prior to any designation of locations referred to in section 48(l)(3)(A)(ix).

Dale D. Goode,

Chief, Regulations Unit, Assistant Chief Counsel (Corporate).

[FR Doc. 89-28111 Filed 12-1-89; 8:45 am]

BILLING CODE 4830-01-M

[Delegation Order No. 193 (Rev. 2)]

Organization Functions and Authority Delegations; District Director

AGENCY: Internal Revenue Service, Treasury.

ACTION: Delegation of authority.

SUMMARY: This delegation order authorizes certain officials to perform the functions of the Commissioner. The text of the delegation order appears below.

EFFECTIVE DATE: November 8, 1989.

FOR FURTHER INFORMATION CONTACT: Melva Scruggs, PFR:P:O, Room 3524, 1111 Constitution Avenue NW., Washington, DC 20224, telephone (202) 566-4273 (not a toll-free call).

Order No. 193 (Rev. 2)

Effective Date: November 8, 1989

Authorization to Perform Functions of the Commissioner

Pursuant to the authority vested in me as Commissioner of Internal Revenue by Treasury Department Order No. 150-10, the Senior Deputy Commissioner is authorized to perform any function the Commissioner is authorized to perform.

The Deputy Commissioner (Operations), Deputy Commissioner (Planning and Resources/Chief Financial Officer), and Chief Information Officer are each authorized to perform only those functions the Commissioner is authorized to perform which arise out of, relate to, or concern the activities or functions each administers.

Each of these officials shall perform functions under this authority in his or her own capacity and under his or her own title and shall be responsible for referring to the Commissioner any matter on which action would appropriately be taken by the Commissioner.

This authority may not be redelegated.

Delegation Order No. 193 (Rev. 1), effective August 30, 1987, is superseded.

Fred T. Goldberg, Jr.,

Commissioner.

[FR Doc. 89-28205 Filed 12-1-89; 8:45 am]

BILLING CODE 4830-01-M

Sunshine Act Meetings

Federal Register
Vol. 54, No. 231
Monday, December 4, 1989

This section of the FEDERAL REGISTER contains notices of meetings published under the "Government in the Sunshine Act" (Pub. L. 94-409) 5 U.S.C. 552b(e)(3).

FEDERAL DEPOSIT INSURANCE CORPORATION

Agency Meeting

Pursuant to the provisions of the "Government in the Sunshine Act" (5 U.S.C. 552b), notice is hereby given that at 2:02 p.m. on Tuesday, November 28, 1989, the Board of Directors of the Federal Deposit Insurance Corporation met in closed session to consider the following matters:

Application of The Howard Savings Bank, Newark, New Jersey, a Bank Insurance Fund member and a State nonmember savings bank, for consent to purchase certain assets of and to assume the liability to pay deposits made in the three Lakewood, New Jersey, branch offices of Security Savings Bank, SLA, Vineland, New Jersey, a Savings Association Insurance Fund member and a state chartered savings and loan association; for consent to convert insurance coverage from the Savings Association Insurance Fund to the Bank Insurance Fund as contemplated by the Financial Institutions Reform, Recovery, and Enforcement Act of 1989; and for consent to establish the three Lakewood, New Jersey, branch offices of Security Savings Bank, SLA as branches of The Howard Savings Bank.

Administrative enforcement proceedings.

Matters relating to the possible closing of certain insured banks.

Recommendation regarding the liquidation of a depository institution's assets acquired by the Corporation in its capacity as receiver, liquidator, or liquidating agent of those assets:

Silverado Banking, Savings & Loan Association Denver, Colorado

In calling the meeting, the Board determined, on motion of Director C.C. Hope, Jr. (Appointive), seconded by Director Robert L. Clarke (Comptroller of the Currency), concurred in by Director M. Danny Wall (Director of the Office of Thrift Supervision), and Chairman L. William Seidman, that Corporation business required its consideration of the matters on less than seven days' notice to the public; that no earlier notice of the meeting was practicable; that the public interest did not require consideration of the matters in a meeting open to public observation; and that the matters could be considered in a closed meeting by authority of subsections (c)(4), (c)(6), (c)(8), (c)(9)(A)(ii), and (c)(9)(B) of the "Government in the Sunshine Act" (5 U.S.C. 552b(c)(4), (c)(6), (c)(8), (c)(9)(A)(ii), and (c)(9)(B)).

The meeting was held in the Board Room on the sixth floor of the FDIC Building located at 550—17th Street, Washington, DC.

Dated: November 29, 1989.

Federal Deposit Insurance Corporation.

Robert E. Feldman,

Deputy Executive Secretary.

[FR Doc. 89-28339 Filed 11-29-89; 5:03 pm]

BILLING CODE 6714-01-M

Corrections

Federal Register
Vol. 54, No. 231
Monday, December 4, 1989

This section of the FEDERAL REGISTER contains editorial corrections of previously published Presidential, Rule, Proposed Rule, and Notice documents. These corrections are prepared by the Office of the Federal Register. Agency prepared corrections are issued as signed documents and appear in the appropriate document categories elsewhere in the issue.

DEPARTMENT OF AGRICULTURE

Small Business Competitiveness Demonstration Program

Correction

In notice document 89-27385 beginning on page 48287 in the issue of Wednesday, November 22, 1989, make the following corrections:

1.On page 48288, in the second column, in the sixth line, insert the word "a" between the words "and" and "Procurement". 12. On the same page, in the third column, in the first line, "research" should read "search".

3. On the same page, in the second column below the table, in the first line remove the word "not".

BILLING CODE 1505-01-D

DEPARTMENT OF COMMERCE

International Trade Administration

University of Chicago, et al.; Consolidated Decision on Applications for Duty-Free Entry of Scientific Instruments

Correction

In notice document 89-25048 appearing on page 43447 in the issue of Wednesday, October 25, 1989, make the following correction:

On page 43447, in the 3rd column, in the 1st complete paragraph, the 12th line should read "$>1\times10^{-4}$ amps/torr He."

BILLING CODE 1505-01-D

COMMITTEE FOR PURCHASE FROM THE BLIND AND OTHER SEVERELY HANDICAPPED

Procurement List 1990; Additions and Deletion

Correction

In notice document 89-26575 appearing on page 47258 in the issue of Monday, November 13, 1989, make the following correction:

In the second column, under **Additions**, in the *Commodities* list, the second line should read "2540-00-737-3309".

BILLING CODE 1505-01-D

COMMITTEE FOR PURCHASE FROM THE BLIND AND OTHER SEVERELY HANDICAPPED

Procurement List 1990; Proposed Additions

Correction

In notice document 89-26576 beginning on page 47258 in the issue of Monday, November 13, 1989, make the following correction:

On page 47258, in the third column, the last line should read "6532-01-127-2213".

BILLING CODE 1505-01-D

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food and Drug Administration

[Docket No. 89N-0465]

Drug Export, Abbott IMx® HBsAg Test Kit

Correction

In notice document 89-26073 beginning on page 46652 in the issue of Monday, November 6, 1989, make the following corrections:

1. On page 46652, in the third column, the heading should read as set forth above.

2. On page 46653, in the second column, in the second complete paragraph, in the fifth line, insert "and" following "Food".

BILLING CODE 1505-01-D

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food and Drug Administration

Advisory Committee; Meeting

Correction

In notice document 89-25699 appearing on page 46128 in the issue of Wednesday, November 1, 1989, make the following correction:

On page 46128, in the first column, under "*Agenda-Open public hearing.*" in the first line, "preset" should read "present".

BILLING CODE 1505-01-D

DEPARTMENT OF LABOR

Mine Safety and Health Administration

30 CFR Part 44

Termination of Waivers Granted Under the Federal Metal and Nonmetallic Mine Safety Act of 1966

Correction

In rule document 89-27446 appearing on page 48564 in the issue of Wednesday, November 22, 1989, make the following correction:

In the second column, in the fourth line, "April 2, 1990" should read "May 21, 1990".

BILLING CODE 1505-01-D

MERIT SYSTEMS PROTECTION BOARD

Call for Riders for the U.S. Merit Systems Protection Board Publication, "Questions and Answers About Whistleblower Appeals"

Correction

In notice document 89-27855 beginning on page 48956 in the issue of Tuesday, November 28, 1989, make the following correction:

On page 48956, in the third column, under **DATE:**, in the third and fourth lines, "[insert date 30 days from date of publication]" should read "December 28, 1989".

BILLING CODE 1505-01-D

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

[89-81]

National Environmental Policy Act; Notice of Intent To Prepare a Draft Environmental Impact Statement (DEIS, TIER-2); Ulysses Mission

Correction

In notice document 89-27331 beginning on page 48168 in the issue of Tuesday, November 21, 1989, make the following correction:

On page 48169, in the second column, in the **DATE:** paragraph, the 30-day comment period was incorrectly calculated. The **DATE:** paragraph should read:

DATE: Written comments must be submitted on or before December 21, 1989.

BILLING CODE 1505-01-D

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 71

[Airspace Docket No. 89-ASW-27]

Revision of Transition Area; Chickasha, OK

Correction

In rule document 89-27154 appearing on page 47971 in the issue of Monday, November 20, 1989, make the following correction:

In the 2nd column, in the 1st paragraph, in the 16th line, "99°" should read "97°".

BILLING CODE 1505-01-D

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 73

[Airspace Docket No. 89-ASW-28]

Amendment to Times of Designation for Restricted Areas at White Sands Missile Range; NM

Correction

In rule document 89-26312 beginning on page 46887 in the issue of Wednesday, November 8, 1989, make the following correction:

On page 46888, in the first column, in the sixth line, insert "not" following "would".

BILLING CODE 1505-01-D

DEPARTMENT OF THE TREASURY

Internal Revenue Service

26 CFR Part 1

[T.D. 8264]

RIN 1545-AK26

Temporary Regulations Under Section 383 of the Internal Revenue Code of 1986; Use of Pre-Change Attributes

Correction

In the correction to rule document 89-22108 appearing on page 46187 in the issue of Wednesday, November 1, 1989, make the following correction:

§ 1.383-1T [Corrected]

On page 46187, in the third column, under § **1.383-1T**, in the fourth line, "383(l)(2)" should read "382(l)(2)".

BILLING CODE 1505-01-D

DEPARTMENT OF THE TREASURY

Internal Revenue Service

26 CFR Part 1

[T.D. 8259]

RIN 1545-AM99

Real Estate Mortgage Investment Conduits; Reporting Requirements and Other Administrative Matters

Correction

In rule document 89-20916 beginning on page 37098 in the issue of Thursday, September 7, 1989, make the following corrections:

§ 1.6049-7T [Corrected]

1. On page 37106, in the third column, in § 1.6049-7T(f)(3)(ii)(B), in the fifth line, "865(c)(3)" should read "856(c)(3)".

2. On page 37107, in the first column, in § 1.6049-7T(f)(3)(ii)(C), in the second and sixth lines, "865(c)(3)(F)" should read "856(c)(3)(F)".

BILLING CODE 1505-01-D

federal register

Monday
December 4, 1989

Part II

Department of Labor

Mine Safety and Health Administration

30 CFR Part 75
Electrical Safety Standards for Underground Coal Mines; Proposed Rule

30 CFR Parts 56 and 57
Electrical Standards for Metal and Nonmetal Mines; Proposed Rule

30 CFR Parts 56, 57, 70, and 71
Noise; Advance Notice of Proposed Rulemaking

30 CFR Part 16
Approval Requirements for Electrical Detonators; Advance Notice of Proposed Rulemaking

DEPARTMENT OF LABOR

Mine Safety and Health Administration

30 CFR Part 75

RIN 1219-AA10

Electrical Safety Standards for Underground Coal Mines

AGENCY: Mine Safety and Health Administration, Labor.

ACTION: Proposed rule.

SUMMARY: This proposed rule would revise the Mine Safety and Health Administration's electrical safety standards for underground coal mines. The proposed revisions would upgrade existing provisions consistent with advances in mining technology, provide alternative methods of compliance and reduce paperwork requirements where possible.

DATE: Written comments must be submitted on or before March 9, 1990.

ADDRESS: Send written comments to the Mine Safety and Health Administration, Office of Standards, Regulations and Variances, Room 631, Ballston Tower No. 3, 4015 Wilson Boulevard, Arlington, Virginia 22203.

FOR FURTHER INFORMATION CONTACT: Patricia W. Silvey, Director, Office of Standards, Regulations and Variances, MSHA, 4015 Wilson Boulevard, Arlington, Virginia 22203; phone (703) 235-1910.

SUPPLEMENTARY INFORMATION:

I. Paperwork Reduction Act

This proposed rule contains information collection requirements in §§ 75.154, 75.155, 75.156, 75.157, 75.159, 75.160, 75.508, 75.527 and 75.1009. These paperwork requirements have been submitted to the Office of Management and Budget (OMB) for review under section 3504(h) of the Paperwork Reduction Act of 1980. Comments on the proposed paperwork provisions should be sent directly to the Office of Information and Regulatory Affairs, Office of Management and Budget, Attention: Desk Officer for MSHA (see address at the end of this discussion). The respondents in each of the paperwork provisions would be mine operators. Each of the following public burden hour estimates includes the time for reviewing instructions, gathering and maintaining the data needed, and completing and reviewing the collection information. In each instance, the resultant information collection would be used by MSHA to assess compliance with the proposed requirements. The information collection requirements contained in the proposal are discussed below.

MSHA qualification of mine electricians and cable splicers (§§ 75.154/75.155/75.157/75.159). In order to become qualified to perform specified underground electrical work, individuals would be required to submit a written application to MSHA and successfully complete qualification tests developed by the Agency and administered by either a state or MSHA. The written application is necessary for administrative purposes in order to determine whether applicants meet the knowledge and experience prerequisites for qualification. It is estimated that the number of applications would average 1,300 per year, requiring 15 minutes per response. States that offer qualification tests must notify the District Manager in writing of the time and place of testing. This would allow the Agency to monitor the state tests and assure that testing is administered in a consistent and equitable fashion. The number of notifications is estimated to be 36 annually, requiring an average of five minutes per notification.

MSHA estimates that 1,932 additional applications will be received per year for qualification in low-voltage cable splicing and repair. The estimated average time per response for this requirement is five minutes. A record of all certified and qualified persons is essential to determine whether difficult and dangerous electrical work is being performed only by those persons who are qualified to do so. The average time required to record each certified or qualified person is estimated to be 15 minutes. The number of records is estimated to be 39,932 annually. The total recordkeeping burden for the qualification of mine electricians is estimated to be 11,467 hours per year.

Electrical annual refresher training and approved training programs (§§ 75.156/75.160). Submission of qualified electrician and cable splicer training plans to MSHA for approval is necessary to assure that persons qualified to perform mine electrical work receive consistent and thorough refresher training which complies with the proposed rules. The estimated number of plans submitted per year is 1,686 and it is estimated to take an average of two hours per plan. Notification of the time and place of the annual refresher training would allow the Agency to monitor the retaining to assure the training is being conducted in accordance to the plan. The number of notifications is estimated to be 1,932 per year and require an average of five minutes per notification. The total annual recording burden for training plan submissions and retraining notification is estimated to be 3,489 hours.

Examination, testing and maintenance of electric equipment and circuits (§§ 75.508/75.1009). Records of unsafe conditions and corrective action taken pertaining to all equipment are necessary to assure that known hazards are corrected before they can cause injury. The Agency estimates that records will be made of 260,832 examinations of mobile and portable equipment and circuits annually and each record will average 20 minutes. An estimated 32,412 records will be made of stationary and hand-held equipment that should also average 20 minutes per entry.

It is estimated that 1,366 records will be made of tests and 4,099 records will be made of the examinations of high-voltage switchgear. The estimated average time of each record is 35 minutes per test record and 20 minutes per examination record. It is estimated that 342 records will also be made of high-voltage grounding resistors and circuit protective devices and that the average time to make each of these records is estimated to be 55 minutes. It is also estimated that 1,122 records will be made annually of the examination and testing of trolley systems. Each of these records should take an average of two hours. The total public reporting burden for the examination and testing of electric equipment is estimated to average 102,255 hours annually.

Map of the mine electrical systems (§ 75.527). A map of the electrical system is essential during a mine emergency for locating potential sources of hazards so that appropriate precautions can be taken. The availability and accuracy of this map could therefore be crucial to the safety of miners. The Agency estimates that an average of three hours and 20 minutes will be necessary annually to maintain a map current. It is estimated that 5,675 hours will be necessary annually to keep about 1,686 mine maps up to date.

Public reporting burden for the collection of information for these electrical standards is estimated to be 122,877 hours annually.

Send comments regarding these burden estimates or any other aspect of this collection of information, including suggestions for reducing this burden, to Patricia W. Silvey, Director, Office of Standards, Regulations, and Variances, MSHA, Room 631, Ballston Tower #3, 4015 Wilson Boulevard, Arlington, Virginia 22203, and to the Office of Information and Regulatory Affairs of OMB, Attention: Diana Rowen; Desk

Officer for the Mine Safety and Health Administration.

II. Background

The Mine Safety and Health Administration (MSHA) is proposing to revise its existing electrical safety standards for underground coal mines. These revisions are proposed pursuant to section 101 of the Federal Mine Safety and Health Act of 1977 (Mine Act), 30 U.S.C. 811, and are consistent with the goals of Executive Order 12291, the Regulatory Flexibility Act and the Paperwork Reduction Act.

On July 9, 1982, MSHA published an Advance Notice of Proposed Rulemaking (ANPRM) in the Federal Register (47 FR 30025) which announced a comprehensive review of the underground coal mining standards in 30 CFR part 75 and solicited public comments. After reviewing the comments, the Agency developed a preproposal draft of revisions to the existing electrical standards. On May 23, 1986, MSHA published a notice in the Federal Register which announced the availability of its preproposal draft and solicited written comments from all interested parties (51 FR 18899). On July 3, 1986, MSHA extended the comment period to August 15, 1986 (51 FR 24387). MSHA has received written comments regarding its preproposal draft from all segments of the coal mining community. The Agency's proposed rule takes into consideration the comments received and, where appropriate, specific comments on major provisions are discussed.

III. Discussion of Proposed Rule

A. General Discussion

Accidents and fatalities related to the use of electricity and electric equipment in underground coal mines have consistently been the cause of injuries and deaths. Since 1970, at least 110 miner fatalities which involved the use of electric equipment or circuits in underground coal mines have been reported to MSHA. These statistics reveal that working with and around electric circuits and equipment in the mining industry can be extremely hazardous for miners.

More recent information indicates that there were 26 fatalities that resulted from electrical accidents during the years 1982 to 1987. This represents approximately nine percent of the fatalities that occurred in underground coal mines during this period. In addition, there were approximately 900 nonfatal injuries from electrical accidents during this period.

The preamble to the proposed rules often makes use of injury and fatality data arising from electrical accidents. Although such information is a useful indicator of where safety standards can be improved, it is important to note the difficulty of attributing an electrical injury or fatality to just one cause. Typically, electrical accidents can occur as a result of more than one contributing hazardous electrical condition. For instance, damage to a cable which exposes its internal components would pose a shock hazard if the grounding protective devices, such as a broken grounding conductor, are also damaged or defective and do not properly cause deenergization. In such a case, both of the conditions would be a contributing cause to a resulting electrical injury or fatality.

Prevention of electrical accidents continues to be a difficult task because of the variety of conditions encountered in coal mines that can affect the function of electric equipment. However, technological advancements and improved practices can aid in the use of electricity in underground coal mines. This proposed rule reflects these advancements and would require certain measures and practices that would increase the safety protection afforded to miners. The proposal would also simplify existing standards and reduce paperwork requirements where possible.

The proposed rule would revise existing electrical safety standards in 30 CFR part 75. It would address hazards related to the use of electricity in underground coal mines by establishing improved safety standards for: qualification of persons; electric equipment in general; trailing cables; grounding; high- and low-voltage circuits; and trolley wire and trolley feeder wires.

With the goal of correcting deficiencies and providing clarity, the subparts that contain electrical standards would be reorganized and restructured to eliminate repeated references from one subpart to another. Existing standards that contain incorporations by reference would be replaced with necessary requirements, tables and charts. Electrical diagrams would also be included with the more complex standards to provide clarity.

In addition, many existing part 75 requirements would be either expanded or rewritten to better address accident history and to assist in the prevention of future accidents. These goals would be particularly addressed through proposed requirements for the use of shielded trailing cable; maintenance of circuits and equipment; electrical work procedures; protective equipment for troubleshooting, testing and handling of cables; trolley circuit protection; grounding of circuits and equipment; qualification of mine electricians, electrical retraining programs and qualification of trailing cable splicers; ground-wire monitors; battery chargers; and circuit breakers and disconnecting device identification.

Proposed requirements for shielded trailing cables would be contained in § 75.601 and would require that low-voltage alternating-current trailing cables be equipped with metallic shielding around each power conductor. This requirement would be implemented over a period of three years, depending upon the type of equipment involved. This would result in less potential for fire and electric shock due to short circuits or bare conductors in cables.

Under §§ 75.508 and 75.810 of the proposal, circuits and equipment would be required to be installed and maintained to prevent hazards. These standards would address the types and frequency of tests and examinations to be conducted on circuits and equipment. Proposed §§ 75.506 and 75.815 would set out procedures to be used by qualified electricians in the performance of electrical work. These procedures specifically pertain to proper disconnecting, locking out, grounding and tagging of circuits and equipment prior to electrical work.

The proposal would contain new requirements for use of protective equipment during troubleshooting and handling of cable. Under the proposal, troubleshooting and testing of energized circuits would be limited to low-voltage circuits, and persons performing this type of work would be required to wear properly rated rubber insulating gloves. Protective equipment would also be required to be used by persons handling energized unshielded low-voltage trailing cable and shielded high-voltage trailing cables.

Improved standards addressing the qualification of persons who perform electrical work are contained in the proposal. Under proposed § 75.153, persons applying for qualification to perform electrical work would be required to pass tests administered by MSHA or a state. The standard would recognize state programs which meet minimum requirements set out in the proposed rule. Annual refresher training would be required for electricians in accordance with proposed § 75.156 to maintain electrical qualification. New procedures pertaining to the qualification of persons for splicing and

repair of low-voltage trailing cables are also included in the proposal.

In addition, proposed standards addressing high-voltage electric face equipment would eliminate the wide use of the petition process to accommodate the safe operation of this equipment. Elimination of petitions would be accomplished through recognition in the proposal that shielded high-voltage cable can be used within 150 feet of the working face. Safety considerations related to this change would be addressed through the incorporation of newly proposed provisions which, in the past, have been included in petitions for modification.

B. Petitions for Modification

Operators with petitions for modification that involve the standards revised under the proposed rules would need to determine the status of those petitions before the effective date of the final rule. For proposed standards which are renumbered, but remain substantively unchanged from the existing standards, operators with modifications granted for these standards need not reapply. However, operators with modifications granted for standards that have been revised would need to comply with the new rule on its effective date. New petitions for modification of the rule may be submitted as necessary in accordance with 30 CFR part 44. If Agency assistance is needed, questions should be directed to the appropriate MSHA District Office.

C. Section by Section Discussion

Section 75.2(j) Definitions

The definitions in this section of the proposed rule are new, included to facilitate understanding of the electrical safety standards which follow. They would be integrated into existing § 75.2 at paragraph (j), and the existing definitions of low-, medium- and high-voltage would be deleted. However, the Agency solicits comment on whether there should be a definitions section applicable only to electrical standards, distinct from existing § 75.2.

The definitions of the electrical terms used are derived from sources commonly accepted by the mining industry and electrical and electronics engineers, including the Institute of Electronic and Electrical Engineers (IEEE) *Standard Dictionary of Electrical and Electronics Terms*, and the *National Electrical Code* (NEC). Definitions found in part 18 of MSHA's regulations were also used as a source for this proposal. In some instances, definitions taken from these sources were modified to apply to electric circuits and equipment used in the coal mining industry.

The proposed definitions represent important information for the interpretation of the electrical standards proposed in subparts B and F through K. The following discussion addresses a number of the more generally used definitions. Where appropriate, other proposed definitions are discussed together with the standards in which they are used.

The term "adequate interrupting capacity" is defined by the proposal as the ability of a circuit breaker or fuse to safely interrupt all values of current which can occur at its location in excess of its trip setting or melting point. Under this definition, adequate interrupting capacity would be determined by comparing the interrupting rating of the device with the actual characteristics of the circuit to be protected. These characteristics would include the circuit's voltage, impedance and power factor or time constant. For example, proposed § 75.602 would require trailing cables to be protected against overcurrents by a circuit breaker of adequate interrupting capacity. That is, a circuit breaker capable of safely interrupting all values of current which can occur at its location in excess of its trip setting or melting point.

"Equipment safety grounding conductor" is a new term, defined as the conductor used to connect the non-current-carrying metallic parts of equipment, raceways, and other metallic enclosures to the system grounding medium. In the Agency's view, it is important to stress that grounding is intended to safeguard persons from shock and burns, and not primarily to protect equipment. Conveying this concept would best be accomplished by using the term "equipment safety grounding conductor" as opposed to "equipment grounding conductor." The IEEE *Standard Dictionary of Electrical and Electronics Terms*, IEEE Standard 100–1977 defines "safety ground conductor" in essentially the same manner as the proposed definition.

"Extended-time rated grounding resistor" is a term used primarily in subpart H, on grounding. The proposal defines it as a resistor capable of carrying rated current for a period of time which exceeds the amount of time necessary for its temperature to reach a constant value, and which is capable of operating at its maximum operating temperature for at least 90 days per year without opening. This type of resistor is one capable of operating for an extended period at increased temperatures without failing in an open position.

A definition of the term "fail-safe" is also included in the proposal. It is used in relation to ground-wire monitors and solid-state direct-current overcurrent relays in the proposed rule. It is a descriptive term, meaning that failure of any component of such devices, other than relay contacts, will not prevent the device from performing its intended function, unless the device is designed to activate a circuit-interrupting device when failure occurs.

For instance, proposed § 75.711 would require that ground-wire monitors for cables extending to face equipment be designed and constructed to be fail-safe. A ground-wire monitor is defined under the proposal as a device which monitors equipment safety grounding conductors, and causes the associated circuit breaker to trip when a change in the impedance of the grounding circuit presents a potential shock hazard. Applying the two definitions, a fail-safe ground-wire monitor would be required under § 75.711 to operate, despite failure of its component parts. It would have to perform its intended function of monitoring and tripping the circuit breaker when necessary.

The definitions of low- and high-voltage systems represent changes in the existing standards, which recognize three voltage classifications. Low-voltage is presently defined in § 75.2(j) as up to and including 660 volts, medium-voltage as 661 to 1,000 volts, and high-voltage as more than 1000 volts. The proposed standards would eliminate the medium-voltage classification, and define a "high-voltage system or circuit" as one with a nominal voltage equal to or greater than 1,040 volts. Systems or circuits having a nominal voltage less than 1,040 volts would be classified as "low-voltage." The medium-voltage category is presently used only in relation to shielding of cables. The proposed cable shielding requirements would eliminate the need for a medium-voltage classification.

The term "nominal voltage" is defined by the proposal to mean the phase-to-phase or line-to-line root-mean-square value assigned to a circuit or system to conveniently designate its voltage class, such as 480 or 4,160 volts. The definition would clarify that the actual operating voltage of a system or circuit may vary from its nominal voltage within a range that permits satisfactory operation of equipment.

The definition of the term "overcurrent" would encompass ground faults, overloads and short-circuits, resulting from a current in excess of the rated current of equipment or the

ampacity of a conductor. The proposal would also define the terms "portable electric equipment," "mobile electric equipment," and "stationary electric equipment." Portable electric equipment would be defined as units which are designed and constructed to facilitate frequent movement from one location to another, and which are not normally located at one site for extended time periods. This would include units such as rock dusters and 10 horsepower pumps. Mobile electric equipment would be defined as units capable of being moved from one location to another by power supplied from a source located on the machine, as in battery-powered scoops, or supplied with power by means of a trailing cable, as in continuous-mining machines.

By contrast, stationary electric equipment would be defined as units which are not designed for frequent movement during normal use. This would encompass units other than mobile or portable, such as belt drives, which are fixed or fastened at a specific location for extended time periods. These distinctions are relevant since some of the proposed regulations would not apply to all three categories of electric equipment.

The terms "qualified cable splicer" and "qualified electrician" would be added to the definitions section in light of proposed standards at §§ 75.153 and 75.157. A qualified cable splicer would be a person who has met the requirements of proposed § 75.157, which contains the parameters of qualification for splicing and repairing low-voltage trailing cables.

In many of the proposed standards, qualified electricians would be required to perform certain work, such as troubleshooting and testing low-voltage circuits and equipment. These persons would be defined as having met the requirements of proposed § 75.153, which contains standards for the qualification of mine electricians. These terms would only be relevant within the context of the proposed electrical standards in subparts B, and F through K. Therefore, the existing definitions of "certified persons" and "qualified persons" at § 75.2 (a) and (b) would not be altered under the proposal.

Subpart B—Qualified Persons

Section 75.153 qualified electricians

Proposed § 75.153 specifies the process by which mine electricians would become qualified to perform underground electrical work. It is derived from existing §§ 75.153 and 75.159, and would address only qualification of mine electricians, and not all qualified persons working in underground coal mines. Several commenters to the preproposal draft suggested that a qualification program for mine electricians be adopted. These commenters pointed to the difficulty and danger involved in electrical work as the reason for requiring such a program. The proposal takes this approach.

Under paragraph (a) of the proposal, in order to become qualified to perform specified underground electrical work after the effective date of the rule, individuals would be required to successfully complete qualification tests developed by MSHA and administered by either the Agency or a state. The testing procedures, outlined in proposed § 75.154, are designed to allow the Agency to determine whether an electrician is capable of safely carrying out the underground electrical tasks required of a qualified electrician. MSHA believes that written and manual demonstrations of an electrician's familiarity with electrical hazards and safe operating procedures are crucial to mine safety.

An applicant for qualification would also have to possess at least one year of experience in a position requiring the installation and maintenance of electric circuits and equipment in a coal or other mine, in the mine equipment manufacturing industry, or in any other industry using or manufacturing similar equipment. This experience requirement, retained from existing § 75.153, would ensure that qualified electricians have a background of electrical work sufficient to prepare them to safely perform electrical tasks in underground coal mines.

The proposal would credit those who have completed two and four-year educational programs in electrical technology and electrical engineering with six months of experience. This aspect of the rule would recognize the value of formal training in these specified fields when applied to the underground coal mine environment.

Existing standards permit qualification of mine electricians with one year of experience, who satisfactorily complete an MSHA-approved electrical training program conducted by a mine operator. The proposal would modify the existing rule by no longer permitting operators to qualify mine electricians under approved electrical training plans. At mines where electrical accidents and fatalities have been on the increase, MSHA inspectors have monitored training given for electrical qualification purposes under approved plans which was incomplete and inadequate. The inspectors found that such plans do not fulfill the terms of the plans approved by MSHA.

The Agency is also aware of some approved training programs which are thorough and beneficial. Additionally, some training programs include qualification testing designed to evaluate the effectiveness of training. The intent of the proposed standard is to assure a consistent qualification process according to specific criteria, using effective training programs as models. This would result in properly qualified mine electricians and assure that electrical work is safely performed by persons with adequate knowledge and skills. Further, the standard would lessen the burden on mine operators by no longer requiring approved training of a specific type and duration. Those electricians who successfully complete the requirements of proposed §§ 75.154 or 75.155 would be qualified as mine electricians, regardless of the initial training they received.

Under paragraph (b), all qualified electricians, those qualified under the proposal as well as electricians qualified before its effective date, would be required to have annual refresher training in accordance with proposed § 75.156. Existing § 75.160 would require operators' refresher training programs to be approved by MSHA. Due to changing technology and the occurrence of avoidable electrical accidents underground, annual refresher training designed to reemphasize safe operating procedures and promote awareness of new technology would be beneficial in maintaining the continued competence of qualified electricians.

Paragraph (c) provides that those electricians qualified before the effective date of the rule would remain qualified, provided they fulfill the annual refresher training requirements of proposed § 75.156. The standard would eliminate the need for time consuming and costly requalification, but would assure that electricians presently qualified are also kept abreast of new technology and safety advancements.

The MSHA District Manager would be authorized under proposed paragraph (d) to revoke an electrician's qualification for cause, including intentional violation of the requirements of part 75 and intentional defeat of any safety device or circuit. Electricians who defeat safety devices, for example, endanger themselves as well as others, and should not be considered qualified to work with potentially dangerous electric equipment and circuits. Under the standard, due process protection would be afforded to qualified

electricians when MSHA intends to revoke their qualified status. Revocation would only be permitted for cause, and would incorporate a process for administrative appeal of Agency action. Under these provisions, electricians would be given notice, ample opportunity to present arguments against revocation, and a means of appealing revocation decisions.

Section 75.154 MSHA Qualification of Mine Electricians

Derived from existing § 75.153, this proposed standard would set forth MSHA's testing procedures for qualification of mine electricians. Under paragraph (a), applications to MSHA for qualification would have to be made in writing to the District Manager of the appropriate Coal Mine Safety and Health District. Since separate tests would be given to qualify electricians in low- and high-voltage categories, applicants would have to specify the category or categories for which qualification is sought.

Paragraph (b) describes the elements of MSHA tests for low-voltage electrical qualification. Tests would include written examination of d-c and a-c theory and application, and the requirements of Federal electrical safety standards in subparts F through H, and K of part 75. Written examination in or practical demonstration of knowledge in low-voltage coal mine electrical equipment and circuits, and electric equipment permissibility requirements would also be included. It is MSHA's view that these areas represent the elements of electrical knowledge which an electrician qualified for low-voltage work should possess in order to safely perform assigned tasks.

For high-voltage qualification under paragraph (c), electricians would be examined in writing or by practical demonstration of knowledge of coal mine electric power distribution circuits and equipment. Written examination of the requirements contained in subpart I of part 75 would also be required. Qualified electricians entrusted with the installation and maintenance of high-voltage circuits and equipment should possess knowledge of the specified subjects, in MSHA's view, to assure that high-voltage electrical work is safely and accurately performed. It is MSHA's intent that Agency personnel who are themselves qualified electricians will administer qualification tests. Their presence would assure that questions or problems arising during testing can be addressed by a person knowledgeable in the subject.

Proposed § 75.155 would permit states to administer qualification testing which meets the requirements of paragraphs (b) and (c) of this section. The option described of requiring written examination or practical demonstration of the specified subjects would be determined by MSHA or the state. The Agency is aware that some states now possess the ability to provide for practical demonstrations which allow accurate evaluation of an applicant's abilities. The standard would promote the development and use of such programs where they are available. However, in order to properly evaluate an applicant's knowledge of subjects such as electrical theory and the requirements of part 75, some subjects would be examined in writing.

Paragraph (d) would allow applicants to take tests for qualification in both the low- and high-voltage categories at the same time. However, tests for each category would be evaluated separately. If the low-voltage portion of the testing is not passed, the high-voltage portion would not be evaluated. Therefore, applicants who do not successfully meet the requirements for qualification to perform low-voltage work would not be eligible to become qualified to perform high-voltage work. This provision would recognize that a great number of common electrical tasks in coal mines involve work with low-voltage circuits and equipment. An electrician qualified in low-voltage would be specifically prepared to perform these tasks. Electricians needed to perform more complex high-voltage work would have to receive additional training in the subjects listed in paragraph (c) of the proposed standard.

Knowledge of high-voltage electricity builds on that of low-voltage electricity. Although both categories share the requirement of familiarity with elements of the low-voltage category, additional training and knowledge would be required for high-voltage qualification. Separate qualification tests would allow electricians to avoid the expenditure of additional time and resources necessary to prepare for qualification in high-voltage work, when some persons would be responsible for performing only low-voltage work at a mine.

Under paragraph (e), applicants for electrical qualification would be required to achieve test scores of at least 80 percent in the voltage category tested. MSHA would also recognize, under the proposal, that practical experience is a valuable asset for mine electricians. Therefore, up to five points, one point for each year of an applicant's experience in excess of the one-year requirement of proposed § 75.153 (a), would be added to the score of each test taken.

Some commenters to the preproposal draft expressed concern that electricians with many years of service would receive too much credit toward qualification, possibly allowing them to become qualified without possessing the required skills and knowledge. The proposed rule would address this concern by limiting credit for experience to five points, to assure that experience alone would not suffice for qualification of mine electricians.

Paragraph (f) would allow electricians to retake MSHA qualification tests if scores of at least 80 percent are not achieved. The first retest could occur within 30 days of notification of the original test results. Applicants would not be eligible for further retesting until at least 30 days after retest results are received. This system would not place a limit on the number of times one could be retested. However, reasonable time intervals between testing would be required in order to promote study to improve applicants' performance on qualification tests.

Section 75.155 State Qualification of Mine Electricians

Under this proposed standard, MSHA would recognize state programs for the qualification of mine electricians for the purpose of meeting MSHA's Federal requirements. Under paragraph (a), the Agency would recognize state programs which meet certain criteria. They would have to include at least the one-year experience requirement specified in proposed § 75.153(a)(2), and the MSHA-developed tests or demonstrations specified in proposed § 75.154 (b) and (c). Alternatively, tests or demonstrations jointly developed and agreed upon by MSHA and a state could be used.

This provision would allow miners to take advantage of state programs to become Federally qualified mine electricians in response to commenters' input that many states presently have effective training and qualification programs. The Agency would allow states to either administer MSHA's tests, or meet with MSHA and develop mutually agreed upon tests or demonstrations. If agreement cannot be reached with an individual state, that state could either give MSHA's test, as a minimum, and require any other additional testing it deems appropriate for state purposes, or simply allow MSHA to administer all Federal qualification tests in that state. This standard would recognize that many states have strong interest in participating in the electrician qualification process. The Agency would

like to promote the efforts of such states, and therefore allow the option of a mutually agreed upon testing scheme. MSHA specifically solicits comments from the states on this issue.

State programs would also have to include provisions to ensure the integrity and fairness of testing and grading procedures for MSHA recognition. This would provide consistent and fair testing of applicants for qualification. For instance, the state would bear the burden of keeping tests confidential and monitoring the materials used by applicants during testing.

Paragraph (b) would require tests given by states for MSHA qualification to be administered by a qualified electrician, as defined by proposed § 75.153. Therefore, a person with the requisite knowledge and experience would be available during testing to respond to questions about the interpretation or intent of the examinations.

Paragraph (c) would require that the District Manager of the district in which testing and grading is to be conducted be notified of the time and place of state-administered testing at least 20 days in advance. The District Manager would have the option of monitoring tests given by the states to ensure that the requirements of state programs recognized by MSHA are met. This aspect of the proposal would assure applicants that testing is administered in a consistent and equitable fashion, in accordance with Federal guidelines or the terms agreed upon by the Agency and the state.

Section 75.156 Electrical Annual Refresher Training Programs

This section is derived from existing § 75.153. Although the refresher training provisions proposed in this section would be similar to those found in part 48, these standards would apply to supervisory as well as non-supervisory mine personnel. All electricians who are qualified in accordance with federal requirements by MSHA or under a recognized state program would have to complete annual refresher training in order to remain qualified.

Under paragraph (a) of the proposal, mine operators would be required to have an annual refresher training program consisting of at least eight hours of safety instruction, and presented by a qualified electrician. This provision is similar to the general requirements of existing § 75.160. However, operators would be required to develop refresher training programs applicable specifically to qualified electricians under the proposal. Mine operators would be in the best position to provide a plan for compliance with the proposed refresher training requirements for qualified electricians working at their mines. Presentation of refresher training by an electrician qualified under § 75.153 would assure that material is reviewed by an instructor who is knowledgeable in the subject, and who is capable of answering difficult questions which may arise.

Operators' programs would be required to include a review of electrical accidents occurring in the industry and their causes, and a review of electrical safety procedures including lockout and tagging methods. To obtain copies of MSHA accident and fatality reports, operators can contact the appropriate MSHA district office. The District Manager would arrange for the reports to be sent to operators upon request from the National Mine Safety and Health Academy.

MSHA believes that training which covers these topics, at a minimum, would update mine electricians on current electrical technology and hazards associated with mine electrical work, and reiterate safe operating procedures designed to avoid these hazards. Dedication of a minimum of eight hours per year for review of these topics would be beneficial to the overall quality and safety of mine electrical work, and would not be unduly burdensome to operators.

Existing § 75.160 requires operators to have an approved plan for retraining of qualified persons. Paragraph (b) of the proposed standards would list minimum requirements for such plans. They would be required to consist of refresher training conducted by the operator, the Agency, a state, associations of mine operators, miners' representatives, other mine operators, private associations or educational institutions. The effect of this provision would be to allow operators to take advantage of any available programs which meet the proposed requirements, thereby affording several compliance alternatives. Operators need not expend time and resources to conduct their own refresher training, but could fulfill the proposed requirements by utilizing other available programs.

Paragraph (c) would state that only electricians who have completed annual refresher training under an operator's approved plan would be permitted to perform work required to be performed by a qualified electrician. This proposed standard would prohibit persons from doing the work of a qualified electrician if they have not successfully completed refresher training at least annually. Thus, persons doing such work would be aware of the latest technology and information about electrical hazards and safety procedures.

Under paragraph (d), derived in part from existing § 75.153 (g), electricians who do not successfully complete refresher training for a period of three consecutive years would no longer be considered qualified. To regain their qualified status, such persons would have to reapply for qualification in accordance with proposed § 75.153. This provision recognizes that there may be periods when a qualified electrician is not called upon to perform electrical work. They may engage solely in mechanical work, or in a non-mining occupation for a time. Such persons may let annual refresher training lapse, but they would be prohibited from doing the work of a qualified electrician during the lapsed period under the requirements of paragraph (c) of the section.

Within a three-year period, completion of refresher training would be sufficient to restore the electrician's qualified status. However, electricians who have not completed refresher training for three consecutive years could regain qualification only by resubmitting to the proposed qualification testing process. This standard would ensure that qualified electricians remain adequately trained in electrical work and safety procedures while they are called upon to do the work of a qualified electrician. If their position does not require them to perform the work of a qualified electrician, they are not required to complete annual retraining. However, to avoid having to retake qualification tests, they must take refresher training before the end of three years.

The District Manager would have the option of monitoring refresher training sessions under paragraph (e). Therefore, the rule would require that notification of the time and place of training be given to the District Manager at least 20 days in advance. The monitoring option would allow the Agency to evaluate the comprehensiveness and adequacy of refresher training programs, and therefore determine whether qualified electricians are being kept abreast of important safety information. In this way, the standard would assure that underground electrical work will be carried out in the safest possible manner for the protection of electricians and miners.

Paragraph (e) would allow the District Manager to revoke approval granted under existing § 75.160 of an operator's refresher training program for cause. If the program no longer complies with the

minimum requirements of the proposed rule, for instance, approval could be revoked. Additionally, section 110 (f) of the Federal Mine Safety and Health Act of 1977 makes the intentional falsification of records required by the Agency criminally punishable. Such action would also be cause for revocation of approval.

Section 75.157 Qualification for Low-Voltage Cable Splicing and Repair

Proposed § 75.157 sets forth new requirements for the qualification of persons to splice and repair low-voltage trailing cables. The intent of the standard is to allow persons other than qualified electricians to repair and splice low-voltage trailing cables, provided they are adequately trained. At the same time, miners handling or working around low-voltage trailing cables would be assured that they are maintained by persons qualified for the task.

The Agency received comments on the preproposal draft which both supported and objected to a qualification program for cable splicing and repair. Supporters of the standard felt that it could have significant overall safety value to the mining industry, by allowing qualified electricians to attend to more demanding electrical work in the mines. At least one commenter expressed concern regarding whether persons who are not qualified electricians could be adequately trained for the difficult tasks of splicing and repairing cables, particularly high-voltage cables. Therefore, the commenter suggested deletion of the proposed standard.

The proposal addresses these comments by allowing persons qualified under proposed § 75.157 to splice and repair only low-voltage trailing cables. Qualified high-voltage electricians would be required by proposed § 75.519 to splice and repair high-voltage cables, which can contain numerous components energized at very high voltages, and would therefore require the expertise of a qualified electrician. Under the proposal, the knowledge and skill of a qualified electrician would be applied to the demanding work of maintaining high-voltage cables, and low-voltage cables could be spliced and repaired by those persons specifically trained and qualified for the task. Therefore, miners would be protected against shock and fire hazards caused by improper splicing or repair of all cables.

For qualification in low-voltage cable splicing and repair, paragraph (a) of the standard would require individuals to have at least one year of experience as a miner on a working section of an underground coal mine, and successfully complete a written MSHA test administered by the Agency or a state. Additionally, applicants for qualification would be required to successfully perform a practical demonstration of their ability to splice and repair low-voltage trailing cables.

Under the proposal, applicants for qualification would be required to demonstrate their knowledge and skill in the subject to representatives of the Agency or a state. It is important that those persons charged with the maintenance of low-voltage cables be sufficiently knowledgeable about safe procedures and electrical hazards involved in order to protect miners from electrical injury caused by faulty splices or repairs. A practical demonstration of cable splicing ability would provide for a more comprehensive and accurate evaluation of an applicant's skill.

Paragraph (b) lists the subjects which would be covered by MSHA's written test. They would include written examination of lockout and tagging procedures, and other safety precautions relevant to splicing and repair of trailing cables, the applicable requirements of part 75, and the purpose and use of cable splicing components. These subjects represent, in MSHA's view, the minimum knowledge which should be required of qualified cable technicians in order to assure miner safety.

Paragraph (c) of the proposed rule would require written tests for low-voltage cable qualification to be administered, and practical demonstrations monitored by an authorized representative of the Agency, or an authorized representative of the state who is a qualified electrician or qualified for low-voltage cable splicing and repair. This would ensure the integrity of testing procedures and would provide for the presence of a person able to respond to technical questions which may arise regarding testing procedures or interpretation. The Agency would not be responsible for providing the facilities and equipment needed for practical demonstrations.

The parameters of the practical demonstrations required by the proposal are discussed in paragraph (d). Applicants would be required to demonstrate their ability to perform all safety precautions required by part 75 for splicing trailing cables, properly repair a damaged outer jacket, and demonstrate the proper methods of splicing metallic cable shielding. The proposed testing procedures would permit thorough evaluation of an applicant's practical abilities to correctly and safely splice and repair low-voltage trailing cables.

Under paragraph (e), the District Manager would have the opportunity to monitor all testing administered by a state for qualification. Notification of the time and place would be required to be given to the District Manager of the MSHA district in which testing will take place at least 20 days in advance for this purpose. This would assure that testing and evaluations are done in accordance with MSHA's regulations.

Revocation by the District Manager of a miner's qualification to splice and repair low-voltage trailing cables for cause would be possible under paragraph (f) of the proposal. Intentional violation of the requirements of part 75 or intentional defeat of safety devices or circuits would be examples of cause for revocation. Persons who intentionally disregard the safety of themselves and fellow miners would be considered unqualified by the Agency to perform cable splice and repair work. As in proposed § 75.153, miners would be given the protection of due process when the Agency intends to revoke their qualification.

Section 75.159 Records of Certified and Qualified Persons

The proposal would revise existing §§ 75.153 and 75.159, by requiring mine operators to maintain available for inspection at the mine, and certify by signature and date as accurate, a list of the names of all persons qualified as electricians or low-voltage cable splicers, the dates of qualification and retraining and the applicable voltage category. Existing § 75.159 now requires operators to maintain lists of all certified and qualified persons designated to perform duties under part 75. Requiring the operator to attest to the accuracy of the list would help to prevent abuses or mistaken inclusion of persons who have not been properly qualified. Under the proposal, authorized representatives of the Secretary and miners' representatives would be able to determine whether mine electrical work is being performed in a safe manner by qualified electricians. It would allow interested persons to readily determine whether electrical work and splicing and repairs of low-voltage cables are being carried out by those who have been properly qualified to do so.

Existing § 75.153(g) now requires individuals to certify to MSHA that they have successfully completed annual refresher training. The purpose of the standard is to aid the Agency in keeping records of qualified persons current and

issuing qualification cards. This standard would not be retained under the proposed rule. The Agency would retain its enforcement capabilities by requiring operators to certify to the accuracy of the list of qualified persons and the information required by the proposed amendment to § 75.159. However, the proposed revision may impact on the Agency's past practice of issuing qualification cards. Individuals would continue to be notified by MSHA that they have successfully completed the requirements for qualification. The Agency solicits comments on this issue from interested parties.

Scope Sections

Sections 75.500, 75.600, 75.700, 75.800, and 75.1000 Scope

Each subpart of the proposed rule would be preceded by a new scope section. Scope sections would be useful in order to clarify the rules which follow it and facilitate compliance efforts. It would also offer to interested parties a concise guide to what would be included and excluded from each proposed subpart. Subpart F would contain general requirements for the installation, maintenance, testing, examination, electrical protection, and performance of electric equipment and circuits. The subpart would also contain specific requirements for low-voltage trailing cables, encompassing mechanical protection, splicing and repair, disconnects, ground-wire monitors, and insulated handling equipment. The design and construction of permissible equipment and intrinsically safe circuits would not be addressed by the subpart, except as specified in §§ 75.503, 75.509, 75.511 and 75.529. Those subjects are covered primarily by the applicable approval regulations contained in 30 CFR part 18.

Subpart G, §§ 75.601 through 75.604, would contain requirements for low-voltage circuits. It would include standards for the design and construction, electrical protection, and cable coupler restraints of trailing cables and low-voltage a-c circuits. The subpart would also address electrical protection and performance of single-phase and three-phase low-voltage a-c systems which supply power to electric equipment located outby the working section. However, single-phase systems energized at 150 volts or less to ground would be addressed in subpart F. Also excluded from the coverage of the subpart are requirements pertaining to mechanical protection, splicing and repair, disconnecting devices, ground-wire monitors, and insulated handling equipment for low-voltage circuits.

Subpart H would include grounding requirements for circuits and equipment, including grounding of metallic parts, raceways and enclosures of electric equipment, methods of grounding a-c and d-c systems, grounding of a-c and d-c equipment frames and components, diode grounding systems, and system and supplemental ground fields. Additional grounding requirements for a-c systems supplying power to stationary lighting fixtures for illumination of working places are addressed by existing subpart R. The primary purpose of the proposed subpart is to reorganize, clarify and simplify existing standards, which are presently found throughout MSHA's regulations. This subpart would represent a consolidation of the grounding requirements for the equipment and systems specified.

Subpart I would contain requirements pertaining to high-voltage circuits and equipment used underground. Section titles in the subpart would specify where the requirements pertain only to high-voltage electric face equipment and associated trailing cables. More general standards applicable to all high-voltage equipment would be contained in subparts F and H. The applicable approval regulations in existing part 18 would address sizing of conductors and overload protection for circuits extending to and on board permissible face equipment.

Subpart K would contain requirements for trolley circuits, including installation, maintenance and electrical protection of trolley systems, and movement of off-track mining equipment and supplies in trolley entries.

Subpart F—Electric Equipment—General

Section 75.501 Permissible Electric Equipment

This proposed standard would set requirements for electric equipment used in working areas of a mine where the dangers of explosions and fire are most present. The section would consolidate the requirements in existing §§ 75.500, 75.500–1, 75.501, 75.501–2, 75.504, 75.505, 75.507, and 75.1002–1. It would offer a clear statement of existing requirements for the use of permissible equipment, and would incorporate MSHA experience regarding procedures for the safe use of some nonpermissible equipment in areas where permissible equipment is normally required.

Under paragraph (a) of the proposal, only permissible electric equipment, with specified exceptions, would be permitted to be located in or inby the last open crosscut, within 150 feet of pillar workings, or longwall and shortwall faces, in areas ventilated by air which has ventilated any working place or any worked-out area, whether pillared or non-pillared, or inaccessible areas. Permissible equipment is defined in existing 30 CFR 75.2(i) as equipment used in face areas which is designed, constructed and maintained so as not to cause a mine explosion or fire, or to the greatest extent possible, other accidents in their use.

This paragraph of the proposal would clarify for the purposes of this standard, MSHA's view that air which has ventilated working places or worked-out areas is air which can contain dangerous levels of methane. Electric equipment located in the specified areas would therefore be required to be permissible, in accordance with the existing approval regulations of part 18.

The hazards addressed by the standard would be methane and coal dust ignitions, explosions, and fires. By requiring that permissible equipment be used in areas where methane and dust concentrations are most dangerous, the risks to miners would be reduced. To enhance miner safety, electric equipment used in these areas would have to be designed, constructed, and maintained in accordance with MSHA approval regulations to eliminate possible ignition sources on such electric equipment.

Paragraph (b) of the proposed rule would be new, and would address comments to the preproposal draft that, at times, nonpermissible repair equipment is needed in working places. For instance, permissible welders are not available in the mining industry, but a welder may be required to repair immobilized electric equipment in a face area. To remedy this problem, the proposed standard would allow limited use of non-permissible repair equipment, provided proper safety precautions are taken. The proposal would allow the use of non-permissible electric welders, hand-held power tools, and test instruments in working areas only to repair disabled and immovable permissible equipment.

However, to assure miner safety, the area would have to be ventilated by air which has not been used to ventilate coal cutting or loading operations, and which contains less than 1.0 percent methane. Further, a fire extinguisher of the type described in existing § 75.1100–1(e), or a 240-pound supply of rock dust would be required to be located within fifty feet of the equipment being repaired. Repairs would have to be made under the supervision of a person

certified as defined in existing § 75.2(a), who would make tests before and during work to determine that less than 1.0 percent methane exists in the area, and make fire checks during and after the repair process.

The Agency's present policy is to permit repair of immobilized permissible equipment if repairs are undertaken in accordance with existing § 75.1106. The relevant provisions of that standard are therefore incorporated in the proposed rule. Although commenters suggested that fire extinguishers should be required within arm's reach of a miner making repairs, a fifty-foot requirement would make the extinguisher readily available, without necessitating continual movement of the extinguisher or large quantities of rock dust to within grasp. The risk to miners from the specified non-permissible repair equipment would be limited by the monitoring and safety precautions built into the proposal. The rule would incorporate the practical policy of allowing immobilized electric face equipment to be repaired with tools necessary for the task.

Paragraph (c) would be a new provision, containing a second exception to the standard at paragraph (a). It would allow the presence of certain equipment certified by MSHA as explosion-proof in areas where permissible equipment is required, provided such installations are approved by the District Manager. Explosion-proof distribution boxes, controller boxes and motors used as part of water pump assemblies, and cable couplers that are certified as explosion-proof by MSHA would be allowed in such areas under the standard. The use of pumps in areas where permissible equipment is required is often necessary to alleviate a dangerous buildup of water. Approved pumps of the size and type needed to meet the need are not always available, requiring the mine operator to assemble a pump capable of removing the water. In such instances, the formal approval process would be too time consuming when a practical necessity exists to remove water quickly and prevent flooding. Additionally, it would be economically burdensome for all mine pumps to be of an approved type, solely to meet a need which may or may not arise.

The proposed standard would allow the District Manager to approve the use of pumps assembled to remove water accumulations in specific instances without necessitating use of the formal approval process. By requiring that the equipment be explosion proof, the likelihood of its causing a fire or methane ignition would be remote. Additionally, safety considerations such as conductor size and circuit protection would be reviewed by the District Manager before the installations are approved, thereby assuring compliance with applicable provisions of part 75.

Section 75.502 Installation of Electric Conductors

As proposed, § 75.502 would limit the types of electric conductors permitted in areas where permissible equipment is required. It would be a new standard, replacing existing § 75.1002, which prohibits the use of all high-voltage cables inby the last open crosscut and within 150 feet of pillar workings.

Under the proposed standard, only trailing cables supplying power to permissible equipment, conductors of permissible equipment and intrinsically safe circuits, shielded cables, conductors of electric equipment needed to make repairs under proposed § 75.501(b), and conductors of electric equipment under proposed § 75.501(c) would be permitted in such areas. These types of conductors and cables would not pose increased risks of fire or explosion in face areas. Though not specifically mentioned in the proposed standard, cables which serve permissible blasting units would be allowed in these areas, as they would be considered conductors of permissible equipment.

This section of the proposal would prohibit the location of conductors such as trolley wires and trolley feeder wires within 150 feet of a mine face. Such electric conductors could provide a ready ignition source, and therefore should be prohibited from use in areas of the mine where methane and dust concentrations pose the highest risk of ignition.

Several commenters to the preproposal draft expressed the need for allowing high-voltage cables to be used in face areas in order to facilitate the use of longwall mining units. The proposal contains a new provision which would address the comments by allowing shielded cables, whether high or low-voltage, to be used in areas where permissible equipment is required. Therefore, shielded high-voltage cables, such as those used in the longwall mining process, would be permitted in face areas.

The modern development of longwall mining systems and the widespread desire to use them in the industry have resulted in a consistent influx of petitions to modify existing § 75.1002 to allow high-voltage cables to supply power to the high-voltage longwall units. The proposal would restructure the existing standard to allow use of such modern technological advances. One purpose for the existing prohibition of high-voltage cables in face areas was to limit the types of equipment used there. Some equipment requiring high-voltage power cables was not permissible. Therefore, prohibiting the use of high-voltage cables had the effect of prohibiting the use of some non-permissible equipment inby the last open crosscut or within 150 feet of pillar workings.

MSHA began to grant petitions for modification to 30 CFR 75.1002 to allow the use of high-voltage longwalls approximately three years ago. To date, there have been no fatal electrical accidents attributable to the use of the high-voltage longwall equipment allowed by petitions. Permitting high-voltage cables in face areas, in conjunction with requiring shielding of such cables and that the equipment served by them be permissible, would not increase the risks of fire and explosions. The proposed rule would permit operators to take advantage of a useful modern mining method without the need for utilizing the petition process.

Section 75.503 Construction, Maintenance, Modification, and Identification of Permissible Electric Equipment

This section would set requirements for the construction, maintenance, modification and identification of permissible electric equipment. It is derived from existing requirements at §§ 75.503, 75.504, 75.505, 75.506, and 75.506–1. It would simplify and clarify the requirements found in the existing standards in order to facilitate compliance efforts.

Paragraph (a) of the proposal would require permissible equipment to be constructed in accordance with the MSHA approval regulations in effect at the time the equipment is manufactured, and maintained in accordance with the regulations under which it was approved. These proposed standards would not represent great change from the existing regulations. Miners required to work with and around such equipment would be assured under the proposal that permissible equipment is maintained in permissible condition, in accordance with the approval regulations of part 18. MSHA has detailed permissibility requirements for electric equipment in part 18, which would work in conjunction with the proposal. In order to retain its permissible status, such equipment must

be maintained in accordance with the applicable approval regulations.

Some commenters to the preproposal draft suggested allowing non-permissible recording devices to be attached to permissible equipment used inby the last open crosscut. Such devices are often used in testing and evaluating plans for longwall sections. Presently, an experimental permit is necessary to attach nonpermissible equipment to an approved machine. The commenters stated that the time necessary to apply for and receive an experimental permit causes delays in setting up longwall sections. This suggestion was not adopted in the proposal, because operators have begun to submit applications for experimental permits far enough in advance of their planned start-up dates. Therefore, adequate lead time is being planned for, and the problem of delays has been reduced since publication of the preproposal draft.

Under paragraph (b), field modifications of permissible equipment would be required to be made and maintained in accordance with the MSHA approval regulations in effect at the time of the modification. This provision would assure that modifications of electric equipment, including modified components of such equipment, will not affect its permissible status. Additionally, modifications to permissible equipment would have to conform to the most up-to-date permissibility standards to ensure that they reflect the state of current technology and information available to the Agency.

Under paragraph (c), a new provision under the proposal, requests for modification of permissible equipment would be required to be made in writing to MSHA's Approval and Certification Center in Triadelphia, West Virginia. Planned modifications would be required to accompany the application to facilitate evaluation of the request by the Agency.

Paragraph (d) would be a new part 75 provision, which would require approval and certification plates to be attached to permissible equipment and maintained so that model numbers, approval numbers, and certification numbers are legible. Existing § 18.11 requires approval plates to identify equipment as permissible. The proposed standard would assure that the plates are maintained so that they are legible while the equipment is in use underground. Legible approval and certification identification plates would allow interested parties to determine at a glance whether equipment operating in working areas has met with the applicable MSHA regulations, thereby helping to identify risks from electric equipment.

Section 75.504 Current Between Frames of Permissible Electric Equipment

This section of the proposal would limit the amount of current permitted to flow between the frames of any two units of permissible equipment operating where permissible equipment is required. The proposed rule would simplify and clarify existing § 75.524, but would not alter the requirements found in the existing standard.

Under the proposal, when two pieces of permissible equipment come in contact, the current permitted to flow between them could be no greater than 1.0 ampere, measured across a 0.1 ohm resistor connected between the frames of the equipment. Limiting the allowable current between the frames of such equipment would reduce the risk to miners of shocks and methane explosions due to inter-machine arcing.

Section 75.505 Installation and Maintenance of Electric Circuits and Equipment

Installation and maintenance of electric circuits and equipment would be addressed by this section, derived primarily from existing § 75.511, which specifies those persons permitted to perform work on electric circuits and equipment. Paragraph (a) would require installation and maintenance of electric circuits and equipment to be performed by a low-voltage or high-voltage qualified electrician, as applicable. This would assure that difficult and dangerous electrical work is performed by those possessing the necessary skill and training to do it. The qualification procedures for such persons are described in § 75.153 of the proposed rules.

Paragraph (b) would contain an exception to the proposed requirements of paragraph (a). Persons trained to perform electrical work who are directly supervised by a qualified electrician would be permitted to perform electrical work on low-voltage circuits. The proposal represents some change from the existing standards. As in the existing rule, trained non-electricians would be permitted to install and maintain electric circuits, but the proposal would allow them to do so only in the presence of, and under the direct supervision of a qualified electrician.

The effect of the rule would be to allow persons other than qualified electricians to assist in the installation and maintenance of low-voltage electric circuits. However, mandatory supervision would bring the expertise and training of the qualified electrician to bear on the work being done.

Some commenters to the preproposal draft expressed the view that overall improvements in electrical safety would result from the standard. Further, valuable experience would be gained by allowing trained persons to work on low-voltage circuits. In this way, persons could fulfill the experience requirements of proposed § 75.153 for future qualification as mine electricians. The proposal would adopt these views.

Paragraph (c) of the proposed standard is new, and would also embody an exception to paragraph (a). Persons qualified under proposed § 75.157 would be permitted to splice and repair low-voltage trailing cables on those parts of the cable which are external to couplers or compartments without the supervision of a qualified electrician. The Agency believes that persons meeting the qualification requirements of proposed § 75.157 would be adequately prepared to safely make splices and repairs on low-voltage trailing cables. By permitting them to do so, the rule would allow qualified electricians to attend to more difficult electrical problems in the mine, while ensuring that low-voltage cable splices and repairs are made in the safest possible manner by persons qualified to perform the tasks.

Paragraph (d) would be a new provision which sets out the direct supervision requirement referred to in paragraph (b) of the proposed rule. The supervising qualified electrician would be responsible for providing direct and immediate supervision and be present during the work. The standard is intended to clarify that at least one supervising qualified electrician must be present and available to the trained person or persons working on low-voltage circuits to provide direction and assistance.

The qualified electrician would have to be in the immediate area, such as on the same working section or in the same shop area as the work being done, to provide accessibility to the persons being supervised. A one-to-one ratio of qualified electricians and trained persons would not be required. However, remote communication with the person or persons being supervised from the mine office or some other locale would not suffice under the standard. If problems should arise beyond the skill or experience of the trained persons, a qualified electrician would be available in the immediate area to quickly come to their assistance.

The supervising electrician would be required to assure that the circuit or

equipment has been deenergized, disconnected and locked out and tagged before work is begun, and to examine and test completed work before the circuit or equipment is reenergized. These measures would assure that electrical tasks are performed safely and accurately so that they will not result in injury to miners. Further, those being supervised in the work would gain valuable experience in electrical work.

Section 75.506 Work on Electric Circuits and Equipment

This section would consolidate the procedures presently required for the performance of work on electric circuits and equipment by existing §§ 75.509, 75.511, 75.705, 75.705–1, and 75.1725. It would require deenergization of electric circuits and equipment before work on them is started, except when energization is necessary for troubleshooting and testing low-voltage circuits and equipment. Paragraph (a) would be new, requiring doors and cover plates on electric equipment which allow access to electric connections to be closed at all times, except during installation, testing, and repair. This would minimize the risk of inadvertent contact with energized components of equipment and circuits.

To deenergize circuits and equipment before work is begun, paragraph (b) of the proposal would require that the appropriate disconnecting device is opened, tagged, and locked out with a padlock and tag for each person assisting in the work. Commenters to the preproposal draft suggested a requirement for more stringent safety procedures for working on electric circuits and equipment due to the dangers involved. Data available to the Agency show that since 1970, approximately 54 fatalities occurred while miners were working on energized circuits and equipment. In the past five years alone, approximately 9 of those miner deaths were related to improper use of or failure to use disconnecting devices. Deaths and injuries have also occurred when equipment was energized before all persons had completed work.

Several commenters to the preproposal draft supported the use of individual locking devices and tags for each person performing work to assure that all persons are aware of whether the circuit or equipment being worked on has been deenergized. The proposed standard would adopt these measures. MSHA believes that the use of padlocks would best assure the safety of those conducting repairs on electric circuits and equipment. Additionally, tags would have to identify each person performing the work and identify the circuit or equipment being worked on. MSHA believes that the circuit or equipment needs to be identified in addition to the person performing the work, to adequately indicate whether all persons assisting in the work have completed their tasks. The Agency solicits comment on the benefits of requiring circuit or equipment identification on the tags. The risk of mistaken or premature removal of the padlock and resulting injury to miners, would be reduced under the proposed standards.

