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**THE WEST VIRGINIA OFFICE OF MINER'S HEALTH, SAFETY, & TRAINING**

**ELECTRICAL INSPECTORS POLICY MANUAL**

(1) WV Code 22A-2-40(1)

All surface transformers, unless of a construction that will eliminate shock hazards, or unless installed at least eight feet above ground, shall be in a house or surrounded by a fence at least six feet high. If the enclosure is of metal, it shall be grounded effectively. The gate or door to the enclosure shall be kept locked at all times, unless authorized persons are present.

POLICY

Where bare, energized high voltage conductors, connections or components associated with the transformer installation are located within eight feet of ground level or within eight feet of the level of a platform from which switches, circuit breakers, or other controls are accessible, the area in which the bare, energized components are located shall be surrounded by a fence, which shall be spaced a minimum of three feet from the bare, energized components.

Only certified electricians, with high voltage qualifications, shall be authorized to enter enclosed areas. Therefore, if switches, circuit breakers, or other controls are accessible only from within the enclosed area, such devices shall be operated by a certified electrician with high voltage qualifications. However, if the enclosed or metal clad switches, circuit breakers, or other controls are accessible from outside the enclosed area, such devices may be operated by any person authorized by the mine operator.

Skid-mounted, metal enclosed power centers installed on the surface areas of an underground coal mine generally do not have bare, high voltage components exposed within eight feet of ground level; therefore, such units are not required to be surrounded by a fence and switches, circuit breakers, or other controls that are an integral part of such units may be operated by any person authorized by the mine operator. However, if the power center is served by bare high voltage conductors connected to insulating bushings on the power center and the bare conductors or connections are within eight feet of ground level, the power center must be surrounded by a fence and any switches, circuit breakers, or other controls accessible only from within the fenced area shall be operated by a certified electrician with high voltage qualification.

(2) WV Code 22A-2-40(2)

Underground transformers shall be air cooled or cooled

POLICY

Underground transformers are not required to be vented to the return airways.

(3) WV Code 22A-2-40(3)

Underground stations containing circuit breakers filled with inflammable liquids shall be put on a separate split of air or ventilated to the return air, and of fireproof construction.

POLICY

Oil-filled cutout switches used as a means of disconnecting an underground power center from the high voltage feeder circuit are not required to be vented to the return airway.

(4) WV Code 22A-2-40(4)

Transformers shall be provided with adequate overload protection.

POLICY

"Transformers" shall mean a transformer or a polyphase bank of two or more single phase transformers operating as a unit.

Each transformer shall be protected by an individual overcurrent device in the primary connection, rated or set at not more than 250 percent of the rated primary current of the transformer. Alternating overcurrent protection schemes allowed by the national electrical code, 1968, are acceptable. Where the standard ampere ratings of fuses and nonadjustable circuit breakers do not correspond with the rating or setting required for transformer overcurrent protection, the next higher standard rating may be used.

Each control circuit transformer which is an integral part of a motor circuit controller shall be provided with overcurrent protective devices in the secondary circuit which are rated or set at not more than 250 percent of the rated secondary current of the transformer. A control circuit transformer provided with overcurrent protective devices only in the primary circuit is adequately protected from overload if the protective devices are rated or set at a value which will provide secondary circuit protection equivalent to 250 percent of the rated secondary current of the transformer.

(5) WV Code 22A-2-40(5)

"DANGER -- HIGH VOLTAGE" signs with the voltage indicated shall be posted conspicuously on all transformer enclosures, high potential switchboards, and other high potential installations.

POLICY

The "Danger -- High Voltage" signs shall be marked to indicate the highest potential present at the electrical installation. The marking shall be conspicuous from a reasonably safe distance from the equipment or the equipment enclosure, if the equipment is enclosed by a fence or other enclosing structure.

(6) WV Code 22A-2-40(6)

Dry insulating platforms of rubber or other suitable non conductive material shall be kept in place at each switchboard and at stationary machinery where shock hazards exist.

POLICY

Generally, dry insulating platforms such as a rubber mat, a dry wooden platform, or a combination of both are required at all open switchboards or panelboards and at all points where switches, circuit breakers or other electrical controls of stationary equipment are activated.

Underground, a dry insulating platform shall be required at any location where a person would normally activate a switch, circuit breaker, or other electrical control device of stationary equipment while standing or sitting on the mine floor. In areas where the mine floor is wet, the rubber mat used must be supported on a suitable structure, such as a wooden pallet, which will prevent the bottom surface of the mat from contacting the water or the wet mine floor. The insulating platform must be of sufficient size to prevent a person from directly contacting the mine floor while operating the control device of the equipment; thus, if a person must lie down in front of a piece of equipment in order to activate a control device, the platform must be large enough to prevent any portion of the persons body from directly contacting the mine floor.

In the surface areas of underground coal mines, a dry insulating platform shall be provided at each location from which an electrical control device is normally operated by a person standing or sitting directly on the earth or on concrete which is directly in contact with the earth.

In high-voltage substations, or similar areas, where a person operates electrical controls while standing on a grounded metal structure or grid, dry insulated platforms are not required if no exposure to energized components exists and the control levers or activators are adequately bonded to the metal structure or grid.

In preparation plants, or similar areas where a person operates electrical controls while standing on the grounded metal surfaces of a building or the concrete encased grounded metal structure of a building, dry insulated platforms shall not be required if the control devices are contained fully within grounded metal enclosures.

(7) WV Code 22A-2-40(7)

Capacitors used for power factor correction shall be noninflammable liquid filled. Suitable drain off resistors or other means to protect miners against electrical shock following removal of power shall be provided.

(8) WV Code 22A-2-40(8)

All unattended underground loading points where electric driven hydraulic systems are used shall utilize a fireproof oil or emulsion.

(9) WV Code 22A-2-40(9)

Before electrical changes are made to permissible equipment for use in a mine, they shall be approved by the Director.

POLICY

Field changes to permissible equipment which have been fully documented and formally accepted by MSHA and for which documentation and proof of acceptance by MSHA have been submitted to the West Virginia Office of Miners, Health, Safety and Training shall be considered as approved by the Director. An on-site examination of the equipment affected by a field change is generally not required by a WVOMHS&T inspector, however, such an inspection may be made at the discretion of an inspector.

(10) WV Code 22A-2-40(10)

Reverse current protection shall be provided at storage battery charging stations to prevent the storage batteries from energizing the power circuits in the event of a power failure.

(11) WV Code 22A-2-40(11)

In all mines all junction or distribution boxes used for making multiple power connections inby the last open crosscut shall be permissible.

(12) WV Code 22A-2-40(12)

All hand-held electric drills, blower and exhaust fans, electric pumps, and such other low horsepower electric face equipment which are taken into or used inby the last open crosscut of any coal mine shall be permissible.

(13) WV Code 22A-2-40(13)

All electric face equipment which is taken into or used inby the last open crosscut of any coal mine shall be permissible.

(14) WV Code 22A-2-40(14)

In mines operated in coal seams which are located at elevations above the water table, the phrase "coal seams above the water table" means coal seams in a mine which are located at an elevation above a river or the tributary of a river into which a local surface water system naturally drains.

(15) WV Code 22A-2-40(15)

The operator of each coal mine shall maintain in permissible condition all electric face equipment, which is taken into or used inby the last open crosscut of any mine.

POLICY

Refer to the Code of Federal Regulations, part 18, for the standards and specifications which permissible electric face equipment are required to meet.

(16) WV Code 22A-2-40(16)

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

(17) WV Code 22A-2-40(17)

All power circuits and electric equipment shall be deenergized before work is done on such circuits and equipment, except when necessary for trouble shooting or testing.

POLICY

When testing or trouble shooting an energized electrical circuit, gloves rated for the maximum voltage of the circuit shall be worn at all times by the person performing the trouble shooting or testing. Violations of this requirement should be cited under Title 36, Series 12, Section 4.17 of the West Virginia Administrative Regulations. Leather protectors must be used with rubber gloves.

Rubber gloves should be tested as required by ASTM standards.

Approved low and medium voltage gloves are required to be tested every six months.

(18) WV Code 22A-2-40(18)

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

POLICY

Repair of energized trolley wires, trolley feeder wires, or trolley cutout switches shall be performed only by a certified electrician; refer to Title 48, Series 7, Section 2.1(b) of the West Virginia Administrative Regulations.

For the purpose of this section, the word "repair" includes work such as straightening kinks in trolley wires and replacing trolley wires and trolley feeder wires in the clips or hangers but does not include work such as installing or removing trolley wires, trolley feeder wires, and trolley cutout switches. Any type of work performed on energized trolley wires other than repair work or installing temporary trolley wire guards should be cited.

The required wiremans gloves must be rated for the maximum voltage of the circuit. Rubber gloves must be fitted with leather protectors. Rubber boots are not required to be rated for the voltage of the circuit, however, such boots must be maintained free from cuts, holes, and excessively worn places. Leather footwear rated for electrical hazards should not be used to satisfy the requirements of this section because, in the normally wet environment of underground coal mines, leather shoes can become highly conductive.

(19) WV Code 22A-2-40(19)

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 who installed them, or, if such persons are unavailable, by persons authorized by the operator or his agent.

POLICY

Only a certified electrician or an apprentice electrician enrolled in an approved electrical training program may perform work on electrical circuits and equipment. All electrical work to be performed by an apprentice electrician shall be examined by a certified electrician prior to any work being performed, and again prior to the circuits or equipment being energized and returned to service.

Lockout devices are required for all disconnecting devices; if the original design of the disconnecting device does not include a lockout device, then the disconnecting device must be retrofitted with a means of lockout.

Only testing and trouble shooting, such as taking voltage and current measurements or observing the operational sequence of relays and contactors, may be performed on an energized circuit or equipment. The circuit or equipment must be deenergized while repair work, such as replacing components or wiring, is being done.

(20) WV Code 22A-2-40(20)

All electric equipment shall be examined weekly, tested, and properly maintained by a qualified person to assure safe operating conditions. When a potentially dangerous condition is found on electrical 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 director and to the miners in such mine.

(POLICY)

The examination book is to be filled out completely and all checks are to be made that are required by the examination book such as circuit breakers on a monthly basis, grounding devices on a weekly basis etc.

The stationary equipment in Prep. Plants are to be examined on a monthly basis.

During extended idle periods such as vacations etc. electrical equipment may be carried in the examination book as out of service, but is required to be examined before returning to service.

(21) WV Code 22A-2-40(21)

All electric conductors shall be sufficient in size and have adequate current-carrying capacity and be of such construction that a rise in temperature resulting from normal operation will not damage the insulating material.

POLICY

Circuit conductors shall have a minimum ampacity and sized not less than that specified by the National Electrical Code, 1968, for the type of load served.

Ampacity tables to be used for determining compliance with this section are given in the Appendix to this volume:

(A) Tables 1 through 6 are to be used for flexible cables and cords manufactured in accordance with the Insulated Cable Engineers Association (ICEA) standards; examples: "SO cords", trailing cables, mine power cables, etc.

(B) Tables 7 through 10 are to be used for all other power conductors. ( National Electrical Code)

(C) Either NEC or ICEA standards will be accepted.

(22) WV Code 22A-2-40(22)

All electrical connection 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 or the wire.

(23) WV Code 22A-2-40(23)

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

POLICY

This section requires fittings of such design as to prevent movement and/or chafing of cable or wire insulation at points where they enter the exterior walls of electric

compartments. Fittings for cable need not be insulated. Fittings for insulated wire shall be provided with insulated bushings.

When insulated wires pass through holes in dividers within the same enclosure, insulated bushings shall be used to bush the holes.

(24) WV Code 22A-2-40(24)

All power wire (except trailing cables on mobile equipment, specially designed cables conducting high-voltage power to underground rectifying equipment or transformers or bare or insulated ground and return wires) shall be supported on well-installed insulators and shall not contact combustible material, roof or ribs.

(25) WV Code 22A-2-40(25)

Power wires and cables, including, but not limited to. phone communication and control wires, except trolley wires, trolley feeder wires and bare signal wires, shall be insulated adequately and fully protected. The provisions of this subdivision shall not become effective until the first day of January, one thousand nine hundred seventy-eight.

POLICY

This section requires that damaged insulation on insulated power wires and cables (including trailing cables) and damaged jackets on power cables (including trailing cables) be repaired.

Repairs to the jacket of a power cable must provide protection for the insulated wires of the cable equivalent to the protection provided by the original undamaged jacket of the cable.

(26) WV Code 22A-2-40(26)

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.

POLICY

Short circuit and overload protection for electric circuits and equipment shall be as specified by the National Electrical Code, 1968, with the following modifications:

1. Trailing cables serving mobile electric equipment shall be provided with short circuit protection as required by 22A-2-40(35).

2. The electric circuits and equipment of permissible electric equipment shall be protected as required by the approval documentation (MSHA) for such equipment.

3. Flexible cables and cords serving as motor feeder circuit conductors or branch circuit conductors for transformer - rectifier type of battery chargers, may be protected against short circuit in accordance with the requirements of 22A-2-40(35) for trailing cable provided that the conductors are provided with adequate overload protection by devices which may be located at the receiving (load) end of the circuit.

4. Cables designed for and installed as aerial suspensions may be provided with only short circuit protection at the sending (source) end of the circuit provided that the conductors are provided with adequate overload protection by devices which may be located at the receiving (load) end of the circuit.

5. Three-phase motors must be provided with overload protection by devices which will cause deenergization of all three phases in the event that any phase is overloaded.

Fuses, circuit breakers, and other devices such as motor starters, fused safety switches, etc. must (1) be rated for the maximum voltage of the circuit to which they are applied; (2) have a current interrupting capacity appropriate for the fault currents that can exist in such circuits, and (3) if applied in motor circuits, be rated in horsepower as required by the NEC.

(27) WV Code 22A-2-40(27)

Incandescent lamps installed along haulageways and at other locations shall not contact combustible material, and if powered from trolley or direct current feeder circuits, need not be provided with separate short circuit or overload protection, if the lamp is not more than eight feet in distance from such circuits.

(28) WV Code 22A-2-40(28)

In all main power circuits, disconnecting switches shall be installed underground within five hundred feet of the bottoms of shafts and boreholes through which main power

circuits enter the underground area of the mine and within five hundred feet of all other places where main power circuits enter the underground area of the mine.

(29) WV Code 22A-2-40(29)

All electric equipment shall be provided with switches or other controls that are safely designed, constructed and installed.

(30) WV Code 22A-2-40(30)

Each ungrounded, exposed power conductor that leads underground shall be equipped with suitable lightning arrestors of approved type within one hundred feet of the point where the circuit enters the mine. Lightning arrestors shall be connected to a low resistance grounding medium on the surface which shall be separated from the neutral ground by a distance of not less than twenty-five feet.

POLICY

Conductors that are (1) provided with metallic shields, or (2) jacketed by a grounded metal covering or enclosure, or (3) installed under grounded metal framework, or (4) buried in the earth, or (5) made of triplex or quadraplex that is supported by a grounded messenger wire, are not considered exposed for the length so protected. If the trolley wire of a direct current system is paralleled by an exposed feeder cable, one lightning arrestor would provide protection for both if they are connected together near the lightning arrestor. Each ungrounded, exposed telephone wire that leads underground shall be protected by a lightning arrestor designed for that purpose.

Lightning arrestor ground fields shall be maintained with as low a resistance to earth as possible, preferably less than 5 ohms and never more than 25 ohms. See NEC Article 250, part H, grounding electrode system.

Lightning arrestor ground fields shall be separated from neutral ground fields by at least 25 feet. This distance prevents lightning surges from being transmitted to the neutral ground fields where they could momentarily energize the frames of equipment grounded to the neutral ground field.

Mines using single phase power originating at the power company's secondary and extending underground cannot normally comply with this section due to the power company's practise of connecting the lightning arrestor ground to the grounded neutral which also connects to the center tap of the transformer, unless an isolation transformer is installed or the power company isolates the lightning arrestor ground from

the center tap ground and a separate neutral ground field is established. (SEE ATTACHED FIGURES 7 and 8 FROM MSHA MANUAL).

Lightning arrestors designed for use on a.c. power systems are not generally suitable for service on d.c. systems, since the means employed to interrupt follow through current is not effective where this current does not periodically pass through zero. Arrestors, however, are available for d.c. service. Modern d.c. arrestors are simple capacitors. They are connected from line to ground and limit the crest value of a voltage surge by absorbing the current as a charge on the capacitor.

For Lightning Arrestors see NEC Article 280.

(31) WV Code 22A-2-40(31)

Except for areas of a coal mine inby the last open crosscut, incandescent lamps may be used to illuminate underground areas. When incandescent lamps are used in a track entry or belt entry or near track entries to illuminate special areas other than structures, the lamps shall be installed in weatherproof sockets located in positions such that the lamps will not come in contact with any combustible material. Lamps used in all other places must be of substantial construction and be fitted with a glass enclosure.

Weatherproof is defined by the NEC as: So constructed or protected that exposure to the weather will not interfere with successful operation.

(32) WV Code 22A-2-40(32)

An authorized representative of the director may require in any mine that electric face equipment be provided with devices that will permit the equipment to be deenergized quickly in the event of an emergency.

(33) WV Code 22A-2-40(33)

An authorized representative of the director shall require manually operated emergency stop switches, designed to deenergize the traction motor circuit when the contactors or controller fail to open, to be installed on all battery powered tractors, taken into or used inby the last open crosscut of any entry or room.

(34) WV Code 22A-2-40(34)

Trailing cables used in coal mines shall meet the requirements for flame resistant cables.

(35) WV Code 22A-2-40(35)

Short circuit protection for trailing cables shall be provided by an automatic circuit breaker or other no less effective device, approved by the director, 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.

