machine that was supposed to remain stopped. A poorly marked, or unmarked, trolley nip can be a great hazard.

Another fairly obvious danger regarding connecting nips involves the actual connection of a nip to the trolley wire. Anyone making this connection should first of all wear eye protection, and, secondly, pay close attention to what he/she is doing. Because a bright flash may occur when the nip is put in place, some people may tend to not look at what they are doing – this could be a fatal mistake. Do not attempt to make a connection with your head turned.

Should you as a bystander see a flash such as we have mentioned above, you should recognize that something has gone wrong and try to render any assistance you can to the temporarily blinded miner. After he/she has been helped, notify the foreman of the problem.

Please complete the following quiz on Trolley Wires and Nips.

V-10 _____ True or False – A miner carrying a slate bar over his/her shoulder when approaching trolley wires is demonstrating a good safety practice.

V-11 List three causes for trolley wires sagging.

1. _____
2. _____
3. _____

V-12 _____ True or False – Power from trolley wires is used to run most major pieces of machinery in the mine.

V-13 _____ True or False – There are two unmarked nips on the ground. Your foreman picked one up without tracing the line back to see what machine the tap is connected to, and then placed the nip on the trolley wire. This was an unsafe practice.

V-14 _____ True or False – A bright flash upon connecting a nip to a trolley wire is normal.

Please go to the next page to check your answers.

Answers to the quiz on Trolley Wires and Nips

V-10 False

V-11 1. Hangers placed too far apart
2 Hangers pulling out of the roof
3. Heat generated by an electrical overload

V-12 False

V-13 True

V-14 False

Nips create a number of other hazards, such as poor insulation, which you should be able to recognize; the need for fuses to operate nips; and the importance of ground and return clamps, which we will not deal with because they are of a more technical nature.

As a beginning miner, it is far more important for you to realize that working with nips and trolley wires is a dangerous business. This work is best left to others until you have gained a great deal of experience in the mine.

If you can recognize the danger of trolley wires and your own limitations in dealing with tapping the power of these wires, then you have mastered the contents of this short section.

Now, let's review the materials in this chapter by taking a self-evaluation quiz. Answer all questions before checking your answers at the end of the exercise.

Self-Evaluation Exercise for Chapter V

Circle the letter of the statements which most correctly completes each of the following:

V-1 Trolley wire guards should be found
- A. At most work areas
- B. Only at man trip stations
- C. At all places where miners have to regularly walk under a trolley wire

V-2 Trolley wires are bare wires which mostly
- A. Provide power for haulage operations
- B. Power all machines in the mine
- C. Run only auxiliary motors, etc., in the mine
- D. Supply power to all belt drive motors

V-3 Which of the following cases represents a safe trolley wire guard condition?
- A. Trolley wire is extending above the guard
- B. Holes are in the guard on one side only
- C. Trolley wire is sagging below the guard
- D. The guard extends above and below the wire on both sides and has no cracks or holes

V-4 On boarding or leaving a man trip, enter or leave
- A. On the side closest to the trolley wires
- B. On the side farthest from the trolley wires
- C. On either side

V-5 When carrying tools in an area with trolley wires
- A. Carry them at waist level
- B. Carry them on your shoulder
- C. Carry them any way that is comfortable

V-6 When a nip hits the trolley wire and there is a bright flash, you know
- A. The situation is normal
- B. There is trouble of some kind
- C. That this happens occasionally, but does not indicate that there is trouble

V-7 Sagging trolley wires may be caused by

A. Hangers being too close together
B. Being pulled down by nips
C. Hangers coming loose from the roof

V-8 Upon seeing a sagging trolley wire

A. Notify mine officials on the surface
B. Notify your foreman
C. Ignore the problem

Please go to the next page to check your answers.

Answers to Self-Evaluation Exercise for Chapter V

V-1 C – At all places where miners have to regularly walk under a trolley wire

V-2 D -- Supply power to all belt drive motors

V-3 D – The guard extends above and below the wire on both sides and has no cracks or holes

V-4 B – On the side farthest from the trolley wires

V-5 A – Carry them at waist level

V-6 B – There is trouble of some kind

V-7 C – Hangers coming loose from the roof

V-8 B – Notify your foreman

Now that you are familiar with some of the hazards associated with trolley wires and nips, you are now ready to move on to Chapter VI, Trailing Cables.

VI. Trailing Cables

In this chapter we will take a closer look at the hazards to your health and safety posed by trailing cables. When you have finished this chapter you will be able to recognize faulty trailing cables and prevent cables from becoming hazardous.

Trailing cables must withstand a lot of abuse. They are pulled, twisted, spooled, and scraped. Sometimes this causes the trailing cable insulation to be damaged. If the insulation has cracks, cuts, holes, or is worn through, the trailing cable is in an unsafe condition and should not be used. Bare wires could be exposed or water could seep into the cable; either condition could result in a miner being electrocuted.

Another type of trailing cable hazard is a hot, smoking, or sparking section of the cable. Any one of these conditions is a signal that something is wrong with the trailing cable. Power should be removed from the trailing cable and it should not be used again until it is repaired or replaced.

A pinched trailing cable is one hazard. The insulation could be damaged and the wires forced together. This could result in fires, explosions, burns, or electrical shock. A pinched trailing cable should not be used until the condition is corrected and the trailing cable is inspected for damage.

Trailing cables should not be allowed to trail in water. The cable's insulation resists water, but a small cut, crack, or hole could go unnoticed. Then, if the trailing cable is trailing in water, water could seep into it. This results in a very dangerous condition. Water is a good conductor of electricity, and, if a miner stepped in the water in which the trailing cable is lying, he/she could be electrocuted.

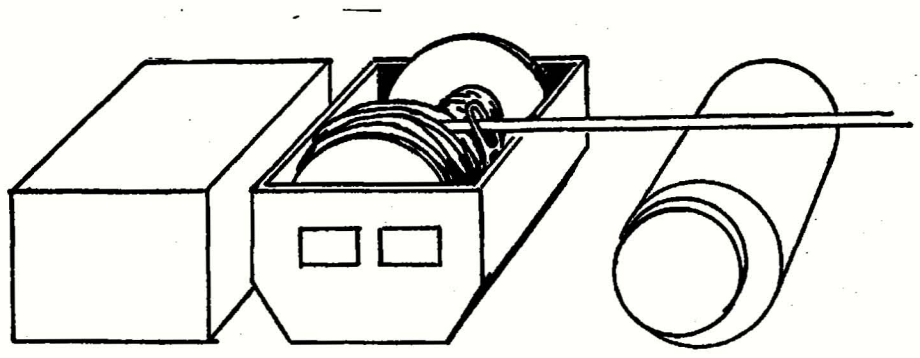
Trailing cables that are not protected from damage by mobile equipment are another hazard. If a trailing cable is located where it could be run over by mobile equipment, the weight of a piece of mobile equipment could crush the trailing cable. This could result in a fire, explosion, or injury to a miner. You will learn how to protect trailing cables from damage later.

There are two basic ways in which to have trailing cables set up on machines, and each way has its own particular hazards.

The first method involves mine machines rolling their trailing cables in and out of a large cable reel that looks like a giant fishing reel. This prevents unneeded lengths or trailing cable from lying around, being damaged, or causing a hazard. The trailing cable enters the machine by going between two pulley wheels called spooling sheaves. The spooling sheaves protect the trailing cable from scraping against the machine as the machine turns left and right.

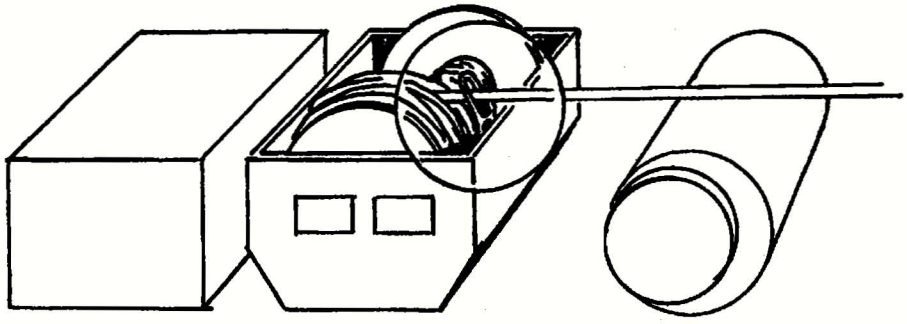
After going through the spooling sheaves, the trailing cable goes to a spooling device. The spooling device feeds the trailing cable onto the cable reel. The spooling device spreads the trailing cable over the entire width of the cable reel as the cable is reeled in.

Malfunctioning or unsafe conditions in the cable reel system can result in fatal accidents. One of the most common malfunctions is a stuck spooling sheave that will not turn. Pulling a trailing cable across a stuck spooling sheave can damage the cable. Also, if spooling sheaves have burrs, nicks, or chunks broken out, the sharp edges can cut the trailing cable insulation.



This illustration shows another possible problem when the spooling device fails. The trailing cable can build up at one spot on the cable reel and eventually bind against the machine. This often causes damage to the trailing cable.