When two or more electric circuits are located within a single compartment, each circuit would be required to be deenergized and properly locked out before electrical work is started on any circuit. Several fatalities have occurred where an individual has contacted an energized circuit while working on a deenergized circuit in the same compartment. The proposal would prevent such occurrences.

Under paragraph (c), the proposal would require that when high-voltage power conductors are required to be deenergized, they would have to be connected to the system grounding conductor by a high-voltage qualified electrician. The high-voltage circuit would have to remain grounded until work has been completed. This provision would prevent the occurrence of reenergization of high-voltage conductors while work is being performed on an associated circuit. Further, grounding would provide a fault path to leak off excess charge in the conductor to prevent shock hazards to miners.

Unlike existing § 75.511, which allows locks to be removed by authorized persons, §§ 75.506(d) and 75.815(e) of the proposal would allow only the person who installs a padlock or tag to remove it. A commenter to the preproposal suggested a requirement that electricians performing work on circuits should have padlocks with their own unique key in order to guard against accidental energization. The suggestion was adopted in the proposal to assure that only the individual who installed a lock could signify when he or she has completed work. A master key or combination would not be available to others, who could mistakenly allow a circuit to be reenergized prematurely. All parties would be made aware of who is working on what equipment or circuit under the proposal. If individuals are made responsible for installation and removal of their own locks and tags, the risk of accidental reenergization of a circuit while work is being done on it would be eliminated.

Each person required to perform work on the circuit or equipment would be responsible for installing and removing their own locking devices, to ensure their personal safety. Between shifts, the circuit or equipment should remain tagged if work has not been completed. Additionally, the supervisor or foreman could tag the equipment or circuit or lock-out with his or her own padlock between shifts. Persons required to continue work on the next shift would be responsible for installing individual locks at that time, and removing them when their work is completed.

There may be some unusual circumstances where the mine operator could demonstrate a need to remove an employee's lock. Recently, the Occupational Safety and Health Administration (OSHA) issued a final rule with such an exception (54 FR 36644). Under the OSHA rule, the employer could remove an employee's lock if, at a minimum, the employer has procedures to: verify that the employee is not at the facility; make all reasonable efforts to contact the employee to inform the employee that the lock has been removed; and can ensure that the employee knows that the lock has been removed before resuming work at the facility. The Agency solicits comments on whether, and if so under what circumstances, such an exception would be appropriate for underground coal mining.

Paragraph (e) of the proposed standard would state that when mechanical repairs or maintenance being performed on electric equipment requires removal of power in accordance with existing § 75.1725 (c), the disconnecting devices would be required to be opened, locked out with a padlock and tagged by persons performing the work. Those persons required to do mechanical work on electric equipment are exposed to serious risk of injury, particularly since they may not have any familiarity with the electrical hazards involved, or the possibility of inadvertent start-up of the equipment. The proposal would assure proper deenergization and lockout of circuits while mechanical work is being performed.

Under paragraph (f), conductors that are not supplying power to electric equipment would be required to be deenergized and either removed from their supply source or have their supply source locked out and any exposed ends insulated. The proposal addresses shock hazards created when a person comes into contact with abandoned or unused energized conductors. Conductors should be disconnected at the

conductor's supply point to assure total deenergization. The option to insulate the wiring ends and lockout the circuit is also included to allow for maintenance and repair as a compliance alternative.

Section 75.507 Electrical Troubleshooting and Testing

This section is derived primarily from existing §§ 75.509, 75.511, 75.705–1 and 75.1720, and would address safety procedures to be used when troubleshooting and testing energized circuits. Proposed § 75.506 would recognize that in some instances, it is necessary for a circuit or equipment to remain energized for troubleshooting and testing. For example, in order to discover the nature of some problems within a circuit, voltage readings must be taken while the circuit remains energized.

Under paragraph (a), the proposal would permit troubleshooting and testing only of low-voltage energized circuits by qualified electricians, when the purpose is to determine voltages and currents. Troubleshooting and testing energized circuits is extremely hazardous work. Therefore, the skills and training of a qualified electrician would be appropriate for performance of these tasks. Troubleshooting and testing would be limited to low-voltage energized circuits, primarily due to the insulation ratings of available troubleshooting and testing equipment. The insulation ratings on equipment commonly used are insufficient for miner protection for use on high-voltage circuits.

Paragraph (b) would require qualified electricians to wear rubber insulating gloves with protective coverings designed to prevent physical damage to the insulation material during troubleshooting and testing. Several commenters to the preproposal draft suggested that properly rated rubber insulating gloves be worn by persons performing troubleshooting and testing of energized circuits for protection against electric shock. A review of the fatality record has shown that at least six fatalities have occurred since 1970 due to contact with energized circuits while trouleshooting and testing without the benefit of gloves. Leather coverings, for example, would protect the insulating material of gloves against tears and physical damage which could render them ineffective for protection against electric shock to the qualified electrician.

Paragraph (c) of the proposal would require high-voltage circuits contained in the same compartment as the low-voltage circuit being tested to be deenergized, grounded, locked-out and tagged, or physically separated by a permanent barrier or partition from the low-voltage circuit before troubleshooting or testing the circuit. These methods of preventing contact with the uninvolved circuit would minimize an electrician's exposure to electric shock, electrocution, and burns from arcing. The proposal thus provides for several equally effective compliance alternatives. A "permanent" barrier is specified to assure that persons will not be forced to insert a temporary or removable barrier while work is being performed and contact energized components of the equipment.

Commenters to the preproposal draft suggested deleting the provision permitting isolation of the uninvolved energized high-voltage circuit by a barrier or partition. MSHA believes, however, that the proper use of permanent barriers of partitions would provide the same measure of protection to the electrician as would the other specified methods.

Paragraph (d) is a new provision, which would set requirements for the gloves required to be worn by qualified electricians under paragraph (b) of the standard. Rubber insulating gloves would have to be rated for at least the nominal voltage of the circuit, examined before each use for damage and defects, and removed from the underground areas of the mine when damaged or defective.

The dangers inherent in working with energized circuits require safety precautions such as the wearing of insulating gloves which are appropriately rated for the voltage of the circuit, to afford maximal protection. The proposal would make qualified electricians responsible in part for their own personal safety by requiring them to examine their gloves for damage or defects before relying on them. It would also assure that protective gloves are removed from the underground areas of the mine to prevent inadvertent use of and reliance on damaged or defective gloves.

Section 75.508 Examination and Testing of Electric Equipment and Circuits

This proposed standard would set requirements for installation, maintenance and periodic examination and testing of electric equipment used underground. The general requirements of existing §§ 75.512, 75.512–2, 75.703–3, 75.800–3, 75.800–4, 75.803, 75.900–3 and 75.900–4 would be included in and replaced by this proposed section. Paragraph (a) is new, and would require electric equipment and circuits to be installed, maintained, and used to prevent fire, electric shock, ignition, or operational hazards. Equipment or circuits that present a hazard to persons due to improper installation or maintenance, misuse, or damage would have to be deenergized and tagged as a hazard. This standard would require that equipment and circuits are maintained in continual safe condition, even between examinations and testing. If a hazardous problem is discovered at any time, the equipment or circuit would have to be deenergized and tagged as a hazard.

Paragraph (b) would require a qualified electrician to make periodic examinations of electric equipment and circuits to determine that the electrical protection, equipment grounding, permissibility, cable insulation, and control devices are being properly maintained to prevent a fire, electric shock, ignition or operational hazard from existing on the equipment. Examinations would be required to include testing of equipment and circuits when necessary to make such determinations; that is, when visual examination alone would not be sufficient to determine whether a problem exists. For instance, to discover whether continuity of the grounding conductor is being maintained in a low-voltage trailing cable, a test must be performed, because this could not be determined through visual examination alone.

Electric equipment used in underground coal mines is subjected to heavy, continual use, which can result in wear and breakdown. The mine atmosphere is also particularly harsh for electric equipment. Unless it is frequently examined, potential problems could go undiscovered, and could compromise the safety of miners working with or around such equipment. This provision would direct the steps necessary for compliance with paragraph (a) of the standard. It reflects the suggestion of commenters to the preproposal draft that more specific testing and examination requirements be included in the proposal in order to clarify the required procedures.

Paragraph (c) would specify the frequency of examinations of low-voltage electric circuits and equipment. It would retain the requirement of existing § 75.512–2 that examinations and necessary tests of mobile and portable equipment and circuits be made when installed and at least every seven days thereafter. Mobile and portable electric equipment and circuits are susceptible to the greatest risk of damage or breakdown from heavy use in a mine. The Agency believes that

frequent tests and examinations of such equipment are an essential part of an effective maintenance program. They would assist in the discovery of equipment defects before they could cause injury to miners.

Low-voltage stationary equipment and circuits would have to be examined and tested when installed and at least every 30 calendar days thereafter, as would hand-held electric power equipment under the proposed rule. The 30-day period represents a change from existing § 75.512–2, which sets a seven-day examination cycle. After considering the level of use and the possible hazards involved with hand-held and stationary equipment, the Agency's view is that examination and testing of these units every 30 days would be more appropriate. Qualified electricians would have more freedom under the proposed rule to concentrate on examination and testing of mobile and portable electric equipment, which represent a greater danger to miners.

Under paragraph (d), surface and underground high-voltage switchgear used in conjunction with circuits extending underground would have to be tested at least once every 90 calendar days. Tests would be required to include breaking the continuity of the ground-check conductor at the extreme end of the monitoring circuit when a ground-check conductor is used, to assure that the entire circuit will be properly deenergized when necessary. Additionally, the circuit breaker would be required to be opened by actuating at least one interlock switch for each power center.

Existing § 75.800–3 is interpreted to require specific testing of surface circuit breakers protecting underground high-voltage circuits, and visual examination of underground circuit breakers once each month. The proposed standard would add specific testing requirements for underground circuit breakers to be performed at least every 90 days, in addition to a visual examination, which would be required every 30 days under paragraph (e) of the section. If visual examinations are completed diligently, actuation of the underground circuit breaker every 90 days, as specified in the proposal, would be adequate to assure that it is in proper working order.

Electrical protective devices are not often called upon to deenergize high-voltage circuits. When they are needed, miners should be assured that they will properly function for their protection. Testing in the specified manner would increase the likelihood that miners are protected against injuries which can occur due to faulty protective devices and equipment. The main circuit breaker would be subject to the more stringent tests and examinations detailed in paragraph (f). Paragraph (e) would require the equipment to be visually examined at least once every 30 calendar days for hazardous conditions resulting from exposed energized parts or equipment defects.

Paragraph (f) would be a new provision, which would require surface high-voltage grounding resistors and circuit protective devices which protect underground circuits to be tested when installed and at least every twelve months thereafter. Commenters requested that specific testing procedures be included in the standard, in order to provide adequate guidance and consistency. Testing of the specified devices would be required to include passage of an amount of current through each current transformer necessary to cause the circuit breaker to open. The standard would also require activation of the circuit breaker by impressing an amount of voltage across each potential ground-fault device necessary to cause the circuit breaker to open, and a determination of whether the grounding resistor is open or shorted. These steps would ensure that protective devices and grounding resistors are maintained in operative condition.

The proposed testing requirements would involve intentional tripping of the circuit breaker to assure that protective devices will work properly at their specified voltage or current levels when called upon to do so. Experience indicates that a twelve-month testing interval is a reasonable period for determining whether adequate circuit protection is provided by the devices.

Should tests or examinations reveal a fire, electric shock, ignition or operational hazard on high-voltage equipment, paragraph (g) would require it to be removed from service or repaired. Requiring prompt repair or removal of hazardous electric equipment and circuits from service would ensure that miners working with or around them would not be injured by them. Repairs would have to be completed on such equipment before it is put back into service.

Under paragraph (h), at the completion of tests and examinations, the person responsible for making them would be required to certify by signature and date that they have been performed, and make a record of unsafe conditions found and corrective actions taken. If the same individual is responsible for examining and testing multiple units of equipment or circuits, only one certification that they have been performed would be necessary. Requiring certification of examinations and testing for each machine or circuit would be unnecessary, provided it can be ascertained that this proposed standard has been complied with.

Paragraph (i) would require the mine operator to keep records and certifications for at least one year, and make them available at the mine for inspection by authorized representatives of the Secretary and representatives of miners. These certifications and records would enable interested persons to easily determine whether equipment and circuits are being tested to assure proper maintenance. They would also aid in investigations of mine accidents and point out patterns of defects which might suggest the need for redesign of units of electric equipment.

Paragraph (j) of the proposal would be new, stating that equipment which remains idle for longer than the proposed testing intervals would not have to be examined or tested while idle. However, to address unknown hazardous conditions arising during idle periods, examination and testing would be required before such equipment is returned to service. Tests of idle equipment would serve no safety purpose, but idle equipment should be examined and tested for malfunctions or hazardous conditions, such as damaged relays or valves, before being returned to service.

Section 75.509 Switches, Control Devices, and Control Circuits

This section of the proposal is derived in part from existing §§ 75.520 and 75.1403–10(m), which contain requirements for switches and controls on underground electric equipment. The revised standard would include performance and design requirements for control circuits on electric equipment to provide for safer operation. Paragraph (a) of the proposal is derived from existing § 75.520, which requires electric equipment to be equipped with switches or other controls that are safely designed, constructed and installed. The proposal would alter and clarify the existing standard by requiring that switches and control devices be installed and maintained on equipment to prevent operational hazards. This would assure that switch wiring designed for this application is used in installation, and prevent the occurrence of malfunctioning switches and control devices.

Under paragraph (b) of the proposal, switches and control devices would have to have voltage and current ratings of at least the voltage and current of the circuit in which they are used. The hazards of electric shocks and

electrocution would be averted by requiring compatibility of voltage and current ratings.

Under paragraph (c), a new provision, a-c remote control circuits would be required to have a maximum voltage of 150 volts. Control circuits for remote switches would be restricted to 150 volts in light of the history of injuries and fatalities associated with them. At least four electrocutions have occurred since 1970, when persons have contacted the frames of control switches or control circuits energized at voltages in excess of 150 volts a-c.

Paragraph (d) would require control circuits having a neutral, or one conductor solidly connected to the grounding medium, to be wired so that ground faults in the equipment will not cause it to suddenly start, prevent it from being stopped, or prevent operation of protective devices connected in the circuit. To be safely operated, equipment must have a means of preventing accidental start-up, as well as a means of stopping it when ground faults exist on the equipment.

Protective devices should also remain operable despite failures or faults. Unexpected start-up of equipment or inability to stop it could lead to serious underground accidents. Similarly, miners must be able to rely on protective devices, such as panic bars, built into equipment they operate or work around. This provision would assure that such safety features would remain operable in emergency situations.

Control circuits, under paragraph (e) of the proposal, would be required to be wired so that stop switches will deenergize the equipment if the start switch remains in the "start" position. The requirement would ensure a means of turning off electric equipment, despite a malfunction causing the switch to become stuck in the start, or on position. The hazards posed to miners from equipment malfunctions would be reduced under this provision.

Paragraph (f) is derived from the safeguard provisions in existing § 75.1403–10(m), which addresses tram control switches on rubber-tired equipment and provides that these switches be designed to automatically return to the stop or off position when released. The proposal is intended to clarify the existing standard, and would require that tram controls on rubber-tired and crawler-mounted mobile electric equipment be designed to be automatically self-centering. The proposed standard would make clear MSHA's position that self-centering tram controls are required for the safe operation of mobile electric equipment equipped with such controls. Since enactment of the existing standard, several pinning and crushing fatalities have been related to tram controls remaining in the tram position, allowing equipment to continue to travel after the tram lever was released. The proposed rule would provide clear mandatory performance regulations for tram levers to address this hazard.

Agency experience, including its investigation of the tragic 1984 Wilberg Mine fire, has indicated that overtemperature devices should be provided and maintained on air compressors. Paragraph (g) would be a new provision which would require automatic overtemperature devices to be provided and maintained on air compressors, other than those which are component parts of locomotives and rock dusting machines. These devices would be required to automatically deenergize the compressor at predetermined settings specified by the manufacturer, but at no greater than 240 degrees Fahrenheit.

At temperatures above 250 degrees, the air compressor oil can begin to break down and its lubrication qualities can be lost. A maximum 240-degree Fahrenheit deenergization setting is consistent with the recommendations of manufacturers of air compressors most commonly used in the mining industry. The risk of fire due to excessive heat could be reduced by compliance with the standard.

Section 75.510 Disconnecting Devices

This section would address requirements for disconnecting devices used to protect underground circuits and equipment. It is derived from existing §§ 75.511, 75.519, 75.519–1, 75.520, 75.601, 75.705–6, 75.705–7, 75.705–8, 75.802, 75.808, 75.809, 75.903 and 75.904, and would embody few changes from those standards. The proposal would consolidate and clarify the existing rules covering disconnecting devices.

Paragraph (a) would require a disconnecting device to be installed in each power circuit that extends underground. When located on the surface, the disconnecting device would have to be positioned within 500 feet of where the circuit enters the underground area of the mine. When located underground, the disconnecting device would have to be within 500 feet of the bottom of the shaft or borehole through which the circuit enters the mine.

The proposal would change the distance required by existing § 75.802(c) for surface high-voltage devices from 100 to 500 feet. This change would recognize that in some instances, the 100-foot distance may lead to less safety for miners if the special circumstances of a mine are not considered. For example, the 100-foot distance could require more than one disconnecting device to be installed in a high-voltage cable which extends longer than 100 feet from the mine. The proposed rule would eliminate unnecessary exposure of miners to the risks involved in making multiple terminations in such cables to install disconnecting devices. Further, due to the natural terrain and physical lay-out at some mines, the 100-foot distance could make disconnecting devices less accessible than they should be in case of emergency. The 500-foot distance would give operators greater flexibility in placing disconnecting devices where they are most easily reached in emergency situations.

Under the new provisions of paragraph (b), disconnecting devices which are not designed for load interruption and are installed at locations specified in paragraph (a)(2) of the section, would be required to be installed so that a circuit breaker operated at the disconnecting device location can deenergize the incoming power circuit before disconnects are opened. The effect of this standard would be to provide devices which are not capable of deenergizing the circuit under load with an alternative means of deenergization. The proposal would also require a visual or audible means, such as an indicating light or a horn, at the disconnect location which enables miners to easily ascertain whether power is being supplied to the device. This would reduce the risk of injury due to arcing when a circuit is disconnected under load.

Paragraph (c) would require disconnecting devices to be installed in conjunction with each circuit breaker, and at the beginning of each branch circuit and trailing cable used underground. Since 1970, at least seven fatal electrical accidents have occurred which involved the failure to use high-voltage disconnecting devices, failure to open the correct disconnecting devices, or failure to lock the devices out. The proposal would facilitate determinations of whether disconnecting devices have properly deenergized the circuit, thereby reducing the risk of electrical accidents and injuries. Additionally, compliance with the proposal would provide for deenergization of the branch circuit to facilitate testing or repairs without necessitating deenergization of the main circuit. Miners could otherwise be tempted to work on an energized circuit to avoid having to deenergize it in its entirety.

The proposal specifies that a disconnecting device be installed at the beginning of each trailing cable. This aspect of the proposal clarifies existing § 75.903, which requires that a disconnecting device be installed in conjunction with the circuit breaker. The proposal would revise this language to require installation of the disconnecting device at the beginning of each trailing cable, to assure total deenergization of the cable.

Paragraph (d), derived from existing §§ 75.601, 75.808, and 75.903, would also require that disconnecting devices be designed to provide visual evidence that all ungrounded power conductors are disconnected when the device is open. Visual evidence would consist of the ability to observe the physical opening of the controls. This would clarify the language in existing §§ 75.601 and 75.903 which require visual evidence that the power is disconnected. It would also modify existing § 75.904 to include the identification of disconnecting devices, as well as circuit breakers.

Each device would have to be equipped with a means for installing a padlock under paragraph (e) of the proposed rule, derived from existing § 75.511. Therefore, disconnecting devices would be capable of properly deenergizing the circuit being worked on, and assuring that it will remain deenergized, in accordance with the requirements of part 75.

Paragraph (f) would require each disconnecting device to be distinctly marked to indicate the specific unit of equipment that it serves. The marking would be required to be identical to the marking of the corresponding circuit breaker or fuse holer, and durable enough to withstand the mining environment. Where a plug and receptacle are used as a disconnecting device, both components would be required to bear identical markings. These provisions would ensure that the protective devices are marked and identified with the breakers they serve and that identifying markings are maintained, despite the harsh mining atmosphere. Numerous accidents have been attributed to disconnecting the wrong cable or trailing cable because of inadequate or improper identification at the circuit breaker and at the disconnecting device.

Under paragraph (g) of the proposed rule, disconnecting devices would be required to have voltage and current ratings compatible with the circuits in which they are used. This would ensure that the operating parameters of the devices are not exceeded during normal operation.

Paragraph (h) is a new provision, which would require that except for trolley taps, low-voltage disconnecting devices not have exposed energized parts, which can represent a serious hazard to miners. Because of the nature of their design and use, trolley taps would be excluded from this provision. Paragraph (i), also new, would require high-voltage disconnecting devices installed underground after the effective date of the proposed rule to be enclosed in a grounded metallic enclosure and have no exposed energized parts. The standard would provide for physical protection of the devices. Persons having to work with or near disconnecting devices would be protected from contacting dangerous voltages which can exist when energized parts are exposed.

Comments to the preproposal draft cited the shock hazards inherent in working with exposed energized parts of high-voltage disconnecting devices as a justification for requiring them to be enclosed. However, they suggested phasing out exposed parts by employing a delayed effective date for the standard. The proposal would address these suggestions by applying the enclosure requirement only to devices installed after the rule's effective date. Existing equipment having exposed parts would be required to have guarding installed in accordance with paragraph (j) of the section. MSHA solicits further public comment on the necessity of this standard, and the proposed compliance schedule.

Paragraph (j), derived from § 75.705–9, would require disconnecting devices having exposed energized parts to be guarded to prevent inadvertent contact, and be operated only by a high-voltage qualified electrician. This provision would address equipment installed prior to the effective date of the proposed standard. Although installation within metallic enclosures as specified in paragraph (i) would be preferable for new equipment, the difficulty in retrofitting existing equipment would necessitate the use of the alternative safety procedure of guarding exposed parts and requiring that work be performed only by a qualified high-voltage electrician for equipment presently in use underground.

Guarding would reduce the incidence of accidental contact with energized parts, which could inflict serious injury on miners. Due to the electrical dangers involved in working with or near high-voltage energized equipment, only those who have demonstrated that they possess the necessary knowledge and skill by compliance with proposed § 75.153 should operate disconnecting devices.

The qualified electrician referred to in the previous paragraph would be required under proposed paragraph (k) to wear rubber insulating gloves rated at least 20,000 volts, which have protective coverings, such as leather, designed to prevent physical damage to the insulating material. The use of insulated sticks, fuse tongs or pullers would also be required when operating disconnecting devices with exposed energized parts. Paragraph (l) would require such equipment to be insulated and maintained to protect the qualified electrician from exposure to voltage.

Paragraph (m) is derived from existing § 75.705–7. It would require gloves, insulated sticks, fuse tongs and pullers to be examined before each use for visible signs of physical damage and defects. If damage or defects are found, these items would be required to be removed from the underground areas of the mine. Under the standard, qualified electricians would have some responsibility for ensuring their own personal safety. It would assure that they would not use and rely for their protection on damaged or defective gloves or tools. Protective items which have been rendered ineffective would not be used inadvertently by qualified electricians responsible for operating disconnecting devices if they are required to be taken out of the underground areas of the mine.

Rubber insulating gloves would have to be electrically tested at least every six months under paragraph (o), derived from existing § 75.706. Testing would involve procedures designed to locate damaged portions of the gloves which are not discernible through visual inspection alone. These provisions are intended for the protection of electricians against unnecessary exposure to life-threatening voltages by emphasizing compliance with accepted safety practices.

Section 75.511 Cable Couplers

Proposed § 75.511 would combine and clarify existing §§ 75.607, 75.803–1, 75.805, 75.902 and 75.902–1, which address requirements for cable couplers. The proposal is intended to provide more performance-oriented standards for the devices. Paragraph (a) would require cable couplers to enclose all power conductors of the circuit in which they are used. This provision would protect miners from electric shocks due to contact with exposed energized conductors.

Couplers would also have to be equipped with a metallic outer shell

when the nominal voltage of the circuit exceeds 600 volts under the proposal. A metallic outer shell would offer mechanical protection for connections, and serve to maintain a continuous grounding path for the coupler. The proposal would require that cable couplers have voltage ratings of at least the nominal voltage of the circuit, and current ratings of at least the maximum continuous current rating of the circuit in which the couplers are used. To protect against electric shocks or burns, couplers should have voltage and current ratings compatible with those of the circuits they serve.

The standard would require construction of cable couplers so that ground-check conductors or interlock circuit conductors will separate first, and equipment safety grounding conductors will separate last when the couplers are disconnected. The safety effect of this sequence would be two-fold. First, it would assure that energized phase conductors are not exposed if the coupler is mistakenly separated under load. Second, it would assure that equipment will remain grounded until after the phase conductors have been separated. In these ways the proposal would prevent electrical arcing and ignitions, and equipment grounding would be maintained while phase conductors are being separated.

Couplers would have to be equipped with an electrical or mechanical interlock on all three-phase circuits and d-c trailing cable circuits which prevents the coupler from being disconnected while energized. The voltage of interlock circuits would be limited to 40 volts on low-voltage circuits and 96 volts on high-voltage circuits under the proposal. This requirement would prevent accidental disconnection of the coupler while under load. Connecting or disconnecting cable couplers under load would be prohibited under the proposed rule. This is a restatement of existing § 75.607, intended to prevent electric shocks, flash burns and ignitions which can be caused by arcing when couplers are disconnected under load.

Paragraph (b) of the proposal is new, and would require cable couplers used on mobile battery-powered electric face equipment to either meet the approval regulations found at 30 CFR § 18.41, or be held in place by a threaded ring or an equivalent mechanical fastening equipped with a captive device removable only by a special tool for separation of the connection. The proposed standard would clarify the Agency's existing policy concerning the use of cable couplers on mobile battery-powered electric face equipment.

Existing § 18.41(f), specifies only the use of padlocks as an alternative for interlocks or explosion-proof couplers on mobile battery-powered electric equipment. However, MSHA currently permits the use of other types of mechanical locking devices, provided they are equally as safe. The proposal would incorporate this policy by allowing the use of the alternative method described.

Section 75.512 Trolley Taps

This standard is derived from existing §§ 75.514 and 75.607, which require electric conductor connections to be mechanically and electrically efficient, and prohibit the making or breaking of cable connections to junction boxes under load. These requirements have been adapted by the proposed standard to apply to trolley tap connections. Under the proposed standard, pressure-type connectors would be required to connect trolley wires and feeder wires to trolley taps when the load of the circuit exceeds 4.0 amperes. The use of standard hook type trolley taps would not be permitted under the proposal because of their tendency to cause arcing connections and excessive heating at connections with higher loads.

Pressure-type connectors are spring-loaded devices which allow for a very tight connection between trolley taps and trolley wires. Hook-type connectors do not mechanically apply pressure to the connection. The looser connection allows for heating and arcing, which could pose the risks of fire or shock to miners. Requiring pressure-type connectors could prevent these occurrences.

Loads of less than four amperes typically serve lighting circuits. Experience indicates that such loads would be provided with adequate conductivity at the power connection to the trolley wire or trolley feeder wire by use of hook-type connectors, presently used for this purpose. A four-ampere cut-off point would have the effect of excluding all motor loads from the ability to use hook-type connectors, but it would eliminate the need for specially-designed connectors for lighting circuits in and around belt drives, for example.

The proposal would not permit connection or disconnection of trolley taps under load. Such a practice would expose miners to unnecessary risk of serious injury from electrical arcing and ignitions. The proposal would ensure that safe work practices are employed to eliminate the hazards when connecting or disconnecting trolley taps.

Section 75.513 Lightning Protection

This proposed standard is derived from existing § 75.521, which requires lightning arresters for exposed ungrounded power conductors and telephone wires extending underground to prevent electric shocks and fires. Paragraph (a) of the proposal would incorporate the existing standard, but the term "surge arresters" would now be used. Surge arresters are defined by proposed § 75.2(j) as devices used to provide protection against lightning surges. They are designed to prevent lightning strikes on the surface from being transmitted to the mine power system and energizing equipment frames.

Paragraph (b) contains new provisions which would no longer require lightning arresters to be installed on power conductors and telephone wires, provided they are buried, installed beneath a protective metallic covering, or enclosed within grounded metallic shields, coverings, or enclosures throughout their entire length. These types of conductors would be, in MSHA's view, sufficiently protected against transmittal of dangerous voltages caused by surface electrical lightning surges. The proposed change would eliminate the need to cut into cables solely to install surge arresters. Thus, miners would not be exposed to the hazards involved in the process, which would not enhance the circuit's electrical protection. Some commenters to the preproposal draft objected to a requirement of surge arresters at particular locations, based on the difficulty of installation in some cases. The proposal would address such concerns by offering an alternative means of compliance under paragraph (b).

Paragraph (c) of the proposal would more clearly describe the proper surface locations for surge arresters than does the existing standard. On the surface, they would be required to be located within 100 feet of where the conductors enter the mine, are buried, installed beneath a protective metallic covering, or enclosed within grounded metallic shields, coverings or enclosures, or are supported by grounded metallic messenger wires.

Although the location of a lightning strike can clearly not be controlled, a 100-foot distance would limit the distance in which lightning could strike in by a lightning arrester, which could permit a voltage surge to be transmitted underground and cause energization of

equipment frames. Lightning strikes outby the arrester would cause excess voltage to be transmitted to ground.

Paragraph (d) would clarify the existing requirement at § 75.521 for the use of "suitable lightning arresters of approved type." The proposal would instead require that surge arresters be rated for the maximum voltage and current of the circuits they protect. Existing § 75.521 contains no such requirement. The change in the wording of the standard would make it more performance-oriented, clarifying that surge arresters should be compatible with the circuits they protect. Lightning surges would be prevented from causing excess voltages on power conductors which can be transmitted underground and energize equipment frames.

Paragraph (e) of the proposed rule would retain the existing requirement at § 75.521 that surge arresters extending underground be connected to a low-resistance ground field that is separated by at least 25 feet from neutral ground fields. This would separate the underground grounding circuit from the surface distribution grounding circuit, thereby reducing the likelihood of a lightning surge being transmitted underground from the surface power system.

Section 75.514 Lighting Fixtures and Photographic Lighting Equipment

Proposed § 75.514 would replace existing § 75.522–1, which contains standards for incandescent lighting used underground where non-permissible equipment may be used. Agency approval is presently required under existing regulations for all devices used for the purpose of lighting the areas of underground coal mines. The proposal would no longer require submittal to a lengthy approval process for lighting devices used in areas where permissible equipment is not required, because the hazards to miners outby face areas are such that prior approval of the equipment is not a necessity, in MSHA's view. The Agency believes that the proposed lighting standards will provide protection equivalent to that under existing standards.

Lighting equipment used in areas where permissible equipment is required currently must be approved under part 18. Proposed § 75.502 would still require such equipment to be permissible. This proposed standard would set installation requirements for lighting devices used only in outby areas, and would offer more flexibility in underground lighting by not restricting lamps to either incandescent or fluorescent types.

Paragraph (a) of the proposal would require lamps used to illuminate slopes and enclosed underground structures to be installed within glass, plastic or equivalent enclosures. The hazard addressed by the standard is breakage of glass and exposure of energized lighting conductors resulting from such damage. This condition gives rise to shock, short-circuit and ignition hazards. Equipment and materials that could damage the lighting fixture are often transported through slope areas of the mine. In addition, enclosed underground structures typically have limited clearance area. The possibility of equipment or persons damaging lighting fixtures and coming in contact with the exposed parts is therefore greater in these areas of the mine.

Under paragraph (b), incandescent lamps used to illuminate walkways and work areas would have to be contained in glass, plastic or equivalent enclosures, or installed within weatherproof sockets. If incandescent lamps are installed in weatherproof sockets, the proposal would require them to be located at least eight feet vertically and three feet horizontally from walkways and work areas. These provisions would assure that miners will not be shocked by contact with lighting devices. Further, the enclosures described would not allow combustible materials or water to contact energized lighting circuits and cause short-circuits or ignitions. The proposal allows the option of using weatherproof sockets in walkways since locating them eight feet above the walkway would provide equivalent protection by location.

For compliance with paragraphs (a) and (b), MSHA would consider any material similar in durability and capable of providing adequate protection against contact by persons, materials or the environment to be equivalent to glass or plastic. By allowing such an alternative, the proposal would not prevent the use of effective enclosure materials which may be developed in the future.

Paragraph (c) would require incandescent lamps located in areas other than those specified in paragraphs (a) and (b) to be installed in weatherproof sockets or within glass, plastic or equivalent enclosures. These provisions would also ensure that miners will not inadvertently contact the energized filaments of broken lighting devices and that lamps would not be able to contact and ignite combustible materials underground. Weatherproof sockets or the specified enclosures would assure that wet mining conditions will not cause short-circuits of lighting fixtures.

Paragraph (d) would reduce the risk of underground mine fires by prohibiting lamps from coming into contact with combustible materials. Except as provided in paragraphs (b)(2) and (c) of the standard, lamps would have to be enclosed within glass, plastic or equivalent enclosures to prevent such contact. Paragraph (e) is new, and would prohibit the use of low-pressure sodium lamps underground. This type of lamp typically contains enough sodium to cause a fire or explosion if the chemical should come in contact with coal dust in the presence of water. Therefore, low-pressure sodium lamps would not be suitable for use underground.

Paragraph (f) would set new provisions for the use of nonpermissible electronic photographic equipment in areas where permissible equipment is required, provided certain safety precautions are taken. Electronic photographic equipment could be used if the area is ventilated with air that has not been used to ventilate coal cutting or loading operations, which contains less than 1.0 percent methane. Air which has not ventilated coal cutting or loading operations would typically contain lower concentrations of methane, and thus, less risk of fire would be present. The equipment could only be used under supervision of a certified person, as defined in existing § 75.2(a), who would be required to test for methane before and during the operation.

The proposed rule would allow the use of photographic equipment underground under controlled conditions. This equipment would be permitted in face areas of underground coal mines provided proper safety measures are followed. Underground photography has been a particularly beneficial tool for operators and the Agency in investigating the causes of mine accidents and preparing training materials intended to avoid such accidents, and this provision would facilitate its use.

Section 75.515 Insulation of Electric Conductors and Cables

This section is derived from existing §§ 75.517, 75.517–1, and 75.804. The proposed standard is intended to simplify interpretation of current standards, although there is little substantive difference between the requirements of the existing and proposed rules. Existing § 75.517–2 would be deleted under the proposal, as it contains compliance dates which would no longer be applicable.

Paragraph (a) of the proposed rule would require insulation having a voltage rating of at least the nominal voltage of the circuit on electric power, control, ground-check, interlock and communication conductors and cables. Properly rated insulation would guard against dangerous eventualities such as short-circuits, flash burns and electrocutions. At least two fatalities have occurred since 1970 because the victims contacted cable whose insulation was inappropriate for the cable's voltage.

Trolley wires and trolley feeder wires installed with mine track, grounded power conductors of d-c feeder systems, equipment and system grounding conductors, and bare signal wires of less than 40 volts would be excepted from the insulation requirement, because of the nature of their uses underground. Insulation of trolley wires in track entries, for instance, would render them inoperative for their intended use. The proposed rule would clarify the term "trolley feeder wires" to indicate that only those used with mine track would be excepted from the standard. Feeder wires which are located in walkways, for instance, would have to be insulated under the proposed rule to protect miners from contacting energized conductors.

Equipment and safety grounding conductors would also be excepted from the insulation requirement under the proposal, since they present little or no shock hazard to miners. MSHA experience indicates that bare signal wires of less than 40 volts would not compromise miner safety as such circuits typically have very low energy levels.

Paragraph (b) is new, and would require exposed electric connections and resistor grids to be insulated. When insulation would be impractical, they would be required to be guarded to prevent inadvertent contact by persons or equipment. This provision would allow compliance alternatives of equal effectiveness for the protection of miners.

Section 75.516 Mechanical Protection of Conductors and Cables

This section would clarify §§ 75.516–2, 75.5l7, and 75.606. Electric conductors and cables, and communication wires and cables would be required to be protected against damage to the outer jacket and insulation. These types of cables and conductors are subjected to heavy use and rough treatment underground. They can be damaged when run over by large equipment, by rubbing against coal ribs or floor, or by wear and tear due to excessive use. This type of mechanical damage, if undiscovered, places miners at risk of injury while handling cables. The term "functional damage" means any damage which would defeat the jacket or insulation's ability to perform its protective function. Scuffing or marking of the outer jacket which does not affect the function of the jacket would not be cited under the proposal.

Existing § 75.606 requires that trailing cables be adequately protected to prevent damage by mobile electric equipment. The proposal would expand this requirement by specifying means for providing trailing cables with protection from damage by mobile electric equipment, by bridges, trenches, suspension from the mine roof, or rib or by location. These are the methods that the Agency would consider appropriate for protecting trailing cables from equipment passing over or under the cables.

The proposal would call for a bridge, trench or suspension device to be built or installed for protection of a trailing cable or for the cable to be located where it would not be exposed to damage by mobile electric equipment. The adequacy of the protection supplied by the bridge, trench, suspension device or location would be measured by how well it protected the trailing cable from physical damage. For example, where a trailing cable is located in a trench, but has been damaged by mobile electric equipment running over the trench, an MSHA inspector might conclude that there was a violation, despite use of a trench, since damage to the cable had not been prevented.

Contact with bare wires on damaged insulated conductors and cables could result in fatal electric shocks to miners. Exposed wires can also represent an ignition source for methane and coal dust. This clarified standard for the physical protection of conductors, cables, wires and trailing cables could prevent such hazards to miners.

Section 75.517 Support of Insulated Conductors and Cables

This section of the proposal is derived from existing §§ 75.516, 75.516–1, and 75.516–2, and would set requirements for the support of insulated conductors and cables. Paragraph (a) would require insulated electric conductors and cables to be installed on insulators or insulated J-hooks. The proposal would no longer limit the use of insulated J-hooks to a six-month temporary period, as does the current regulation. Insulated J-hooks would be permitted to support insulated conductors and cables under the proposal because those having appropriate dielectric and tensile strengths have been demonstrated to be excellent insulators for the protection of insulated conductors and cables.

Contact by insulated conductors and cables with combustible materials, roof, or ribs would be prohibited under the proposal, as in the existing regulations. Such contact represents a fire hazard, should the conductor's insulation become overheated or damaged. However, trailing cables, metallic shielded cables, conductors installed in conduits, equipment and system grounding conductors, and grounded power conductors on d-c feeder circuits would be excepted from the proposed support requirements. These types of conductors are designed to withstand stress and physical damage, therefore eliminating the need for the protection offered by insulators and insulated J-hooks. Conductors in conduits would be included in the excepted class because conduit provides adequate protection for the conductor.

Under paragraph (b), a new provision, materials other than insulators may be used to support cables meeting the requirements of proposed § 75.601, provided they are supported from noncombustible materials. Materials used to suspend cables would be required to be flame-resistant, insulated for at least the maximum voltage of the circuit, and have a tensile strength of at least three times the weight supported. These specifications would describe suitable materials for the support of flame-resistant trailing cables, therefore offering some flexibility to operators in their choice of support methods. This provision of the proposed rule would incorporate current Agency policy on the use of support materials other than those which would be required by paragraph (a).

Paragraph (c) would require that communications circuits be installed so as not to contact light or power circuits. The effect of this provision would be to prevent energization of the communication circuit and equipment to the voltage potential of the power circuit. The risks of electric shock or electrocution would be minimized under the standard.

Paragraph (d) would require communication wires or cables installed in track entries to be located on the opposite side of the trolley wire or trolley feeder wire. Possible physical damage to the communication circuit and the passage of voltage from the trolley circuit would thereby be prevented. The exception in the existing standard for communication wires which are buried would no longer be necessary, since burying the circuit

would be an acceptable means of installation under proposed paragraph (b), provided it does not contact light or power circuits.

Section 75.518 Insulators and Insulated J-Hooks

Proposed § 75.518 is derived from existing § 75.516–1. It would set more specific requirements than does the existing standard for insulators and insulated J-hooks suitable for the support of insulated conductors and cables. Under the proposal, insulators and insulated J-hooks would be required to have flame-resistant insulating material with a dielectric strength of at least eight times the maximum voltage of the circuit. Flame-resistance and adequate dielectric strength would assure that an overheated cable would not become grounded through the insulator and cause a ground fault in the circuit.

Additionally, a new provision of the proposal would require insulators and insulated J-hooks to have a tensile strength of at least three times the supported weight. This would prevent failure of the suspension mechanism. Failure of one of the supports could cause a chain reaction failure of all of the supports which suspend a cable. Such an occurrence could allow cables to contact the mine floor or mining equipment, which could damage the cable, creating a risk of fire or electrical injury to miners. Failure of supports could also cause heavy cable to fall and strike persons working or traveling nearby. The standard would assure that cables are adequately supported in order to prevent such injuries.

Section 75.519 Splices, Repairs and Terminations of Conductors and Trailing Cables

This section is derived from standards for maintenance of conductors and cables in existing §§ 75.511, 75.514, 75.517, 75.604, 75.804, 75.810 and 75.906. The proposal would consolidate and clarify existing requirements for splices, repairs and terminations and establish procedures for making acceptable repairs and splices in trailing cables and shielded cable. It would clarify existing standards to promote proper repair and splicing of low-voltage cables to maintain the integrity of all components within a cable, and to retain to the greatest extent possible, their original characteristics.

Under paragraph (a), high-voltage cables would be required to be spliced, terminated, or repaired by high-voltage qualified electricians. As discussed previously, the Agency feels that such persons would bring the necessary skill and knowledge to the task to assure safety. For similar reasons, paragraph (b) would require that low-voltage trailing cables be spliced, repaired or terminated by a qualified electrician or a qualified cable splicer.

Paragraph (c) of the proposal would require splices and repairs in low-voltage trailing cables to be made with splice and repair kits that meet the flame-resistance tests in existing § 18.64. Existing §§ 75.600 and 75.600–1 require that trailing cables used in underground coal mines meet the requirements for flame-resistant cables set forth in 30 CFR 18.64. The proposal would clarify the intent of the existing rule by requiring that splice and repair kits meet the flame-resistance tests in part 18.

The proposal would no longer permit the use of what are commonly called "temporary splices" in trailing cables. The *Standard Dictionary of Mining, Mineral and Related Terms* cites the Federal Coal Mine Safety Act of 1963 in defining a temporary splice as one that does not have a rubber or neoprene jacket vulcanized over the splice and bonded to the cable jacket. Presently, one temporary splice is permitted for a period of twenty-four hours in order to allow equipment served by a damaged cable to finish the shift or be moved for repairs. Such splices could be made quickly, and therefore helped to prevent costly and burdensome delays.

As noted, the proposed standard would require all low-voltage trailing cable splices to be made with splice kits. Such kits are developed to facilitate the making of splices in a quick and efficient manner. With temporary splices, the methods and types and amounts of materials used are largely up to the individual performing the work. For instance, the outer jacket is often sealed with tape in lieu of proper vulcanizing. By contrast, splice kits typically leave little room for individual differences in splicing methods. The kits contain precise instructions and materials designed to preserve the integrity of the original cable.

A review of the fatality record since 1970 reveals that at least two miners have been electrocuted as a result of contact with leakage current through temporary splices. With the use of splice kits, splices in trailing cables having adequate insulation and proper jackets can be made as easily, and in about the same time as temporary splices. Therefore, the need for temporary splices has been alleviated by advancements in splice kit technology.

Flame-resistance tests are made on assembled specimens by MSHA's Approval and Certification Center. Acceptance markings appear on the outer jacket of the repair or splice, indicating that it has passed the tests and was found to be acceptable by MSHA. This would ensure that, when the splice and repair kit was assembled in accordance with the manufacturer's instructions, the kit would have fire-resistant properties similar to those of the cable's original components. MSHA is considering proposing an approval regulation for splice and repair kits. Under such a proposal, a splice and repair kit for trailing cables would have to be approved by MSHA prior to its use in a coal mine.

Paragraph (d) would require that the outer jacket of each splice and repair in a high-voltage trailing cable be vulcanized or molded with materials that are flame-resistant in accordance with § 18.64. Under the existing regulations, splices and repairs often overlap the outer jacket of the trailing cable at each edge. This overlap, referred to as lipping, is often held down with electrical tape. The proposal would allow this practice to continue. Paragraph (e) would require splices and repairs in all other cables to be sealed to exclude moisture. Therefore, the wetness of the underground atmosphere would not cause sparking or arcing at the splice or repair site.

Under paragraph (f), only one connection point in each conductor would be permitted in a trailing cable splice. Splice kits are not designed for more than one connection point for each conductor. A potential hazard occurs when kits are utilized outside their designed use parameters. Kits are designed in order to provide the best electrical conductivity possible. Part of this design is the single connection of two severed ends of trailing cable. The introduction of more than one connection point reduces the electrical conductivity of the splice to an unacceptable level that could lead to inadequate electrical conductivity for the circuit and an eventual shock and fire hazard on the circuit and the equipment the circuit serves.

Paragraph (g) would require that terminations of shielded high-voltage cables include stress-relief on each conductor, in order to prevent unnecessary strain on and damage to the conductors capable of creating a shock hazard. Under paragraph (h), metallic shielding of single-conductor cables would be required to be connected to messenger wires and equipment safety grounding conductors at each splice and termination. Compliance with this provision would increase the likelihood of maintaining a reliable grounding circuit.

Paragraph (i) would contain performance specifications for splices and repairs. They would be required to have conductivity and current-carrying capacity sufficient to prevent insulation damage from heated conductors. This provision would require a splice or repair to match the ampacity of the rest of the cable as closely as possible, which would reduce the risk of damage to the insulation from overheating of the connection. Damaged insulation could place miners at risk of contacting energized cable components.

Severed conductors would have to be joined by welding or compression-type connectors. MSHA's experience in evaluating the reasons for trailing cable splice separation indicates that welding and compression-type connectors are the most effective and reliable. The knotting of the severed ends of conductors or other similarly inefficient means of joining conductors would result in a weaker cable which could lead to cable separation when the cable is put under tension or is otherwise stressed. The use of knotting could also cause the splice or repair to be electrically inefficient because of the incompleteness of the connection, and create a high-resistance area within the cable. This could result in overheating, arcing and sparking of the splice, causing a shock or fire hazard. The proposal would prohibit the use of such splicing methods, and require the use of tight-fitting connections, provided for by welding or compression-type connectors.

Each power, control, and ground-check conductor would have to be individually re-insulated with insulation of at least the same thickness, temperature rating, and dielectric strength as that of the original insulation. This would address the potential hazard of splice failures due to insulation deterioration caused by overheating and voltage stresses exceeding the insulation rating. Phase-to-phase and phase-to-ground short-circuits from weaker insulation would also be prevented under the provision.

Splices and repairs would be required to have semi-conducting tape replaced over the insulation of each power conductor within shielded cables. Semi-conducting tape is part of a two-part shielding system employed in the design of the cable. It is an important safety function to replace the semi-conducting tape over the power conductor insulation to ensure that the splice or repair retains the same shielding properties as the original cable.

Additionally, the proposal would require shielding in the form of metallic braid or serving (wrap), or metallic tape to be replaced over each power conductor and applied in half-lapped layers within shielded trailing cables. As discussed previously, it is critical to maintain shielding continuity in a shielded cable splice or repair. Any break in continuity of the shielding reduces its safety function. The use of metallic serving or braid would provide for durability in the trailing cable, while also providing sufficient flexibility of the replacement shielding so that it is essentially the same as the original cable.

In shielded cables other than trailing cables, metallic shielding in the form of metallic braid, or serving (wrap), or metallic tape would be required to be replaced over each power conductor and applied in half-lapped layers. The option of using tape would be permitted only for shielded cables other than trailing cables due to the increased potential for damage to trailing cables. Tape would only be effective on cables that are not subject to the constant flexing and bending of trailing cables.

Finally, the outer jacket would have to be replaced to provide at least the same thickness and protection as that of the original jacket. Therefore, the proposal would provide for the physical strength of the repaired jacket. These provisions would serve to preserve as nearly as possible, the physical and electrical characteristics of the original cable in making splices and repairs. Therefore, the likelihood of electrical arcing or heating at the connection points would be reduced.

Section 75.520 Conductor and Cable Fittings and Strain Relief Devices

This standard is derived in part from existing §§ 75.515 and 75.605, which require suitable fittings where cables enter the metal frames of motors, splice boxes, and electric compartments. The proposed rule embodies few changes from the existing rules. Paragraph (a) would require cables to enter metallic frames of electric enclosures through fittings sized for the cables, and which prevent damage to cable jackets and the insulation of the internal conductors. Permissible equipment would be covered by the applicable approval regulations. The standard would lead to secure fittings which would cause minimal strain on and damage to the connections.

Under paragraph (b), conductors would be required to enter metallic frames of enclosures through fittings with insulated bushings sized for the conductors. The term "electric enclosures" would encompass those types of compartments specified in existing § 75.515. Insulated bushings would offer physical protection for conductors to assure that secure or tight fittings will not damage them and create a shock hazard.

Paragraph (c) would embody an exception to the previous two provisions. Cables and conductors in conduit entering metallic frames of electric enclosures would not have to be equipped with fittings or bushings when protection against damage by sharp edges is provided. The exception is intended to offer a compliance alternative for the protection of cables and conductors. Conduit would offer added physical and mechanical protection and support where a cable enters a metallic box, and therefore eliminate the need for further protective measures. Metallic conduit would prevent the stresses an unprotected cable would be subjected to, and would also provide an efficient ground path in case of damage to the cable.

Paragraph (d) would require fittings to be installed so as to prevent mechanical strain on electrical connections. Hazards resulting from improper conductor and cable fittings include electric shock and electrocution from energized equipment frames. Since 1970, at least two fatal electrical accidents have been related to improperly installed fittings on cables entering electric compartments. By requiring fittings used where cables and insulated conductors enter electric compartments to be designed to prevent strain on electrical connections, chaffing and damage to the cable or conductor would be prevented, and the number of injuries to miners from these conditions would be reduced.

Trailing cables would have to be attached to the equipment being supplied by an insulated strain clamp or cable grip. As a matter of policy, both strain clamps and cable grips are permitted to meet the existing requirement at § 75.605. The proposal would make it clear that all trailing cables may use cable grips in lieu of strain clamps to provide this protection.

Section 75.521 Damaged Conductors and Cables

This proposed section is derived from existing §§ 75.517 and 75.603 which set requirements for protection of power wires and cables, and splices in trailing cables, respectively. The proposal would set conditions under which damaged or defective conductors and cables would have to be removed from service or repaired. Under the proposal, conductors and cables would be required to be deenergized, disconnected in accordance with

proposed § 75.506, and either removed from service or repaired when the outer jacket, conductor, conductor insulation, or a splice or repair has been damaged, and when a splice or repair heats or sparks.

Maintaining conductors and cables in proper physical condition is essential to the level of safety of miners handling and working around them. Damaged outer jackets or improperly made splices, for example, could subject miners to electrical injury or electrocution. Cable damage could also provide an ignition source when energized conductors are exposed to the coal mine atmosphere. The proposed standard would address these dangers.

Section 75.522 Ampacities of Low-Voltage Conductors

This standard, derived from existing §§ 75.513 and 75.513–1, would set allowable ampacities and sizes for low-voltage conductors. Ampacity is defined by the proposal as the current-carrying capacity of electric conductors expressed in amperes. The proposed standard would consolidate ampacity regulations for conductors supplying a single motor, two or more motors, battery chargers, welders, lighting fixtures, heaters, transformers and rectifiers, multiple loads and other equipment. The standard would not apply to conductor ampacities for permissible equipment, which are specified in the appropriate approval regulations.

The proposal represents some change from the existing rules. References to the 1968 edition of the NEC, which, according to comments to the preproposal draft made interpretation cumbersome, would be deleted. The proposed rule and accompanying ampacity tables would provide operators with the information necessary to select the proper conductors to safely serve electric equipment.

Under paragraph (a), electric conductors would be required to be of a size and current-carrying capacity to assure that a rise in temperature resulting from normal operating conditions does not damage the insulation and conductors. Such damage could expose persons to electric shock, electrocution, or fire hazards. Therefore, conductor sizes and ampacities should be compatible with the voltage and current levels used in the circuit.

In paragraph (b), the required ampacities of conductors supplying a single motor would be at least 125 percent of the maximum full-load current of the motor. Paragraph (c) would set the ampacity of feeder conductors which supply one or more loads to be at least the sum of the full-load currents of all the motors plus 25 percent of the highest full-load current of the largest motor.

Paragraph (d) would require the size of conductors specified in paragraphs (a) through (c) to conform with ampacity Tables F–1 through F–4, which would accompany the standard. The tables list minimum sizes of conductors for flexible cords rated 300 and 600 volts, portable power cables rated 2,000 volts or less, and conductors other than flexible cords or portable cables rated 2,000 volts or less. The tables are based on information derived from the NEC and the Insulated Cable Engineers Association (ICEA), accepted by electrical engineers as reliable resource materials containing safe industry standards.

Section 75.523 Overcurrent Protection

This section would address overcurrent protection for electric circuits and equipment with circuit breakers, fuses or other automatic circuit interrupting devices. Overcurrent protection for high-voltage trolley circuits, trailing cables, and permissible equipment would not be addressed by the standard. Standards specifically applicable to these circuits and equipment are contained in MSHA's approval regulations in part 18 and other subparts of the proposed electrical standards. Therefore, § 75.524 would only apply to equipment and circuits which are not specifically addressed elsewhere in MSHA's rules.

Performance requirements for overcurrent protective devices would be spelled out in the proposed rule, based on references to the ratings tables accompanying the proposal. The standard and tables would replace existing §§ 75.518 and 75.518–1, which refer to the 1968 edition of the NEC for information governing overcurrent protection. The tables accompanying the proposal would codify overcurrent protection requirements, and eliminate the need for reference to the code. They are based on accepted safety standards, as well as information taken from the NEC.

Paragraph (a) of the proposed rule would require all electric circuits and equipment to be protected against overcurrents by circuit breakers, fuses, or other automatic circuit interrupting devices which meet the proposed requirements, except as otherwise provided in MSHA's regulations. The overcurrent protection provisions and the tables specifying ratings and settings for protective devices would assure proper deenergization of circuits and equipment in the event of overcurrent conditions. Arcing and conductor overheating, and the resulting hazards to miners such as fires and electric shock would thereby be prevented.

Under paragraph (b), overload devices would be required to be installed in each ungrounded conductor supplying motors. They would have to be rated or set as specified in Table F–5, detailing maximum ratings or settings of motor overload protective devices, and cause deenergization of all ungrounded power conductors of three-phase motors when any phase is overloaded. This would assure that overcurrent conditions are not transmitted to all phases.

Paragraph (c) would require circuit breakers to be installed to provide short-circuit protection for branch circuits supplying three-phase motors, and rated or set as specified in Table F–6. The reference table would list maximum ratings or settings for circuit breakers providing short-circuit protection for motor branch circuits and devices supplying power to three-phase motors.

Under paragraph (d), circuit breakers or fuses would be required to be installed to provide short-circuit protection for branch circuits supplying single-phase and d-c motors. They would have to be rated or set in accordance with proposed Table F–7. This table would set maximum ratings or settings of circuit overcurrent protection devices for single-phase motors and direct-current motors.

Paragraph (e) would require that where a setting specified in Table F–6 is insufficient for the starting current of a-c motors, the setting of a circuit breaker may be increased. However, the setting would be required to be 1300 percent or less than the motor's full-load current on instantaneous-trip circuit breakers, and 400 percent of the motor's full-load current for inverse-time circuit breakers.

Paragraph (f) would require overcurrent protection in the form of either circuit breakers or fuses for motor feeder circuits, transformers, and welders in accordance with Table F–8. Under paragraph (g), circuit breakers or fuses with ratings or settings not to exceed the full-load current ratings of the equipment would be required for the protection of all circuits and equipment not specified in paragraphs (b) through (f) of the section. Under paragraph (h), all supply conductors, control circuit conductors, lighting current conductors and those not specifically addressed in the previous paragraphs would be required to be protected in accordance with their ampacity.

Under paragraph (i), overcurrent protection would not be required on incandescent lamps supplied from d-c systems, provided the length of ungrounded conductors does not exceed eight feet. MSHA experience demonstrates that a requirement for overcurrent protection in these circumstances would not be justified since the design of incandescent bulbs is such that their filaments will fuse during an overcurrent situation. An eight-foot limitation would decrease the likelihood of the ungrounded conductor contacting the mine track. The higher resistance of a much longer conductor could cause it to overheat in such a situation, posing a fire hazard to miners.

Paragraph (j) would provide that when the required rating of a fuse or circuit breaker without an adjustable-trip unit does not correspond to a standard rating for fuses or circuit breakers, the protective device used would not be permitted to exceed the next higher standard rating. In such cases, the Agency would permit the use of a lower standard rating, or the next higher standard rating.

Circuit breakers or fuses providing short-circuit protection would be required, under paragraph (k), to be installed where the circuit conductors are connected to the supply. However, feeder tap conductors which are 25 feet or less in length, have ampacities of at least one-third of the ampacity of the feeder conductors, and terminate at a circuit breaker or fuse with current ratings that do not exceed the ampacity of the feeder tap conductors, would not have to meet the requirements of this provision. The 25-foot requirement is consistent with national standards, which recognize that a longer length could unnecessarily increase the resistance in the circuit. The proposal would limit the resistance in the circuit to a value that would allow adequate fault current to flow through the system, thereby allowing the system overcurrent protection to properly operate.

Section 75.524 General Requirements for Overcurrent Devices

This proposed section is also derived from §§ 75.518 and 75.518–1, and would contain general performance standards and specifications for overcurrent devices. Under paragraph (a), connection of fuses, circuit breakers, or a combination of both in parallel would be prohibited. This would ensure that the integrity of the protective device is maintained, and that ratings for protective overcurrent devices are used which will not cause damage to the circuit. The design of fuses and circuit breakers currently employed in the industry requires full-line current for the devices to accurately operate within their parameters.

Paragraphs (b) and (c) would require fuses and circuit breakers to have voltage ratings of at least the maximum voltage, and a continuous current rating of at least the maximum full-load current of the circuit being protected. This would assure that overcurrent devices would be effective for the protection of the circuits they serve by requiring compatibility of voltage and current ratings.

Under paragraph (d), fuses and circuit breakers would be required to have interrupting current ratings of at least the maximum fault current available at the fuse or breaker. Under this provision, the protective device would be able to clear a faulted condition without damage to itself. Therefore, the effectiveness of the protective device would be preserved, and miners would be protected from electrical hazards caused by undetected overcurrents in a circuit.

Paragraph (e) would require circuit breakers to be installed so that the "up" position of the handle indicates the "on" position. The effect of this provision would be to provide a consistent indication of when the circuit breaker is operating. Without this provision, the on position for two circuit breakers in one mine could be indicated by different directional positions. In the dark and dusty atmosphere of underground coal mines, this could easily lead to mistakes. A similar situation is presented by a standard light switch in a typical home, where the up position indicates on and the down position indicates off. These standard positions help to prevent the homeowner from changing a bulb in a live socket, for instance. Similarly, the proposed standard would minimize the risk of a miner mistakenly energizing or failing to deenergize the circuit due to confusion over the appropriate position of the circuit breaker handle.

Paragraph (f) of the proposal would prohibit automatic reclosure of circuit breakers after tripping operations, except as provided in proposed § 75.1006. Therefore, circuit breakers would remain in the open position with the circuit remaining deenergized until manually reset. Unlike surface utility lines, in which changing environmental conditions can cause and clear fault conditions, faults in an underground electric circuit will not normally clear themselves because they typically occur due to persistent fault conditions. The proposal would assure that a malfunction in the electric circuit will not persist and cause repetitive tripping of the breaker, which could represent a fire and shock hazard underground. Additionally, it would assist rescue operations if the breaker has been tripped due to a miner coming in contact with an energized component of the circuit. Automatic reclosure of the circuit breaker would allow reenergization of the circuit before rescue could be attempted, placing rescuers in danger as well.

Under paragraph (g), thermal cutouts, thermal relays, and other devices used for overload protection of motor circuits would be prohibited for use as protection against short-circuits unless they are designed for that purpose. Such devices are not normally designed to clear a short-circuit condition due to the high fault currents that could occur in a circuit.

A fuse or overcurrent trip device of a circuit breaker would be required, under paragraph (h), to be connected in series with each ungrounded power conductor. Connection in series would assure that the total current is measured in the circuit in order to evaluate whether an overcurrent is present. This would protect miners by not allowing overcurrents to go undetected, which can cause damage to cable insulation from overheating, and resultant injury to miners contacting the cable. A combination of a current transformer and relay used as an overcurrent trip device would be excepted from the proposed standard because it is designed to measure the amount of current in a circuit. Therefore, the excepted combination already provides the protection which would be offered under the proposed standard.

Paragraph (i) would require overcurrent devices to be readily accessible and protected against physical damage. This provision would assure that the physical integrity of protective devices is maintained, and that they are easily reached in an emergency situation.

Paragraph (j) would prohibit the use of renewable link-type fuses for protection of low-voltage circuits and equipment. The protective function of such fuses is easily defeated. The NEC no longer references renewable link-type fuses, though it does not specifically prohibit them. Fuses are intended to open circuits under controlled conditions when an overcurrent condition occurs by breaking the circuit connection and thereby deenergizing the circuit.

Non-renewable link-type fuses are contained in a sealed casing, and the links are manufactured to assure predictability. By contrast, the links in

renewable link-type fuses can be changed or replaced. A problem which often arises is replacement of a link with heavy conductors or other inappropriate substances which will not melt and open the circuit when an overcurrent situation arises. This practice is comparable to placing a penny in a fuse to purposely or accidentally defeat the circuit tripping function of the device, which can cause serious fires and shock hazards. For these reasons, the Agency has determined that renewable link-type fuses are not reliable for use as low-voltage circuit protective devices.

Section 75.525 Identification of Circuit Breakers and Fuse Holders

This standard is derived from existing §§ 75.601, 75.809 and 75.904, and would require legible and durable markings for identification of circuit breakers, trolley taps, fuse switchboxes, and other fuse holders. Markings would be required to identify the specific unit of equipment protected. Without a means of identifying circuit breakers and fuses, and what equipment they serve, miners would be put at risk that someone will accidentally reenergize the wrong circuit and cause an unexpected start-up of a piece of equipment, for example.

Section 75.526 Nameplates and Markings

This proposed standard is new, and would require nameplates or other durable markings indicating the manufacturer's name and the rated voltage and current of motors, transformers and circuit breakers. The proposal would provide for greater familiarity with the equipment, the size and type of overcurrent protection required, and other details which would assist in maintenance of the equipment and proper sizing of conductors. The majority of the specified equipment presently in use in underground mines is sold with such nameplates attached. If a nameplate is damaged or dislodged from the machine, it would be a fairly simple matter for the mine operator to order a replacement plate from the manufacturer.

Section 75.527 Map of the Mine Electrical System

This proposed rule would require that a map of a mine's electrical system be maintained and be made available to representatives of miners and authorized representatives of the Secretary. The proposal is derived from existing §§ 75.508, 75.508–1 and 75.508–2, which require a map showing the location and electrical rating of all stationary electric apparatus in connection with the mine electrical system, and the location and details concerning mine trolley tracks when used in a mine.

Although the existing regulations would be altered by the proposed rule, MSHA believes that the same or a higher level of safety would be maintained under it. Unlike the existing standards, the proposal would specify the circuits and equipment covered, require inclusion on the map of information enabling evaluation of protection devices for trolley circuits, and extend the time period for updating the map.

Paragraph (a) of the proposed rule would require that a mine electrical system map be maintained and made available to authorized representatives of the Secretary and representatives of miners. The map would be required to show the size and location of circuit breakers, fuses, transformers, cables, rectifiers, switchgear, and disconnecting devices of high-voltage systems. The size and location of stationary equipment operated by 10 horsepower or larger motors, and trolley wires, trolley feeder wires and return feeder wires would have to be reflected on the map.

Trolley system information would be required, including size and location of track rails used as power conductors, with a notation as to whether one or both rails are bonded or welded at every joint, size, location and setting of d-c circuit breakers protecting trolley circuits, and the location of cutouts and deadblocks installed in trolley circuits. A map of a coal mine's electrical system is required so that all persons at the mine will be able to determine the location of the permanent equipment and circuits there. This is essential information, since the safety of miners may depend on the ability to identify and quickly locate the switches, circuits or equipment that should be deenergized during an emergency situation or maintenance operations.

Paragraph (b) of the proposal would allow up to five working days to reflect changes to the map after the affected circuit or equipment is reenergized and returned to service. The present regulations require changes in the electrical system to be reflected on the map by the end of the next working day. The proposed standard would address comments to the preproposal draft that five days is a more reasonable time period in which to accurately reflect electrical system changes on the map.

One of the most common changes in an underground electrical system is the extension of the trolley system. Many of the installations required to be shown on the mine map are permanent structures, which are rarely moved. Power centers serving stationary equipment, for example, would not normally be moved with any frequency. Therefore, the majority of the installations shown on the map would not be significantly affected by the proposed time extension. In MSHA's view, an extension of the compliance time to five days would not result in a decrease in safety for miners. A more detailed and accurate reflection of changes, such as the extension of a trolley system, could be made under the proposal than under the present standard.