POLICY

| AWG | Short Circuit Ampacity |
|---|---|
| 14 | 50 |
| 12 | 75 |
| 10 | 150 |
| 8 | 200 |
| 6 | 300 |
| 4 | 500 |
| 2 | 800 |
| 1 | 1000 |
| 1/0 | 1250 |
| 2/0 | 1500 |
| 4/0 | 2500 |

(36) WV Code 22A-2-40(36)

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.

(37) WV Code 22A-2-40(37)

One temporary splice may be made in any trailing cable. Such trailing cable may only be used for the next twenty-four hour period. No temporary splice shall be made in a trailing cable within twenty-five feet of the machine, except cable reel equipment. 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 a mechanical joining of one or more conductors that have been severed.

(38) WV Code 22A-2-40(38)

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.

(39) WV Code 22A-2-40(39)

Trailing cables shall be clamped to machines in a manner to protect the cable from damage and to prevent strain on the electrical connections. No cables shall be hung in a manner which will damage the insulation or conductor.

(40) WV Code 22A-2-40(40)

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

(41) WV Code 22A-2-40(41)

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

(42) WV Code 22A-2-40(42)

All metallic sheaths, armors and conduits enclosing power conductors shall be electrically continuous throughout and shall be grounded by methods approved by an authorized representative of the director.

(43) WV Code 22A-2-40(43)

Except where waived by the director, metallic frames, casings, and other enclosures of electrical equipment that can become alive through failure of insulation or by contact with energized parts shall be grounded, and on or before the first day of January, one thousand nine hundred seventy-eight, shall have a ground monitoring system.

POLICY

See Ground Monitoring Waiver Guidelines (copy attached)

(44) WV Code 22A-2-40(44)

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.

(45) WV Code 22A-2-40(45)

The attachment of grounding wires to a mine track or other grounded power conductors will be approved if separate clamps, suitable for such purpose, are used and installed to provide a solid connection.

(46) WV Code 22A-2-40(46)

The frames of all offtrack direct-current machines and the enclosures of related detached components shall be effectively grounded or otherwise maintained at no less safe voltages.

(47) WV Code 22A-2-40(47)

Installation of silicon diodes shall be restricted to electric equipment receiving power from a direct-current system with one polarity grounded. Where such diodes are used on circuits having a nominal voltage rating of two hundred fifty, they must have a forward current rating of four hundred amperes or more, and have a peak inverse voltage rating of four hundred or more. Where such diodes are used on circuits having nomimal voltage rating of five hundred fifty, they must have a forward current rating of two hundred fifty amperes or more, and have a peak inverse voltage rating of eight hundred or more.

(48) WV Code 22A-2-40(48)

In addition to the grounding diode, a polarizing diode must be installed in the machine control circuit to prevent operation of the machine when the polarity of a trailing cable is reversed.

(49) WV Code 22A-2-40(49)

When installed on permissible equipment, all grounding diodes, over-current devices, and polarizing diodes must be placed in explosion-proof compartments.

(50) WV Code 22A-2-40(50)

High-voltage lines, both on the surface and underground, shall be de-energized 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.

POLICY

Approved High voltage gloves are required to be tested every 30 days if used on engergized lines and tested every six months if used in conjunction with a hot stick.

Hot sticks are required to be tested annually.

(51) WV Code 22A-2-40(51)

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.

(52) WV Code 22A-2-40(52)

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.

(53) WV Code 22A-2-40(53)

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.

(54) WV Code 22A-2-40(54)

Solely for purposes of grounding ungrounded high-voltage power systems, grounded messenger wires used to suspend the cables of such systems may be used as a grounding medium.

(55) WV Code 22A-2-40(55)

When not in use, power circuits underground shall be de-energized on idle days and idle shifts, except that rectifiers and transformers may remain energized.

POLICY

Circuits supplying power to Automatically operated pumps shall be considered as being in use, although the pumps may not be operated continuously.

(56) WV Code 22A-2-40(56)

High-voltage circuits entering the underground area of any coal mine shall be protected by suitable circuit breakers of adequate interrupting capacity. Such breakers shall be equipped with devices to provide protection against undervoltage, grounded phase, short circuit and overcurrent.

POLICY

The tests required may be conducted one of three ways:

1. Primary injection test. This test method involves passing sufficient current to cause the circuit breaker to trip through at least two current transformers associated with the circuit breaker. Since this method requires that test connections be made on high-voltage conductors or terminals, stringent safety procedures must be followed. This method simultaneously tests the current transformer ratio, the current transformer secondary wiring, the operation and calibration of the relays, and the operation of the circuit breaker tripping circuit.

2. Secondary injection test. This test method involves passing sufficient current to cause the circuit breaker to trip through at least two of the protective relays associated with the circuit breaker. This method simultaneously tests the operation and calibration of the relays and the operation of the circuit breaker trip circuit.

3. Mechanical activation test. This test method involves mechanically activating at least two of the protective relays associated with the circuit breaker with a nonconductive probe. This method tests the operation of the circuit breaker trip circuit.

(57) WV Code 22A-2-40(57)

Circuit breakers protecting high-voltage circuits entering an underground area of any coal mine shall be

located on the surface and in no case installed either underground or within a drift.

(58) WV Code 22A-2-40(58)

One circuit breaker may be used to protect two or more branch circuits, if the circuit breaker is adjusted to afford overcurrent protection for the smallest conductor.

(59) WV Code 22A-2-40(59)

The grounding resistor, where required, shall be of the proper ohmic value to limit the voltage drop in the grounding circuit external to the resistor to not more than one hundred volts under fault conditions. The grounding resistor shall be rated for maximum fault current continuously and insulated from ground for a voltage equal to the phase-to-phase voltage of the system.

(60) WV Code 22A-2-40(60)

High-voltage circuits extending underground and supplying portable,mobile or stationary high-voltage equipment shall contain either a direct or derived neutral which shall be grounded through a suitable resistor at the source transformers, and a grounding circuit, originating at the grounded side of the grounding resistor, shall extend along with the power conductors and serve as a grounding conductor for the frames of all high-voltage equipment supplied power from the circuit, except that the director or his authorized representative may permit ungrounded high-voltage circuits to be extended underground to feed stationary electrical equipment if such circuits are either steel armored or installed in grounded, rigid steel conduit throughout their entire length, and upon this finding that such exception does not pose a hazard to the miners. Within one hundred feet of the point on the surface where high-voltage circuits enter the underground portion of the mine, disconnecting devices shall be installed and so equipped or designed in such a manner that it can be determined by visual observation that the power is disconnected, except that the director or his authorized representative may permit such devices to be installed at a greater distance from such area of the mine if he determines, based on existing physical conditions, that such installation will be more accessible at a greater distance and will not pose any hazard to the miners.

POLICY

System neutrals are normally obtained by using source transformers or generators with wye-connected secondary

windings. The neutral is then readily available for grounding purposed. For delta-connected systems, grounding transformers are used to derive a neutral that is then grounded through a suitable resistor. Shown in simplified form the proper method of connecting resistance-grounded circuits extending underground. (Refer to appendix drawings No. 2 and No. 3.)

The type of grounding transformer most commonly used is a three-phase zigzag transformer. The impedance of the transformer to three phase currents is high, so that when there is no fault on the system, only a small magnetizing current flows in the transformer windings. The transformer impedance to ground-fault current, however, is low. The transformer divides the ground-fault current into three equal components; these currents are in phase with each other and flow in the three windings of the grounding transformer. The method of winding is such that when these three equal currents flow, the current in one section of the windings of each leg of the core is in a direction opposite to that in the other section of the winding of that leg. The only magnetic flux that results from the zero-sequence fault currents is the leakage flux about each winding section. This accounts for the low impedance of the transformer to ground-fault current. (Refer to appendix drawing No. 4.)

A wye-delta transformer bank can also be used to derive a neutral. In this case, the delta windings must be closed to provide a path for the zero-sequence current. The wye windings must have the same voltage rating as the phase-to-neutral voltage of the circuit that is to be grounded, but the delta windings can be made up at any convenient voltage level. Also, the delta windings may be used to supply other loads. The connections and current distribution in a wye-delta grounding transformer bank. (Refer to appendix drawing No. 4.)

Grounding transformers must be sized to carry the rated ground-fault current of the system continuously. Consequently, the kva rating of a zigzag grounding transformer or a wye-delta grounding transformer or a wye-delta grounding bank shall not be less than the rated phase-to neutral voltage of the system in KV times the rated ground-fault current of the system (I) in amperes. If other loads are supplied from a wye-delta grounding transformer bank, the rating of the transformer bank must be adequate to supply the additional loads plus the rated ground-fault current.

Transformer banks connected wye on the primary side and supplied power from a resistance-grounded circuit shall not have the primary neutral grounded. Such a configuration as shown in drawing # 6 would provide the circuit with two

neutrals (one resistance grounded and one solidly grounded) and would effectively short circuit the grounding resistor. Such a configuration is a violation of this section.

This section requires that the grounding resistor be located at the source transformers. As used in this section, the term "source transformers" means in the transformers that supply power to the electric circuits.

The frames of electric equipment receiving power from a resistance grounded system that supplies a circuit extending underground must be grounded to the grounded side of the grounding resistor, regardless of whether the equipment is located on the surface or underground. However, the metallic frames, enclosures, and supporting structures of all high-voltage equipment and conductors located inside either a portable or stationary substation (including the source transformers, control transformer, grounding resistor, and circuit breakers) must be grounded to the same grounding medium to prevent hazardous step and touch potentials from existing within the substation during a grounded-phase condition or a lightning strike. Therefore, the metallic frames, enclosures, and supporting structures of all electric equipment and conductors located inside either a portable or stationary substation shall be grounded to the substation grounding medium.

All high-voltage power transformers and other equipment that receive power from a resistance grounded system that supplies a circuit extending underground should be located outside the substation containing the source transformers and the frames, enclosures, and supporting structures of such equipment should be grounded to the grounded side of the grounding resistor. When equipment receiving power from a resistance grounded circuit is installed inside the same substation as the source transformers, it is extremely impractical without creating step and touch potential hazards within the substation during fault conditions and lightning strikes. The grounding requirements for surface and underground equipment supplied from a high-voltage resistance grounded circuit are illustrated in drawing No. 5.

Ungrounded three-phase high-voltage circuits may be permitted to feed stationary equipment only after an investigation has been made to determine that the use of such circuit in a particular mine does not pose a hazard to the miners.

If an operator desires to install an ungrounded circuit underground, an application should be made to the Director. The Director shall assign electrical inspectors to make an investigation of the application and, if it is determined that no hazard is created by the installation of the ungrounded circuit, the Director shall notify the operator in

writing of the acceptability of the circuit and of any restrictions imposed on the operation of the circuit.

Ungrounded circuits shall not be accepted for circuits feeding portable power centers and rectifiers that supply power to mobile equipment. SHC cables (cables having a common metallic shield around all conductors) are not to be accepted for use in ungrounded high-voltage circuits.

In all cases where ungrounded circuits are accepted for use underground, the circuit breaker protecting the circuit must be equipped with a ground-fault tripping circuit. Ground-indicating lights that do not trip the circuit breaker upon occurrence of a phase-to-ground fault are not acceptable. Failure to provide grounded-phase protection for ungrounded high-voltage circuits installed underground shall be cited as a violation.

(61) WV Code 22A-2-40(61)

High-voltage resistance grounded systems serving portable or mobile equipment shall include a fail-safe ground check circuit to monitor continuously the grounding circuit to assure continuity, and the fail-safe ground check circuit shall cause the circuit breaker to open when either the ground or pilot check wire is broken, or other no less effective device approved by the director or his authorized representative to assure such continuity.

POLICY

Fail Safe Ground Check Circuits on High Voltage Resistance Grounded Systems:

Ground check circuits are required to be designed so as to insure a safe dependable path for fault currents by causing the circuit breaker to open when either of the following occurs:

1. The ground check wire is broken at any point: or

2. The grounding conductor is broken at any point.

If low-resistance parallel paths are present that prevent the ground check circuit from actuating the ground check relay when the grounding conductor is broken, the ground check circuit shall be acceptable as compliance with this section if the ground check circuit is designed to cause the circuit breaker to open when the impedance of the grounding circuit increases beyond the amount necessary to cause a 100 volt drop external to the grounding resistor during a fault condition.

The following method may be approved by electrical inspection personnel as an alternate method for assuring continuity of a safe, dependable path for fault current for resistance-grounded circuits extending to permanently installed stationary equipment located on the surface.

1. The grounding circuit shall originate at the grounded side of the grounding resistor and shall extend along with the power conductors and shall serve as a grounding conductor for the frames of all equipment receiving power from the circuit.

2. The second grounding circuit shall connect the frames of all stationary equipment to a low-resistance ground field located near the utilization location.

3. The resistance of the grounding resistor and the resistance of the ground field shall be maintained in such a manner that not more than 100 volts will appear between the equipment frames and earth under a fault condition in the event that the grounding conductor should be severed. (See drawing # 1)

Ground Check Systems not Employing Pilot Check Wires: Wireless ground check circuits shall not be approved unless such circuits are tested and evaluated by Technical Support.

(62) WV Code 22A-2-40(62)

Underground high-voltage cables used in resistance grounded systems shall be equipped with metallic shields around each power conductor with one or more ground conductors having a total cross-sectional area of not less than one half the power conductor, and with an insulated internal or external conductor not smaller than 10 (A.W.G.) for the ground continuity check circuit.

POLICY

(63) WV Code 22A-2-40(63)

All such Cables shall be adequate for the intended current and voltage. Splices made in such cables shall provide continuity of all components. (See appendix tables #1-6)

(64) WV Code 22A-2-40(64)

Single-phase loads such as transformer primaries, shall be connected phase-to-phase.

POLICY

This refers to resistance grounded systems only.

(65) WV Code 22A-2-40(65)

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

POLICY

The intent of this section is to protect the miners against contact with the energized cable. Citations issued under this section should include a description of any damage to the cable. The minimum requirement for regularly travelled is weekly.

High-voltage cable under falling roof, rib rolls, or roof falls should not be cited under this section unless it can be determined that cable damage has resulted.

Energized high-voltage cables shall be stored in unused crosscuts or other unused areas away from haulageways or mantrip stations where men or equipment could contact or damage such cables.

Cables entering power centers or other portable equipment shall be securely clamped to the frame of the equipment in such a manner as to prevent strain on the electrical connections.

When high-voltage cable that is not buried in a man-made trench or placed so as to afford protection against damage, such as high-voltage cable suspended across a track entry and high-voltage cable installed on the mine floor across a path over which men regularly travel, shall be covered by a trough made of wood, metal, metal pipe, rigid plastic pipe, or other material that would provide similar protection. Trolley wire guard or brattice cloth is not acceptable as a covering to protect high-voltage cable from damage.

High-voltage cable installed less than 6 1/2 feet above the floor or rail where men regularly work or travel shall be guarded. Areas where men regularly work or pass include mantrip stations, underground shops. belt drive and pump installations, and section loading points, as well as walkways from the end of the track to working sections and walkways to the installations specified above. Wood, metal,

metal pipe, plastic pipe, plastic trolley wire guard, or similar material may be used to prevent miners from contacting the cable.

(66) WV Code 22A-2-40(66)

Disconnecting devices shall be installed at the beginning of branch lines on underground high-voltage circuits and equipped or designed in such a manner that it can be determined by visual observation that the circuit is deenergized when the switches are open.

POLICY

A "branch line" means a circuit that is formed by connection to an existing high-voltage circuit for the purpose of feeding branch loads.

(67) WV Code 22A-2-40(67)

Circuit breakers and disconnecting switches underground shall be marked for identification.

POLICY

The identifying markers for circuit breakers and disconnecting switches shall be large enough and shall be located so they can be readily seen if the circuits need to be deenergized quickly.

Either metallic or plastic material may be used for the marker to adequately identify the circuit (e.g., No. 2 Belt Drive, No. 3 Rectifier, 1 Rt. 3 North, etc.).

The identifying markers shall leave no doubts as to which circuit or circuits will be deenergized when the switches are pulled.

(68) WV Code 22A-2-40(68)

In the case of high-voltage cables used as trailing cables, temporary splices shall not be used and all permanent splices shall be made in accordance with the manufacturers' specifications.

(69) WV Code 22A-2-40(69)

Frames, supporting structures and enclosures of stationary, portable, or mobile underground high-voltage equipment and all high-voltage equipment supplying power to such equipment receiving power from resistance grounded systems shall be effectively grounded to the high-voltage ground.

(70) WV Code 22A-2-40(70)

Low and medium-voltage power circuits serving three-phase alternating current equipment serving portable or mobile equipment shall be protected by suitable circuit breakers of adequate interrupting capacity which are properly tested and maintained as prescribed by the director. Such breakers shall be equipped with devices to provide protection against under-voltage, grounded phase, short circuit and overcurrent.

POLICY

Each of the four protective features required must be provided for all underground low and medium-voltage three-phase a.c. circuits with the exception of trailing cables, which must have short-circuit, undervoltage, and grounded-phase protection. Circuit breakers providing short-circuit protection for trailing cables shall be adjusted so as not to exceed the maximum allowable instantaneous settings specified. Short-circuit and overcurrent protection for circuits other than trailing cables shall conform to the National Electrical Code. Charts listing sizes and proper overload and short-circuit protection for motors and motor circuits conductors can be found in Appendix. These tables shall be used to determine compliance with this section.

"Adequate interrupting capacity" is the ability of a circuit breaker to safely interrupt the maximum amount of current that can flow through its contacts upon occurrence of a short circuit at any point in the circuit without damage to itself.

Grounded-Phase Protection

Low and medium-voltage three-phase circuits used underground shall be protected against the harmful effects of a grounded phase in any circuit connected to the same transformer secondary. Consequently, if one bank of transformers supplies power to both underground and surface loads, the circuits extending to the surface loads, as well as both the surface and underground portions of the circuit(s) extending to the underground load(s) shall be provided with grounded-phase protection.