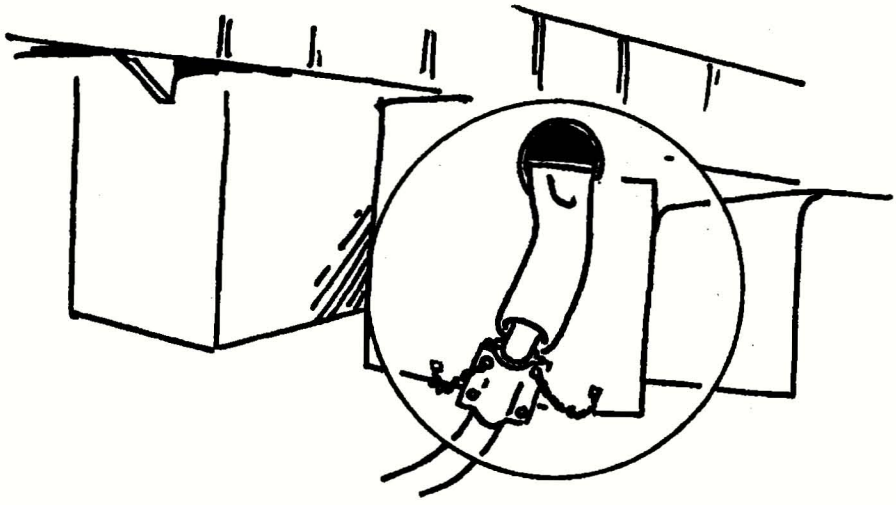
As shown, the eye of the spooling device can also have a bad effect on the cable.



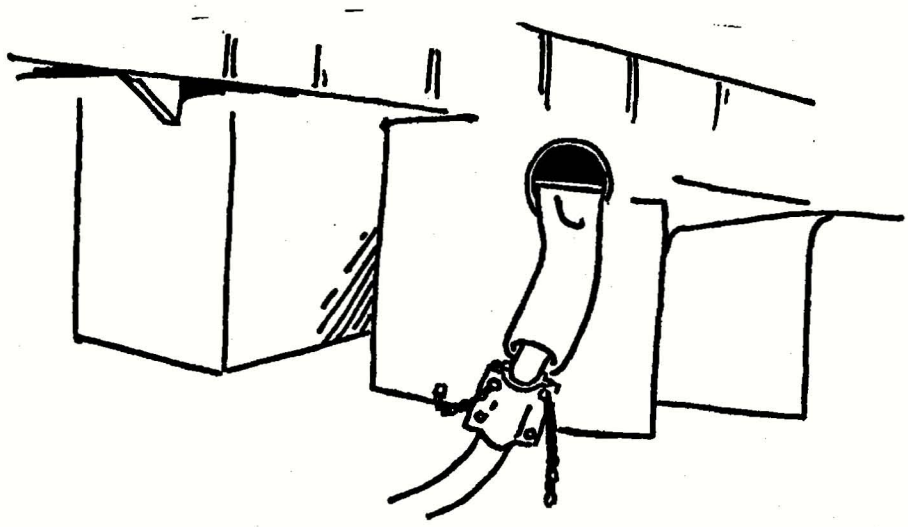
As the cable is fed through the eye, it can be damaged if the eye has any nicks, burrs, or chipped places. The sharp edges can cut the trailing cable insulation.

Finally, dirty cable reels are another hazard. If a cable reel is dirty and the trailing cable malfunctions or overheats, a fire can result. Also, insufficiently lubricated cable reels can bind and damage the trailing cable by pulling on it too hard or by jerking on it.

Machines have a special clamp that keeps the trailing cable from being pulled out. This clamp is called a strain relief clamp.



The illustration on the previous page shows a strain relief clamp in a safe condition. The strain relief clamp is properly attached to the machine, properly insulated, tightly clamped on the trailing cable, and the trailing cable has sufficient slack between the strain relief clamp and the machine cable entrance. The strain relief clamp protects the trailing cable connections to a machine. As the machine pulls the trailing cable, the strain relief clamp absorbs the strain put on the trailing cable and prevents the trailing cable connection from being pulled loose.



This illustration shows a strain relief clamp that is not properly attached to the machine. One chain attaching the strain relief clamp to the machine is broken. This could allow the trailing cable connections to be pulled resulting in the trailing cable being pulled out of the machine. This will result in the bare wires on the end of the trailing cable being exposed. They could short against each other or the machine. This would cause fires, explosions, or electrocutions.

Yet another problem appears when the strain relief clamp is not tightly clamped on the trailing cable. With a strain relief clamp in this condition, the trailing cable could be pulled through the clamp. This would result in the trailing cable connection to the machine being put under a strain and eventually it would be pulled loose from the machine.

Another problem is to have a trailing cable without sufficient slack between the strain relief clamp and the cable entrance of the machine. As the trailing cable is pulled, it would tighten up before the strain relief clamp could absorb the strain. The trailing cable could then be pulled loose from the machine.

The final danger you should be aware of is insulation. If a strain relief clamp is not adequately insulated, it could cut into the trailing cable insulation and short out the trailing cable wires. This could result in fires, explosions, or electrocutions.

It is therefore extremely important that checks be made on the clamp's insulation in addition to precautions against the cable pulling loose from a machine due to a faulty strain release clamp.

Please complete the following quiz on Trailing Cables.

VI- 1 Why shouldn't a trailing cable with damaged insulation be used?

_____

_____

VI- 2 If a trailing cable is smoking, what should be done and why?

_____

_____

_____

VI- 3 What can happen to a trailing cable if it is pinched? What action should be taken?

_____

_____

_____

IV- 4 Why shouldn't trailing cables be allowed to trail in water?

_____

_____

IV- 5 Two pulley wheels are used to channel the trailing cable onto the cable reels and keep the cable from scraping the machine. These pulleys are called _____

_____.

IV- 6 _____ True or False – A spooling sheave with chunks broken out of it can cause no serious damage.

IV- 7 List a cause for a trailing cable to bind. _____

_____.

IV- 8 A dirty cable reel may cause what? _____

IV- 9 _____ True or False – As long as one chain on a two chain strain relief clamp is in place, the trailing cable cannot be pulled out of the machine.

IV-10 _____ True or False – As long as both chains are attached to the strain relief clamp, the clamp will prevent the trailing cable from pulling loose from a machine.

IV-11 List three possible reasons for a strain relief clamp to fail in preventing a trailing cable from pulling loose from a machine.

_____

_____

_____

IV-12 _____ True or False – The foreman does not have to be notified if the insulation of a strain relief clamp is only slightly damaged.

Please go to the next page to check your answers.

Answers to quiz on Trailing Cables

VI- 1 Bare wires could be exposed or water could seep into the cable causing a miner to be electrocuted.

VI- 2 Remove power immediately and do not use it again until repaired. The smoke is a sign that something is wrong.

VI- 3 Insulation could be cut and wires forced together. The pinched condition should be corrected and the cable inspected for damage.

IV- 4 If defective, water may seep into the cable causing a miner to be electrocuted.

IV- 5 Spooling sheaves

VI- 6 False

VI- 7 Poor lubrication

VI- 8 Fire

VI- 9 False

VI-10 False

VI-11 -- Strain relief clamp not properly attached to the machine
-- Strain relief clamp not tightly clamped
-- Trailing cable without sufficient slack between the strain relief clamp and the machine

VI-12 False

If the cable reel or strain relief clamp is working properly, the hazards connected with the trailing cable are reduced somewhat; however, there are still plenty of possible problems and precautions to be taken to avoid these problems.

For example, it is important that proper procedures be followed when connecting or disconnecting trailing cables. Trailing cable connections should be made or broken only after the miner has ensured that the machine is deenergized and all the appropriate switches and circuit breakers are off.

If a trailing cable connection is made with the machine's switches and circuit breakers on, an arc, which is a bright flash, would occur that could burn or blind the miner

connecting the trailing cable. Also, the machine could suddenly energize and injure someone working near it.

Disconnecting the trailing cable while the machine is energized could also cause an arc with the same consequences. Also, suddenly deenergizing the machine could cause a miner, who is working with or near the machine, to be injured.

So far we have dealt only with the trailing cable problems miners have near a machine. Since these cables may be several hundred feet long, it should be no surprise that there can be troubles along the rest of the cable as well as at the machine. This long "tail" to a machine must be kept in good shape and protected from damage.

Probably the easiest way for the trailing cable to be damaged is by being run over and crushed by mobile equipment. This type of occurrence has caused fires, explosions, and deaths.

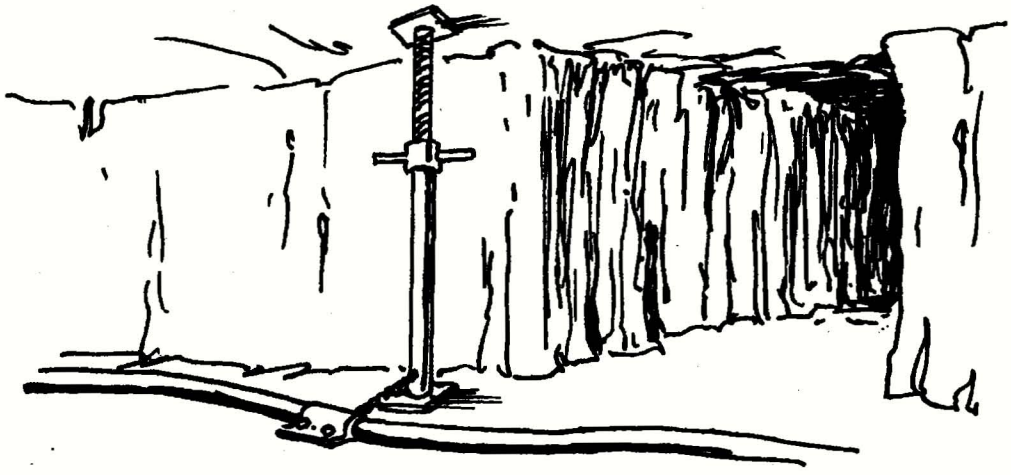
There are several ways of protecting trailing cables from damage by mobile equipment. One way is to suspend a trailing cable from the roof. This keeps the trailing cable out of the way and prevents it from being run over by mobile equipment. The trailing cable should be kept close to the roof. A trailing cable should not sag to where it can be struck or hooked by equipment passing under it. Another way of keeping trailing cables out of the way is to suspend the trailing cable from the rib.