Section 75.528 Alternating-Current Battery Chargers for Mining Vehicles

This proposed section would be new, and would set requirements for a-c battery chargers to enhance miner safety by helping to prevent electric shock and electrocution hazards. Under the proposal, a-c battery chargers for mining vehicles installed on or after the rule's effective date would be required to have a two-winding transformer which electrically isolates the battery charging circuit from the a-c supply circuit, and a control circuit with a maximum voltage not exceeding 150 volts.

Electrostatic, or "Faraday," shields would also be required between the secondary and primary windings when the battery charger is supplied from a circuit having a voltage greater than 150 volts. Shields would be required to be constructed of aluminum or copper, connected to the battery charger frame, and have a cross sectional area consistent with proposed § 75.714(c). A transformer fault can transfer the voltage of the primary or incoming circuit to the lower voltage secondary or outgoing circuit. This, in turn, could cause energization of the frame of the equipment being charged. Metallic Faraday shields would allow current to trip the circuit breaker if a fault occurs in the transformer.

For example, a breakdown of the insulation between a typical 480-volt primary winding and a 220-volt secondary winding could cause transmittal of the higher voltage to the secondary circuit. A grounded, metallic shield between the windings would prevent such a transfer of voltage and energization of the equipment frame. Since 1970, at least two fatal accidents have occurred as a result of short-circuits between primary and secondary windings of battery charger transformers. Several fatalities are also attributable to contact with frames of

control switches or bare control wires energized at voltages in excess of 150 volts. The proposed rule would help to prevent similar accidents in the future.

Only a-c battery chargers installed after the effective date of the proposed rule would be addressed by it. Battery chargers typically have a short service life underground, and therefore must be replaced with some frequency. Thus, as battery chargers are replaced over the next few years, all of the equipment should achieve compliance with the proposed standard. Additionally, retrofitting such equipment would be extremely difficult. Therefore, a delayed effective date which would cause the rule to apply only to new equipment would be appropriate.

Section 75.529 Emergency Deenergization Devices for Mobile Electric Equipment

This proposed standard would consolidate the requirements of existing §§ 75.523, 75.523–1 and 75.523–2, which set standards for automatic deenergization devices, commonly referred to as "panic bars." Panic bars are devices capable of quickly deenergizing the tramming motors of mobile electric face equipment in an emergency. Like the present standards, proposed § 75.529 would set performance requirements for deenergization devices, detailing proper placement and operational requirements, as well as MSHA acceptance procedures for alternative safety devices.

Paragraph (a) of the proposal would require devices capable of quickly deenergizing the tramming motors on underground mobile electric face equipment. Emergency deenergization devices consisting of an electro-mechanical stop switch and an actuating bar extending a sufficient distance in each direction from the stop switch would be required at each location from which the equipment can be operated. The effect of this provision would be to require a panic bar at every position on the equipment from which it can be operated or moved. Therefore, the operator of mobile electric equipment should be within reach of the deenergization device at all times.

On battery-powered articulated equipment, which normally place the operator at a 90-degree angle from the direction of travel, panic bars and emergency stop switches would be required on both sides of the operators' compartments. This proposal is consistent with MSHA policy addressing the implementation of existing § 75.523–2, and would provide operators of articulated equipment with the ability to quickly deenergize the tramming motors without having to alter position. MSHA's experience indicates that problems associated with impairment of vision and movement of those operating such equipment make it necessary to locate a means of actuating the stop switch on both sides of the equipment operator. This proposal would help prevent an equipment operator from being pinned, crushed, or rolled between the ribs, roof or other obstruction and the machine being operated.

When the equipment can be trammed from a location other than the operator's compartment, the proposal would require installation of actuating bars so that it is located between the operator and the machine at all times it is being trammed. This provision would assure that the deenergization device is readily accessible to equipment operators in case of emergency.

The proposal would retain the existing requirement that the actuating bar be capable of operating the electro-mechanical stop switch when it is moved a distance not to exceed two inches, by a force of fifteen pounds or less. MSHA recognizes that some resistance in the movement of the actuating bar is necessary to prevent unintentional actuation. However, the Agency believes that maximum limits are necessary to assure that panic bars are capable of easy actuation, by exertion of minimal force by the operator.

Panic bars would also be required to be installed so as not to interfere with the normal operation of the equipment. These performance criteria would assure that emergency deenergization devices are easily accessible in emergency circumstances at all locations from which equipment may be operated. Panic bars could be activated to stop the tramming of heavy equipment through use of minimum force, yet would be required to present no interference with other equipment controls. The proposal would reduce the risks of being pinned or crushed to miners working on such equipment.

Paragraph (b) would retain the existing exception from the panic bar requirement for mobile electric face equipment that is equipped with a substantially constructed cab which meets the requirements of part 75. According to existing § 75.1710(b)(2), a cab is a structure providing overhead and lateral protection against falls of roof, rib, and face, or rib and face rolls. Such cabs, then, are substantially designed to protect equipment operators against being crushed or pinned by heavy materials or objects. The presence of such cabs would assure that the operator would not be pinned or crushed by a collision with the rib, for example, while inside the operator's compartment.

Paragraph (c) of the proposed rule would permit the Director of Technical Support to approve other emergency deenergization devices if they would provide equivalent protection. Application for acceptance of alternative devices would be made to the Chief of MSHA's Approval and Certification Center in Triadelphia, West Virginia. This provision exists in the current standard to provide operators with the ability to utilize advancements in technology which may provide equivalent protection for miners with the approval of the Director of Technical Support.

Section 75.530 Use of Insulated Trailing Cable Handling Equipment

This section is derived in part from existing § 75.706, and would set requirements for the use of protective handling equipment while moving insulated trailing cables. Paragraph (a) is new, and would require the use of insulated hooks, tongs, slings, gloves, mitts, aprons, or other insulated personal protective equipment capable of protecting against shock when energized high-voltage and unshielded low-voltage trailing cables are moved manually. A review of the fatality and accident record since 1970 reveals that at least seven persons have been electrocuted while handling trailing cables as a result of contact with exposed conductors. Without shielding, and the protection against ground faults it provides, even a small, hard to detect opening in the power conductor insulation poses a shock hazard.

One commenter to the preproposal draft suggested that the proposed requirement for gloves during handling of trailing cables is unnecessary since other sections of the regulations require that trailing cables be maintained in a safe condition. This suggestion was not adopted in the proposal. An evaluation of the severe conditions to which trailing cables are normally exposed suggests that, even when trailing cables are properly examined and maintained, there is still the possibility that the cable could be damaged before a hazardous condition is detected. As another commenter pointed out, most of the fatal accidents previously referred to resulted from the handling of either a cable with an undetected defective splice or one with undetected damaged insulation. Furthermore, since coal mines are usually damp and wet and thereby

enhance conductivity, the potential for shock hazards associated with damaged energized trailing cables becomes even greater. Insulated handling devices would provide a significant measure of protection against such hazards.

Other commenters to the preproposal draft suggested deletion of the proposed requirement for the use of gloves during cable handling. They reasoned that if the proposal requires shielded cable, the need for insulated gloves or protective equipment would be eliminated. They stated that defects or damage in shielded cable would usually provide enough grounding current to deenergize the circuit so that the extra protection of insulated gloves or a similar protective device would be unnecessary. The proposal does not delete the requirement for protective devices, but would not require their use when handling low-voltage trailing cables that are shielded. In addition, to promote regulatory flexibility, the proposal adopts the suggestion of one commenter to allow equally safe alternative protective devices to be used, such as insulated hooks, tongs, etc. The Agency solicits comments on the benefits of retaining this requirement for persons handling high-voltage cables that are shielded.

Paragraph (b) would require that insulating equipment be rated for at least the nominal voltage of the circuit for low-voltage trailing cables, and for at least 20,000 volts for high-voltage trailing cables. These values would provide proper protection in light of the circuit voltages involved.

The required protective equipment would have to be examined before each use for visible signs of damage or defects, and removed from the underground area of the mine when found to be damaged or defective. Compliance with this standard would place responsibility on the user of protective equipment to inspect it for hazardous conditions. For example, a simple test commonly used to detect damage in insulating gloves is to fill them with air and observe if there is any leakage. Therefore, persons would not rely on equipment which would be ineffective for protection against shock while handling trailing cables.

Paragraph (c) would require that insulated handling equipment for use with high-voltage trailing cables be electrically tested every six months. More formal testing procedures of handling equipment would assure that minuscule, though possibly lethal damage will not go undetected.

Section 75.531 Deenergized Underground Power Circuits; Idle Days-Idle Shifts

This proposed standard would retain the existing requirements of § 75.706. It would require that power circuits underground be deenergized on idle days and idle shifts when not in use. Compliance with the standard would assure that unattended equipment remains deenergized while not in use, thereby reducing the likelihood of accidents underground. For instance, a roof fall could occur in an unattended area, causing combustible materials to contact an energized circuit and ignite. Rectifiers and transformers would be excepted from this requirement, since it is necessary for some types of equipment, such as pumps, to operate even during idle days and shifts.

Subpart G—Low-Voltage Circuits

Section 75.601 General Requirements for Trailing Cables

This section is partially new, and partially derived from the general requirements for trailing cables in existing §§ 75.600, 75.600–1, 75.701–1, 75.703–3, 75.906, and 75.907. The proposal would retain the existing requirement that trailing cables meet the flame-resistance tests of 30 CFR 18.64, and that underground trailing cable energized between 660 and 1,000 volts have metallic shielding. It would also phase in new shielding requirements over a period of three years. The shielding exception in existing § 75.907 that excludes cable on cable reels with insulation rated at 2,000 volts or more would be retained for a period of three years. The proposal would also include new performance specifications for trailing cables.

Paragraph (a) is derived from existing § 75.600, which requires that trailing cables used in coal mines meet the requirements established by the Secretary for flame-resistance, in § 75.600–1. The requirements for flame-resistance testing are set forth in 30 CFR 18.64. The proposal would combine these two rules by requiring that trailing cables be flame-resistant in accordance with 30 CFR 18.64. Presently, the Agency evaluates representative samples of trailing cables to ensure that the cables meet the flame-resistance tests, and the Agency would continue to evaluate samples of new trailing cable for this purpose under the proposal.

Paragraph (b) is new, and would require that the grounding conductors in shielded trailing cables be bare. Bare grounding conductors are recommended by ICEA standards. Additionally, few shielded cables being used in the industry are manufactured with insulated grounding conductors. The design of shielded trailing cables places the grounding conductor in direct contact with the shielding. The safety advantages of having the shielding and the bare grounding conductors in direct contact along the length of the cable is that the contact creates an enhanced ground path which ensures tripping reliability.

Bare grounding conductors are sized to carry ground fault currents effectively, whereas shielding is not. However, since they are in continuous contact, the safety provided by the shielding is enhanced by the current carrying properties of the bare grounding conductors. Consequently, even if the shielding is severed, it could still be effectively grounded for its entire length, and the grounding conductor could still carry enough grounding current from the shielding to trip the circuit breaker.

Paragraph (c) is new, and would require that ground-check conductors and interlock circuit conductors be contained in the cable and have a cross-sectional area equal to or greater than No. 10 AWG when the circuit power conductors are No. 10 AWG or larger, or the cross-sectional area of one circuit power conductor when the circuit power conductors are smaller than No. 10 AWG. The proposed sizing of these conductors and the proposed specification that they be located within the cable are based on ICEA standards for evaluating cable durability in the harsh environment of a coal mine. Conductors inside the trailing cables are afforded the additional mechanical protection of the shielding, the conductor insulation and the outer jacket, as well as the support and cushion of the other conductors inside the jacket.

Paragraph (d) is derived from existing § 75.906, which requires one or more grounding conductors in each trailing cable for mobile electric equipment, and existing § 75.907 which requires trailing cables energized from 661 volts to 1,000 volts phase-to-phase to have a grounding conductor. The proposal would require trailing cables to have at least one grounding conductor unless the cables supply double insulated tools or equipment, or equipment that is silicon-diode grounded. Providing a grounding conductor or other effective means of protection would prevent the energization of equipment frames and the resultant shock hazards to the miners.

MSHA has evaluated the safety features of double insulated tools and

appliances and has concluded that a grounding conductor would not be needed for such equipment. Double insulated tools are constructed with two independent and separate insulating systems. Should one system fail, the other would act as the back-up. Similarly, a trailing cable serving equipment protected by a silicon-diode system would not be required to have a grounding conductor. The diode system utilizes the grounded power conductor in the trailing cable to replace the grounding conductor, and it performs an equivalent safety function. The presence of the diode system on the frame of the equipment would allow any ground fault on the equipment to momentarily pass to the equipment and the attached diode. As the fault passes through the diode, the silicon-diode system would deenergize the circuit, thereby rendering the frame of the equipment safe.

A new provision in paragraph (e) would require that trailing cables for mobile haulage equipment have power conductors that are at least No. 6 AWG for a-c circuits, and No. 4 AWG for d-c circuits. These minimum sizes are presently required for trailing cables serving permissible equipment under 30 CFR part 18. Extending this requirement to all trailing cables would provide for physical strength in the structure of cables that would help ensure their durability in the underground coal mine environment.

Paragraph (f) is new, and would require that power conductors in trailing cables for non-haulage equipment employing cable reels be at least No. 8 AWG. This is the minimum size presently in use in the industry. Cables that are smaller than No. 8 AWG would not have suitable mechanical strength for use on cable reels because of the stress and constant flexing encountered by cables used with cable reel equipment.

Paragraph (g) is new, and would require that, one year after the effective date of the rule, trailing cables serving mobile electric equipment not employing cable reels and energized at between 150 volts phase-to-ground and 660 volts phase-to-phase (381 volts phase-to-ground) have grounded metallic shielding around each power conductor. The proposal would also require that, three years after the effective date of the rule, trailing cables energized at between 150 volts phase-to-ground and 660 volts phase-to-phase which serve mobile cable reel equipment have grounded metallic shielding around each power conductor.

The type of shielding specified in the standard is commonly referred to as SH–D cable. It is designed so that the metallic shield surrounds each power conductor individually. By contrast, SH–C cables are designed with shielding surrounding the entire conductor assembly. The proposal specifies that the shielding must be around each power conductor to address the risk of phase-to-phase faults. Cables which have shielding around the entire assembly are lighter weight, but they do not provide protection against phase-to-phase faults. Additionally, maintaining proper contact between the shielding and the grounding conductor can be problematic with the design of SH–C type cable. These problems were discussed in a paper by R.H. King and G.J. Conroy, "How to Prepare for Shielded Trailing Cables," presented at the Fifth Institute for Mine Health and Safety, Colorado School of Mines, November 1979.

The most common application of the proposal would be to three-phase equipment energized at 480 and 575 volts phase-to-phase, and single phase equipment energized at 240 volts phase-to-ground. Under present rules, trailing cables energized at voltages falling within these ranges are not required to be shielded.

The proposal would require metallic shielding to be connected to the grounding system. Such shielding would provide a low-resistance return path to ground so that phase-to-ground current will trip the ground-fault protective device required by proposed § 75.602. Therefore, a fault in the cable would cause the breaker to trip and deenergize the circuit before harming miners. If the fault current is insufficient to trip the circuit breaker, the shielding simply serves as a grounding path to conduct the current to ground instead of using a human body or mining machine as a path to ground.

Metallic cable shielding would provide an engineering safeguard for the protection of miners, which is a passive or "built-in" defense against shock and electrocution through contact with cable voltages. The Agency recognizes the advantage of engineering protection in some instances in addition to procedural safeguards that can be defeated by carelessness, mistake, lack of training or tampering. Cables which are properly shielded and maintained would not expose miners to the consequences of such human factors. The Agency has found that a reliable backup safety feature is necessary when the failure or violation of a procedural safeguard would otherwise result in the death of a miner.

These other safety features associated with preventing electrical cable-related accidents, such as ground-fault tripping and deenergization of cables before work is performed, are also included in present regulations and retained in the proposed rule. Compliance with these standards, as well as those requiring proper maintenance of electric equipment and circuits and the use of personal protective equipment are crucial to miner safety. Although perfect compliance with all of MSHA's mandatory standards and the absence of human error are desirable, due to many varying circumstances, it would be unrealistic to assume such circumstances at all times. Therefore, the elimination of as many factors contributing to electrical injuries as possible through a shielding requirement would lessen the risks to miners.

The proposal primarily addresses shock hazards, but would also address fire and ignition hazards associated with the use of trailing cables. An in-depth analysis of MSHA fatality reports revealed that a total of 21 cable-related fatalities occurring since 1970 could have been avoided through the use of metallic shielding on low-voltage trailing cables. Thirteen occurred from 1970 through 1978, while the remaining eight occurred since 1978. While diligent compliance with all existing electrical standards may have prevented some of the fatal accidents, it is not unusual for violations to exist that go unnoticed by the miners working on the section. For example, bad splices and cable damage are often difficult or impossible to detect by visual observation.

In reviewing the fatality reports of these 21 cases, the Agency determined that six could have been prevented by proper deenergization and locking and tagging out, while five others could have been prevented through proper installation and maintenance of grounding devices, existing requirements whose violations are more easily detected. Thus, MSHA estimates that ten fatalities during this 18-year period could have been avoided principally through the use of shielding.

MSHA further analyzed the types of equipment involved in the 21 fatalities and found that two-thirds involved cable reel equipment, and the remaining one-third involved machines employing drag cables. Roof bolters, shuttle cars, loading machines, continuous miners, a coal drill, a utility truck, and a bridge conveyor were involved in the accidents. In the ten-year period 1979 through 1988, eight fatal trailing cable-related accidents have occurred. Of these, six cable reel machines (three roof bolters and three shuttle cars) and two drag cable machines (a bridge conveyor and a continuous miner) were

involved. However, the last drag cable-related fatality occurred in 1980. MSHA believes this reduction may be attributable to several factors. First there has been a reduction in the use of conventional equipment, such as loaders and face drills, in favor of continuous-type mining equipment (resulting in fewer pieces of face equipment with drag cables). Furthermore, there has been a steady replacement of 480-volt continuous miners with 950-volt continuous miners, which existing rules already require to be equipped with shielded trailing cables. As a result, the number of low-voltage drag cable machines in use has decreased in recent years. This, combined with improved cable maintenance and more reliable and sensitive personal protective equipment, has resulted in some reduction in accidents on all cable equipment.

Given that these factors may have eliminated drag cable-related fatalities in recent years, the Agency solicits public comment on whether drag cables continue to present a hazard warranting metallic shielding. Are there certain uses of drag cables which may present less risk than others? Is the Agency's cost estimate of $4.4 million per year (presented in the Agency's Economic Impact and Regulatory Flexibility Analysis for the Proposed Rule for Electrical Safety in Underground Coal Mines, p. IV–9) accurate for the requirement to provide metallic shielding on all drag trailing cables? Based on the information available to the Agency, it is proposing to require metallic shielding on both drag cables and cables used on reel equipment. However, the Agency will reexamine the drag cable requirement in the final rulemaking.

Primarily, the use of shielded trailing cables would increase safety for miners required to physically handle the cables by reducing the likelihood of exposure to bare or shortcircuited energized power conductors. MSHA also conducted a preliminary analysis of 132 cable-related accident and injury reports involving mobile electric equipment occurring since 1983. Of these, 82 non-fatal accidents were identified as having occurred while employees were handling or attempting to perform maintenance on cables. The injuries included shocks and severe burns to the limbs and face areas, resulting in a combined total of 1,675 lost work days.

An unshielded trailing cable may be damaged to the point of exposing conductors, but continue to function properly. This hazardous condition will not be detected until a return path is established. The construction of unshielded cables does not provide this return path within the cable components unless the grounding conductor or power conductors come in contact with the exposed or damaged conductor when damage occurs. This would only occur if damage is extreme enough to result in mutilation or smashing of the cable. By contrast, the construction of the proposed type of shielded trailing cables provides a metallic outer covering surrounding each power conductor. A return path is provided by the shielding in a damaged cable to conduct dangerous currents to the ground-fault protective device instead of exposing personnel to contact with an energized circuit.

One of the identified fatalities occurred when an equipment operator stepped on or near an inadequately repaired area in a continuous miner trailing cable. The miner then reached for the controls of a shuttle car, and upon contacting the grounded metallic frame of the shuttle car, was exposed to the differing potential between the equipment frame and the cable voltage, 277 volts, a-c, which caused electrocution. An MSHA inspector who investigated the accident discovered that the cable appeared to be properly insulated. However, the victim was exposed to leakage current through damaged and wet cable insulation.

The shuttle car frame provided a path for current flow through the victim's body. If shielding had been present around the trailing cable power conductors, the leakage current would have been conducted to ground by the shielding, eliminating the shock hazard to the victim. The undiscovered damage to the cable may have been located if the fault current had been great enough to cause the circuit breaker to trip and deenergize the circuit before the individual contacted it.

Several of the fatalities occurred when miners mistakenly used a metallic tool to cut into an a-c trailing cable that had not been properly deenergized. The existing standards, as well as the proposal, would require circuits to be deenergized before work is begun, but human error or an erroneous assumption that the circuit has been deenergized can lead to such fatalities. For example, an individual qualified to perform mine electrical work was exposed to 277 volts, a-c when he cut into a damaged shuttle car trailing cable to make repairs. Another mine electrician had mistakenly deenergized the wrong trailing cable. In this case, despite the violation of existing procedural rules, the victim would not have been fatally injured if an additional, reliable engineering control in the form of grounded metallic shielding had been provided.

Shielded trailing cables would also reduce the likelihood of fire and ignitions in the presence of coal dust and methane by providing additional protection against conductor short circuits, and because the symmetrical construction of shielded cables reduces the occurrence of induced currents and subsequent intermachine arcing. A review of reports of dust and gas ignitions between 1983 and 1987 showed that four reported ignitions were attributable to trailing cables arcing and exploding. After reviewing this data, the Agency concluded that adequate cable shielding could have prevented these incidents.

The Agency is aware that some debate exists concerning the technical feasibility of requiring metallic shielding on low-voltage trailing cables used on cable reel equipment. In paragraphs (g) and (h), the proposed three-year phase-in schedule for shielded trailing cable serving equipment that employs cable reels is based on the Agency's review of available research and technology in this area. However, MSHA specifically solicits public comment on the technical feasibility and availability of metallic shielded cable, as well as the proposed compliance schedule.

The Agency has identified three primary areas of concern in the use of shielded cables on cable reel equipment; its ability to spool properly, increased weight, and flexibility. Improper layering of the cables resulting from poor spooling can greatly reduce the cable storage capacity on the reel and increase stresses on the cable from binding and twisting. Although the larger diameters of shielded cables will somewhat reduce the storage capacity of cable reels, this reduction should not be a significant factor if proper spooling techniques are used. Similarly, properly layered cable would not be exposed to increased stresses. It is expected that cable reel components presently in use can be modified to adequately handle the new shielded cable diameters.

Shielded cables constructed with shielding around each power conductor can weigh as much as 30 percent more than unshielded cables of the same size and design. Cable reels have been reported to experience difficulty in handling the added weight of such cables, increasing the probability of the equipment running over its own cables. This problem could be overcome by the use of higher reeling tensions.

Shielded cables are typically less flexible than unshielded cables, making them more susceptible to damage resulting from bending when used on cable reel equipment. Such damage can lessen the effectiveness of shielding and the cable's service life if appropriate coverage area is not used. Repeated reeling and the related flexing of the cables can cause metallic shielding to break or gap, losing its protective characteristics. However, research conducted on the electrical and mechanical performance of flexible shielding systems in portable trailing cables by the Anaconda Company, a major cable manufacturer, yielded encouraging results.

In Anaconda's research, two shielded cables, one with full copper braid shielding and one with cotton/copper braid shielding, were tested in a laboratory and subjected to repeated reeling and bending to simulate service conditions and accelerate the cable damage produced in a mine. A research paper by T.E. Hansen of the Anaconda Company, Wire and Cable Division, detailed the results of the testing. The paper, presented at the Tenth Annual Meeting Conference of the IEEE Industry Applications Society in 1975, concluded that:

> The performance of the cotton/copper and full copper braid shielded EP insulated cables under simulated service flexing conditions suggests both designs should retain their ground system integrity through a long service life. . . The possibility of a broken shield wire in a copper/cotton braid shield, penetrating the insulation to cause premature cable failure and a shorter service life than an unshielded cable seems remote, in agreement with a user's report that during 15 years experience, the durability of copper/cotton shielded cables was comparable to nonshielded cables in trailing cable applications. Hanson, T.E., "Performance of Flexible Shielding in Trailing Cables," Conference Record Cat. No. 75CH0999–31A, p. 5, 1975.

MSHA expects that shielded trailing cables which are able to withstand the flexing involved in normal cable reel usage can be made available within the specified compliance period.

The Bureau of Mines funded an investigation into the feasibility of using shielded cable in underground coal mines, undertaken at the Pennsylvania State University. Bureau of Mines Information Circular 8799, "Mine Power Systems Research, Trailing Cables," Contract #G0155197, R.H. King and J. Hanslovan, "Low-Voltage Shielded Cables", 1977. The investigation focused on safety effects, cost, reliability and life of shielded cables, and included laboratory testing of cable shielding. Tests were performed at the Pennsylvania State University Mine Electrical Research Laboratory in conjunction with the investigation. A flexing machine was used to simulate reeling effects, and it was found that, "No significant shield-wire breakage occurred in any of the SH–D samples; however, grounding conductors broke frequently. The shield maintained the grounding-circuit continuity when grounding conductors were damaged." Id. at 40.

The report concluded that the introduction of shielded low-voltage cables has potential for hazard reduction, and stressed the importance of adequate shielding coverage and a low-resistance contact between the shield and grounding conductor. In addressing the availability of low-voltage shielded cables, the report concluded, "Initially, a wide range of low-voltage shielded cables would not be available. Some cable manufacturers indicated that a one- to two-year tool-up period would be necessary. Others did not anticipate an extensive problem." Id. at 47.

Several mines are presently using shielded cable on cable reel equipment, other than rapid-tramming equipment such as shuttle cars, with encouraging results. The operators of four U.S. mines have voluntarily used shielded cable successfully on cable reels serving face drills, roof-bolters and cutting machines. Three of the mines are coal mines at which shielded cable has been used on all a-c equipment for several years. The largest conductor size used is #6 AWG. The mine operators have stated that usable cable lengths have not been affected by shielding at these mines.

Shielded cable has also been used voluntarily on cable reel equipment in a Wyoming trona mine for the past 27 years. The mine employs conventional mining methods which are nearly identical to those used in underground coal mines. Shielded trailing cables are used to supply roof bolters, face drills and cutting machines on up to 15 working sections at the mine.

Additionally, shielded cables have been required in other countries for many years. MSHA representatives have received information on the use of metallic shielded cables from government mining officials in Canada, the United Kingdom and Australia. In 1977, the Canadian Standards Association (CSA) first published a requirement for grounded shielding consisting of tinned copper, wire mesh or the equivalent around each power conductor in all cables operating on circuits over 125 volts in coal mines. (CSA Standard C22.5–1977, Wiring Methods, § 4.1.2.10.) The most recent edition of the Canadian standards retains the requirement. (CSA Standard M421–M85, Use of Electricity in Mines, § 6.9.3.3.) Although the CSA is a consensus standards organization, all provinces in which underground coal mining is performed currently enforce the shielding provision, according to Canadian officials.

Similarly, the Principal Electrical Inspector of Mines and Quarries in Great Britain informed MSHA that shielded trailing cables, including those serving shuttle cars and other cable reel equipment, have been required in Great Britain for approximately 15 years. MSHA was informed that the United Kingdom is at an advanced stage towards issuing new electricity regulations which retain their existing requirement for shielding of the individual conductors of trailing cables.

Both Canada and Great Britain have allowed an alternative compliance method in the form of semi-conducting shielding instead of metallic shielding. If mine operators in these countries choose the option of using semi-conducting shielding, resistance grounding with an extremely sensitive trip level must also be used. This is due to the fact that semi-conducting shielding is normally made of a rubberized or elastomeric type of material which has a higher resistance than metallic shielding. Although semi-conducting shielding is an option in Canada and Great Britain, mining officials in those countries estimate that it is seldom used by mine operators because of the difficulties encountered with its use.

The MSHA proposal would allow only the use of metallic shielding, as the Agency considers this the safest method of providing adequate protection against electric shock. Several problems may exist with the use of semi-conducting shielding. First, the sensitivity that would be required of the ground-fault protective system in order to provide adequate protection may be difficult to maintain due to nuisance tripping. Additionally, the design of semi-conducting shielding can make it more difficult to locate fault sources when the ground-fault protective device deenergizes a circuit. This is due to the elasticity and resilience of semi-conducting shielding, which can make damage less obvious. The Agency solicits comment on the feasibility and safety benefits of the use of semi-conducting shielding.

Canadian and British mining officials stated that the estimated life span of metallic shielded trailing cable used on shuttle cars ranges from four months to one year. The relatively short cable life

was explained to be due to the prohibition in both countries of the making of temporary and permanent cable splices in some cable components while underground. Due to this prohibition, a common practice is to cut damaged cable at the damaged point and to put it to use in some other capacity.

The information received from these countries indicates that the technology for providing shielding on cable reel equipment does exist and is being employed abroad. However, preliminary indications from some cable manufacturers suggest that producing the quantities and type of shielded cables that would be required under the proposal would be costly and time consuming. As a result, a period of time for development of shielded cables complying with the proposed requirements, retooling and inventory disposal must be considered. Therefore, the proposal would provide a one-year phase-in period for shielded cable on mobile electric equipment not employing cable reels, energized with a nominal a-c voltage from 150 volts phase-to-ground to 660 phase-to-phase, and a three-year phase-in for shielded cable on electric equipment employing cable reels.

The information gathered by the Agency suggests that, despite the present limited utilization of shielded cable on cable reels in this country, an effective and efficient shielded cable for this use is feasible and can be produced for widespread use in the coal mining industry. However, MSHA specifically encourages comments on the technical feasibility, benefits and costs of the proposed shielding requirement and implementation timetables so that the Agency can better evaluate the need for this requirement and its impact on the coal mining industry.

Paragraph (h) is derived from existing § 75.907, which requires medium-voltage trailing cables, energized at between 661 volts and 1,000 volts, to have grounded metallic shielding around each power conductor or over the assembly, except on equipment employing cable reels where the cable insulation is rated at 2,000 volts or more. The proposal would require that trailing cables energized with a nominal a-c voltage greater than 660 volts be provided with a grounded metallic shield around each power conductor on all equipment not employing cable reels on the effective date of the rule, since "medium voltage" trailing cables are presently required to have metallic shielding. Metallic shielding would be required for cables greater than 660 volts serving cable reel equipment three years after the effective date of the rule.

While the existing standard allows shielding around the power conductor assembly as one alternative in meeting its requirements, the proposal would no longer permit this, and instead would require that shielding be installed around each power conductor. It should be noted that cable having shielding around the entire assembly is generally not in use in the mining industry, and not readily available from cable manufacturers, although existing requirements permit its use.

The Agency believes that shielding around each power conductor (SH–D cable) is safer than shielding around the conductor assembly (SH–C cable) because of the increased protection and coverage it provides. SH–C cables do possess some advantages in weight and flexibility, but they do not provide phase-to-phase fault protection. Additionally, maintaining proper contact between the shielding and the grounding conductor can be problematic. These problems are not encountered with the use of SH–D type cables.

Paragraph (i) would require that prior to the end of the three-year phase-in period for cable reel equipment in paragraph (h), what is presently called "medium voltage" cables must be shielded. The effect of the standard is to retain the existing shielding requirement in § 75.907 until the proposed shielding requirements become effective. The difference between the proposed and existing standards is that shielding around the power conductor assembly would no longer be an optional compliance method. As discussed in connection with paragraph (h), the Agency would no longer consider this a viable alternative in meeting the shielding requirement.

Paragraph (j) is new, and would require that shielding around power conductors be applied in the form of braid or serving (wrap). Metallic braid would be required to provide at least 84 percent coverage, and metallic wire serving would have to provide at least 60 percent coverage. The Agency believes that this type of shielding, when applied according to the manufacturer's recommendations, would provide the best combination of coverage and physical durability. Tape would not be suitable for this use because it lacks the physical strength characteristics of braid and wrap. The coverage values are generally accepted and presently used in the mining industry.

A new standard at paragraph (k) would provide for a maximum limit on the length of any trailing cable, depending on the size of the cable. Table G–1 would specify trailing cable lengths. Limits on the length of trailing cables serving permissible equipment now exist in part 18. When the length of a particular cable increases, the resistance within that cable also increases. This would pose a potential electrical hazard, since an increase in length creates a corresponding decrease in available current at the end of the cable. Should a ground fault or short circuit occur in an extended length of cable, the fault currents available may be insufficient to trip protective devices and clear the fault. This could result in the occurrence of dangerous voltages on the frame of the equipment being served or in the cable, leading to shock and fire hazards.

Section 75.602 Electrical Protection for Alternating-Current Circuits

This section is derived from existing §§ 75.518, 75.601, 75.601–1, 75.602, 75.900 and 75.900–2, as applied to low-voltage a-c trailing cables and circuits. The proposal would establish requirements for overcurrent, ground-fault, and undervoltage protection, and would specify installation procedures for ground-fault current transformers. The proposal would delete the maximum allowable instantaneous circuit breaker settings for trailing cables specified in existing § 75.601–1, and would replace them with two tables that provide comprehensive settings for the types of circuit breakers used in underground coal mines. The Agency believes this would increase safety, as well as provide greater flexibility in the design and use of shortcircuit devices. Additionally, the proposal would require a test circuit for ground-fault protective devices on power centers six months after the effective date of the standard.

Paragraph (a) would consolidate and clarify existing §§ 75.601 and § 75.900. The proposal would require that trailing cables be protected against short circuits, undervoltages and ground faults by a circuit breaker of adequate interrupting capacity. Adequate interrupting capacity is defined for purposes of this proposal as the ability of a circuit breaker to safely interrupt all values of current which can occur at its location in excess of a breaker's trip setting.

Commenters expressed concern over the language of the preproposal draft. They interpreted this provision to mean that separate devices that are not an integral part of the circuit breaker would

be required to provide undervoltage and ground-fault protection. This is not the intent of the proposal. Circuit breakers with protective devices integrated into their construction that provide short-circuit and overcurrent protection would be acceptable under the proposal. The technology making this possible is reliable, especially where the voltages are lower than 1,040 volts. A single device which provides all of the protection required by the proposed standard would be acceptable.

Paragraph (b) is partially new and partially derived from existing § 75.601. The proposal would clarify the existing standard for single-phase a-c trailing cables by requiring that single-phase trailing cables energized at 150 volts or less to ground be protected against short circuits by a circuit breaker of adequate interrupting capacity. The new portion of the proposal would require the circuit breaker to also provide ground-fault protection. This would protect against the potential hazard of one of the power conductors becoming grounded, causing a possible shock or fire.

Under the proposal, fuses would not be permitted to provide ground-fault protection. A single fuse can adequately protect only one power conductor at a time, and the proposal would address the protection of all power conductors. If fuses were provided for each power conductor, and a fault occurred on one of the conductors, all of the fuses may not open, leaving one or more of the conductors energized and creating a shock hazard.

Paragraph (c) is derived from existing § 75.601–1, which requires that circuit breakers providing short-circuit protection for trailing cables be set so as not to exceed the maximum allowable instantaneous settings specified in the accompanying table. The proposal would consolidate and clarify these requirements and provide new tables that would provide greater flexibility in the use of circuit breakers protecting a-c circuits. The proposal would require that each ungrounded power conductor of a trailing cable be protected against short circuits by one of three types of circuit breakers, set in accordance with Tables G–2 and G–3, which would accompany the standard.

Circuit breakers would have to be an inverse-time circuit breaker with a maximum current rating specified in Table G–2, an instantaneous-trip circuit breaker with a maximum instantaneous setting specified in Table G–3, or a short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds, and a maximum setting as specified in Table G–3. The Agency believes that the specified settings would provide better circuit protection than the existing settings. Inverse-time circuit breakers are not permitted under the existing rules. However, the Agency believes they would provide protection equivalent to that provided by instantaneous breakers. Commenters to the preproposal requested that more acceptable table values for maximum short-circuit protection be provided. MSHA has done this with the two new tables, and believes that the use of these tables will best serve the electrical safety needs of the coal mining industry.

Paragraph (d) is derived from existing § 75.601–1, which permits higher circuit breaker settings with the approval of an authorized representative of the Secretary. The proposal would require the District Manager to approve any such changes in writing, if technical data deem it appropriate and it would not pose a hazard to miners. This would clarify an existing Agency policy under which MSHA carefully evaluates proposed breaker setting changes before any action is taken, and then only with the consent of the District Manager.

Paragraph (e) would require overcurrent, ground-fault and undervoltage protection by circuit breakers of adequate interrupting capacity for a-c resistance-grounded three-phase circuits, a-c single-phase circuits energized at more than 150 volts-to-ground, and a-c ungrounded circuits installed in accordance with proposed § 75.701(b). The requirement that circuit breakers provide ground-fault protection is new. It would protect against the potential hazard of one of the power conductors grounding out and causing a possible shock or fire. The proposal would not allow fuses to be used for ground-fault protection or require the use of separate devices for reasons addressed in connection with proposed § 75.602(a).

Paragraph (f) of the proposal would retain and clarify existing § 75.900–2(c) by providing that when a circuit breaker is used to protect two or more branch circuits, it shall provide overcurrent protection for the smallest conductor. Compliance with the standard would ensure interruption of power whenever an overcurrent appears on any of the conductors in any branch circuit. Failure to do this could lead to overheating and damage to the conductors, resulting in shock and fire hazards.

Paragraph (g) would require overcurrent protection for low-voltage circuits in accordance with proposed section § 75.523, which contains general requirements applicable to low-voltage a-c circuits. That section is referenced here because of the importance of clarifying overcurrent protection requirements for these circuits. It should be noted that proposed § 75.523 would replace existing §§ 75.518 and 75.518–1, which incorporate by reference the 1968 edition of the NEC.

Paragraph (h) is new, and would require ground-fault devices to deenergize the faulted circuit at 40 percent or less of the maximum ground-fault current of the system. The Agency believes that this would ensure reliable tripping for a ground fault, and considers 40 percent a practical threshold value for detecting ground-fault conditions.

Paragraph (i) is also new, and would require that the ground-fault device nearest the load operate with no intentional time delay. Compliance with the standard would assure rapid deenergization of the circuit, but additional devices could be set for an intentional delay for selective tripping. However, the operating time of the device furthest from the load would be limited to one second. This would provide for a period of time in which all faults on the protected circuits must be cleared and still allow for a reasonable time delay to protect against nuisance tripping. A fault remaining on the protected circuits for more than one second would present a serious shock hazard.

Paragraph (j) is new, and would prohibit equipment safety grounding conductors from passing through or being connected in series with ground-fault current transformers. Installing ground-fault current transformers in series with an equipment safety grounding conductor would result in a failure to detect any parallel electrical path to the equipment safety grounding conductor for a ground-fault current. A similar situation occurs when equipment safety grounding conductors are passed through the ground-fault current transformers. Should a ground fault occur, devices sensing only the equipment safety grounding conductor may not be able to sense enough of the fault current to deenergize the circuit because of the parallel electrical paths. The fault current would remain on the cable and possibly on the equipment the cable serves.

Paragraph (k) is new, and would require resistance-grounded systems for trailing cables to have a test circuit, to be operated at least once each seven days, that injects a current of 50 percent or less of the maximum ground-fault current of the system, causing each circuit breaker to open. Grounding resistors and circuit breakers are the backbone safety devices of a resistance

grounded system for the prevention of fire, ignition and shock hazards. Use of a testing circuit under controlled conditions would indicate whether these devices will operate when required to do so.

Safety advantages would be gained with the use of a test circuit device in that the ground-fault device can be checked while it is still protecting the circuit, and it can be determined whether a ground-fault device needs to be replaced before an actual ground fault occurs. Since the ground-fault protective devices are passive, they do not operate until a fault exists. With a testing capability, the ability of ground-fault devices to operate if needed can be verified.

The standard would become mandatory six months after the effective date of the rule. Information available to the Agency indicates that there were 2,322 working sections in U.S. underground coal mines in 1987. Each working section represents at least one power center, which would require installation of the test circuit. MSHA is aware of existing circuitry and designs for test circuits which would comply with the proposed rule. However, based on the number of power centers involved, MSHA has estimated that a six-month phase-in of the standard is needed to allow sufficient retrofitting and installation time on all affected equipment.

Paragraph (l) is new and would require that the ground-fault current device and the circuit breaker be removed from service or repaired when the circuit breaker fails to open upon operation of the test circuit required in paragraph (k). This would ensure that both the breaker and the ground-fault devices are not used until it is determined which device is malfunctioning and that device is replaced or repaired.

Paragraph (m) is partially derived from existing § 75.900–2, which allows undervoltage devices to be circuit breakers with shunt trip or undervoltage release devices. These two options are retained in the proposal. However, it would require that when a shunt trip is used, a circuit utilizing a stored energy device must also be used to assure that the breaker will trip if the control voltage is lost. This is necessary because the shunt trip is a passive device that must be energized to trip the circuit breaker. Should power to the control circuit of the circuit breaker be lost and a fault occurs, there would be no way to trip the breaker, and the fault would remain on the circuit. A stored energy device would assure that power is retained for the device to trip the circuit breaker.

Paragraph (n) is new, and would require circuit breakers protecting multiple trailing cables operating in parallel to be interlocked so that all such trailing cables will be deenergized simultaneously. The result would be that when a unit of equipment is served by more than one trailing cable, and one of the cables is deenergized, the remaining cables would also be deenergized. This would protect against the hazard of persons mistakenly beginning work on the equipment before all trailing cables serving it have been deenergized. A shock hazard could also occur if only one breaker trips when a fault appears on the cable. The other breakers may not trip because the length of cable between their protective devices and the fault exceeds the limits of the parameters of their settings. When these breakers do not trip, the energized circuit would continue to feed the fault.

Section 75.603 Electrical Protection for Direct-Current Trailing Cables

This section would consolidate and revise the existing requirements in §§ 75.601, 75.601–1, 75.601–2, 75.601–3 and 75.900 as they apply to d-c trailing cables, and would establish some new requirements. The proposal would specify the types of circuit breakers that would be acceptable for protection of d-c trailing cables and provide more specificity as to what fuses would be allowed for short-circuit protection of ungrounded power conductors and how these fuses could be utilized.

Paragraph (a) of the proposal would consolidate and clarify existing requirements for circuit breakers and dual element fuses. It would require each ungrounded power conductor of a trailing cable to be protected against short circuits by one of three methods. It would be accompanied by revised tables that would provide greater flexibility in the application of trailing cables to d-c circuits. These tables were developed to conform to the d-c power systems presently used in underground coal mining.

The proposal would allow the use of inverse-time circuit breakers of adequate interrupting capacity, with a maximum current rating as specified in Table G–2 to protect d-c circuits. These breakers are not permitted under existing standards, but MSHA considers them as effective as the instantaneous breakers and would now allow their use. An individual fuse with a maximum current rating as specified in Table G–2 could be used under the proposal when the trailing cable is supplied from a solid-grounded system. Fuses would be inappropriate for use in conjunction with a resistance-grounded system, since they are not able to open all phases simultaneously. Also, fuses may not be sensitive enough to operate properly with resistance grounding.

Additionally, the use of an instantaneous-trip circuit breaker of adequate interrupting capacity and a maximum instantaneous setting as specified in Table G–4 would continue to be permitted under the proposal. The line-to-line instantaneous circuit breaker settings would have to be used for short-circuit protection of trailing cables supplying power to diode-grounded equipment and for those containing a separate equipment safety grounding conductor, if the circuit is provided with separate ground-fault protection. The line-to-ground values would have to be used for short-circuit and ground-fault protection of trailing cables containing a separate equipment safety grounding conductor when the circuit is not provided with separate ground-fault protection.

Paragraph (b) is derived from existing § 75.601–1, which permits an authorized representative of the Secretary to allow deviation from maximum instantaneous breaker settings when it appears justified. Since it is the Agency's policy that the District Manager carefully review and thoroughly evaluate any request to allow higher settings on breakers, MSHA has modified this requirement to conform with present policy. Under the proposal, the District Manager, and not the authorized representative, could grant permission in writing for higher breaker settings if technical data deem it appropriate and it would not pose a hazard to miners. Since fuses would be an alternative means of protecting ungrounded power conductors against short circuits under the proposal, this provision would also allow higher fuse ratings with the written permission of the District Manager.

Paragraph (c) clarifies existing § 75.601–2, which prohibits the use of fuses to provide short-circuit protection, unless specifically approved by the Secretary. The proposal would require that fuses be approved in accordance with part 28. Thus, an operator could look at the approval markings on a fuse to ascertain that it has been approved by the Secretary for use in the protection of d-c trailing cables.

Paragraph (d) is derived from existing § 75.601 which requires that when a fuse is used, it shall have adequate current interrupting capacity. The proposal would retain this rule, in effect, by requiring that fuses have a d-c voltage

rating at least equal to the maximum system voltage, and by specifying in Table G–4 the maximum current ratings allowed for use with d-c trailing cables.

Paragraph (e) is new, and would require that each trailing cable in a resistance-grounded d-c circuit be protected against ground faults by a circuit breaker that deenergizes the circuit when the ground-fault current exceeds 40 percent of the current rating of the grounding resistor. This would preclude the use of fuses in resistance-grounded systems. The 40 percent deenergization setting is conservatively within the relay setting range of 40 to 50 percent typically used by power center manufacturers.

A new provision in paragraph (f) would require trailing cables supplied from a system that has the direct neutral of the rectifier bridge supply-transformer solidly grounded to be protected against ground faults by an instantaneous-trip circuit breaker of adequate interrupting capacity that deenergizes the circuit at a current value not to exceed 50 amperes. The 50 ampere value would be sufficient to provide reliable relay operation. It is also consistent with tripping values used in other protective schemes for d-c equipment, such as the relay trip values for silicon diode grounding.

Paragraph (g) is new, and would require the ground-fault device nearest the load to operate with no intentional time delay. This would deenergize the faulted circuit as quickly as possible, thereby minimizing the potential for shock and fire hazards associated with faults. Since the proposal would only require the devices nearest the load to have no intentional time delay, other ground-fault devices protecting the circuit that feeds the circuit nearest the load could have intentional time delays, which could prevent nuisance tripping in the system.

Paragraph (h) is also new, and would prohibit equipment safety grounding conductors from passing through or being connected in series with ground-fault current transformers. If a current transformer were installed in series with or around an equipment safety grounding conductor, it would fail to detect parallel electrical paths to the equipment safety grounding conductor. Should a ground fault occur, the devices would sense only the equipment safety grounding conductor and may be unable to detect enough fault current to trip the circuit breaker.

Section 75.604 Physical Restraints for Cable Couplers

This section is derived from existing § 75.602, which requires that when two or more circuit breakers with different ratings, trip elements, or instantaneous-trip ranges are installed in the same distribution box, power center, or rectifier, a means must be provided to prevent the connection of incompatible plugs and receptacles. When there are two or more circuit breakers with dissimilar settings at the same location, there is a possibility of connecting a trailing cable to the wrong circuit breaker, which may be ineffective for protecting the cable. Dangerous overheating of the cable and resulting shock and fire hazards could occur.

The proposal would retain the existing performance standard, with some language modification for clarity. Any physical restraint which prevents the connection of a cable to a circuit breaker that is not properly rated or adjusted for that cable would be acceptable. The proposal is intended to provide flexibility in choosing compliance alternatives of equivalent safety effect.

Subpart H—Grounding

Section 75.701 Low-Voltage Alternating-Current System Grounding

This section is derived from existing §§ 75.700, 75.701, 75.704, and 75.901, and would require resistance grounding for low-voltage a-c systems, defined as those having a nominal voltage of 1,040 volts or less. Of the grounding-related fatalities in underground coal mines since 1970, approximately 80 percent involved low-voltage a-c electric equipment. The requirements in this proposed section would help to reduce the number of future fatalities in underground coal mines.

The standard would require low-voltage a-c systems extending or originating underground to be grounded by having either a direct or a derived neutral connected to the grounding medium through a grounding resistor. The effect of the provision would be to require resistance-grounding for low-voltage a-c systems extending or originating underground. A resistance-grounded system is one defined in proposed § 75.2(j) as an electrical system in which the neutral point of the transformer or generator winding is intentionally grounded through a current limiting resistor. The resistor would limit ground-fault current to a value equal to or less than the values specified by this subpart, but greater than the system capacitive charging current.

Should a phase-to-ground fault occur in a low-voltage a-c system, resistance-grounding would serve to limit the voltage which could occur on frames of equipment supplied by the system. Additionally, fire hazards would be minimized since the current flow in the resistance-grounded system would be limited to 25 amperes under proposed § 75.707.

Paragraphs (a) through (e) describe exceptions to the resistance-grounding requirement, which the Agency would consider acceptable alternative grounding methods. The list of exceptions includes solid-grounded and ungrounded systems, defined in proposed § 75.2(j) as an electrical system grounded through a connection in which no impedance has been intentionally inserted, where the short-circuit current-carrying capacity of the grounding connection is at least equal to the bolted phase-to-neutral fault current. Ungrounded systems would be defined as those without an intentionally-made connection to ground, except through potential indicating or measuring devices.

Paragraph (a) would allow the use of a solid-grounded single-phase system, provided it supplies only stationary or portable electric equipment, and has either a direct neutral or a phase conductor solidly connected to the system grounding medium, so that the phase-to-ground voltage is limited to 150 volts or less. Because of its continuous movement and use underground, mobile electric equipment is susceptible to more ground faults from damage to power conductors than are stationary and portable units. The Agency believes that resistance-grounded systems would provide the most reliable ground-fault protection for mobile electric equipment, and that solid grounding is only appropriate for the protection of electrical systems which supply stationary and portable electric equipment.

Paragraph (b) would allow the use of ungrounded low-voltage a-c systems, provided they supply only stationary equipment, have ground-fault protection which automatically deenergizes all phase conductors when any one is grounded, and have all phase conductors totally enclosed in either rigid metallic conduit, metallic armored cable, metal-clad cable, or shielded cable when the phase-to-phase voltage exceeds 150 volts. Figure H–1, which would accompany the proposal, illustrates the standard. Under the proposal, conductors with a phase-to-phase voltage of 150 volts or less would be permitted to be enclosed in non-metallic conduits or cables.

Existing § 75.901(a) provides that the Secretary may permit the underground use of ungrounded low- and medium-voltage circuits which serve stationary equipment, if the circuits are either steel

armored or installed in grounded rigid steel conduit. The proposed standard would eliminate the need to request that the Secretary permit the use of such systems, provided the installation requirements are met. Overvoltage conditions associated with ungrounded systems can diminish the useful life of cable insulation and result in machine failures more frequently than in grounded systems. Therefore, an adequate detection system used for removing ground faults is essential for the effective operation of ungrounded systems.

Effective ground-fault protection and the requirement of metallic enclosures in ungrounded systems would minimize the possibility of a fault remaining on the system and energizing the frames of electric equipment. For example, an ungrounded system would be permitted to serve a stationary bore hole pump if it has a ground-fault protection system to detect faults and automatically cause deenergization of the phase conductors, as well as having totally enclosed conductors. The standard would assure that loads are connected to the source of power and that abnormally high voltages which could injure miners will not occur on the pump's frame.

The exception in paragraph (c) would allow the use of ungrounded single-phase systems having a phase-to-phase voltage of 150 volts or less, and which originate on the secondary side of a two-winding transformer equipped with a metallic, or "Faraday," shield connected to the grounding medium. The purpose of the shield would be to isolate the low-voltage secondary winding from the primary winding in the transformer to prevent primary-to-secondary transformer faults. Shielding would protect miners from exposure to dangerous voltages due to transformer faults. Figure H–2 would illustrate the provision.

Paragraph (d) would be a new provision allowing some a-c systems to be ungrounded, provided they supply only a rectifier mounted with the source transformer or generator on a common metallic frame and have the conductors totally enclosed in either rigid metallic conduit, metallic armored cable, metal clad cable, or shielded cable when the phase-to-ground voltage exceeds 150 volts. One effect of the standard would be to allow a three-phase a-c system to supply a d-c trolley rectifier having one conductor solidly connected to the track. On a 300-volt d-c trolley system, the maximum phase-to-ground voltage of the a-c system would be less than the 150 volts-to-ground maximum specified in the proposal.

The proposal would alleviate an apparent conflict between existing §§ 75.901 and 75.701–3, and would incorporate MSHA's interpretation of those standards. Existing § 75.701–3 requires equipment receiving power from d-c power systems to be grounded. Existing § 75.901(a) presently requires underground a-c systems to be resistance grounded, or ungrounded by permission of the Secretary under certain circumstances. Rectifier systems cannot have both the a-c and d-c systems grounded at the same time. Therefore, the standard would incorporate current Agency policy by permitting some a-c systems supplying rectifiers to be ungrounded, provided they comply with the specified alternative method of ground-fault protection.

Paragraph (e) would allow the use of ungrounded systems which have the supply transformer and all other components contained in a single metallic enclosure or installed on the common metallic frame of electric face equipment. These methods would eliminate the possibility of simultaneous phase-to-ground faults at the transformer and the equipment. Simultaneous faults at these locations could energize the metallic frames of all of the equipment served by the same power system, exposing miners to electric shock or electrocution.

Section 75.702 Low-Voltage Alternating-Current System Grounding Mediums

Section 75.702 would address grounding mediums for low-voltage a-c systems. It is derived from existing §§ 75.701–2 and 75.901, which address requirements for grounding of metallic frames, casings and other enclosures of equipment receiving power from single-phase 110–220-volt circuits and low-and medium-voltage three-phase a-c power systems. The proposed standard would require the system grounding medium for low-voltage a-c systems to be the metallic frame or metallic enclosure of the generator, transformer, or transformer bank, connected to a low-resistance ground field. The effect of this provision would be to require a system grounding medium for all low-voltage a-c systems which would facilitate the conduction of abnormal electric currents to a low-resistance ground field instead of energizing the equipment frames. An illustration of the provision would be found in Figure H–3.

The requirements of the existing standards would be altered by deleting the reference to borehole casings and water lines. The use of these devices would continue to be permitted under the proposal only if they meet the requirements of proposed § 75.709, which would set requirements for low-resistance ground fields.

Section 75.703 High-Voltage Alternating-Current System Grounding

This section would address requirements for high-voltage a-c system grounding, currently found in §§ 75.802 and 75.901. Under the proposed standards, there would be only two voltage categories, high- and low-voltage. Under the proposal, resistance-grounded systems having a direct or a derived neutral connected to the grounding medium through a grounding resistor would be required on high-voltage a-c systems, defined in the proposal as those with nominal voltages greater than 1,040-volts. Some 2,400-volt circuits meeting the specifications listed in the standard would be excepted from the requirement.

Paragraphs (a) through (d) list requirements for ungrounded systems which would be excepted from the resistance-grounding requirement. Ungrounded systems which supply only stationary equipment, have a nominal voltage not exceeding 2,400 volts, ground-fault protection which automatically deenergizes all phase conductors when any phase conductor is grounded, and all phase conductors totally enclosed in rigid metallic conduit, metallic armored cable, metal clad cable, or shielded cable, would be excepted from the resistance grounding requirement. Figure H–4 would accompany the standard as an illustration.

These provisions would protect miners against serious shock and electrocution hazards while working with or near high-voltage a-c equipment and circuits. Resistance-grounded systems would be appropriate for the protection of mobile and portable electric equipment, since such equipment is subjected to heavy use, and is therefore more susceptible to power cable damage and resulting ground faults. Ungrounded high-voltage a-c systems would be permitted to serve stationary equipment having ground-fault protection which minimizes miners, exposure to electrocution and electric shock.

Section 75.704 High-Voltage Alternating-Current System Grounding Mediums

This section is derived from existing § 75.802, and would require specific grounding mediums for resistance-grounded and ungrounded high-voltage a-c systems. Paragraph (a) would

require the grounding medium for a resistance-grounded system to be a low-resistance ground field for a transformer-derived system, or the metallic frame of the supply transformer or generator that is connected to a low-resistance ground field. Allowing the frame of the supply generator connected to a low-resistance ground field to serve as the grounding medium would be a new provision.

The proposed standard would provide for a common grounding medium connected to a low-resistance ground field for the generator and the equipment it serves, thereby minimizing the possibility of simultaneous ground faults causing lethal voltages to occur on the generator and equipment frames. Under the existing standard, the grounding medium could be considered to be the low-resistance ground field, allowing the generator and equipment to have separate grounding mediums, which increases the possibility of simultaneous faults.

Paragraph (b) would require the grounding medium for an ungrounded electrical system to be the metallic frame or metallic enclosure of the supply transformer, transformer bank, or generator which is connected to a low-resistance ground field. These provisions would require all high-voltage a-c grounding mediums to be connected to a low-resistance ground field, so that dangerous voltages will not occur on the frames of equipment. Figure H–5 is intended to illustrate the standard.

Section 75.705 Direct-Current System Grounding

This section of the proposal would consolidate and clarify the requirements for grounding of d-c electrical systems in existing §§ 75.701–3 and 75.703–2. The proposal contains additions to the existing rules to provide for grounding of battery-powered systems, systems derived on-board mobile electric face equipment, and ungrounded d-c systems.

The standard would require d-c electrical systems extending or originating underground to be one of seven types. Under paragraph (a), solid-grounded d-c trolley systems having one conductor solidly connected to the track would be acceptable. In this way, the track would be used as the grounding medium for the system. If one conductor is connected to the track at all times, the equipment frames of units supplied with electric power by the trolley system would be precluded from carrying dangerous voltages in the event of a fault.

Under paragraph (b), d-c systems other than trolley systems would also be permitted to be solid grounded, provided they have one conductor solidly connected to the system grounding medium. Use of a solid-grounded d-c system having the direct neutral of the a-c system supplying only a rectifier bridge solidly connected to the grounding medium would be permitted under paragraph (c) of the proposed standard. The effect of this standard would be to provide solid grounding when neither line conductor of the d-c output of the system is grounded. Figure H–7 would illustrate this configuration. Line-to-ground voltages would be limited to one half of the system voltage by the requirements of the standard, an appropriate range, since most d-c system nominal voltages are no greater than 330 volts. Under the standard, such systems would be limited to 165 volts line-to-ground.

Under paragraph (d), resistance-grounded systems having either a direct or a derived neutral of the a-c system supplying the rectifier bridge connected to the grounding medium through a grounding resistor would be permitted. In this type of system, the voltages which could appear on equipment frames would be limited to a range which would help to avoid fire and shock hazards. Figure H–8 would illustrate this provision of the proposal.

Paragraph (e) of the standard would be new, and would allow the use of ungrounded systems only if they have ground-fault protection which automatically deenergizes all power conductors when any phase conductor is grounded, and a line-to-line system voltage of 330 volts or less. Under the standard, all d-c systems greater than 330 volts would be required to be intentionally grounded. Figure H–9 would show the configuration described. Compliance with the proposal would assure that systems which are not intentionally grounded are provided with effective alternative protection.

Paragraph (f) is a new provision allowing for the use of ungrounded battery-powered systems. The design of battery-powered equipment minimizes the possibility of multiple faults occurring, so the metallic frames of such equipment cannot become energized with voltages which present danger to miners. Therefore, such systems would be permitted to be ungrounded under the proposal. Similarly, ungrounded systems derived on-board mobile electric equipment would be permitted by paragraph (g). Experience indicates that intentional grounding of these systems would not provide a safety advantage for miners, since all components supplied by them are on a common grounded metallic frame.

Section 75.706 Direct-Current System Grounding Mediums

Proposed § 75.706 is derived from existing §§ 75.701–1, 75.701–3 and 75.703–2, and would address grounding mediums for d-c electrical systems. Paragraph (a) of the proposal would require the system grounding medium for each d-c trolley system to be the mine track. Experience indicates that mine track serves as an efficient grounding medium for these systems.

Under paragraph (b), the system grounding medium for d-c systems derived on-board mobile electric equipment, including battery-powered equipment, would be required to be the metallic frame of unit. In the Agency's view, the equipment frame is an effective medium for assuring that stray voltages will not appear on the frame of mobile electric equipment and place miners at risk of electrocution or electric shock.

Paragraph (c) would require that the metallic frame or enclosure of the power source, connected to a low-resistance ground field, serve as the system grounding medium for d-c systems other than trolley systems and systems derived on-board mobile electric equipment. This provision would be illustrated by Figure H–10. Connection to a low-resistance ground field would assure that unusual or accidental voltages would be conducted to ground by following a low-resistance path. These types of system grounding mediums would assure a safe and dependable grounding system for d-c electrical systems by minimizing the appearance of dangerous voltages between the metallic frames of equipment and earth when faults occur.

Section 75.707 Grounding Resistors

This section would set new performance requirements for d-c grounding resistors. Paragraph (a) would require grounding resistors used on low-voltage systems to have a resistance value that limits ground-fault current to 25 amperes or less. Ground-fault currents that are not limited by a grounding resistor could cause electrical arcing and resultant ignition of combustible materials. As discussed previously, a 25-ampere maximum current in the proposal would help to reduce the likelihood of such occurrences.

On high-voltage systems, grounding resistors would be required to have a resistance value that limits the voltage drop in the grounding circuit external to the resistor to not more than 100 volts during a ground fault. The standard

would be illustrated by Figure H–6. The 100-volt value has been an accepted industry standard since at least 1970. Experience indicates that limiting the voltage which can appear on the frames of high-voltage equipment to 100 volts or less would help to prevent dangerous potential shock hazards.

Under paragraph (b), grounding resistors would be required to be extended-time rated at a current value at least equal to the maximum ground-fault current that can flow through them, making resistors compatible with the currents to which they could be exposed. Under the proposed definition of "extended-time rated," resistors would have to be capable of operating at their maximum operating temperature for 90 days per year without failing. The new definition is intended to reflect the present state of technology with regard to grounding resistors. Failure of an open grounding resistor when subjected to faults which are not immediately cleared by the circuit breaker would be minimized. An open grounding resistor would allow ground faults to go undetected, thereby defeating the grounding protection for the circuit and leaving miners unprotected from dangerous voltages which could appear on equipment frames.

Paragraph (c) would require grounding resistors to be supported by insulators having voltage ratings at least equal to the phase-to-phase a-c voltage of the system. Appropriately insulated supports, capable of withstanding the phase-to-phase voltages in a circuit, would adequately protect the grounding resistor from shorting. A shorted grounding resistor could defeat the protective function of resistance grounding and expose miners to shock hazards and the risk of fire.

Paragraph (d) would require grounding resistors to be located in the same substation or enclosure, or installed on a common metallic frame with the a-c source that supplies the system. The proposed standard would clarify that the resistor should be located at the power source, which may not always be the power center. The standard would help to prevent a neutral conductor from opening between the transformer and grounding resistor, or shorting of the grounding resistor. Such an occurrence could disable ground-fault protective devices from detecting fault conditions and therefore allow dangerous voltages to occur on equipment frames.

Section 75.708 Loads Connected on Resistance-Grounded Systems

This section would require loads to be connected phase-to-phase on a-c systems and line-to-line on d-c systems that are resistance-grounded, presently required by §§ 75.806 and 75.905. The proposal would not change the requirements of the existing standards, but would consolidate them for clarity and consistency. The effect of the proposed standard would be to forbid line-to-ground connections on a-c and d-c systems, which can cause nuisance tripping of ground-fault devices.

Recurrent or "nuisance" tripping of a circuit when no fault condition exists could lead miners to circumvent the protective devices in the circuit in order to continue work. This would defeat the intended function of the grounding system and expose miners to unnecessary risk of electric shock. Additionally, each time the circuit is tripped, current is passed through the grounding resistor, which can cause damage and failure over time. The proposed standard would help to avert nuisance tripping and its possibly hazardous consequences.

The proposed rule would also prevent the use of the grounding conductor as a power conductor, which could increase the likelihood of inter-machine arcing or the appearance of abnormal voltages on the frames of equipment supplied by resistance-grounded systems. Use of the grounding conductor as a power conductor could cause it to fail or become damaged, rendering it ineffective for its intended function as part of the grounding protection system.

Section 75.709 Low-Resistance Ground Fields

Proposed § 75.709 would set requirements for the design and construction of low-resistance system and supplemental ground fields. These standards are presently found at §§ 75.700–1 and 75.701–1. Paragraph (a) of the proposal is new, and would require low-resistance ground fields used in the safety grounding system to be designed and installed in a manner to assure that the maximum exposure voltage under fault conditions will not create hazardous step and touch potentials. In evaluating ground field safety, the standard would require consideration of the parameters of the system, including soil resistivity, available fault currents, ground field construction, and the operating times of protective devices.

Paragraph (b) would require low-resistance ground fields used in the safety grounding system to have resistances to earth no greater than 25 ohms. Electric current follows the path of lowest resistance that it encounters. Therefore, the lower the resistance of a ground field, the more likely it is that protective devices can operate to remove ground faults and minimize the possibility of energization of equipment frames. A maximum 25-ohm resistance to earth would serve to maintain resistance at a low level to facilitate proper operation of ground-fault protective devices.

The system resistance value may deviate from the 25-ohm maximum only if evaluation of the system in accordance with the safety considerations of paragraph (a) indicates that a lower value of resistance is necessary, or a higher value of resistance may safely be used. In this manner, some flexibility would be added to the rule to take into consideration the special circumstances of each mine and its ground-fault protection system.

Under a new provision in paragraph (c), resistance to earth would be required to be tested by a low- or high-voltage qualified electrician as applicable, when installed and at least annually thereafter. Records of tests would be required to be made in accordance with proposed § 75.508. This would assure that resistance is maintained at the required value to assure effective operation of the grounding system.