Grounded-phase protective devices for resistance-grounded circuits should be adjusted to operate on as low a value of fault current as practical, preferably not more than 50 percent of the current rating of the neutral grounding resistor.

Low and Medium-Voltage Circuit Breakers

Low-voltage power circuit breakers used in an electrical circuit have three major applications:

1. To interrupt fault currents;
2. To provide overload protection where required; and
3. To switch to open and close the electrical circuit.

Conventional breakers use bimetallic elements and electromagnetic elements to provide overload and short-circuit protection. This type of protective action is referred to as thermal-magnetic and is the industry standard. On some circuit breakers, the instantaneous trip unit ampere ranges can be readily determined; if this is not the case, trip ranges must be determined by various techniques. On Westinghouse circuit breakers, remove the cover from the front of the breaker and locate the range on the front of the trip unit. It may be necessary to contact the manufacturer of a particular circuit breaker to determine the trip unit range. The tables in Appendix contain information regarding continuous ampere ratings and adjustable instantaneous trip ranges of circuit breakers commonly used in the coal industry.

(71) WV Code 22A-2-40(71)

Power centers and portable transformers shall be deenergized before they are moved from one location to another, except that, when equipment powered by sources other than such centers or transformers is not available, the director may permit such centers and transformers to be moved while energized, if he determines that another equivalent or greater hazard may otherwise be created, and if they are moved under the supervision of a qualified person, and if such centers and transformers are examined prior to such movement by such person and found to be grounded by methods approved by an authorized representative of the director and otherwise protected from hazards to the miner. A record shall be kept of such examinations. High-voltage cables, other than trailing cables, shall not be moved or handled at any time while energized, except that when such centers and transformers are moved while energized as permitted under this section, energized high-voltage cables attached to such centers and transformers may be moved only by a qualified person and the operator of such mine shall require that such person wear approved and tested insulated wireman's gloves.

(72) WV Code 22A-2-40(72)

Low and medium-voltage three-phase alternating-current circuits used underground shall contain either a direct or derived neutral which shall be grounded through a suitable resistor at the power center, and a grounding circuit, originating at the grounded side of the grounding resistor, shall extend along with the power conductors and serve as a grounding conductor for the frames of all the electrical equipment supplied power from the circuit, except that the director or his authorized representative may permit

ungrounded low and medium-voltage circuits to be used underground to feed such stationary electrical equipment if such circuits are either steel armored or installed in grounded rigid steel conduit throughout their entire length. The grounding resistor, where required, shall be of the proper ohmic value to limit the ground fault current to twenty-five amperes. The grounding resistor shall be rated for maximum fault current continuously and insulated from ground for a voltage equal to the phase to phase voltage of the system.

POLICY

When two phase conductors of a three-phase resistance grounded circuit are used to power single-phase loads, the equipment frames must be grounded to the grounded side of the grounding resistor. The grounding circuit shall be provided with a ground check circuit.

Ungrounded three-phase low and medium-voltage circuits may be permitted in an underground coal mine to feed stationary equipment only after an investigation has been made by an electrical personnel and after that investigation finds that the use of such circuits in a particular mine does not pose a hazard to the miners.

When two phase conductors of an ungrounded surface three-phase circuit are taken underground for use as a control circuit, this circuit exhibits all the hazards inherent in an ungrounded three-phase circuit and shall be judged accordingly.

If an operator wishes to install an ungrounded circuit underground, including the control circuit described above, application should be made to the Director. The Director shall assign electrical inspectors or electrical engineers to an investigation of the application, and if it is determined that no hazard is created by the installation to the ungrounded circuit, the Director shall notify the operator in writing of the acceptability of the circuit and of any restrictions imposed on the operation of the circuit.

Ungrounded circuits feeding portable distribution boxes or power centers that supply power to mobile equipment are not to be accepted.

In all cases where ungrounded circuits are accepted for use underground, the circuit breaker protecting the circuit must be equipped with grounded-phase protection. Ground indicating lights that do not trip the circuit breaker when a phase-to ground fault occurs are not acceptable. Failure to provide grounded-phase protection for ungrounded low-voltage circuits installed underground should be cited as a violation.

(73) WV Code 22A-2-40(73)

Low and medium-voltage resistance grounded systems serving portable or mobile equipment shall include a fail-safe ground check circuit to monitor continuously the grounding circuit to assure continuity which ground check circuit shall cause the circuit breaker to open when either the ground or pilot check wire is broken, or other not less effective device approved by the director or his authorized representative to assure such continuity, except that an extension of time, not in excess of twelve months, may be permitted by the director on a mine-to-mine basis if he detemines that such equipment is not available. Cable couplers shall be constructed so that the ground check continuity conductor shall be broken first and the ground conductor shall be broken last when the coupler is being uncoupled.

POLICY

Low and Medium Voltage Ground Check Monitor Circuits:

The following criteria shall be used for determining compliance of ground check circuits in low-medium voltage systems supplying power only to stationary equipment.

1. If a ground check conductor is used, the ground circuit will trip the circuit breaker when the ground check conductor is broken.

2. The ground check circuit will trip the circuit breaker if the ground wire is broken at any point in the grounding circuit. If low resistance parallel paths for fault current and monitoring current are present, the ground check circuit will be acceptable if it is designed to trip the circuit breaker when the impedance of the grounding circuit increases beyond the amount to cause a 40 volt drop in the grounding circuit external to the grounding resistor under a fault condition.

3. The ground check device shall be of failsafe design. "Failsafe" is interpreted to mean that the failure of any component, other than relay contacts, shall not prevent the ground check circuit from opening the circuit breaker when the conditions described in criterial 1 and 2 occur, unless the ground check circuit is designed to open the circuit breaker when such failure occurs.

Ground check circuits that have been accepted by Technical Support are assigned an MSHA acceptance number.

Ground check devices that do not bear an MSHA acceptance number will be temporarily accepted if the first two criteria are satisfied. MSHA will obtain a similar device and will evaluate it for "failsafe" design.

When an arc suppression device is installed in a power center, the ground check circuit should be connected on the machine side of the device. Monitoring through an arc suppression device preloads the device and reduces its effectiveness in suppressing intermachine arcing and may also cause false tripping of the ground check circuit. Any device inserted in a grounding conductor (including an arc suppression device and a parallel-path suppression device) shall have a short-circuit capacity that is not less than that of the grounding conductor in which it is installed. MSHA Technical Support tests such devices to determine their short-circuit capacity.

When an arc suppression or parallel path suppression device for a circuit is installed in a power center or distribution box and the receptacle for the circuit is not insulated from the metal frame of the power center or the distribution box, the circuit grounding conductor must be insulated through the receptacle and the associated plug. This is necessary to prevent shorting out the arc suppression or parallel path suppression device.

Nevertheless, the metal casings of both the plug and receptacle must be grounded. Normally, the receptacle is grounded by bolting it directly to the metal frame of the power center or distribution box. However, the plug must be grounded to the metal frame of the power center of the distribution box by an external grounding shunt or separate internal grounding conductor in the receptacle and plug. The grounding shunt or grounding conductor shall be sized in accordance with Section 75.701-4. In some cases, receptacles are insulated from the metal frames of power centers to prevent shorting out arc suppression or parallel path suppression devices. In such cases, both the receptacles and the associated plugs shall be grounded to the grounding conductors in the cables. In all cases, the metal casings of both halves of in-line cable couplers shall be grounded to the grounding conductors in the cables.

When wireless ground check circuits are used, an interlock circuit shall be provided for all cable couplers (including in-line cable couplers) to ensure that the power circuit will be deenergized before the power conductors are broken when the coupler is uncoupled. Typically, the pilot pins are connected together in the cable couplers to provide an interlock to trip the circuit breaker.

The wiring methods used on power center receptacles and cable couplers shall not result in the ground check circuits becoming ineffective. The pilot pins of the cable couplers shall not be connected together when one of the two pilot pins is connected to the system ground.

Resistance grounded circuits extending to stationary low-or medium-voltage three-phase equipment located on the surface are not required to be equipped with ground check circuits.

Approved Ground Check Systems Not Employing Pilot Check Wires.

This Section requires MSHA approval of all wireless ground check circuits; therefore, only wireless ground check devices bearing an MSHA acceptance number will be acceptable.

(74) WV Code 22A-2-40(74)

Disconnecting devices shall be installed in conjunction with circuit breakers serving portable or mobile equipment to provide visual evidence that the power is connected.

POLICY

A connecting plug on the outby end of the trailing cable connected to the power center or distribution box will be accepted as a disconnecting device. Other means, such as switches with visible contacts, may also be acceptable for this purpose. Molded case circuit breakers are not acceptable as visible disconnecting devices.

(75) WV Code 22A-2-40(75)

Circuit breakers shall be marked for identification.

POLICY

(Breaker, Receptacle, and Cable coupler.)

(76) WV Code 22A-2-40(76)

Single-phase loads shall be connected phase-to-phase. (See policy of 22A-2 40(64)

(77) WV Code 22A-2-40(77)

The trailing cables for medium-voltage circuits shall include grounding conductors, a ground check conductor, and grounded metallic shields around each power conductor or a grounded metallic shield over the assembly, except that on equipment employing cable reels, cables without shields may

be used if the insulation is rated two thousand volts or more.

(78) WV Code 22A-2-40(78)

Trolley wires and trolley feeder wires shall be provided with cutout switches at intervals of not more than two thousand feet and near the beginning of all branch lines.

(79) WV Code 22A-2-40(79)

Trolley wires and trolley feeder wires shall be provided with overcurrent protection.

POLICY

Automatic circuit interrupting devices that will deenergize the affected circuit upon occurrence of a short circuit at any point in the circuit will meet the requirement of overcurrent protecion.

A load test is required to assure that adequate short circuit amperes are available at the extreme end of the circuit being tested to trip the circuit breaker.

The setting of an automatic circuit interrupting device should not exceed 75 percent of the minimum available short circuit current in the protected circuit to compensate for inaccuracies in the setting and the voltage drop across arcing faults. (SEE TABLE # 11)

(80) WV Code 22A-2-40(80)

Trolley wires and trolley feeder wires, high-voltage cables, and transformers shall not be located within fifteen feet of the last open crosscut and shall be kept at least one hundred fifty feet from pillar workings.

POLICY

The Technical Review Committee must grant permission for High Voltage in face areas.

(81) WV Code 22A-2-40(81)

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.
(C) At man-trip stations.

POLICY

Guarding shall extend 6 feet past the extended door.

(82) WV Code 22A-2-40(82)

Temporary guards shall be provided where trackmen and other persons work in close proximity to trolley wires and trolley feeder wires.

(83) WV Code 22A-2-40(83)

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

POLICY

Refer to Adm. Reg. on Movement of equipment.

(84) WV Code 22A-2-40(84)

Trolley and feeder wires shall be installed as follows: Where installed on permanent haulage, they shall be:

(A) At least six inches outside the track gauge line.

(B) Kept taut and not permitted to touch the roof, rib or crossbars. Particular care shall be taken where they pass through door openings to preclude bare wires from coming in contact with combustible material.

(C) Installations of trolley wire hangers shall be provided within three feet of each splice in a trolley wire. (A trolley clip on both sides of the splice with a solid metal brace bolted onto the trolley clips is acceptable in lieu of the trolley wire hangers.)

TABLE 1 **Ampacity Tables for Portable Cords, Portable Power Cables, and Mine Power Cables Manufactured in Accordance with the Insulated Cable Engineers Association (ICEA) Standards**

Table B-1. -- Ampacities for 0-2000 volt portable cords and portable power cables with insulation temperature ratings of 75°C, unshielded copper conductors

| Conductor Size AWG or MCM | Ampacities* Number of Current-Carrying Conductors | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **14 | | 20 | 17 |
| **12 | | 28 | 22 |
| **10 | | 33 | 28 |
| 8 | 75 | 63 | 63 |
| 6 | 106 | 81 | 81 |
| 4 | 138 | 113 | 106 |
| 3 | 163 | 131 | 125 |
| 2 | 188 | 150 | 144 |
| 1 | 213 | 175 | 163 |
| 1/0 | 250 | 213 | 181 |
| 2/0 | 294 | 244 | 213 |
| 3/0 | 344 | 281 | 244 |
| 4/0 | 394 | 325 | 275 |
| 250 | 438 | 356 | 306 |
| 300 | 494 | 388 | 344 |
| 350 | 556 | 419 | 381 |
| 400 | 600 | 450 | 406 |
| 500 | 681 | 519 | 469 |

* Ampacities are based on an ambient temperature of 20°C. To determine ampacities at other ambient temperatures, see Table B-7.

**Maximum voltage ratings are (1) 600 volts for S, SO, ST, and STO cables, and (2) 300 volts for SJ, SJO, SJT, and SJTO cables.

SOURCE: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-19-81, National Electrical Manufacturers Association Publication No. WC 3-1980.

TABLE 2 Ampacities for 0-2000 volt portable cords and portable cables with insulation temperature ratings of 90°C, unshielded copper conductors

| Conductor Size AWG or MCM | Ampacities* Number of Current-Carrying Conductors | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **14 | | 20 | 17 |
| **12 | | 28 | 22 |
| **10 | | 33 | 28 |
| 8 | 98 | 85 | 70 |
| 6 | 129 | 112 | 93 |
| 4 | 171 | 150 | 123 |
| 3 | 197 | 171 | 142 |
| 2 | 227 | 197 | 163 |
| 1 | 263 | 225 | 190 |
| 1/0 | 304 | 256 | 219 |
| 2/0 | 352 | 295 | 254 |
| 3/0 | 407 | 337 | 294 |
| 4/0 | 472 | 387 | 329 |
| 250 | 525 | 428 | 378 |
| 300 | 590 | 472 | 421 |
| 350 | 651 | 514 | 465 |
| 400 | 708 | 555 | 507 |
| 500 | 820 | 618 | 575 |

*Ampacities are based on an ambient temperature of 20°C. To determine ampacities at other ambient temperatures, see Table B-7.

**Maximum voltage ratings are (1) 600 volts for S, ST, SO, and STO cords and (2) 300 volts for SJ, SJO, SJT, and SJTO cords.

SOURCE: Ethylene-Propylene- Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-68-516, National Electrical Manufactures Association Publication No. WC 8-1976.

TABLE 3 Ampacities for 2,001-15,000 volt portable power cables with insulation temperature ratings of 75°C, shielded copper conductors

| Conductor Size AWG or MCM | Ampacities* Number of Current-Carrying Conductors 1 | | 3 | |
|---|---|---|---|---|
| | 2001-5000 V | 5001-15000 V | 2001-5000 V | 5001-1500 V |
| 8 | 75 | 88 | 63 | 69 |
| 6 | 105 | 119 | 81 | 88 |
| 4 | 138 | 150 | 106 | 119 |
| 3 | 163 | 175 | 125 | 131 |
| 2 | 188 | 206 | 144 | 156 |
| 1 | 213 | 238 | 163 | 175 |
| 1/0 | 250 | 269 | 181 | 206 |
| 2/0 | 294 | 306 | 213 | 238 |
| 3/0 | 344 | 356 | 244 | 269 |
| 4/0 | 394 | 413 | 275 | 306 |
| 250 | 438 | 450 | 306 | |
| 300 | 494 | 506 | 344 | |
| 350 | 556 | 556 | 381 | |
| 400 | 600 | 606 | 406 | |
| 500 | 681 | 694 | 469 | |

*Ampacities are based on an ambient temperature of 20°C. To determine ampacities at other ambient temperatures, see Table B-7.

SOURCE: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-19-81, National Electrical Manufacturers Association Publication No. WC 3-1980.

TABLE 4 Ampacities for 0-15,000 volt portable power cables with insulation temperature ratings of 90°C, shielded copper conductors

| Conductor Size AWG or MCM | Ampacities* | | | |
|---|---|---|---|---|
| | Number of Current-Carrying Conductors | | | |
| | 1 | | 3 | |
| | 2001-8000 V | 8001-15000 V | 0-8000V | 8001-15000 V |
| 8 | | | | |
| 6 | 132 | | 110 | |
| 4 | 175 | | 144 | |
| 3 | 202 | | 165 | |
| 2 | 230 | 230 | 188 | 210 |
| 1 | 266 | 266 | 217 | 225 |
| 1/0 | 307 | 306 | 249 | 254 |
| 2/0 | 353 | 352 | 287 | 290 |
| 3/0 | 407 | 405 | 329 | 334 |
| 4/0 | 472 | 468 | 379 | 384 |
| 250 | 524 | 519 | 419 | 424 |
| 300 | 585 | 579 | 470 | |
| 350 | 648 | 641 | 513 | |
| 400 | 703 | 696 | 555 | |
| 500 | 812 | 800 | 632 | |

*Ampacities are based on an ambient temperature of 20°C. To determine ampacities at other ambient temperatures, see Table B-7.

SOURCE: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission on Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-68-516, National Electrical Manufacturers Association Publication No. WC 8-1976.

TABLE 5 Ampacities for 20001-15000 volt, three-conductor, mine power cables, shielded copper conductors

| Conductor Size AWG or MCM | Ampacities* | | | | | |
|---|---|---|---|---|---|---|
| | 2001-8000 Volts | | | 8001-15000 Volts | | |
| | 75 °C | 85 °C | 90 °C | 70 °C | 85 °C | 90 °C |
| 6 | 99 | 107 | 110 | | | |
| 4 | 130 | 139 | 144 | | | |
| 2 | 170 | 182 | 188 | 168 | 187 | 194 |
| 1 | 196 | 210 | 217 | 192 | 215 | 221 |
| 1/0 | 226 | 242 | 249 | 221 | 247 | 254 |
| 2/0 | 260 | 278 | 287 | 253 | 282 | 290 |
| 3/0 | 299 | 320 | 329 | 290 | 324 | 334 |
| 4/0 | 343 | 367 | 379 | 333 | 372 | 384 |
| 250 | 379 | 407 | 419 | 368 | 410 | 424 |
| 300 | 423 | 454 | 470 | 409 | 456 | 473 |
| 350 | 465 | 499 | 513 | 449 | 502 | 517 |
| 400 | 500 | 538 | 555 | 482 | 539 | 558 |
| 500 | 571 | 614 | 632 | 548 | 613 | 632 |

*Ampacities are based on an ambient temperature of 20 °C. To determine ampacities at other ambient temperatures, see Table B-7.