If a trailing cable is on the floor of the mine it should be kept to one side, close to the rib. This keeps it out of the roadway and prevents it from being run over by mobile equipment.

The trailing cable must also be anchored so that pulling and jerking will not put a strain on the trailing cable connection to the trolley wire or power distribution center.

Anchoring the trailing cable is called "snubbing" the trailing cable. If the trailing cable is not properly snubbed, pulling and jerking on the trailing cable could cause the power distribution center, the trolley wire, or the trailing cable connector to be damaged. If a trailing cable is suspended from the roof or rib, the trailing cable snub also prevents the trailing cable from being pulled down. If a post jack is used to snub a trailing cable, the post jack must be tightly installed between the roof and floor. If it is not, a sudden jerk on the trailing cable could send the jack flying, injuring someone working nearby. In th next illustration you see a trailing cable snubbed with a post jack. Timbers and other roof supports should not be used for snubbing trailing cables. A jerk on the trailing cable could pull down the roof support which could cause the roof to fall.

Devices installed as primary roof support **may not** be used to anchor trailing cables.



Trailing cables should be inspected before each use for proper snubbing, defects, and proper protection from damage by mobile equipment. Trailing cables should also be inspected if damage or an unsafe condition is suspected. Before inspecting a trailing cable, the power should be deenergized and the disconnecting device locked out. Failure to inspect trailing cables can cause severe consequences such as fires, explosions, injuries, and death.

Please complete the following quiz on Trailing Cables.

VI-13 What is the likely result of connecting or disconnecting a trailing cable when the machine's switches and circuit breakers are all on? _____

_____

VI-14 You are moving down a passageway and find a crushed cable. What has most likely caused this? Why is it a problem? _____

_____

_____

VI-15 At an intersection of several passageways, a trailing cable can be best safeguarded from damage by vehicle by

A. Keeping the cable on the floor, next to the rib
B. Suspending the cable from the roof
C. Suspending the cable from the rib

VI-16 _____ True or False – A trailing cable must be snubbed so that pulling and jerking the cable will not put a strain on its connections.

VI-17 When should trailing cables be inspected?

A. Before each use
B. Whenever damage to the cable is suspected
C. Whenever an unsafe condition is suspected
D. All of the above

Please go to the next page to check your answers.

Answers to the quiz on Trailing Cables

VI-13 The miner connecting or disconnecting the machine may be burned or blinded by an arc (a bright flash).

VI-14 A vehicle has caused this. It is a problem since the crushed cable can cause fires and explosions.

VI-15 B – Suspending the cable from the roof

VI-16 True

VI-17 D – All of the above

SPLICES

Sometimes trailing cables have to be joined again – usually after they have been cut. Joining them properly is called "splicing."

Trailing cable splices provide another source of hazards. There are two kinds of trailing cable splices, permanent and temporary.

Temporary Splices

A temporary trailing cable splice is made when the splice has to be made in a hurry. The use of temporary trailing cable splices is restricted by Federal law. The restrictions are as follows:

1. **Temporary trailing cable splices must be adequately insulated.** A temporary trailing cable splice that has exposed bare wires or is inadequately insulated could result in fires, explosions, injuries or death.

2. **Temporary trailing cable splices must be mechanically strong.** A temporary cable splice that is not mechanically strong could be pulled apart by the pulling and rough use a trailing cable has to take.

3. **A trailing cable may not have more than one temporary splice.** A temporary trailing cable splice is a fast repair that will be used only for a short time (24 hours) until it must be made permanent. Having two temporary splices on a trailing cable would create an unsafe condition twice as hazardous.

4. **A temporary trailing cable splice may not be within 25 feet of the equipment powered by the training cable. This does not apply to equipment which spools up the trailing cable on a large reel.** The portion of the trailing cable closest to the equipment which it powers is under more strain than the remainder of the trailing cable. A temporary trailing cable splice might not be able to take this extra strain and it would pull apart. Equipment that has cable reels spool the trailing cable in and out; thus, no single section of the trailing cable is close to the machine all the time.

5. **Suitable connectors must be used.** Power conductors and grounding conductors in all splices shall be joined together with a mechanical connector. The conductors of a temporary splice shall be joined together so that the current will not cause excessive heat at the connection.

Permanent Splices

Now let's discuss permanent splices. All temporary trailing cable splices must be changed to permanent trailing cable splices. A permanent trailing cable splice is required by law to be mechanically strong, flexible, adequately insulated, and sealed against moisture. The conductors must be joined together with suitable connectors. Permanent trailing cable splices, as their name states, are made to be permanent. There is no time limit for using a permanent trailing cable splice. Permanent trailing cable splices must be mechanically strong and adequately insulated for the same reasons temporary trailing cable splices must be mechanically strong and adequately insulated. A permanent trailing cable splice must be flexible because it must bend with the trailing cable. An inflexible permanent trailing cable splice could not be bent around corners or rolled up in a cable reel. A permanent trailing cable splice must be flame-resistant because, if a malfunction occurred inside the splice, the splice could catch on fire if it was not flame-resistant. Permanent trailing cable splices must be sealed against moisture so water can't seep into the cable and short it out.

Any trailing cable splice, permanent or temporary, that is hot, smoking, sparking, or damaged should be repaired immediately.

SAFETY PRACTICES

Certain safety practices should be followed when working with or near trailing cables. These safety practices can help prevent physical injury to you or other miners.

Trailing cables which are lying limp on the mine floor present another hazard. They can suddenly be pulled tight and move very quickly. If you are standing close to the trailing cable when this happens, you could be struck and injured by it. You should always stay clear of trailing cables and stay alert to changing trailing cable conditions. Also, you should never kneel on, stand on, sit on, or stand over a trailing cable. The trailing cable can move so quickly that you will not have time to get away from it.

If you need to cross over a trailing cable, you should do so only if the trailing cable is not moving. Always cross the trailing cable carefully and quickly while staying alert to changing cable conditions. If you are not careful when you cross a trailing cable, it could suddenly move or rise off the floor and severely injure you or your fellow miners.

Please complete the following quiz on Trailing Cable Splices.

VI-18 Which of the following temporary splice safety precautions are required by law?

A. Mechanically strong
B. Adequately insulated
C. Only one temporary splice per cable
D. Cannot be used for more than 24 hours
E. All of the above

VI-19 Which of the following are required regarding permanent splices of trailing cables?

A. Sealed against moisture
B. Mechanically strong
C. Must be inflexible
D. Flame resistant

VI-20 _____ True or False – If you have to cross a trailing cable, you should always make sure the cable is not moving and cross it quickly and carefully while staying alert to changing conditions.

Please go to the next page to check your answers.

Answers to quiz on Splices

VI-18 E – All of the above

VI-19 A, B, and D

VI-20 True

Now that you are familiar with the hazards associated with trailing cables, test your knowledge by completing the self-evaluation exercise. Answer all questions before checking your answers.

Self-Evaluation Exercise for Chapter VI

VI- 1 The two types of trailing cable splices are _____ and _____.

VI-·2 If a splice has to be made in a hurry, a _____ splice is usually made.

VI- 3 A trailing cable splice that is hot should be _____.

VI- 4 If a section of trailing cable is hot, smoking, or sparking, always _____ the power to it.

VI- 5 The purpose of a strain relief clamp is to _____ the trailing cable connection to a piece of equipment.

VI- 6 If a strain relief clamp is not properly insulated, it could cut the trailing cable and _____ the wires.

VI- 7 _____ should not be used for snubbing trailing cables.

VI- 8 _____ are used to channel the trailing cable onto the cable reels and keep it from scraping the equipment.

VI- 9 A dirty cable reel may cause a _____.

VI-10 Machines have a special clamp which keeps the cable from being pulled out. This clamp is called a _____ clamp.

True or False

VI-11 _____Trailing cables may be allowed to trail in water.

VI-12 _____A temporary trailing cable splice cannot be within 25 feet of the non cable reel equipment powered by the trailing cable.

VI-13 _____A cable reel reels the trailing cable in and out of the machine.

VI-14 _____A spooling device protects the trailing cable from scraping against the machine.

VI-15 _____A spooling sheave must turn.

VI-16 _____Trailing cable connections should be made or broken only when the equipment is deenergized and the appropriate switches and circuit breakers are off.

VI-17 _____Insufficiently lubricated cable reels can never bind and damage the trailing cable.

VI-18 _____A trailing cable should always be anchored or snubbed.

VI-19 _____A temporary trailing cable splice cannot be used for more than 12 hours.

VI-20 _____Any trailing cable splice, permanent or temporary, that is hot, smoking, sparking or is damaged should be repaired immediately.