Paragraph (d) would be a new requirement that the surface area of ground field materials have at least four square feet of contact with soil. For example, the use of three grounding rods measuring ⅝-inch in diameter and eight feet in length would achieve compliance with the proposed standard, since they would provide at least four square feet of contact with soil. Typically, many more than three grounding rods are presently used in the construction of ground fields. In MSHA's view, four square feet would be a suitable minimum surface area of contact with soil to ensure that the ground field has a low resistance to earth. The proposed requirements for ground fields would aid in protecting miners from shock and burn hazards due to voltages appearing between frames or enclosures of electric equipment and earth. A safe, dependable grounding medium would be provided for under this proposed standard.

Section 75.710 Alternating-Current Equipment Frame Grounding

General grounding requirements for a-c equipment would be addressed by this standard, which is derived from §§ 75.700–1, 75.701, 75.701–1, 75.802 and 75.901. Paragraph (a) lists structures to be connected to the system grounding medium by equipment safety grounding

conductors. Metallic frames, enclosures and other exposed non-current-carrying metallic parts of electric equipment would be required to be connected to the grounding medium in this manner, unless they are double insulated. Therefore, a common grounding medium would be shared by the unit of equipment and exposed non-current-carrying parts associated with it.

In case of insulation failure on a power conductor, which can allow contact between the energized conductor and some portion of a metal enclosure, the enclosure may become energized with the voltage of the conductor. Anyone contacting the enclosure would then be exposed to the voltage of the conductor. A common grounding medium would assure that no difference in voltages capable of injuring or electrocuting miners would exist between the structures. Metal frames which are double insulated would be excepted from the standard since the insulation system would provide adequate protection against these dangers. Damage to the first insulation system would not expose miners to energized parts. Some nationally recognized private concerns perform insulation testing to assure that dangerous leakages of current will not occur. Equipment which has been listed by such groups as double-insulated would be acceptable to the Agency for purposes of the exception.

Metallic fences and barriers around high-voltage equipment and installations would also have to be connected to the system grounding medium by equipment safety grounding conductors. This would prevent the occurrence of abnormal voltages on the structures due to contact with an energized conductor. A person who brushes against or leans upon an energized fence, for example, could otherwise be exposed to a serious shock hazard if the fence is not properly connected to the grounding system.

Metallic battery trays would also be required to be connected to the grounding medium by equipment safety grounding conductors. Therefore, a connection to the safety grounding system would be provided to minimize the risk of harm to miners contacting them.

Equipment safety grounding conductors would be required to connect metallic messenger wires to the system grounding medium under a new provision of the proposal. Messenger wires are sometimes used to support single-conductor energized cables in underground mines. If a splice in such a cable should become damaged where it is supported by messenger wire, the messenger wire could become energized with the voltage of the cable. This would present shock and fire hazards where energized messenger wires contact the mine roof or other combustible materials. Grounding of metallic messenger wires would avert such an eventuality.

Metallic structures or racks which support electric equipment or conductors would be required to be connected to the system grounding medium by equipment safety grounding conductors under a new provision of the proposal. Cable trays which hold energized power cables would be an example of structures addressed by the standard. A breakdown in the cable insulation could cause the metal tray to become energized with the voltage of the conductor, presenting a possibly lethal hazard to persons unknowingly coming into contact with the tray. Under the proposal, the tray would be required to be connected to the grounding medium in order to prevent shock injuries by limiting the voltage which can occur on the tray.

Paragraph (b) would require metallic cable shielding to be connected to the equipment safety grounding conductor at each termination. This provision would ensure a complete, low-impedance path to the grounding medium to prevent stray voltages from energizing the shielding and exposing miners to a shock hazard.

Before batteries are connected to a battery charger, paragraph (c) would require the metallic battery trays to be connected to the grounded metallic frame of the charger by equipment safety grounding conductors. Trays would be required to remain connected to the frame until the batteries have been disconnected from the charger. Several commenters to the preproposal draft stated their concern that continuous or permanent grounding of battery trays could create an unnecessary risk of fire. They suggested that grounding of battery trays should be required only during charging operations. The proposal would adopt this approach.

Over the last twenty years, there have been several occurrences of accidental energization of equipment being serviced by battery chargers, with resulting death to persons who unknowingly contacted the energized equipment frame. The proposed grounding standard would help to reduce the occurrence of similar accidents in the future by assuring that battery trays are properly connected to the grounding medium during operations which pose a risk of electrical injury.

Section 75.711 Ground-Wire Monitors for Alternating-Current Equipment

This section is derived in part from existing §§ 75.803, 75.803–1, 75.803–2, 75.902, 75.902–1, and 75.902–4. The existing standards require a fail-safe ground-wire monitor for resistance-grounded systems with a maximum ground check circuit voltage of 40 volts. They also require that systems not using a ground check conductor must be designed to open the breaker when the ground continuity is broken. Finally, they provide that when grounding equipment frames of stationary, portable or mobile electric equipment which receives power from resistance-grounded systems, separate connections shall be used. The proposal would reformat and retain these requirements with two exceptions. The performance standards in the proposal are intended to address newer monitor designs which were not contemplated by the existing standards.

Paragraph (a) is derived in part from § 75.902, which requires that resistance-grounded systems have a ground-wire monitor to continuously monitor the grounding circuit to assure continuity. The proposal would slightly modify this requirement, by requiring that resistance-grounded systems have ground-wire monitors to continuously monitor the continuity of the grounding circuits to the equipment affected, with two exceptions.

Low-voltage circuits supplying power to longwall illumination systems would be excepted from the requirement. The low-voltage illumination circuits would be excepted because they are connected to the metal frame of the power transformer that is well grounded and because of their low operating voltages and their safe location strung from the roof or supports.

Low-voltage stationary equipment meeting certain criteria would also be excepted from the requirement. Stationary equipment which is permanently installed at a fixed location, having all load components securely attached to a common metallic frame or structure and each component grounded by two independent equipment safety grounding conductors sized in accordance with § 75.714, would be exempted. At least one of the grounding conductors would have to be visible for its entire length. The power conductors outby the working section carrying ground-wire monitor circuits are not normally subjected to severe flexing and physical abuse that might cause damage to them. Since the hazard is reduced on permanently installed

stationary equipment, monitoring would no longer be the only method accepted for assuring the integrity of the grounding system.

Under paragraph (b), high-voltage resistance-grounded systems would be required to have ground-wire monitors to continuously monitor the continuity of the grounding circuits, except for circuits extending from systems which supply power to surface stationary equipment. Figure 11 would illustrate the provision. The use of ground-wire monitors would ensure a continuous grounding circuit to outby electric equipment at all times. Problems with the ground wire would be detected under the proposed requirements so that the circuit would be deenergized by a circuit breaker before a fault in the system could cause energization of equipment frames and result in electrical injuries to miners.

However, ground-wire monitors would not be required on surface circuits which supply stationary electric equipment located on the surface. These systems would be excepted from the ground-wire monitor requirement, provided the requirements of paragraph (c) are met. Circuits supplying stationary equipment without ground-wire monitors would have to have the metallic frames or enclosures of the equipment separately connected to supplemental low-resistance ground fields at the equipment, and to the system ground fields by equipment safety grounding conductors. Circuit breakers would have to be separately connected to supplemental ground fields at the circuit breaker, and to system ground fields by equipment safety grounding conductors.

Circuits without ground-wire monitors would also be required to have supplemental and system ground fields with resistance-to-earth values which do not exceed the value obtained by dividing 100 volts by the maximum ground-fault current of the system. These provisions would allow the specified systems to be exempted from the monitor provision but would instead require additional grounding. The ground fields described would establish a return path for ground-fault current that would assure that miners would not be exposed to voltages in excess of 100 volts.

Paragraph (d) would set performance requirements for ground-wire monitors used for electric face equipment. Ground-wire monitors would be required to be designed and constructed to be fail-safe. Use of the term fail-safe in existing standards for ground-wire monitors has resulted in some confusion. Therefore, the term "fail-safe" is defined in proposed § 75.2(j) as a device's ability to perform its intended function despite the failure of any component, other than relay contacts. Monitors would also be required to provide continuous monitoring of the grounding circuit for the equipment or motor it serves. Therefore, monitors would be a reliable method of continuously evaluating the condition of the ground wire to assure proper functioning of the grounding system and deenergization of the circuit in case of damage to the ground wire.

Paragraph (e) would clarify existing § 75.902, with one change that would incorporate present Agency policy. The existing standard requires that the ground-wire monitor trip the circuit breaker when either the ground or pilot check-wire is broken. The existing rule also provides for MSHA to approve a no-less-effective device to monitor the grounding circuit to assure continuity. Under the proposal, ground-wire monitors would be required to cause the affected circuit breaker to open when the ground-check conductor is broken at any point, and either the equipment safety grounding conductor is broken at any point, or 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 ground-fault conditions for all low-voltage circuits and high-voltage trailing cables, or a 100-volt drop for high-voltage circuits other than trailing cables.

A ground-check conductor is used in conjunction with the ground-wire monitor to continuously evaluate the condition of the ground wire. The equipment safety grounding conductor provides a path for ground-fault currents so that circuit breakers will function to deenergize the circuit. Damage to either of these conductors would seriously threaten the effectiveness of the grounding system. Impedance capable of causing a voltage drop in excess of 40 volts in the grounding circuit external to the resistor would also lessen the effectiveness of a system's grounding protection. Therefore, ground-wire monitors would have to cause deenergization of the circuit if conductors are damaged or impedance is raised to a hazardous level.

The performance standards for ground-wire monitors in the proposed rule are intended to clarify the present use of the term "fail-safe." Additionally, the new standard would address new types and designs of monitors, including impedance-type monitors and continuity-type monitors, which are currently in use in the industry. The Agency is contemplating rulemaking in order to promulgate an approval regulation for ground-wire monitors on permissible equipment. However, under the proposal, the Agency would continue its practice of accepting only ground-wire monitors that meet MSHA's criteria for effective performance and fail-safe design.

This is presently accomplished through a testing and evaluation program administered by MSHA's Technical Support Engineering and Testing Division. Ground-wire monitors submitted for acceptance are carefully evaluated to assure compliance with the Agency's performance criteria for a fail-safe design. Units which meet the criteria and the applicable requirements of Part 75 would be accepted by Technical Support and assigned an MSHA acceptance number.

Under paragraph (f), the open-circuit voltage for ground-wire monitors would be limited to 40 volts or less on low-voltage circuits and circuits to electric face equipment. The maximum open-circuit voltage for circuits other than circuits to electric face equipment would be 96 volts. This voltage was arrived at by using a multiple of 24, a voltage common to relay ratings presently in use. The difference is attributable to the increased methane level and resultant fire hazard in areas where electric face equipment operates. These would provide for adequate voltage to allow operation of the devices, but the voltage would be low enough to minimize shock hazards to miners. The specified voltage is intended to coincide with voltages common to relay ratings.

The existing standards require that separate connections be used when practicable in grounding equipment frames of all stationary, portable or mobile electric equipment receiving power from resistance-grounded systems. The proposal would require that ground-check and equipment safety grounding conductors always be separately connected to the metallic frames or enclosures of electric equipment. MSHA's experience indicates that it is practicable in all cases to make separate connections, and this is reflected in current policy. If the grounding conductor and the ground-check conductor are secured by one connector, both could be accidentally dislodged or detached simultaneously, leaving the circuit unprotected against ground faults. This could not occur if the grounding conductor and the ground-check conductor were secured separately.

Section 75.712 Direct-Current Equipment Frame Grounding

This proposed section is derived in part from existing § 75.701–3, and would

include requirements for grounding of equipment supplied with power by d-c electrical systems. Paragraph (a) would require certain equipment and structures to be connected to the appropriate grounding medium, as specified in proposed § 75.706, by equipment safety grounding conductors. The requirement would apply to metallic frames, enclosures, and other exposed, non-current-carrying metallic parts of electric conductors and equipment. This method of grounding would ensure a low-impedance connection to the system grounding medium for non-current-carrying metallic structures and parts. Metallic messenger wires used to support d-c conductors would be covered by the standard for similar reasons.

Two new provisions would require metallic racks and structures supporting trolley wires and trolley feeder wires, and metallic overcasts in trolley entries to be connected to the system grounding medium by equipment safety grounding conductors. This part of the proposal would encompass structures such as steel arches, overcasts and square sets. A reliable grounding path would be provided under the standard in case of insulation failure where trolley wires are supported from metallic racks and structures. Mine fires have occurred since 1980 where electrical faults caused by insulation failure have energized racks or structures, which in turn ignited combustible materials. The proposed rule would help reduce the occurrences of underground fires and electric shock hazards caused by insulation failures.

Paragraph (b) would require silicon diode grounding systems to be installed in accordance with proposed § 75.713. Paragraph (c) would require component parts of complete units of equipment to be solidly connected to the frames of the equipment. Therefore, the hazard of a miner being exposed to differing voltages between the unit of equipment and its component parts would be averted. For example, a miner contacting the metallic headlight enclosure of a shuttle car which is not properly connected to the frame of the unit could receive an electric shock if the voltage which exists on the headlight enclosure differs from that of the equipment frame. Grounding through a common medium would serve to minimize the possibility of such an occurrence.

Section 75.713 Silicon Diode Grounding

This section of the proposal would govern the use of silicon diode grounding, currently addressed under §§ 75.701–3 and 75.703–3. Several commenters to the preproposal draft requested clarification of whether silicon diode grounding would continue to be acceptable under the proposal. This section would make clear under what conditions silicon diode grounding would be permitted. The proposed standard would contain specific design and performance standards for silicon diode grounding of the metallic frame, enclosure, or other exposed non-current-carrying metallic parts of mobile equipment. The proposal would encompass electric mining equipment such as roof-bolters, continuous miners, and shuttle cars.

Under the standard, when the metallic frames of mobile equipment are grounded by silicon diodes, the diode grounding system would have to meet certain criteria. Under paragraph (a), the polarity of each grounding diode would be required to be compatible with the grounded polarity of the d-c system. When the polarity of the grounding diode is proper, current will only flow from the frame of the equipment to the grounded power conductor during faults. However, if the polarity were reversed, dangerous voltages would remain on the frame of the equipment. Further, the overcurrent devices which would be required by paragraph (c) of the standard would be unable to detect the occurrence of a ground fault if polarity were reversed. Reversed polarity could therefore defeat the grounding system and expose miners to electrocution hazards.

Under paragraph (b), each grounding diode would be required to have a threaded base used to solidly connect the diode to the machine frame. This provision would serve to ensure a solid, complete grounding path for mobile equipment. It would prohibit the use of "hockey-puck" style connections, which utilize a pressure connector. Unlike hockey-puck connections, a threaded base diode would screw into the frame of equipment, keeping stray materials from interfering with the connection and the correct functioning of the diode. A threaded base would aid in the dissipation of heat, while a method such as soldering might be ineffective when exposed to excessive heat. Additionally, diodes are contained in explosion-proof enclosures, and are therefore rarely open to visual inspection. Pressure connectors could become loosened without detection of the problem.

Under paragraph (c), an overcurrent device would be required to be installed between grounding diodes and the grounded power conductor when a silicon diode grounding system is used. The overcurrent device would have to be designed to cause the main contactor or the circuit interrupting device to deenergize all circuits on the machine when 50 amperes or more flows through the grounding diode.

The proposal would therefore require the circuit breaker to trip when a current of 50 amperes or more passes through the diode. A current of less than 50 amperes, in MSHA's view, represents a reasonable cut-off point, which is presently in use in the industry. However, methane monitors would be permitted to remain functional to continuously test for dangerous gas levels despite deenergization of a circuit.

Paragraph (d) of the proposed standard would require installation of a polarizing diode in the control circuit which prevents the unit of equipment from being operated when the polarity of the supply conductors is reversed. This provision is derived from existing § 75.703–3(d)(8), and incorporates a commonly accepted industry practice. As discussed previously, improper polarity of the diode can defeat the grounding system. Under this provision, operation of equipment would be made impossible if the diode's polarity is reversed, thus preventing unanticipated energization of the frame of the equipment.

Under paragraph (e), the forward current rating of each grounding diode would have to be equal to or greater than 750 amperes when used to ground a continuous mining machine, or equal to or greater than 400 amperes when used to ground other equipment, regardless of the voltage of the equipment. Lower forward current ratings, in MSHA's view, could cause the grounding diode to open and fail to trip the circuit breaker during a fault, leaving the equipment frame ungrounded. The proposal would assure a safe and dependable grounding circuit which will not fail under overcurrent conditions for all equipment, without reference to voltage.

Paragraph (f) of the standard would require the peak inverse voltage rating of the grounding and polarizing diodes to be equal to or greater than 1,200 volts. The value is derived from existing § 75.703–3(d)(2) and (3). This proposed requirement would help to prevent failure of these two solid-state devices. Underground electric equipment can be subjected to severe overvoltages, which can cause the grounding or polarizing diode junction to rupture and short circuit, defeating the protective functions of the two types of diodes. If the polarizing diode ruptures, its ability to retard the function of the control circuit would be lost. This could allow

the equipment frame to be energized if polarity is reversed. The proposed standard would address these hazards.

Section 75.714 Equipment Safety Grounding Conductors

Design and performance requirements for equipment safety grounding conductors would be addressed in this proposed section, which is derived from existing §§ 75.701, 75.702, 75.703 and 75.804. Grounding conductors are an essential part of grounding systems in that they are used to connect non-current-carrying exposed parts of equipment and structures to a specified grounding system. They are the means of preventing the appearance of dangerous voltages on equipment frames and structures by providing a path from the equipment to the grounding medium for abnormal currents to follow. Proper performance and design of these conductors are essential to the prevention of electrical accidents related to inadequate or ineffective grounding conductors.

Paragraph (a) would require that equipment safety grounding conductors for portable and mobile electric equipment be one or more stranded copper conductors contained within the cable or flexible cord supplying the equipment. Grounding conductors should be enclosed inside cables serving heavily used portable or mobile electric equipment in order to protect them from physical damage and deterioration. Stranded copper conductors would provide the necessary flexibility and strength for use within cables or flexible cords.

Paragraph (b) would set requirements for equipment safety grounding conductors for stationary equipment. They would be required to be made of copper or an equivalent material, and be either contained together with the circuit conductors in the raceways, cables, or cords, or wrapped around the raceways, cables or cords containing the circuit conductors. The closer the grounding conductor is located to the power conductor, the less impedance exists between the two. Thus, fault currents will flow through the conductor to the grounding medium and not directly to earth. Minimum impedance would facilitate effective operation of the circuit protection.

Paragraph (c) would detail the required cross-sectional area of equipment safety grounding conductors. When the circuit conductor is No. 6 AWG or larger, the combined cross-sectional area would be required to be equal to or greater than one-half of the cross-sectional area of the circuit conductor. When the circuit conductor is smaller than No. 6 AWG, the combined cross-sectional area of the equipment safety grounding conductor would have to be equal to or greater than that of the circuit conductor. Experience indicates that these minimum sizes for conductors would be necessary to safely carry currents to which they may be exposed.

Paragraph (d), would require equipment safety grounding conductors installed outside of raceways, cables or cords, and used to ground stationary equipment to be No. 6 AWG or larger. Grounding conductors of this size would be able to withstand physical damage and deterioration from the underground mine environment.

Under paragraph (e), switches, fuses, circuit breakers, ground-fault devices and overcurrent devices would be prohibited from being installed in equipment safety grounding conductors. This provision would ensure that the devices specified could not interfere with the operation of the grounding conductor.

Paragraph (f) of the proposed rule would require ground-wire devices installed in the equipment safety grounding conductor for the purpose of suppressing inter-machine arcing, or in conjunction with ground-wire monitoring systems, to be designed and constructed to withstand the maximum amount of phase-to-phase fault current to which they may be exposed without creating a shock or fire hazard. The effect of this provision would be to permit the use of arc suppression devices, which can minimize ignition hazards if they are substantially designed and constructed to perform their intended function despite elevated fault currents. The proposal would provide standards designed to assure that the use of such devices would not increase the hazards to miners.

Paragraph (g) of the proposed standard would require that when ground-wire devices addressed by paragraph (f), such as arc traps and ground-wire monitor filters and diodes, are used, they would have to be connected to the grounding medium by two separate grounding conductors. A single ground-wire monitor is not capable of detecting whether ground-wire devices are properly connected to the grounding medium, as well as monitor the ground wire itself. Two separate monitors would be needed. The proposed standard would provide for a back-up grounding conductor connection in case one should fail or become damaged, without necessitating the use of two monitors.

Under paragraph (h), separate connections to the mine track, the grounded return-feeder conductor, or the metallic frame or enclosure used as the grounding medium would be required for the equipment safety grounding conductor and the return power conductor on d-c powered equipment. If the grounding and return conductors are attached to the grounding medium by the same connection, both could easily be dislodged or damaged. If both are simultaneously dislodged, the frame of the equipment could become energized to hazardous voltages, creating a risk of electrical injury to miners. Separate connections would assure the integrity of the grounding system and address the hazards.

Paragraph (i) would require equipment safety grounding conductors for draw-out equipment or plugs and receptacles to be the first conductors connected when making connections, and the last conductors broken when breaking connections. In this way, the grounding system for the equipment would remain intact while draw-out units, such as circuit breakers, are being installed or removed. Therefore, ground-fault protection against arcing and ignitions would be provided while devices are being withdrawn or separated.

Under paragraph (j), equipment safety grounding conductors would be required to be connected by welds, pressure connectors or clamps. In MSHA's view, these methods would provide for the most electrically efficient connections. Finally, paragraph (k) would require equipment safety grounding conductors to be bare or properly identified. The effect of this provision would be to alert interested parties as to which of the conductors is the connection to the grounding system.

Subpart I—High-Voltage Alternating-Current Circuits

Section 75.801 High-Voltage Systems

This section of the proposal would contain new provisions requiring high-voltage electrical systems to originate on the surface, except that systems supplying power to underground face equipment would be permitted to originate either on the surface or underground. Systems which originate on the surface would pose less of a fire and shock hazard than those which originate underground. Power sources for high-voltage systems generate large amounts of electricity to supply mining equipment. If they are located underground where miners regularly work and travel, they could pose an electric shock or fire hazard.

Additionally, effective grounding systems are necessary to protect miners from exposure to energized equipment

frames caused by faults in the system. Proposed Subpart H would require high-voltage systems to be resistance-grounded and connected to a low-resistance ground field. Although quite effective for grounding purposes, the resistors used in this type of grounding system typically generate heat when subjected to a sustained grounded phase condition, which could ignite underground combustible materials. It would therefore be hazardous to allow such an ignition source to exist underground in the presence of combustible materials.

However, the standard would allow high-voltage systems that supply power to underground face equipment to originate either on the surface or underground. The Agency is aware of the availability of some specially-designed power centers which can be used safely underground to facilitate the use of high-voltage face equipment. Some equipment used in face areas, such as longwall mining units, utilize high horsepower motors which would require very large and heavy cables for transmission of power to low-voltage face equipment. Allowance of high-voltage systems serving face equipment to originate underground would alleviate the difficulty and danger of having to use such cables.

The proposed standards would set requirements for the use of high-voltage systems which originate underground to minimize risks of injury to miners from fire or electric shock. For instance, the allowable amount of heat generated by such systems would be limited under proposed § 75.808 to reduce the risk of fire. That standard would also set grounding requirements that would limit ground-fault current to less than 6.5 amperes for systems with voltages of 2,400 volts or less, and 3.75 amperes for systems with voltages greater than 2,400 volts. The proposed standards would also require ground-fault protection for motor circuits to be highly sensitive, set at 0.1 amperes or less, thereby providing a high degree of protection against ground faults.

In systems which typically originate on the surface, circuit breakers are not normally set to trip when exposed to a ground fault of less than 10 amperes. However, proposed § 75.808 would require super sensitive protective devices on underground systems which would trip the circuit breaker at an extremely low current value of 0.1 amperes.

The provisions of subpart I would also require two back-up systems for ground-fault protection of underground power sources. This would assure that faults will not exist in the system for extended periods of time sufficient to overheat the grounding resistor and cause a mine fire or shock hazard. MSHA believes that compliance with the proposed safety standards would make the use of systems which originate underground to supply face equipment safe for miners. The Agency also solicits comments on whether the need for high-voltage equipment other than that supplying face equipment is anticipated.

Section 75.802 Protection for Circuits, Other Than Trailing Cables

This section would set requirements for the protection of high-voltage circuits other than trailing cables. It is derived in part from existing §§ 75.518–1, 75.800, 75.800–1 and 75.800–2, which require circuit breakers for high-voltage circuits underground, and detail location and schematic requirements for circuit breakers. The proposal would consolidate present standards for ground-fault and undervoltage protection of high-voltage circuits, and set minimum operating requirements for protective devices.

Paragraph (a) would require circuit breakers of adequate interrupting capacity to protect high-voltage systems that supply underground electric equipment. These circuit breakers would be required to be equipped with devices which provide overcurrent protection, ground-fault protection and, except for branch circuits supplying only stationary surface loads, undervoltage protection. Figure I–1 would accompany the proposed standard to illustrate the provision.

Requiring circuit breakers to be of adequate interrupting capacity would protect against fire hazards by ensuring that circuit breakers will clear fault conditions which could otherwise generate extreme heat at the fault location. If a circuit breaker is underrated, high levels of fault current could cause it to be destroyed, possibly injuring persons operating the breakers.

Overcurrent protection in the form of devices such as relay circuits would serve to protect high-voltage systems against short circuits and overloads. Undervoltage protection on high-voltage circuits would also help to prevent injuries resulting from unexpected start-up of electric equipment after a power outage. Effective undervoltage protection would assure that the system carries enough voltage so that circuit breakers will remain energized for protection of the circuit. Undervoltage devices are designed to detect the voltage of the circuit and cause the circuit breaker to open and deenergize the circuit upon a sudden loss of voltage and keep it deenergized until manually reset. Otherwise, unexpected start-up of belts or equipment could injure miners.

Undervoltage devices would not be required for branch circuits which supply only stationary surface loads. The exception would have primary impact on surface loads such as ventilation fans, which would not normally represent a hazard if suddenly restarted after an undervoltage situation, since persons do not regularly work near such equipment. For instance, it may be desirable for surface ventilation fans to restart as quickly as possible to maintain a safe underground atmosphere for miners. By contrast, underground equipment such as pumps could cause a fire or methane ignition if it restarts suddenly while unattended.

Proposed § 75.2(j) would define undervoltage as a lack of or failure of voltage, as compared to the current interpretation of the term, which characterizes undervoltage as a 40–60 percent drop in system voltage. The change would eliminate the occurrence of circuit trips when there is a sudden load on the system resulting in a normal voltage drop. For example, use of a high-voltage continuous miner can create a heavy load on the system with no resultant hazard. The proposed definition would not require activation of undervoltage devices unless an abnormal lack of, or failure of voltage occurs.

Paragraphs (b) through (j) would contain performance requirements for the circuit protective devices which would be required under the section. Under paragraph (b), high-voltage circuits extending underground would be required to be protected by at least one circuit breaker located on the surface. This provision is derived from existing § 75.800–1, and should clarify that some breakers could be located underground for the protection of branch circuits. Compliance with the standard would assure accessibility of the device in the event of an emergency and facilitate testing and maintenance operations.

The standard would make clear that additional circuit breakers could be installed underground to provide overcurrent and ground-fault protection for branch circuits. It would allow establishment of new points of origin for ground-check circuits. For example, a circuit breaker located at the beginning of a branch circuit would allow selective deenergization of the circuit in order to address problems which may arise in an isolated part of it. The necessity to deenergize the entire circuit from the surface would be avoided under the proposed standard.

Under paragraph (c), overcurrent protection for high-voltage circuits would be required to consist of devices which protect at least two power conductors, which is consistent with existing § 75.5l8–1 and the NEC. In three-phase high-voltage circuits, overcurrents normally occur on at least two of the three power conductors. The standard would provide for an effective overcurrent detection system. Protection of only one power conductor could allow overcurrents to go undetected and place miners at risk if the circuit is not properly deenergized by the protective device.

Under paragraph (d), one circuit breaker used to provide overcurrent protection for two or more branch circuits would be required to provide overcurrent protection for the smallest conductor. If protection is provided only for the larger conductors, an overcurrent on the smallest conductor in the circuit could go undetected and increase the risks of fire or shock hazards.

Paragraph (e) would require overcurrent devices to have a pickup value of 125 percent or less of the ampacity for the smallest power conductors in the protected circuit, as listed in Tables I–1 and I–2, which would accompany the proposed rule. The devices would be required to have inverse-time current characteristics which cause them to operate within two seconds when a current ten times the allowable ampacity of the smallest power conductor flows in the circuit. Tables I–1 and I–2 specify allowable ampacities of shielded, high-voltage mine power cables with copper and aluminum conductors, respectively.

These performance requirements are derived from MSHA policy and the NEC. Therefore, the exiting incorporation by reference of the NEC in § 75.518–l would be deleted under the proposed rule. The pickup value is the minimum value at which devices used to detect overcurrents in the circuit will recognize the overcurrent condition and cause deenergization of a circuit. According to the NEC, currents in excess of 125 percent of the conductor ampacity could cause damage to the circuit and resulting potential fire or shock hazards to miners.

The proposed inverse-time current characteristics requirement would be a new provision. It would define the current levels which would be tolerated by the circuit without causing damage to conductors. Allowance of a current ten times the conductor's ampacity for a period of two seconds would not normally represent a hazardous condition. For example, the standard would allow brief inrush currents to enable equipment to be started up. Otherwise, the inrush of current required for energization of a piece of electric equipment would be detected as an overcurrent, and the circuit would immediately be deenergized.

Paragraph (f) would be a new standard, which would require ground-fault protective devices to be adjusted to deenergize the faulted circuit at 40 percent or less of the maximum ground-fault current of the system. This provision would set the maximum trip value of the circuit at 40 percent of ground-fault current, while existing § 75.800 does not presently specify a trip value. The maximum trip value would be determined under the proposal by the current rating of the grounding resistor used. For example, on a system with a 25-ampere grounding resistor, the ground-fault protective device would be required to operate at a fault current of 10 amperes. MSHA's view is that a 40 percent value is a reasonable level for ground fault tripping.

Under paragraph (g), a new provision, the ground-fault protective device located nearest to the load would be required to activate with no intentional time delay. The operating time of upstream ground-fault protective devices within a system could be increased under the proposal to provide selective tripping, but the operating time of the most upstream device could not exceed 3.0 seconds under the proposal.

Rapid response time of ground-fault detection devices would assure speedy tripping in overcurrent and fault situations, and thus prevent prolonged exposure to dangerous voltages. The circuit breaker nearest to the load or piece of equipment affected, would have to respond instantaneously in order to prevent fire and shock hazards. To provide for selective tripping, operating time for upstream circuit breakers may be increased, provided the most upstream device, nearest the source, operates within three seconds of the first device in order to assure rapid deenergization of the circuit.

Under paragraph (h), also new, equipment safety grounding conductors would not be permitted to pass through or be connected in series with ground-fault current transformers. It is important to prohibit such a configuration, because if a ground fault occurs in the circuit, the fault current could flow in a parallel path. Under this condition, the current transformer would not detect the fault and open the circuit, and multiple faults could result. Compliance with the proposal could reduce the occurrence of shock and fire hazards caused by fault conditions.

Paragraph (i) would require undervoltage devices to be undervoltage trip coils, or shunt trip coils energized by undervoltage relays or ground-wire monitor relays. Experience indicates that these types of devices provide the most reliable form of undervoltage protection for underground high-voltage circuits to prevent injuries to miners. Shunt trip coils without undervoltage or ground-monitor relays would not cause the circuit to trip until reenergization occurs after a loss of voltage. This could lead to sudden momentary restarting of equipment, which would place miners in danger of physical injury from unexpected energization of underground equipment. Shunt trip coils would be required to be operated by stored energy devices such as a battery or capacitor, to allow the device to receive power for activation despite deenergization of the circuit.

Paragraph (j) would be a new standard, prohibiting circuit breakers installed to protect underground high-voltage circuits from automatically reclosing after operation. This would be a new requirement for circuit breakers. Automatically reclosing circuit breakers are commonly used with success by electric utilities where faults are often caused by temporary environmental phenomena, such as lightning or wind gusts, which clear themselves naturally. However, in the underground mine environment, automatic reclosures could be dangerous to miners, because faults rarely clear themselves in high-voltage mine power systems. Injuries can occur underground when circuit breakers automatically reclose after a fault. For example, if a fault is caused when a miner inadvertently contacts an energized high-voltage conductor, it is essential that the circuit breaker not automatically reclose after tripping in order to protect the miner or those attempting rescue from shock or electrocution.

Compliance with the provision would also prevent the automatic and unexpected restarting of electric equipment. If the circuit breaker has to be manually reset after a power outage, for instance, the opportunity for unexpected reenergization of underground mine equipment would be minimized. Therefore, miners would be protected against crushing or pinning accidents from underground equipment which suddenly starts up.

Section 75.803 High-Voltage Distribution Equipment

This section is derived in part from existing § 75.803–1, and would set requirements for barriers on high-

voltage distribution equipment. Paragraph (a) would be new, requiring that high-voltage distribution equipment be enclosed in a grounded metallic enclosure and have no exposed energized parts. This would assure that miners will not inadvertently come into contact with lethal voltages. To allow adequate compliance time and reduce the compliance burden, disconnecting devices installed underground on or before the effective date of the rule would be excepted from the standard.

Under paragraph (b), also new, high-voltage a-c distribution equipment would be required to be equipped with interlock and emergency stop switches. The devices would have to automatically deenergize the incoming power conductors to the distribution equipment when a cover, lid or panel that exposes energized high-voltage parts is removed or when the emergency stop switch is activated.

The proposed standard would require installation of magnetic switches or microswitches which are capable of detecting when a lid or cover over energized parts of equipment is opened. The interlock switches would be required to cause deenergization of the equipment whenever energized parts are exposed. For example, if a cover panel over an energized circuit is inadvertently removed in order to work on electric components of a unit of high-voltage equipment, it would be automatically deenergized by activation of the interlock device. Therefore, the miner engaging in work on the unit would not be exposed to dangerous voltages within the equipment. Further, activation of the emergency stop switch would serve to deenergize a unit of equipment should a hazardous situation arise.

Emergency stop switches capable of deenergizing high-voltage equipment would facilitate rescue attempts in case of emergency. Since 1970, two fatal electrical accidents have occurred when miners contacted energized high-voltage conductors or parts within equipment, and fellow miners had to call outside the mine to have the circuits deenergized prior to attempting rescue. An operative emergency stop switch on such equipment could be instrumental in lessening the effects of such accidents by allowing for rapid response to emergencies where they occur.

One commenter to the preproposal draft suggested that the requirement should only be applicable to equipment installed after the rule's effective date, in order to allow for phase-in time for replacement of existing equipment. Another commenter supported the standard as a necessary safety improvement for the benefit of miners.

A review of the fatality record since 1970 has shown that at least eight miners have been electrocuted as a result of removing high-voltage compartment covers or lids and contacting energized parts inside. At least seven of those accidents could possibly have been prevented if interlock switches had been installed to deenergize the equipment when energized parts were exposed. Due to the fatality record and the continued danger presented to miners, the Agency believes that all high-voltage electric equipment, not solely equipment installed after the effective date of the rule, should have to comply with the standard.

Paragraph (c) would set a maximum open-circuit voltage for interlock circuits at 96 volts. This would allow the use of enough voltage for the operation of the interlock circuit, but would be insufficient to cause serious injury to miners. The voltage specified in the standard is derived from the voltage permitted for ground check circuits in existing § 75.803–1. It would be compatible with the voltages allowed under the proposal for other devices used within high-voltage circuits, such as ground-wire monitors, and it should not pose operational difficulties.

Paragraph (d) would be a new standard, becoming effective 18 months after the effective date of the rule, and would require all high-voltage distribution equipment, including high-voltage switchgear and power centers to be equipped with barriers. Barriers would be required to provide separate compartments for the incoming high-voltage disconnecting switch and feed-through circuit, the power transformer, the low-voltage distribution circuits, and the control circuitry, including ground-fault protective devices and ground-wire monitors. At least two miners have been electrocuted since 1970 as a result of contact with energized components of equipment within the same compartment as the components being worked on. Compliance with the proposal would assure that persons performing work on a control circuit, for example, would not inadvertently come into contact with energized power transformer parts. Compliance with the proposed standards would reduce the risks of shock and electrocution to miners.

The standard's 18-month compliance period would allow operators and manufacturers sufficient time for retrofitting existing equipment and designing new distribution equipment which would comply with the standard. MSHA estimates that approximately 11,000 existing pieces of equipment would be affected by the proposed standard. Of that number, 60 to 70 percent would need to be entirely retrofitted for compliance. Additionally, only approximately half of the newly-manufactured equipment would be in complete compliance with the standard.

To be properly retrofitted, distribution equipment now in use should be removed from the underground areas of the mine. The compliance period would facilitate the use of a change-out retrofitting program, which would permit the removal of units of distribution equipment from service one at a time in order to be retrofitted. Therefore, production would not have to be suspended in order to retrofit all of the affected equipment at once.

Paragraph (e) would be new, requiring barriers to be constructed of grounded metal or non-conductive insulating board. The provision would assure the use of sturdy materials for isolating each compartment from the others. The use of flexible belt material, for example, would not effectively prevent contact with the energized components of a compartment adjacent to the one being worked on. Grounding, or the use of non-conductive board, would assure that abnormal voltages will not appear on the barriers and cause electrical injuries.

Section 75.804 High-Voltage Cables, Other Than Trailing Cables

This section is derived from existing §§ 75.705–1l, 75.804, 75.807 and 75.812, and would set installation and shielding requirements for high-voltage cables, other than trailing cables. Under paragraph (a), high-voltage cables would be required to be located, buried, guarded, insulated, or otherwise protected from physical damage and contact with other wires or cables. Insulation used to prevent contact with other wires or cables would have to be in addition to that provided by the conductor insulation or cable jacket. This provision would be retained from existing § 75.807, and would assure that high-voltage cables would be protected from physical damage, so as not to provide an ignition or shock hazard due to exposed energized conductors.

Under paragraph (b), high-voltage cables which are suspended above the mine floor would be required to be securely anchored. This provision would help to assure that heavy cables will not fall to the mine floor or onto equipment and injure miners or become damaged. Failure of one cable support can cause a

chain reaction failure of all supports due to the weight of high-voltage cables. Secure anchoring would reduce the likelihood of such failures and possible miner injuries.

Paragraph (c) would require single-conductor high-voltage cables to be hung on well-supported messenger wire or insulated cable hangers. Hanging such cables from messenger wires or on insulated hangers would provide cables with physical protection against damage. The use of these support methods would assure that high-voltage cables are securely hung and protected against faults caused by physical damage.

Paragraph (d) would be retained from existing § 75.812, and would prohibit movement or handling of energized high-voltage cables. High-voltage cables can represent a great hazard to miners if they are damaged or have been improperly spliced or repaired. Contact with a faulty splice, for instance, could cause fatal injuries to a miner. The great bulk and weight of high-voltage cables could prompt cable handlers to use their bodies to help support the cable being moved. In such circumstances, insulated gloves alone would not protect the miner from exposure to the cable's voltage at a damaged or improperly spliced point. The proposal would assure that cables are deenergized before being moved to prevent electrical injuries.

Paragraph (e) would be new, requiring high-voltage cable power conductors to be at least No. 8 AWG. This size conductor would offer the necessary physical strength for the cables to withstand damage. Shock hazards and the risk of fire would be reduced under the proposed standard.

Paragraph (f) would be a new provision, requiring high-voltage cables other than single-conductor cables to contain one or more bare equipment safety grounding conductors. The purpose of a bare equipment safety grounding conductor is to detect faults in a circuit. If all conductors within a cable were insulated, faults could go undetected by the grounding conductor.

Under paragraph (g), ground-check conductors and interlock circuit conductors contained within high-voltage cables would be required to be at least No. 10 AWG. Paragraph (h) would require ground-check conductors and interlock circuit conductors which are external to high-voltage cables to be at least No. 8 AWG. This would be a new requirement for interlock circuits. These conductor sizes would be appropriate for the amount of current carried and the level of use to which the conductors would be put. Ground-check conductors and interlock circuit conductors which are not contained within the cable are subject to greater physical damage. Therefore, larger conductor sizes would be required for external circuits.

Paragraph (i) would require single-conductor cables to have equipment safety grounding conductors of either a bare ground-wire or a grounded messenger wire. This provision would give operators the option of using the messenger wire such cable is hung on for grounding purposes, or a bare grounding conductor could be added to the cable.

Paragraph (j) would require high-voltage cables to have metallic shielding around each power conductor. The percentage of coverage and acceptable types of shielding would be specified under paragraph (k) of the standard. The proposed shielding requirement would prevent voltage stresses in the conductor from damaging the remainder of the cable. Shielding is presently required under existing § 75.804, but that standard does not specify any required percentage of coverage. Due to the potential difficulty of modifying the amount of shielding on power conductors in cables presently in use to comply with the new shielding coverage requirements of paragraph (k), the standard would apply only to cables acquired after the effective date of the rule.

Paragraph (k) would be a new standard, requiring that metallic shielding be applied in the form of braid, wire serving (wrap) or tape. Metallic braid would have to supply at least 84 percent coverage, and wire serving at least 60 percent coverage. Metallic tape would be required to provide 100 percent coverage. To prevent the use of cables with inadequate shielding, the Agency believes that minimum amounts of coverage should be specified. Those included in the proposal were adopted from the Insulated Cable Engineers Association (ICEA) standards, and would represent acceptable minimum shielding requirements. The differences in the required percentages of coverage are attributable to the design of the acceptable shielding materials. Electric shock, flash burns, electrocutions, and mine fires caused by unshielded or inadequately shielded high-voltage cables would be addressed by the proposed standard.

Section 75.805 Movement of High-Voltage Power Centers and Portable Transformers

This proposed section is derived from § 75.812, which prohibits the movement of high-voltage energized power centers and portable transformers unless permitted by the Secretary. The proposed standard would require power centers and portable transformers to be deenergized before they are moved from one location to another.

Several hazards are involved with the movement of these pieces of equipment while energized. First, high-voltage power centers contain extremely hazardous voltage levels. Movement of them while energized could cause faults at or near the equipment, which could energize their frames. The energized frame of a power center could cause fatal injuries to a miner contacting it during moving operations. Second, power centers and transformers are typically very large and heavy pieces of equipment which are difficult to move. Rough treatment during movement could cause energized cables to be pulled out of their connections to the equipment. Contact with the exposed components of the cable could injure or electrocute mine personnel. Two fatalities have occurred in these circumstances within the past 15 years.

Existing § 75.812 requires operators to request permission from the Secretary prior to movement of energized power centers and portable transformers. For a permit to be granted, operators must meet the burden of showing that it is safer to move an energized power center than a deenergized power center. The intent of the standard was to allow the use of energized electric mine equipment, such as a continuous miner, to move the power center. Less than five permits have been granted on this basis since 1970.

In the past, if the power center was deenergized before movement, all of the equipment capable of moving the heavy structure was also deenergized. Large battery-powered equipment was not available in many mines when the existing standard was promulgated, so power centers often had to remain energized to supply electric power to the equipment required to move it. Today, however, the widespread use of battery-powered equipment capable of moving large and bulky loads would negate the need for allowing power centers or portable transformers to remain energized during movement. The proposed standard would eliminate hazards associated with the practice of moving energized power centers or portable transformers. In light of the danger and associated difficulty in meeting the burden of proof for the grant of a permit, the present standard would be modified as proposed.

Section 75.806 Connection Boxes

This standard would be new, and would set requirements for connection boxes used in high-voltage circuits. Connection boxes would be required to be constructed of metal or its equivalent, be watertight, have the incoming and outgoing equipment safety grounding conductors separately connected to the metallic enclosures, and be located in dry areas. Metal or an equivalent material would provide adequate physical strength to protect the connection. Moisture at the connection could cause arcing and short circuits, presenting shock hazards to miners. The proposed standard would address electric shock and electrocution hazards, as well as the risk of underground fire. Its requirements are intended to provide physical and electrical protection of the connection to minimize the risk of injury to miners at the connection site.

There has been considerable confusion in the mining industry over the acceptability of using high-voltage cable connection boxes in underground coal mines. Part 77 of MSHA's rules addresses connection boxes, but no regulation for the use of connection boxes presently appears in part 75. This has led to the filing of a large number of petitions for modification to use the structures underground. The proposal would clarify that the use of connection boxes would be an acceptable method for connecting two lengths of high-voltage cable in underground coal mines, and would establish safety requirements for their construction and use.

Sections 75.807 through 75.815 Underground Electric Face Equipment

Sections 75.807 through 75.815 would apply specifically to high-voltage power systems supplying underground electric face equipment. Presently, § 75.1002 precludes the use of high-voltage cables within 150 feet of pillared areas. Therefore, it has been a common practice for mine operators to file petitions for modification of that standard so that they may utilize equipment such as high-voltage longwall mining equipment or high-voltage continuous miners in face areas. However, proposed § 75.502 would permit the use of shielded high-voltage cables in face areas.

Electric face equipment, which is used in the working areas of a mine, in by the last open crosscut, is presently required to be permissible in accordance with approval regulations in 30 CFR part 18. The equipment addressed would still be required to comply with the requirements of part 18, but the following sections of subpart I would set additional safety requirements for the use of high-voltage equipment, trailing cables, and power cables in face areas.

The standards in the following sections would be used in lieu of petitions for modification, and are derived from the special terms and conditions included in petitions which have been granted by the Agency, as well as existing standards. In some instances, policies incorporated into existing standards for high-voltage equipment that is not required to be permissible were used as a basis for the proposed standards which would address permissible equipment.

Section 75.807 Voltage Requirements of Electric Face Equipment

This section would limit the amount of voltage which could be used by electric face equipment. Paragraph (a) would set the nominal voltage of the power circuits of electric face equipment at 4,160 volts or less. This voltage is consistent with the requirements of part 18 for permissible equipment. The hazards associated with voltages up to 4,160 volts could be minimized by compliance with the proposed requirements for circuit protective devices, conductor sizes, and grounding in this subpart and elsewhere in the proposal.

Under paragraph (b), the nominal voltage of the control circuits of electric face equipment would not be permitted to exceed 150 volts-to-ground. The effect of this provision would be to keep control circuit voltages low enough to minimize shock hazards. The 150-volt maximum is consistent with the voltage levels presently used for control circuits.

Section 75.808 Electrical Protection of Electric Face Equipment

This section is derived in part from existing §§ 75.518–1, 75.800, and 75.800–2, and would address methods of providing electrical protection for face equipment supplied by high-voltage systems. This type of equipment is used in areas where explosive concentrations of methane, coal dust and combustible materials are most likely to exist in a mine. The effects of ground faults, electrical arcing and short circuits, therefore, could have extreme consequences on the safety of miners. Effective electrical protection for face equipment would reduce the possibility of ignitions and miner contact with energized equipment frames.

Paragraph (a) would require high-voltage systems that supply electric face equipment to be protected by circuit breakers of adequate interrupting capacity, equipped with devices that provide overcurrent, ground-fault and undervoltage protection. The proposed standard, then, would require a circuit breaker for high-voltage systems serving face equipment that will function without damage to itself despite the level of current to which it is exposed. This would assure that the circuit breaker will remain undamaged by overcurrents and thus be able to clear faults in the system.

As discussed in connection with proposed § 75.802(a), overcurrent devices would assure that the high-voltage system is protected against short circuits and overloads. Ground-fault protection would also minimize the risk of shock injuries to miners. Undervoltage protective devices would be required to deenergize the circuit upon detection of a sudden loss of, or failure of voltage. The circuit would then have to be manually reset to prevent unexpected start-up of equipment, which could cause crushing injuries to miners.

Paragraph (b) would require high-voltage motor circuits to be provided with instantaneous short-circuit protection set at the lesser of no greater than 175 percent of the locked-rotor current of the motor, or no greater than 75 percent of the minimum phase-to-phase short-circuit current available at the motor terminals. This provision would set the maximum trip levels of circuit breakers serving high-voltage motor circuits to assure that adequate short-circuit current is available to trip the circuit breaker. Further, it would ensure that current high enough to allow start-up of high-voltage motors could be used without tripping the circuit.

At the specified levels, the protective devices would have to function with no intentional time delay. They would have to immediately deenergize the circuit at these levels, which experience indicates would offer adequate circuit protection. Immediate deenergization would assure that overcurrent, ground-fault or undervoltage conditions would not exist in the circuit for any prolonged periods.

Paragraph (c) is new, and would require high-voltage motor circuits to be provided with backup short-circuit protection in addition to that required in paragraph (b), and would list required trip settings for the devices. When the high-voltage circuit has a nominal voltage of more than 2,400 volts, backup short-circuit protection would have to be set at no more than 1,200 amperes. If the circuit's nominal voltage is 2,400 volts or less, the devices would be required to be set at 2,000 amperes. These settings would assure that circuit breakers used for the protection of high-voltage circuits

are tripped when exposed to fault currents from short circuits.

Paragraph (d), a new provision, would require time delays used for coordination with downstream short-circuit protective devices to be no more than 0.4 seconds. The effect of this provision would be to limit the time delay between tripping of sequential protective devices when selective tripping is used. Therefore, the circuit would be rapidly deenergized in overcurrent situations, but selective tripping would allow for deenergization of only the affected portions of the circuit, if desired.

Paragraph (e) would be new, requiring ground-fault currents to be limited by a neutral grounding resistor to not more than 6.5 amperes when the nominal voltage of the power circuit is 2,400 volts or less, and 3.75 amperes when the power circuit voltage is greater than 2,400 volts. Grounding resistors are employed in resistance-grounded systems to limit the level of fault current in a circuit. The levels specified in the proposed standard would reduce shock hazards and prevent the grounding resister from overheating and becoming an ignition source. These would be appropriately low levels for use in high-voltage systems used in face areas, where the presence of methane can pose ignition hazards. However, these levels should not cause operational problems within the system.

Paragraph (f), also new, would require high-voltage motor circuits to be provided with ground-fault protection having no intentional time delay and set at 0.1 amperes. This would provide for a highly sensitive and responsive ground-fault detection system for high-voltage circuits supplying face equipment. The protective devices would have to operate instantaneously when exposed to 0.1 amperes, under the standard. Therefore, compliance with the standard could greatly reduce the likelihood of a ground fault energizing the frames of face equipment and resulting in fire and shock hazards.

Under a new provision in paragraph (g), high-voltage circuits extending from the section power center would be required to have backup ground-fault protection set at no more than 40 percent of the current rating of the neutral grounding resistor. Backup protective devices would assure that faults occurring in a circuit extending from the section power source will not energize the frames of the face equipment served by it. The proposed standard would use the current ratings for grounding resistors, specified in paragraph (e) of the section, as a deenergization bench mark.

For example, if a 6.5 ampere grounding resistor is used, the backup device would have to operate to deenergize the circuit at 2.6 amperes or less. A 40 percent trip level would provide adequate backup protection which would assure that faults in circuits extending from the power center would not expose miners to the risks of fire or electrocution.

The standard would also require the total time delay used for coordination with downstream short-circuit protective devices to be 0.4 seconds or less. This provision would limit the time which lapses between tripping of the most upstream protective device and those positioned downstream from it when selective tripping is used. Consecutive tripping should occur with no more than 0.4 second total time delay. This would allow the use of selective tripping in order to isolate an affected circuit, but would also assure that the entire circuit is deenergized in rapid fashion to prevent prolonged exposure to dangerous fault currents.

Paragraph (h) would require the high-voltage neutral grounding resistor to be provided with overtemperature protection that will open the ground-check circuit for the high-voltage circuit supplying the section power center if the grounding resistor is subjected to a sustained ground fault. The overtemperature rating or setting of the device would have to be 50 percent or less of the maximum temperature rise of the grounding resistor. These are new provisions.

Grounding resistors typically generate heat when subjected to sustained ground faults. An overtemperature device would cause interruption of the high-voltage circuit supplying the section power center by opening the ground-wire monitor circuit before extreme heat could cause damage to the grounding resistor. Therefore, the resistor would not become disabled, leaving the circuit unprotected, and the possibility of fire would be reduced. The 50 percent overtemperature setting would assure that the affected circuit is quickly deenergized under a sustained fault, but the setting would be high enough to prevent operational problems. It would not cause deenergization of the circuit when exposed to the non-hazardous amounts of heat generated by equipment during normal use in the system.

Paragraph (i) is new, and states that equipment safety grounding conductors would be prohibited from being passed through or connected in series with ground-fault current transformers. Such a configuration, in MSHA's view, could lead to multiple faults occurring in the high-voltage circuit, because it may not allow a fault current to be conducted through the grounding conductor. Therefore, the current transformer would not detect the fault and open the circuit. Particularly in face areas of the mine, installing equipment safety grounding conductors within or in series with the current transformer could lead to ignitions and shock hazards.

Under a new provision in paragraph (j), ground-fault current devices would be required to have a test circuit that injects a current of 50 percent or less of the maximum ground-fault current of the system, and that causes the circuit breakers to open. This testing procedure would help to determine whether ground-fault current devices are functioning properly to monitor the circuit they protect. It would also test the sensitivity of the device to fault currents.

Paragraph (k) addresses types of undervoltage devices which would be acceptable for protection of high-voltage circuits supplying face equipment. The proposal would require that these devices be undervoltage trip coils or shunt trip coils energized by undervoltage relays or ground-monitor relays. Experience indicates that these devices provide the most reliable form of undervoltage protection for underground high-voltage a-c circuits, to assure that devices designed to deenergize the circuits under fault conditions will remain operational.

Undervoltage devices are used to detect the loss or failure of voltage in a circuit, so that it will be deenergized if insufficient voltage exists to energize circuit protective devices. Shunt trip coils without undervoltage or ground-monitor relays would not allow the circuit breaker to trip the circuit until the circuit is reenergized after a loss or failure of voltage. The proposed standard would therefore prevent momentary reenergization of equipment served by the circuit and reduce miners' exposure to shock hazards, as well as the risk of being pinned or crushed by face equipment which suddenly starts up. Shunt trip coils would be required to be energized by stored energy devices, such as a battery or capacitor, to assure that the coils would receive power even if the circuit has suffered a voltage failure.

Paragraph (l) would also be new, and would prohibit the use of circuit breakers which automatically reclose after operation. Automatic reclosure of the circuit breaker would allow immediate reenergization of a circuit which has sustained a fault. Faults occurring in underground electrical

systems do not normally clear themselves, as surface utility lines often do. For instance, a fault could be caused by a miner or some object contacting the power conductors in a damaged high-voltage cable. Unless the object is removed, the fault will be sustained and recurrent tripping will continue if the circuit breaker is designed to automatically reclose. This could cause damage to the circuit protective system and expose miners to serious shock hazards.

Section 75.809 Disconnecting Devices for Electric Face Equipment

This standard is derived from existing § 75.808, and would also contain a new requirement for disconnecting devices for high-voltage electric face equipment. Paragraph (a) would require the main circuit breaker at the section power center to be equipped with a disconnecting device designed and installed so that it can be determined by visual observation that the contacts are open, without removing any of the section power center covers. Visual evidence of whether the contacts are open would be required, to allow miners to readily assess that circuits being worked on are deenergized before work is begun. Visual evidence which negates the need for opening the power center covers would prevent unnecessary exposure of miners to the high-voltage components of the equipment.

Paragraph (b) is new, and would require the main controller of longwall mining equipment to be equipped with a disconnecting device that automatically grounds all load power conductors when the device is in the open position. This provision would protect persons working on a circuit that is accidentally reenergized. Automatic grounding of the load power conductors would introduce an intentional fault in the circuit if inadvertent reenergization occurs, which would immediately deenergize the circuit. The persons performing the work would thus be protected from exposure to energized components of the circuit.

Section 75.810 Testing, Examination, and Maintenance of High-Voltage Electric Face Equipment

This standard is derived in part from existing §§ 75.512, 75.512–2, 75.800–3, 75.800–4. It would be used in conjunction with proposed § 75.502, which would allow the use of high-voltage cables in face areas to supply high-voltage equipment. Proper testing, examination and maintenance of high-voltage electric face equipment, such as longwall systems, operated in the presence of methane and combustible materials, would assure that it would not pose increased hazards to miners.

Paragraph (a) would require an electrician qualified for high-voltage work in accordance with proposed § 75.153 to test, examine, and maintain high-voltage face equipment and circuits to determine that the electrical protection, equipment grounding, permissibility, cable insulation, and control devices are properly maintained to prevent fire, electric shock, ignition or operational hazards from existing on the equipment. Keeping face equipment free from these hazards would be assured by the training and expertise of a high-voltage qualified electrician. Testing and examination of high-voltage equipment used in face areas on a regular basis would assure that hazardous conditions are discovered and addressed before they can cause injuries to miners.

Paragraph (b) is new, and would require each high-voltage grounding resistor and electrical protective device for face equipment to be subjected to specific tests when installed. Testing would be required to include passing an amount of current through each current transformer necessary to cause the circuit breaker to open, and impressing an amount of voltage across each potential ground-fault device necessary to cause the circuit breaker to open. The qualified electrician would be responsible for determining whether the grounding resistor is open or shorted and assuring that the overtemperature protective device is capable of opening the incoming ground-wire monitor circuit. The proposed testing procedures would represent a thorough evaluation upon installation of the equipment of whether the devices designed to eliminate hazards to miners would operate effectively when required to do so.

Paragraph (c) would require additional post-installation inspections and examinations of high-voltage face equipment on a periodic basis. At least once every seven days, such equipment would be required to be inspected and examined, including actuation of the ground-fault test circuit which would be required by proposed § 75.808(j). A seven-day interval would be a reasonable period in light of the use and location of the equipment. The standard would assure that problems which arise during normal use of mining equipment would be identified and dealt with appropriately, so that miners would not be exposed to fire or electrocution hazards. Actuation of the ground-fault test circuit would help to identify any damage or defects in the grounding systems which protect face equipment.

Paragraph (d) would require that each high-voltage circuit breaker be opened at least every 30 days by opening the corresponding ground-check conductor at the extreme end of the ground-wire monitoring circuit, where a ground-check conductor is used. This procedure would assure that the circuit breaker will operate effectively to deenergize the entirety of the circuit it protects. Testing every 30 days would be, in MSHA's view, an appropriate interval for evaluating the effectiveness of these devices.

Under paragraph (e), when examinations or tests of face equipment reveal a fire, electric shock, ignition or operational hazard, the equipment would be required to be removed from service or repaired. This provision would assure that equipment which poses any danger to miners would not be used before the hazardous condition is repaired.

Paragraphs (f) and (g) contain requirements for documentation of testing and repairs. At the completion of examinations and tests, the person who made them would be required to certify by signature and date that they have been conducted. A record of any unsafe condition found and corrective action taken would also have to be made. Certifications and records would be required to be kept for at least one year and made available at the mine for inspection by authorized representatives of the Secretary and representatives of miners at the mine. Records and certifications of testing and repairs would be valuable tools in the investigation of mine accidents and to point out patterns of equipment defects for improvements in equipment design.

Section 75.811 Cables for High-Voltage Electric Face Equipment

This section is derived in part from existing §§ 75.600–1 and 75.804, and would set requirements for the physical and electrical protection of high-voltage power cables and trailing cables used in conjunction with electric face equipment. Paragraph (a) would require each high-voltage cable to have a voltage rating of at least the nominal phase-to-phase voltage of the circuit in which it is used. This would assure that cables serving high-voltage face equipment will possess current-carrying capability which is compatible with the current carried by the circuit. This would reduce the likelihood of fire and shock hazards caused by damage to cables having inappropriate voltage ratings.

Under paragraph (b), high-voltage cables would be required to have a

grounded metallic shield around each power conductor. The shielding component of the cable would prevent voltage stresses in the conductors from damaging the other components of the cable and causing faults in the circuit.

Paragraph (c) is new, and would require metallic shielding applied in the form of braid to provide at least 84 percent coverage. Under paragraph (d), also new, metallic shielding in the form of a serving (wrap) would have to provide at least 60 percent coverage for the power conductors. The designs of these types of shielding are determinative of the percentages of coverage which would offer effective protection for power conductors. Shielding in the form of metallic tape would not be permitted under the standard. The potential for repeated flexing of the cable could cause separation of the tape, resulting in exposure of energized power conductors. Tape shielding is unable to withstand the continuous flexing required of this type of cable. Particularly in face areas, where methane concentrations can present a greater hazard, exposure of energized conductors would pose an ignition source. Tape, therefore, would not be appropriate for shielding of high-voltage power cables supplying face equipment.

Under paragraph (e), high-voltage trailing cables would be required to be flame-resistant, in accordance with the requirements of existing § 18.64. That standard details tests for the flame-resistant characteristics of cables used in underground face areas for permissibility purposes. Flame-resistant cables would reduce the spread of fire, should a prolonged short circuit ignite the cable jacket.

Paragraph (f), a new provision, would require power conductors to be at least No. 4 AWG, therefore ensuring sufficient physical strength to lessen the likelihood of the conductors being broken. Under paragraph (g), high-voltage cables would be required to contain one or more bare equipment safety grounding conductors. The purpose of a bare equipment safety grounding conductor is to assure detection of faults in a circuit. If all conductors within a cable were insulated, it would be difficult for protective devices to detect the occurrence of a fault. Therefore, fault currents could go unchecked by the protective devices of the circuit, presenting a shock hazard by energizing the frames of equipment.

Paragraph (h) would require ground-check and interlock circuit conductors to be contained within high-voltage cables, and be at least No. 10 AWG. Containment of these conductors within the cable would protect them from physical damage. No. 10 AWG conductors would possess physical and electrical strength that is appropriate for their uses.

Section 75.812 Cable Support Systems; High-Voltage Longwall Electric Face Equipment

This section of the proposal is new, and would address the handling and support of high-voltage cables serving longwall electric face equipment. Paragraph (a) would require longwall mining systems to be equipped with cable handling systems and support systems that are designed, installed, and maintained to protect high-voltage cables from damage, and to minimize the possibility of miners inadvertently contacting the cables. Although longwall mining systems are considered to be a useful and productive mining method, the high-voltage cables used to supply them with power could present shock and fire hazards if they are damaged or defective. The handling and support systems included in the proposal would guard cables to achieve minimum exposure to physical damage or stress.

Under paragraph (b), high-voltage cables used on longwall mining systems would be required to be deenergized before removing entry conveyor belt structures. Movement of energized cables while removing entry conveyor belt structures could lead to the occurrence of faults in the circuit, which would pose risks of fire and electrocution to miners. The standard would address these dangers by requiring deenergization of the cables prior to movement of belt structures.

Section 75.813 Guarding of Cables for High-Voltage Electric Face Equipment

This proposed standard is partially new, and partially derived from existing § 75.807. It would set new guarding requirements for high-voltage cables supplying electric face equipment. Paragraph (a) would require the cables to be guarded where persons regularly work or travel over or under the cables to prevent physical damage to the cables and miner contact with them. A new provision would also require guarding where the cables leave cable handling systems or support systems to extend to electric components. The effect of this provision would be to reduce flexing and stress on cables to prevent physical damage which might pose shock and fire hazards.

Paragraph (b) would set performance requirements for guarding. It would have to protect high-voltage cables from physical damage and prevent miner contact. Guarding would also be required to be constructed of grounded metal or nonconductive, flame-resistant material. These standards would assure that guarding possesses adequate physical and electrical protective characteristics to perform its function. Use of the specified materials would assure that miners would not be exposed to the voltage of the cable.

Section 75.814 Safety Devices for High-Voltage Systems Supplying Electric Face Equipment

This is a new standard, which would set requirements for devices designed to prevent miner contact with energized internal components of high-voltage electric equipment. Paragraph (a) would require each unit of high-voltage equipment to be equipped with a barrier between the main disconnecting device and motor starter compartments and between each motor starter compartment. Compliance with the standard would assure that in gaining access to the disconnecting device, persons would not make contact with energized components of adjacent motor starter compartments.

Under paragraph (b), high-voltage equipment would be required to have covers arranged so that persons could perform work on the motor starter compartment without being exposed to energized high-voltage conductors or parts when the disconnecting device at the main controller is in the open position. This provision would minimize shock hazards to persons performing work on the equipment. Cover interlock switches would be required to automatically deenergize the high-voltage circuit supplying the unit when any cover that provides access to energized high-voltage conductors or parts is removed. Implementation of this provision would provide automatic protection for miners performing work on the internal components of the equipment.

Under paragraph (c), barriers would be required to be constructed of grounded metal or non-conductive insulating board. These materials would provide the necessary physical strength and protective electrical characteristics for an effective barrier. The proposed standard would prevent the use of materials such as belting, which would not be sturdy enough to prevent contact with the energized components of adjacent compartments.

Paragraph (d) would require control circuits of electric face equipment to have a two-winding transformer that electrically isolates it from the high-voltage circuits. Additionally, control circuits would be required to have an

electrostatic, or "Faraday," shield between the secondary and primary windings. The shields would have to be made of aluminum or copper and connected to the equipment frame, with a cross-sectional area consistent with proposed § 75.714(c). The shields would prevent inadvertent contact with energized equipment components. The use of aluminum or copper materials connected to the equipment frame would assure physical strength, good conductivity, and an efficient connection to the grounding system.

Section 75.815 Procedures for Working on High-Voltage Systems Supplying Electric Face Equipment

This section is derived from existing §§ 75.509, 75.511 and 75.705. It would set requirements for performing work on high-voltage systems supplying electric face equipment. The requirements would be similar to the general requirements in proposed § 75.506 for work on electric circuits and equipment, with additional standards specifically applicable to work with high-voltage systems supplying face equipment.