SOURCE: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-19-81, National Electrical Manufacturers Association Publication No. WC 3-1980.

Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. WC 8-1976.

TABLE 6 Ampacities for 2001-15000 volt, three-conductor mine power cables, shielded aluminum conductors

| Conductor Size AWG or MCM | Ampacities* | | | | | |
|---|---|---|---|---|---|---|
| | 2001-8000 Volts | | | 8001-15000 Volts | | |
| | 75°C | 85°C | 90°C | 70°C | 85°C | 90°C |
| 4 | 101 | 109 | 112 | | | |
| 2 | 133 | 143 | 146 | 132 | 146 | |
| 1 | 153 | 164 | | 151 | 168 | |
| 1/0 | 176 | 188 | 195 | 173 | 192 | 198 |
| 2/0 | 203 | 217 | 223 | 197 | 221 | 227 |
| 3/0 | 234 | 251 | 257 | 227 | 253 | 261 |
| 4/0 | 269 | 288 | 296 | 261 | 290 | 300 |
| 250 | 298 | 319 | 328 | 288 | 322 | 332 |
| 350 | 366 | 392 | 404 | 353 | 395 | 406 |
| 400 | 396 | 424 | 425 | 381 | 425 | 433 |
| 500 | 458 | 487 | 502 | 435 | 486 | 500 |

*Ampacities are based on an ambient temperature of 20°C. To determine ampacities at other ambient temperatures, see Table B-7.

SOURCE: Rubber-Insulated Wire are Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-19-81, National Electrical Manufacturers Association Publication No. WC 3-1980.

Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Insulated Cable Engineers Association, Publication No. S-68-516, National Electrical Manufacturers Association Publication No. WC 8-1976.

Ampacity Tables for Power Conductors,
from the National Electrical Code, 1968

Table 7 Ampacities of insulated copper conductors, single conductor in free air (based on ambient temperature of 30° C).

| Size | Temperature Rating of Conductor | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| AWG MCM | 60° C (140°F) | 75° C (167°F) | 85° C (185°F) | 90° C (194°F) | 110° C (230°F) | 125° C (257°F) | 200° C (392°F) | |
| | TYPES RUW (14-2) T TW | TYPES RH RHW, RUH (14-2), THW THWN XHHW | TYPES V MI | TYPES TA, TBS, SA, AVB, SIS, FEP, FEPB, RHH, THHN XHHW | TYPES AVA AVL | TYPES AI (14-8), AIA | TYPES A (14-8), AA FEP FEPB | Bare and Covered Conductors |
| 14 | 20 | 20 | 30 | 30 | 40 | 40 | 45 | 30 |
| 12 | 25 | 25 | 40 | 40 | 50 | 50 | 55 | 40 |
| 10 | 40 | 40 | 55 | 55 | 65 | 70 | 75 | 55 |
| 8 | 55 | 65 | 70 | 70 | 85 | 90 | 100 | 70 |
| 6 | 80 | 95 | 100 | 100 | 120 | 125 | 135 | 100 |
| 4 | 105 | 125 | 135 | 135 | 160 | 170 | 180 | 130 |
| 3 | 120 | 145 | 155 | 155 | 180 | 195 | 210 | 150 |
| 2 | 140 | 170 | 180 | 180 | 210 | 225 | 240 | 175 |
| 1 | 165 | 195 | 210 | 210 | 245 | 265 | 280 | 205 |
| 0 | 195 | 230 | 245 | 245 | 285 | 305 | 325 | 235 |
| 00 | 225 | 265 | 285 | 285 | 330 | 355 | 370 | 275 |
| 000 | 260 | 310 | 330 | 330 | 385 | 410 | 430 | 320 |
| 0000 | 300 | 360 | 385 | 385 | 445 | 475 | 510 | 370 |
| 250 | 340 | 405 | 425 | 425 | 495 | 530 | ... | 410 |
| 300 | 375 | 445 | 480 | 480 | 555 | 590 | ... | 460 |
| 350 | 420 | 505 | 530 | 530 | 610 | 655 | ... | 510 |
| 400 | 455 | 545 | 575 | 575 | 665 | 710 | ... | 555 |
| 500 | 515 | 620 | 660 | 660 | 765 | 815 | ... | 630 |
| 600 | 575 | 690 | 740 | 740 | 855 | 910 | ... | 710 |
| 700 | 630 | 755 | 815 | 815 | 940 | 1005 | ... | 780 |
| 750 | 655 | 785 | 845 | 845 | 980 | 1045 | ... | 810 |
| 800 | 680 | 815 | 880 | 880 | 1020 | 1085 | ... | 845 |
| 900 | 730 | 870 | 940 | 940 | .... | .... | ... | 905 |
| 1000 | 780 | 935 | 1000 | 1000 | 1165 | 1240 | ... | 965 |
| 1250 | 890 | 1065 | 1130 | 1130 | .... | .... | ... | .... |
| 1500 | 980 | 1175 | 1260 | 1260 | 1450 | .... | ... | 1215 |
| 1750 | 1070 | 1280 | 1370 | 1370 | .... | .... | ... | .... |
| 2000 | 1155 | 1385 | 1470 | 1470 | 1715 | .... | ... | 1405 |

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968; USAS C1-1968), National Fire Protection Association

## Ampacity Tables for Power Conductors from the National Electrical Code, 1968

Table 8 Ampacities of insulated copper conductors, not more than three conductors in raceway or cable or direct burial (based on ambient temperature of 30 °C).

| Size | Temperature Rating of Conductor. | | | | | | |
|---|---|---|---|---|---|---|---|
| AWG MCM | 60 °C (140° F) | 75° C (167° F) | 85° C (185° F) | 90° C (194° F) | 110° C (230° F) | 125° C (257° F) | 200° C (392° F) |
| | TYPES RUW (14-2), T TW | TYPES RH RHW RUH (14-2), THW THWN, XHHW THW-MTW | TYPES V MI | TYPES TA TBS, SA, AVB, SIS, FEP, FEPB, RHH THHN XHHW | TYPES AVA AVL | TYPES AI (14-8) ALA | TYPES A (14-8), AA FEP FEPB |
| 14 | 15 | 15 | 25 | 25 | 30 | 30 | 30 |
| 12 | 20 | 20 | 30 | 30 | 35 | 40 | 40 |
| 10 | 30 | 30 | 40 | 40 | 45 | 50 | 55 |
| 8 | 40 | 45 | 50 | 50 | 60 | 65 | 70 |
| 6 | 55 | 65 | 70 | 70 | 80 | 85 | 95 |
| 4 | 70 | 85 | 90 | 90 | 105 | 115 | 120 |
| 3 | 80 | 100 | 105 | 105 | 120 | 130 | 145 |
| 2 | 95 | 115 | 120 | 120 | 135 | 145 | 165 |
| 1 | 110 | 130 | 140 | 140 | 160 | 170 | 190 |
| 0 | 125 | 150 | 155 | 155 | 190 | 200 | 225 |
| 00 | 145 | 175 | 185 | 185 | 215 | 230 | 250 |
| 000 | 165 | 200 | 210 | 210 | 245 | 265 | 285 |
| 0000 | 195 | 230 | 235 | 235 | 275 | 310 | 340 |
| 250 | 215 | 255 | 270 | 275 | 315 | 335 | ... |
| 300 | 240 | 285 | 300 | 300 | 345 | 380 | ... |
| 350 | 260 | 310 | 325 | 325 | 390 | 420 | ... |
| 400 | 280 | 335 | 360 | 360 | 420 | 450 | ... |
| 500 | 320 | 380 | 405 | 405 | 470 | 500 | ... |
| 600 | 355 | 420 | 455 | 455 | 525 | 545 | ... |
| 700 | 385 | 460 | 490 | 490 | 560 | 600 | ... |
| 750 | 400 | 475 | 500 | 500 | 580 | 620 | ... |
| 800 | 410 | 490 | 515 | 515 | 600 | 640 | ... |
| 900 | 435 | 520 | 555 | 555 | ... | ... | ... |
| 1000 | 455 | 545 | 585 | 585 | 680 | 730 | ... |
| 1250 | 495 | 590 | 645 | 645 | ... | ... | ... |
| 1500 | 520 | 625 | 700 | 700 | 785 | ... | ... |
| 1750 | 545 | 650 | 735 | 735 | ... | ... | ... |
| 200 | 560 | 665 | 775 | 775 | 840 | ... | ... |

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968; USAS C-1 1968), National Fire Protection Association

Table 9 Ampacities of insulated aluminum conductors, single conductor in free air (based on ambient temperature of 30° C).

| Size | Temperature Rating of Conductor. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| AWG MCM | 60 °C (140°F) | 75° C (167°F) | 85° C (185°F) | 90° C (194°F) | 110° C (230°F) | 125° C (257°F) | 200° C (392°F) | |
| | TYPES RUW (12-2), T, TW | TYPES RH, RHW, RUH (12-2), THW THWN XHHW | TYPES V MI | TYPES TA, TBS, SA, AVB, SIS, RHH THHN XHHW | TYPES AVA, AVL | TYPES AI (12-8), AIA | TYPES A (12-8) AA | Bare and Covered Conductors |
| 12 | 20 | 20 | 30 | 30 | 40 | 40 | 45 | 30 |
| 10 | 30 | 30 | 45 | 45 | 50 | 55 | 60 | 45 |
| 8 | 45 | 55 | 55 | 55 | 65 | 70 | 80 | 55 |
| 6 | 60 | 75 | 80 | 80 | 95 | 100 | 105 | 80 |
| 4 | 80 | 100 | 105 | 105 | 125 | 135 | 140 | 100 |
| 3 | 95 | 115 | 120 | 120 | 140 | 150 | 165 | 115 |
| 2 | 110 | 135 | 140 | 140 | 165 | 175 | 185 | 135 |
| 1 | 130 | 155 | 165 | 165 | 190 | 205 | 220 | 160 |
| 0 | 150 | 180 | 190 | 190 | 220 | 240 | 255 | 185 |
| 00 | 175 | 210 | 220 | 220 | 255 | 275 | 290 | 215 |
| 000 | 200 | 240 | 255 | 255 | 300 | 320 | 335 | 250 |
| 0000 | 230 | 280 | 300 | 300 | 345 | 370 | 400 | 290 |
| 250 | 265 | 315 | 330 | 330 | 385 | 415 | ... | 320 |
| 300 | 290 | 350 | 375 | 375 | 435 | 460 | ... | 360 |
| 350 | 330 | 395 | 415 | 415 | 475 | 510 | ... | 400 |
| 400 | 355 | 425 | 450 | 450 | 520 | 555 | ... | 435 |
| 500 | 405 | 485 | 515 | 515 | 595 | 635 | ... | 490 |
| 600 | 455 | 545 | 585 | 585 | 675 | 720 | ... | 560 |
| 700 | 500 | 595 | 645 | 645 | 745 | 795 | ... | 615 |
| 750 | 515 | 620 | 670 | 670 | 775 | 825 | ... | 640 |
| 800 | 535 | 645 | 695 | 695 | 805 | 855 | ... | 670 |
| 900 | 580 | 700 | 750 | 750 | ... | ... | ... | 725 |
| 1000 | 625 | 750 | 800 | 800 | 930 | 990 | ... | 770 |
| 1250 | 710 | 855 | 905 | 905 | ... | ... | ... | ... |
| 1500 | 795 | 950 | 1020 | 1020 | 1175 | ... | ... | 985 |
| 1750 | 875 | 1050 | 1125 | 1125 | ... | ... | ... | ... |
| 2000 | 960 | 1150 | 1220 | 1220 | 1425 | ... | ... | 1165 |

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968; USAS C1-1968), National Fire Protection Association

Table 10 Ampacities of insulated aluminum conductors, not more than three conductors in raceway or cable or direct burial (based on ambient temperature of 30 ° C).

| Size | Temperature Rating of Conductor. | | | | | | |
|---|---|---|---|---|---|---|---|
| AWG MCM | 60 ° C (140 ° F) | 75 ° C (167 ° F) | 85 ° C (185 ° F) | 90 ° C (194° F) | 110 ° C (230 ° F) | 125 ° C (257° F) | 200 ° C (392 ° F) |
| | TYPES RUW (12-2), T TW | TYPES RH RHW, RUH (12-2), THW, THWN XHHW | TYPES V MI | TYPES TA, TBS, SA, AVB, SIS RUH THHN XHHW | TYPES AVA, AVL | TYPES AI (12-8), AIA | TYPES A (12-8), AA |
| 12 | 15 | 15 | 25 | 25 | 25 | 30 | 30 |
| 10 | 25 | 25 | 30 | 30 | 30 | 40 | 45 |
| 8 | 30 | 40 | 40 | 40 | 45 | 50 | 55 |
| 6 | 40 | 50 | 55 | 55 | 60 | 65 | 75 |
| 4 | 55 | 65 | 70 | 70 | 80 | 90 | 95 |
| 3 | 65 | 75 | 80 | 80 | 95 | 100 | 115 |
| 2 | 75 | 90 | 95 | 95 | 105 | 115 | 130 |
| 1 | 85 | 100 | 110 | 110 | 125 | 135 | 150 |
| 0 | 100 | 120 | 125 | 125 | 150 | 160 | 180 |
| 00 | 115 | 135 | 145 | 145 | 170 | 180 | 200 |
| 000 | 130 | 155 | 165 | 165 | 195 | 210 | 225 |
| 0000 | 155 | 180 | 185 | 185 | 215 | 245 | 270 |
| 250 | 170 | 205 | 215 | 215 | 250 | 270 | ... |
| 300 | 190 | 230 | 240 | 240 | 275 | 305 | ... |
| 350 | 210 | 250 | 260 | 260 | 310 | 335 | ... |
| 400 | 225 | 270 | 290 | 290 | 335 | 360 | ... |
| 500 | 260 | 310 | 330 | 330 | 380 | 405 | ... |
| 600 | 285 | 340 | 370 | 370 | 425 | 440 | ... |
| 700 | 310 | 375 | 395 | 395 | 455 | 485 | ... |
| 750 | 320 | 385 | 405 | 405 | 470 | 500 | ... |
| 800 | 330 | 395 | 415 | 415 | 485 | 520 | ... |
| 900 | 355 | 425 | 455 | 455 | ... | ... | ... |
| 1000 | 375 | 445 | 480 | 480 | 560 | 600 | ... |
| 1250 | 405 | 485 | 530 | 530 | ... | ... | ... |
| 1500 | 435 | 520 | 580 | 580 | 650 | ... | ... |
| 1750 | 455 | 545 | 615 | 615 | ... | ... | ... |
| 2000 | 470 | 560 | 650 | 650 | 705 | ... | ... |

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968; USAS C1-1968), National Fire Protection Association

TABLE # 11

E
NL = NO LOAD VOLTAGE

E
L = LOAD VOLTAGE

I
TEST = TEST CURRENT

R
T = TOTAL RESISTANCE OF TRACK AND TROLLEY

I
SC = SHORT CIRCUIT CURRENT

**EXAMPLE FORMULA # 1**

$$\frac{E_{NL} - E_{L}}{I_{TEST}} = R_{T} \qquad \frac{300v - 250v}{300a} = \frac{50v}{300a} = 0.16$$

$$I_{SC} = \frac{E_{NL}}{R_{T}} = \frac{300a}{0.16} \quad 1875a \times 75\% = 1406a$$

The interrupting device should be set at no more than 1406 amps.