Please go to the next page to check your answers.

Answers to Self-Evaluation Exercise for Chapter VI

VI- 1 Permanent, temporary

VI- 2 Temporary

VI- 3 Repaired immediately

VI- 4 Remove or deenergize (Disconnect)

VI- 5 Protect

VI- 6 Short

VI- 7 Timbers

VI- 8 Spooling sheaves

VI- 9 Fire

VI-10 Strain relief

VI-11 False

VI-12 True

VI-13 True

IV-14 False

VI-15 True

VI-16 True

VI-17 False

VI-18 True

VI-19 False

VI-20 True

Congratulations! You have just completed the programmed practice portion of this program. If you have followed directions carefully and have corrected your errors, you have increased your knowledge of electrical hazards and how to handle them. How well you use this information will affect not only your safety, but the safety of others.

The last section of this workbook is Chapter VII, Summary and Case Studies. This chapter contains information on electrical accidents, precautions with trailing cables and trolley wires, and some actual case studies. The case studies will allow you to apply information you have learned to actual problems. The answers to the case study questions are also given in the workbook.

You should now turn to the next chapter.

VII. SUMMARY AND CASE STUDIES

CABLES

The major problems with cables are poor splices and breaks in the insulation.

Precautions with Trailing Cables

- Trailing cables should be inspected at the beginning of your shift. **Caution: Be sure to wear eye protection and dry gloves to protect your hands and eyes.**

- First, check the power distribution box. The high-voltage switch is usually left on. If it is **off** leave it off and check with the supervisor or foreman. **DO NOT ATTEMPT TO ENERGIZE IT YOURSELF.**

- Make certain that power to the trailing cable is turned off. Turn the power switch on the machine off.

- If the trailing cable is obtaining power through a trolley nip, be certain the nip is removed from the trolley wire. Then visually inspect the return and frame ground clamps to ensure that they are in good mechanical condition and are properly clamped.

- After you are certain that the machine and its trailing cable are deenergized and locked out, begin inspecting the cable. Start at the distribution box. Be sure that the cable connector is properly identified and secured.

- Beginning with the cable entrance on the connector, check the trailing cable for physical damage and splices. One properly made temporary splice may be used, but not for more than 24 production shift hours, nor within 25 feet of the machine (except cable reel equipment). It is a good practice to have an electrician replace a temporary splice with a permanent splice before beginning work.

- Permanent splices should be checked for mechanical strength and flexibility. They should be effectively insulated, sealed against moisture, and flame resistant.

- Continuing from the power center to the machine, check the cable for abrasions at the points most vulnerable to damage, such as corners, intersections, or places where it might have been run over. Trailing cables which have exposed wire, or splices that heat or spark under load, must not be used. Immediately notify the foreman of all temporary splices and defects found in the trailing cable. Observe the condition of the roof and ribs while walking to the machine.

See that the cables are properly suspended across entryways or roadways. They should be placed as close to the rib as possible or adequately protected to prevent damage by mobile equipment.

- The trailing cable is under the greatest strain at the strain clamp. Inspect for abrasions and spots that may have been pinched. **Be sure that the cable is slack when the strain clamp chains are tight.**

  If the strain clamp assembly is improperly or loosely fastened to the machine, the trailing cable may loop under the tracks of the miner or the wheels of the shuttle car. This could allow the cable to be run over and damaged. A strain clamp which is loosely fastened to the trailing cable may permit the cable to be pulled out of the machine. The strain clamp should be insulated.

- After you have thoroughly checked the cable, energize the circuit by turning on the power switches. While the equipment is operating, look for a hot, smoking, or sparking trailing cable. If noticed, turn off the circuit immediately.

Remember: If you happen to be hooking up a trailing cable or splicing it, be sure to properly splice back together **all** wires. **Do not leave the ground wire unconnected.**

TROLLEYS

The main problems with trolley wires occur when trolley nips are connected or when placing the trolley pole on the wire. Arcs represent the greatest hazard at this point.

Safety Procedures for Attaching Trailing Cables to a Trolley Wire

- Wear safety glasses and dry gloves and use an insulated mat if one is available.

- First check the main power switch on the equipment and make sure it is in the **off** position. Lock out, if possible, or tag with a **"DANGER – DO NOT TURN ON"** sign. Machine controls should be in a neutral position.

- Assemble the trolley nip if it has been taken apart for safety reasons. The trolley nip should be thoroughly examined to see that it is clearly labeled, properly fused, insulated, and in sound mechanical condition.

- Attach the return clamp and ground clamp to the rail or feeder, if the feeder is the same polarity as the rail. Be sure that they are tight and that the connections are good.

  WARNING: Never connect the trolley nip to the trolley wire if the return clamps are not connected.

- Connect the nip to the trolley wire. Be sure to hold the insulated section of the nip and make contact with the power source momentarily.
    - ✓ Wear dry gloves and eye protection and stand on an insulated mat, if available.
    - ✓ Be careful to look at what you are doing, but do not look directly at the momentary contact. Turn away from it enough to avoid possible flash burns, but not so much that you touch the wire with your hand or arm. This could be fatal.
    - ✓ A flash (arc) indicates that something is wrong or the machine may be turned on. Check to see if all power switches and circuit breakers are OFF. If there is no load on the line, the arc was probably caused by a short circuit.
    - ✓ Disconnect the power source, attach a DANGER tag, and report the incident to the foreman.

When a trolley wire is exposed (i.e., uninsulated), it must be treated with caution.

- Look out for trolley wires that are sagging below the trolley wire guard.

- Never enter or leave a man trip on the trolley wire side.

- Use extreme caution in carrying tools or equipment near or under a trolley wire. For example, never carry tools on your shoulder.

- Do not connect or disconnect a trolley pole from the trolley wire when the power is in the ON position.

CASE STUDIES

Now that you have studied electrical hazards and the procedures that should be followed when they occur, a look at several actual accidents will help you to apply your knowledge in determining what happened and how it could have been prevented. Each of these case studies offers an opportunity to learn about accidents, their causes, and methods of prevention.

Accidents are usually complex. An accident may have a number of individual events that can be listed as causes. In some instances eliminating one or more of the causes would have been enough to eliminate the accident. As you read the following case studies, try to identify the various causes of the accident and how each cause might have been prevented.

Case No. 1 (Surface)

The day shift crew started work in the pit at 7:00 a.m. Both loading and stripping operations were performed all day. An 8-cubic-yard shovel was used to load coal and a 45-cubic-yard shovel was used to strip overburden.

A power outage occurred at mid-day while the crew was moving the coal loading shovel past the stripping shovel. Both shovels received power from the same substation; Fred (pit foreman) directed a member of his crew to re-close the circuit breaker at the substation. Since the circuit breaker would not remain closed (indicating an electrical fault), Fred suspected a ground fault in the cable supplying the loading shovel. Fred then cut power to the loading shovel by opening an oil switch in the loading shovel circuit. Fred then disconnected the cable.

The substation circuit breaker controlling both shovels was tried again and this time, with the loading shovel disconnected, the circuit remained energized. Continuing on the assumption that a ground fault condition existed, Fred drove along the cable looking for the cause of the power outage. Fred stopped at a cable junction box about half way back toward the shovels. Two boxes were in this area about 30 feet apart – one for the stripping shovel cable and the other for the coal loading shovel cable. The cables for the two shovels were buried at two roadway crossings. Near one of these road crossings, the two cables were switched (crossed over each other).

Fred recalled that a terminal was loose in one of the junction boxes and decided to find and tighten it. He raised the cover of the box of what he assumed was the circuit leading to the coal loading shovel **but failed to realize that the cables were crossed.** After raising the lid, Fred, with a metal "T" wrench, tried to tighten the nut on an energized terminal in the cable junction box leading to the stripping shovel. He was not wearing high-voltage gloves and received a severe electrical shock.

Tom stated that he was about 10 feet from Fred when he saw a flash in the junction box and realized that Fred had gotten in a junction box which was energized. He quickly removed the belt from his trousers, looped it around Fred's right ankle and pulled him free of the junction box. It had been raining steadily throughout the day, making the area very wet and muddy. Upon being freed from the energized junction box, Fred fell with his face in the mud. Tom placed him on his back, removed his glasses, then took off his own coat and coveralls and placed the coat under Fred's head. After covering him with the coveralls, Tom went to the truck and used the radio to call for assistance and to notify the mine officials of the accident.

After receiving first aid and medical attention, Fred recovered.

What were the causes of the accident?

- _____
  _____
- _____
  _____
- _____
  _____

After giving your answers, check your responses with the following two paragraphs.

Some additional information, not presented in the case study, was that grounding leads were attached to the frame of the junction box. These leads should have been connected to the terminal blocks before electrical work was performed.

There were several causes for the accident. First, Fred was not a qualified electrician and had no business attempting to perform repair work. Second, Fred was working with his bare hands even though he had a pair of high-voltage gloves in his truck. Finally, the circuits in the junction box were not properly identified or labeled.

The following violations were found. (You were not provided enough information to cover all of the incident.)

- The man performing the electrical work was not a qualified electrician.
- The man failed to determine that the circuit was deenergized before performing electrical work on the circuit.
- The ground cable was not connected to the terminal blocks in the junction box before electrical work was performed.
- The circuit supplying power to Nos. 4 and 7 vacuum switches were not identified to show which units they controlled.
- The power conductors supplying power to the stripping shovel were not connected to the system ground.