Paragraph (a) would require safety precautions to be taken by the qualified electrician required to perform electrical work on high-voltage face equipment before any work, including testing, troubleshooting, and fault finding, is performed in the motor starter compartment. The qualified electrician would be responsible for assuring that the contacts of the main circuit disconnecting device at the main controller are open and grounded, locking out the disconnecting device with a padlock, and tagging the disconnecting device. These precautions would assure that the affected circuit has been properly deenergized and disconnected so that persons performing work on it would not be exposed to shock or electrocution hazards.

Paragraph (b) would detail procedures to be followed by the qualified electrician before any electrical work is performed on a high-voltage cable or motor. The electrician would be responsible for assuring that the cable is disconnected, connecting the phase conductors in the cable to the grounding conductors, locking out the cable with a padlock, and tagging the cable coupler for the cable. Work with high-voltage equipment and circuits can be extremely hazardous. Without taking precautions such as properly locking-out and tagging the affected circuit, qualified electricians would be exposed to the risk of electrocution from someone inadvertently reenergizing the circuit being working on.

Paragraph (c) is new, and would require disconnecting devices and couplers to be locked with an individual padlock for each person performing work. Therefore, the opportunity for accidental reenergization of the equipment or circuit before all persons have completed work would be reduced. For similar reasons, a new provision in paragraph (d) would require tags used on deenergized high-voltage electric circuits and equipment to identify each person performing work, and the circuit or equipment being worked on. Under paragraph (e), only the person who installed a padlock or tag would be permitted to remove it. These steps would assure that electricians working on high-voltage circuits or equipment are well-identified and protected from accidental exposure to possibly lethal electric shock.

Individual padlocks, removable only by the persons who installed them, would place responsibility on the persons performing work to assure their personal safety. If work on the circuit has not been completed by the end of a shift, the circuit should remain tagged. A mine official, such as a foreman, could attach his or her own padlock or tag the circuit until work is resumed by another qualified electrician, who would be responsible for installing an individual lock. The danger and accident history of reenergization of circuits before work has been completed make such measures necessary for the protection of miners against electrocution or electric shock.

Subpart K—Trolley Wires and Trolley Feeder Wires

Section 75.1001 Installation

This proposed standard is derived in part from existing §§ 75.516, 75.1003 and 75.1003–1. It would specify the location of trolley wires and trolley feeder wires, and specify when guarding of these wires is necessary. Paragraph (a) would require trolley wires and trolley feeder wires to be at least six inches outside of the track rail, except where the wires cross over the rails at track switches. The six-inch clearance would be measured from the trolley or trolley feeder wire to a vertical line extending from the outside of the track rail.

In MSHA's view, a 6-inch clearance would provide an appropriate margin of error to minimize possible contact between the trolley circuit and the frames of track equipment operating in the trolley entry. This provision would help protect miners from flash burns and mine fires that can occur when contact with trolley wires and trolley feeder wires takes place. Additionally, this provision would minimize trolley wire contact by personnel using or operating track-mounted equipment. Two fatalities have occurred since 1970 when track equipment operators contacted the trolley wire while attempting to reset trolley poles.

Paragraph (b) is derived from existing § 75.516, which prohibits power wires from contacting combustible materials, roof, or ribs. The proposal would modify the present standard by prohibiting trolley wires and trolley feeder wires from contacting combustible materials, metallic water lines, metallic structures, roof or ribs. Metallic water lines and metallic structures would be included in the proposal to minimize the hazards associated with trolley circuit conductors contacting metallic structures or metal waterlines. Such contact could cause electrical arcing or cause the structures to act as unintentional electrical conductors.

Paragraph (c) is derived from existing § 75.1003 which requires that trolley wires, bare trolley feeder wires and bare signal wires be insulated where they pass through doors and stoppings. This rule would be retained in the proposal with a more definitive requirement that insulation be provided for trolley wires and trolley feeder wires where they cross within six inches of power wires and cables. MSHA has identified these locations as areas where miners are frequently exposed to shock hazards.

Paragraph (d) of the proposal would require that trolley and trolley feeder wires installed after the effective date of the rule have at least six inches of radial clearance from the metallic parts of track-mounted equipment. This would establish a minimum safe distance (radial) from any metallic part of track-mounted equipment to the trolley or trolley feeder wires to minimize potential shock and fire hazards through inadvertent contact as equipment travels through trolley entries.

Paragraphs (e), (f), (g), and (h) are new, and would require the installation of deadblocks in radial stub-feed and parallel connected rectifier trolley systems. Radial stub-feed systems would be required to have deadblocks installed between adjacent rectifiers to isolate or separate the systems. Deadblocks would also be required to be installed in parallel with each stub-feed circuit breaker. Figure K–1 would illustrate the provision. Parallel-connected rectifier trolley systems would be required to have deadblocks installed in parallel with each tie-feeder breaker and each stub-feed breaker. Figure K–2 would illustrate this standard.

Deadblocks would ensure that each radial stub-feed trolley system would be electrically independent, in order to prevent the over-extension of circuit protection. When such an over-extension occurs, the system, due to increased circuit resistance, may be unable to provide the amount of short-circuit current necessary to actuate circuit protection devices. The proposal would require deadblocks to be installed at each stub-feed or tie-feeder circuit breaker for precisely the same reasons.

Paragraph (g) would require that at least two insulating gaps be provided in the deadblocks that will extinguish arcs. Requiring at least two insulating gaps would assure circuit isolation of adjacent portions of the trolley circuit and prevent fire and shock hazards when one gap is inadvertently shorted.

Under paragraph (h), each deadblock would be required to be distinctly marked at its location so it can be quickly located in the event of an emergency. This would assist emergency workers in determining where power can be accessed for emergency operations.

Section 75.1002 Insulated Hangers

Portions of this proposed standard are derived from existing § 75.516, which requires that power wires be supported on insulators. Paragraph (a) of the proposal would retain the insulator requirement. With uninsulated hangers, the voltage on the supported trolley wire or trolley feeder wire could energize the uninsulated supporting hanger, causing fire and shock hazards. Additionally, it could energize other adjacent metallic structures. The proposal would reduce the chances of such accidents by assuring that voltages and currents are confined to the trolley wires or trolley feeder wires.

The proposal would require hangers to have a dielectric strength of at least 15 times the nominal voltage of the trolley system in which they are used, under paragraph (b). MSHA arrived at this figure by evaluating the "American Standard Safety Rules for Installing and Using Electrical Equipment," 1964, sponsored by the American Mining Congress and the U.S. Bureau of Mines. After an evaluation was made, it was determined that the minimum dielectric strength would be ten times the maximum no load voltage of a typical trolley circuit, plus an additional safety factor of 1000 volts. The proposed insulation allows for a safety margin that would minimize the possibility of a hanger failing electrically and causing a mine fire or creating a shock hazard.

Paragraph (c) would require that hangers have two insulators stacked together when uninsulated wires are supported from metallic arches, square sets, overcasts, and other similar metallic structures. This new requirement would address the increased potential fire, shock, and ignition hazards associated with having the hanger attached to a metallic structure, instead of the coal mine roof. Under such circumstances, the potential hazard is greater because of the increased electrical conductivity associated with metallic structures. Moreover, insulators are susceptible to failure. A requirement for two insulators would provide an additional measure of protection.

Section 75.1003 Guarding

This section is partially derived from existing §§ 75.509, 75.510, 75.1003 and 75.1003–1, and is partially new. The requirements in the proposal emphasize that guarding is required not only where miners work, but at other locations where they are exposed on a frequent or regular basis to the shock hazards of exposed energized trolley circuits. Since 1970, there have been at least nine fatalities involving miners who came into contact with unguarded trolley wires.

Paragraph (a) of the proposal retains and clarifies the requirements of existing § 75.1003. It would require guarding of trolley wires and trolley feeder wires where supplies are loaded, unloaded or stored, at mantrip stations, on each side of all doors and stoppings through which wires pass, where persons work within 3 feet of the trolley circuit wires, except for persons operating rail-mounted haulage equipment at track switches, and where persons regularly pass under the wires. Agency experience has been that guarding is necessary on trolley circuit wires, not only where persons perform their normal work tasks and are therefore exposed to energized trolley circuits, but also where they load or unload supplies or generally work with supplies.

Paragraph (b) would require that trolley wires and trolley feeder wires be deenergized when guarding is installed or removed. An exception to this provision would allow the installation and removal of certain types of special temporary guarding while the trolley system is energized. Such temporary guarding, designed for installation or removal while the trolley system is energized, would provide adequate protection for the person during installation and removal. This temporary guarding would allow trolley systems to continue operating safely during installation or removal of guarding since it is designed to protect the installer from exposure to bare energized trolley circuit wires.

Section 75.1004 Cutout Switches

The section is derived in part from existing § 75.1000. The provisions of that standard have been retained with minor word changes for clarification. Paragraph (a) would require a cutout switch which opens both the trolley wire and trolley feeder wire at each rectifier or d-c generator, each tie feeder circuit breaker, each branch line within 100 feet of the trolley turnout, and at intervals of not more than 2,000 feet in the trolley circuit. The proposal would clarify the existing requirement that cutout switches be provided near the beginning of branch lines by requiring that cutout switches be provided at each branch line within 100 feet of the trolley turnout.

Under the existing standard, inability to locate the cutout switches in trolley systems has made it difficult for miners to quickly deenergize trolley circuits in emergency situations. If a fire were to occur on a trolley system, the ability to quickly deenergize the circuit could prevent further spread and reduce the chances of serious injury to miners. Requiring cutout switches at the specified locations would assure that effective and expeditious means for deenergizing trolley circuits are available throughout the mine.

One commenter to the preproposal draft suggested that plugs and receptacles be accepted as an alternative to a cutout switch for disconnecting power in a trolley circuit. Although plugs and receptacles can serve this purpose, they can be easily damaged, especially when located near a trolley track system. A plug and receptacle arrangement could also give rise to the possibility that a short circuit could occur inside the coupler, resulting in a hazardous situation.

Paragraph (b) is new, and would require that each cutout be distinctly marked at its location so it can be quickly found in the event of an emergency. Distinctly marked cutout switches would assure that they can be readily identified in the event of a fire or other electrical accident. The Agency believes that the poor lighting conditions in underground coal mines would justify the need for this requirement.

Section 75.1005 Circuit Protection

This section is derived from existing § 75.518–1, which incorporates by reference the 1968 edition of NEC. It is also derived from existing §§ 75.1001

and 75.1001–1 which require that trolley wires and trolley feeder wires be provided with overcurrent protection by automatic circuit interrupting devices that protect against short circuits. Short-circuit protection is accepted throughout the industry as overcurrent protection for trolley circuits. The proposal would include performance-oriented requirements for circuit breakers used to protect trolley wires and trolley feeder wires, and would specify under what conditions the breakers would be required to deenergize the system.

Paragraph (a) would require that trolley wires and trolley-feeder wires be protected against short circuits by circuit breakers. The use of fuses to provide protection for trolley circuits would not constitute compliance with the proposed rule. The proposal would, however, allow fuses to protect equipment and circuits supplied from a trolley system, but not the trolley systems themselves. Trolley circuits may be subjected to extreme overload conditions, typically up to 150 percent for 2 hours, and the circuit protective device must be capable of operating under these conditions without damaging itself or its components.

Several problems are associated with the use of fuses for protection of trolley circuits. Fuses, sized to provide short-circuit protection, could not effectively withstand the extreme overload conditions and would tend to open prematurely. Additionally, fuses sized to withstand the extreme overcurrents of trolley systems may not provide proper short-circuit protection due to their melting times. Due to the electrical characteristics of trolley systems, it is not clear whether fuses would be capable of safely interrupting overcurrents that are 200–300 percent of the current rating of the fuses.

Another problem is that fuses must be replaced after one interruption. This may expose mine personnel to unnecessary hazards because the power circuit cannot be used until the blown fuse has been replaced, thus creating the hazard of unnecessary delay in the transportation of persons and material during mine emergencies which can accompany power outages.

The proposal would require that d-c breakers not be set at more than 50 percent of the minimum available bolted short-circuit current when that current is less than 800 amperes, or 75 percent when that current is 800 amperes or more. Alternating-current breakers protecting stub-feed trolley systems could not be set at more than 40 percent of the minimum available bolted short-circuit d-c when that current is less than 800 amperes, or 60 percent when that current is 800 amperes or more, under the proposal. These settings are based on general industry standards for circuit breakers and MSHA studies. The studies included an evaluation of the relationship between currents and the voltages of arcing faults on the trolley systems. Arcing faults on trolley systems have been documented as the cause of numerous mine fires.

Paragraph (b) is derived from the NEC, which prohibits circuit breakers from being arranged or installed in parallel. That standard is currently incorporated by reference in existing § 75.518–1, and would be retained in the proposal. When two circuit breakers are installed in parallel, the amount of current required to deenergize the faulted circuit is dependent upon the opening of both circuit breakers. Should a short circuit occur, neither circuit breaker would open, and a hazardous fault would be left on the circuit. By requiring that breakers not be installed in parallel, adequate protection would be assured for trolley circuits.

Paragraph (c) is derived from an NEC standard which requires that an overcurrent device be placed in each ungrounded conductor, incorporated by reference in existing § 75.518–1. The proposal would retain the requirement and modify it for application to trolley systems in underground coal mines. It would require that a d-c circuit breaker be connected in series with the ungrounded power conductor at each rectifier supplying a radial stub-feed trolley system, unless an a-c circuit breaker is connected in series with each ungrounded conductor supplying power to the rectifier bridge. This would ensure that each conductor is provided with adequate short-circuit protection, in order to prevent the fire hazards associated with arcing ground faults on the trolley circuit. Figure K–3 would accompany the proposed standard for illustration.

Paragraph (d) is also derived from an NEC standard, and would require that one year from the effective date of the rule, at least two d-c tie-feeder circuit breakers be connected in the ungrounded power conductor of each rectifier used to supply power to a parallel-connected rectifier trolley system. This would prevent the overextension of protection for parallel-connected rectifier circuits. Such an overextension could lead to arcing fauits on the trolley wires, which would act as an ideal ignition source underground. MSHA's experience with one-breaker systems indicates that short-circuit protection could be overextended when one or more of the rectifiers becomes deenergized. Figure K–4 would illustrate the proposed standard.

Paragraph (e) would require each tie-feeder breaker located at a parallel-connected rectifier to automatically open when either the rectifier bridge loses its source of power or when any main circuit breaker that is located between the tie-feeder breaker and the rectifier opens. This proposed rule addresses another circumstance under which the overextension of protection could lead to an arcing fault current that could cause a mine fire. It is derived from existing standards, as well as the NEC.

Section 75.1006 Circuit Breakers

This section is derived in part from existing §§ 75.518–1, and 75.1001–1. Paragraphs (a) through (f) are derived from the NEC, 1968, but the existing incorporation by reference in existing § 75.518–1 would be deleted under the proposal. The NEC requires that overcurrent protection devices be selected and coordinated with the total impedance and other characteristics of the circuit being protected to prevent external damage to the electric components of the circuit during fault conditions. In MSHA's view, d-c trolley systems can present extreme fire hazards upon failure of electric components, more so than other types of electrical systems. Because of this, MSHA has evaluated the NEC standards and used the results of the evaluation to develop proposed requirements that would ensure that trolley circuit breakers are properly installed with safe and effective settings.

Paragraph (a) would require that d-c circuit breakers used on trolley systems having a nominal circuit voltage of between 250 to 300 volts have a minimum voltage rating of 330 volts. Paragraph (b) would require that d-c circuit breakers used on trolley systems having a nominal circuit voltage of between 500 and 600 volts have a minimum voltage rating of 660 volts. The voltage ratings of d-c circuit breakers in paragraphs (a) and (b) would be specified to assure the proper circuit interruption based on no-load voltages of trolley systems in use at coal mines. They are based on the no-load voltages of typical trolley systems in underground coal mines.

Paragraph (c) would require that d-c circuit breakers have interrupting-current ratings with a time constant of 30 milliseconds of not less than 15,000 amperes for frame sizes less than 1,000 amperes; not less than 25,000 amperes for frame sizes 1,000 amperes to 2,000

amperes; and not less than 50,000 amperes for frame sizes over 2,000 amperes. The 30 milliseconds time constant is obtained by dividing the system inductance by the system resistance. A 1980 study by the Agency on time constants and a 1984 study by the U.S. Bureau of Mines in the same technical area indicate that time constants of trolley systems can approach 30 milliseconds. The interrupting current ratings are based on the frame size and have been derived from nationally recognized standards for trolley circuits.

Paragraph (d) would require that a-c circuit breakers installed at radial stub-feed rectifiers have an interrupting current rating not less than 20 times the continuous full load d-c ratings of the rectifiers. The factor of 20 is based on rectifiers having short-circuit current capacity levels less than 25 times the full-load current of the rectifiers. Since the conversion factor between a-c and the d-c is a value of 0.8, an adequate safety factor would be provided in the proposal by requiring the factor of 20 (25 times 0.8=20). This safety factor would provide trolley circuits with adequate protection against short circuits that have been related to numerous mine fires.

Paragraph (e) would require that d-c circuit breakers installed at the rectifiers have continuous current ratings not less than 120 percent of the continuous full-load current ratings of the rectifiers. Paragraph (f) would require that a-c breakers installed in radial stub-feed rectifiers have continuous current ratings of not less than the continuous full load d-c ratings of the rectifiers. These continuous full-load current values take into account the extreme overload conditions (up to 150 percent for 2 hours) that can occur on trolley systems. It is necessary that circuit breakers be able to withstand overloads over time without damage to components of the system. The specified values would provide a minimum factor of safety to prevent this damage.

Paragraph (g) would require that each d-c circuit breaker be equipped with an instantaneous overcurrent relay that causes the circuit breaker to deenergize the circuit with no intentional time delay. This would prevent overcurrents from extending beyond the first circuit breaker from the load while still allowing time delays on other breakers to prevent nuisance tripping. Thus, the shock and fire hazard would be minimized without tripping the entire circuit.

Paragraph (h) is new, and would require that d-c electronic overcurrent relays installed one year after the effective date of this proposed rule be fail-safe and bi-directional. Trolley systems are continuously subjected to overvoltage conditions from the operation of haulage equipment, and these overvoltage conditions are a major factor in the failure of solid-state circuit protection devices used on circuit breakers. The proposed standard would minimize the risk of fire under these circumstances.

Paragraphs (i) and (j) are new, and would require that automatically reclosing circuit breakers be equipped with load measuring devices. Paragraph (i) would require that the devices prevent the circuit breakers from reclosing whenever the prospective load current exceeds 300 amperes. Paragraph (j) would require that automatically reclosing circuit breakers installed in parallel-connected rectifier trolley systems be equipped with voltage differential devices that prevent the circuit breakers from reclosing whenever the voltage across the circuit breakers is between 15 and 85 percent of the nominal system voltage. These proposed requirements are based on MSHA's experience regarding automatic reclosing devices. When these devices are not used, effective short-circuit protection cannot be ensured, due to the possibility of the circuit breaker reclosing when short circuits or extreme overloads are present on trolley circuits.

Section 75.1007 Handling

This section of the proposal is derived in part from existing §§ 75.509 and 75.510. Existing § 75.509 requires that all power circuits and electric equipment be deenergized before work is performed, except when necessary for trouble shooting or testing. Section 75.510 requires that energized trolley wires be repaired only by a person trained to perform electrical work and to maintain electric equipment and such person be required to wear approved and tested insulated shoes and wireman's gloves. The proposal would clarify the existing exception, and would allow miners to perform certain tasks on energized trolley circuits provided safety precautions are taken.

Paragraph (a) would require the deenergization of trolley circuits before any work is done, except in specified circumstances. Deenergization would not be required when reinstalling wires in hangers or installing or removing temporary guarding designed to minimize shock hazards. Persons doing this work would be required to wear rubber boots and rubber insulating gloves with protective coverings designed to prevent physical damage to the insulating material.

Trolley wires contain dangerous amounts of voltage and also present special hazards because they are bare. Insulated boots would protect the miners from shock caused by contact with the trolley circuit and a conducting medium such as the track or a puddle of water. Because of the damp nature of some coal mines, rubber boots would be an important safety measure for protection against shock and electrocution from trolley circuits. Similarly, rated gloves would protect a miner from potential shock and flash burn hazards while working on energized trolley circuits.

Paragraph (b) is new, and would require that rubber insulating gloves used for handling trolley wires be rated for at least 1000 volts. Such gloves are rated in accordance with the American Society for Testing and Materials (ASTM). This is the lowest rated glove available under ASTM standards, and would provide the necessary protection against electric shock hazards.

Paragraphs (c) and (d) are also new, and would require the examination of rubber boots, rubber insulating gloves and protective coverings before each use for visible signs of damage or defects and their removal from use should damage or defects be found. Gloves can be easily examined before each use. An examination commonly used is to fill the gloves with air and observe if there is any leakage. If any leakage is found, the gloves would be required to be removed from service. A small hole in either the gloves or the boots is enough of an insulation failure to allow electrical current to flow through and cause injury to the wearer.

Section 75.1008 Track Bonding

This section is derived from existing § 75.514, which requires that all electrical connections be mechanically and electrically efficient. Since mine track is used as an electrical conductor in conjunction with trolley wires and trolley feeder wires, the proposal would require that the track be mechanically and electrically efficient by setting specific bonding requirements at various locations on the track. This would ensure adequate electrical conductivity of return circuits. These proposed requirements are based on accepted industry practices and MSHA's experience with trolley systems.

Paragraph (a) would require that track used to transport coal from a junction of tracks of two or more coal-producing sections have both rails welded or bonded at every joint and have the rails cross-bonded at intervals of 200 feet or less. Additionally, it would require that

track used to transport coal from a single coal-producing section or used only to transport miners and supplies have one rail welded or bonded at every joint and have the rails cross-bonded at intervals of 200 feet or less. Under the standard, an authorized representative of the Secretary may require both rails to be welded or bonded at every joint when necessary to provide adequate electrical conductivity in the trolley system.

Track switches would be required to have each switch approach cross-bonded within 20 feet of the switch and the straight and curved track sections bonded together within five feet of the switch frog. Compliance with these proposed requirements would ensure miner safety by preventing loose or bad connections of track that could cause the connections to overheat during use.

Paragraph (b) would require that metal ties, when used as cross bonds, be welded to both rails. Agency experience indicates that both rails need to be welded to the metal ties to assure an electrically efficient connection. Paragraph (c) would require that track not be used before it is bonded except by equipment necessary to install the bonds. Track that is used before it is bonded can cause arcing, which can result in a fire hazard or shock hazard to persons contacting rail-mounted equipment.

Paragraph (d) would require that return-feeder wires connected in parallel with track rails be bonded to the track rails at intervals not to exceed 1,000 feet. This requirement would ensure electrically efficient connections between the track and the return-feeder wire to prevent arcing faults on the return-feeder wires.

Section 75.1009 Examinations, Tests and Maintenance of Trolley Systems

This section of the proposal is derived in part from existing §§ 75.512, and 75.1001–1, which would be modified under the proposal. The recordkeeping requirements in the existing standards would be replaced with a combination of certification and recordkeeping requirements.

Paragraph (a) would incorporate essentially the same requirements as existing § 75.5l2. It would require that trolley systems be tested, examined and maintained by a qualified electrician. This would ensure that work on trolley system is performed by persons who are knowledgeable of electrical hazards and skilled in preventing them.

Paragraph (b) is new, and would require that trolley circuits be tested at least once every 180 days to determine the available short circuit currents by passing measured amounts of currents through the circuits at the extreme ends of the circuits protected by each circuit breaker and measuring voltage drops at each of these locations. The test procedures are designed to ensure that protection is available against the extreme fire hazards caused by short circuits on trolley systems. Short-circuit protective devices are passive, and do not operate to deenergize the circuit until an extreme overload is present on the circuit. With this test procedure, it can be determined if the device will operate as required before a short circuit occurs on the system.

Paragraph (c) is new, and would require that the available short-circuit currents be calculated from voltage-drop tests and used to determine maximum allowable circuit breaker settings. This standard would conform to industry standards and the Agency's experience in evaluating trolley systems, and would assure that available short-circuit currents are properly determined.

Paragraph (d) would require that circuit breakers and their components be examined for physical damage once every 180 days. Electric equipment used in underground coal mines is subjected to heavy, continual use, which often results in wear and breakdown. The mine atmosphere is also particularly harsh for electric equipment. Unless it is regularly examined, potential safety problems could go undetected and could present hazards to persons working with or around the equipment.

The proposal would also require that short-circuit devices be tested and calibrated to values no more than the indicated values, and no less than 85 percent of the indicated values. The proposed values would assure that short-circuit devices detect all short circuits. Therefore, trolley systems would not become over-extended and the potential of fire hazards due to arcing faults would be reduced.

Current-actuated short-circuit devices would have to be tested and calibrated under the proposal by passing the amounts of current indicated by the settings through the devices to cause actuation. A new aspect of this proposal would allow current-actuated short-circuit devices to be tested and calibrated with external calibration sources when the devices are equipped with calibration coils. This option would allow for testing while the circuit is energized. However, compliance with the standard would assure that devices are fully operable before a hazardous fault has occurred on the system.

Electronic short-circuit devices would be required to be tested and calibrated by passing the amounts of current indicated by the settings through the devices to cause actuation. A new provision of the proposal would allow calibration voltages to be applied to sensor leads to cause actuation with the sensor leads disconnected from the shunts. Test and calibration values would be determined by the indicated settings. MSHA's experience indicates that this option would constitute an effective and reliable method for testing and calibrating electronic short-circuit devices for trolley systems.

A new provision in the proposed standard would require that load-measuring devices and load-indicating circuits be tested and calibrated by simulating load currents of 350 amperes or less through the circuit breaker. This provision reflects Agency experience and represents accepted industry practice regarding what reclosing load currents would be tolerable for underground coal mine trolley systems.

Voltage-differential devices would now be required to be tested and calibrated to prevent reclosure by applying voltages not less than 15 percent of the nominal system voltages across the circuit breaker terminals. This provision is based on evaluation of trolley systems and the safety practices needed to ensure that voltage-differential devices function properly to prevent premature breaker reclosure. Arcing faults on the circuit and the resulting fire hazard would be prevented by compliance with the standard.

Additionally, a new provision would require that loadmeasuring devices, voltage-differential relays, and reclosing selective relays, be tested and calibrated at least every 180 days to values within plus or minus (±)15 percent of the indicated values. This provision would conform to accepted industry practice and the Agency's experience in evaluating circuit breakers for trolley systems.

Paragraph (e) is new, and would require that when examinations, tests, or calibrations of trolley systems reveal a potential fire or shock hazard, the affected part of the trolley system either be removed from service or repaired. Requiring the removal or repair of potentially hazardous electric equipment or circuits would ensure that persons are not exposed to potentially hazardous conditions.

Paragraph (f) is new, and would require that trolley systems be aligned and maintained to provide for smooth tracking of trolley connectors on trolley wires. This would prohibit the presence of kinks, oversize splices, irregular surfaces, and other physical defects that cause trolley poles to dislodge. At least

two fatalities can be attributed to instances where poles were dislodged and hit a person riding in a track-mounted vehicle. Compliance with the proposed standard would reduce the likelihood of such occurrences by requiring a uniform trolley installation that should perform as designed and prevent the trolley pole from becoming dislodged.

Paragraph (g) of the proposal would require that upon the completion of examinations and tests required by this section, the person who makes the examinations and tests certify by signature and date that they have been conducted. The proposal would differ from the existing rule in that it would require a record to be made of unsafe conditions found and corrective actions taken. Where such conditions are not found, the proposal would require only the certification that the examination or test was conducted. This proposed requirement would eliminate a recordkeeping requirement in the existing rules.

Paragraph (h) would require that certifications and records be kept for at least one year and be made available at the mine for inspection by authorized representatives of the Secretary and representatives of the miners. The proposal provides essentially the same access to documents as the existing requirements. However, the proposal would also allow document access to representatives of miners. This provision is consistent with other MSHA standards that address certification and recordkeeping requirements.

Section 75.1010 Movement and Transportation of Metallic Mining Supplies and Off-Track Mining Equipment in Entries Containing Trolley Wires or Trolley Feeder Wires

This section is derived in part from existing §§ 75.1003–1 and 75.1003–2, which require that adequate precautions be taken to ensure that equipment being moved along haulageways will not come into contact with trolley wires and trolley feeder wires. The procedures necessary to meet these requirements are also specified in the present rules. The proposal would retain and reorganize the standards to clarify several alternative approaches.

Paragraph (a) would contain new requirements that would call for deenergization of trolley wires and trolley feeder wires for at least 200 feet on each side of metallic mining supplies or off-track mining equipment when they are either moved or transported under their own power or by other non-trolley powered equipment. This would assure that such supplies or equipment will come into contact with energized wires. Metallic supplies or equipment contacting energized wires could become energized, presenting a shock hazard for persons handling them. Arcing faults could also occur, leading to the possibility of a mine fire.

Paragraph (b) would address safety procedures to be taken when metallic mining supplies or off-track mining equipment are moved or transported by trolley-powered equipment. It would require that the supplies or equipment being transported not extend beyond the specified confines of the transporting car or the car directly ahead or behind the transporting car.

As an alternative, the cargo could be cleaned to remove combustible materials, grounded by means of a 4/0 AWG or larger copper conductor that is connected to the mine track or to the metallic frame of the track-haulage conveyance, placed and secured to prevent accidental movement while being transported, covered on the top and on the trolley wire side with conveyor belting or other equivalent material that is flame-resistant in accordance with § 18.65, examined by a qualified electrician beforehand, and moved or transported under the direct and immediate supervision of a certified person. Requiring these precautions would recognize that it is not always possible to transport supplies or equipment within the confines of the track haulage car. It would take the circumstances of the mine into account while ensuring the safety of the move.

Paragraph (c) of the proposal would require that when supplies or off-track equipment are moved in accordance with paragraph (b)(3) of the rule, and the maximum height of the supplies or equipment while being transported is within 12 inches of the minimum height of the trolley wire at any location along the move, additional precautions would be required. A qualified electrician would be required to be stationed at the supply rectifier, prepared to deenergize the circuit in case of an emergency.

The qualified electrician would be required to be in direct two-way communications with the certified person supervising the move and a responsible person on the surface. Trolley phones used for two-way communications would have to be battery powered unless a backup communication system is available. Finally, persons who are not directly involved in the move would be required to clear a specified area. This provision recognizes that in situations where the cargo will be coming into very close proximity to the trolley wires, extraordinary measures must be taken to assure that the move is conducted in a safe manner.

Derivation Table

The following derivation table lists the number of each proposed standard and the number of the existing standard from which it is derived.

Proposed section	Existing section
75.153(a)	75.153(a).
75.153(a)(1)	75.153(a) (1) and (3).
75.153(a)(2)	75.153(a)(3).
75.153(b)	75.153(g).
75.153(c)	75.153 (f) and (f).
75.153(d)	New.
75.154(a)	75.153(c).
75.154(b)	75.153(b).
75.154(b)(1)	75.153(b) (1) and (2).
75.154(b)(2)	75.153(b)(3).
75.154(b)(3)	75.153(b)(4).
75.154(b)(4)	75.153(b)(5).
75.154(c)	New.
75.154(c)(1)	75.153(b)(3).
75.154(c)(2)	75.153(b)(5).
75.154(d)	New.
75.154(e)	75.153(d).
75.154(f)	75.153(e).
75.155(a)(1)	75.153(a)(1).
75.155(a) (2) and (3)	New.
75.155 (b) and (c)	New.
75.156(a) (1) and (2)	New.
75.156(b)	75.160.
75.156 (c) and (d)	75.153(g).
75.156(d)	New.
75.156(f)	75.160.
75.157	New.
75.158	75.155.
75.159	75.153(g) and 75.159.
75.500	New.
75.501(a)(1)	75.500 (a) through (d), 75.500–1, 75.501, 75.501–2, 75.501–2(a), 75.501–2(b), 75.504, and 75.505.
75.501(a)(2)	75.1002–1(a).
75.501(a)(3)	75.507 and 75.507–1(a).
75.501 (b) and (c)	New.
75.502	75.1002.
75.503(a)	75.503, 75.504, 75.505, 75.506(a), 75.506(b), 75.506(c), 75.506(d), 75.506–1(a), and 75.506–1(b).
75.503(b)	75.504, 75.505, 75.506–1(a), and 75.506–1(b).
75.503 (c) and (d)	New.
75.504	75.524.
75.505(a)	75.511 and 75.512.
75.505(b)	75.511.
75.505(c)	New.
75.505(d)	75.511.
75.506(a)	New.
75.506(b)	75.509 and 75.705.
75.506(b) (1) and (2)	75.511.
75.506(b)(3)	New.
75.506(b)(4)	75.509.
75.506(c)	75.705–1 and 75.705–1 (a) and (b).
75.506(d)	75.511.
75.506(e)	75.511 and 75.1725(c).
75.506(f)	New.
75.507(a)	75.509 and 75.705–1(a).
75.507(b)	75.511 and 75.1720(c).
75.507(c)	75.511 and 75.705–1(a).
75.507(d)	New.
75.508(a)	New.
75.508(b)	75.512, 75.703–3(d)(11), 75.800–3(a), and 75.900–3.

Proposed section	Existing section
75.508(c)	75.512-2, 75.703-3(d)(11), and 75.900-3.
75.508(d)	75.800-3 (a) and (b).
75.508(d)(1)	75.803.
75.508(d)(2)	New.
75.508(e)	75.512, 75.800-3(a).
75.508(f)	New.
75.508(g)	75.512, 75.800-3(c).
75.508(h)	75.512, 75.800-4, and 75.900-4.
75.508(i)	75.512, 75.800-4, and 75.900.
75.508(j)	New.
75.509 (a) and (b)	75.520.
75.509(c)	New.
75.509 (d) and (e)	75.520.
75.509(f)	75.1403-10(m).
75.509(g)	New.
75.510(a)	75.519, 75.519-1, and 75.802(c).
75.510(b)	New.
75.510(c)	75.601, 75.808, and 75.903.
75.510(d)	75.601, 75.808, and 75.903.
75.510(e)	75.511.
75.510(f)	75.601 and 75.809.
75.510(g)	75.520.
75.510 (h) and (i)	New.
75.510(j)	75.705-9.
75.510(k)	75.511 and 75.705-6.
75.510(l)	New.
75.510 (m) and (n)	75.705-7.
75.510(o)	75.705-8.
75.511(a)(1)	75.805.
75.511(a)(2)	75.805 and 75.902.
75.511(a)(3)	75.805 and 75.902.
75.511(a)(4)	New.
75.511(a)(5)	75.805 and 75.902.
75.511(a)(6)	75.803-1 and 75.902-1.
75.511(a)(7)	75.607.
75.511(b) (1) and (2)	New.
75.512(a)	75.514.
75.512(b)	75.607.
75.513 (a) through (e)	75.521.
75.514(a)	75.522-1(a).
75.514(b)	75.522-1 (a) and (b).
75.514 (c) and (d)	75.522-1(a).
75.514(e)	New.
75.514(f)	75.522.
75.515(a)	75.517, 75.517-1, 75.804(a), 75.812, 75.906, and 75.907.
75.515(b)	New.
75.516	75.516-2 (a) and (b), 75.517, and 75.606.
75.517(a)	75.516 and 75.516-1.
75.517(b)	New.
75.517(c)	75.516-2(c) and 75.807.
75.517(d)	75.516-2(c).
75.518	75.516-1.
75.519(a)	75.511.
75.519(b)	New.
75.519(c)	75.604(c).
75.519(d)	75.604(b), 75.604(c), 75.810, and 75.906.
75.519(e)	75.604(b).
75.519 (f) through (h)	New.
75.519(i) (1) and (2)	75.514, 75.604(a), and 75.810.
75.519(i)(3)	75.514, 75.604(b), 75.804(b), and 75.810.
75.519(i)(4)	75.514, 75.810, and 75.906.
75.519(i)(5)	75.804(b).
75.519(i)(6)	75.804(b), 75.810, and 75.906.
75.519(i)(7)	75.517, 75.604(c), 75.804(b), and 75.810.
75.520 (a) and (b)	75.515.
75.520(c)	New.
75.520(d)	75.515 and 75.605.
75.520(e)	75.605.
75.521	75.517 and 75.603.
75.522(a)	75.513 and 75.513-1.
75.522 (b) through (d)	75.513-1.
75.523 (a) through (c)	75.518 and 75.518-1.
75.523 (d) through (h)	75.518-1.
75.523(i)	75.518-2.
75.523 (j) and (k)	75.518-1.
75.524(a)	75.518-1.
75.524(b)	75.518 and 75.518-1.
75.524(c)	75.518 and 75.518-1.
75.524(d)	75.518 and 75.518-1.
75.524(e)	75.518-1.
75.524(f)	New.
75.524(g)	75.518-1.
75.524(h)	75.518 and 75.518-1.
75.524 (i) and (j)	75.518-1.
75.525	75.601, 75.809, and 75.904.
75.526	New.
75.527(a)	75.508 and 75.508-1.
75.527(b)	75.508-2.
75.528	New.
75.529	75.523, 75.523-1, and 75.523-2.
75.529(a)	75.523 and 75.523-1.
75.529(a) (1) through (3)	75.523-2(b).
75.529(a)(4)	75.523-2(c).
75.529(a)(5)	New.
75.529(b)	75.523-1(b).
75.529(c)	75.523-1(c).
75.530 (a) through (c)	New.
75.531	75.706.
75.600	New.
75.601(a)	75.600 and 75.600-1.
75.601(b)	New.
75.601(c) (1) and (2)	New.
75.601(d)	75.701-1, 75.703-3(a), 75.906, and 75.907.
75.601(d)(1)	New.
75.601(d)(2)	75.703-3(d).
75.601 (e) through (g)	New.
75.601 (h) and (i)	75.907.
75.601 (j) and (k)	New.
75.602(a)	75.601 and 75.900.
75.602(b)	75.601.
75.602(c)(1)	New.
75.602(c)(2)	75.601-1 and 75.900-2 (d).
75.602(c)(3)	75.601-1.
75.602(d)	75.601-1 and 75.900-2 (d).
75.602(e)(1)	75.900.
75.602(e)(2)	New.
75.602(e)(3)	75.900.
75.602(f)	75.900-2(c).
75.602(g)	75.518 and 75.518-1.
75.602 (h) through (k)	New.
75.602(l)	75.512.
75.602(m) (1) and (2)	75.900-2(a).
75.602(n)	New.
75.603(a)(1)	New.
75.603(a)(2)	75.601, 75.601-3, and 75.703-3(d)(4).
75.603(a)(3)	75.601-1 and 75.703-3(d)(5).
75.603(b)	75.601-1.
75.603(c)	75.601-2.
75.603(d)	75.601.
75.603(e)	75.601 and 75.900.
75.603 (f) through (h)	New.
75.603(g)	New.
75.603(h)	New.
75.604	75.602.
75.700	New.
75.701	75.901(a).
75.701(a)	75.701-2.
75.701(b)	75.901(a).
75.701 (c) through (e)	New.
75.702	75.901(a).
75.703	75.802(a).
75.703 (a) through (d)	75.802(b).
75.704(a)(1)	75.802(a).
75.704(a)(2)	New.
75.704(b)	75.701-1(a), 75.701-1(b), 75.701-1(c), and 75.701-1(d).
75.705(a)	75.701-3(a).
75.705(b)	75.701-3(b) and 75.701-3(d).
75.705 (c) and (d)	75.703-2(b).
75.705 (e) and (f)	New.
75.705(f)	New.
75.705(g)	75.703-2(b).
75.706(a)	75.701-3(a).
75.706(b)	75.703-2(b).
75.706(c)	75.701-1(d) and 75.703-2(a).
75.707(a)(1)	75.901(a) (New for direct-current).
75.707(a)(2)	75.801.
75.707(b)	75.801 and 75.901(a) (New for direct-current).
75.707(c)	75.801 and 75.901(a) (New for direct-current).
75.707(d)	75.802(a) and 75.901(a) (New for direct-current).
75.708	75.806 and 75.905.
75.709(a)	New.
75.709(b)	75.700-1 (a) through (c) and 75.701-1 (a) through (d).
75.709 (c) and (d)	New.
75.710(a)(1)	75.700-1, 75.701, 75.802(a), and 75.901(a).
75.710(a)(2)	75.701 and 75.802(a).
75.710(a)(3)	75.901(a).
75.710(a)(4)	New.
75.710(a)(5)	75.811.
75.710(b)	New.
75.710(c)	75.701-1 and 75.901(a).
75.711(a)	75.902 and 75.902-2.
75.711(a)(1)	New.
75.711(a)(2)	75.902.
75.711(b)	75.803.
75.711(c)(1)	75.704.
75.711(c)(1)	75.704-1 and 75.803.
75.711(c) (2) and (3)	75.803.
75.711(d)(1)	75.803, 75.902, and 75.902-2.
75.711(d)(2)	75.803 and 75.902.
75.711(e) (1) and (2)	75.803 and 75.902.
75.711(f)(1)	75.902-1 and part 18.
75.711(f)(2)	75.902-1.
75.711(g)	75.902-4.
75.712(a)(1)	75.701-3 (a) through (c) and 75.703-3 (a) through (c).
75.712(a) (2) through (4)	New.
75.712(b)	75.701-3(c) and 75.703-3(d).
75.712(c)	75.703 and 75.703-1.
75.713(a)	75.703-3(d)(1) and 75.703-3(d)(3).
75.713(b)	75.703-3(d)(7).
75.713(c)	75.703-3(d)(6).
75.713(d)	75.703-3(d)(8).
75.713(e)	75.703-3(d)(2), 75.703-3(d)(3), and 75.703-3(d)(10).
75.713(f)	75.703-3(d)(3).
75.714 (a) and (b)	New.
75.714(b) (1) and (2)	New.
75.714(c) (1) and (2)	75.701-4(a).
75.714 (d) through (g)	New.
75.714(h)	75.701-5.
75.714 (i) through (k)	New.
75.800	New.
75.801	New.

Proposed section	Existing section
75.802 (a) (1) through (3)	75.800.
75.802(b)	75.800–1.
75.802(c)	75.518–1.
75.802(d)	75.800–2(c).
75.802(e)(1)	75.518–1.
75.802(e)(2)	New.
75.802 (f) through (h)	New.
75.802(i) (1) and (2)	75.800–2(a).
75.802(j)	New.
75.803 (a) and (b)	New.
75.803(c)	75.803–1.
75.803 (d) and (e)	New.
75.804 (a) through (c)	75.807.
75.804(d)	75.812.
75.804 (e) and (f)	New.
75.804 (g) and (h)	75.804(a).
75.804(i)	75.705–11.
75.804(j)	75.804(a).
75.804(k) (1) through (3)	New.
75.805	75.812.
75.806	New.
75.807 (a) and (b)	New.
75.808(a)	75.518–1 and 75.800.
75.808(b)	75.518–1.
75.808(c) (1) and (2)	New.
75.808(d)	New.
75.808(e) (1) and (2)	New.
75.808 (f) through (j)	New.
75.808(k) (1) and (2)	75.800–2(a).
75.808(l)	New.
75.809(a)	75.808.
75.809(b)	New.
75.810(a)	75.512, 75.800–3(a), and 75.800–3(c).
75.810(b) (1) through (4)	New.
75.810(c)	75.512 and 75.512–2.
75.810 (d)	75.800–3 (a) and (b).
75.810(e)	75.512.
75.810 (f) and (g)	75.512 and 75.800–4.
75.811(a)	75.804(b).
75.811(b)	75.804(a).
75.811 (c) and (d)	New.
75.811(e)	75.600–1.
75.811(f)	New.
75.811 (g) and (h)	75.804(a).
75.812	New.
75.813(a)(1)	75.807.
75.813(a)(2)	New.
75.813(b)	75.807.
75.814(a)	New.
75.814(b) (1) and (2)	New.
75.814 (c) and (d)	New.
75.815(a)(1)	75.509 and 75.705.
75.815(a) (2) and (3)	75.511.
75.815(b)(1)	75.509 and 75.705.
75.815(b)(2)	75.705.
75.815(b) (3) and (4)	75.511.
75.815 (c) and (d)	New.
75.815(e)	75.511.
75.1000	New.
75.1001(a)	75.1003–1.
75.1001(b)	75.516.
75.1001(c)	75.1003.
75.1001(d)	75.1003–1.
75.1001 (e) through (h)	New.
75.1002(a)	75.516.
75.1002 (b) and (c)	New.
75.1003(a)(1)	75.1003(a).
75.1003(a)(2)	75.1003(c).
75.1003(a)(3)	75.1003(b).
75.1003(a) (4) through (6).	75.1003(a).
75.1003(b)	75.509 and 75.510.
75.1004(a) (1) and (2)	New.
75.1004(a) (3) and (4)	75.1000.
75.1004(b)	New.
75.1005 (a) through (c)	75.518–1, 75.1001, and 75.1001–1(a).
75.1005 (d) and (e)	New.
75.1006 (a) through (f)	75.518–1.
75.1006(g)	75.1001–1(a).
75.1006 (h) through (j)	New.
75.1007(a)	75.509 and 75.510.
75.1007(a)(1)	75.509 and 75.510.
75.1007(a)(2)	New.
75.1007(b)	75.510
75.1007 (c) and (d)	New.
75.1008(a) (1) and (2)	75.514.
75.1008 (b) and (c)	New.
75.1008(d)	75.514.
75.1009(a)	75.512.
75.1009(b)	New.
75.1009(c)	New.
75.1009(d)	75.512 and 75.1001–1(b).
75.1009 (e) and (f)	New.
75.1009 (g) and (h)	75.1001–1(c).
75.1010(a)	75.1003–1 and 2.
75.1010(b)(1)	75.1003–1 and 75.1003–2 (a) and (g).
75.1010(b)(2)	New.
75.1010(b)(3)	75.1003–2 (a)(1), (c), (d), and (e).
75.1010(c)(1)	75.1003–2 (f).
75.1010(c)(2)	75.1003–2(f) (3) and (4).
75.1010(c)(3)	75.1003–2(f)(5).

Distribution Table

The following distribution table lists the section numbers of the existing standards and the section numbers of the proposed standards which contain revised provisions derived from the corresponding existing sections.

Existing section	Proposed section
75.153(a)	75.153(a).
75.153(a)(1)	75.153(a)(1) and 75.155(a)(1).
75.153(a)(2)	Remove.
75.153(a)(3)	75.153(a)(1) and 75.153(a)(2).
75.153(b)	75.154(b).
75.153(b) (1) and (2)	75.154(b)(1).
75.153(b)(3)	75.154(b)(2) and 75.154(c)(1).
75.153(b)(4)	75.154(b)(3).
75.153(b)(5)	75.154(b)(4) and 75.154(c)(2).
75.153(c)	75.154(a), 75.154(a)(1), and 75.154(a)(2).
75.153(d)	75.154(e).
75.153(e)	75.154(f).
75.153(f)	75.153(c).
75.153(g)	75.153(c), 75.156(c), and 75.159.
75.154	Remove.
75.155	75.158.
75.159	75.159.
75.160	75.156(b) and 75.156(e).
75.500 (a) through (d)	75.501(a)(1).
75.500–1	75.501(a)(1).
75.501	75.501(a)(1).
75.501–1	Remove.
75.501–2 and 75.501–2 (a) and (b).	75.501(a)(1).
75.501–3(a) and 75.501–3(a)(1)–(6).	Remove.
75.501–3(b) and 75.501–3(b)(1)–(3).	Remove.
75.501–3 (c) and (d)	Remove.
75.502	Remove.
75.503	75.503(a).
75.503–1	Remove.
75.504	75.501(a)(1), 75.503(a), and 75.503(b).
75.505	75.501(a)(1), 75.503(a), and 75.503(b).
75.506 (a) through (d)	75.503(a).
75.506–1 (a) and (b)	75.503(a) and 75.503(b).
75.506–1(c)	Remove.
75.507 and 75.507–1(a)	75.501(a)(3).
75.507–1(b) and (c)	Remove.
75.508	75.527(75.516.
75.516–2(c)	75.517 (c) and (d).
75.516–2(d)	Remove.
75.517	75.515(a), 75.516, 75.519(i)(7), and 75.521.
75.517–1	75.515(a).
75.517–2 (a) through (d)	Remove.
75.518	75.523(a), 75.523(b), 75.523(c), 75.524(b), 75.524(c), 75.524(d), 75.523((h), and 75.602(g).
75.518–1	75.523(a), 75.523 (b) through (h), 75.523 (j) and (k), 75.524 (a). through (e), 75.524 (g) through (j), 75.602(g), 75.802(c), 75.802(e)(1), 75.808(a), 75.808(b), 75.1005 (a) through (c), and 75.1006 (a) through (f).
75.518–2	75.523(i).
75.519 and 75.519–1	75.510 (a).
75.520	75.509 (a), (b), (d), 75.509(e), and 75.510(g).
75.521	75.513 (a) through (f).
75.522	Remove.
75.522–1(a)	75.514(a) through (d).
75.522–1(b)	75.514(b).
75.523	75.529 and 75.529(a).
75.523–1	75.529 and 75.529(a).
75.523–1(b)	75.529(b).
75.523–1(c)	75.529(c).
75.523–2	75.529.
75.523–2(b)	75.529(a) (1) through (3).
75.523–2(c)	75.529(a)(4).
75.523–3	Remove.
75.524	75.504.
Appendix A	Remove.
75.600	75.601(a).
75.600–1	75.601(a) and 75.811(e).
75.601	75.510(c), 75.510(d), 75.510(f), 75.525, 75.602(a), 75.602(b), 75.603(a)(2), 75.603(d), and 75.603(e).
75.601–1	75.602(c)(2), 75.602(c)(3), 75.602(d), 75.603(a)(3), and 75.603(b).
75.601–2	75.603(c).
75.601–3	75.603(a)(2).
75.602	75.604.
75.603	75.521.
75.604(a)	75.519(i) (1) and (2).
75.604(b)	75.519(d), 75.519(e), and 75.519(i)(3).
75.604(c)	75.519(c), 75.519(d), and 75.519(i)(7).
75.605	75.520 (d) and (e).
75.606	75.516.
75.607	75.511(a)(7) and 75.512(b).
75.700	75.710(a)(1), 75.710(b) and 75.712(a)(1).
75.700–1	75.710(a)(1).
75.700–1 (a) through (c)	75.709(b).
75.700–1(d)	Remove.
75.701	75.710(a) (1) and (2).
75.701–1	75.601(d) and 75.710(c)

Existing section	Proposed section
75.701-1 (a) and (b)	75.506(c), 75.704(b), and 75.709(b).
75.701-1(c)	75.704(b) and 75.709(b).
75.701-1(d)	75.704(b), 75.706(c), and 75.709(b).
75.701-1(e)	Remove.
75.701-2	75.701(a).
75.701-3(a)	75.705(a), 75.706(a), and 75.712(a)(1).
75.701-3(b)	75.705(b) and 75.712(a)(1).
75.701-3(c)	75.712(a)(1) and 75.712(b).
75.701-3(d)	75.705(b).
75.701-4(a)	75.714(c)(1).
75.701-4(b)	75.714(c)(2).
75.701-5	75.714(h).
75.702 and 75.702-1	Remove.
75.703 and 75.703-1	75.712(c).
75.703-2(a)	75.706(c)
75.703-2(b)	75.705(c), 75.705(d), 75.705(g), and 75.706(b).
75.703-3(a)	75.601(d) and 75.712(a)(1).
75.703-3 (b) and (c)	75.712(a)(1).
75.703-3(d) (1)	75.713(a).
75.703-3(d)	75.601(d)(2) and 75.712(b).
75.703-3(d)(1)	75.713(a).
75.703-3(d)(2)	75.713(e).
75.703-3(d)(3)	75.713(a), 75.713(e), and 75.713(f).
75.703-3(d)(4)	75.603(a)(2).
75.703-3(d)(5)	75.603(a)(3).
75.703-3(d)(6)	75.713(c).
75.703-3(d)(7)	75.713(b).
75.703-3(d)(8)	75.713(d).
75.703-3(d)(9)	Remove.
75.703-3(d)(10)	75.713(e).
75.703-3(d)(11)	75.508 (b) and (c).
75.703-4	Remove.
75.704 and 75.704-1	75.711(c)(1).
75.705	75.506(b), 75.815(a)(1), 75.815(b)(1), and 75.815(b)(2).
75.705-1	75.506(c).
75.705-1(a)	75.507 (a) and (c).
75.705-1 (b)	75.506(c).
75.705-1 (c) and (d)	Remove.
75.705-2 (a) and (b)	Remove.
75.705-3 through -5	Remove.
75.705-6	75.510 (k).
75.705-7	75.510 (m) and (n).
75.705-8	75.510(o).
75.705-9	75.510(j).
75.705-10	Remove.
75.705-11	75.804(i).
75.706	75.531.
75.800	75.802(a)(1), 75.802(a)(2), 75.802(a)(3), and 75.808(a).
75.800-1	75.802(b).
75.800-2(a)	75.802(i) (1) and (2), and 75.808(k) (1) and (2).
75.800-2(b)	Remove.
75.800-2(c)	75.802(d).
75.800-3(a)	75.508(b), 75.508(d), 75.508(e), 75.810(a), and 75.810(d).
75.800-3(b)	75.508(d) and 75.810(d).
75.800-3(c)	75.508(g) and 75.810(a).
75.800-4	75.508 (h) and (i) and 75.810 (f) and (g).
75.801	75.707(a)(2), 75.707(b), and 75.707(c).
75.802(a)	75.703, 75.704(a)(1), 75.707(d), 75.710 (a)(1) and 75.710 (a)(2).
75.802(b)	75.703(a), 75.703(b), and 75.703 (c) and (d).
75.802(c)	75.510(a).
75.803	75.508(d)(1), 75.711(b), 75.711(c) (1) through (3), 75.711(d) (1) and (2), and 75.711(e) (1) and (2).
75.803-1	75.511(a)(6) and 75.803(c).
75.803-2	Remove.
75.804(a)	75.515(a), 75.804(g) through (j), 75.811(b), and 75.811 (g) and (h).
75.804(b)	75.519(i) (3), (5), (6), and (7), and 75.811(a).
75.805	75.511(a)(1), 75.511(a)(2), 75.511(a)(3), and 75.511(a)(5).
75.806	75.708.
75.807	75.517(c), 75.804(a), 75.804(b), 75.804(c), 75.813(a)(1), and 75.813(b).
75.808	75.510 (c) and (d), and 75.809(a).
75.809	75.510(f) and 75.525.
75.810	75.519(d), 75.519(i) (1), (2), (3), (4), (6), and (7).
75.811	75.710(a)(5).
75.812	75.515(a), 75.804(d), and 75.805.
75.812-1 and -2	Remove.
75.900	75.508(i), 75.602(a), 75.602(e)(1), 75.602(e)(3), and 75.603(e).
75.900-1	Remove.
75.900-2(a)	75.602(m)(1) and (2).
75.900-2(b)	Remove.
75.900-2(c)	75.602(f).
75.900-2(d)	75.602(c)(2), 75.602(d).
75.900-3	75.508 (b) and (c).
75.900-4	75.508(h).
75.901(a)	75.701, 75.701(b), 75.702, 75.707(a)(1), 75.707(b), 75.707(c), 75.707(d), 75.710 (a)(1), 75.710(a)(3), and 75.710(c).
75.902	75.511(a) (2), (3), and (5), 75.711(a), 75.711(a)(2), 75.711(d)(1), 75.711(d)(2), and 75.711(e) (1) and (2).
75.902-1	75.511(a)(6) and 75.711(f) (1) and (2).
75.902-2	75.711(a) and 75.711(d)(1).
75.902-4	75.711(g).
75.903	75.510 (c) and (d).
75.904	75.525.
75.905	75.708.
75.906	75.515(a), 75.519(d), 75.519 (i)(4), 75.519(i)(6), and 75.601(d).
75.907	75.515(a), 75.601(d), 75.601(h), and 75.601(i).
75.1000	75.1004(a)(3) and 75.1004(a)(4).
75.1001	75.1005(a), 75.1005(b), and 75.1005(c).
75.1001-1(a)	75.1005(a), 75.1005(b), 75.1005(c) and 75.1006(g).
75.1001-1(b)	75.1009(d)(1-7).
75.1001-1(c)	75.1009(g) and 75.1009(h).
75.1002	75.502.
75.1002-1(a)	75.501(a)(2).
75.1002-1 (b) and (c)	Remove.
75.1003	75.1001(c).
75.1003(a)	75.1003(a)(1), 75.1003(a)(4), 75.1003(a)(5), and 75.1003 (a)(6).
75.1003(b)	75.1003(a)(3).
75.1003(c)	75.1003(a)(2).
75.1003-1	75.1001(a), 75.1001(d), 75.1010(a) and 75.1010(b)(1).
75.1003-2(a)	75.1010(a) and 75.1010(b)(1).
75.1003-2(a)(1)	75.1010(b)(3).
75.1003 2(a)(2)	Remove.
75.1003-2(b)	Remove.
75.1003-2(c) through (e)	75.1010(b)(3).
75.1003-2(f)	75.1010(c)(1).
75.1003-2(f) (1) and (2)	Remove.
75.1003-2(f)(2)	Remove.
75.1003-2(f)(3) and (4)	75.1010(c)(2).
75.1003-2(f)(5)	75.1010(c)(3).
75.1003-2(g)	75.1010(b)(1).

IV. Executive Order 12291 and Regulatory Flexibility Act

In accordance with Executive Order 12291, MSHA has prepared an initial analysis to identify potential costs and benefits associated with the proposed changes to its electrical standards for underground coal mines. In this analysis summarized below, MSHA had determined that the proposed rule will not result in major cost increases, nor have an incremental effect of $100 million or more on the economy. Hence, the rule is not a major rule. MSHA estimates that, after all cost savings are accounted for, annual and annualized costs will increase by $8.3 million. Initial or one-time costs are expected to increase by $2.7 million. Because many provisions in the existing rule were retained, but moved to new subparts, it would not be meaningful to compare cost increases or decreases by subpart.

The requirement for grounded metallic shields around power conductors on trailing cables will result in the greatest cost increase in the proposed rule. Approximately 92 percent of the cost of the rule, or $7.6 million in annual and annualized costs, can be attributed to this requirement, found in proposed § 75.601. During the 3-year phase-in of this requirement, insulated personal protective equipment (e.g., gloves) shall be used when energized high-voltage and unshielded low-voltage trailing cables are moved manually, as required in proposed § 75.530. The costs of § 75.530 are estimated to be $510,000 annualized, including approximately

$133,000 for gloves to be worn while handling high-voltage trailing cables.

The standard that would result in the greatest initial cost would be proposed § 75.803(d), which would require barriers for high-voltage power centers, load breakers, and rectifiers. MSHA estimates that these barriers will cost $1.6 million. The proposed standard that would result in the second greatest increase in initial costs is proposed § 75.157, qualification for low-voltage cable splicing and repair. This is a new requirement and the first-year costs of qualifying persons to splice and repair low-voltage trailing cables is $859,000. However, 76 percent ($650,000) of this cost will be borne by MSHA in developing and administering a test the first year.

Substantial cost savings will also result from changes made to existing rules. The largest savings is related to proposed § 75.508(c), which calls for less frequent examination and testing of certain electrical equipment. This change will save $4.6 million per year.

MSHA estimates that between five and six fatalities and approximately 180 nonfatal injuries would be avoided each year as a result of compliance with the proposed rule. Of these nonfatal injuries, approximately 85 percent would be lost workday injuries. Approximately 2 fatalities and 60 nonfatal injuries could be prevented each year by the new standards in the proposed rule.

Two of the standards that are expected to reduce accidents are proposed §§ 75.803 and 75.601. The first of these standards would require interlocks and emergency stop switches on high-voltage distribution equipment. These switches would automatically deenergize the conductors entering the equipment when a cover or lid over energized components is removed or when the emergency stop switch is activated. Six fatalities in the last ten years were identified where this proposed requirement alone, or in conjunction with another proposed requirement, could have prevented the accident.

Proposed § 75.601, which would require grounded metallic shielding around power conductors on trailing cables, is also expected to save lives. In the last 10 years, MSHA estimates that approximately eight lives could have been saved through the use of shielding. Proposed § 75.506, which would require each person who works on a circuit to be responsible for installing and removing his or her own padlock or other locking device to deenergize the circuit prior to working on it. Approximately two lives could have been saved in the last 10 years with this requirement. Proposed § 75.519 would prohibit temporary splices, a requirement that also could have saved two lives over the 10-year period.

Rubber insulating gloves would be required while troubleshooting and testing energized circuits under proposed § 75.507. Troubleshooting and testing of low-voltage energized circuits would be limited to qualified electricians. It is estimated that these proposed requirements could have prevented two fatalities during the last ten years.

The Agency has not proposed exemption of small mines from any provision of the proposal. MSHA's proposal would clarify compliance responsibilities for all mine operators, adopt performance-oriented standards where possible, and keep recordkeeping burdens to the minimum necessary. Of the approximately 1,700 underground mining operations affected by the proposed regulations, MSHA estimates that 907 are small businesses. The total annualized and annual costs for small mines will increase by an estimated $2.4 million, or about $2,600 per mine. Initial costs will increase by approximately $0.6 million, or roughly $700 per mine. For purposes of the Regulatory Flexibility Act, MSHA has defined small business entities as mines with fewer than 20 employees. The annual and annualized capital costs for small mines represents less than 1.0 percent of the revenues for those mines.

The Agency specifically solicits comments and data on how the proposed regulations would impact the mining industry.

List of Subjects in 30 CFR Part 75

Mine safety and health mandatory safety standards, underground coal mine electrical safety standards.

Dated: November 22, 1989.

William J. Tattersall,

Assistant Secretary for Mine Safety and Health.

It is proposed to amend Subparts A, B, F, G, H, I, J and K, of part 75, subchapter I of title 30, Code of Federal Regulations, as follows:

PART 75—MANDATORY SAFETY STANDARDS—UNDERGROUND COAL MINES

1. The authority citation for part 75 continues to read as follows:

Authority: 30 U.S.C. 811, 957 and 961.

2. The table of contents to part 75 is amended by revising subparts F through K as set forth below.

3. Section 75.2(j) is revised as set forth below.

4. The heading for Subpart B and §§ 75.153, 75.154, and 75.159 are revised; § 75.155 is redesignated as § 75.158; and new §§ 75.155 through 75.157 are added as set forth below.

5. Subparts F through K are revised as set forth below.

Subpart F—Electric Equipment—General

Sec.

75.500 Scope.
75.501 Permissible electric equipment.
75.502 Installation of electric conductors, and cables.
75.503 Construction, maintenance, modification, and identification of permissible electric equipment.
75.504 Current between frames of permissible electric equipment.
75.505 Installation and maintenance of electric circuits and equipment.
75.506 Work on electric circuits and equipment.
75.507 Electrical troubleshooting and testing.
75.508 Examination and testing of electric equipment and circuits.
75.509 Switches, control devices, and control circuits.
75.510 Disconnecting devices.
75.511 Cable couplers.
75.512 Trolley taps.
75.513 Lightning protection.
75.514 Lighting fixtures and photographic lighting equipment.
75.515 Insulation of electric conductors and cables.
75.516 Mechanical protection of conductors and cables.
75.517 Support of insulated conductors and cables.
75.518 Insulators and insulated J-hooks.
75.519 Splices, repairs and terminations of conductors and cables.
75.520 Conductor and cable fittings and strain relief devices.
75.521 Damaged conductors and cables.
75.522 Ampacities of low-voltage conductors.
75.523 Overcurrent protection.
75.524 General requirements for overcurrent devices.
75.525 Identification of circuit breakers and fuse holders.
75.526 Nameplates and markings.
75.527 Map of the mine electrical system.
75.528 Alternating-current battery chargers for mining vehicles.
75.529 Emergency deenergization devices for mobile electric equipment.
75.530 Use of insulated trailing cable handling equipment.
75.531 Deenergized underground power circuits; idle days—idle shifts.

Subpart G—Low-Voltage Circuits

75.600 Scope.
75.601 General requirements for trailing cables.
75.602 Electrical protection for alternating-current circuits.

Sec.
75.603 Electrical protection for direct-current trailing cables.
75.604 Physical restraints for cable couplers.

Subpart H—Grounding

75.700 Scope.
75.701 Low-voltage alternating-current system grounding.
75.702 Low-voltage alternating-current system grounding mediums.
75.703 High-voltage alternating-current system grounding.
75.704 High-voltage alternating-current system grounding mediums.
75.705 Direct-current system grounding.
75.706 Direct-current system grounding mediums.
75.707 Grounding resistors.
75.708 Loads connected on resistance-grounded systems.
75.709 Low-resistance ground fields.
75.710 Alternating-current equipment frame grounding.
75.711 Ground-wire monitors for alternating-current equipment.
75.712 Direct-current equipment frame grounding.
75.713 Silicon diode grounding.
75.714 Equipment safety grounding conductors.

Subpart I—High-Voltage Alternating-Current Circuits

75.800 Scope.
75.801 High-voltage systems.
75.802 Protection for circuits, other than trailing cables.
75.803 High-voltage distribution equipment.
75.804 High-voltage cables, other than trailing cables.
75.805 Movement of high-voltage power centers and portable transformers.
75.806 Connection boxes.
75.807 Voltage requirements of electric face equipment.
75.808 Electrical protection of electric face equipment.
75.809 Disconnecting devices for electric face equipment.
75.810 Testing, examination, and maintenance of high-voltage electric face equipment.
75.811 Cables for high-voltage electric face equipment.
75.812 Cable support system; high-voltage longwall electric face equipment.
75.813 Guarding of cables for high-voltage electric face equipment.
75.814 Safety devices for high-voltage systems supplying electric face equipment.
75.815 Procedures for working on high-voltage systems supplying electric face equipment.