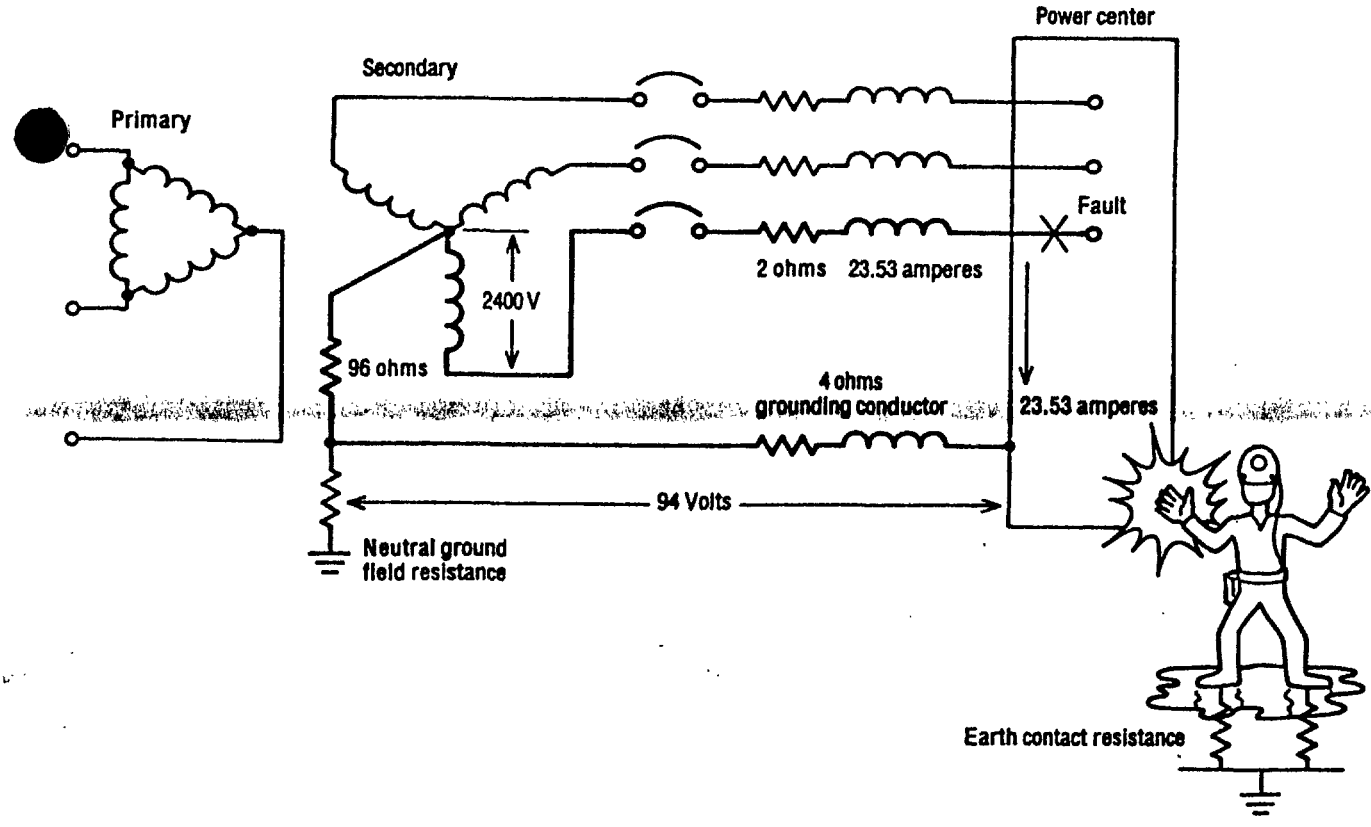
**EXAMPLE FORMULA # 2**

$$\frac{E_{NL} \times I_{TEST}}{E_{NL} - E_{L}} = I_{SC} \qquad \frac{300v \times 300a}{300v - 250v} = \frac{90000w}{50v} = 1800a$$

75% of 1800a = 1350a

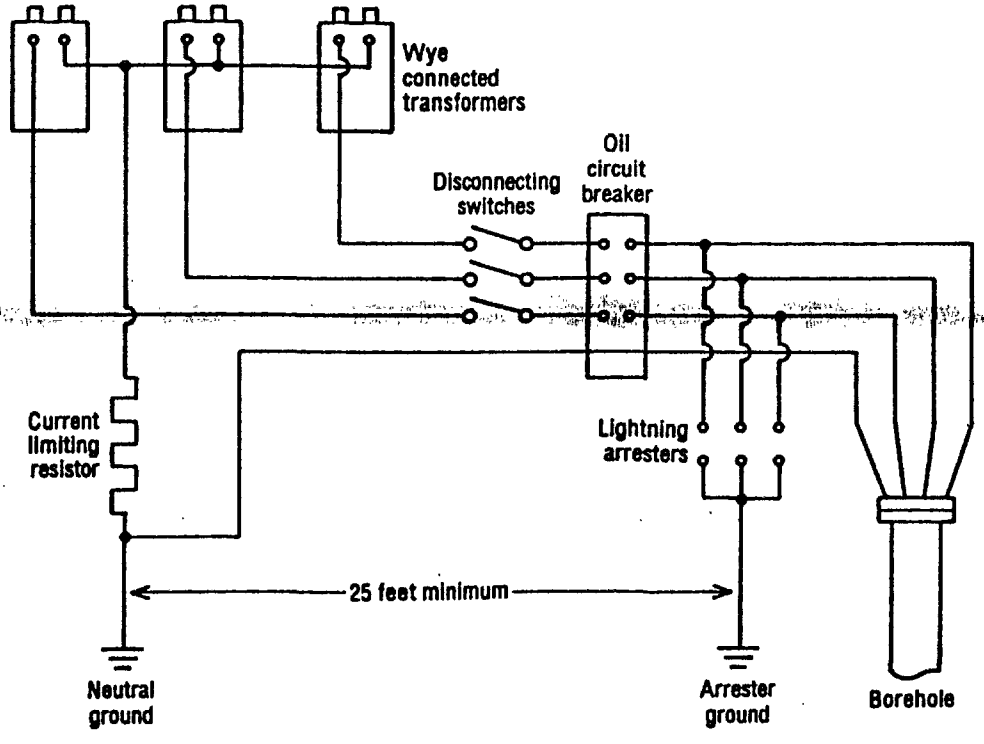
The interrupting device should be set at no more than 1350 amps.

DRAWING NUMBER 1



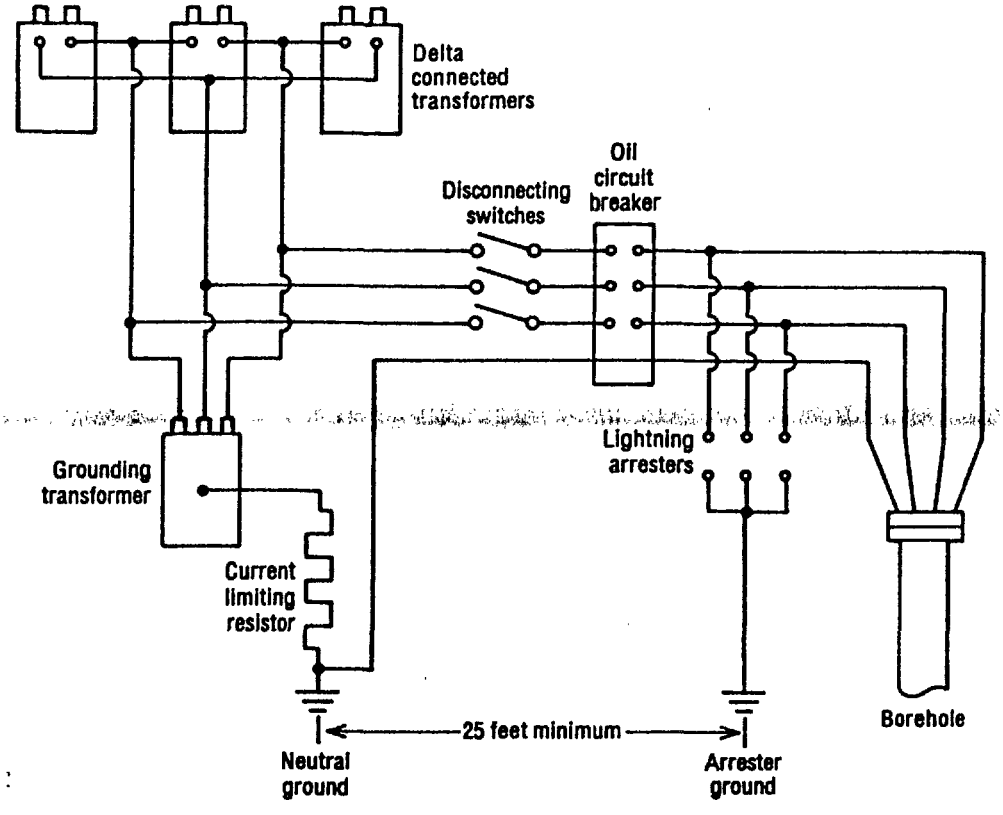

Touch potential of resistance grounded system under fault conditions.

DRAWING NUMBER 2




- Wye-connected power system with current-limiting resistor.

DRAWING NUMBER 3




Delta-connected power system with grounding transformer and current-limiting resistor.

DRAWING NUMBER 4

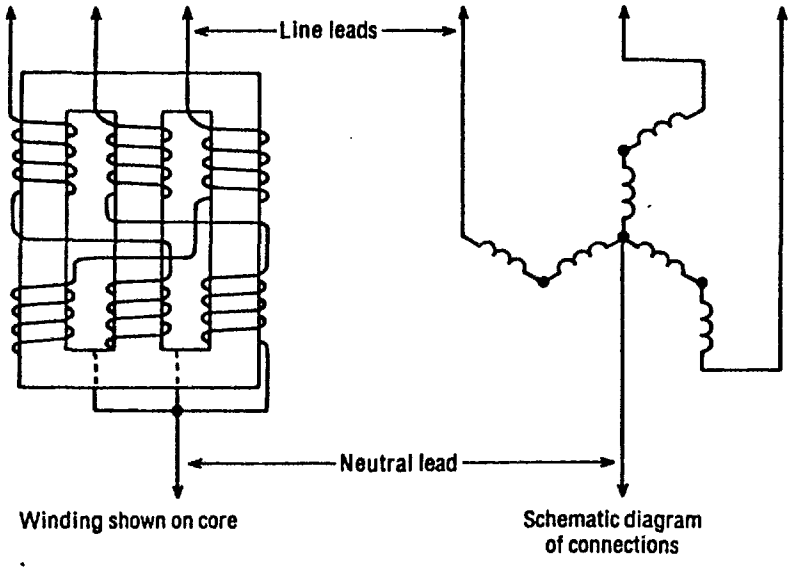



Figure 28. - Zigzag three-phase grounding transformer.

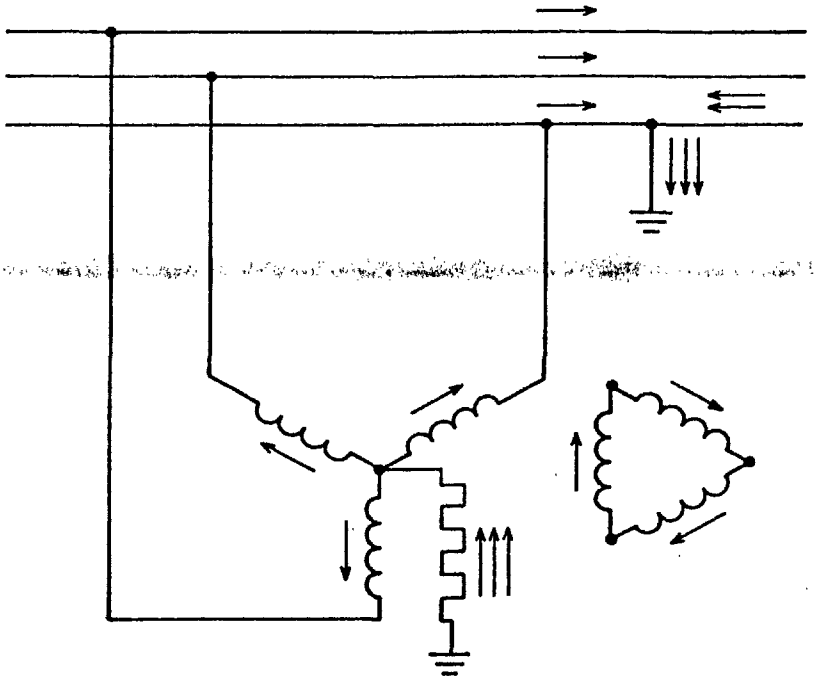
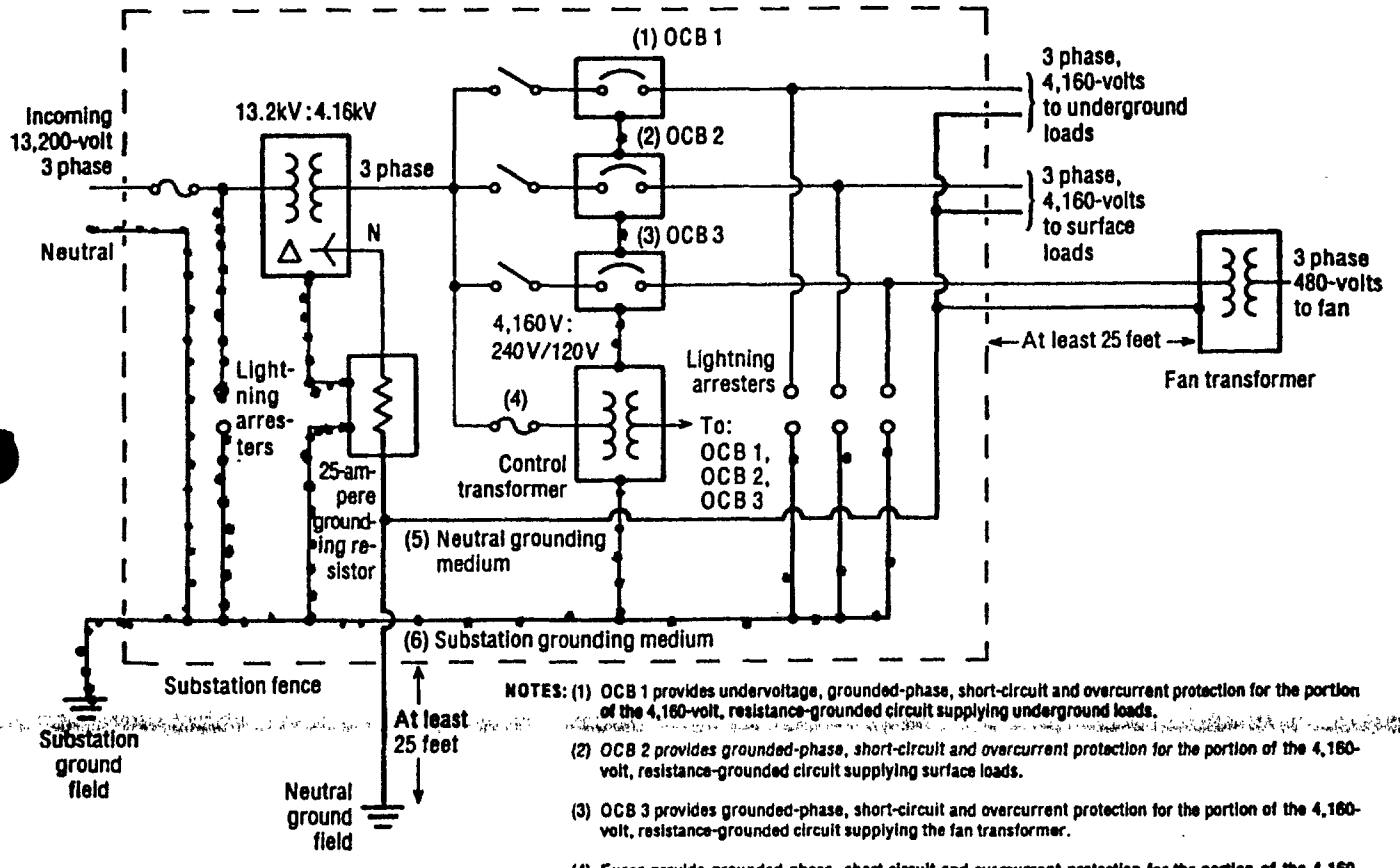


Figure 29. Connections and current distribution in a wye-delta grounding transformer.

DRAWING NUMBER 5




NOTES: (1) OCB 1 provides undervoltage, grounded-phase, short-circuit and overcurrent protection for the portion of the 4,160-volt, resistance-grounded circuit supplying underground loads.

(2) OCB 2 provides grounded-phase, short-circuit and overcurrent protection for the portion of the 4,160-volt, resistance-grounded circuit supplying surface loads.

(3) OCB 3 provides grounded-phase, short-circuit and overcurrent protection for the portion of the 4,160-volt, resistance-grounded circuit supplying the fan transformer.

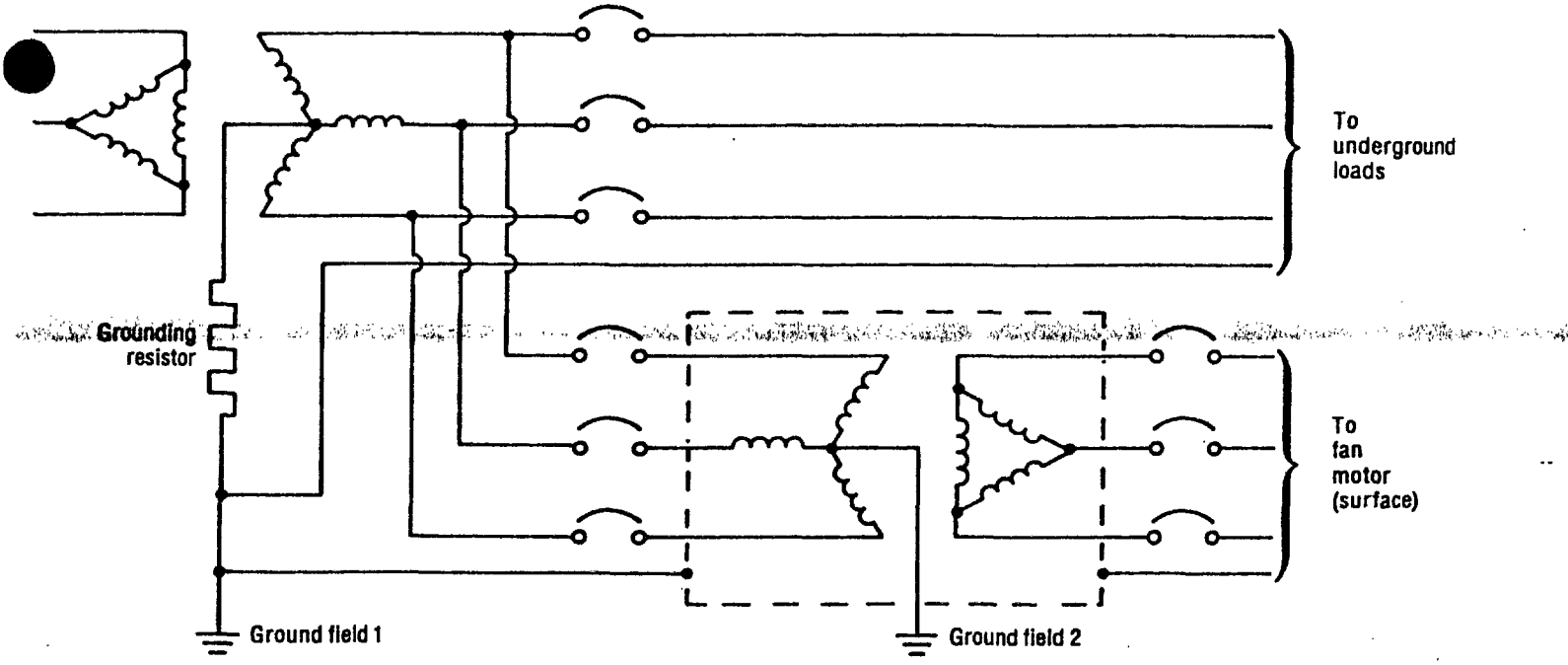
(4) Fuses provide grounded-phase, short-circuit and overcurrent protection for the portion of the 4,160-volt, resistance-grounded circuit supplying the 4,160V:240V/120V control transformer in the substation. The maximum fuse size is 5 amperes (20% x 25 amperes).