Case No. 2 (Underground)

On the day of the accident, Jack (an electrician), along with other employees, entered the mine at 4:00 p.m. and arrived at the work area 20 minutes later. Jack started to work on a disabled shuttle car while other members of the crew proceeded with their regular work duties. Tom, a shuttle car operator, notified Jack that another car's trailing cable had pulled apart. Jack went to the power center to disconnect and tag out the trailing cable. The cable was tangled on the reel and Tom had pulled off a section and had started to cut the permanent-type splice jacket off of the faulty splice. Jack returned, told Tom to lay the cable down because he was not positive he had disconnected the correct cable and that he would do the repair work. Jack, while sitting on the damp bottom, cut the outer jacket insulation from the cable and cut into the white phase level with a pair of cutters. Tom and other crew members heard Jack make a moaning sound. Tom ran to the power center and deenergized the trailing cable. Crew members performed artificial ventilation with no results. (**Additional Information:** The circuit breaker and the trailing cables were properly marked and identified at the power distribution center.)

What was the cause(s) of the accident?

_____

_____

_____

An investigation revealed that the victim had disconnected and tagged out the wrong trailing cable (the cable to the car he had worked on first). It could not be determined why the victim did not check to see if he had disconnected the correct cable after making the statement he was not positive he had disconnected the right one. (Several witnesses testified that Jack had made the statement.) The victim was a qualified electrician, he was aware of the proper procedure for disconnecting and tagging out a trailing cable, and he had attended a safety meeting concerning the splicing of cables the day before the accident.

The cause of the accident was the performance of work on an energized power circuit. The accident could have been prevented by checking to verify that the correct cable had been disconnected and tagged out.

A large number of accidents tend to occur when there is some change in routine. In this case, Jack was already working on a shuttle car. When Jack was interrupted to work on the second shuttle car, his mind still may have been on the first car as he disconnected the first car's trailing cable.

Case Study No. 3 (Underground)

On the day of the accident, Bill (an electrician), along with three other men, entered the mine at 4:00 a.m. to perform clean-up work and move the shuttle car cable anchors. After arriving in the work area, Bill told the other members of the crew that he would operate the shuttle car as he needed to talk to the loading machine operator. This was the last conversation anyone was to have with Bill. Bill was found 15 minutes later, lying next to a defective permanent splice on the trailing cable of the shuttle car. Efforts to revive him were unsuccessful.

The shuttle car involved was energized and found to be inoperative. A circuit breaker, located inside the control panel, was in the tripped position. When this circuit was reset the shuttle car operated normally. At the time of the accident, Bill was making a 90 degree turn and struck the shuttle car against the rib which caused the breaker to open. The regular shuttle car operator stated that this breaker occasionally tripped when the car traveled over a rough spot in the mine floor or when a coal rib was struck. The regular operator did not know if Bill was aware of this problem.

It was the opinion of the investigating committee that when the shuttle car circuit breaker tripped, Bill assumed that the circuit breaker at the power center had tripped. Apparently, Bill observed the defective splice and assumed that this had created a ground fault that activated the breaker at the power center. The outer insulating jacket on the cable had pulled loose from the splice jacket which had moved a distance of about 14 inches,

thereby leaving insulated conductors exposed. Evidence indicated that Bill contacted a bare place in a phase lead while attempting to apply tape.

What were the causes of the accident?

_____

_____

_____

_____

The victim in this case was an electrician. Failure of the victim to properly de-energize the circuit and disconnect and tag the cable before performing work on the cable was the cause of the accident. The design and construction of the trailing cable which allowed the insulated conductors to move inside the outer jacket and the use of trailing cables containing obviously defective splices were contributing factors.

This concludes your Electrical Hazards programmed instruction course. If you have carefully read the material and answered/checked all the questions, you should have a good basic understanding of the subject. This does **not** mean you can relax or quit learning about the subject. Make it a point to get more information on this and other subjects related to your health and safety in the mines. Your personal health, safety, and future in your occupation is at stake.

If you are satisfied that you have mastered this material, you should consider taking the final examination located in the back of this book. Successful completion of this examination will make you eligible for a Certificate of Accomplishment and one Continuing Education Unit* from the National Mine Health and Safety Academy.

Send the final examination to:

National Mine Health and Safety Academy
Department of Instructional Services
1301 Airport Road
Beaver, WV 25813-9426
Fax: 304/256-3247
E-Mail: Fox.Rhonda@dol.gov

The exam will be graded and a Certificate of Completion will be mailed to you.

*One Continuing Education Unit (CEU) is defined as ten contact hours of participation in an organized continuing education experience under responsible sponsorship and capable direction. CEUs are cumulative and transferable between most institutions dealing with continuing education programs.

APPENDICES

Appendix A

GLOSSARY OF TERMS

Alternative current (AC) – Current that reverses direction at regular intervals, usually 60 times a minute. (60 cycle AC).

Arc – Intense light and heat created when a circuit is opened or closed.

Battery – Source of DC electricity created from a chemical reaction.

Charging station – A room underground or on the surface for charging and exchanging batteries. Atmosphere in the station may be explosive as a result of hydrogen released from the batteries during the recharging cycle.

Circuit breakers – An overload protective device that automatically disconnects power under abnormal conditions.

Crosscut – A passage driven at right or other angles to the main entry in a mine.

Current – Movement of small particles (electrons) through electric conductors measured in amperes (amps).

Deenergize – To remove power to a circuit. See energized.

Direct current (DC) – An electric current flowing in one direction only and usually somewhat free from pulsations.

Energized – A circuit that has electric power connected to it.

Entry – A working place where the coal is extracted from the seam in the initial mining.

Face – An area of a coal mine where coal is being extracted from its natural deposit in the earth. The face is formed during the mining cycle.

Ground wire/frame ground wire – A wire, connected to the metal frame of electric equipment on one end and the earth on the other, used to prevent electric shock.

Inby – Toward the working face, away from the entrance. Opposite of outby.

Insulation – Non-conducting material such as rubber or plastic used to cover electric conductors.

Outby – Away from the face, toward the mine. Opposite of inby.
ermissible – Completely assembled and conforming in every respect with the design formally approved by MSHA.

Qualified electrician – An electrician who, through training and experience, has shown that he/she can perform electrical work safely and efficiently.

Splice – Mechanical joining of conductors that have been separated.

Trailing cable – A flexible electric cable used to conduct power to mobile mining machines. The cable is heavily insulated and protected.

Trolley wire – A bare conductor supported from the mine roof that supplies DC power to electric locomotives.

Voltage – The electrical pressure that forces a current to flow in an electrical circuit, measured in volts.

Appendix B

FEDERAL REGULATIONS

The following regulations are from Title 30 of the Code of Federal Regulations, Chapter 1, Parts 75 and 77. Part 75 contains regulations for underground coal mines and Part 77 contains regulations for surface coal mines and surface work areas of underground coal mines.

The regulations selected for inclusion in this appendix are regulations that affect every miner. For example, there are a number of regulations covering trailing cables and personal protective equipment such as the use of rubber gloves. This appendix will make you aware of the broad coverage of the electrical regulations.

A revised Code of Federal Regulations is issued each July and is kept up-to-date during the year by individual issues of the Federal Register.

UNDERGROUND

75.500 Permissible electric equipment.

On and after March 30, 1971:

(a) All junction or distribution boxes used for making multiple power connections inby the last open crosscut shall be permissible;

(b) All handheld electric drills, blower and exhaust fans, electric pumps, and such other low horsepower electric face equipment as the Secretary may designate on or before May 30, 1970, which are taken into or used inby the last open crosscut of any coal mine shall be permissible;

(c) All electric face equipment which is taken into or used inby the last open crosscut of any coal mine classified under any provision of law as gassy prior to March 30, 1970, shall be permissible; and

(d) All other electric face equipment which is taken into or used inby the last crosscut of any coal mine, except a coal mine referred to in 75.501, which has not been classified under any provision of law as a gassy mine prior to March 30, 1970, shall be permissible.

75.501-2 Permissible electric face equipment.

(a) On and after March 30, 1971, in mines operated entirely in coal seams which are located at elevations above the water table:

(1) All junction or distribution boxes used for making multiple power connections inby the last open crosscut shall be permissible; and

(2) All handheld electric drills, blower and exhaust fans, electric pumps, and all other electric-driven mine equipment, except low horsepower rock dusting equipment, that employs an electric current supplied by either a power conductor or battery and consumes not more than 2,250 watts of electricity, which is taken into or used inby the last open crosscut shall be permissible.

(b) On and after March 30, 1974, in mines operated entirely in coal seams which are located at elevations above the water table, all electric face equipment which is taken into or used inby the last crosscut shall be permissible.

75.507 Power connection points.

Except where permissible power connection units are used, all power-connection points outby the last open crosscut shall be in intake air.

75.508 Map of electrical system.

The location and the electrical rating of all stationary electric apparatus in connection with the mine electric system, including permanent cables, switchgear, rectifying substations, transformers, permanent pumps, and trolley wires and trolley feeder wires, and settings of all direct-current circuit breakers protecting underground trolley circuits, shall be shown on a mine map. Any changes made in a location, electric rating, or setting shall be promptly shown on the map when the change is made. Such map shall be available to an authorized representative of the Secretary and to the miners in such mine.

75.510 Energized trolley wires; repair.

Energized trolley wires may be required only by a person trained to perform electrical work and to maintain electrical equipment and the operator of a mine shall require that such person wear approved and tested insulated shoes and wireman's gloves.