Subpart J—[Reserved]

Subpart K—Trolley Wires and Trolley Feeder Wires

75.1000 Scope.
75.1001 Installation.
75.1002 Insulated hangers.
75.1003 Guarding.
75.1004 Cutout switches.
75.1005 Circuit protection.
75.1006 Circuit breakers.
75.1007 Handling.
75.1008 Track Bonding.
75.1009 Examinations, tests and maintenance of trolley systems.
75.1010 Movement and transportation of metallic mining supplies and off-track mining equipment in entries containing trolley wires or trolley feeder wires.

Subpart A—General

§ 75.2 Definitions.

* * * * *

(j) The following definitions apply to electrical safety standards in subparts B and F through K:

(1) *"Adequate interrupting capacity for circuit breakers and fuses"* means the ability of a circuit breaker or fuse to safely interrupt all values of current which can occur at its location in excess of its trip setting or melting point.

(2) *"Ampacity"* means the current-carrying capacity of electric conductors expressed in amperes.

(3) *"Branch circuit"* means the circuit conductors extending beyond the final short-circuit device protecting the circuit.

(4) *"Branch line"* means a circuit which extends from an ongoing circuit.

(5) *"Cable"* means an assembly of one or more insulated conductors enclosed by an additional abrasion resistant covering or jacket. A cable may also contain one or more uninsulated equipment safety grounding conductors. A power cable is any cable except communication, instrumentation and control cables.

(6) *"Circuit breaker"* means a device designed to open and close a circuit by non-automatic means and to open the circuit automatically at a predetermined overcurrent value without damage to the device when operated within its rating.

(7) *"Circuit breaker adjustable-trip unit"* means a trip unit of a circuit breaker which can be set to trip at various current values and/or times within a predetermined range.

(8) *"Circuit breaker setting"* means the value of current or time at which an adjustable circuit breaker is set to trip.

(9) *"Conductor"* means a bare or insulated wire or combination of wires not insulated from one another, suitable for carrying an electric current.

(10) *"Dielectric strength (withstand voltage)"* means the ability of insulating materials and spacings to withstand specified overvoltages for a specified time without flashover or puncture.

(11) *"Equipment safety grounding conductor"* means a conductor used to connect the non-current-carrying metallic parts of electric equipment, raceways, and other metallic enclosures to the system grounding medium.

(12) *"Extended-time rated grounding resistor"* means a resistor capable of carrying a rated current for a period of time that exceeds the period of time necessary for its temperature to reach a constant value, and which is capable of operating at its maximum operating temperature for at least 90 days per year without opening.

(13) *"Fail-safe"* is a term related to ground-wire monitors and solid-state direct-current overcurrent relays meaning that failure of any component other than relay contacts will not prevent a device from performing its intended function, unless the device is designed to activate a circuit-interrupting device when such failure occurs.

(14) *"Feeder circuit"* means the conductors between the power source and the final branch circuit short-circuit protective device.

(15) *"Fuse"* means an overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it.

(16) *"Ground-fault"* means an unintentional connection between an electric circuit and the grounding system.

(17) *"Ground-wire monitor"* means a device having the primary function of monitoring the equipment safety grounding conductor of a circuit and causing the affected circuit breaker to trip when a change in the impedance of the grounding circuit presents a potential electrical shock hazard.

(18) *"High-voltage distribution equipment"* means a unit of high-voltage equipment which switches, controls, or transforms an incoming high-voltage circuit to one or more high-voltage or low-voltage circuits.

(19) *"High-voltage system or circuit"* means a system or circuit with a nominal voltage greater than 1,040 volts.

(20) *"Instantaneous-trip circuit breaker"* means a circuit breaker with no intentional time delay designed in its tripping action.

(21) *"Inverse-time circuit breaker"* means a circuit breaker with an intentional time delay in its tripping action, which delay decreases as the magnitude of the current increases.

(22) *"Low-voltage system or circuit"* means a system or circuit with a nominal voltage of 1,040 volts or less.

(23) *"Maximum voltage"* means the highest root-mean-square voltage which occurs in a system or circuit under normal operating conditions.

(24) *"Mobile electric equipment"* means electric equipment capable of movement from one location to another by power supplied from a source located on the machine or transmitted to the machine by means of a trailing cable.

(25) *"Nominal voltage"* means the phase-to-phase or line-to-line root-mean-square value assigned to a circuit or system for designation of its voltage class, such as 480 or 4,160 volts. Actual voltage at which the circuit or system operates may vary from the nominal voltage within a range that permits satisfactory operation of equipment.

(26) *"Non-adjustable circuit breaker"* means a circuit breaker which has no adjustment to alter the value of current at which it will trip or the time required for its operation.

(27) *"Off-track equipment"* means machines and devices which are not track-mounted in normal operation, such as main frames of mining machines, mobile electric face equipment, pump assemblies, battery chargers, power centers, rectifiers, switchgear, belt conveyor drive units, tailpieces, and compressors.

(28) *"Overcurrent"* means any current in excess of the rated current of equipment or the ampacity of a conductor, which may result from overload, short-circuit, or ground-fault conditions.

(29) *"Overload"* means operation of equipment in excess of normal full-load rating, or loading of a conductor in excess of rated ampacity, which would cause damage or dangerous overheating if allowed to continue.

(30) *"Parallel-connected rectifier trolley system"* means a trolley system which has two or more rectifiers connected together so that their individual output currents are added and flow to common loads.

(31) *"Portable electric equipment"* means electric equipment which is designed and constructed to facilitate frequent movement from one location to another, and which does not normally remain at a fixed location for extended periods of time.

(32) *"Qualified cable splicer"* means an individual who has met the requirements of 30 CFR 75.157.

(33) *"Qualified electrician"* means an individual who has met the requirements of 30 CFR 75.153.

(34) *"Radial stub-feed trolley system"* means a trolley system in which independent feeders branch out radially and connect one or more loads to only one source of power, through which the normal flow of energy is in one direction only.

(35) *"Resistance-grounded system"* means an electrical system in which the neutral point of the transformer or generator winding is intentionally grounded through a current limiting resistor which limits ground-fault current to a value equal to or less than the values specified in subparts H and I, but greater than the system capacitive charging current.

(36) *"Short circuit"* means an abnormal connection of relatively low impedance, whether made accidentally or intentionally, between two points of different potential.

(37) *"Solid-grounded system"* means an electrical system grounded through a connection in which no impedance has been intentionally inserted, where the short-circuit current-carrying capacity of the ground connection is at least equal to the bolted phase-to-neutral fault current.

(38) *"Splice"* means the mechanical and electrical connection of one or more severed conductors in a single length of conductor or cable.

(39) *"Stationary electric equipment"* means electric equipment other than mobile or portable that is fastened, secured or installed such that it cannot be readily moved from one location to another during normal use.

(40) *"Surge arrester"* means a device which is used to provide protection against lightning surges.

(41) *"System"* means a combination of all conductors and associated apparatus connected together without intervening transforming apparatus.

(42) *"Tie-feeder or multiple-feeder circuit breaker"* means a circuit breaker which connects together two or more independent sources of power.

(43) *"Trailing cable"* means a portable cable or flexible cord through which electrical energy is transmitted to any off-track mobile electric equipment, or a portable cable or flexible cord which receives electrical energy from a section power center, section distribution box, section rectifier, or section nipping station.

(44) *"Undervoltage protection"* means the effect of a device which operates on failure of voltage to cause and maintain the interruption of power to a circuit so as to prevent automatic restarting of the equipment.

(45) *"Ungrounded system"* means an electrical system without an intentionally-made connection to ground, except through potential indicating or measuring devices.

(46) *"Voltage-to-ground"* means the root-mean-square voltage between any conductor of the circuit or system and that point of the circuit or system which is grounded.

* * * * *

Subpart B—Qualified Persons

§ 75.153 Qualified electricians.

(a) Upon the effective date of this rule, to become a qualified electrician, an individual shall:

(1) Successfully complete the qualification tests administered by MSHA according to 30 CFR 75.154 or a state according to 30 CFR 75.155; and

(2) Have at least one year of experience in a position requiring the installation and maintenance of electric circuits and equipment in a coal or other mine, in the mine equipment manufacturing industry, or in any other industry using or manufacturing similar equipment. Six months of experience may be credited to persons who have completed a two-year electrical technology program or a four-year electrical engineering program.

(b) In order to retain qualification, all qualified electricians shall complete an annual refresher training program in accordance with the requirements of 30 CFR 75.156. Annual refresher training shall be approved in accordance with 30 CFR 75.160.

(c) Electricians qualified prior to the effective date of this rule shall remain qualified, subject to fulfillment of the annual refresher training requirement.

(d) The District Manager may revoke an electrician's qualification for cause, including intentional violation of the requirements of part 75 or the intentional defeat of any safety device or circuit. Before any revocation becomes effective, the District Manager shall send written reasons for revocation to the electrician, who shall be given ten days to respond. Unless otherwise determined by the District Manager, revocation shall become effective ten days from notification to the electrician. A decision by the District Manager to revoke an electrician's qualification may be appealed by the electrician to the Administrator for Coal Mine Safety and Health, MSHA, 4015 Wilson Boulevard, Arlington, Virginia 22203. Such an appeal shall be submitted to the Administrator within 30 days from the effective date of the revocation. Upon revocation of an electrician's qualified status, the District Manager shall immediately notify the appropriate mine operator.

§ 75.154 MSHA qualification of mine electricians.

(a) Application to take electrical qualification tests shall be made to the District Manager of the appropriate Coal Mine Safety and Health District, and shall include:

(1) A written request to be tested for qualification in low-voltage, high-voltage or both voltage categories; and

(2) Written evidence that the applicant meets the electrical

experience requirement in 30 CFR 75.153(a)(2).

(b) Tests for low-voltage qualification shall include:

(1) Written examination of direct-current and alternating-current theory and application;

(2) Written examination or practical demonstration of knowledge in low-voltage coal mine electric equipment and circuits;

(3) Written examination or practical demonstration of knowledge of permissibility requirements for coal mine electric equipment; and

(4) Written examination of the requirements of subparts F through H and subpart K of this part.

(c) Tests for high-voltage qualification shall include:

(1) Written examination or practical demonstration of knowledge of coal mine electric power distribution circuits and equipment; and

(2) Written examination of the requirements of subpart I of this part.

(d) Applicants may take tests for qualification in both the low-voltage and high-voltage categories on the same occasion, but shall not be qualified in the high-voltage category without successfully passing the low-voltage tests.

(e) A score of at least 80 percent on each of the tests in the relevant voltage category is required for qualification. One percentage point, up to five percentage points, shall be added to the score of each test for each year of the applicant's experience in excess of the required one year.

(f) Applicants for electrical qualification may retake the tests for which a score of less than 80 percent was received within 30 days following notification to the applicant of the test results. Applicants failing to achieve a score of at least 80 percent on the tests retaken are not eligible for further retesting until 30 days after the applicant is notified of the retest results.

§ 75.155 State qualification of mine electricians.

(a) State programs for the qualification of mine electricians, which include at least the following, shall be recognized by MSHA:

(1) The experience requirement specified in 30 CFR 75.153(a)(2);

(2) The MSHA-developed tests or demonstrations specified by 30 CFR 75.154 (b) and (c), or comparable tests or demonstrations jointly developed and agreed upon by MSHA and a state; and

(3) Procedures necessary to ensure the integrity and fairness of testing and grading.

(b) Tests given by the states shall be administered by a qualified electrician.

(c) The District Manager for the Coal Mine Safety and Health District in which testing and grading is to be conducted shall be notified of the time and place of testing at least 20 days in advance. The District Manager shall have the option of monitoring all testing and grading.

§ 75.156 Electrical annual refresher training programs.

(a) An electrical annual refresher training program consisting of at least eight hours of safety instruction shall be presented by a qualified electrician, and programs shall include:

(1) A review of electrical accidents occurring in the industry and their causes; and

(2) A review of electrical safety procedures including lockout and tagging methods.

(b) Operators' programs shall consist of conducting their own refresher training, or participation in refresher training programs conducted by MSHA, a state, other Federal agencies, associations of mine operators, miners' representatives, other mine operators, private associations, or educational institutions.

(c) Only electricians who have completed an annual refresher training program shall perform work required to be performed by a qualified electrician.

(d) Electricians who have not completed refresher training for a period of three consecutive years are no longer considered qualified. They may only regain their qualified status by reapplication for qualification in accordance with 30 CFR 75.153.

(e) The District Manager shall be notified of the time and place of annual refresher training at least 20 days in advance, and shall have the option of monitoring retraining sessions.

(f) Approval of an operator's electrical annual refresher training program required by 30 CFR 75.160 may be revoked by the District Manager for cause.

§ 75.157 Qualification for low-voltage cable splicing and repair.

(a) Individuals shall be considered qualified to splice or repair low-voltage trailing cables if they—

(1) Have at least one year of experience as a miner in a working section of an underground coal mine;

(2) Successfully complete a written test administered by MSHA or a state; and

(3) Successfully perform a practical demonstration of ability to splice and repair low-voltage trailing cables.

(b) Tests for qualification in low-voltage cable splicing and repair shall be developed by MSHA, and shall include written examination of—

(1) Lockout and tagging procedures, and other safety precautions relevant to the repair and splicing of trailing cables;

(2) The applicable requirements of this part; and

(3) The purpose and use of cable splicing components.

(c) Written tests shall be administered and practical demonstrations shall be monitored by an authorized representative of MSHA, or an authorized representative of the State who is a qualified electrician or qualified for low-voltage cable splicing and repair.

(d) The practical demonstration of an applicant's ability shall include:

(1) Performance of all safety precautions required by this part for splicing trailing cables;

(2) Proper splicing of a round No. 2 AWG, three-conductor, type GGC trailing cable;

(3) Proper repair of a damaged outer jacket; and

(4) Demonstration of proper methods of splicing metallic cable shielding.

(e) The District Manager of the Coal Mine Safety and Health District in which tests and demonstrations are to be conducted shall be notified of the time and place of testing at least 20 days in advance and shall have the option of monitoring the testing and demonstrations.

(f) The District Manager may revoke a miner's qualification to splice and repair low-voltage trailing cable for cause, including intentional violation of the requirements of this part or the intentional defeat of any safety device or circuit. Before any revocation becomes effective, the District Manager shall send written reasons for revocation to the miner, who shall be given ten days to respond. Unless otherwise determined by the District Manager, revocation shall become effective ten days from notification to the miner. A decision by the District Manager to revoke an individual's qualification to splice and repair cables may be appealed by the miner to the Administrator for Coal Mine Safety and Health, MSHA, 4015 Wilson Boulevard, Arlington, VA 22203. Such an appeal shall be submitted to the Administrator within 30 days from the effective date of the revocation. Upon revocation of an individual's qualified status, the District Manager shall immediately notify the appropriate mine operator.

§ 75.159 Records of certified and qualified persons.

The operator of each coal mine shall maintain available for inspection at the mine and certify by signature and date as correct, a list of all certified and qualified persons required to perform duties under part 75. The list shall include the names of those persons who have been qualified as mine electricians, or to splice and repair low-voltage cables, the applicable voltage category and dates of qualification and retraining.

Subpart F—Electric Equipment—General

§ 75.500 Scope.

(a) This subpart contains general requirements pertaining to the installation, maintenance, testing, examination, electrical protection and performance of electric circuits and equipment. Requirements pertaining to these and other safety aspects of circuits and equipment are specified in more detail in subpart G, Low-Voltage Circuits; subpart H, Grounding; subpart I, High-Voltage Alternating-Current Circuits; and subpart K, Trolley Wires and Trolley Feeder Wires, of this part.

(b) This subpart does not contain requirements pertaining to the design and construction of permissible equipment and intrinsically safe circuits, except as provided in 30 CFR 75.503, 75.509, 75.511, and 75.529.

§ 75.501 Permissible electric equipment.

(a) Electric equipment in the following areas shall be permissible, except as specified in paragraphs (b) and (c) of this section and 30 CFR 75.514:

(1) In or inby the last open crosscut;

(2) Within 150 feet of pillar workings, or longwall and shortwall faces;

(3) Areas that are ventilated by air that has ventilated any working place or any worked-out area, whether pillared or non-pillared; and

(4) Inaccessible areas.

(b) Non-permissible electric welders, hand-held power tools and test instruments may be used to repair permissible equipment that is disabled and cannot be moved from areas where permissible equipment is required, provided:

(1) The area is ventilated with air that has not been used to ventilate coal cutting or loading operations;

(2) Repairs are made in air that contains less than 1.0 percent of methane;

(3) A fire extinguisher complying with 30 CFR 75.1100–1(e), or 240 pounds of rock dust is made available within 50 feet of the equipment being repaired; and

(4) Repairs are made under the supervision of a certified person, who shall immediately before and during such repairs, test with means approved by the Secretary to assure the presence of less than 1.0 percent methane, and shall make a diligent search for fire during and after such repairs.

(c) The following equipment which is certified by MSHA as explosion-proof may be used in areas requiring permissible equipment, provided such installations are approved by the District Manager:

(1) Distribution boxes, controller boxes, and motors used as part of water pump assemblies; and

(2) Cable couplers.

§ 75.502 Installation of electric conductors and cables.

Electric conductors and cables shall not be installed in areas where permissible equipment is required, other than the following:

(a) Trailing cables supplying power to permissible equipment.

(b) Conductors of permissible equipment.

(c) Conductors of intrinsically safe circuits.

(d) Shielded cables.

(e) Conductors of electric equipment required for making repairs as described in 30 CFR 75.501(b).

(f) Conductors of electric equipment as described in 30 CFR 75.50l(c).

§ 75.503 Construction, maintenance, modification, and identification of permissible electric equipment.

(a) Electric equipment required to be permissible shall be constructed in accordance with the MSHA approval regulations in effect at the time the equipment is manufactured, and be maintained in accordance with the regulations under which the equipment was approved.

(b) Field modifications of permissible electric equipment shall be made and maintained in accordance with the MSHA approval regulations in effect at the time the equipment is modified.

(c) Written applications for modification of permissible equipment and plans for modifications shall be filed with the MSHA Approval and Certification Center, Box 251 Industrial Park Road, Triadelphia, West Virginia 26059.

(d) Approval and certification plates shall be attached to permissible electric equipment and shall be maintained so that model numbers, approval numbers, and certification numbers are legible.

§ 75.504 Current between frames of permissible electric equipment.

In areas where permissible equipment is required, the current that flows between the frames of any two units of equipment that contact each other shall not exceed 1.0 ampere as determined from the voltage that is measured across a 0.1 ohm resistor connected between the frames of the equipment.

§ 75.505 Installation and maintenance of electric circuits and equipment.

(a) Except as provided in paragraphs (b) and (c) of this section, electric circuits and equipment shall be installed and maintained by a low-voltage or high-voltage qualified electrician, as applicable.

(b) Persons trained to perform electrical work who are supervised by a qualified electrician as required in paragraph (d) of this section shall be permitted to install and maintain low-voltage circuits.

(c) Persons qualified under 30 CFR 75.157 shall be permitted to repair and splice low-voltage trailing cables on those parts of the trailing cable which are external to couplers or compartments.

(d) The qualified electrician who supervises trained persons performing electrical work shall—

(1) Provide direct and immediate supervision and be present during the work;

(2) Assure that the circuit or equipment is properly deenergized, disconnected, locked out, and tagged before work is started; and

(3) Examine the completed work before the circuit or equipment is energized.

§ 75.506 Work on electric circuits and equipment.

(a) Doors and cover plates on electric equipment which allow access to electric connections, shall be closed at all times, except during installation, testing, and repair.

(b) Except when necessary for troubleshooting and testing, as specified in 30 CFR 75.507, electric circuits and equipment shall be deenergized before electrical work is started in accordance with the following:

(1) The appropriate disconnecting device shall be opened, locked out with a padlock and tagged by persons performing the work;

(2) The disconnecting device shall be locked out with an individual padlock for each person performing work;

(3) The tag shall identify each person performing the work and identify the circuit or equipment being worked on;

(4) When two or more electric circuits are located within a single compartment, each circuit shall be deenergized and locked out before electrical work is started on any circuit.

(c) When high-voltage power conductors are required to be deenergized, they shall be connected to the system grounding conductor by a high-voltage qualified electrician, and the high-voltage circuit shall remain grounded until the work is completed.

(d) Padlocks and tags shall only be removed by the person who installed them.

(e) When mechanical repairs or maintenance being performed on electric equipment requires the power to be removed in accordance with 30 CFR 75.1725(c), the disconnecting devices shall be opened, locked out with a padlock, and tagged by the persons performing the work.

(f) Conductors that are not supplying power to electric equipment shall be deenergized and shall—

(1) Be removed from their supply source; or

(2) Have their supply source locked out and any exposed ends insulated.

§ 75.507 Electrical troubleshooting and testing.

(a) Troubleshooting and testing of energized circuits shall be performed only—

(1) On low-voltage circuits; and

(2) When the purpose of troubleshooting and testing is to determine voltages and currents.

(b) Electrical troubleshooting and testing of energized circuits shall only be performed by a qualified electrician wearing rubber insulating gloves with protective coverings designed to prevent physical damage to the insulation material.

(c) Before troubleshooting and testing a low-voltage circuit contained in a compartment with a high-voltage circuit, the high-voltage circuit shall either be deenergized, grounded, locked out and tagged, or physically separated by a permanent barrier or partition from the low-voltage circuit.

(d) Rubber insulating gloves used when troubleshooting and testing shall be—

(1) Rated at least for the nominal voltage of the circuit;

(2) Examined before each use for visible signs of damage or defects; and

(3) Removed from the underground area of the mine when damaged or defective.

§ 75.508 Examination and testing of electric equipment and circuits.

(a) Electric equipment and circuits shall be installed, maintained, and used to prevent fire, electrical shock, ignition, or operational hazards. Electric equipment or circuits that present a hazard to persons due to improper installation or maintenance, misuse, or damage, shall be deenergized and tagged as a hazard.

(b) A low- or high-voltage qualified electrician, as applicable, shall make examinations of all electric equipment and circuits to determine that the electrical protection, equipment grounding, permissibility, cable insulation, and control devices, are being properly maintained to prevent fire, electric shock, ignition or operational hazards from existing on the equipment. Examinations shall include testing when necessary to make such determinations.

(c) The examinations of low-voltage equipment and circuits required by paragraph (b) of this section shall be made:

(1) When installed, and at least every 7 days on mobile and portable electric equipment and circuits; and

(2) When installed and at least every 30 calendar days on stationary equipment and circuits and hand-held power equipment.

(d) Surface and underground high-voltage switchgear used in conjunction with circuits which extend underground shall be tested at least once each 90 calendar days as follows:

(1) The circuit breaker shall be opened by breaking the continuity of the ground-check conductor at the extreme end of the monitoring circuit when a ground-check conductor is used.

(2) The circuit breaker shall be opened by activating at least one interlock switch for each power center.

(e) The equipment specified in paragraph (d) of this section shall be visually examined at least once every 30 calendar days for hazardous conditions resulting from exposed energized parts or equipment defects.

(f) Each high-voltage grounding resistor and high-voltage circuit protective device located on the surface to protect underground circuits shall be tested when installed and at least every 12 months thereafter as follows:

(1) Pass current through each current transformer necessary to cause the circuit breaker to open.

(2) Impress voltage across each potential ground-fault device necessary to cause the circuit breaker to open.

(3) Determine whether the grounding resistor is open or shorted.

(g) When examinations or tests of equipment or circuits reveal a fire, electrical shock, ignition or operational hazard, the equipment shall either be removed from service or repaired.

(h) At the completion of examinations and tests required by this section, the person who makes the examinations and tests shall certify by signature and date that they have been conducted. A record shall be made of any unsafe condition found, and corrective action taken.

(i) Certifications and records shall be kept for at least one year, and shall be made available at the mine for inspection by authorized representatives of the Secretary and representatives of miners at the mine.

(j) When equipment is idle for more than the number of days required for examination by this section, examinations need not be conducted, except that examinations shall be conducted prior to the equipment being returned to service.

§ 75.509 Switches, control devices, and control circuits.

(a) Switches and control devices shall be properly installed and maintained on electric equipment so that it can be safely operated.

(b) Switches and control devices on electric equipment shall have voltage and current ratings of at least the voltage and current of the circuit in which they are used.

(c) Alternating-current remote control circuits shall have a maximum voltage of 150 volts.

(d) Control circuits having a neutral or one conductor solidly connected to the grounding medium shall be wired so that ground faults in the circuits will not—

(1) Start equipment;

(2) Prevent equipment from being stopped; or

(3) Prevent operation of protective devices connected in the circuit.

(e) Control circuits shall be wired so that stop switches will deenergize the affected circuit if a start switch remains in the "start" position.

(f) Tram controls on mobile electric equipment shall return automatically to the neutral position when released.

(g) Automatic over-temperature switches shall be provided and maintained on air compressors other than those compressors which are component parts of locomotives and rock dusting machines. Such switches shall automatically deenergize the compressor at predetermined settings specified by the manufacturer of the compressor, not to exceed 240 degrees fahrenheit.

§ 75.510 Disconnecting devices.

(a) A disconnecting device shall be installed in each power circuit that extends underground and shall be located—

(1) On the surface within 500 feet of where the circuits enter the underground area of the mine; and

(2) Underground, within 500 feet from the bottom of shafts and boreholes when the circuit enters the mine through a shaft or borehole.

(b) Disconnecting devices which are not designed for load interruption, and are located as specified in paragraph (a)(2) of this section shall be—

(1) Installed so that the incoming power circuit can be deenergized by a circuit breaker which can be operated at the disconnect device location, before such devices are opened; and

(2) Provided with a visual or audible means, at the disconnect location, to determine that the incoming power has been removed from such device.

(c) Disconnecting devices shall be installed in conjunction with each circuit breaker and at the beginning of each branch circuit and trailing cable used underground.

(d) Disconnecting devices shall be designed to provide visual evidence that all ungrounded power conductors of the circuit are disconnected when the devices are open.

(e) Disconnecting devices shall be equipped with a means for installing a padlock.

(f) Each disconnecting device shall be distinctly marked to indicate the specific unit of equipment that it serves. The marking shall be identical to the marking of the corresponding circuit breaker or fuse holder, and shall be of sufficient durability to withstand the mining environment. Where a plug and receptacle are used as a disconnecting device, both the plug and receptacle shall be marked identically.

(g) Disconnecting devices shall have voltage and current ratings compatible with the circuits in which they are used.

(h) Except for trolley taps, low-voltage disconnecting devices shall not have exposed energized parts.

(i) High-voltage disconnecting devices installed underground after [insert the effective date of the rule] shall be enclosed in a grounded metallic enclosure and shall have no exposed energized parts.

(j) High-voltage disconnecting devices having exposed energized parts shall be—

(1) Guarded to prevent inadvertent contact with energized parts; and

(2) Operated only be a high-voltage qualified electrician.

(k) Qualified electricians who operate high-voltage disconnecting devices with exposed energized parts shall wear rubber insulating gloves rated at least 20,000 volts which have protective coverings designed to prevent physical damage to the insulating material, and shall use insulated sticks, fuse tongs, or pullers when operating the disconnecting devices.

(l) Insulated sticks, fuse tongs, and pullers shall be insulated and maintained to protect the qualified electrician from exposure to voltage.

(m) Gloves, insulated sticks, insulated fuse tongs, and insulated pullers shall be examined before each use for visible signs of physical damage and defects.

(n) Damaged or defective gloves, sticks, fuse tongs, and pullers shall be removed from the underground areas of the mine.

(o) Rubber insulating gloves shall be electrically tested at least every 6 months.

§ 75.511 Cable couplers.

(a) Cable couplers shall—

(1) Enclose all power conductors of the circuit in which the coupler is used;

(2) Be equipped with a metallic outer shell when the nominal voltage of the circuit exceeds 600 volts;

(3) Have voltage ratings of at least the nominal voltage of the circuit in which the couplers are used;

(4) Have current ratings of at least the maximum continuous current rating of the circuit in which the couplers are used;

(5) Be constructed so that ground-check conductors or interlock circuit conductors will separate first and equipment safety grounding conductors will separate last when the couplers are disconnected;

(6) Be equipped with an electrical or mechanical interlock on all three phase circuits and direct-current trailing cable circuits which prevents the coupler from being disconnected while energized. The voltage of interlock circuits shall not exceed 40 volts on low-voltage circuits or 96 volts on high-voltage circuits; and

(7) Not be connected or disconnected under load.

(b) Cable couplers on mobile battery-powered electric face equipment shall:

(1) Meet the requirements of 30 CFR 18.41; or

(2) Be held in place by a threaded ring or equivalent mechanical fastening equipped with a captive device removable only by a special tool to separate the connection.

§ 75.512 Trolley taps.

(a) Trolley taps shall be connected to trolley wires and feeder wires only by pressure-type connectors when the load of the circuit exceeds 4 amperes.

(b) Trolley taps shall not be connected or disconnected under load.

§ 75.513 Lightning protection.

(a) Surge arresters shall be provided for exposed ungrounded power conductors and telephone wires that extend underground.

(b) Power conductors and telephone wires that are buried, installed beneath a protective metallic covering, or enclosed within grounded metallic shields, coverings, or enclosures, throughout their entire length need not be equipped with surge arresters.

(c) Surge arresters shall be located on the surface within 100 feet of the point where the conductors—

(1) Enter the mine;

(2) Are buried;

(3) Are installed beneath a protective metallic covering;

(4) Are enclosed within grounded metallic shields, coverings, or enclosures; or

(5) Are supported by grounded metallic messenger wires.

(d) Surge arresters shall be rated for the voltage and current of the circuit they protect.

(e) Surge arresters providing lightning protection for conductors that extend underground shall be connected to a low-resistance ground field that is separated from neutral ground fields by a distance of not less than 25 feet.

§ 75.514 Lighting fixtures and photographic lighting equipment.

(a) Lamps used to illuminate slopes and enclosed underground structures shall be installed within glass, plastic or equivalent enclosures.

(b) Incandescent lamps used to illuminate walkways and work areas shall be installed—

(1) Within glass, plastic or equivalent enclosures; or

(2) In weatherproof sockets, provided they are located at least eight feet above travelways and work areas.

(c) In locations other than those specified by paragraphs (a) and (b) of this section, incandescent lamps shall be installed in weatherproof sockets, or within glass, plastic or equivalent enclosures.

(d) Lamps shall not contact combustible materials, and except as provided in paragraphs (b)(2) and (c) of this section, shall be enclosed within glass, plastic or equivalent enclosures.

(e) Low-pressure sodium lamps shall not be used underground.

(f) Non-permissible electronic photographic equipment may be used in

underground mines in areas where permissible equipment is required provided that—

(1) Such areas are ventilated with air that has not been used to ventilate coal cutting or loading operations;

(2) The air in such areas contain less than 1.0 percent methane; and

(3) The equipment is used under the supervision of a certified person who shall immediately before and during its use, test with means approved by the Secretary to assure the presence of less than 1.0 percent methane.

§ 75.515 Insulation of electric conductors and cables.

(a) Electric power, control, ground-check, interlock and communication conductors and cables shall have insulation with a voltage rating of at least the nominal voltage of the circuit in which they are used, except for—

(1) Trolley wires and trolley feeder wires installed with mine track;

(2) Grounded power conductors of direct-current feeder systems;

(3) Equipment and system grounding conductors; and

(4) Bare signal wires of 40 volts or less.

(b) Exposed electric connections and resistor grids shall be insulated. When insulation would be impractical, they shall be guarded to prevent inadvertent contact by persons or equipment.

§ 75.516 Mechanical protection of conductors and cables.

Electric conductors and cables, and communication wires and cables shall be protected to prevent functional damage to the outer jacket and insulation. Trailing cables shall be protected against damage from mobile electric equipment by bridges, trenches, suspension from the mine roof or rib, or by location.

§ 75.517 Support of insulated conductors and cables.

(a) Insulated electric conductors and cables shall be supported by insulators or insulated J-hooks and shall not contact combustible materials, roof, or ribs, except for the following:

(1) Trailing cables;

(2) Metallic shielded cables;

(3) Conductors installed in conduits;

(4) Equipment and system grounding conductors; and

(5) Grounded power conductors on direct-current feeder circuits.

(b) Materials other than insulators may be used to support cables meeting the requirements of 30 CFR 75.601, provided such cables are supported from non-combustible materials. Materials used to support the cables shall be flame resistant, insulated for at least the maximum voltage of the circuit, and have a tensile strength of at least three times the weight supported.

(c) Communication circuits shall not contact light or power circuits.

(d) Communication wires or cables installed in track entries shall be installed in the entry on the opposite side of the trolley wire or trolley feeder wire.

§ 75.518 Insulators and insulated J-hooks.

Insulators and insulated J-hooks shall have—

(a) Flame-resistant insulating material;

(b) Insulating material with a dielectric strength of at least eight times the maximum voltage of the circuit; and

(c) A tensile strength of at least three times the supported weight.

§ 75.519 Splices, repairs and terminations of conductors and cables.

(a) High-voltage cables shall be spliced, terminated, or repaired by high-voltage qualified electricians.

(b) Low-voltage trailing cables shall be spliced, repaired, or terminated by a qualified electrician or a qualified cable splicer.

(c) Splices and repairs in low-voltage trailing cables shall be made with splice and repair kits that meet the flame-resistance tests in 30 CFR 18.64.

(d) The outer jacket of each splice and repair in a high-voltage trailing cable shall be vulcanized or molded with materials that are flame resistant in accordance with 30 CFR 18.64.

(e) Splices and repairs in cables shall be sealed to exclude moisture.

(f) A splice in a trailing cable shall contain only one connection point in each conductor.

(g) Terminations of shielded high-voltage cables shall include stress-relief on each power conductor.

(h) Metallic shielding of single-conductor cables shall be connected to messenger wires and equipment safety grounding conductors at each splice and termination.

(i) Each splice and repair shall have—

(1) Conductivity and current-carrying capacity that prevents insulation damage due to heating of conductors;

(2) The severed conductors joined by welding or compression-type conductors;

(3) Each power, control, and ground check conductor individually reinsulated with insulation having a thickness temperature rating, and dielectric strength of at least that of the original insulation;

(4) Semiconducting tape replaced over the insulation of each power conductor within shielded cables;

(5) Metallic shielding in the form of metallic braid or serving (wrap) replaced over each power conductor and applied in half-lapped layers, on shielded trailing cables;

(6) Metallic shielding in the form of metallic braid or serving (wrap), or metallic tape replaced over each power conductor and applied in half-lapped layers, on shielded cables other than trailing cables; and

(7) The outer jacket replaced to provide at least the same thickness and protection as that of the original jacket.

§ 75.520 Conductor and cable fittings and strain relief devices.

(a) Except as provided in paragraph (c), cables shall enter metallic frames of electric enclosures through fittings sized for the cable which prevent damage to cable jackets and the insulation of the internal conductors.

(b) Except as provided in paragraph (c), conductors shall enter metallic frames of electric enclosures through fittings with insulated bushings sized for the conductors.

(c) Cables and conductors in conduit that enter metallic frames of electric enclosures need not be equipped with fittings or bushings when protection against damage by sharp edges is provided.

(d) Cables and conductors shall be secured to prevent mechanical strain on electrical connections.

(e) Trailing cables shall be attached to the equipment supplied by an insulated strain clamp or cable grip.

§ 75.521 Damaged conductors and cables.

Conductors and cables shall be deenergized, disconnected in accordance with 30 CFR 75.506, and either removed from service or repaired when they have—

(a) A damaged outer jacket;

(b) Damaged conductor insulation;

(c) A damaged conductor;

(d) A damaged splice or repair; or

(e) A splice that heats or sparks.

§ 75.522 Ampacities of low-voltage conductors.

(a) Electric conductors shall be of a size and current-carrying capacity to assure that a rise in temperature resulting from normal operating conditions does not damage the insulation and conductors.

(b) Branch circuit conductors supplying electric equipment shall have ampacities of at least 125 percent of the maximum full-load current rating of the equipment.

(c) Feeder circuit conductors supplying one or more loads shall have ampacities of at least the sum of the full-

load current rating of each load, plus 25 percent of the highest full-load current rating of the largest load.

(d) The ampacity of conductors for the equipment specified in paragraphs (b) and (c) of this section shall be at least that specified in Tables F–1 through F–4 below:

(1) Table F–1 for flexible cords rated 300 and 600 volts.

TABLE F–1.—ALLOWABLE AMPACITIES OF 300- AND 600-VOLT FLEXIBLE CORDS; COPPER CONDUCTORS

Conductor size AWG	Types S, SO, SJO, ST, STO, SJT, SJTO, SOO, SJOO, STOO, SJTOO		Types AFS, AFSJ, HSJ, HSJO, HS, HSO
	Current-carrying conductors		Current-carrying conductors
	2	3	3
14	18	15	20
12	25	20	30
10	30	25	35
8	.....	35	.....

(2) Table F–2 for portable power cables rated 2,000 volts or less.

TABLE F–2.—ALLOWABLE AMPACITIES OF SHIELDED AND UNSHIELDED 0- TO 2000-VOLT PORTABLE POWER CABLES; COPPER CONDUCTORS

[Based on Ambient Air Temperature of 20 °C (68 °F)]

Conductor size AWG or MCM	Ampacities—Number of current-carrying conductors in cable or raceway						
	1		2		3		
	75 °C [1]	90 °C [1]	75 °C [1]	90 °C [1]	75 °C [1]	90 °C [1]	90 °C [2]
8	75	98	63	85	63	70	.....
6	106	128	81	112	81	93	110
4	138	171	113	150	106	123	144
3	163	197	131	171	125	142	165
2	188	227	150	197	144	163	188
1	213	263	175	225	163	190	217
1/0	250	304	213	256	181	219	249
2/0	294	352	244	295	213	254	287
3/0	344	407	281	337	244	294	329
4/0	394	472	325	387	275	339	379
250	438	525	356	428	306	378	419
300	494	590	388	472	344	421	470
350	556	651	419	514	381	465	513
400	600	708	450	555	406	507	555
500	681	820	519	618	469	575	632

[1] 0–2000 Volt Insulation, Unshielded Portable Power Cable
[2] 0–2000 Volt Insulation, Shielded Portable Power Cable

(3) Tables F–3 and F–4 for conductors other than flexible cords, or portable cables rated 2,000 volts or less.

TABLE F–3.—ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS RATED 0 TO 2000 VOLTS, 60 °C TO 90 °C, NOT MORE THAN THREE CURRENT-CARRYING CONDUCTORS IN RACEWAY OR CABLE (BASED ON AMBIENT AIR TEMPERATURE OF 20 °C (68 °F))

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18	.....	.....	.....	15	.....	.....	.....	.....	.....
16	.....	.....	20	19	.....	.....	.....	.....	.....
14	20	20	27	25	.....	.....	.....	.....	.....
12	25	25	33	30	20	20	27	25	12
10	35	35	43	40	29	30	33	35	10
8	46	55	60	59	35	44	43	49	8
6	64	72	76	81	46	55	60	65	6
4	81	94	103	103	64	72	82	81	4
3	98	111	120	119	75	83	92	92	3
2	110	127	136	140	87	99	109	108	2
1	127	144	158	162	98	111	120	124	1

TABLE F-3.—ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS RATED 0 TO 2000 VOLTS, 60 °C TO 90 °C, NOT MORE THAN THREE CURRENT-CARRYING CONDUCTORS IN RACEWAY OR CABLE (BASED ON AMBIENT AIR TEMPERATURE OF 20 °C (68 °F))—Continued

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
0	144	166	179	184	116	133	141	146	0
00	167	193	207	211	133	149	158	162	00
000	191	221	234	243	150	171	185	189	000
0000	225	254	272	281	173	199	212	221	0000
250	248	282	299	313	196	227	239	248	250
300	277	315	337	346	219	254	272	275	300
350	299	343	370	378	243	276	294	302	350
400	323	370	397	410	260	298	321	329	400
500	370	420	451	464	300	343	364	378	500
600	410	464	500	513	329	376	402	416	600
700	445	508	544	562	358	414	440	454	700
750	462	525	560	578	370	425	457	470	750
800	474	541	582	599	381	436	467	486	800
900	502	575	614	632	410	470	506	518	900
1000	526	602	641	664	433	492	527	540	1000
1250	572	652	696	718	468	536	571	589	1250
1500	601	691	739	761	502	575	614	632	1500
1750	629	718	766	794	526	602	647	664	1750
2000	647	735	788	810	543	619	663	680	2000

TABLE F-4.—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2,000 VOLTS (BASED ON AMBIENT AIR TEMPERATURE OF 20 °C (68 °F))

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size awg or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				19					
16			25	26					
14	25	30	33	35					
12	30	35	43	40	25	30	33	35	12
10	40	50	60	55	35	40	43	40	10
8	69	77	82	86	52	61	65	65	8
6	92	105	109	113	69	83	87	86	6
4	121	138	147	151	92	111	114	119	4
3	139	160	174	178	110	127	138	140	3
2	162	188	201	205	127	149	158	162	2
1	191	215	234	238	150	171	179	189	1
0	225	254	272	281	173	199	212	221	0
00	260	293	315	324	202	232	245	254	00
000	300	343	364	378	231	265	288	297	000
0000	347	398	424	437	271	309	332	340	0000
250	393	448	478	491	306	348	375	383	250
300	433	492	527	545	335	387	413	427	300
350	485	558	598	616	381	436	467	481	350
400	526	602	647	664	410	470	505	518	400
500	595	685	734	756	468	536	571	589	500
600	664	762	815	842	526	597	647	664	600
700	728	834	897	923	578	657	707	729	700
750	757	867	929	956	595	685	734	756	750
800	785	901	962	994	618	713	761	783	800
900	843	961	1033	1064	670	774	826	848	900
1000	901	1033	1109	1139	722	829	886	913	1000
1250	1028	1177	1261	1296	820	945	1011	1037	1250
1500	1132	1298	1386	1431	918	1050	1125	1161	1500
1750	1236	1414	1516	1561	1010	1160	1245	1280	1750
2000	1334	1531	1636	1685	1109	1271	1359	1442	2000

§ 75.523 Overcurrent protection.

(a) All electric circuits and equipment shall be protected against overcurrents by circuit breakers, fuses, or other automatic circuit interrupting devices in accordance with this section, except as otherwise provided in MSHA's regulations.

(b) Overload devices shall be installed in each ungrounded power conductor supplying motors and shall—

(1) Be rated or set as specified in Table F–5; and

(2) Cause deenergization of all ungrounded power conductors when any conductor is overloaded.

TABLE F–5.—MAXIMUM RATING OR SETTING OF MOTOR OVERLOAD PROTECTIVE DEVICES

Motor markings	Percent of full load current
Service Factor Greater than 1.15	125
Temperature Rise not Over 40 degrees C	125
All Others	115

(c) Circuit breakers shall be installed to provide short-circuit protection for branch circuits supplying three-phase motors and shall be rated or set as specified in Table F–6.

TABLE F–6.—MAXIMUM RATING OR SETTING OF MOTOR BRANCH-CIRCUIT SHORT-CIRCUIT PROTECTIVE DEVICES FOR THREE-PHASE MOTORS

Type of motor	Percent of full-load current	
	Instantaneous trip breaker	Inverse time breaker
All Polyphase Squirrel-Cage and Synchronous Motors with Full-Voltage, Resistor or Reactor Starting:		
No Code Letter	700	250
Code Letter F to V	700	250
Code Letter B to E	700	200
Code Letter A	700	150
All AC Squirrel-Cage and Synchronous Motors with Autotransformer Starting:		
Not More than 30 Amps No Code Letter	700	200
More than 30 Amps:		
No Code Letter	700	200
Code Letter F to V	700	200
Code Letter B to E	700	200
Code Letter A	700	150
High-Reactance Squirrel-Cage:		
Not More than 30 Amps No Code Letter	700	250
More than 30 Amps No Code Letter	700	200
Wound-Rotor—No Code Letter	700	150

(d) Circuit breakers or fuses shall be installed to provide short-circuit protection for branch circuits supplying single-phase and direct-current motors and shall be rated or set as specified in Table F–7.

TABLE F–7.—MAXIMUM RATING OR SETTING OF MOTOR BRANCH-CIRCUIT SHORT-CIRCUIT PROTECTIVE DEVICES FOR SINGLE-PHASE MOTORS AND DIRECT-CURRENT MOTORS

Type of motor	Percent of full-load current			
	Nontime delay fuse	Dual element (time-delay) fuse	Instantaneous trip breaker	Inverse time breaker
Single-Phase, All Types No Code Letter	300	175	700	250
All AC Single-Phase with Full-Voltage, Resistor or Reactor Starting:				
No Code Letter	300	175	700	250
Code Letter F to V	300	175	700	250
Code Letter B to E	250	175	700	200
Code Letter A	150	150	700	150
Direct-Current (Constant Voltage)				
No More than 50 HP No Code Letter	150	150	250	150
More than 50 HP No Code Letter	150	150	175	150

(e) Where the setting specified in Table F–6 above is not sufficient for the starting current of alternating-current motors, the setting of a circuit breaker shall be permitted to be increased, but shall in no case exceed 1,300 percent of the motor's full-load current on instantaneous trip circuit breakers and 400 percent of the motor's full-load current for inverse-time circuit breakers.

(f) Circuit overcurrent protection for motor feeder circuits, transformers, and welders shall be provided by either circuit breakers or fuses in accordance with Table F–8 below:

TABLE F–8.—MAXIMUM OVERCURRENT PROTECTION SETTINGS FOR TRANSFORMERS, WELDERS, WELDER BRANCH CIRCUITS, AND MOTOR FEEDER CIRCUITS

Circuits and equipment	Ratings	Location
Transformers	250% of rated full load primary current	Each ungrounded power conductor supplying power to the transformer.
Welders	200% of rated primary current	Each ungrounded power conductor supplying power to equipment.
Welder Branch Circuit	200% of cable ampacity	Each ungrounded power conductor.
Motor Feeder Circuits	100% of the fuse or circuit breaker rating protecting the largest motor plus the sum of the full load currents of all the other motors supplied from the system or 100% of the ampacity of the feeder conductors.	Each ungrounded power conductor at the beginning of the feeder circuit.

(g) All electric equipment not addressed in paragraphs (b) through (f) of this section shall be protected by circuit breakers or fuses with ratings or settings not to exceed the full load current ratings of the equipment.

(h) All supply, control, lighting, and other conductors not addressed in paragraphs (b) through (f) of this section shall be protected at their ampacity.

(i) Overcurrent protection shall not be required on incandescent lamps supplied from direct-current systems, provided the length of ungrounded conductors does not exceed eight feet.

(j) When the required rating of a fuse or circuit breaker without an adjustable trip unit does not correspond to a standard rating for fuses or circuit breakers, the protective device used shall not exceed the next higher standard device rating.

(k) Circuit breakers or fuses providing short-circuit protection shall be installed where the circuit conductors are connected to the supply, except for feeder tap conductors that—

(1) Do not exceed 25 feet in length;

(2) Have ampacities of at least one-third of the ampacity of the feeder conductors; and

(3) Terminate at a circuit breaker or fuse with a current rating that does not exceed the ampacity of the feeder tap conductors.

§ 75.524 General requirements for overcurrent devices.

(a) Fuses, circuit breakers, or a combination of both shall not be connected in parallel.

(b) Fuses and circuit breakers shall have voltage ratings of at least the maximum voltage of the circuit being protected.

(c) Fuses and circuit breakers shall have a continuous current rating of at least the maximum full-load current of the circuit.

(d) Fuses and circuit breakers shall have interrupting current ratings of at least the maximum fault current available at the fuse or breaker.

(e) Circuit breakers shall be installed so that the "up" position of the handle indicates the "on" position.

(f) Circuit breakers shall not automatically reclose after tripping operations, except as provided in 30 CFR 75.1006.

(g) Thermal cutouts, thermal relays and other devices used for overload protection of motor circuits shall not be used for protection against short circuits, unless the devices are designed for short-circuit protection.

(h) A fuse or an overcurrent trip device of a circuit breaker shall be connected in series with each ungrounded power conductor, except that a combination of a current transformer and relay used as an overcurrent trip device does not have to be installed in series.

(i) Overcurrent devices shall be readily accessible and protected against physical damage.

(j) Renewable link-type fuses shall not be used for protection of low-voltage circuits and equipment.

§ 75.525 Identification of circuit breakers and fuse holders.

Circuit breakers, trolley taps, fuse switchboxes, and other fuse holders shall be legibly, durably, and distinctively marked to identify the unit of equipment or circuit protected.

§ 75.526 Nameplates and markings.

Motors, transformers, and circuit breakers shall have a nameplate or other durable markings indicating the manufacturer's name and the rated voltage and current.

§ 75.527 Map of the mine electrical system.

(a) A map of the mine electrical system shall be maintained and made available for inspection by authorized representatives of the Secretary and representatives of the miners, and shall indicate—

(1) The size and location of circuit breakers, fuses, transformers, cables, rectifiers, switchgear, and disconnecting devices of high-voltage systems;

(2) The size and location of stationary equipment operated by 10 horsepower or larger motors;

(3) The size and location of trolley wires, trolley feeder wires and return feeder wires;

(4) The size and location of track rails used as power conductors with a notation as to whether one or both rails are bonded or welded at every joint;

(5) The size, location and settings of direct-current circuit breakers protecting trolley circuits;

(6) The location of cutout switches and deadblocks installed in trolley circuits; and

(7) The size and location of compressor stations.

(b) Changes in the mine electrical system shall be reflected on the map within 5 working days after the circuit or equipment is reenergized and returned to service.

§ 75.528 Alternating-current battery chargers for mining vehicles.

Alternating-current battery chargers for mining vehicles installed on or after [insert the effective date of the rule] shall have—

(a) A two-winding transformer that electrically isolates the battery charging circuit from the alternating-current supply circuit;

(b) A control circuit with a maximum voltage which does not exceed 150 volts; and

(c) An electrostatic (Faraday) shield between the secondary and primary windings when the charger is supplied from a circuit having a voltage that exceeds 150 volts. Such shields shall be aluminum or copper, connected to the battery charger frame, and have a cross-sectional area consistent with 30 CFR 75.714(c).

§ 75.529 Emergency deenergization devices for mobile electric equipment.

(a) Except as provided in paragraph (b) of this section, mobile electric face equipment shall have devices capable of quickly deenergizing the tramming motors of the equipment as follows:

(1) An emergency deenergization device consisting of an electro-mechanical stop switch and an actuating bar extending a sufficient distance in each direction from the stop switch to permit quick actuation of the device shall be installed at each location from which the equipment can be operated;

(2) Actuating bars shall be installed on both sides of the operator's compartment on battery-powered articulated equipment that has the seating arranged so that the equipment operator normally faces a position 90 degrees from the direction of travel;

(3) When the equipment can be trammed from a location other than the operator compartment, the actuating bar shall be installed so that the bar is located between the operator and the machine at all times the machine is being trammed;

(4) The actuating bar shall be capable of causing the electro-mechanical stop switch to operate when it is moved a distance not to exceed two inches, and by a force of fifteen pounds or less; and

(5) Actuating bars shall not interfere with the normal operation of the equipment.

(b) Mobile electric face equipment that is equipped with a substantially constructed cab which meets the requirements of part 75 shall not be required to be provided with devices that will quickly deenergize the tramming motors of the equipment in the event of an emergency.

(c) The Director of Technical Support may approve other emergency deenergization devices if it is determined that equivalent protection would be provided. Operators shall apply to the Chief of the Approval and

Certification Center, Mine Safety and Health Administration, Industrial Park Boulevard, Rural Route 1, Box 251, Triadelphia, West Virginia 26059, for acceptance of the installation of other devices used in lieu of devices that will deenergize the tramming motors.

§ 75.530 Use of insulated trailing cable handling equipment.

(a) When energized high-voltage and unshielded low-voltage trailing cables are moved manually, insulated hooks, tongs, slings, gloves, mitts, aprons or other insulated personal protective equipment capable of protecting against shock shall be used.

(b) Insulated personal protective equipment shall be—

(1) Rated for at least the nominal voltage of the circuit for low-voltage trailing cables;

(2) Rated for at least 20,000 volts for high-voltage trailing cables;

(3) Examined before each use for visible signs of damage or defects; and

(4) Removed from the underground area of the mine when damaged or defective.

(c) Insulated handling equipment for use with high-voltage trailing cables shall be electrically tested every 6 months.

§ 75.531 Deenergized underground power circuits; idle days—idle shifts.

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

Subpart G—Low-Voltage Circuits

§ 75.600 Scope.

(a) The standards in this subpart contain requirements pertaining to low-voltage circuits, and include:

(1) Section 75.601, which addresses design and construction of trailing cables;

(2) Sections 75.602 and 75.603, which address electrical protection (short circuit, ground-fault, and undervoltage) of trailing cables. Section 75.602 also addresses electrical protection (overcurrent, ground-fault, and undervoltage) of low-voltage alternating-current systems which supply power to electric equipment located out by the working section, except for requirements pertaining to single-phase systems energized at 150 volts or less to ground, which are specified in subpart F. Specific requirements for overcurrent protection are specified in subpart F; and

(3) Section 75.604 addresses cable coupler physical restraint requirements for all low-voltage circuits.

(b) This subpart does not contain requirements pertaining to:

(1) Mechanical protection, splicing and repair, disconnecting devices, ground-wire monitors, and insulated handling equipment for low-voltage circuits, which are specified in subpart F of this part;

(2) System and equipment grounding, which are specified in subpart H;

(3) Electrical protection of alternating-current systems supplying power to stationary lighting fixtures for illumination of working places, which are specified in subparts F and R;

(4) Splicing and repairing of low-voltage cables and conductors, which are addressed in subpart F.

(5) The design and construction of on-board circuits and components of permissible equipment and intrinsically safe circuits.

§ 75.601 General requirements for trailing cables.

(a) Each trailing cable shall be flame resistant in accordance with 30 CFR 18.64.

(b) Each grounding conductor in a shielded trailing cable shall be bare.

(c) Ground-check and interlock conductors shall be contained in the cable and shall have a cross-sectional area equal to or greater than:

(1) No. 10 AWG when the circuit power conductors are No. 10 AWG or larger; or

(2) The cross-sectional area of one circuit power conductor when the circuit power conductors are smaller than No. 10 AWG.

(d) Each trailing cable shall contain at least one equipment safety grounding conductor unless the cable supplies—

(1) A tool that is double insulated; or

(2) A unit of equipment that is silicon diode grounded in accordance with subpart H.

(e) The power conductors in trailing cables for mobile haulage equipment shall be at least—

(1) No. 6 AWG for cables supplying alternating-current equipment; and

(2) No. 4 AWG for cables supplying direct-current equipment.

(f) Each power conductor in trailing cables for non-haulage equipment employing cable reels shall be at least No. 8 AWG.

(g) Trailing cables for mobile electric equipment energized with a nominal alternating-current voltage from 150 volts phase-to-ground to 660 volts phase-to-phase (381 volts phase-to-ground) shall be provided with a grounded metallic shield around each power conductor in accordance with the following schedule:

(1) Mobile electric equipment not employing cable reels after [insert date one year from the effective date of the final rule]; and

(2) Cable reel equipment after [insert date three years from the effective date of the final rule].

(h) Trailing cables energized with a nominal alternating-current voltage greater than 660 volts (381 volts phase-to-ground) shall be provided with a grounded metallic shield around each power conductor in accordance with the following schedule:

(1) Equipment not employing cable reels on and after [insert the effective date of the final rule]; and

(2) Cable reel equipment after [insert date three years from the effective date of the final rule].

(i) Prior to [insert date three years after the effective date of the final rule], trailing cables for low-voltage cable reel equipment energized with a nominal alternating-current voltage greater than 660 volts (381 volts phase-to-ground) shall be provided with a grounded metallic shield around each power conductor unless provided with insulation with a voltage rating of at least 2,000 volts.

(j) Metallic shielding on shielded cables acquired after [Insert the effective date] shall be applied in the form of braid or serving (wrap) to meet the following applicable requirements.

(1) Metallic braid shall provide at least 84 percent coverage.

(2) Metallic wire serving (wrap) shall provide at least 60 percent coverage.

(k) The length of a trailing cable shall not exceed the length specified in Table G–1 of this section.

TABLE G–1—MAXIMUM LENGTH OF TRAILING CABLE

	Conductor size		Maximum cable length in feet	
	AWG [1]	MCM [2]	Direct current	Alternating current
Less than.	6	.....	500	750
	6	.....	550	750
	4	.....	600	750
	3	.....	650	750
	2	.....	700	750
	1	.....	750	750
	1/0	.....	800	800
	2/0	.....	850	850
	3/0	.....	900	900
	4/0	.....	1000	1000
		250 or greater.	1000	1000

[1] AWG means American wire gage.
[2] MCM means one thousand circular mils.

§ 75.602 Electrical protection for alternating-current circuits.

(a) Except as provided in paragraph (b), each trailing cable shall be protected against short circuits, undervoltages, and ground faults by a circuit breaker of adequate interrupting capacity.

(b) Each single-phase trailing cable energized at 150 volts or less to ground shall be protected against short circuits and ground faults by a circuit breaker of adequate interrupting capacity.

(c) Each ungrounded power conductor of a trailing cable shall be protected by—

(1) An inverse-time circuit breaker with a maximum current rating specified in Table G–2 below;

(2) An instantaneous-trip circuit breaker with a maximum instantaneous setting specified in Table G–3 below; or,

(3) A short-time delay electronic circuit breaker having a time delay not to exceed 0.1 second and a maximum setting as specified in Table G–3.

TABLE G–2—MAXIMUM RATINGS OF FUSES PROTECTING DIRECT-CURRENT TRAILING CABLES AND INVERSE-TIME CIRCUIT BREAKERS

Conductor size (AWG or MCM)	Maximum inverse-time circuit breaker or fuse rating (amperes)		
	1 Ungrounded power conductor	2 Ungrounded power conductors	3 Ungrounded power conductors
14	15	15	15
12	20	20	20
10	30	30	25
8	60	50	50
6	90	70	70
4	110	110	110
3	150	150	150
2	150	175	175
1	175	200	200
1/0	200	225	225
2/0	250	250	250
3/0	300	300	300
4/0	350	350	350
250	350	350	350
300	400	350	350
350	450	350	350
400	500	400	400
500	600	450	400

TABLE G–3.—MAXIMUM SETTINGS OF INSTANTANEOUS AND ELECTRONIC CIRCUIT BREAKERS PROTECTING 480, 600, AND 1040 VOLT ALTERNATING-CURRENT TRAILING CABLES

Conductor size (AWG or MCM)	Cable length (feet)	Maximum circuit breaker setting (amperes)		
		480V	600V	1040V
14	0–500	75	100	
	501–750	50	75	
12	0–500	125	175	
	501–750	100	125	
10	0–500	200	250	
	501–750	150	200	
8	0–500	300	400	
	501–750	200	300	
6	0–550	450	550	850
	501–750	350	450	700
4	0–500	750	900	1250
	501–600	650	800	1100
	601–750	550	650	1000
3	0–500	900	1100	1400
	501–650	700	900	1200
	651–750	650	800	1100
2	0–500	1100	1250	1500
	501–600	950	1100	1400
	601–750	800	950	1250
1	0–500	1300	1450	1650
	501–600	1100	1300	1550
	601–750	950	1100	1400
1/0	0–500	1500	1650	1750
	501–600	1300	1500	1650
	601–750	1100	1300	1500
	751–800	1050	1250	1500
2/0	0–500	1700	1800	1850
	501–600	1500	1650	1750
	601–750	1350	1450	1650
	751–850	1200	1350	1550
3/0	0–500	1900	1950	1900
	501–600	1700	1800	1800
	601–750	1500	1650	1700
	751–900	1300	1450	1650
4/0	0–500	2100	2100	1950
	501–600	1900	1950	1900
	601–750	1700	1800	1800
	751–1000	1400	1550	1650
250	0–500	2150	2150	2000
	501–600	2000	2050	1900
	601–750	1750	1850	1850
	751–1000	1500	1650	1700
300	0–500	2300	2250	2000
	501–600	2100	2100	1950
	600–750	1900	1950	1900
	751–1000	1600	1750	1750
350	0–500	2350	2300	2050
	501–600	2200	2200	2000
	601–750	2000	2000	1900
	751–1000	1700	1800	1800
400	0–500	2450	2350	2100
	501–600	2250	2250	2000
	601–750	2050	2100	1950
	751–1000	1800	1850	1850
500	0–500	2500	2400	2100
	501–600	2350	2300	2050
	601–750	2150	2150	1950
	751–1000	1900	1950	1850

(d) Upon investigation, the District Manager may permit in writing other circuit breaker short-circuit settings if technical data deem it appropriate and it does not pose a hazard to the miners.

(e) Overcurrent, ground-fault and undervoltage protection shall be provided by circuit breakers of adequate interrupting capacity for the following alternating-current circuits, other than trailing cables:

(1) Resistance-grounded three-phase circuits.

(2) Single-phase circuits energized at more than 150 volts-to-ground.

(3) Ungrounded circuits installed in accordance with 30 CFR 75.701(b).

(f) A circuit breaker used to protect two or more branch circuits shall provide overcurrent protection for the smallest conductor.

(g) Overcurrent protection for alternating-current circuits other than trailing cables shall meet the requirements of 30 CFR 75.523.

(h) Ground-fault devices shall deenergize the faulted circuit at 40 percent or less of the maximum ground-fault current of the system.

(i) The ground-fault device nearest the connected load shall be activated with no intentional time delay. When the operating times of upstream ground-fault detection devices within a system are increased to provide selective tripping, the operating time of the most upstream device shall not exceed 1.0 second.

(j) Equipment safety grounding conductors shall not pass through or be connected in series with ground-fault current transformers.

(k) Effective [insert date six months after effective date] resistance-grounded systems for trailing cables shall have a test circuit that injects a current of 50 percent or less of the maximum ground-fault current of the system. The test circuit shall be operated at least once every seven days, causing each circuit breaker to open.

(l) The ground-fault current device and circuit breaker shall be removed from service or repaired when the circuit breaker fails to open upon operation of the test circuit required by paragraph (k) of this section.

(m) Undervoltage devices shall be—

(1) Undervoltage trip coils; or

(2) Shunt trip coils energized by undervoltage relays or ground-monitor relays. Such coils shall be energized by stored energy devices to assure the circuit breaker will trip upon loss of control voltage.

(n) Circuit breakers protecting multiple trailing cables operating in parallel shall be interlocked such that all such trailing cables will be deenergized simultaneously.

§ 75.603 Electrical protection for direct-current trailing cables.

(a) Except as provided in paragraph (f), each ungrounded power conductor of a trailing cable shall be protected against short circuits by one of the following:

(1) An inverse-time circuit breaker of adequate interrupting capacity with a

maximum current rating as specified in Table G–2 above;

(2) An individual fuse with a ximum current rating as specified in Table G–2 when the trailing cable is supplied from a solid-grounded system; or

(3) An instantaneous-trip circuit breaker of adequate interrupting capacity with a maximum instantaneous setting as specified in Table G–4.

TABLE G–4.—MAXIMUM SETTINGS OF INSTANTANEOUS CIRCUIT BREAKERS PROTECTING 300 AND 600 VOLT DIRECT-CURRENT TRAILING CABLES

Conductor size (AWG or MCM)	Cable length (feet)	300 VDC maximum instantaneous circuit breaker setting (amperes)		600 VDC maximum instantaneous circuit breaker setting (amperes)	
		Line-line [1]	Line-ground [2]	Line-line [1]	Line-ground [2]
14	0–500	50	50	50	50
12	0–500	75	75	125	125
10	0–500	75	75	200	200
8	0–500	100	100	300	300
6	0–550	200	100	450	300
4	0–500	450	250	600	500
	501–600	350	200	550	400
3	0–500	450	350	700	550
	501–650	400	250	600	450
2	0–500	600	450	750	600
	501–600	550	400	700	550
	601–700	450	300	650	500
1	0–500	900	600	1400	1050
	501–600	750	500	1250	950
	601–750	600	400	1050	800
1/0	0–500	1100	750	1600	1250
	501–600	950	650	1450	1100
	601–750	750	550	1250	950
	751–800	700	500	1200	900
2/0	0–500	1350	950	1800	1450
	501–600	1150	800	1650	1300
	601–750	950	650	1450	1100
	751–850	850	600	1350	1050
3/0	0–500	1550	1150	2000	1650
	501–600	1400	1000	1850	1500
	601–750	1150	800	1650	1300
	751–900	1000	700	1500	1150
4/0	0–500	1850	1400	2200	1850
	501–600	1600	1200	2050	1700
	601–750	1400	1000	1850	1500
	751–1000	1100	750	1600	1250
250	0–500	2050	1550	2350	2000
	501–600	1800	1350	2200	1850
	601–750	1550	1150	2000	1650
	751–1000	1250	900	1750	1400
300	0–500	2300	1750	2450	2150
	501–600	2050	1550	2350	2000
	601–750	1750	1300	2150	1800
	751–1000	1450	1050	1900	1550
350	0–500	2550	1950	2600	2300
	501–600	2250	1700	2450	2150
	601–750	1950	1500	2300	1950
	751–1000	1600	1200	2050	1700
400	0–500	2750	2150	2650	2400
	501–600	2450	1900	2550	2250
	601–750	2150	1600	2400	2050
	751–1000	1750	1350	2150	1800
500	0–500	3050	2450	2800	2550
	501–600	2800	2200	2700	2400
	601–750	2450	1900	2550	2250
	751–1000	2050	1550	2350	2000

[1] The line-to-line instantaneous circuit breaker settings shall be used for trailing cables supplying power to diode grounded equipment and for trailing cables containing a separate equipment safety grounding conductor if the circuit is provided with separate ground-fault protection.