(5) The metallic frames, supporting structures and enclosures of all electric equipment and conductors supplied from the 4,160-volt, resistance-grounded circuit and located outside of the substation are grounded to the neutral grounding medium.

(6) The metallic frames, supporting structures and enclosures of all electric equipment and conductors in the substation, including the substation fence, are solidly grounded to the substation grounding medium.

One-line diagram showing grounding and grounded-phase protection requirements for a high-voltage resistance grounded circuit supplying both surface and underground loads.

DRAWING NUMBER 6




An unacceptable ground fault configuration. This system <u>will not</u> comply since fault current will flow through the second neutral (connected to ground field 2), effectively shorting out the grounding resistor during fault conditions.

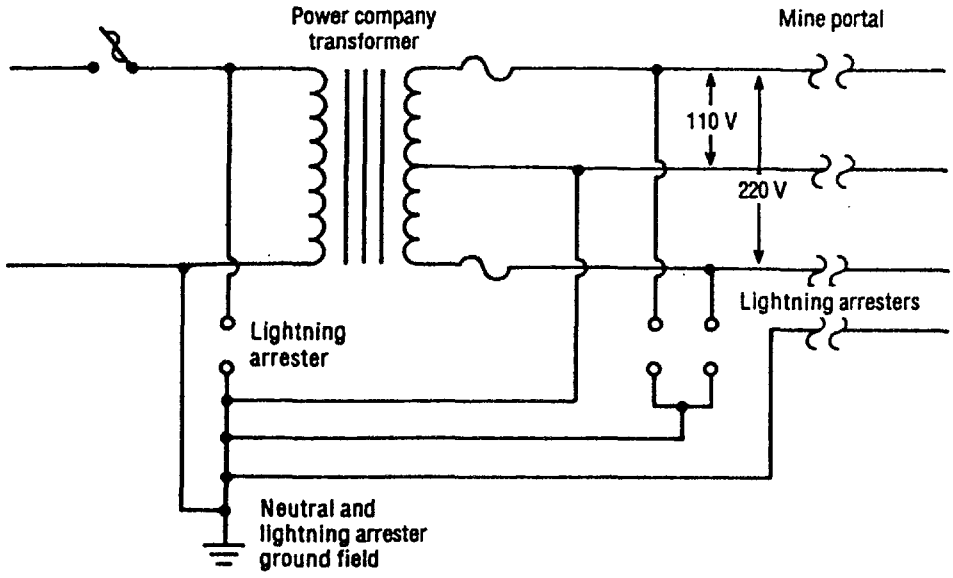



Figure 7. - Unacceptable lightning arresters for single-phase circuits. Single-phase circuits, such as the one shown above, are not acceptable to supply power to underground loads since the neutral and lightning arrester grounds are not separated by at least 25 feet.

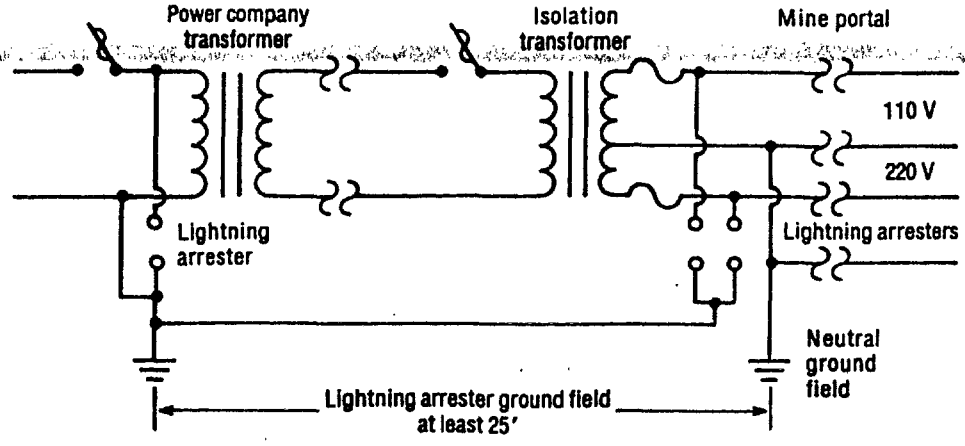



Figure 8. - Acceptable lightning arresters for single-phase circuits. This circuit, with an isolation transformer installed, is acceptable since the neutral and lightning arrester grounds are separated by at least 25 feet.

STATE OF WEST VIRGINIA
DEPARTMENT OF ENERGY
DIVISION OF MINES AND MINERALS

---

GUIDELINES FOR GROUND MONITOR SYSTEM WAIVER - A.C. AND D.C.
In Lieu of Chapter 22A, Article 2, Section 40(43)

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CHAPTER 22A, ARTICLE 2, SECTION 40(43) PROVIDES:

Except where waived by the director, 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, and on or before the first day of January, One Thousand Nine Hundred and Seventy-Eight, shall have a ground monitoring system.

The following guidelines shall govern waiver of the grounding and ground monitoring requirements by the director.

I. DEFINITIONS --

"Low-Resistance Ground Field" constructed of electrodes, buried metallic piping system, metal framework of a building, well or borehole casing, steel piling or other buried metallic materials having a total resistance to ground of not more than 5 ohms. Low-resistance grounding fields shall be measured at the time of installation and at least annually therafter to insure that a sufficiently low-resistance to ground has been achieved and is being maintained. The results of such measurements shall be recorded and made available to an authorized representative of the Department of Energy.

"Ground-Fault Indicator" means a device to provide ground fault indication for an ungrounded circuit. Ground-fault indicators shall be adjusted to give a visual indication when the line-to-ground voltage on any power conductor decreases to less than 30 percent of the nominal system voltage for a circuit supplied power from a three phase system, or less than 50 percent of the nominal voltage for a circuit supplied power from a single phase system.

"Ground-Check Circuit" device to insure a safe dependable path for fault current which will cause the circuit breaker to open:

(a) If a ground check conductor is used, when the ground check conductor is broken; or
(b) If no ground check conductor is used, then the ground wire is broken at any point in the grounding circuit.

However, where low resistance parallel paths for fault current and monitoring current are present, then ground check circuit will be acceptable if it is designed to open the circuit breaker when the impedance of the grounding circuit increases beyond the amount necessary to cause a 40-volt drop in the grounding circuit external to the grounding resistor under fault conditions in low and medium voltage circuits or a 100 volt drop in the grounding circuit external to the grounding resistor under fault conditions in high voltage circuits.

II. PORTABLE AND MOBILE THREE PHASE EQUIPMENT --

All three phase circuits extending to low, medium, and high voltage portable and mobile equipment shall be provided with a ground check circuit for the grounding conductor pursuant to Chapter 22A, Article 2, Section 40, Subsections (61) and (73).

III. STATIONARY THREE PHASE EQUIPMENT --

All stationary three phase equipment shall comply with the provisions of Chapter 22A, Article 2, Section (40)43 unless a waiver is granted by the Director of the Department of Energy. A Waiver will be granted on a mine-by-mine basis upon application to the Director if one of the following methods is used:

A. UNGROUNDED SYSTEMS

1. Low, Medium, and High Voltage Circuits

A grounding conductor one-half the size of the power conductors shall originate from a low resistance ground field at the power source. Such grounding conductor shall be connected to the metallic frames and enclosures of the power source and shall extend along with the power conductors as a grounding circuit for the metallic frames and other metallic enclosures of all stationary equipment receiving power from the system. The grounding conductor shall also be connected to a low resistance ground field(s) at the service equipment for buildings and other stationary installations. Such circuits shall be provided with a ground fault indicator located at a location monitored by a competent person, and a ground fault shall not be allowed to exist for more than 24 hours.

2. High Voltage Circuits

When earth is used as a grounding conductor for the metal frames and enclosures of stationary equipment, the interrupting time of the circuit breaker or fuses and the design of the ground grid shall be in accordance with the Institute of Electrical and Electronics Engineers (IEEE), No. 80-1972, "Guide for Safety in Alternating Current Substation Grounding." A professional engineer shall certify that the ground grids and circuit protection are installed in accordance with said standard.

3. High Voltage Circuits

Circuits being supplied power from an ungrounded system shall be protected by a circuit breaker equipped with a device to provide ground fault protection when one phase becomes grounded. The device shall cause the circuit breaker to trip when the line-to-ground voltage on any power conductor decreases to less than 30 percent of the nominal system voltage for a circuit supplied power from a three phase system. Low resistance ground fields shall be installed and maintained at the source transformers and service equipment installations. The ground fields shall have sufficiently low impedance to facilitate opening the circuit breaker under fault conditions. The grounding conductors, metal frames and enclosures of the source transformers and service and utilization equipment shall be connected to the respective ground field.

4. Low, Medium, and High Voltage Circuits

Systems shall be installed in accordance with the recommendations set forth in the National Electric Code which is in effect at the time of installation. Existing systems installed according to the "1968" dated National Electric Code may also be accepted. The Director of the Department of Energy shall have jurisdiction over enforcement of the Code and will have responsibility for making interpretations of its rule.

B. GROUNDED SYSTEMS

1. Low, Medium, and High Voltage Circuits

Equipment receiving power from a grounded power system shall be protected by a circuit breaker equipped with devices to provide ground fault tripping for the circuit. Low resistance

ground field shall be installed at the source transformers and each service equipment installation. A grounding conductor shall originate from the ground field at the source transformers and serve as a grounding circuit for the metal frames and enclosures of all equipment receiving power from the circuit. The grounding conductor shall also be connected to a low resistance ground field at each service equipment installation.

2. Low, Medium, and High Voltage Circuits

Systems shall be installed in accordance with the recommendations set forth in the National Electric Code which is in effect at the time of installation. Existing systems installed according to the "1968" dated National Electrical Code may be accepted. The Director of the Department of Energy shall have jurisdiction over enforcement of the Code and will have responsibility for making interpretations of its rules.

3. High Voltage Circuits

When earth is used as a grounding conductor for the metal frames and enclosures of stationary equipment, the interrupting time of the circuit breaker of fuses and the design of the ground grid shall be in accordance with the Institute of Electrical and Electronics Engineers (IEEE) No. 80-1971 "Guide for Safety in Alternating Current Substation Grounding". A professional engineer shall certify that the ground grids and circuit protection are installed in accordance with said standards.

IV. PORTABLE, MOBILE, AND STATIONARY SINGLE PHASE EQUIPMENT --

All portable, mobile, and stationary single phase equipment shall comply with the provisions of Chapter 22A, Article 2, Section 40(43), unless a waiver is granted by the Director of the Department of Energy. A Waiver will be granted upon application thereof which sets forth a positive program that will assure continuity of the grounding circuit. Criteria for acceptance shall be as follows:

1. Double Grounding (separate connections);

2. UL Approved Double Insulated;

3. GFCI (Ground Fault Circuit Interrupter);

4. Compliance with National Electrical Code in effect at time of installation; or

5. Any Other No Less Effective Approved Method.

V. PORTABLE, MOBILE, AND STATIONARY D.C. EQUIPMENT --

Temporary waivers will be granted for monitoring D.C. Ground Circuits upon request by a mine operator until effective systems for conducting such monitoring have been developed and are commercially available.

VI. PREPARATION PLANTS --

Where not already provided for above, in preparation plants, shops, and other metal structure installations, the metal frames and enclosures of electric equipment shall have two separate grounding connections to the grounding medium (Double-Grounded). In addition, where flexible conduit is used as part of the grounding circuit, shunts shall be installed to bridge the flexible conduit.

Appendix D---Full-load currents in amperes, direct-current motors

Table D-1. Full-load currents in amperes, direct-current motors

The following values of full-load currents are for motors running at base speed

| HP | 120V | 240V |
|---|---|---|
| 1/4 | 2.9 | 1.5 |
| 1/3 | 3.6 | 1.8 |
| 1/2 | 5.2 | 2.6 |
| 3/4 | 7.4 | 3.7 |
| 1 | 9.4 | 4.7 |
| 11/2 | 13.2 | 6.6 |
| 2 | 17 | 8.5 |
| 3 | 25 | 12.2 |
| 5 | 40 | 20 |
| 71/2 | 58 | 29 |
| 10 | 76 | 38 |
| 15 | | 55 |
| 20 | | 72 |
| 25 | | 89 |
| 30 | | 100 |
| 40 | | 140 |
| 50 | | 173 |
| 60 | | 206 |
| 75 | | 255 |
| 100 | | 341 |
| 125 | | 425 |
| 150 | | 506 |
| 200 | | 675 |

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968 USAS C1-1968), National Fire Protection Association

Table D-2. Full-load currents in amperes, single-phase alternating-current motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. Motors built for especially low speeds or high torques may have higher full-load currents, and multispeed motors will have full load current varying with speed, in which case the name plate current ratings shall be used

To obtain full-load currents of 208-and 200-volt motors, increase corresponding 230-volt motor fullload currents by 10 and 15 per cent, respectively.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120 and 220 to 240.

| HP | 115V | 230V |
|---|---|---|
| 1/6 | 4.4 | 2.2 |
| 1/4 | 5.8 | 2.9 |
| 1/3 | 7.2 | 3.6 |
| 1/2 | 9.8 | 4.9 |
| 3/4 | 13.8 | 6.9 |
| 1 | 16 | 8 |
| 11/2 | 20 | 10 |
| 2 | 24 | 12 |
| 3 | 34 | 17 |
| 5 | 56 | 28 |
| 71/2 | 80 | 40 |
| 10 | 100 | 50 |

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968; USAS C1-1968), National Fire Protection Association

Table D-3. Full-load currents in amperes, three-phase alternating-current motors

| | Induction Type Squirrel-Cage and Wound Rotor Amperes | | | | | Synchronous Type †Unity Power Factor Amperes | | | |
|---|---|---|---|---|---|---|---|---|---|
| HP | 115V | 230V | 460V | 575V | 2300V | 220V | 440V | 550V | 2300V |
| 1/2 | 4 | 2 | 1 | .8 | | | | | |
| 3/4 | 5.6 | 2 | 1.4 | 1.1 | | | | | |
| 1 | 7.2 | 3.6 | 1.8 | 1.4 | | | | | |
| 11/2 | 10.4 | 5.2 | 2.6 | 2.1 | | | | | |
| 2 | 13.6 | 6.8 | 3.4 | 2.7 | | | | | |
| 3 | | 9.6 | 4.8 | 3.9 | | | | | |
| 5 | | 15.2 | 7.6 | 6.1 | | | | | |
| 71/2 | | 22 | 11 | 9 | | | | | |
| 10 | | 28 | 14 | 11 | | | | | |
| 15 | | 42 | 21 | 17 | | | | | |
| 20 | | 54 | 27 | 22 | | | | | |
| 25 | | 68 | 34 | 27 | | 54 | 27 | 22 | |
| 30 | | 80 | 40 | 32 | | 65 | 33 | 26 | |
| 40 | | 104 | 52 | 41 | | 86 | 43 | 35 | |
| 50 | | 130 | 65 | 52 | | 108 | 54 | 44 | |
| 60 | | 154 | 77 | 62 | 16 | 128 | 64 | 51 | 12 |
| 75 | | 192 | 96 | 77 | 20 | 161 | 81 | 65 | 15 |
| 100 | | 248 | 124 | 99 | 26 | 211 | 106 | 85 | 20 |
| 125 | | 312 | 156 | 125 | 31 | 264 | 132 | 106 | 25 |
| 150 | | 360 | 180 | 144 | 37 | | 158 | 127 | 30 |
| 200 | | 480 | 240 | 192 | 49 | | 210 | 168 | 40 |

For full-load currents of 208- and 200-volt motors, increase the corresponding 230 volt motor full-load current by 10 and 15 per cent, respectively.

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full-load current varying with speed, in which case the nameplate current rating shall be used.

*For 90 and 8- per cent P. F. the above figures shall be multiplied by 1.1 and 1.25 respectively.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120, 220 to 240, 440 to 480 and 550 to 600 volts.

SOURCE: National Electrical Code, 1968 Edition, (NFPA No. 70-1968; USAS C1-1968), National Fire Protection Association

## APPENDIX E -- Minimum Requirements for Short-Circuit and Overload Protection for Motors and Motor Circuit Conductors

Table E-1. - Motor and circuit protection, 110- to 120-volt single-phase motors

| HP | Full Load Current of Motor | *Minimum Size of Power Conductor (AWG) | Minimum Size of Ground Conductor (AWG) | **Instantaneous Branch Circuit Protection, 700% of Motor Full Load Current | Maximum Thermal Motor Running Protection |
|---|---|---|---|---|---|
| 1/4 | 5.8 | 14 | 14 | 41 amp | 8 amp |
| 1/3 | 7.2 | 14 | 14 | 51 amp | 9 amp |
| 1/2 | 9.8 | 14 | 14 | 69 amp | 13 amp |
| 3/4 | 13.8 | 14 | 14 | 97 amp | 18 amp |
| 1 | 16 | 14 | 14 | 112 amp | 20 amp |
| 1-1/2 | 20 | 12 | 12 | 140 amp | 25 amp |
| 2 | 24 | 10 | 10 | 168 amp | 30 amp |
| 3 | 34 | 10 | 10 | 238 amp | 43 amp |
| 5 | 56 | 8 | 8 | 392 amp | 70 amp |
| 7-1/2 | 80 | 6 | 9 | 560 amp | 100 amp |
| 10 | 100 | 4 | 7 | 700 amp | 125 amp |

* Based on 75° C insualtion, 20° C ambient temperature, single copper conductor in free air.