75.511 Low-, medium-, or high-voltage distribution circuits and equipment; repair.

No electrical work shall be performed on low-, medium-, or high-voltage distribution circuits or equipment, except by a qualified person or by a person trained to perform electrical work and to maintain electrical equipment under the direct supervision of a qualified person. Disconnecting devices shall be locked out and suitably tagged by the persons who perform such work, except that in cases where locking out is not possible, such devices shall be opened and suitably tagged by such persons. Locks or tags shall be removed only by the persons who installed them or, if such persons are unavailable, by persons authorized by the operator or his agent.

75.512 Electric equipment; examination, testing and maintenance.

All electric equipment shall be frequently examined, tested, and properly maintained by a qualified person to assure safe operating conditions. When a potentially dangerous condition is found on electric equipment, such equipment shall be removed from service until such condition is corrected. A record of such examinations shall be kept and made available to an authorized representative of the Secretary and to the miners in such mine.

75. 514 Electrical connections or splices; suitability.

All electrical connections or splices in conductors shall be mechanically and electrically efficient, and suitable connectors shall be used. All electrical connections or splices in insulated wire shall be reinsulated at least to the same degree of protection as the remainder of the wire.

75. 515 Cable fittings; suitability.

Cables shall enter metal frames of motors, splice boxes, and electric compartments only through proper fittings. When insulated wires other than cables pass through metal frames, the holes shall be substantially bushed with insulated bushings.

75.517 Power wires and cables; insulation and protection.

Power wires and cables, except trolley wires, trolley feeder wires, and bare signal wires, shall be insulated adequately and fully protected.

75.518 Electric equipment and circuits; overload and short circuit protection

Automatic circuit-breaking devices or fuses of the correct type and capacity shall be installed so as to protect all electric equipment and circuits against short circuit and overloads. Three-phase motors on all electric equipment shall be provided with overload protection that will deenergize all three phases in the event that any phase is overloaded.

75.523-1 Deenergization of self-propelled electric face equipment installation requirements.

(a) Except as provided in paragraphs (b) and (c) of this section, all self-propelled electric face equipment which is used in the active workings of each underground coal mine on and after March 1, 1973, shall, in accordance with the schedule of time specified in paragraphs (a)(1) and (2) of this section, be provided with a device that will quickly deenergize the tramming motors of the equipment in the event of an emergency. The requirements of this paragraph (a) shall be met as follows:

(1) On and after December 15, 1974, for self-propelled cutting machines, shuttle cars, battery-powered machines, and roof drills and bolters;

(2) On and after February 15, 1975, for all other types of self-propelled electric face equipment.

(b) Self-propelled electric face equipment that is equipped with a substantially constructed cab which meets the requirements of this part, shall not be required to be provided with a device that will quickly deenergize the tramming motors of the equipment in the event of an emergency.

(c) An operator may apply to the Director of Technical Support, Mine Safety and Health Administration, Department of Labor, 1100 Wilson Boulevard, Arlington, VA 22209 for approval of the installation of devices to be used in lieu of devices that will quickly deenergize the tramming motors of self-propelled electric face equipment in the event of an emergency. The Director of Technical Support may approve such devices if he determines that the performance thereof will be no less effective than the performance requirements specified in 75.523-2.

75.523-2 Deenergization of self-propelled electric face equipment; performance requirements.

(a) Deenergization of the tramming motors of self-propelled electric face equipment, required in paragraph (a) of 75.523-1, shall be provided by:

(1) Mechanical actuation of an existing pushbutton emergency stopswitch;

(2) Mechanical actuation of an existing lever emergency stopswitch; or

(3) The addition of a separate electromechanical switch assembly.

(b) The existing emergency stopswitch or additional switch assembly shall be actuated by a bar or lever which shall extend a sufficient distance in each direction to permit quick deenergization of the tramming motors of self-propelled electric face equipment from all locations from which the equipment can be operated.

75.523-3 Automatic emergency-parking brakes.

(a) Except for personnel carriers, rubber-tired, self-propelled electric haulage equipment used in the active workings of underground coal mines shall be equipped with automatic emergency-parking brakes in accordance with the following schedule.

(1) On and after May 23, 1989 –

(i) All new equipment ordered; and

(ii) All equipment originally furnished with or retrofitted with automatic emergency-parking brakes which meet the requirements of this section.

(2) On and after May 23,1991, all other equipment.

(b) Automatic emergency-parking brakes shall –

(1) Be activated immediately by the emergency deenergization device required by 30 CFR 75.523-1 and 75.523-2;

(2) Engage automatically within 5.0 seconds when the equipment is deenergized;

(3) Safely bring the equipment when fully loaded to a complete stop on the maximum grade on which it is operated;

(4) Hold the equipment stationary despite any contraction of brake parts, exhaustion of any non-mechanical source of energy, or leakage; and

(5) Release only by a manual control that does not operate any other equipment function.

(c) Automatic emergency-parking brakes shall include a means in the equipment operator's compartment to –

(1) Apply the brakes manually without deenergizing the equipment; and

(2) Release and reengage the brakes without energizing the equipment.

(d) On and after November 24, 1989, rubber-tired, self-propelled electric face equipment not covered by paragraph (a) of this section shall be equipped with a means incorporated on the equipment and operable from each tramming station to hold the equipment stationary –

(1) On the maximum grade on which it is operated; and

(2) Despite any contraction of components, exhaustion of any non-mechanical source of energy, or leakage.

(e) The brake systems required by paragraphs (a) or (d) of this section shall be applied when the equipment operator is not at the controls of the equipment, except during movement of disabled equipment.

75.601 Short circuit protection of trailing cables.

Short circuit protection for trailing cables shall be provided by an automatic circuit breaker or other no less effective device approved by the Secretary of adequate current-interrupting capacity in each ungrounded conductor. Disconnecting devices used to disconnect power from trailing cables shall be plainly marked and identified and such devices shall be equipped or designed in such a manner that it can be determined by visual observation that the power is disconnected.

75.602 Trailing cable junctions.

When two or more trailing cables junction to the same distribution center, means shall be provided to assure against connecting a trailing cable to the wrong size circuit breaker.

75.603 Temporary splice of trailing cable.

One temporary splice may be made in any trailing cable. Such trailing cable may only be used for the next 24-hour period. No temporary splice shall be made in a trailing cable within 25 feet of the machine, except cable reel equipment. Temporary splices in trailing cables shall be made in a workmanlike manner and shall be mechanically strong and well insulated. Trailing cables or hand cables which have exposed wires or which have splices that heat or spark under load shall not be used. As used in this section, the term "splice" means the mechanical joining of one or more conductors that have been severed.

75.604 Permanent splicing of trailing cables.

When permanent splices in trailing cables are made, they shall be:

(a) Mechanically strong with adequate electrical conductivity and flexibility;

(b) Effectively insulated and sealed so as to exclude moisture; and

(c) Vulcanized or otherwise treated with suitable materials to provide flame-resistant qualities and good bonding to the outer jacket.

(d) Made using splice kits accepted or approved by MSHA as flame resistant.

75.605 Clamping of trailing cables to equipment.

Trailing cables shall be clamped to machines in a manner to protect the cables from damage and to prevent strain on the electrical connections.

75.606 Protection of trailing cables.

Trailing cables shall be adequately protected to prevent damage by mobile equipment.

75.607 Braking trailing cable and power cable connections.

Trailing cable and power cable connections to junction boxes shall not be made or broken under load.

75.701 Grounding metallic frames, casings, and other enclosures of electric equipment.

Metallic frames, casings, and other enclosures of electric equipment that can become "alive" through failure of insulation or by contact with energized parts shall be grounded by methods approved by an authorized representative of the Secretary.

75.701-2 Approved method of grounding metallic frames, casings and other enclosures receiving power from single-phase 110-220-volt circuit.

In instances where single-phase 110-220-volt circuits are used to feed electrical equipment, the only method of grounding that will be approved is the connection of all metallic frames, casings and other enclosures of such equipment to a separate grounding conductor which establishes a continuous connection to a grounded center tap of the transformer.

75.705 Work on high-voltage lines; deenergizing and grounding.

High-voltage lines, both on the surface and underground, shall be deenergized and grounded before work is performed on them, except that repairs may be permitted, in the case of energized surface high-voltage lines, if such repairs are made by a qualified person in accordance with procedures and safeguards, including, but not limited to, a requirement that the operator of such mine provide, test, and maintain protective devices in making such repairs, to be prescribed by the Secretary prior to March 30, 1970.

75.705-4 Simultaneous repairs.

When two or more persons are working on an energized high-voltage surface line simultaneously, and any one of them is within reach of another, such persons shall not be allowed to work on different phases or on equipment with different potentials.

75.705-5 Installation of protective equipment.

Before repair work on energized high-voltage surface lines is begun, protective equipment shall be used to cover all bare conductors, ground wires, guys, telephone lines, and other attachments in proximity to the area of planned repairs. Such protective equipment shall be installed from a safe position below the conductors or other apparatus being covered. Each rubber protective device employed in the making of repairs shall have a dielectric strength of 20,000 volts, or more.

75.705-6 Protective clothing; use and inspection.