[2] The line-to-ground instantaneous circuit breaker settings shall be used for trailing cables containing a separate equipment safety grounding conductor when the circuit is not provided with separate ground-fault protection.

(b) Upon investigation, the District Manager may permit in writing higher fuse ratings or circuit breaker settings than those specified in paragraph (a) of this section for short-circuit protection if technical data deem them appropriate and they do not pose a hazard to the miners.

(c) Fuses shall be approved in accordance with part 28 of this Chapter.

(d) Fuses shall have a direct-current voltage rating of at least equal to the maximum system voltage.

(e) Each trailing cable supplied from a resistance-grounded system shall be protected against ground faults by a circuit breaker of adequate interrupting capacity, that deenergizes the circuit when the ground-fault current exceeds 40 percent of the current rating of the grounding resistor.

(f) Each trailing cable supplied power from a system that has the direct neutral of the rectifier bridge supply-transformer solidly grounded shall be protected against ground faults by an

instantaneous trip circuit breaker of adequate interrupting capacity that deenergizes the circuit at a ground-fault current value not to exceed 50 amperes.

(g) The ground-fault device nearest the load shall operate with no intentional time delay.

(h) Equipment safety grounding conductors shall not pass through or be connected in series with ground-fault current transformers.

§ 75.604 Physical restraints for cable couplers.

When two or more circuit breakers with different ratings, trip elements, or instantaneous trip ranges are installed in the same distribution box, power center, or rectifier, each cable coupler (plug) shall be equipped with a physical restraint to prevent the connection of a cable to a circuit breaker that is not properly rated or adjusted for that cable.

Subpart H—Grounding

§ 75.700 Scope.

(a) The standards in this subpart apply to—

(1) Grounding of metallic parts, raceways and enclosures of electric equipment;

(2) Grounding methods of alternating-current and direct-current systems;

(3) Grounding of alternating-current equipment frames and components, including battery cases, connected to alternating-current battery charging systems;

(4) Grounding of direct-current equipment frames and components including messenger wires, metallic racks and structures that support power conductors and metallic overcasts;

(5) Diode grounding systems; and

(6) System and supplemental low-resistance ground fields.

(b) Additional requirements for grounding high-voltage electric face equipment are also specified in subpart I.

(c) Additional requirements for grounding alternating-current systems supplying power to stationary lighting fixtures for illumination of working places are specified in more detail in subpart R.

§ 75.701 Low-voltage alternating-current system grounding.

Each low-voltage alternating-current system that extends or originates underground, shall be grounded by having either a direct or a derived neutral connected to the grounding medium through a grounding resistor, except for the following systems:

(a) A solidly-grounded single-phase system that—

(1) Supplies only stationary or portable electric equipment; and

(2) Has either a direct neutral or phase conductor solidly connected to the system grounding medium so that the phase-to-ground voltage is 150 volts or less.

(b) An ungrounded system that—

(1) Supplies only stationary equipment;

(2) Has ground-fault protection which automatically deenergizes all phase conductors when any phase conductor is grounded; and

(3) Has all phase conductors totally enclosed in either rigid metallic conduit, metallic armored cable, metal-clad cable or shielded cable when the phase-to-phase voltage exceeds 150 volts. See Figure H–1 in Appendix A.

(c) An ungrounded single-phase system that—

(1) Has a phase-to-phase voltage of 150 volts or less; and

(2) Originates on the secondary side of a two-winding transformer equipped with a metallic (Faraday) shield connected to the grounding medium to isolate the low-voltage secondary winding from the primary winding. See Figure H–2 in Appendix A.

(d) An ungrounded system that—

(1) Supplies only a rectifier which is mounted with the source transformer or generator on a common metallic frame; and

(2) Has the conductors totally enclosed in either rigid metallic conduit, metallic armored cable, metal clad cable, or shielded cable when the phase-to-ground voltage exceeds 150 volts.

(e) An ungrounded system that has the supply transformers and all other components contained in a single metallic enclosure or installed on the common metallic frame of electric face equipment.

§ 75.702 Low-voltage alternating-current system grounding mediums.

The system grounding medium for a low-voltage alternating-current system shall be the metallic frame or metallic enclosure of the generator, transformer, or transformer bank that is connected to a low-resistance ground field. See Figure H–3 in Appendix A.

§ 75.703 High-voltage alternating-current system grounding.

High-voltage alternating-current systems that extend underground shall be grounded by having either a direct or a derived neutral connected to the grounding medium through a grounding resistor, except for ungrounded systems that—

(a) Supply only stationary equipment;

(b) Have a nominal phase-to-phase voltage which does not exceed 2,400 volts;

(c) Have ground-fault protection which automatically deenergizes all phase conductors when any phase conductor is grounded; and

(d) Have all phase conductors totally enclosed in rigid metallic conduit, metallic armored cable, metal-clad cable, or shielded cable. See Figure H–4 in Appendix A.

§ 75.704 High-voltage alternating-current system grounding mediums.

(a) The system grounding medium for a resistance-grounded system shall be—

(1) A low-resistance ground field for a transformer-derived system; or

(2) The metallic frame of the supply transformer or generator that is connected to a low-resistance ground field.

(b) The system grounding medium for an ungrounded system shall be the metallic frame or metallic enclosure of the supply transformer, transformer bank, or generator which is connected to a low-resistance ground field. See Figure H–5 in Appendix A.

§ 75.705 Direct-current system grounding.

Each direct-current system that extends or originates underground shall be one of the following systems:

(a) A solid-grounded trolley system that has one conductor solidly connected to the track.

(b) A solid-grounded system, other than a trolley system, that has one conductor solidly connected to the system grounding medium.

(c) A solid-grounded system that has the direct neutral of the alternating-current system supplying only a rectifier bridge solidly connected to the system grounding medium. See Figure H–7 in Appendix A.

(d) A resistance-grounded system that has either a direct or a derived neutral of the alternating-current system supplying only a rectifier bridge connected to the grounding medium through a grounding resistor. See Figure H–8 in Appendix A.

(e) An ungrounded system that has—

(1) Ground-fault protection which automatically deenergizes all power conductors when any phase conductor is grounded; and

(2) A line-to-line system voltage of 330 volts or less. See Figure H–9 in Appendix A.

(f) A battery-powered system that is ungrounded.

(g) An ungrounded system derived on-board mobile electric equipment.

§ 75.706 Direct-current system grounding mediums.

(a) The system grounding medium for each direct-current trolley system shall be the mine track.

(b) The system grounding medium for direct-current systems derived on-board mobile electric equipment, including battery-powered equipment, shall be the metallic frame of the equipment.

(c) The system grounding mediums for all other direct-current systems shall be the metallic frame or metallic enclosure of the power source that is connected to a low-resistance ground field. See Figure H–10 in Appendix A.

§ 75.707 Grounding resistors.

Each grounding resistor shall—

(a) Have a resistance value that—

(1) Limits ground-fault currents to 25 amperes or less on low-voltage systems; and

(2) Limits the voltage drop in the grounding circuit external to the resistor to not more than 100 volts during a ground-fault on high-voltage systems. See Figure H–6 in Appendix A;

(b) Be extended-time rated at a current value at least equal to the maximum ground-fault current that can flow through the resistor;

(c) Be supported by insulators which have voltage ratings that are at least equal to the phase-to-phase alternating-current voltage of the system; and

(d) Be located in the same substation or enclosure or installed on a common metallic frame with the alternating-current source supplying the system.

§ 75.708 Loads connected on resistance-grounded systems.

Loads shall be connected phase-to-phase on alternating-current systems and line-to-line on direct-current systems that are resistance-grounded.

§ 75.709 Low-resistance ground fields.

(a) Low-resistance ground fields used in the safety grounding system shall be designed and installed in a manner to assure that the maximum exposure voltage under fault conditions will not create hazardous step and touch potentials. The following parameters shall be considered in evaluating ground field safety—

(1) Soil resistivity;

(2) Available fault current;

(3) Grounding field construction; and

(4) Operating times of protective devices.

(b) Low-resistance ground fields used in the safety grounding system shall be maintained at 25 ohms or less, unless an evaluation of the system in accordance with paragraph (a) of this section indicates that—

(1) A lower value of resistance is necessary; or

(2) A higher value of resistance may be used.

(c) Resistance to earth shall be tested by a low-voltage or high-voltage qualified electrician, as applicable, when installed and at least annually thereafter. Records of such tests shall be made in accordance with 30 CFR 75.508.

(d) Materials used for ground fields shall have at least four square feet of surface area in contact with soil.

§ 75.710 Alternating-current equipment frame grounding.

(a) The following equipment shall be connected to the system grounding mediums required by 30 CFR 75.702 and 75.704 by equipment safety grounding conductors:

(1) Metallic frames, enclosures, and other exposed non-current-carrying metallic parts of conductors and equipment, unless double insulated.

(2) Metallic fences and barriers around high-voltage equipment and installations.

(3) Metallic battery trays.

(4) Metallic messenger wires.

(5) Metallic structures or racks that support electric equipment or conductors.

(b) Metallic cable shielding shall be connected to the equipment safety grounding conductor at each termination.

(c) Before batteries are connected to a battery charger, the metallic battery trays shall be connected to the grounded metallic frame of the battery charger and shall remain connected until the batteries have been disconnected from the charger.

§ 75.711 Ground-wire monitors for alternating-current equipment.

(a) Low-voltage resistance-grounded systems shall have ground-wire monitors to continuously monitor the continuity of the grounding circuits to the equipment affected except for—

(1) Low-voltage circuits supplying power to longwall illumination systems; and

(2) Low-voltage stationary equipment installed in accordance with all of the following:

(i) The equipment is permanently installed at a fixed location.

(ii) All load components of the equipment are securely attached to a common metallic frame or structure.

(iii) Each component of the equipment is grounded by two independent equipment safety grounding conductors each sized in accordance with 30 CFR 75.714.

(iv) At least one of the equipment safety grounding conductors to each component is visible for its entire length.

(b) High-voltage resistance-grounded systems shall have ground-wire monitors to continuously monitor the continuity of the grounding circuits, except for the portions of the circuits extending from resistance-grounded systems that supply power to either surface stationary equipment or stationary circuit breakers located downstream and used to protect circuits extending underground.

(c) Circuits supplying surface stationary equipment that are not equipped with ground-wire monitors shall meet the following:

(1) Metallic frames or enclosures of the equipment shall be separately connected to supplemental ground fields at the equipment, and to the system ground field by equipment safety grounding conductors. See Figure H–11 in Appendix A.

(2) Circuit breakers shall be separately connected to supplemental ground fields at the circuit breaker, and to the system ground fields by equipment safety grounding conductors. See Figure H–11 in Appendix A.

(3) Supplemental system ground fields shall have resistance-to-earth values which do not exceed the value obtained by dividing 100 volts by the maximum ground-fault current of the system.

(d) Ground-wire monitors for cables extending to electric face equipment shall—

(1) Be designed and constructed to be fail safe; and

(2) Provide continuous monitoring of the grounding circuit to the equipment.

(e) Ground-wire monitors shall cause the affected circuit breaker to open when:

(1) The ground-check conductor is broken at any point; and

(2) Either the equipment safety grounding conductor is broken at any point, or the impedance of the grounding circuit increases beyond the amount necessary to cause a drop in the voltage of the grounding circuit external to the grounding resistor equal to—

(i) 40 volts under ground-fault conditions for all low-voltage circuits and high-voltage trailing cables; or

(ii) 100 volts under ground-fault conditions for high-voltage circuits other than trailing cables.

(f) The open circuit voltage for ground-wire monitors shall not exceed—

(1) 40 volts for low-voltage circuits and circuits to electric face equipment; and

(2) 96 volts for high-voltage circuits other than circuits to electric face equipment.

(g) Ground-check and equipment safety grounding conductors shall be separately connected to the metallic frames or enclosures of electric equipment.

§ 75.712 Direct-current equipment frame grounding.

(a) The following shall be connected to the appropriate grounding medium required by 30 CFR 75.706 by equipment safety grounding conductors—

(1) Metallic frames, enclosures, and other exposed noncurrent-carrying metallic parts of conductors and equipment.

(2) Metallic messenger wires used to support direct-current conductors.

(3) Metallic racks and structures used to support trolley wires and trolley feeder wires.

(4) Metallic overcasts in trolley entries.

(b) Silicon diode grounding systems shall be installed in accordance with 30 CFR 75.713.

(c) Component parts of complete units of equipment shall be solidly connected to the frames of the equipment.

§ 75.713 Silicon diode grounding.

When the metallic frames of mobile equipment are grounded by silicon diodes, the diode grounding system shall meet the following:

(a) The polarity of each grounding diode shall be compatible with the grounded polarity of the direct-current system.

(b) Each grounding diode shall have a threaded base used to solidly connect the diode to the machine frame.

(c) An overcurrent device shall be installed between the grounding diode(s) and the grounded power conductor, and shall cause the main conductor or the circuit interrupting device to deenergize all circuits on the machine when 50 amperes or more flows through the grounding diode, except that methane monitor circuits may remain energized.

(d) A polarizing diode that prevents the unit of equipment from being operated when the polarity of the supply conductors is reversed shall be installed in the control circuit.

(e) The forward current rating of each grounding diode shall be equal to or greater than 750 amperes when used to ground a continuous mining machine or equal to or greater than 400 amperes when used to ground other equipment.

(f) The peak inverse voltage rating of the grounding and polarizing diodes, shall be at least 1,200 volts.

§ 75.714 Equipment safety grounding conductors.

(a) Equipment safety grounding conductors for portable and mobile electric equipment shall be one or more stranded copper conductors contained within the cable or flexible cord supplying the equipment.

(b) Equipment safety grounding conductors for stationary equipment shall be copper or equivalent, and be either—

(1) Contained together with the circuit conductors in the raceways, cables, or cords; or

(2) Wrapped around the raceways, cables, or cords containing the circuit conductors.

(c) The combined cross-sectional area of equipment safety grounding conductors shall be equal to or greater than—

(1) One-half the cross-sectional area of one circuit conductor when the circuit conductor is No. 6 AWG or larger; or

(2) The cross-sectional area of one circuit conductor when the circuit conductor is smaller than No. 6 AWG.

(d) Equipment safety grounding conductors installed outside of raceways, cables, or cords and used to ground stationary equipment shall be No. 6 AWG or larger.

(e) Switches, fuses, circuit breakers, ground-fault devices and overcurrent devices shall not be installed in equipment safety grounding conductors.

(f) Ground-wire devices installed in the equipment safety grounding conductor for the purpose of inter-machine arc suppression or in conjunction with ground-wire monitoring systems shall be designed and constructed to withstand the maximum amount of phase-to-phase fault current to which they may be exposed without creating an electrical shock or fire hazard.

(g) When used, ground-wire devices specified in paragraph (f) of this section shall be connected to the grounding medium with two separate conductors.

(h) On direct-current powered equipment, the equipment safety grounding conductor and the return power conductor shall be separately connected to the mine track, grounded return-feeder conductor, or metallic frame or enclosure used as the grounding medium.

(i) Equipment safety grounding conductors for draw-out equipment or plugs and receptacles shall be the first conductors made when making connections and the last conductors broken when breaking connections.

(j) Equipment safety grounding conductors shall be connected by welds, pressure connectors, or clamps.

(k) Equipment safety grounding conductors shall be bare or shall be properly identified.

Subpart I—High-Voltage Alternating-Current Circuits

§ 75.800 Scope.

(a) This subpart contains requirements pertaining to high-voltage circuits and equipment used underground. Section titles in this subpart specify when the requirements pertain only to high-voltage electric face equipment and associated trailing cables. Several requirements pertaining to all high-voltage circuits and equipment are also specified in subparts F and H.

(b) This subpart does not apply to the ampacities of conductors and overload protection for circuits extending to and on board permissible face equipment, which are specified in the applicable approval regulations.

§ 75.801 High-voltage systems.

High-voltage systems shall originate on the surface, except systems that supply power to underground face equipment may originate underground.

§ 75.802 Protection for circuits, other than trailing cables.

(a) High-voltage systems supplying underground electric equipment shall be protected by circuit breakers of adequate interrupting capacity which are equipped with devices that provide all of the following:

(1) Overcurrent protection.

(2) Ground-fault protection.

(3) Undervoltage protection, except for branch circuits supplying only stationary surface loads. See Figure I–1 in Appendix A.

(b) High-voltage circuits that extend underground shall be protected by at least one circuit breaker located on the surface.

(c) Overcurrent protection for high-voltage circuits shall consist of protective devices that protect at least two power conductors.

(d) A circuit breaker used to provide protection for two or more branch circuits shall provide overcurrent protection for the smallest conductor.

(e) Overcurrent devices shall have—

(1) A pickup value of 125 percent or less of the ampacity for the smallest power conductors in the protected circuit as listed in Tables I–1 and I–2; and

(2) Inverse-time current characteristics that require the device to operate within 2 seconds when a current 10 times the allowable ampacity of the smallest power conductor, as listed in Tables I–1 and I–2, flows in the circuit.

TABLE I-1 ALLOWABLE AMPACITIES OF SHIELDED, THREE CONDUCTOR, 2001-15,000 VOLT, MINE POWER CABLE; COPPER CONDUCTORS

[Based on Ambient Temperature of 20 °C]

Conductor size (AWG or MCM)	Ampacities			
	2001-8000 Volts		8001-15000 Volts	
	75 °C	90 °C	75 °C	90 °C
6	99	110	.....	.....
4	130	144	.....	.....
2	170	188	175	194
1	196	217	200	221
1/0	226	249	230	254
2/0	260	287	263	290
3/0	299	329	301	334
4/0	343	379	346	384
250	379	419	383	424
300	423	470	426	473
350	465	513	468	517
400	500	555	502	558
500	571	632	571	632

TABLE I-2.—ALLOWABLE AMPACITIES OF SHIELDED, THREE CONDUCTOR, 2001-15,000 VOLT MINE POWER CABLES; ALUMINUM CONDUCTORS

[Based on Ambient Temperature of 20° C]

Conductor size (AWG or MCM)	Ampacities			
	2001-8000 Volts		8001-15000 Volts	
	75° C	90° C	75° C	90° C
4	101	112	.....	.....
2	133	146	136	.....
1	153	.....	156	.....
1/0	176	195	179	198
2/0	203	223	205	227
3/0	234	257	236	261
4/0	269	296	271	300
250	298	328	300	332
350	366	404	367	406
400	396	425	397	433
500	458	502	453	500

(f) Ground-fault protective devices shall be adjusted to deenergize the faulted circuit at 40 percent or less of the maximum ground-fault current of the system.

(g) The ground-fault protective device nearest to the load shall activate with no intentional time delay. When the operating times of upstream ground-fault detection devices within a system are increased to provide selective tripping, the operating time of the most upstream ground-fault detection device shall not exceed 3.0 seconds.

(h) Equipment safety grounding conductors shall not pass through or be connected in series with ground-fault current transformers.

(i) Undervoltage devices shall be—

(1) Undervoltage trip coils; or

(2) Shunt trip coils energized by undervoltage relays or ground-monitor relays. Such coils shall be energized by stored energy devices to assure the circuit breaker will trip upon loss of control voltage.

(j) A circuit breaker which is installed to protect an underground high-voltage circuit shall not automatically reclose after operation.

§ 75.803 High-voltage distribution equipment.

(a) Except for disconnecting devices installed underground on or before [insert effective date of the rule], high-voltage distribution equipment shall be enclosed in a grounded metallic enclosure, and shall have no exposed energized parts.

(b) High-voltage alternating-current distribution equipment shall be equipped with interlock and emergency stop switches which will automatically deenergize the incoming power conductors to the distribution equipment when a cover, lid, or panel that exposes energized high-voltage parts is removed, or when the emergency stop switch is actuated.

(c) The open-circuit voltage for an interlock circuit shall not exceed 96 volts.

(d) Effective [insert date 18 months after the effective date of the rule], all high-voltage distribution equipment, including high-voltage switchgear and power centers shall be equipped with barriers that provide separate compartments for:

(1) The incoming high-voltage disconnecting switch and feed-through circuit;

(2) The power transformer;

(3) The low-voltage distribution circuits; and

(4) The control circuitry, including ground-fault protective devices and ground-wire monitors.

(e) Barriers shall be constructed of grounded metal or nonconductive insulating board.

§ 75.804 High-voltage cables, other than trailing cables.

(a) High-voltage cables shall be located, buried, guarded or insulated to provide protection against physical damage and contact with other wires or

cables. Insulation to prevent contact with other wires or cables shall be in addition to that provided by the conductor insulation or cable jacket.

(b) High-voltage cables suspended above the mine floor shall be securely anchored.

(c) Single-conductor high-voltage cables shall be hung on a well supported grounded messenger wire or on insulated cable hangers.

(d) High-voltage cables shall not be moved or handled while energized.

(e) The power conductors in high-voltage cables shall be at least No. 8 AWG.

(f) Each high-voltage cable, other than a single-conductor cable, shall contain one or more bare equipment safety grounding conductors.

(g) Ground-check conductors and interlock circuit conductors contained in high-voltage cables shall be at least No. 10 AWG.

(h) Ground-check conductors and interlock circuit conductors which are external to high-voltage cables shall be at least No. 8 AWG.

(i) Single-conductor cables shall have equipment safety grounding conductors of either a bare ground-wire or a grounded messenger wire.

(j) High-voltage cables shall have grounded metallic shielding around each power conductor.

(k) Metallic shielding on high-voltage cables acquired after [insert the effective date of the rule] shall be applied in the form of braid, wire serving (wrap) or tape, as follows:

(1) Metallic braid shall provide at least 84 percent coverage.

(2) Metallic wire serving (wrap) shall provide at least 60 percent coverage.

(3) Metallic tape shall provide 100 percent coverage.

§ 75.805 Movement of high-voltage power centers and portable transformers.

Power centers and portable transformers shall be deenergized before they are moved from one location to another.

§ 75.806 Connection boxes.

Connection boxes used in high-voltage circuits shall—

(a) Be constructed of metal or its equivalent;

(b) Be watertight;

(c) Have the incoming and outgoing equipment safety grounding conductors separately connected to the metallic enclosures; and

(d) Be located in dry areas.

§ 75.807 Voltage requirements of electric face equipment.

(a) The nominal voltage of the power circuits of electric face equipment shall not exceed 4160 volts.

(b) The nominal voltage of the control circuits of electric face equipment shall not exceed 150 volts-to-ground.

§ 75.808 Electrical protection of electric face equipment.

(a) High-voltage systems supplying electric face equipment shall be protected by circuit breakers of adequate interrupting capacity which are equipped with devices that provide all of the following:

(1) Overcurrent protection.

(2) Ground-fault protection.

(3) Undervoltage protection.

(b) Each high-voltage motor circuit shall be provided with instantaneous short-circuit protection set at not more than 175 percent of the locked-rotor current of the motor or at not more than 75 percent of the minimum phase-to-phase short-circuit current available at the motor terminals, whichever value is less.

(c) High-voltage motor circuits shall be provided with backup short-circuit protection set at not more than—

(1) 1,200 amperes when the nominal voltage of the circuit exceeds 2,400 volts: or

(2) 2,000 amperes when the nominal voltage of the circuit is 2,400 volts or less.

(d) Time delays used for coordination with downstream short-circuit protective devices shall be not more than 0.4 seconds.

(e) Ground-fault currents shall be limited by a neutral grounding resistor to not more than—

(1) 6.5 amperes when the nominal voltage of the power circuit is 2,400 volts or less; or

(2) 3.75 amperes when the nominal voltage of the power circuit exceeds 2,400 volts.

(f) High-voltage motor circuits shall be provided with ground-fault protection, with no intentional time delay, set at not more than 0.1 amperes.

(g) High-voltage circuits extending from the section power center shall be provided with backup ground-fault protection set at not more than 40 percent of the current rating of the neutral grounding resistor. Time delays used for coordination with downstream ground-fault protection devices shall be not more than 0.4 seconds.

(h) The high-voltage neutral grounding resistor shall be provided with overtemperature protection that will open the ground-wire monitor circuit for the high-voltage circuit supplying the section power center if the grounding resistor is subjected to a sustained ground fault. The overtemperature rating or setting shall not exceed 50 percent of the maximum temperature rise of the grounding resistor.

(i) Equipment safety grounding conductors shall not pass through or be connected in series with ground-fault current transformers.

(j) Ground-fault current devices shall have a test circuit that injects a current of 50 percent or less of the maximum ground-fault current of the system and causes the circuit breakers to open.

(k) Undervoltage devices shall be—

(1) Undervoltage trip coils; or

(2) Shunt trip coils energized by undervoltage relays or ground-monitor relays. Such coils shall be energized by stored energy devices to assure the circuit breaker will trip upon loss of control voltage.

(l) Circuit breakers shall not automatically reclose after operation.

§ 75.809 Disconnecting devices for electric face equipment.

(a) The main circuit breaker at the section power center shall be equipped with a disconnecting device designed and installed so that it can be determined by visual observation that the contacts are open without removing any of the section power center covers.

(b) The main controller of longwall mining equipment shall be equipped with a disconnecting device that automatically grounds all load power conductors when the device is in the open position.

§ 75.810 Testing, examination, and maintenance of high-voltage electric face equipment.

(a) A high-voltage qualified electrician shall test, examine, and maintain high-voltage face equipment and circuits to determine that the electrical protection, equipment grounding, permissibility, cable insulation, and control devices, are being properly maintained to prevent fire, electrical shock, ignition or operational hazards from existing on the equipment.

(b) Each high-voltage grounding resistor and electrical protective device for electric face equipment shall be tested when installed in accordance with the following:

(1) Pass current through each current transformer necessary to cause the circuit breaker to open.

(2) Impress voltage across each potential ground-fault device necessary to cause the circuit breaker to open.

(3) Determine whether the grounding resistor is open or shorted.

(4) Assure that the overtemperature protective device will open the incoming ground-wire monitor circuit.

(c) Each unit of high-voltage electric face equipment shall be inspected and examined at least every seven days. Examination shall include actuation of the ground-fault test circuit required by 30 CFR 75.808(j).

(d) Each high-voltage circuit breaker shall be opened at least every 30 days by opening the corresponding ground-check conductor at the extreme end of the ground-wire monitoring circuit, where a ground-check conductor is used.

(e) When examinations or tests of equipment reveal a fire, electrical shock, ignition or operational hazard, the equipment shall either be removed from service or repaired.

(f) At the completion of examinations and tests required by this section, the person who makes the examinations and tests shall certify by signature and date that they have been conducted. A record shall be made of any unsafe condition found, and corrective action taken.

(g) Certifications and records shall be kept for at least one year, and shall be made available at the mine for inspection by authorized representatives of the Secretary and representatives of miners at the mine.

§ 75.811 Cables for high-voltage electric face equipment.

(a) Each high-voltage cable shall have a voltage rating of at least the nominal phase-to-phase voltage of the circuit in which it is used.

(b) Each high-voltage cable shall have grounded metallic shielding around each power conductor.

(c) Metallic shielding applied in the form of a braid shall provide at least 84 percent coverage.

(d) Metallic shielding applied in the form of a serving (wrap) shall provide at least 60 percent coverage.

(e) High-voltage trailing cables shall be flame resistant in accordance with 30 CFR 18.64.

(f) The power conductors shall be at least No. 4 AWG.

(g) High-voltage trailing cables shall contain one or more bare equipment safety grounding conductors.

(h) Ground-check and interlock circuit conductors shall be contained within the high-voltage cable, and be at least No. 10 AWG.

§ 75.812 Cable support system; high-voltage longwall electric face equipment.

(a) Longwall mining systems shall be equipped with cable handling systems and support systems that are designed, installed, and maintained to protect the high-voltage cables from damage and to minimize the possibility of miners inadvertently contacting the cables.

(b) High-voltage cables used on longwall mining systems shall be deenergized prior to the removal of the entry conveyor belt structure.

§ 75.813 Guarding of cables for high-voltage electric face equipment.

(a) High-voltage cables shall be guarded at the following locations:

(1) Where persons regularly work or travel over or under the cables; and

(2) Where the cables leave cable handling systems or support systems to extend to electric components.

(b) Guarding shall protect the cables from damage and prevent miners from contacting the cables. The guarding shall be grounded metal or nonconductive, flame-resistant material.

§ 75.814 Safety devices for high-voltage systems supplying electric face equipment.

(a) Each unit of high-voltage equipment shall be equipped with a barrier between—

(1) The main disconnecting device and motor starter compartment; and

(2) Each motor starter compartment.

(b) Each unit of high-voltage equipment shall have—

(1) Covers arranged so that persons can work in the motor starter compartment without being exposed to energized high-voltage conductors or parts when the disconnecting device at the main controller is in the open position; and

(2) Cover interlock switches provided to automatically deenergize the high-voltage circuit supplying the unit when any cover that provides access to energized high-voltage conductors or parts is removed.

(c) Barriers shall be constructed of grounded metal or nonconductive insulating board.

(d) Control circuits of electric face equipment shall have—

(1) A two-winding transformer that electrically isolates the control circuit from the high-voltage circuits; and

(2) An electrostatic (Faraday) shielded between the secondary and primary windings. Such shields shall be aluminum or copper, connected to the equipment frame, and have a cross-sectional area consistent with 30 CFR § 75.714(c).

§ 75.815 Procedures for working on high-voltage systems supplying electric face equipment.

(a) Before any electrical work, including testing, troubleshooting, and fault finding, is performed in the motor starter compartment, the high-voltage qualified electrician who performs the work shall—

(1) Assure that the contacts of the main circuit disconnecting device at the main controller are open and grounded;

(2) Lock out the disconnecting device with a padlock and;

(3) Tag the disconnecting device.

(b) Before any electrical work, including testing, troubleshooting and fault finding, is performed on a high-voltage cable or motor, the high-voltage qualified electrician who performs the work shall—

(1) Assure that the high-voltage cable is disconnected;

(2) Connect the phase conductors in the high-voltage cable to the grounding conductors;

(3) Lock out the cable with a padlock and;

(4) Tag the cable coupler for the cable.

(c) Disconnecting devices and couplers shall be locked with an individual padlock for each person performing work.

(d) Tags used on deenergized electric circuits and equipment shall identify each person performing work on the circuit or equipment and identify the circuit or equipment being worked on.

(e) Padlocks and tags shall only be removed by the persons who installed them.

Subpart J—[Reserved]

Subpart K—Trolley Wires and Trolley Feeder Wires

§ 75.1000 Scope.

Sections 75.1001 through 75.1010 apply to all trolley systems that extend or originate underground. These sections provide requirements for—

(a) The installation and maintenance of trolley systems;

(b) Electrical protection of trolley systems; and

(c) Movement of off-track mining equipment and supplies in trolley entries.

§ 75.1001 Installation.

(a) Trolley wires and trolley feeder wires shall be located at least six inches outside of the track rail except where the wires cross over the rails at track switches.

(b) Trolley wires and trolley feeder wires shall not contact combustible materials, metallic waterlines, metallic structures, roof, or ribs.

(c) Trolley wires, bare trolley feeder wires, and bare signal wires shall be insulated where they pass through doors and stoppings and where they cross

within six inches of power wires and cables.

(d) Trolley wires and bare trolley feeder wires installed after [Insert the effective date] shall have at least six inches of radial clearance from the metallic parts of track-mounted equipment to the wires.

(e) Radial stub-feed trolley systems shall be provided with deadblocks installed—

(1) Between adjacent rectifiers; and

(2) In parallel with each stub-feed circuit breaker. See Figure K–1 in Appendix A.

(f) Parallel-connected rectifier trolley systems shall be provided with deadblocks installed—

(1) In parallel with each tie-feeder circuit breaker; and

(2) In parallel with each stub-feed circuit breaker. See Figure K–2 in Appendix A.

(g) Deadblocks shall be provided with at least two insulating gaps which will extinguish arcs on the trolley system.

(h) Each deadblock shall be distinctly marked at its location so as to be found quickly in event of an emergency.

§ 75.1002 Insulated hangers.

(a) Trolley wires and trolley feeder wires shall be supported on insulated hangers.

(b) Insulated hangers shall have a dielectric strength of at least 15 times the nominal voltage of the trolley system on which they are used.

(c) Each insulated hanger shall have two insulators stacked together when uninsulated wires are supported from metallic arches, square sets, overcasts, and other similar metallic structures.

§ 75.1003 Guarding.

(a) Energized trolley wires and bare trolley feeder wires shall be guarded to prevent accidental contact—

(1) Where supplies are stored, loaded, or unloaded;

(2) At mantrip stations;

(3) On each side of all doors and stoppings through which wires pass;

(4) Where a person works within three feet of the trolley wire except for a person operating rail-mounted haulage equipment;

(5) At track switches; and

(6) Where persons regularly pass under the wires.

(b) Trolley wires and trolley feeder wires shall be deenergized when guarding is installed or removed unless the guarding is temporary guarding designed to minimize shock hazards while it is being installed or removed. Temporary guarding shall be installed or removed in accordance with 30 CFR § 75.1007.

§ 75.1004 Cutout switches.

(a) A cutout switch which opens both the trolley wire and trolley feeder wire, shall be provided at—

(1) Each rectifier or direct-current generator.

(2) Each tie feeder circuit breaker.

(3) Each branch line within 100 feet of the trolley turnout.

(4) Intervals of not more than 2,000 feet in the trolley circuit.

(b) Each cutout switch shall be distinctly marked at its location so as to be found quickly in event of an emergency.

§ 75.1005 Circuit protection.

(a) Trolley wires and trolley feeder wires shall be protected against short circuits by circuit breakers as follows:

(1) Direct-current circuit breakers set at not more than 50 percent of the minimum available bolted short-circuit current when that current is less than 800 amperes.

(2) Direct-current circuit breaker set at not more than 75 percent of the minimum available bolted short-circuit current when that current is 800 amperes or more.

(3) Alternating-current circuit breakers protecting radial stub-feed trolley systems set at not more than:

(i) 40 percent of the minimum available bolted short-circuit direct-current when that current is less than 800 amperes; or

(ii) 60 percent of the minimum available bolted short-circuit direct-current when that current is 800 amperes or more.

(b) Circuit breakers shall not be connected in parallel.

(c) A direct-current circuit breaker shall be connected in series with the ungrounded power conductor at each rectifier supplying a radial stub-feed trolley system, unless an alternating-current circuit breaker is connected in series with each ungrounded conductor supplying power to the rectifier bridge. See Figure K–3 in Appendix A.

(d) On or after [insert date one year from the effective date of the rule], at least two direct-current tie-feeder circuit breakers shall be connected in the ungrounded power conductor of each rectifier used to supply power to a parallel-connected rectifier trolley system. See Figure K–4 in Appendix A.

(e) Each tie-feeder circuit breaker located at a parallel-connected rectifier shall automatically open when either—

(1) The rectifier bridge loses its source of power; or

(2) When any main circuit breaker located between the tie-feeder breaker and the rectifier opens.

§ 75.1006 Circuit breakers.

(a) Direct-current circuit breakers used on trolley systems with nominal circuit voltages of 250 to 300 volts shall have a minimum voltage rating of 330 volts.

(b) Direct-current circuit breakers used on trolley systems with nominal circuit voltage of 500 to 600 volts shall have a minimum voltage rating of 660 volts.

(c) Direct-current circuit breakers shall have interrupting-current ratings not less than the following values at a time constant (L/R) of 30 milliseconds:

(1) 15,000 amperes for frame sizes less than 1,000 amperes.

(2) 25,000 amperes for frame sizes 1,000 amperes to 2,000 amperes.

(3) 50,000 amperes for frame sizes over 2,000 amperes.

(d) Alternating-current circuit breakers installed at radial stub-feed rectifiers shall have an interrupting current rating not less than 20 times the continuous full load direct-current ratings of the rectifiers.

(e) Direct-current circuit breakers installed at rectifiers shall have continuous current ratings not less than 120 percent of the continuous full-load current ratings of the rectifiers.

(f) Alternating-current circuit breakers installed in radial stub-feed rectifiers shall have continuous current ratings not less than the continuous full load direct-current ratings of the rectifiers.

(g) Each direct-current circuit breaker shall be equipped with an instantaneous overcurrent relay that causes the circuit breaker to deenergize the circuit with no intentional time delay.

(h) Direct-current electronic overcurrent relays installed after [insert date one year from the effective date] shall be—

(1) Fail-safe; and

(2) Bi-directional.

(i) Automatically reclosing circuit breakers shall be equipped with load measuring devices that prevent the circuit breakers from reclosing whenever the prospective load current exceeds 300 amperes.

(j) Automatically reclosing circuit breakers installed in parallel-connected rectifier trolley systems shall be equipped with voltage differential devices that prevent the circuit breakers from reclosing whenever the voltage across the circuit breakers is between 15 and 85 percent of the nominal system voltage.

§ 75.1007 Handling.

(a) Trolley wires and trolley feeder wires shall be deenergized before any mechanical or electrical work is

performed on them except that persons wearing rubber boots and rubber insulating gloves with protective coverings designed to prevent physical damage to the insulating material may—

(1) Reinstall wires in hangers; or

(2) Install or remove temporary guarding that is designed to minimize shock hazards.

(b) Rubber insulating gloves used for handling trolley wires or trolley feeder wires shall be rated for at least 1,000 volts.

(c) Rubber boots, rubber insulating gloves, and protective coverings shall be examined before each use for visible signs of damage or defects.

(d) Boots, rubber gloves, and protective coverings with visible signs of damage or defects shall not be used.

§ 75.1008 Track bonding.

(a) Mine track used as a power conductor shall be welded or bonded as follows:

(1) Track used to transport coal from a junction of tracks of two or more coal-producing sections shall have both rails welded or bonded at every joint and shall have the rails crossbonded at intervals of 200 feet or less.

(2) Track used to transport coal from a single coal-producing section or used to transport only miners and supplies shall have one rail welded or bonded at every joint and shall have the rails cross-bonded at intervals of 200 feet or less. An authorized representative of the Secretary may require that both rails be welded or bonded at every joint when necessary to provide adequate electrical conductivity of the trolley system.

(3) Track switches shall have each switch approach cross-bonded within 20 feet of the switch and shall have the straight and curved track sections bonded together within five (5) feet of the switch frog.

(b) Metal ties when used as cross bonds shall be welded to both rails.

(c) Track shall not be used before it is bonded except when using equipment necessary to install the bonds.

(d) Return-feeder wires connected in parallel with track rails shall be bonded to the track rails at intervals not to exceed 1,000 feet.

§ 75.1009 Examinations, tests and maintenance of trolley systems.

(a) Trolley systems shall be tested, examined and maintained by a qualified electrician.

(b) Trolley circuits shall be tested at least once every 180 days to determine available short-circuit currents by—

(1) Passing measured amounts of currents through the circuits at the extreme ends of the circuits protected by each circuit breaker; and

(2) Measuring voltage drops at each of these locations.

(c) Available short-circuit currents shall be calculated from voltage-drop tests and used to determine maximum allowable circuit breaker settings.

(d) Circuit breakers shall be examined, tested and calibrated at least once every 180 days in accordance with the following:

(1) Circuit breakers and components shall be examined for physical damage.

(2) Short-circuit devices shall be tested and calibrated to values no greater than the indicated values and no less than 85 percent of the indicated values.

(3) Current-actuated short-circuit devices shall either be tested and calibrated by passing the amounts of current indicated by the settings through the devices to cause actuation or be tested and calibrated with external calibration sources when the devices are equipped with calibration coils.

(4) Electronic short-circuit devices shall be tested and calibrated either by passing current through the circuit breaker to cause actuation or by applying calibration voltages to the sensor leads to cause actuation with the sensor leads disconnected from the shunts. The test and calibration values shall be determined by the indicated settings.

(5) Load-measuring devices and load-indicating circuits shall be tested and calibrated to prevent reclosure by simulating load currents of 350 amperes or less through the circuit breaker.

(6)Voltage-differential devices shall be tested and calibrated to prevent reclosure by applying voltages not less than 15 percent of the nominal system voltages across the circuit breaker terminals.

(7) Load-measuring devices, voltage-differential relays, reclosing selective relays, and load-indicating circuits shall be tested and calibrated to values within plus or minus (±) 15 percent of the indicated values.

(e) When examinations, tests, or calibrations of trolley systems reveal a potential fire or shock hazard, the affected part of the trolley system shall either be removed from service or repaired.

(f) Trolley wires shall be aligned and maintained to provide for smooth tracking of trolley connectors on trolley wires.

(g) At the completion of examinations and tests required by this section, the person who makes the examinations and tests shall certify by signature and date that they have been conducted. A record shall be made of any unsafe condition found and corrective action taken.

(h) Certifications and records shall be kept for at least one year and shall be made available at the mine for inspection by authorized representatives of the Secretary and representatives of the miners.

§ 75.1010 Movement and transportation of metallic mining supplies and off-track mining equipment in entries containing trolley wires or trolley feeder wires.

(a) When metallic mining supplies or off-track mining equipment is either moved or transported under its own power or by other non-trolley-powered equipment, trolley wires and trolley feeder wires shall be deenergized for a distance of at least 200 feet on each side of the supplies or off-track mining equipment.

(b) When metallic mining supplies or off-track mining equipment are moved or transported by trolley-powered equipment, the supplies or off-track equipment shall be either—

(1) Placed and secured in a mine car so that no portion of the supplies or equipment extends above any side or end of the car used to transport the equipment.

(2) Transported on a supply car, provided that no portion of the supplies or equipment extends above the height of the vehicle located immediately in front of or behind the supply car; or

(3) Be moved in accordance with the following:

(i) Supplies or equipment shall be cleaned to remove combustible materials.

(ii) Supplies or equipment shall be grounded by a 4/0 AWG or larger copper conductor that is connected to the mine track or to the metallic frame of the track-haulage conveyance.

(iii) Supplies or equipment shall be placed and secured to prevent accidental movement (shifting) while being transported.

(iv) Supplies or equipment shall be covered on the top and on the trolley wire side with conveyor belting or other equivalent material that is flame-resistant in accordance with 30 CFR 18.65.

(v) Supplies or equipment shall be examined by a qualified electrician prior to moving or transporting the unit to ensure that it has been cleaned, grounded and covered.

(vi) Supplies or equipment shall be moved or transported under the direct and immediate supervision of a certified person.

(c) When supplies or off-track mining equipment are moved in accordance with paragraph (b)(3) of this section, and the vertical clearance between the supplies or equipment being transported and the trolley wire or trolley feeder wire at any location along the move is less than 12 inches, the following additional requirements shall be followed:

(1) A qualified electrician shall be stationed at the rectifier which supplies power to the trolley circuit where the supplies or equipment is being transported so that the trolley circuit can be deenergized in case of an emergency.

(2) Direct two-way communications shall be provided between the qualified electrician, the certified person supervising the move and a responsible person on the surface. Trolley phones used for two-way communication shall be battery powered unless a backup communication system is available which can be readily connected to the mine communication system.

(3) Miners who are not directly involved in the equipment move shall not be in the current of air that has passed over the supplies or equipment.

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Appendix A—Illustrations

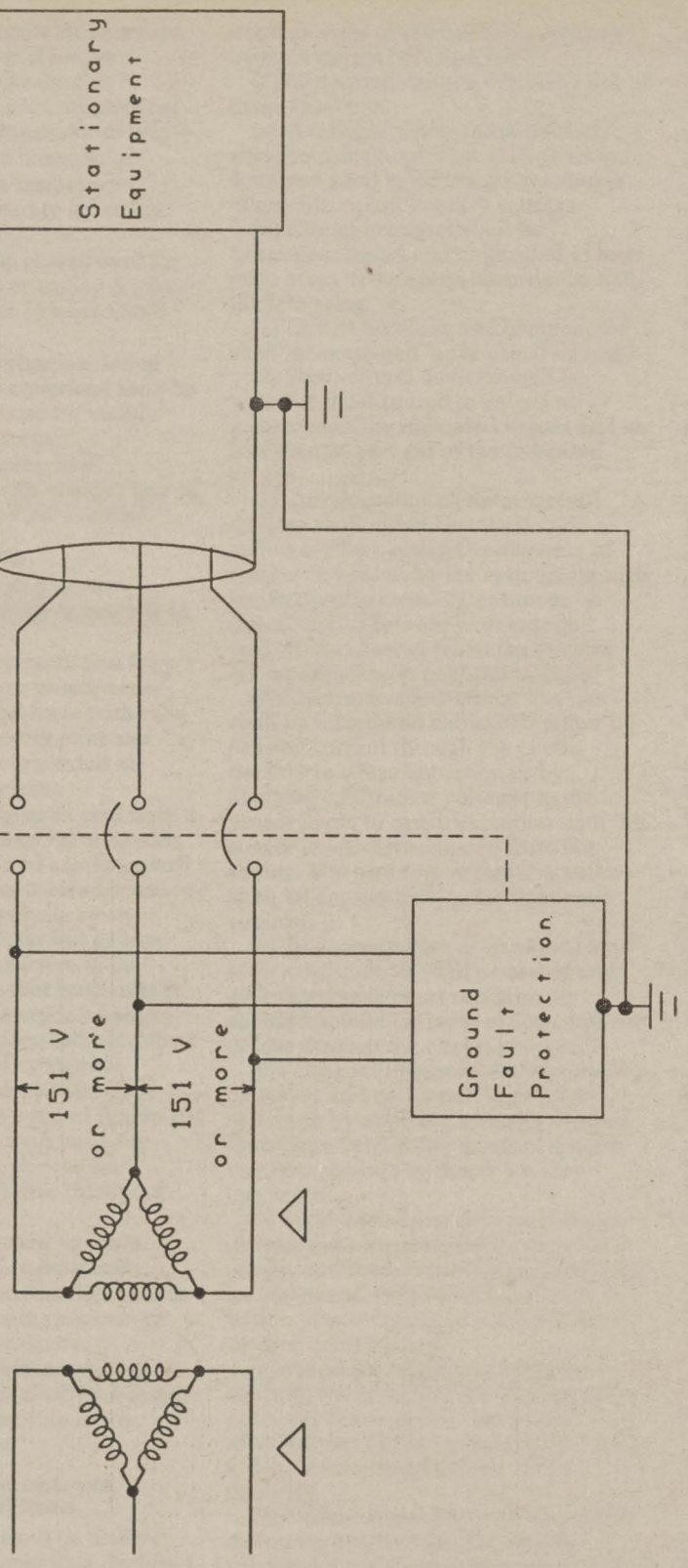

Figure H-1 - Illustration for requirements of 75.701(b)(3)

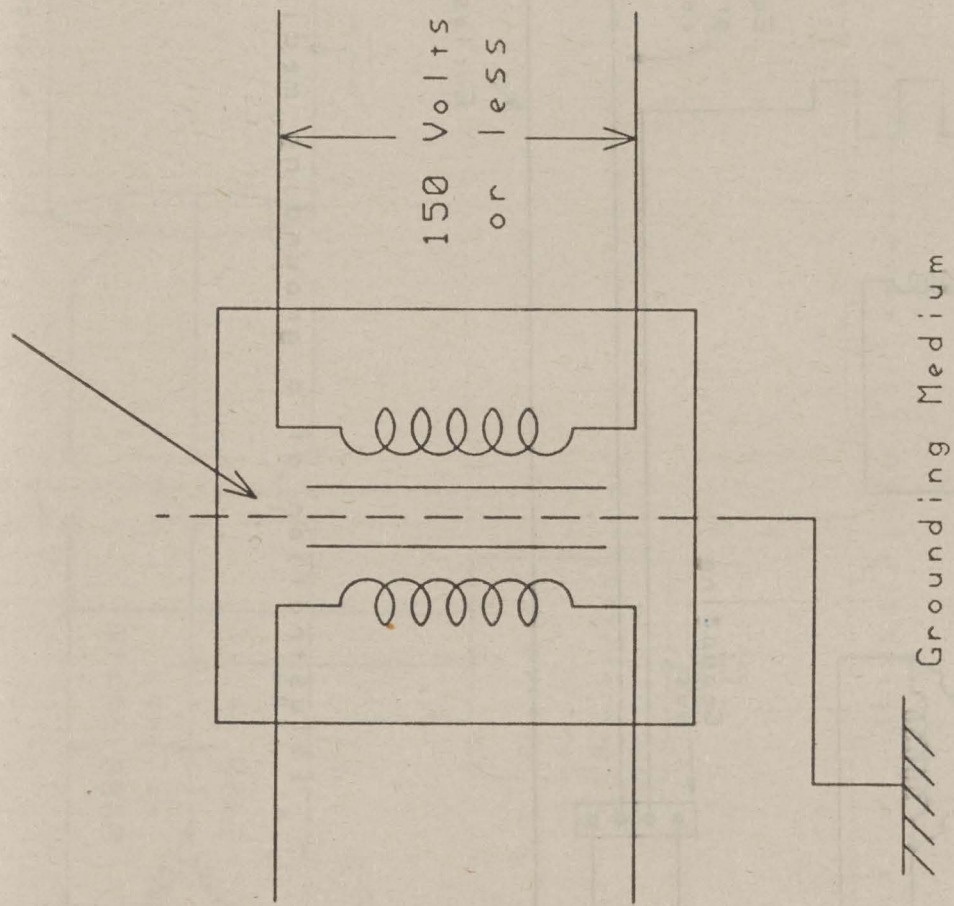

Figure H-2 - Illustration of a Faraday shield for 75.701(c)(2)

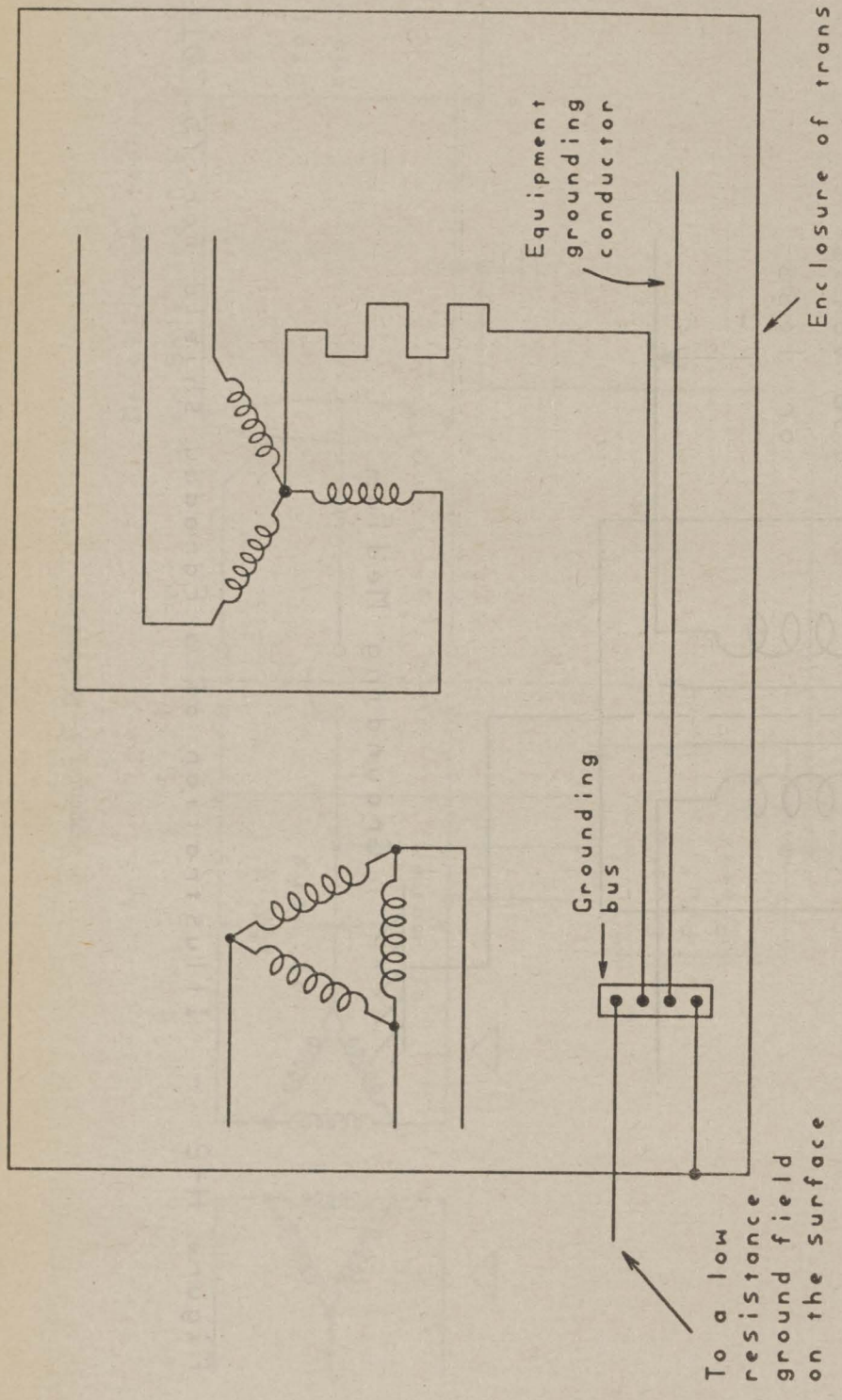

Figure H-3 - Illustration of a grounding medium for 75.702

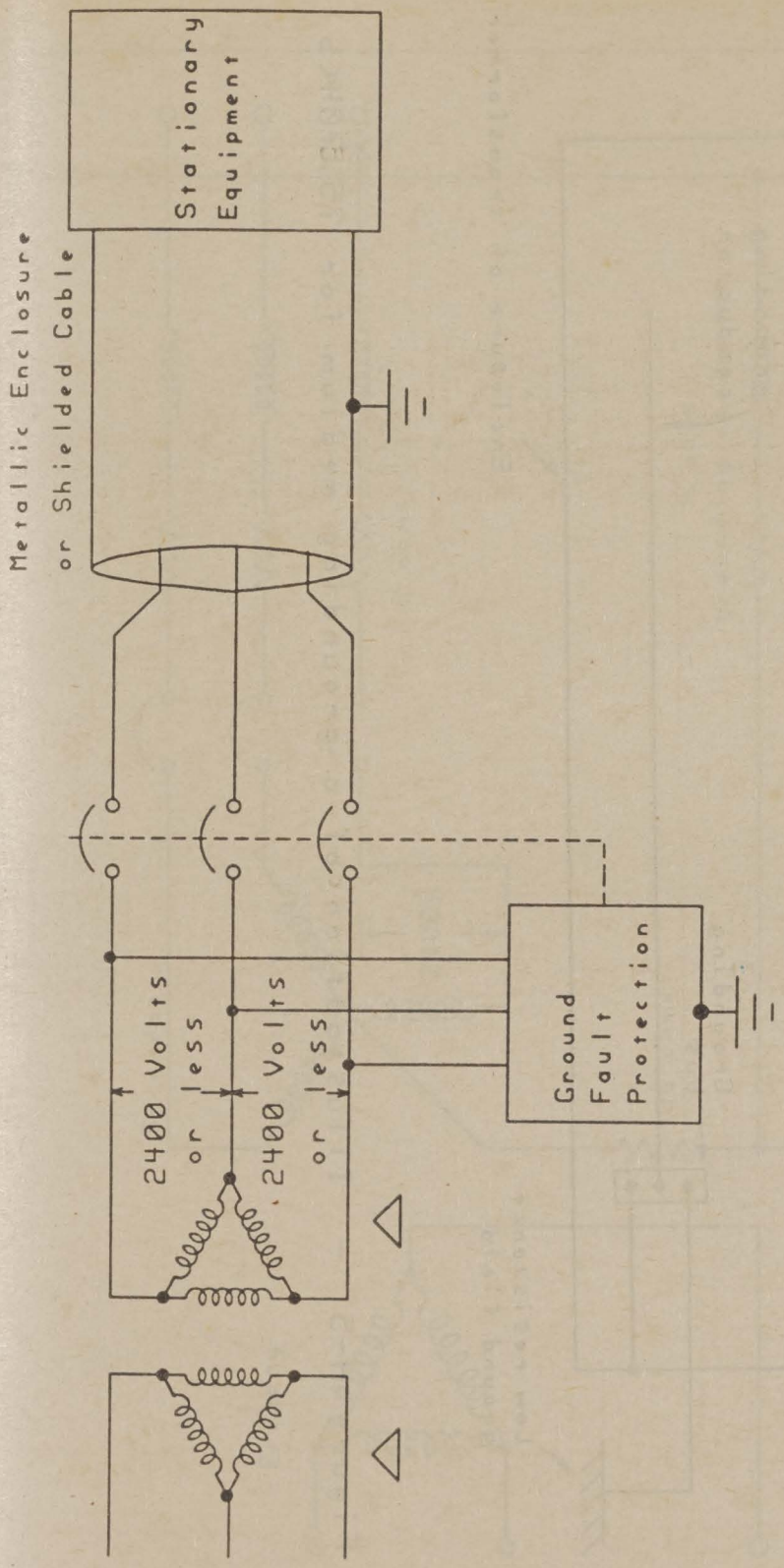

Figure H-4 - Illustration for requirements of 75.703

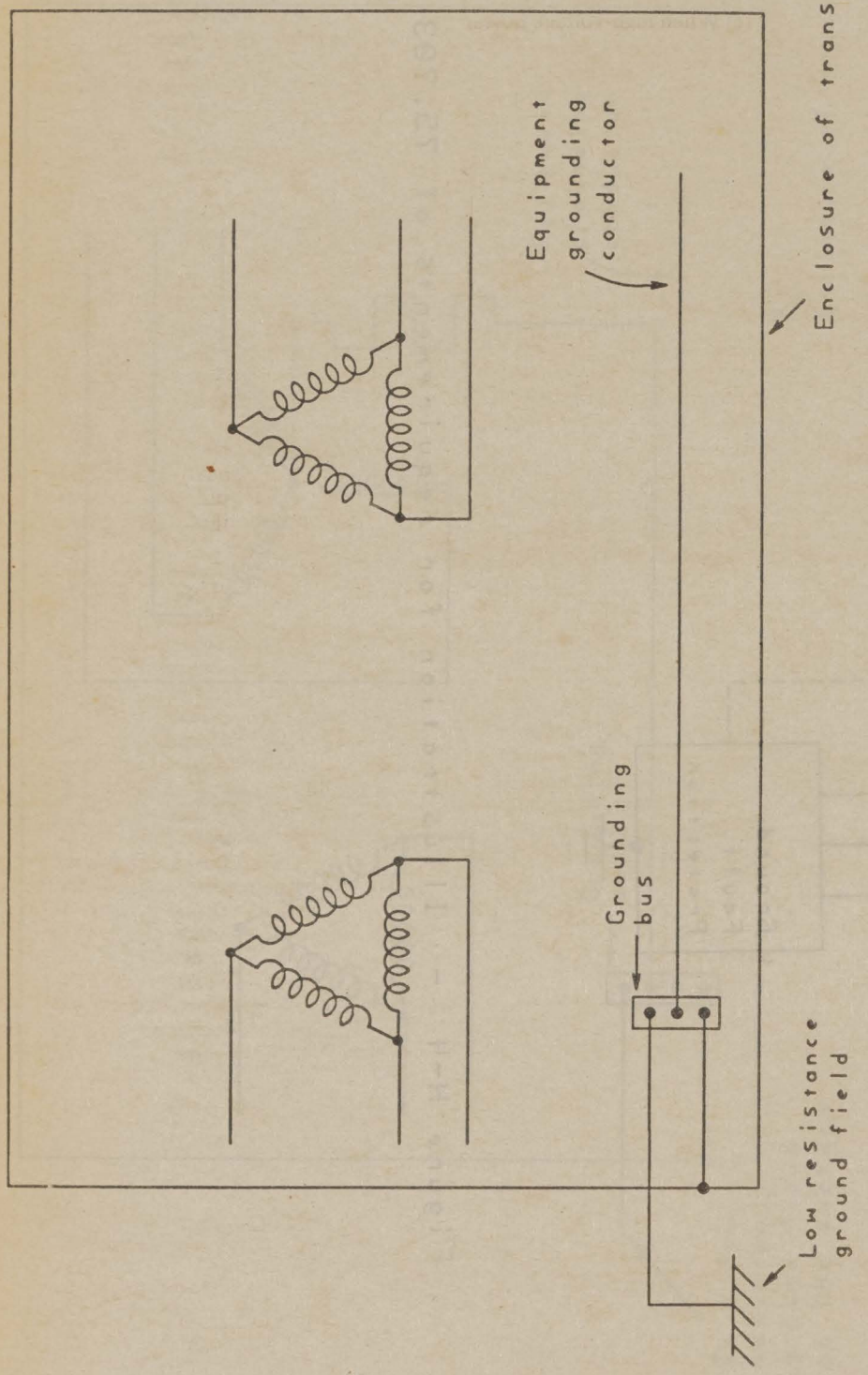

Figure H-5 - Illustration of a grounding medium for 75.704(b)

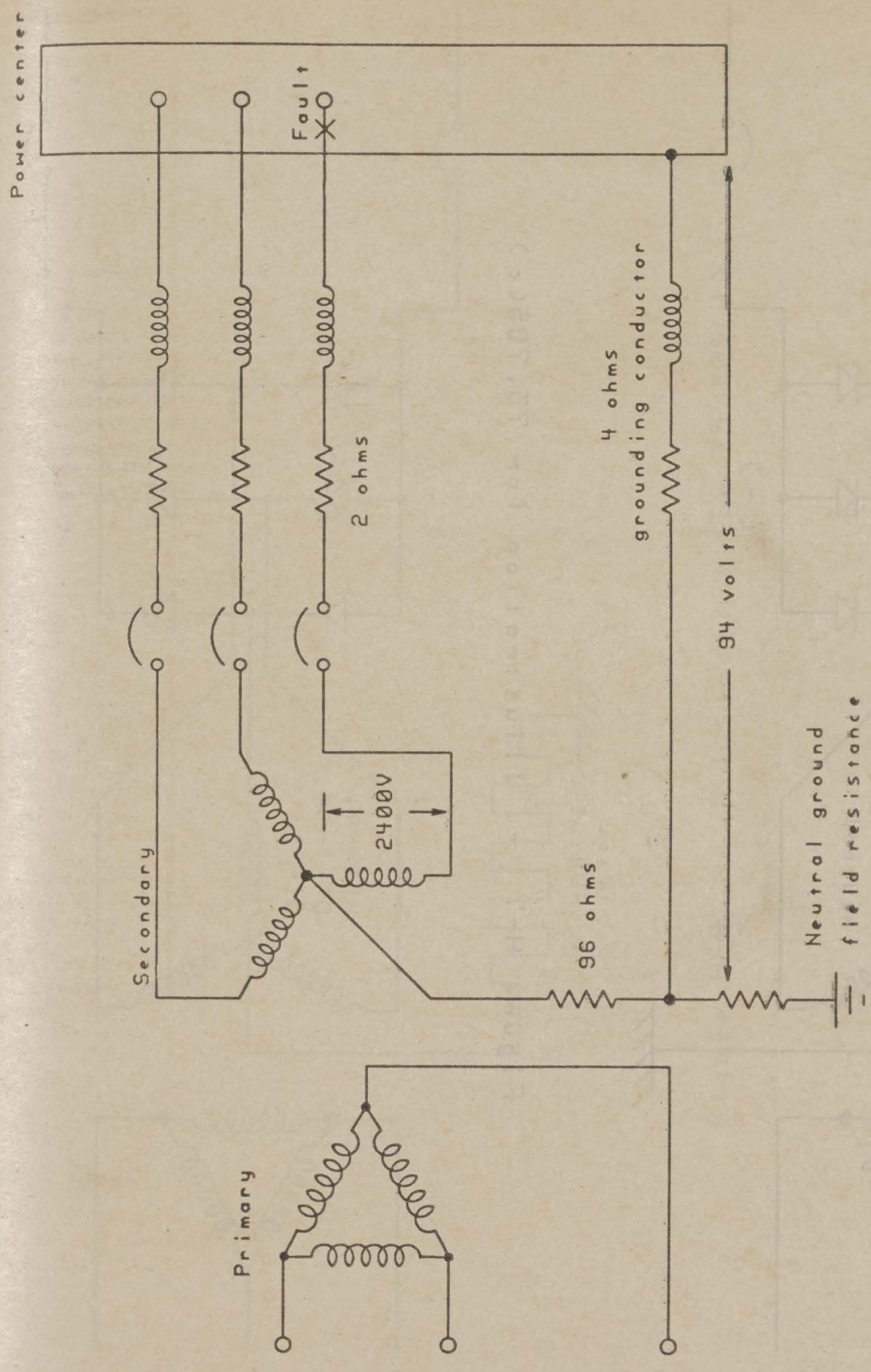

Figure H-6 - Illustration of requirements for 75.707(a)(2)