**The setting of an instantaneous trip circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 1300 percent of the motor full-load current.

Table E-2. -- Motor and circuit protection, 200- to 240-volt single-phase motors

| HP | Full Load Current of Motor | *Minimum Size of Power Conductor (AWG) | Minimum Size of Ground Conductor (AWG) | **Instantaneous Branch Circuit Protection, 700% of Motor Full Load Current | Maximum Thermal Motor Running Protection |
|---|---|---|---|---|---|
| 1/4 | 2.9 | 14 | 14 | 21 amp | 4 amp |
| 1/3 | 3.6 | 14 | 14 | 26 amp | 5 amp |
| 1/2 | 4.9 | 14 | 14 | 35 amp | 7 amp |
| 3/4 | 6.9 | 14 | 14 | 49 amp | 9 amp |
| 1 | 8 | 14 | 14 | 56 amp | 10 amp |
| 1-1/2 | 10 | 14 | 14 | 70 amp | 13 amp |
| 2 | 12 | 14 | 14 | 84 amp | 15 amp |
| 3 | 17 | 14 | 14 | 119 amp | 22 amp |
| 5 | 28 | 10 | 10 | 196 amp | 35 amp |
| 7-1/2 | 40 | 8 | 8 | 280 amp | 50 amp |
| 10 | 50 | 8 | 8 | 350 amp | 63 amp |

* Based on 75°C insulation, 20°C ambient temperature, single copper conductor in free air.

** The setting of an instantaneous trip circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 1300 percent of the motor full-load current.

Table E-3. Motor and circuit protection, 220- to 240- volt three-phase motors

| HP | Full Load Current of Motor | Minimum Cable Size (AWG) | | | *Instantaneous Branch Circuit Protection, 700% of Motor Full Load Current | **Inverse Time Breaker Rating |
|---|---|---|---|---|---|---|
| | | Portable Cord | 75 °C Portable Cable | 90° C Portable Cable | | |
| 1 | 3.6 | 18 | --- | --- | 26 amp | -- |
| 1-1/2 | 5.2 | 18 | --- | --- | 37 amp | 15 |
| 2 | 6.8 | 16 | --- | --- | 48 amp | 20 |
| 3 | 9.6 | 14 | --- | --- | 68 amp | 25 |
| 5 | 15.2 | 12 | --- | --- | 107 amp | 40 |
| 7-1/2 | 22 | 10 | --- | --- | 154 amp | 60 |
| 10 | 28 | 8 | --- | --- | 196 amp | 70 |
| 15 | 42 | --- | 8 | 8 | 294 amp | 110 |
| 20 | 54 | --- | 6 | 8 | 378 amp | 150 |
| 25 | 68 | --- | 4 | 6 | 476 amp | 175 |
| 30 | 80 | --- | 4 | 4 | 560 amp | 200 |
| 40 | 104 | --- | 2 | 3 | 728 amp | 300 |
| 50 | 130 | --- | 1 | 2 | 910 amp | 350 |
| 60 | 154 | --- | 2/0 | 1/0 | 1,078 amp | 400 |
| 75 | 192 | --- | 3/0 | 2/0 | 1,344 amp | 500 |
| 100 | 248 | --- | 300 MCM | 4/0 | 1,736 amp | 700 |

Note:

*The setting of an instantaneous trip circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 1300 percent of the motor full load current.

**The rating of an inverse time circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 400 percent of the motor full-load current.

Table E-5. Motor and circuit protection, 550- to 600-volt three-phase motors

| HP | Full Load Current of Motor | Minimum Cable Size (AWG) | | | *Instantaneous Breaker Setting | **Inverse Time Breaker Rating |
|---|---|---|---|---|---|---|
| | | Portable Cord | 75 °C Portable Cable | 90 °C Portable Cable | | |
| 1 | 1.4 | 18 | -- | -- | 10 amp | --- |
| 1-1/2 | 2.1 | 18 | -- | -- | 15 amp | --- |
| 2 | 2.7 | 18 | -- | -- | 19 amp | --- |
| 3 | 3.9 | 18 | -- | -- | 28 amp | 15 |
| 5 | 6.1 | 16 | -- | -- | 43 amp | 20 |
| 7-1/2 | 9 | 14 | -- | -- | 63 amp | 25 |
| 10 | 11 | 14 | -- | -- | 77 amp | 30 |
| 15 | 17 | 10 | -- | -- | 119 amp | 50 |
| 20 | 22 | 10 | -- | -- | 154 amp | 60 |
| 25 | 27 | 8 | -- | -- | 189 amp | 70 |
| 30 | 32 | 6 | -- | -- | 224 amp | 80 |
| 40 | 41 | 4 | 8 | -- | 287 amp | 110 |
| 50 | 52 | 2 | 6 | 8 | 364 amp | 150 |
| 60 | 62 | 2 | 6 | 6 | 434 amp | 175 |
| 75 | 77 | --- | 4 | 4 | 539 amp | 200 |
| 100 | 99 | --- | 3 | 3 | 693 amp | 250 |
| 125 | 125 | --- | 1 | 2 | 875 amp | 350 |
| 150 | 144 | --- | 1/0 | 1 | 1,008 amp | 400 |
| 200 | 192 | --- | 3/0 | 2/0 | 1,344 amp | 500 |

*The setting of an instantaneous trip circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 1300 percent of the motor full load current.

**The rating of an inverse time circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 400 percent of the motor full-load current.

Table E-4. Motor and circuit protection, 440- to 480-volt three-phase motors

| HP | Full Load Current of Motor | Minimum Cable Size (AWG) | | | *Instantaneous Branch Circuit Protection, 700% of Motor Full Load Current | **Inverse Time Breaker Rating |
|---|---|---|---|---|---|---|
| | | Portable Cord | 75 ° C Portable Cable | 90 ° C Portable Cable | | |
| 1 | 1.8 | 18 | --- | --- | 13 amp | -- |
| 1-1/2 | 2.6 | 18 | --- | --- | 19 amp | -- |
| 2 | 3.4 | 18 | --- | --- | 24 amp | -- |
| 3 | 4.8 | 18 | --- | --- | 34 amp | 15 |
| 5 | 7.6 | 16 | --- | --- | 54 amp | 20 |
| 7-1/2 | 11 | 14 | --- | --- | 77 amp | 30 |
| 10 | 14 | 12 | --- | --- | 98 amp | 35 |
| 15 | 21 | 10 | --- | --- | 147 amp | 60 |
| 20 | 27 | 8 | --- | --- | 189 amp | 70 |
| 25 | 34 | 6 | --- | --- | 238 amp | 90 |
| 30 | 40 | 4 | 8 | --- | 280 amp | 100 |
| 40 | 52 | 2 | 6 | 8 | 364 amp | 150 |
| 50 | 65 | -- | 6 | 6 | 455 amp | 175 |
| 60 | 77 | -- | 4 | 4 | 539 amp | 200 |
| 75 | 96 | -- | 3 | 4 | 672 amp | 250 |
| 100 | 124 | -- | 1 | 2 | 868 amp | 350 |
| 125 | 156 | -- | 2/0 | 1/0 | 1092 amp | 400 |
| 150 | 180 | -- | 3/0 | 2/0 | 1260 amp | 450 |
| 200 | 240 | -- | 250 MCM | 4/0 | 1680 amp | 600 |

Note:

*The setting of an instanteaneous trip circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 1300 percent of the motor full load current.

**The rating of an inverse time circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 400 percent of the motor full-load current.

Table E-6. Motor and circuit protection, 230- to 250-volt direct-current motor

| HP | Full Load Current | Minimum Cable Size (AWG) | | | Maximum Branch Circuit Protection | | |
|---|---|---|---|---|---|---|---|
| | | Portable Cord | 75 °C Portable Cable | 90 °C Portable Cable | Fuse Rating | Instantaneous Breaker Setting | Inverse Time Breaker |
| 1/4 | 1.5 | 18 | -- | -- | 2.25 | 4 | -- |
| 1/2 | 2.6 | 18 | -- | -- | 4 | 7 | -- |
| 3/4 | 3.7 | 18 | -- | -- | 6.25 | 10 | -- |
| 1 | 4.7 | 18 | -- | -- | 8 | 12 | 15 |
| 1-1/2 | 6.6 | 18 | -- | -- | 10 | 17 | 15 |
| 2 | 8.5 | 16 | -- | -- | 15 | 22 | 15 |
| 3 | 12.2 | 14 | -- | -- | 20 | 31 | 20 |
| 5 | 20 | 12 | -- | -- | 30 | 50 | 30 |
| 7-1/2 | 29 | 8 | -- | -- | 45 | 73 | 45 |
| 10 | 38 | 6 | 8 | -- | 60 | 95 | 60 |
| 15 | 55 | 4 | 6 | 8 | 90 | 138 | 90 |
| 20 | 72 | 2 | 4 | 6 | 110 | 180 | 110 |
| 25 | 89 | -- | 4 | 6 | 150 | 223 | 150 |
| 30 | 106 | -- | 2 | 4 | 175 | 265 | 175 |
| 40 | 140 | -- | 1 | 2 | 225 | 350 | 225 |
| 50 | 173 | -- | 2/0 | 1 | 300 | 433 | 300 |
| 60 | 206 | -- | 3/0 | 1/0 | 350 | 361 | 350 |
| 75 | 255 | -- | 4/0 | 3/0 | 400 | 447 | 400 |
| 100 | 341 | -- | 400 MCM | 200 MCM | 600 | 597 | 600 |
| 125 | 425 | -- | 2-3/0 | 400 MCM | 700 | 744 | 700 |
| 150 | 506 | -- | 2-4/0 | 2-3/0 | 800 | 886 | 800 |
| 200 | 675 | -- | 2-400 MCM | 2-250 MCM | 1000 | 1182 | 1000 |

*The setting of an instantaneous trip circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 1300 percent of the motor full-load current.

**The rating of a fuse or inverse time circuit breaker may be increased above these values to allow proper starting of the motor but shall in no case exceed 400 percent of the motor full-load current.

## APPENDIX H -- Continuous Ampere Ratings and Magnetic Trip Ranges Adjustment Positions for Common Molded Case Circuit Breakers

Table H-1. Continuous ampere ratings and magnetic trip ranges/adjustment postitions for Westinghouse standard front-adjustable magnetic-only circuit breakers

| Breaker Type | Continuous Rating Amps | Magnetic Trip Range/Adjustment Positions Low to High | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | High |
| FB | 3 | 7 | 8 | 8.5 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 18 | 19 | 20 | 22 |
| FB | 5 | 15 | 17 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 33 | 36 | 39 | 42 | 45 |
| FB | 10 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 80 | 85 | 90 | 100 | 105 | 110 |
| FB | 25 | 32 | 35 | 39 | 43 | 47 | 50 | 54 | 58 | 62 | 65 | 69 | 73 | 76 | 80 |
| FB | 25 | 66 | 75 | 80 | 85 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 165 | 175 | 190 |
| FB | 30 | 50 | 56 | 65 | 72 | 80 | 90 | 96 | 105 | 110 | 120 | 125 | 135 | 140 | 150 |
| FB | 30 | 90 | 100 | 110 | 115 | 125 | 140 | 155 | 170 | 185 | 200 | 215 | 230 | 250 | 270 |
| FB | 50 | 66 | 75 | 80 | 85 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 165 | 175 | 190 |
| FB | 50 | 160 | 180 | 195 | 210 | 230 | 250 | 285 | 320 | 350 | 380 | 405 | 430 | 455 | 480 |
| FB | 70 | 100 | 110 | 125 | 140 | 150 | 165 | 175 | 190 | 205 | 215 | 230 | 245 | 255 | 270 |
| FB | 100 | 150 | 170 | 190 | 205 | 225 | 250 | 285 | 320 | 350 | 380 | 405 | 430 | 455 | 480 |
| FB | 100 | 450 | 500 | 540 | 580 | 625 | 670 | 750 | 825 | 900 | 1000 | 1125 | 1250 | 1400 | 1550 |
| FB | 150 | 575 | 650 | 700 | 750 | 825 | 900 | 1050 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 |
| JB-KB | 250 | 350 | 400 | 440 | 480 | 525 | 560 | 610 | 660 | .... | .... | .... | .... | .... | 700 |
| JB-KB | 250 | 625 | 700 | 780 | 860 | 940 | 1020 | 1050 | 1170 | .... | .... | .... | .... | .... | 1250 |
| JB-KB | 250 | 750 | 850 | 930 | 1030 | 1125 | 1210 | 1300 | 1400 | .... | .... | .... | .... | .... | 1500 |
| JB-KB | 250 | 875 | 980 | 1100 | 1200 | 1300 | 1400 | 1500 | 1640 | .... | .... | .... | .... | .... | 1750 |
| JB-KB | 250 | 1125 | 1290 | 1425 | 1560 | 1700 | 1840 | 1980 | 2115 | .... | .... | .... | .... | .... | 2250 |
| JB-KB | 250 | 1250 | 1400 | 1560 | 1720 | 1880 | 2040 | 2100 | 2340 | .... | .... | .... | .... | .... | 2500 |
| LBB-LB | 400 | 350 | 400 | 440 | 480 | 525 | 560 | 610 | 660 | .... | .... | .... | .... | .... | 700 |
| LBB-LB | 400 | 625 | 700 | 780 | 860 | 940 | 1020 | 1050 | 1170 | .... | .... | .... | .... | .... | 1250 |
| LBB-LB | 400 | 750 | 850 | 930 | 1030 | 1125 | 1210 | 1300 | 1400 | .... | .... | .... | .... | .... | 1500 |
| LBB-LB | 400 | 875 | 980 | 1100 | 1200 | 1300 | 1400 | 1500 | 1640 | .... | .... | .... | .... | .... | 1750 |
| LBB-LB | 400 | 1125 | 1290 | 1425 | 1560 | 1700 | 1840 | 1980 | 2115 | .... | .... | .... | .... | .... | 2250 |
| LBB-LB | 400 | 1500 | 1690 | 1875 | 2065 | 2250 | 2440 | 2630 | 2815 | .... | .... | .... | .... | .... | 3000 |
| LBB-LB | 400 | 2000 | 2250 | 2500 | 2750 | 3000 | 3250 | 3500 | 3750 | .... | .... | .... | .... | .... | 4000 |
| LA | 600 | 1125 | 1265 | 1405 | 1555 | 1690 | 1830 | 1970 | 2110 | .... | .... | .... | .... | .... | 2250 |
| LA | 600 | 1500 | 1685 | 1875 | 2060 | 2250 | 2435 | 2625 | 2810 | .... | .... | .... | .... | .... | 3000 |
| LA | 600 | 2000 | 2250 | 2500 | 2750 | 3000 | 3250 | 3500 | 3750 | .... | .... | .... | .... | .... | 4000 |
| LA | 600 | 2500 | 2815 | 3125 | 3440 | 3750 | 4065 | 4375 | 4690 | .... | .... | .... | .... | .... | 5000 |
| LA | 600 | 3000 | 3375 | 3750 | 4125 | 4500 | 4875 | 5250 | 5625 | .... | .... | .... | .... | ..... | 6000 |

SOURCE: Application Data 29-160, Westinghouse Electric Corportation, Low Voltage Breaker Division, Bever, Pennsylvania 15009

Table H-2. Continuous ampere ratings and magnetic trip ranges for Westinghouse Seltronic front-adjustable magnetic-only circuit breakers

| Beaker Type | Continous Rating Amps | Magnetic Trip Range Continuously Adjustable | |
|---|---|---|---|
| | | Low | High |
| LC | 600 | 375 | 750 |
| LC | 600 | 450 | 900 |
| LC | 600 | 500 | 1000 |
| LC | 600 | 625 | 1250 |
| LC | 600 | 750 | 1500 |
| LC | 600 | 875 | 1750 |
| LC | 600 | 1000 | 2000 |
| LC | 600 | 1250 | 2500 |
| LC | 600 | 1375 | 2750 |
| LC | 600 | 1500 | 3000 |
| LC | 600 | 1750 | 3500 |
| LC | 600 | 2000 | 4000 |
| LC | 600 | 2250 | 4500 |
| LC | 600 | 2500 | 5000 |
| LC | 600 | 3000 | 6000 |
| MC | 800 | 2000 | 4000 |
| MC | 800 | 2500 | 5000 |
| MC | 800 | 3000 | 6000 |
| MC | 800 | 3500 | 7000 |
| MC | 800 | 4000 | 8000 |
| NC | 1200 | 2400 | 4800 |
| NC | 1200 | 2800 | 5000 |
| NC | 1200 | 3200 | 6000 |
| NC | 1200 | 3600 | 7000 |
| NC | 1200 | 4000 | 8000 |
| NC | 1200 | 4800 | 9600 |
| PC | 2000 | 3000 | 6000 |
| PC | 2000 | 3600 | 7200 |
| PC | 2000 | 4200 | 8400 |
| PC | 2000 | 4800 | 9600 |
| PC | 2000 | 5400 | 10800 |
| PC | 2000 | 6000 | 12500 |
| PC | 2500 | 3500 | 7000 |
| PC | 2500 | 4000 | 8000 |
| PC | 2500 | 4500 | 9000 |
| PC | 2500 | 5000 | 10000 |
| PC | 2500 | 6250 | 12500 |
| PC | 3000 | 3200 | 6400 |
| PC | 3000 | 3600 | 7200 |
| PC | 3000 | 4000 | 8000 |
| PC | 3000 | 5000 | 10000 |
| PC | 3000 | 6000 | 12000 |

SOURCE: Application Data 29-160, Westinghouse Electric Corporation, Low Voltage Breaker Division, Beaver, Pennsylvania 15009