All persons performing work on energized high-voltage surface lines shall wear protective rubber gloves, sleeves, and climber guards if climbers are worn. Protective rubber gloves shall not be worn wrong side out or without protective leather gloves. Protective devices worn by a person assigned to perform repairs on high-voltage surface lines shall be worn continuously from the time he leaves the ground until he returns to the ground, and, if such devices are employed for extended periods, such person shall visually inspect the equipment assigned him for defects before each use and, in no case, less than twice each day.

75.705-7 Protective equipment; inspection.

Each person shall visually inspect protective equipment and clothing provided him in connection with work on high-voltage surface lines before using such equipment and clothing, and any equipment or clothing containing any defect or damage shall be discarded and replaced with proper protective equipment or clothing prior to the performance of any electrical work on such lines.

75.705-9 Operating disconnecting or cutout switches.

Disconnecting or cutout switches on energized high-voltage surface lines shall be operated only with insulated sticks, fuse tongs, or pullers which are adequately insulated and maintained to protect the operator from the voltage to which he is exposed. When such switches are operated from the ground, the person operating such devices shall wear protective rubber gloves.

75.906 Trailing cables for mobile equipment, ground wires, and ground check wires.

Trailing cables for mobile equipment shall contain one or more ground conductors having a cross-sectional area of not less than one-half the power conductor, and, on September 30, 1970, an insulated conductor for the ground continuity check circuit or other no less effective device approved by the Secretary or his authorized representative to assure such continuity, except that an extension of time, not in excess of 12 months may be permitted by the Secretary on a mine-by-mine basis if he determines that such equipment is not available. Splices made in the cables shall provide continuity of all components.

75. 1003 Insulation of trolley wires, trolley feeder wires and bare signal wires; guarding of trolley wires and trolley feeder wires.

Trolley wires, trolley feeder wires, and bare signal wires shall be insulated adequately where they pass through doors and stoppings, and where they cross other power wires and cables. Trolley wires and trolley feeder wires shall be guarded adequately:

(a) At all points where men are required to work or pass regularly under the wires;

(b) On both sides of all doors and stoppings; and

(c) At man-trip stations.

The Secretary or his authorized representatives shall specify other conditions where trolley wires and trolley feeder wires shall be adequately protected to prevent contact by any person, or shall require the use of improved methods to prevent such contact. Temporary guards shall be provided where trackmen and other persons work in proximity to trolley wires and trolley feeder wires.

75.1003-1 Other requirements for guarding of trolley wires and trolley feeder wires.

Adequate precaution shall be taken to insure that equipment being moved along haulageways will not come in contact with trolley wires or trolley feeder wires.

75.1003-2 Requirements for movement of off-track mining equipment in areas of active workings where energized trolley wires or trolley feeder wires are present; pre-movement requirements; certified and qualified persons.

(a) Prior to moving or transporting any unit of off-track mining equipment in areas of the active workings where energized trolley wires or trolley feeder wires are present:

(1) The unit of equipment shall be examined by a certified person to ensure that coal dust, float coal dust, loose coal oil, grease, and other combustible materials have been cleaned up and have not been permitted to accumulate on such unit of equipment; and,

(2) A qualified person, as specified in 75.153 of this part, shall examine the trolley wires, trolley feeder wires, and the associated automatic circuit interrupting devices provided for short circuit protection to ensure that proper short circuit protection exists.

(b) A record shall be kept of the examinations required by paragraph (a) of this section, and shall be made available, upon request, to an authorized representative of the Secretary.

(c) Off-track mining equipment shall be moved or transported in areas of the active workings where energized trolley wires or trolley feeder wires are present only under the direct supervision of a certified person who shall be physically present at all times during moving or transporting operations.

(d) The frames of off-track mining equipment being moved or transported, in accordance with this section, shall be covered on the top and on the trolley wire side with fire-resistant material which has met the applicable requirements of Part 18 of Subchapter D of this Chapter (Bureau of Mines Schedule 2G).

(e) Electrical contact shall be maintained between the mine track and the frames of off-track mining equipment being moved in-track and trolley entries, except that rubber-tired equipment need not be grounded to a transporting vehicle if no metal part of such rubber-tired equipment can come into contact with the transporting vehicle.

(f) A minimum vertical clearance of 12 inches shall be maintained between the farthest projection of the unit of equipment which is being moved and the energized trolley wires or trolley feeder wires at all times during the movement or transportation of such equipment; provided, however, that if the height of the coal seam does not permit 12 inches of vertical clearance to be so maintained, the following additional precautions shall be taken:

(1) (i) Except as provided in paragraph (f)(1)(ii) of this section electric power shall be supplied to the trolley wires or trolley feeder wires only from outby the unit of equipment being moved or transported.

(ii) Where direct current electric power is used and such electric power can be supplied only from inby the equipment being moved or transported, power may be supplied from inby such equipment provided a miner with the means to cut off the power, and in direct communication with persons actually engaged in the moving or transporting operation, is stationed outby the equipment being moved.

(2) The settings of automatic circuit interrupting devices used to provide short circuit protection for the trolley circuit shall be reduced to not more than one-half of the maximum current that could flow if the equipment being moved or transported were to come into contact with the trolley wire or trolley feeder wire;

(3) At all times the unit of equipment is being moved or transported, a miner shall be stationed at the first automatic circuit breaker outby the equipment being moved and such miner shall be: (i) In direct communication with persons actually engaged in the moving or transporting operation, and (ii) capable of communicating with the responsible person on the surface required to be on duty in accordance with 75.1600-1 of this part;

(4) Where trolley phones are utilized to satisfy the requirements of paragraph (f)(3) of this section, telephones or other equivalent two-way communication devices that can readily be connected with the mine communication system shall be carried by the miner stationed at the first automatic circuit breaker outby the equipment being moved and by a miner actually engaged in the moving or transporting operation; and,

(5) No person shall be permitted to be inby the unit of equipment being moved or transported, in the ventilating current of air that is passing over such equipment, except those persons directly engaged in moving such equipment.

(g) The provisions of paragraphs (a) through (f) of this section shall not apply to units of mining equipment that are transported in mine cars, provided that no part of the equipment extends above or over the sides of the mine car. (38 FR 29998, Oct. 31, 1973, as amended at 60 FR 33723, June 29, 1995)

Surface

77.500 Electric power circuits and electric equipment; deenergization.

Power circuits and electric equipment shall be deenergized before work is done on such circuits and equipment, except when necessary for troubleshooting or testing.

77.501 Electric distribution circuits and equipment; repair.

No electrical work shall be performed on electric distribution circuits or equipment, except by a qualified person or by a person trained to perform electrical work and to maintain electrical equipment under the direct supervision of a qualified person. Disconnecting devices shall be locked out and suitably tagged by the persons who perform such work, except that in cases where locking out is not possible, such devices shall be opened and suitably tagged by such persons. Locks or tags shall be removed only by the persons who installed them or, if such persons are unavailable, by persons authorized by the operator or his agent.

77.504 Electrical connections or splices; suitability.

Electrical connections or splices in electric conductors shall be mechanically and electrically efficient, and suitable connectors shall be used. All electrical connections or splices in insulated wire shall be reinsulated at least to the same degree of protection as the remainder of the wire.

77.509 Transformers; installation and guarding.

(a) Transformers shall be of the totally enclosed type, or shall be placed at least 8 feet above the ground, or installed in a transformer house, or surrounded by a substantial fence at least 6 feet high and at least 3 feet from any energized parts, casings, or wiring.

(b) Transformer stations shall be enclosed to prevent persons from unintentionally or inadvertently contacting energized parts.

(c) Transformer enclosures shall be kept locked against unauthorized entry.

77.510 Resistors; location and guarding.

Resistors, heaters, and rheostats shall be located so as to minimize fire hazards and, where necessary, provided with guards to prevent personal contact.

77.511 Danger signs at electrical installations.

Suitable danger signs shall be posted at all major electrical installations.

77.513 Insulating mats at power switches.

Dry wood platforms, insulating mats, or other electrically nonconductive material shall be kept in place at all switchboards and power-control switches where shock hazards exist. However, metal plates on which a person normally would stand and which are kept at the same potential as the grounded, metal, non-current-carrying parts of the power switches to be operated may be used.

77.600 Trailing cables; short-circuit protection; disconnecting devices.

Short-circuit protection for trailing cables shall be provided by an automatic circuit breaker or other no less effective device, approved by the Secretary, of adequate current-interrupting capacity in each ungrounded conductor. Disconnecting devices used to disconnect power from trailing cables shall be plainly marked and identified and such devices shall be equipped or designed in such a manner that it can be determined by visual observation that the power is disconnected.

77.601 Trailing cables or portable cables; temporary splices.

Temporary splices in trailing cables or portable cables shall be made in a workmanlike manner and shall be mechanically strong and well insulated. Trailing cables or portable cables with exposed wires or splices that heat or spark under load shall not be used.

77.602 Permanent splicing of trailing cables.

When permanent splices in trailing cables are made, they shall be:

(a) Mechanically strong with adequate electrical conductivity;

(b) Effectively insulated and sealed so as to exclude moisture; and

(c) Vulcanized or otherwise made with suitable materials to provide good bonding to the outer jacket.

77.603 Clamping of trailing cables to equipment.

Trailing cables shall be clamped to machines in a manner to protect the cables from damage and to prevent strain on the electrical connections.

77.604 Protection of trailing cables.

Trailing cables shall be adequately protected to prevent damage by mobile equipment.

77.605 Breaking trailing cable and power cable connections.

Trailing cable and power cable connections between cables and to power sources shall not be made or broken under load.

77.606 Energized trailing cables; handling.

Energized medium- and high-voltage trailing cables shall be handled only by persons wearing protective rubber gloves (see 77.606-1) and, with such other protective devices as may be necessary and appropriate under the circumstances.

77.606-1 Rubber gloves; minimum requirements.

(a) Rubber gloves (lineman's gloves) worn while handling high-voltage trailing cables shall be rated at least 20,000 volts and shall be used and tested in accordance with the provisions of 77.704-6 through 77.704-8.

(b) Rubber gloves (wireman's gloves) worn while handling trailing cables energized by 660 to 1,000 volts shall be rated at least 1,000 volts and shall not be worn inside out or without protective leather gloves.

(c) Rubber gloves shall be inspected for defects before use on each shift and at least once thereafter during the shift when such rubber gloves are used for extended periods. All protective rubber gloves which contain defects shall be discarded and replaced prior to handling energized cables.

77.704 Work on high-voltage lines; deenergizing and grounding.

High-voltage lines shall be deenergized and grounded before work is performed on them, except that repairs may be permitted on energized high-voltage lines if (a) such repairs are made by a qualified person in accordance with procedures and safeguards set forth in 77.704-1 through 77.704-11 of this Subpart H as applicable, and (b) the operator has tested and properly maintained the protective devices necessary in making such repairs.

77.704-5 Installation of protective equipment.

Before repair work on energized high-voltage surface lines is begun, protective equipment shall be used to cover all bare conductors, ground wires, guys, telephone lines, and other attachments in proximity to the area of planned repairs. Such protective equipment shall be installed from a safe position below the conductors or other apparatus being covered. Each rubber protective device employed in the making of repairs shall have a dielectric strength of 20,000 volts, or more.

77.704-6 Protective clothing; use and inspection.

All persons performing work on energized high-voltage surface lines shall wear protective rubber lineman's gloves, sleeves, and climber guards if climbers are worn. Protective rubber gloves shall not be worn wrong side out or without protective leather gloves. Protective devices worn by a person assigned to perform repairs on high-voltage surface lines shall be worn continuously from the time he leaves the ground until he returns to the ground and, if such devices are employed for extended periods, such person shall visually inspect the equipment assigned him for defects before each use and, in no case, less than twice each day.

77.704-7 Protective equipment; inspection.

Each person shall visually inspect protective equipment and clothing provided him in connection with work on high-voltage surface lines before using such equipment and clothing, and any equipment or clothing containing any defect or damage shall be discarded and replaced with proper protective equipment or clothing prior to the performance of any electrical work on such lines.

77.807-1 High-voltage powerlines; clearances above ground.

High-voltage powerlines located above driveways, haulageways, and railroad tracks shall be installed to provide the minimum vertical clearance specified in National Electrical Safety Code: *Provided, however,* That in no event shall any high-voltage powerline be installed less than 15 feet above ground.

77.807-2 Booms and masts; minimum distance from high-voltage lines.

The booms and masts of equipment operated on the surface of any coal mine shall not be operated within 10 feet of an energized overhead powerline. Where the voltage of overhead power lines is 69,000 volts, or more, the minimum distance from the boom or mast shall be as follows:

Nominal power line voltage (in 1,000 volts)	Minimum distance (feet)
69 to 114	12
115 to 229	15
230 to 344	20
345 to 499	25
500 or more	35

77.807-3 Movement of equipment; minimum distance from high-voltage lines.

When any part of any equipment operated on the surface of any coal mine is required to pass under or by any energized high-voltage powerline and the clearance between such equipment and powerline is less than that specified in 77.807-2 for booms and masts, such powerlines shall be deenergized or other precautions shall be taken.

FINAL EXAMINATION
PI-05 ELECTRICAL HAZARDS

FINAL EXAMINATION

Circle the letter of the word(s) or phrase(s) which most correctly completes each of the following sentences or answers the question.

1. Damage to a trailing cable caused by pulling and tugging on the cable can be avoided by using a
   a. strain relief clamp
   b. wire bushing
   c. splice
   d. nip

2. The measure of electrical pressure is
   a. Amps
   b. Ohms
   c. Watts
   d. Volts

3. The most important factor in ensuring your safety is
   a. management policy
   b. your own behavior
   c. use of proper safety devices
   d. the people working around you

4. Trailing cables are set up on machines using
   a. cable reels or trolley nips
   b. cable reels or strain relief clamps
   c. strain relief clamps or trolley nips
   d. strain relief clamps or "idiot proof" connectors

5. A permanent splice in a trailing cable must be
   a. adequately insulated, flexible, flame resistant and sealed
   b. adequately insulated, inflexible, flame resistant, and sealed
   c. adequately insulated and inflexible with ground connections eliminated
   d. adequately insulated and flexible with ground connections eliminated

6. Trolley wire guards should be found
   a. at most work areas
   b. everywhere there is a trolley wire
   c. only at man trip stations
   d. where miners must walk under a trolley wire

7. When operating a piece of equipment that develops an electrical problem, the first thing you should do is
   a. post a warning sign
   b. turn off the power
   c. notify the miners working around you
   d. inform the foreman or supervisor

8. When connecting a trailing cable to a power distribution center, which of the following is **unsafe**?
   a. the connections between the two are tight
   b. the machine being connected has all power switches off
   c. the trailing cable is connected to the correct connection
   d. the power center circuit breaker is on

9. A sign and lock on a circuit breaker should be removed by
   a. anyone with a key to the lock
   b. the foreman
   c. a qualified electrician
   d. the person who tagged and locked the breaker

10. The main function of trolley wires is to power
    a. haulage machinery
    b. continuous miners at the face
    c. auxiliary fans
    d. transformers

11. Which of the following equipment conditions would cause a permissible piece of electrical equipment to become non-permissible?
    a. approval plate is scratched
    b. missing lock washer on explosion proof housing
    c. electrical components enclosed in explosion proof housing
    d. miner is operating the machine at too high a speed

12. AC power is transferred from a power distribution center to a piece of mine machinery through
    a. transformers
    b. strain release clamps
    c. trailing cables
    d. trolley wires

13. Which of the following does **NOT** describe the location of a power distribution center? The location must be
    a. in a return airway
    b. high and dry
    c. free of debris
    d. well rock dusted

14. Non-permissible equipment can be used
   a. inby the last open crosscut
   b. in the return air
   c. at the face
   d. outby the last open crosscut

15. Which of the following is **NOT** characteristic of a good splice. It must
   a. be sealed to keep out moisture
   b. keep the wires bare so they can "breathe"
   c. be mechanically sound
   d. have adequate electrical conductivity

Indicate whether the following items are true or false by writing a "T" or "F" on the line provided.

16. ____ No matter how long a trailing cable is, it may only have one temporary splice.

17. ____ If arcing occurs between two mine machines, both machines should immediately be energized.

18. ____ The purpose of the adjustments on a circuit breaker is so the machine operator can control the amount of power going to his machine.

19. ____ A trailing cable should be slack at the machine when the strain relief clamp chains are tight.

20. ____ As long as the insulation on a pinched cable is not cut or cracked, the cable is in safe condition.

21. ____ A power distribution center must be located in intake air outby the last open crosscut.

22. ____ It is common practice to use DC power to operate AC equipment.

23. ____ A temporary trailing cable splice cannot be used for more than 24 hours.

24. ____ Some power distribution centers convert AC to DC.

25. ____ An electrical overload could result in a hazardous condition by causing the trolley wire to sag.

26. ____ The power distribution center lowers voltage to a level that can be used by mine machinery.

27. ____ To be properly installed, the trolley wire guard must be set up so that the trolley wire either extends above or below the guard.

28. ____ Any power distribution center having more than one circuit breaker, each with a different rating, must have connections which physically prevent a trailing cable to be attached to the wrong connector.

29. ____ The purpose of using permissible equipment is to prevent ignition of explosive gases.

30. ____ Even if you are not a qualified electrician, you should lock out and tag the switch or circuit breaker controlling the power to the electrical equipment you are going to repair.

31. ____ A good location to place a trailing cable so it won't get run over is in the middle of the floor of the mine where everyone can see it.

32. ____ One of the purposes of a cover plate on a piece of machinery is to eliminate a possible source of ignition for explosive gases.

33. ____ A tool which uses electricity to operate can be referred to as a "load."

34. ____ Replacing a fuse with another having a higher rating can result in too little power being delivered.

35. ____ A trailing cable is under greatest strain at the strain relief clamp.

In the blank, fill in the word(s) which best completes the sentence or answers the question.

36. If a trailing cable connection is made while the machine switches and circuit breakers are on, a miner could become blinded as a result of the _____ which could occur.

37. Batteries being recharged give off the explosive gas _____.

38. Not only can defective cables and trolley wires cause physical injury to miners, but the defect could also cause a (an) _____.

39. Once equipment is approved as being permissible, it must be _____ _____ in order to remain permissible.

40. The term used to describe the joining together of a trailing cable after it has been cut is _____.

41. To protect wires from damage from the sharp edges of a switch box, a (an) _____ is used.

42. For protection against excessive electrical current, the overload should cause the circuit breaker to _____.

43. Electrical equipment approved by MSHA as being permissible must have a (an) _____ on it.

44. DC power is brought into the mine through _____ wires.

45. Electrical current which constantly changes in the direction of flow is called _____.