Table H-3. -- Continuous ampere ratings and magnetic trip ranges/adjustment positions for General Electric standard duty front-adjustable magnetic-only circuit breakers

| Catalog No. 3-Pole | Continuous Rating Amps | Trip Setting Positions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Low | 2 | 4 | 6 | 8 | 10 | High |
| TEC36003 | 3 | 8 | 13 | 18 | 23 | 28 | 33 | 38 |
| TEC36007 | 7 | 18 | 30 | 42 | 54 | 65 | 78 | 90 |
| TEC36015 | 15 | 42 | 68 | 94 | 120 | 146 | 172 | 198 |
| TEC36030 | 30 | 90 | 140 | 190 | 240 | 290 | 340 | 390 |
| TEC36050 | 50 | 180 | 260 | 340 | 420 | 500 | 580 | 660 |
| TEC36100 | 100 | 300 | 468 | 636 | 804 | 972 | 1140 | 1308 |
| TEC36150 | 150 | 600 | 950 | 1300 | 1650 | 2000 | 2350 | 2700 |

| | | Low | 2 | 3 | 4 | High |
|---|---|---|---|---|---|---|
| TFC36225A | 225 | 1000 | 1325 | 1650 | 1950 | 2250 |
| TJC36400B | 400 | 1200 | 1400 | 1880 | 2500 | 4000 |
| TJC36600A | 600 | 1800 | 2400 | 3300 | 4500 | 6000 |
| TKC36800A | 800 | 2400 | 3200 | 4400 | 6000 | 8000 |
| TKC361200A | 1200 | 2400 | 3200 | 4400 | 6000 | 8000 |

| Catalog No. 2-Pole | Continuous Rating Amps | Trip Setting Positions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Low | 2 | 4 | 6 | 8 | 10 | High |
| TEC26007 | 7 | 18 | 30 | 42 | 54 | 66 | 78 | 90 |
| TEC26015 | 15 | 42 | 68 | 94 | 120 | 146 | 172 | 198 |
| TEC26030 | 30 | 90 | 140 | 190 | 240 | 290 | 340 | 390 |
| TEC26050 | 50 | 180 | 260 | 340 | 420 | 500 | 580 | 660 |
| TEC26100 | 100 | 300 | 468 | 635 | 804 | 972 | 1140 | 1308 |
| TEC26150 | 150 | 600 | 950 | 1300 | 1650 | 2000 | 2350 | 2700 |

SOURCE: General Electric Company

## MAGNETIC TRIP RATINGS

| MAGNETIC TRIP RANGE | PREMIUM DUTY CAT. NO. SUFFIX | STANDARD DUTY CAT. NO. SUFFIX | RANGE OF ALLOWABLE(1) CONDUCTOR SIZE, AWG OR MCM |
|---|---|---|---|
| 50-180 | MD | MD | 14-10 |
| 150-500 | MD | MD | 10-4 |
| 300-1000 | MD1 | MDA | 6-1 |
| 500-1500 | MD2 | MDB | 4-2/0 |
| 900-3000 | MD3 | MDC | 1-500 |
| 1250-3000 | MD4 | MDD | 1/0-500 |
| 2000-4000 | MD5 | MDE | 3/0-500 |

(1) Based on Mandatory Safety Standards, underground coal mines, for protection of trailing cables.

(2) Applies to 1000V Premium Mine Duty breakers only.

## CIRCUIT BREAKER SETTINGS **

| FRAME | RATING | LO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | HI |
|---|---|---|---|---|---|---|---|---|---|---|
| NB | 1000 | 2500 | 2815 | 3125 | 3440 | 3750 | 4065 | 4375 | 4890 | 5000 |
| MA (AC) | 600 | 1500 | 1685 | 1875 | 2060 | 2250 | 2435 | 2625 | 2810 | 3000 |
| MA | 700 | 2000 | 2250 | 2500 | 2750 | 3000 | 3250 | 3500 | 3750 | 4000 |
| MA (DC) | 600 | 750 | 845 | 935 | 1030 | 1125 | 1220 | 1310 | 1405 | 1500 |
| LA | 400 | 500 | 563 | 625 | 688 | 750 | 813 | 875 | 938 | 1000 |
| KA | 225 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 |
| KA | 180 | 150 | 181 | 212 | 243 | 274 | 305 | 336 | 368 | 400 |
| KA | 70 | 350 | 395 | 435 | 480 | 525 | 570 | 610 | 655 | 700 |
| LA | 200 | 1250 | 1406 | 1563 | 1719 | 1275 | 2031 | 2188 | 2344 | 2500 |

** The above chart is for Pemco Power Centers. The Ensign and Line Power have the charts listed on each circut breaker.

| CABLE SIZE | 14 | 12 | 10 | 8 | 6 | 4 | 3 | 2 | 1 | 1/0 | 2/0 | 3/0 | 4/0 UP. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAX AMP. | 50 | 75 | 150 | 200 | 300 | 500 | 600 | 800 | 1000 | 1250 | 1500 | 2000 | 2500 |

1. Determine cable size which in turn shows maximum amperage.
2. Determine the Frame type and the corresponding Hi-lo trip range from breaker.
3. Then go to the matching Frame and Trip Range scale and find the maximum setting allowable, which can be no higher than the maximum allowable amperage.

**Comments and questions from various operators after reviewing the electrical inspector's policy manual.**

Q 1. 22A-2-40(1) Policy Change 15' from ground level (bare connection or conductors of High Voltage).

A This policy changed to 8 feet according to law.

Q 2. 22A-2-40(10) Reverse Current Protection Law should read for DC connected battery chargers only -(Transformers should give reverse current protection on AC chargers.)

A Our policy is what the law states.

Q 3. 22A-2-40(19) Policy indicates only certified electricians or trainees can work on electrical equipment. Can only certified electricians or trainees change out motors? Does this mean other people cannot help bolt motors on, lift in place or does this mean other persons can help but not hook-up electrical wires to motor?

A Refer to title 48 - series 7 for example of electrical work. The law refers to electrical work NOT mechanical work.

Q 4. 22A-2-40(43) Need to know if policy is going to include 110 control lines from belts (remote, slip, sequence, gob switches and etc.) if it does this could be a problem.

A GFCI is an option - not a requirement. No, a GFCI is not a requirement for 110V control lines and etc.

Q 5. 22A-2-40(56) Policy concurs testing, law has nothing in it about testing. Also, policy gives no information about when test are to be done (monthly, semi-annually, or yearly)

A Refer to 22A-2-40(20) Which requires testing. The Administrative Regs, Series 12 states monthly.

Q 6. 22A-2-40(65) Need better definition of regular work or travel. Does this mean daily travel or work or weekly? We have to guard all High voltage cable where it enters sections switches, belt power centers. These are visited 3 times a day only for inspection, no regular work or travel.

A Regularly travelled is defined as weekly.

**Comments and questions from various operators after reviewing the electrical inspector's policy manual.**

Q 1. 22A-2-40(1) Policy stipulates fifteen feet minimum requirement for electrical components, connections, etc. The Code provides for an eight feet minimum, so the policy appears to be more restrictive than the regulations.

A The policy will be changed to 8 feet according to law.

Q 2. 22A-2-40(5) The policy states that signs shall be conspicuous for a safe distance. This statement is too vague and would be better if we specified the minimum size of the letters on the signs. Example: Danger-High Voltage in 4" letters.

A Conspicuous means easy to notice or obvious however, the law states no standards as to size of lettering.

Q 3. 22A-2-40(6) This policy is too vague...in the third paragraph, the requirement for surface areas of an underground mine requires insulated mats when a grounded grid, outside, in the weather, would be safer since the insulated mat would more than likely become wet from the elements. Also, it makes little sense to separate a surface electrical area at an underground mine from a preparation plant since the electrical hazard would be better isolated by grounded grids instead of a mat. The entire policy needs to be reviewed and allowances made to provide a better safeguard.

A On the surface an insulated platform or a grid grounded to the grounding medium of the equipment being operated will be accepted.

Q 4. 22A-2-40(20) This policy should be clearer in defining "grounding devices." What does the policy mean...diodes, grounding resistors? Also, the policy of removing equipment from service in lieu of the weekly examinations should be included. During idle periods such as strikes or the temporary abandonment of sections when equipment is not energized or operated, examinations serve no purpose. In those situations, the equipment should be carried out of service and the exam made prior to returning the equipment to operation. Consideration should also be made to include other stationary electrical equipment such as lathes, and drill presses in shops and make them exempt from the weekly examination requirement. This type of electrical equipment could be examined monthly.

A A grounding device is a frame ground conductor or a grounding diode. The equipment is allowed to be tagged out during idle periods and exams made prior to operation.

Q 5. 22-2-40(21) Why use the ICEA standards? Why not stay with the National Electric Code like MSHA?

A Either NEC or ICEA standards will be accepted.

Q 6. 22-2-40(26) MSHA allows eighty percent rating of devices for minimum available fault current. Why does the state policy permit only seventy-five percent? Also, why does the state require Horsepower ratings when present devices used are rated in current as the standard?

A The paragraph that states 70% will be deleted from the policy. Fused switches and line starters for motor circuits are rated in horsepower.

Q 7. 22A-2-40(50) Low and Medium voltage gloves have no place in the policy for this regulation. Testing of High Voltage gloves when not used while working with energized lines is not necessary.

A L/M gloves will be moved to 40(17). High voltage gloves are required to be tested even when used in conjunction with hot sticks.

Q 8. 22A-2-40(62) The policy addresses lid switches for power centers...the regulation concerns high voltage cables and the lid switches policy has nothing to do with the regulation.

A The policy relating to this section will be deleted.

Q 9. 22A-2-40(70) Present tables do not take into consideration the short time, starting transit loads for high efficiency motors.

A Our policy conforms to 1968 NEC Standard.

**Comments and questions from various operators after reviewing the electrical inspector's policy manual.**

Q 1. 22A-2-40(1) The policy elects to increase the required height requirements for bare energized high voltage conductors or components, associated with the transformer installations from 8 to 15 feet. This height requirement arbitrarily raises the distance far above that of the National Electrical Code. Enforcement should be limited to that height specified in the regulation.

The regulation grants access of "authorized" persons who may enter substations. The policy further restricts access to "certified electricians." This proposal would place an unnecessary restriction on contractors such as, servicemen from power companies from entering our substations to read meters, servicemen from Westinghouse or General Electric occasionally used for specialized repairs, and electrical contractors hired for modifications or installations of substations.

The policy fails to explain if the state will enforce "bare conductor" definition as that of MSHA, which identifies any conductor or ground to a resistor in a substation "bare" if it is not shielded.

A The policy will be changed to 8 feet according to the law.

Q 2. 22A-2-40(18) The regulation states that energized trolley wires may be repaired only by a person "trained" to perform electrical work...The policy would further restrict this activity to that of a "certified electrician." This certification requirement will far exceed the needs of a "wireman," and will not enhance the safety of that individual.

A See Administrative Regulations title 48 Series 7.2(12)

Q 3. 22A-2-40(19) The regulation permits individuals to perform limited electrical work if they have been trained and the work is done under the supervision of a certified electrician. The policy establishes an "apprentice" classification and a requirement for an "approved" electrical training program. Specialized training programs that have already been established would no longer be acceptable under these policy enforcement guidelines, even though they would be in full compliance with the regulation. Example would be: changing fuse in the trolley pole, splicing a single conductor shuttle car trailing cable.

A The Administrative Regulations that require an approved training program and an apprentice electrician have been in

effect since 1981. Title 48 Series 7 requires all electrical work to be performed by a Certified Electrician or a card carrying apprentice electrician under the direct or immediate supervision of a certified electrician.

Q 4. 22A-2-40(30) The regulation plainly requires that suitable lighting arresters be connected to a "low resistance grounding medium... The policy sets a preference of "less than 5 ohms" and never more than 25 ohms. Although the aforementioned range would serve as a goal, it might not always be obtainable. This could lend to enforcement difficulties in forcing an operator to strive to lower the resistance to obtain as close to 5 ohms, while in reality not improving on actual mine safety.

A Acceptable ground field for lightning arrestors is 25 ohms or less.

Q 5. 22A-2-40(43) Requirements for ground monitoring systems. The state could have taken the opportunity to clarify what is expected on surface and underground. When the regulation was passed in 1978, the legislature knew that regulation was ambiguous and therefore provided the director a means to solve these problems. Instead of explaining these differences (surface - underground) the state refers to waiver guidelines and compounds the situation by including ground fault interrupters.

A GFCI is an option, not a requirement.

Q 6. 22A-2-40(50) High voltage lines, both surface and underground, the operator must provide, test and maintain devices in making repairs.

The policy expands this regulation to require specific devices - hot sticks; and further states they be tested annually. This requirement has been defeated in the states hearing board and should be removed from the policy.

A hot stick is required, under this policy at the mine site where "stick operated switches are present." The language of the policy could be interpreted to require a stick at each location throughout the mine site. Suitable language would be "a hot stick is required at the mine." Any electrician could carry a hot stick on their truck and eliminate the possibility of an unauthorized person accessing an unattended hot stick.

A The policy states that hot sticks be tested annually and a hot stick be at the mine site where stick operated switches are present. (Has this requirement been defeated in the hearing board? Under what terms?)

Q 7. 22A-2-40(56) Requirements of high voltage circuit breakers.

The wording of the regulation is plain and simple. The policy does not address breakers but expands the requirement to include testing. If a policy for this regulation is needed, it could make reference to federal code 30CFR 75.800(1-4).

A Our policy is in accordance with MSHA Policy.

Q 8. 22A-2-40(60) Ground resistor to be located at the source transformer. Enforcement of the listed policy will create anarchy as it deviates from an accepted industry practice of installing the resistor with pump controls. This distance could range from 100 to 200 feet from the source transformer.

A This refers to a grounding resistor in a resistance grounded power system. (This is a requirement of WV Mining Law.)

Q 9. 22A-2-40(66) Visual disconnect on branch line breakers. Industry electricians will agree that a visual disconnect at each "branch line" will enhance mine safety. However, the policy fails to grandfather existing units until such time they might be rebuilt or timely replaced.

A The Law plainly addresses this.

Q 10. 22A-2-40(70) Low-medium three phase AC circuits. The regulation plainly requires four safety devices on all low-medium, three phase AC circuits on <u>mobile</u> or <u>portable</u> equipment.

The policy extends the requirement to all equipment including underground "stationary" equipment. While this is an accepted practice for surface installations, it has never applied to underground stationary equipment. this equates to a major cost item for new breakers required solely by a change in policy and not a change in regulations.

A This has always been the accepted practice in underground mines. (Underground circuits already have these safety devices with their circuit breakers.)

**Comments and questions from various operators after reviewing the electrical inspector's policy manual.**

Q 1. 22A-2-40(1) Change from platform 8' high to energized parts must be 15' from ground level. ( Fenced otherwise)

A The 15' requirement will be deleted from the policy.

Q 2. 22A-2-40(3) Can we still use power centers with oil filled disconnect switches?

A The law or the policy prohibits the use of oil filled cutout switches.

Q 3. 22A-2-40(6) Do rubber mats require insulation rating or dielectric tests?

A The law or policy does not require a rating or dielectric testing of rubber mats, however, testing of different types of conveyor belts, used for rubber mats, have revealed very low insulating values.

Q 4. 22A-2-40(7) Who makes a capacitor with noninflammable liquid? Is this underground or surface?

A The underground law requires noninflammable liquid for capacitors.

Q 5. 22A-2-40(8) What about hydraulic take-ups on surface belts? Emulsion oil will freeze and will not work on surface installations.

A The law requires fireproof oil or emulsion for all unattended underground loading points. The policy for this section of law will be deleted.

Q 6. 22A-2-40(10) Does this apply to AC chargers? I need an explanation as to how a battery can feed back on an AC system.

A Our policy is as the law states.

Q 7. 22A-2-40(17) Define ASTM standards for use.

A D-120 for initial and Part 28 for six month test.

Q 8. 22A-2-40(18) If rubber boots are not required to be rated for the circuit voltage, what are they to be rated for? Is just no holes or cuts the only requirements?

A Refer to policy for explanation.

Q 9. 22A-2-40(19) Define electric equipment? A miner is electric equipment, but can I use anyone to physically replace an electric motor?

A The law refers to electrical work NOT mechanical work. Refer to Title 48 Series 7 of Administrative Regulations.

Q 10. 22A-2-40(20) Define grounding device? Can we eliminate weekly examinations at preparation plants?

A An example of a grounding device is a frame ground conductor or a grounding diode. Stationary equipment in preparation plants are required to be examined on a monthly basis as stated in the policy.

Q 11. 22A-2-40(26) Define long cable? Does paragraph 3 conflict with #70?

A This paragraph will be deleted from the policy.

Q 12. 22A-2-40(30) Explain the statement -( are not considered exposed for the length so protected.) What do you mean by degree of systems neutral grounding?

A State requirements are according to MSHA policy on exposed conductors. For definition-refer to systems neutral grounding in industrial power systems handbook by Beemans.

check NEC from

Q 13. 22A-2-40(31) Define weatherproof?

A Refer to National Electrical Code, article 100 for definition of weatherproof.

Q 14. 22A-2-40(43) Do control lines and portable tools require GFI's?

A GFI's are an option of the ground monitoring waiver guidelines, NOT a requirement.

Q 15. 22A-2-40(50) Is a record required for electrical test of high voltage gloves and hot sticks?

A A record of test results is required for hot sticks. The dated test stamp is accepted for gloves.

Q 16. 22A-2-40(56) Law refers to circuit protection- Policy refers to ways protective tests may be made. Test how often?

MSHA A Concerning test and how often - refer to 22A-2-40(20) and Administrative Regulations Title 36 Series 12 Section 4.20

Q 17. 22A-2-40(65) Define regularly travelled?

A Regularly travelled is defined as 4 mos weekly.