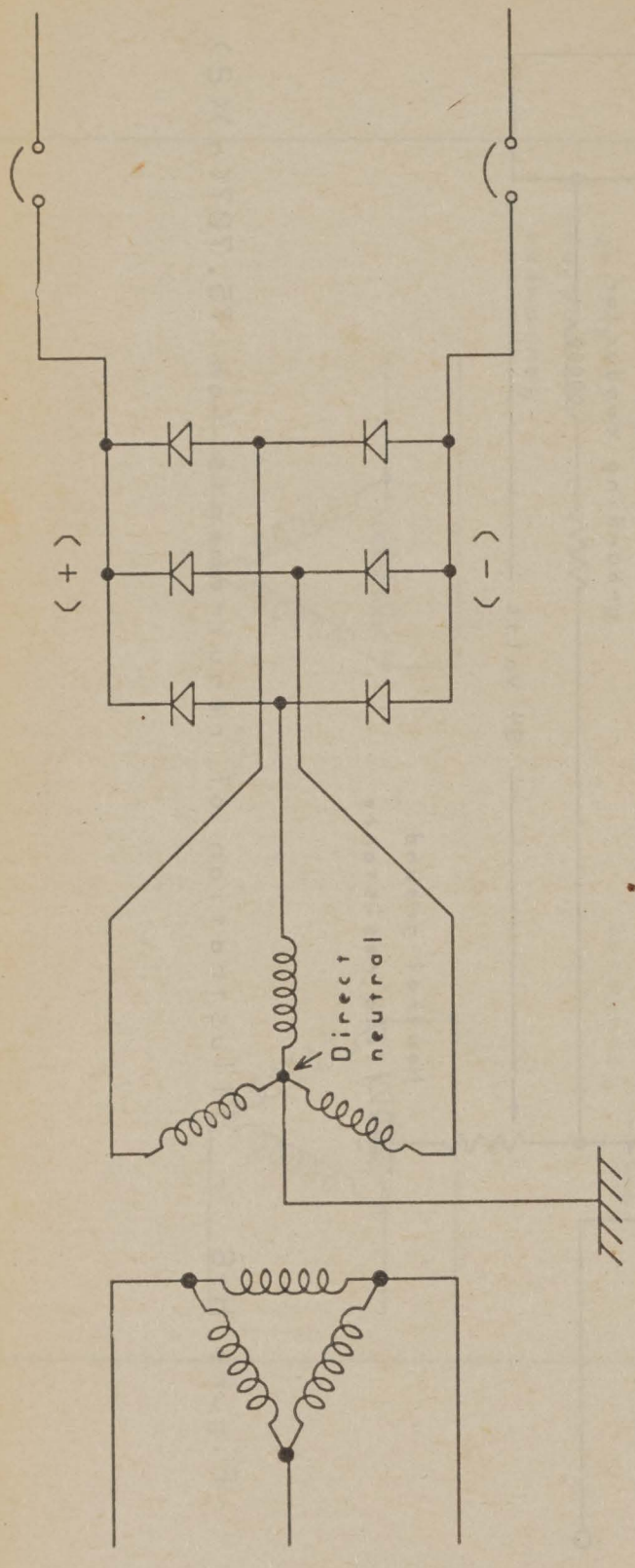

Figure H-7 - Illustration for 75.705(c)

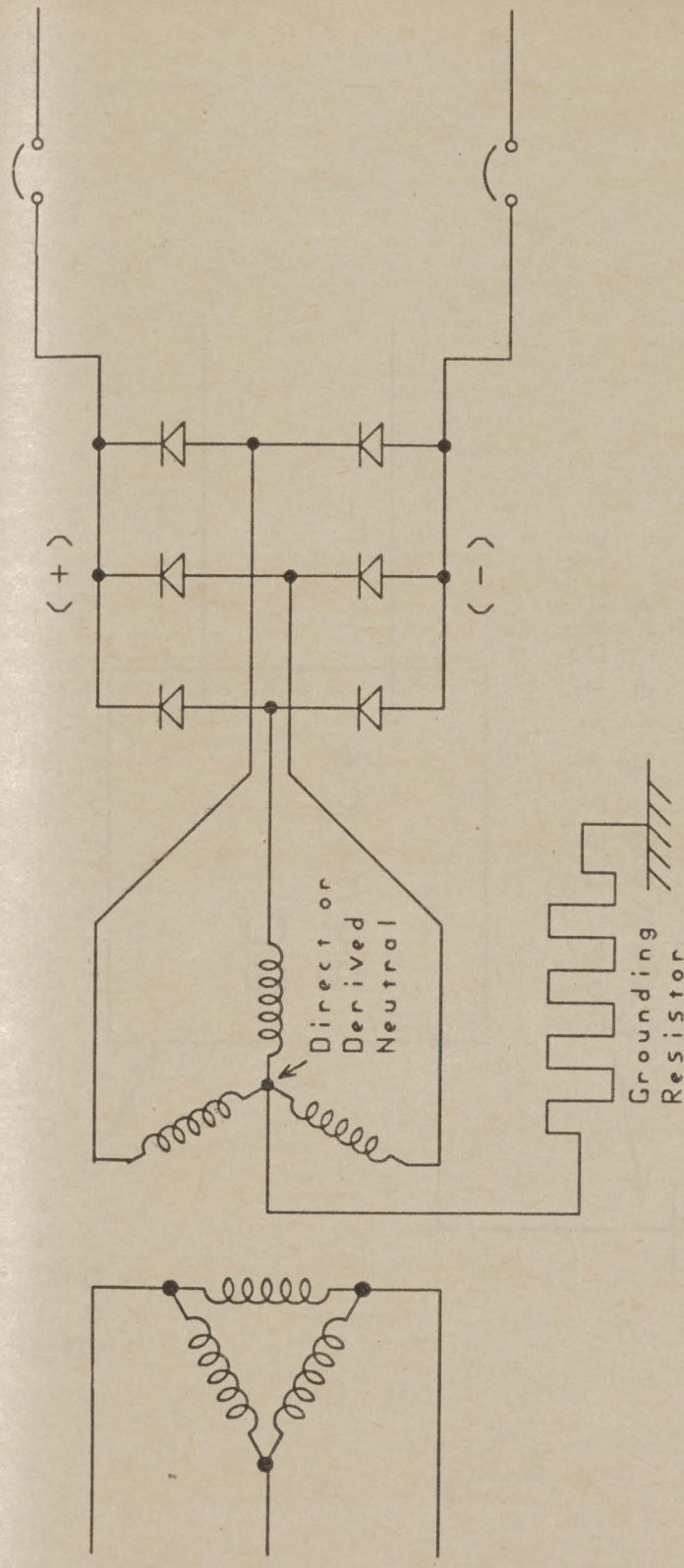

Figure H-8 - Illustration for 75.705(d)

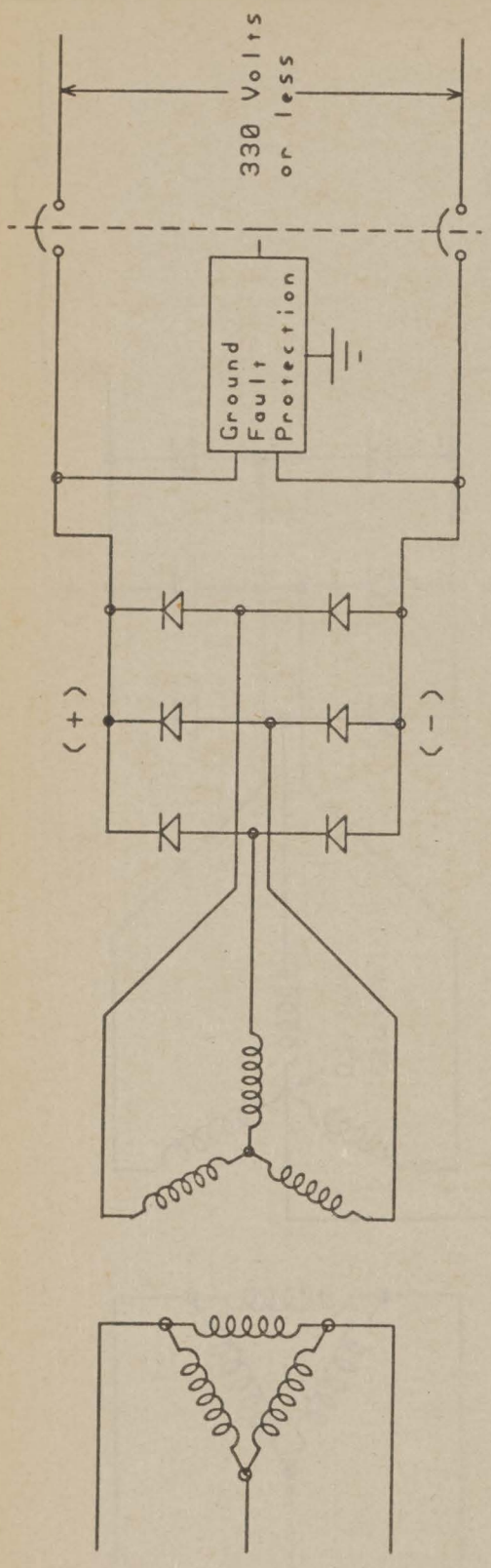

Figure H-9 - Illustration for 75.705(e)

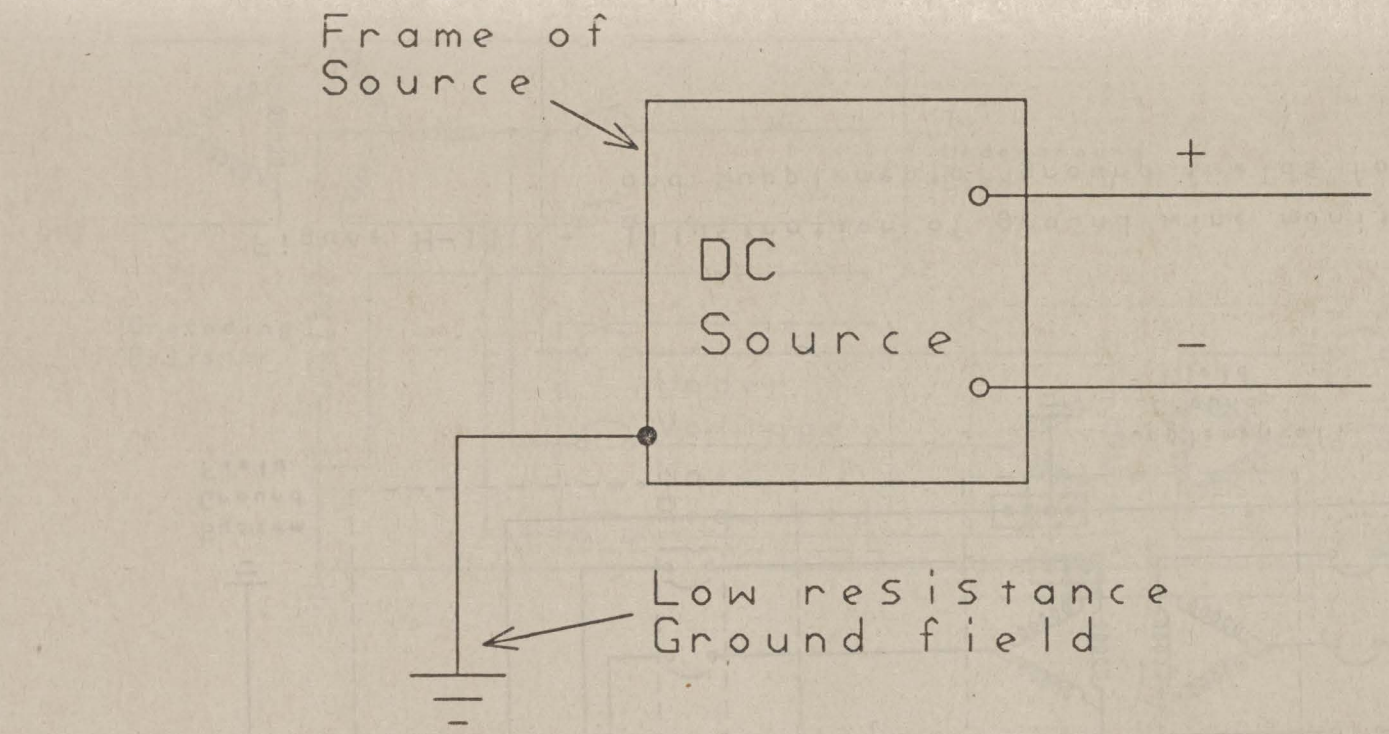

Figure H-10 - Illustration for 75.706(c)

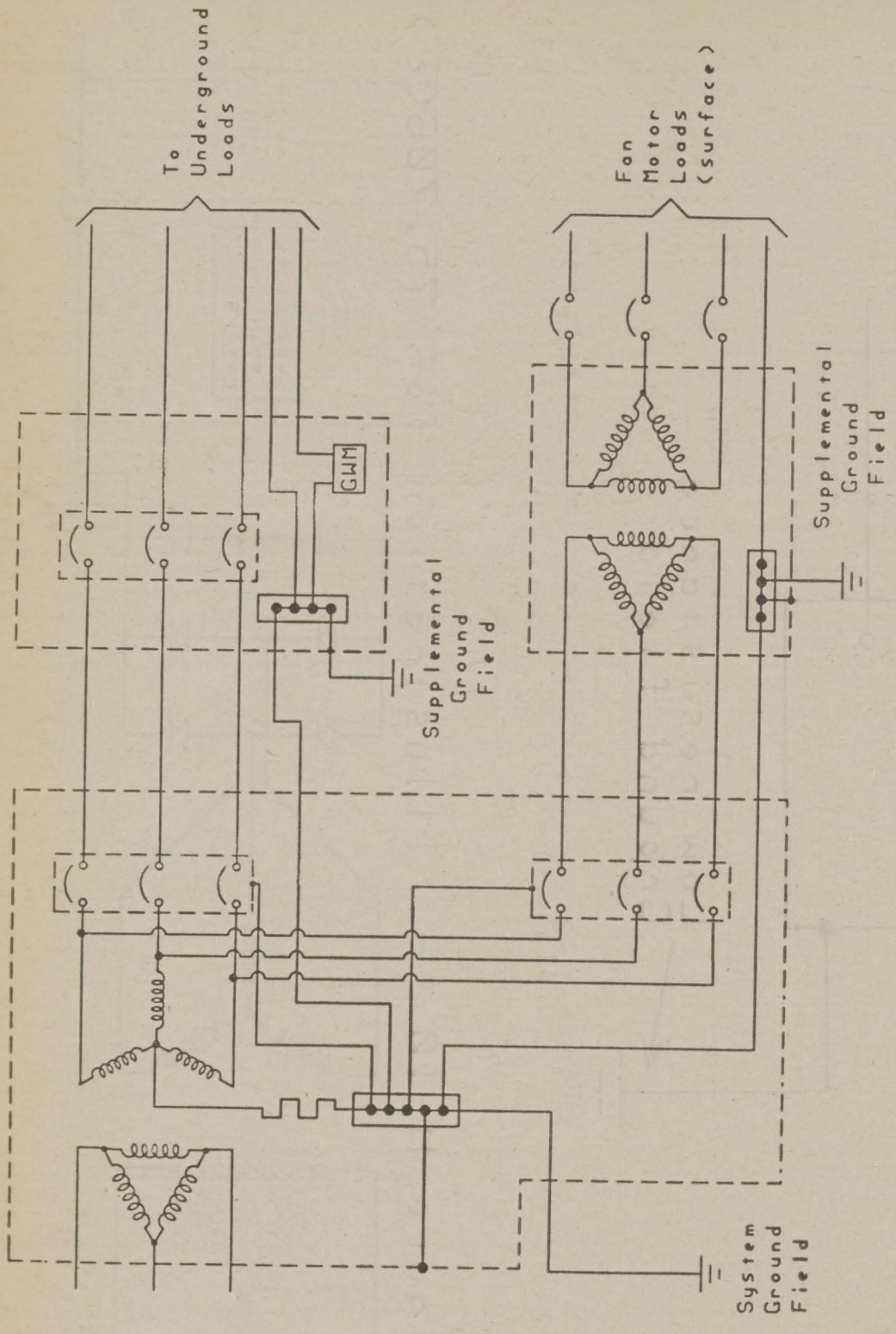

Figure H-11 - Illustration of ground wire monitoring and supplemental ground fields for 75.711(c)

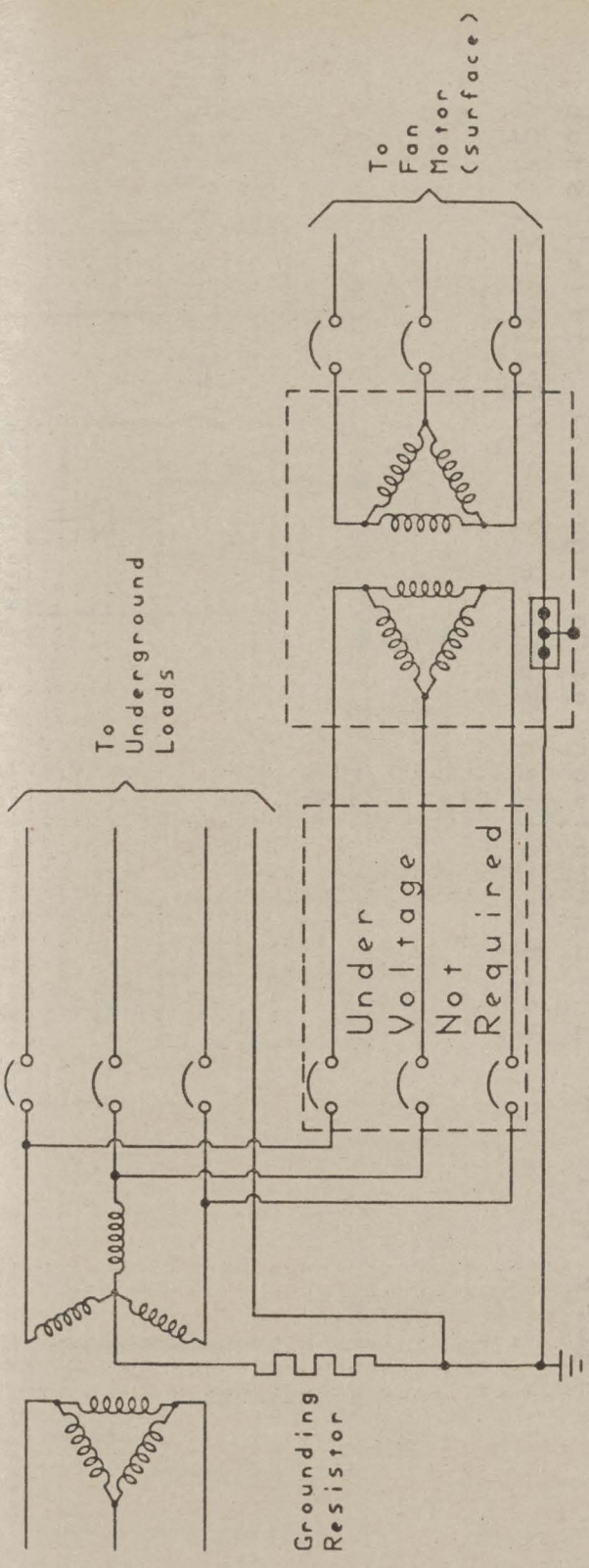

Figure I-1 - Illustration of a branch circuit for 75.802(a)(3)

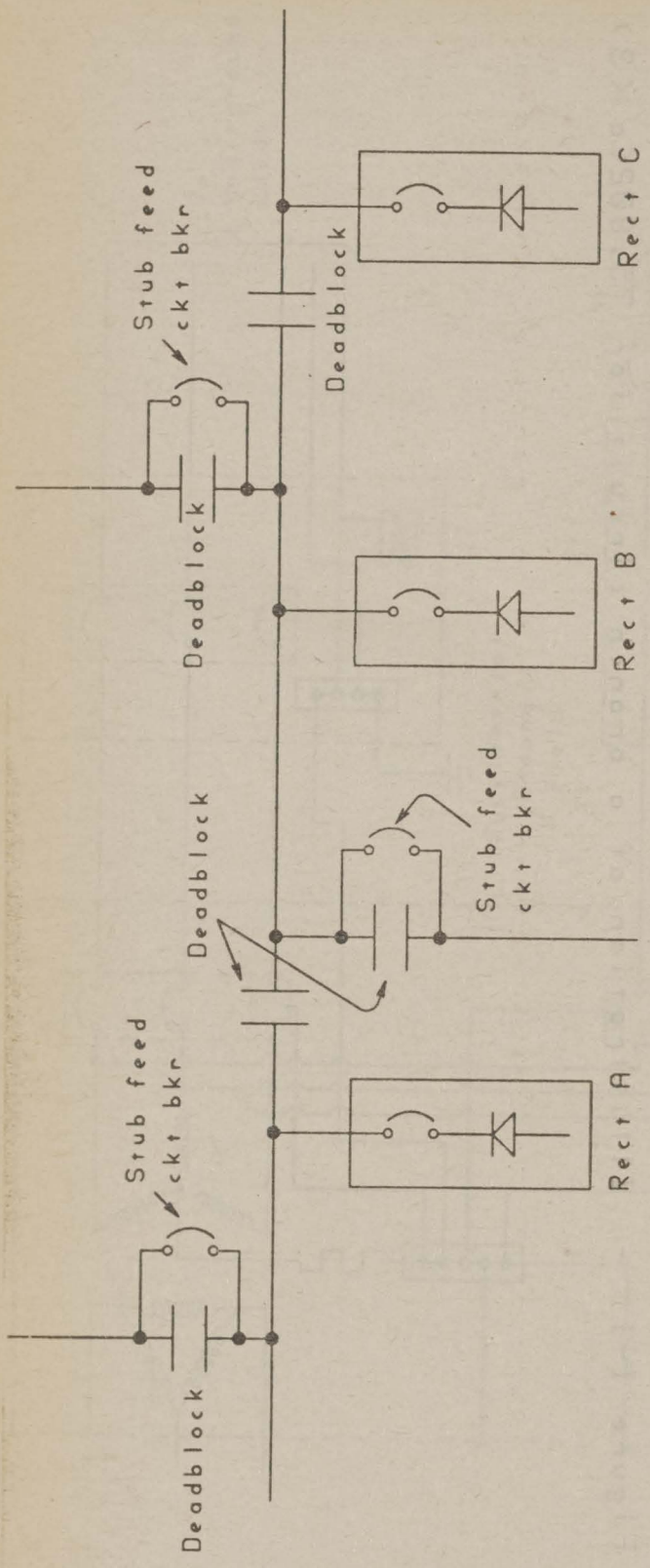

Figure K-1 - Illustration of a typical radial stub feed trolley system for 75.1001(e)(2)

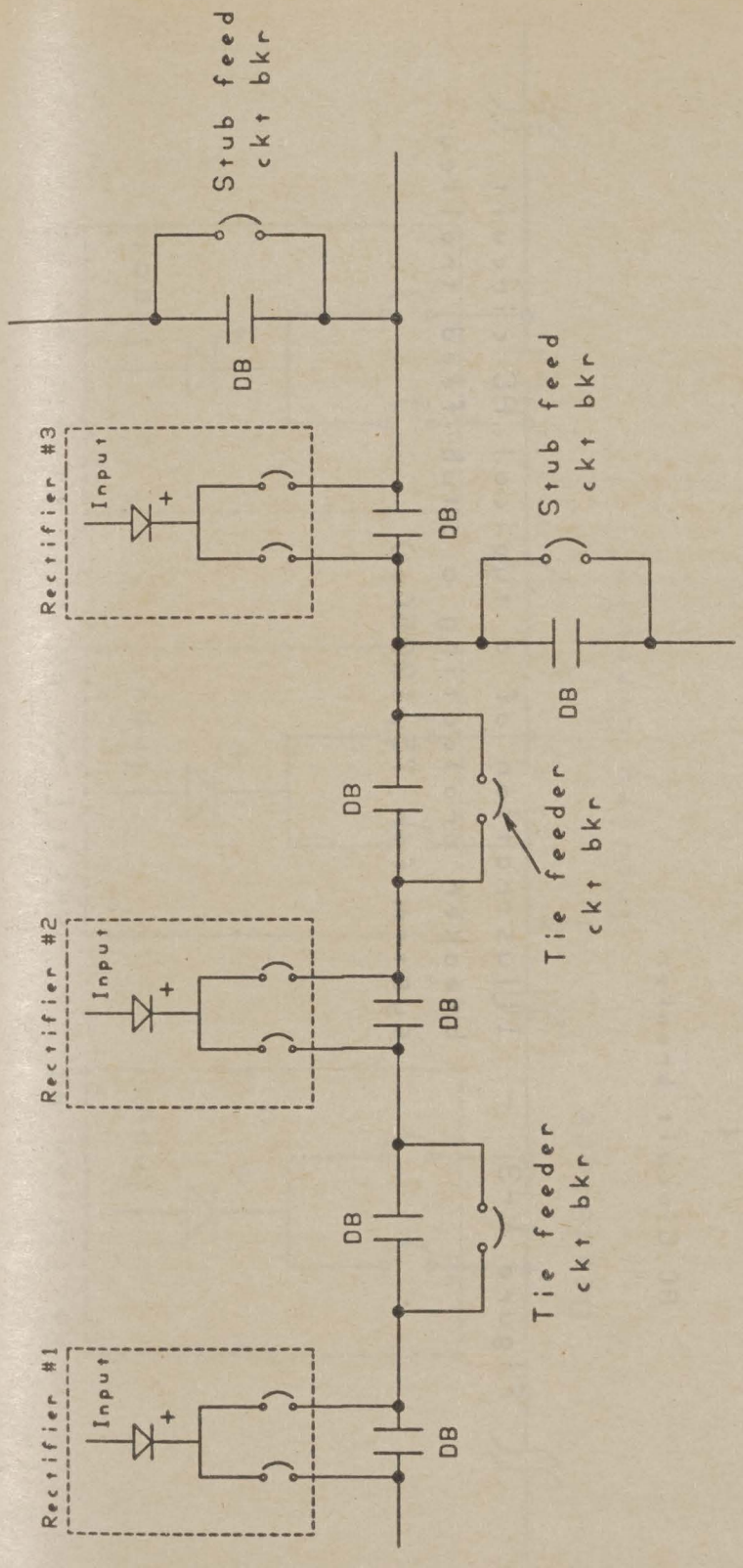

Figure K-2 - Illustration of a typical parallel-connected rectifier trolley system for 75.1001(f)(2)

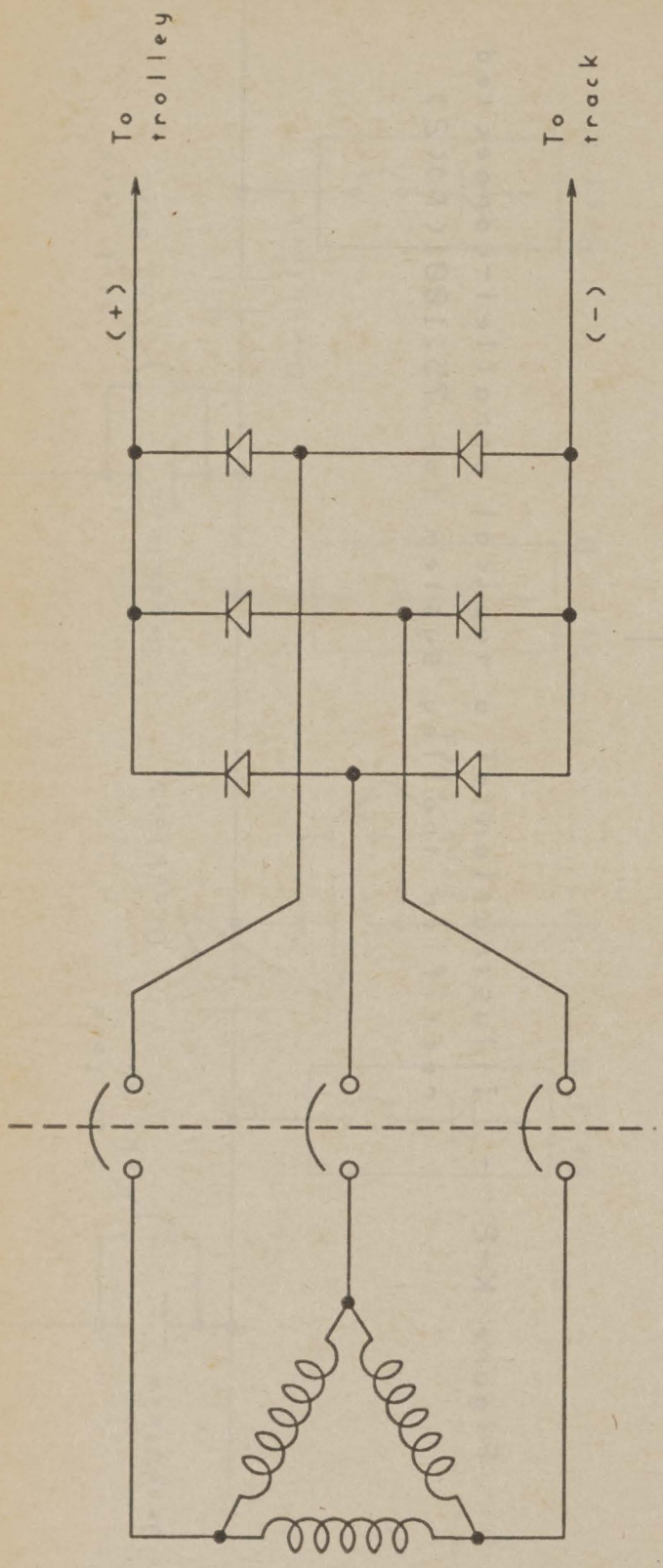

Figure K-3 - Illustration of a typical AC circuit breaker protecting a stub feed trolley system for 75.1005(c)

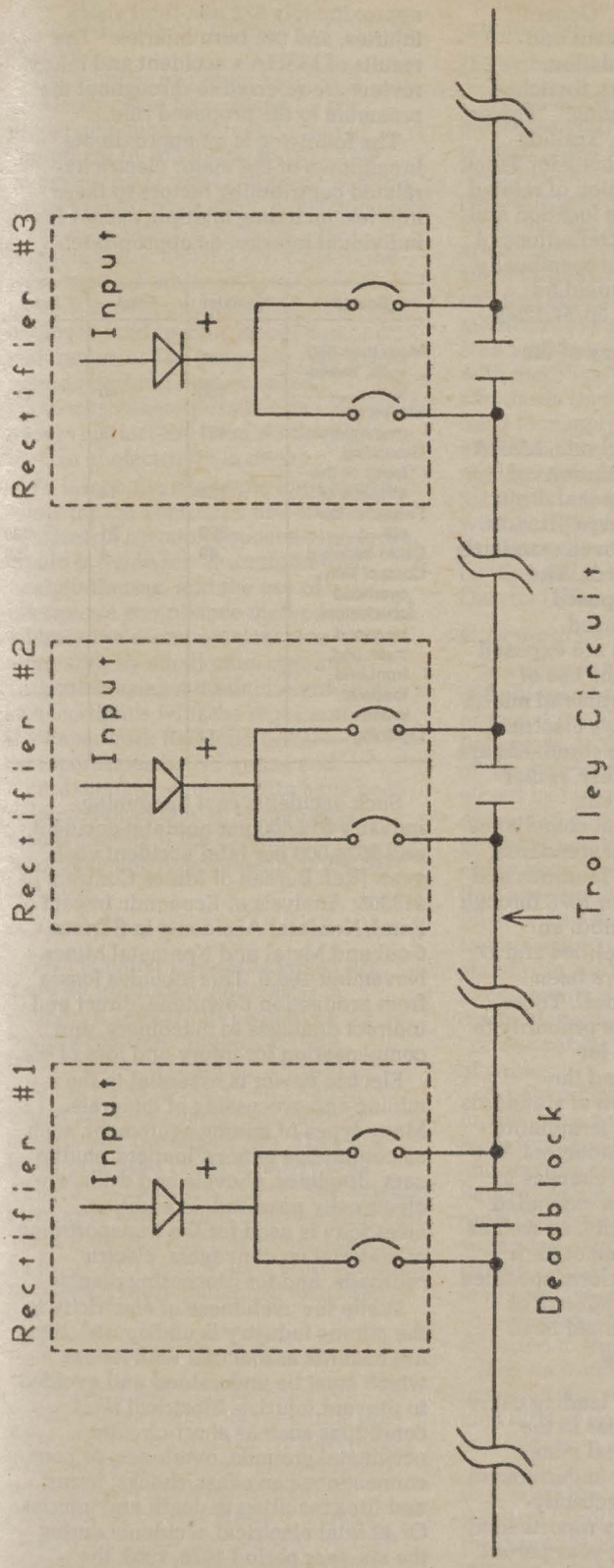

Figure K-4 - Illustrations for 75.1005(d)

[FR Doc. 89-27799 Filed 11-28-89; 8:45 am]
BILLING CODE 4510-43-C

DEPARTMENT OF LABOR

RIN 1219-AA14

30 CFR Parts 56 and 57

Electrical Standards for Metal and Nonmetal Mines

AGENCY: Mine Safety and Health Administration, Labor.

ACTION: Proposed rule.

SUMMARY: This proposed rule would update and clarify the Mine Safety and Health Administration's (MSHA) electrical safety standards at metal and nonmetal mines. These revisions would upgrade existing provisions consistent with technological advances in mining, eliminate unnecessary and duplicative standards and recordkeeping requirements, and allow for compliance alternatives.

DATES: Written comments and requests for public hearings on the proposed rule must be received on or before March 9, 1990.

ADDRESS: Send comments and requests for public hearings to the Office of Standards, Regulations, and Variances; MSHA, Room 631, Ballston Towers #3; 4015 Wilson Boulevard, Arlington, Virginia 22203.

FOR FURTHER INFORMATION CONTACT: Patricia W. Silvey, Director, or Yvonne Johnson, Project Officer, Office of Standards, Regulations, and Variances, MSHA, (703) 235-1910.

SUPPLEMENTARY INFORMATION:

I. Rulemaking Background

This proposed rule is part of MSHA's comprehensive review of its metal and nonmetal safety and health standards. MSHA announced the availability of a preproposal draft on May 20, 1983 (48 FR 22895), and invited public comment. During the review process, MSHA received suggestions and recommendations from many commenters. MSHA addressed commenters' suggestions in the proposal, as well as the specific goals of Executive Order 12291, the Regulatory Flexibility Act, and the Paperwork Reduction Act.

To aid in comparing the existing standards with the revised standards, this document includes a derivation table and a distribution table which cross-reference the existing standard numbers with the proposed standard numbers. In the following discussion, the designation "56/57" indicates that the standard applies to both parts 56 and 57.

The proposed revisions to Subpart K of parts 56 and 57 are contained in eight distinct categories, titled: "General;" "Work on Electric Equipment and Circuits;" "Guarding, Insulation, Separation;" "Connections, Switches, Controls;" "Safety Grounding;" "Power Cables and Conductors;" "Trailing Cables;" and "Trolley Circuits for Track Haulage." The categorization of related standards would facilitate location and use of the proposed rule. Definitions of terms used throughout and specifically applicable to subpart K would be contained in proposed §§ 56/57.12000.

II. Discussion and Summary of the Proposed Rule

A. General Discussion

In drafting this proposed rule, MSHA considered the recommendations of commenters to the preproposal draft. The revisions are intended to provide mine operators with improved standards to address electrical hazards. The primary benefit of the proposed standards would be increased protection for miners who are exposed to the hazards related to the use of electricity in metal and nonmetal mines, and the prevention of future electrical injuries and fatalities. The standards are directed toward miner safety, rather than protection of equipment.

MSHA estimates that full compliance with the existing electrical standards should have prevented 66 fatalities and 1,012 nonfatal injuries from 1978 through 1988. During this same period, an estimated additional 2 fatalities and 17 nonfatal injuries could have been prevented under the proposal. These additional benefits are due primarily to the proposed requirement for undervoltage protection and the expansion and clarification of standards addressing the insulation, termination, and shielding of power conductors. The proposed non-substantive changes to existing standards, such as expanded provisions to improve clarity, as well as the proposed new requirement for a qualified electrician to perform specified work, will increase the likelihood of preventing injuries that should have been prevented by existing requirements.

Electrical hazards are a leading cause of fatal and nonfatal injuries in the nation's metal and nonmetal mines. MSHA personnel recently undertook an informal analysis of all electricity-related accident and injury reports filed with the Agency for the 11-year period 1978 through 1988. The analysis showed that there were an estimated 1,300 electrical accidents occurring during that period, involving injuries to miners such as shocks and burns. This number includes 80 fatal electrocutions, approximately 372 non-fatal shock injuries, and 841 burn injuries.[1] The results of MSHA's accident and injury review are referred to throughout the preamble to the proposed rule.

The following is an approximate breakdown of the major electricity-related contributing factors to these injuries, including multiple causes for individual injuries, as appropriate:

Source	Nonfatal	Fatal	Total
More than 650 volts, line-to-line	169	40	209
Electrical maintenance	491	19	510
Grounding, faulty or the absence of	136	14	150
Failure to lock out	309	21	330
Cable handling	49	4	53
Contact with overhead conductors, by raised truck bed, front-end loaders, cranes	53	22	75
Lightning	11	1	12

Such accidents cost the mining industry $12,400 per nonfatal accident, and $674,000 per fatal accident each year. (Ref. Bureau of Mines Contract J0 113005; Analysis of Economic Impact of Fatal/Nonfatal Accidents in Surface Coal and Metal and Nonmetal Mines, November 1983). This includes losses from production downtime, direct and indirect damages to machinery, and compensation for injury and loss of life.

Electric power is essential to the mining and processing of minerals. Many types of mining equipment, such as continuous miners, loaders, shuttle cars, draglines, shovels and drills, are electrically powered. In addition, electricity is used for the transportation of material on conveyors, electric railroads, and for processing plants.

While the usefulness of electricity to the mining industry is undisputed, there are hazards associated with its use which must be understood and avoided to prevent injuries. Electrical fault conditions such as short-circuits, accidental grounds, overloads, or poor connections can cause shocks, burns, and fires resulting in death and injuries. Of 49 fatal electrical accidents during the six-year period 1978-1983, the majority occurred when persons contacted the energized frames of

[1] The analysis did not include a review of mechanical or crushing injuries caused by accidental electric equipment startup.

equipment, or contacted exposed energized parts of electric equipment or circuits.

The number of similar electrical accidents could be reduced by the proper selection and installation of equipment by enclosing or isolating energized parts, providing safe working space around equipment, using adequate insulation, safety grounding, and warning signs, locking switches in the open position under certain circumstances, using insulated flooring or gloves, and regular inspection and maintenance. The proposed rule would provide performance-oriented standards, where possible, to safeguard miners against the hazards arising from the use of electricity in mines.

To lessen the economic impact and allow for the continued use of existing equipment, certain proposed standards would provide for "grandfathering." Grandfathering, and the use of alternative compliance methods, would address the economic concerns expressed by small mine operators without causing a diminution of safety. In accordance with the requirements of the Paperwork Reduction Act, incorporations by reference and recordkeeping requirements have been deleted. For example, the proposal would eliminate the existing recordkeeping requirements in §§ 56/57.12028.

B. Transfers

Two existing standards which are more appropriately addressed in Subpart K (Electricity) would be transferred from Subpart C (Fire Prevention and Control). They are existing §§ 56/57.4011 and 57.4057, which address abandoned electric circuits and trailing cables. They are being proposed under Subpart K as §§ 56/57.12104 and 57.12700. The existing standards will remain codified with Fire Prevention and Control standards as §§ 56/57.4011 and 57.4057 until revisions to Subpart K are published as a final rule.

C. Incorporations By Reference

Existing §§ 56/57.12045 and 56/57.12048 incorporate by reference the *National Electrical Code* of 1968 (NEC). Existing §§ 56/57.12047 incorporate by reference the *National Electrical Safety Code* of 1961 (NESC); Part 2: "Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines;" and Supplement 2, 1968 (NESC). The NEC contains nationally recognized safety standards for the electrical industry. The proposed rule would replace the incorporated documents with specific performance-oriented requirements.

D. Petitions for Modification

Operators with petitions for modification that involve the standards revised under the proposed rule would need to determine the status of those petitions before the effective date of the final rule. For proposed standards which are renumbered, but remain substantively unchanged from the existing standards, operators with modifications granted for these standards need not reapply. Operators with modifications granted for standards that have been revised would need to comply with the new rule on its effective date. New petitions for modification of the rule may be submitted, as necessary, in accordance with 30 CFR part 44. If Agency assistance is needed, questions should be directed to the appropriate MSHA District Office.

E. Definitions

Sections 56/57.12000 would contain definitions of terms used throughout the proposal which apply specifically to Subpart K, to facilitate comprehension of the standards. Existing §§ 56/57.2 would be revised and several definitions deleted to eliminate repetition. The proposal would incorporate a definition of the term "cable"which conforms to that used by the Insulated Cable Engineering Association (ICEA). The term is used in several of the proposed standards, and it is defined in response to commenters, concerns that a distinction needs to be made between "power cables" and other specific types of cables.

A power cable would be defined so as to encompass all types of cables, including feeder cables, trailing cables, and flexible cords which conduct power. Several commenters to the preproposal draft objected to this definition and suggested exclusion of low energy cables such as communication, instrumentation and control cables. This recommendation was adopted and is reflected in the proposed language.

The definition of "cable" was revised to reflect that a cable may include uninsulated equipment safety grounding conductors to distinguish it from a "conductor". Commenters also requested that a specific definition of the term "trailing cable" be included in the proposal to identify it as a special purpose flexible power cable.

The proposed definition of a "circuit breaker" is consistent with the Institute of Electrical and Electronics Engineers (IEEE) and NEC definitions of the term. The phrase "injury to itself" would be replaced with the phrase "damage to the device". One commenter suggested that the definition of a circuit breaker should include "overcurrent and ground-fault settings." This approach would result in redundancy, as specific overcurrent and ground-fault settings are listed within the proposed standards in subpart K.

Commenters also suggested that the word "current" be substituted for "overcurrent," stating that "overcurrent" does not allow for use of magnetic and filament type breakers. Overcurrent was retained because it addresses the intended hazards and is consistent with IEEE and NEC definitions. As used in the proposed definitions, it means any current in excess of the rated current of equipment, or the ampacity of a conductor, which may result from ground-fault, overload or short-circuit conditions.

This proposal would revise the existing definition of a "conductor" in response to recommendations from several commenters. The proposal would clarify that a conductor is a wire which is intended to carry an electric current. This change would prevent application of electrical requirements to materials such as messenger wires, metallic equipment frames, and fences which are capable of carrying electric current, but are not intended for that purpose. This change would not except messenger wires intended for use as equipment safety grounding conductors from complying with applicable requirements.

"Equipment safety grounding conductor" would be a new term describing the conductor which connects the non-current-carrying metallic parts of electric equipment, raceways and other metallic enclosures to the safety grounding system. Commenters suggested using the term "equipment grounding conductor," as used by the NEC. The NEC is design-oriented and related directly to the installation and protection of equipment. By contrast, MSHA's proposed standards are primarily performance-oriented, and intended to enhance miner safety. In the Agency's view, it is important to stress that grounding is intended to safeguard persons from shock and burns, and not primarily to protect equipment. Conveying this concept would best be accomplished by using the term "equipment safety grounding conductor" as opposed to "equipment grounding conductor." The IEEE Standard 277-1983, "IEEE Recommended Practice for Cement Plant Power Distribution," uses this term to describe proper equipment grounding of quarry-related mining equipment, and

its *Standard Dictionary of Electrical and Electronics Terms*, IEEE Standard 100–1977, defines "safety ground conductor" in essentially the same manner as the proposed definition.

The existing definition of the word "insulated" would be revised by removal of explanatory language and clarification that compliance flexibility exists. The existing definition of "insulation" would be deleted, as its meaning is spelled out within the proposed standards.

New definitions of the terms "mobile electric equipment," "portable electric equipment" and "stationary electric equipment" would be included in the proposal as a means for classifying equipment according to the electrical hazards associated with its use. Varying methods of protection would be required under the proposal in accordance with the type of equipment. Therefore, separate definitions were necessary to distinguish between machine types. Equipment characteristics such as facility and method of movement, and type and duration of use were considered in defining these terms.

The proposal would incorporate a new definition of the term "overcurrent" derived from commenter suggestions and the NEC definition. Commenters indicated that a definition is necessary to distinguish "overcurrent" from "overload." Overcurrent is a descriptive term applied to ground-fault, short-circuit and overload conditions, where equipment is operated or conductors are loaded in excess of their rating or ampacity. The proposed definition of "overload" would revise the existing definition to clarify the term, and distinguish it from other faults. It is consistent with the NEC definition of an overload.

Several of the proposed standards would require electrical work to be performed by a "qualified electrician." That term is new, and would be defined as an individual who has met the requirements of proposed §§ 56/57.12100. Those sections would require certain mine electricians to be qualified under an operator's electrical training and qualification program.

The proposal would include a new definition of the term "rated," as used in Subpart K. A device is rated by testing it and making a comparison with a national consensus standard such as those prepared by the American National Standards Institute (ANSI), Underwriters Laboratories (UL), the IEEE, the ICEA, and Factory Mutual (FM). If no nationally-developed consensus standard is applicable, the manufacturer provides documentation that a device has been tested and does not present a burn, fire or shock hazard.

The proposed new definition of the term "safety grounding system" is derived from the IEEE and NEC definitions of "grounding system" and "equipment grounding conductor." It would be defined as a complete installation intended to provide a low-impedance fault current path to the system's protective device for non-current-carrying metallic parts enclosing electric conductors or circuits.

The proposal would modify the existing definition of a "short circuit" by changing the term "resistance" to "impedance" as suggested by commenters. The term "potential" has been retained and is consistent with the IEEE definition (Standard 100–1977).

Several other definitions have been included in the proposal to facilitate interpretation of the proposed standards and identify new terms. For instance, the proposed rule would utilize the terms "nominal voltage," "jacket," and "ground fault." They have been explained in proposed §§ 56/57.12000 for convenience.

Existing definitions of the terms "low potential" and "high potential" would be eliminated under the proposal. In lieu of utilizing broad voltage classifications, the proposed standards would apply to specific equipment or circuit voltages. Therefore, the low- and high-voltage categories were no longer necessary. Likewise, existing definitions of "electrical grounding" and "reverse-current protection" would be deleted, as they are not used in the proposed standards. The definition of a "distribution box" would be included in the applicable standards.

F. Section-by-Section Analysis

The following analysis examines the proposed rule and its effect on existing standards.

General

Sections 56/57.12100 Qualified Electricians

Sections 56/57.12100 would be new, addressing the qualification of mine electricians. Because of the danger and difficulty involved in some mine electrical work, Subpart K would require certain tasks to be performed by a qualified electrician. This standard would require such work to be performed by individuals who have met the requirements of an operator's qualification program. In the Agency's view, such persons would possess the knowledge and skill necessary to safely and accurately complete electrical work which affects their own well-being, as well as the well-being of other miners.

The need for specific qualifications to perform electrical work is illustrated by the number and types of electrical accidents occurring in metal and nonmetal mines. A review of electrical accident reports from 1978 through 1988 has indicated that 17 of the 80 electricity-related fatalities during that time (approximately 21%), and 382 of the 1213 nonfatal electricity-related injuries (approximately 32%) reported involved persons who had not been properly trained in electrical work procedures. Many of the injuries and fatalities reported to MSHA involved non-electricians engaged in electrical maintenance or repair work. For example, in 1986, a mechanic was electrocuted when he inserted fuse cut-outs, one in each hand, into a high-voltage overhead feeder while standing in the raised bucket of a frontend loader. An individual trained in electricity and its hazards would never have attempted this, knowing such a procedure would lead to death or serious injury.

The intent of the standard is to assure that persons engaged in dangerous electrical work are made aware, not only of the proper technical procedures, but of the hazards associated with such work. Additionally, requiring certain work to be performed by trained, qualified electricians would serve to enhance compliance with other mandatory electrical standards in 30 CFR parts 56 and 57. Persons knowledgeable in these requirements are more apt to be diligent in complying with them.

The standard would offer a wide variety of compliance alternatives, to be chosen at the option of the mine operator. For instance, metal and nonmetal mine electricians could be qualified under procedures used by other Federal or state agencies. As an alternative, operators could take advantage of labor union apprenticeship programs for the qualification of mine electricians, as is presently the practice in some mines. This flexibility in compliance alternatives would serve to promote training of mine electricians. MSHA does not want to discourage participation in training programs, such as apprenticeships, under the standard. Additionally, electrical work is often done by independent contractors, particularly in smaller metal and nonmetal mines. Providing qualification compliance alternatives would not disallow such a practice.

Sections 56/57.12101 Electric Equipment and Conductors

This proposed standard would revise and combine existing §§ 56/57.12002, 56/57.12030, 56/57.12035, 56/57.12040 and 56/57.12041. It would address safe practices for the selection, installation, use and maintenance of electric equipment and conductors. Paragraph (a) would require electric equipment and conductors to be installed and maintained by a qualified electrician, and used in a manner which prevents shock and burn hazards to persons. Equipment and conductors presenting such hazards would be required to be tagged and the hazard corrected. This would assure that persons responsible for the maintenance and repair of electric equipment have the knowledge and skill necessary to perform the work safely, and that miners working near electric equipment are not exposed to the risk of injury.

The preproposal draft listed several environmental factors to be considered with the use of electric equipment and wiring. Several commenters suggested that paragraph (a) be deleted or revised, because the environmental factors listed were vague and did not enhance safety. The environmental factors listed in paragraph (a) have been deleted, and the standard has been revised to clarify its intent.

Paragraph (b) would require electric equipment and conductors installed after the effective date of the rule to be selected and located in surroundings compatible with their design and intended use. This would minimize the compliance burden of the proposal on operators, particularly of small mines, while assuring miner protection on newly installed equipment.

Sections 56/57.12102 Bare Conductors

This section would revise existing §§ 56/57.12012. It would limit the allowable voltage of bare conductors accessible to contact by persons to 40 volts. Several commenters believed that the preproposal draft coverage of all bare conductors accessible to contact would expand the scope of the existing standards, which only address bare signal wires. This position was not adopted in the proposal because the same shock hazard exists on all exposed bare conductors, regardless of whether it is a signal wire or power conductor.

In the preproposal draft, the term "potential" in existing §§ 56/57.12012 was replaced by the more accepted and recognized term "voltage." The term "inadvertent" was added to clarify that the phrase "accessible to contact" means accessible to inadvertent or unintentional contact. These revisions would be retained in the proposed rule.

Sections 56/57.12103 Overcurrent Protection

Sections 56/57.12103 would require overload and short-circuit protection for electric circuits and equipment, other than trailing cables, with fuses or other automatic circuit interrupting devices. Such devices would be required under paragraph (a) to safely interrupt the circuit under all overload and short-circuit fault conditions. Overcurrent protection for trailing cables and trolley circuits would be addressed in proposed §§ 56/57.12701 and 56/57.12801, respectively.

Performance requirements for overcurrent protective devices would be spelled out in the proposed rule, based on references to the ratings tables accompanying the proposal. The standard and tables would replace existing §§ 56/57.12001 and 56/57.12065. The tables accompanying the proposal would codify overcurrent protection requirements, eliminating need for reference to the NEC. They are derived from accepted safety standards, as well as information taken from the NEC.

The overcurrent protection provisions and the tables specifying ratings and settings for protective devices would assure proper deenergization of circuits and equipment in the event of overcurrent conditions. Arcing and conductor overheating, and the resulting hazards to miners such as fires and electrical shock would thereby be prevented.

Under paragraph (b), motors would be required to be protected against overloads at no more than 125 percent of their full-load current, and paragraph (c) would require short-circuit protection of motors as specified in Tables 56/57.12103–1 and 56/57.12103–2. Some commenters were concerned that specified values could prevent motors from starting. The values are based on the NEC, and should not pose frequent start-up problems. However, in the eventuality that the specified values would cause insufficient current for the starting of alternating-current (ac) motors, paragraph (d) would permit adjustments in circuit breaker trip values. In no instance would the setting be permitted to exceed 1300 percent of the motor's full-load current on instantaneous-trip circuit breakers, or 400 percent of the motor's full-load current for inverse-time circuit breakers. Therefore, the standard would provide maximum circuit protection, but would allow for the practical necessity of having sufficient current for equipment start-up.

Paragraph (e) would require all three-phase motors to be protected so that an overcurrent in any phase will deenergize all ungrounded phases. This would assure that the remaining phase conductors will not also become overloaded and increase the risk of shocks and fires. Under paragraph (f), transformers would have to be protected on the primary side, with overcurrent protection rated at no more than 250 percent of their rated full-load current.

Paragraph (g) would provide that when the required rating of a fuse or circuit breaker without an adjustable-trip unit does not correspond to a standard rating for fuses or circuit breakers, the protective device used would not be permitted to exceed the next higher standard rating. In such cases, the Agency would permit the use of a lower standard rating, or the next higher standard rating to allow for flexibility when necessary.

Circuit breakers or fuses providing short-circuit protection would be required under paragraph (h) to be installed where the circuit conductors are connected to the supply. However, feeder tap conductors which are 25 feet or less in length, have ampacities of at least one-third of the ampacity of the feeder conductors, and terminate at a circuit breaker or fuse with current ratings that do not exceed the ampacity of the feeder tap conductors, would not have to meet the requirements of this provision. The 25-foot requirement is consistent with national standards, which recognize that a longer length could significantly increase the resistance in the circuit. The proposal would limit the resistance in the circuit to a value that would allow adequate fault current to flow through the system, thereby allowing the system overcurrent protection to properly operate.

Paragraph (i) would require wiring to be protected at no more than the ampacity specified in proposed §§ 56/57.12601. However, as specified in paragraph (j), overcurrent protection would not be required on incandescent lamps supplied from direct-current (d-c) systems, provided the length of ungrounded conductors does not exceed eight feet. MSHA experience demonstrates that a requirement for overcurrent protection in these circumstances would not be justified, since the design of incandescent bulbs is such that their filaments will fuse during an overcurrent situation. The higher resistance of a conductor longer than eight feet could cause it to overheat in such a situation, posing a fire hazard to miners.

Paragraph (k) would state that the overload protection requirements of the standard would not apply where interruption of a circuit presents a hazard to persons. However, measures would have to be taken to warn persons when an overload occurs. Two examples of where an overload warning would be permitted are: (1) An electrically driven fire pump providing water or fire retardant to fight a fire which endangers miners, (2) an electrically driven mine hoist used to transport miners to a safe location during an emergency evacuation. Overload warning could be given by a warning light or alarm which clearly indicates that the circuit is overloaded.

Paragraph (l) is new, and would prohibit connection of fuses, circuit breakers, or a combination of both in parallel. This would ensure that the integrity of the protective device is maintained, and that ratings for protective overcurrent devices are used which will not cause damage to the circuit. The design of fuses and circuit breakers presently employed in the industry requires full-line current for the devices to accurately and reliably operate within their parameters.

Sections 56/57.12104 Unused Conductors

This standard would revise existing §§ 56/57.4011 and would transfer these Subpart C (Fire Prevention and Control) standards to Subpart K, because the hazards addressed are electrical. The proposal addresses shock hazards created when a person comes into contact with abandoned or unused energized conductors.

The existing standard would be revised to clarify the meaning of the term "abandoned" and identify the type of equipment the standard addresses. In response to commenters, the term "conductors" is substituted for the phrase "electric wiring" and the subheading changed from "unused wiring" to "unused conductors." Some commenters stated that confusion exists about where conductors should be disconnected. The proposal specifies that the disconnection shall be made at the conductor's supply point. The standard would also include the option of insulating the conductor ends and locking-out the circuit to allow for maintenance and repair, as suggested by some commenters. MSHA considers the combination of insulating and locking-out exposed ends to provide protection equivalent to removing the conductor from its supply source. If the conductors were merely insulated, and the supply source was not also locked out, an individual would be able to energize the conductor by mistake. In addition, the insulation could be damaged, rendering it ineffective. Locking-out would provide back-up protection. The combination of these two would make it impossible to mistakenly energize an unused conductor.

Sections 56/57.12105 Doors and Cover Plates

This standard would revise existing §§ 56/57.12032, and would require that doors and cover plates on electric equipment which allow access to electric connections be kept closed, except during installation, testing and repairs. The term "door" would be substituted for the term "inspection" for clarity. Commenters indicated that a shock hazard occurs only with exposed uninsulated connections, and recommended the standard apply only to these connections. This recommendation was not adopted in the proposal, since insulated connections are exposed to damaging environmental conditions such as water, sunlight, vibration and material spillage, which can cause deterioration of the insulation. If insulated connections are damaged and accessible to contact, a shock hazard would exist.

One effect of this standard would be to assure that control switches are not located in the same compartment as electric connections. To operate such switches, persons should not be exposed to injury through contact with electrical connections. Such switches should be positioned on the outside of the compartments.

Sections 56/57.12106 Danger Signs

This proposed section is derived from and combines existing §§ 56/57.12021 and 56/57.12022. It would require the posting of visible danger signs at all substations, switchyards and control centers to warn against entry by unauthorized persons, due to potential shock and electrocution hazards involved with such locations.

Several commenters objected to the preproposal draft standard's application to "major electrical installations," stating that its scope would require posting of warning signs in unnecessary areas. In response to these concerns, the proposal has been revised to require posting of signs only at the specified areas. The proposal would adopt commenters' recommendations that the term "prohibit" be deleted since signs cannot prohibit entry, but only warn against entry. One commenter recommended that warnings should be aimed at "unauthorized persons." This suggestion was not adopted because the proposed language adequately identifies persons to be alerted by warning signs.

Sections 56/57.12130 Clearance of Equipment

This section would combine and revise existing §§ 56/57.12045 and 56/57.12071. It would address shock hazards created when equipment such as cranes, trucks, end-loaders, shovels, ladders, surveyor rods, tools or supplies contact bare overhead conductors. According to MSHA's review of injury reports from 1978 through 1988, approximately 75 electrical injuries, including 22 fatalities, have occurred under these circumstances.

Paragraph (a) would require bare overhead conductors of more than 650 volts, line-to-line, installed parallel to roadways and under which haulage trucks have access, to be suspended at least ten feet higher than the raised bed of any haulage truck used at the mine. A ten-foot clearance would prevent contact by individuals, as well as accidental energization of the haulage equipment frame. Commenters believed that this provision would require all overhead high-voltage conductors to be raised. The proposal has been revised to only address conductors alongside the road, and not those that cross over the road. An example would be a truck parking area adjacent to a haulage road. In response to commenters' suggestions, the proposal would apply only to bare conductors of more than 650 volts. MSHA estimates that half of the electricity-related fatalities from 1978 through 1988 involved greater than 650 volts.

Under paragraph (b), when equipment is moved or operated near energized bare overhead conductors of less than 69,000 volts, and the clearance is less than 10 feet, the conductors would be required to be deenergized, or other precautionary measures taken to prevent energization of the equipment frames. This provision would not apply to trolley conductors, but would apply to overhead utility or power conductors. It would minimize the risk of persons being shocked or electrocuted through contact with energized conductors.

Paragraph (c) would contain safety precautions to be used when equipment is moved or operated near energized bare overhead conductors of 69,000 volts or more. Such conductors would be required to be deenergized, or a minimum clearance established between the conductor and the equipment, as specified in Table 56/57.12130, accompanying the standard. The distances specified would provide

minimum safety clearance for the protection of persons.

Commenters expressed concern that compliance with the preproposal draft requirement of a 50-foot limitation for storing and stockpiling supplies and materials near overhead high-voltage conductors would be difficult to achieve. In response to these concerns, the 50-foot limitation was deleted. Paragraph (d) of the proposal would only prohibit storage and stockpiling of supplies and materials directly underneath bare conductors.

Work on Electric Equipment and Circuits

Sections 56/57.12200 Lockout Procedures.

This section would revise existing §§ 56/57.12016 and 56/57.12017. It would mandate lockout procedures to provide protection against mechanical and electrical hazards. Paragraph (a) would require electric circuits and equipment to be deenergized before electrical or mechanical work is performed on them, except when energization is necessary for performing mechanical work. This provision would assure that persons are protected against shock and electrocution, as well as being caught in or pinned by equipment.

From 1978 through 1988, there were 209 electrical injuries, including 40 fatalities, involving contact with voltages over 650 volts. During the same time period, MSHA estimates that 510 accidents, 19 fatal, occurred during electrical maintenance work. For example, one individual was killed by contacting an energized 13,200-volt line while cleaning an insulator. If the circuit had been properly deenergized and locked out during maintenance, the fatality would not have occurred. Performance of work on equipment or circuits which were not properly locked out was a contributing factor in 309 nonfatal and 21 fatal accidents during that time. Many of the victims had attempted to work directly on energized circuits. The proposed standard would strengthen existing standards to assure that electrical and mechanical work is performed with minimum risk, and that involved circuits and equipment are deenergized unless power is essential to performing mechanical work.

Paragraph (b) would require installation of individual padlocks for each person performing work and individual tags identifying each person to prevent the circuits from being inadvertently energized and equipment set in motion prior to the completion of work. Additionally, to assure the safety of each individual, only the person installing a padlock or tag would be permitted to remove it. The provision in existing §§ 56/57.12016 allowing authorized persons to remove locks and tags would not be retained under the proposal in order to enhance miner safety.

There may be some unusual circumstances in which the mine operator could demonstrate a need to remove an employee's lock. Recently, the Occupational Safety and Health Administration (OSHA) issued a final rule with such an exception. (54 FR 36644) Under the OSHA rule, the employer could remove an employee's lock if, at a minimum, the employer has procedures to: verify that the employee is not at the facility; make all reasonable efforts to contact and inform the employee that the lock has been removed; and ensure that the employee knows that the lock has been removed before resuming work at the facility. The Agency solicits comments on whether and under what circumstances such an exception would be appropriate for metal and nonmetal mining.

At least two of the fatal accidents previously mentioned occurred when power was accidentally applied to circuits being tested. The proposed requirement would greatly reduce the likelihood of accidental reenergization before all persons are able to place themselves out of danger, or before each person working on the circuit is identified. Each individual would be made responsible for installing and removing a padlock and tag. At the change of shifts, it would be the responsibility of a foreman or other supervisory personnel to assure that the circuit or equipment being worked on is properly tagged or locked out.

The rule would specifically require a padlock for locking out purposes since this device is presently in use throughout the industry. Most electric equipment in use is capable of easy installation of a means to attach a padlock. The Agency does not foresee a necessity for extensive alteration of equipment designs for compliance purposes. MSHA considers padlocks to be the most reliable, tamper proof devices available for the purpose.

The need for both locks and tags stems from the nature of the mining industry. Specifically, the underground environment is normally quite dark, making it difficult to visually ascertain whether a tag has been affixed to a circuit. Additionally, mining differs from other industries in the lengths of the circuits used. An electrical cable used underground may extend hundreds of feet, snaking around corners and entries. Such use would be unusual in a non-mining setting. These conditions facilitate the possibility of electrical accidents, absent appropriate precautions, and indicate a need for requiring both locking-out and tagging of electric circuits or equipment before work is performed on them. However, MSHA solicits comment on whether to permit the option of tagging out circuits and equipment alone in surface facilities and structures which are more similar to typical industrial atmospheres.

Paragraph (c) of the proposed rule would permit testing to locate electrical problems and adjusting of energized circuits, provided safety precautions are taken. The circuit voltage would have to be 1040 volts or less, the work performed by a qualified electrician, as specified in proposed §§ 56/57.12100, and procedures, tools and equipment used which are designed to assure personal safety. This would be an option only when it would be impractical to deenergize the circuit. The term "troubleshooting" was deleted and the word "adjusting" is now used for clarification.

Sections 56/57.12201 Plugs and Receptacles

This standard would revise existing §§ 56/57.12007. It would help to reduce shock and burn hazards by prohibiting the practice of making or breaking cable connections under load on circuits greater than 150 volts, line-to-ground. The proposal has been clarified by inclusion of a voltage limitation, and would allow for connectors of the load-break type. The title of the preproposal draft standard "Load-Break Disconnects," was revised in response to comments that the title and standard's language were inconsistent.

Some commenters suggested the voltage level be raised to 480, while others suggested it be deleted. It was also suggested that the value be made 150 volts to achieve consistency with other proposed standards. A value of 150 volts, line-to-ground was chosen because it would not diminish the safety measures intended by the standard.

Sections 56/57.12202 Fuses

This section is derived from existing §§ 56/57.12036 and 56/57.12037, and would address shock and burn hazards that may be created when installing or removing fuses by hand. Some commenters were concerned that the preproposal draft did not allow the use of "screw-in type fuses," which can be safely handled without the use of a tool. The proposal provides for the use of "tools or procedures," that would prevent electric shock or burns. This

language would have the effect of permitting the use of screw-in type fuses. One commenter recommended that the proposal not allow a fuse to be installed by hand in an energized circuit. This recommendation was not adopted, since some fuses can safely be installed by hand in energized circuits using the proper procedures.

Sections 56/57.12203 Cable Handling

Existing §§ 56/57.12014 and 56/57.12039 would be revised under this proposed standard for handling energized cables. Paragraph (a) of the proposal would prohibit movement of power cables energized to a voltage in excess of 150 volts line-to ground by other equipment unless sleds or slings insulated from the equipment are used. To avoid confusion, the standard specifies that the pulling or dragging of a trailing cable by the equipment it powers would not be prohibited.

Several commenters suggested that MSHA accept the alternative use of shielded cable with ground fault tripping set at 25 amperes. These measures do not provide sufficient personal protection against shock, because 25 amperes is five-thousand times the accepted safe level of current, according to information made available to the Agency. Some commenters suggested that MSHA limit the application of the proposed rule to cables of more than 650 volts, line-to-line. This recommendation was not adopted, because the hazards addressed also apply to cables of 650 volts or less, line-to-line.

Paragraph (b) is derived from existing §§ 56/57.12104. It would require the use of insulated hooks, tongs, slings, gloves, mitts, aprons, or other insulated personal protective equipment capable of protecting against shock when power cables energized to a voltage in excess of 150 volts line-to-ground are moved manually. One commenter suggested that insulated aprons should be an acceptable means of personal protection for cable handlers. This recommendation was adopted, and the proposal includes examples of equipment which would be acceptable for compliance purposes. The specific equipment used would be left to the discretion of the operator, provided it offers adequate miner protection.

Paragraph (c) would set standards for the maintenance of insulated handling equipment. It would have to be examined before each use for visible signs of damage or defects, and removed from use when damaged or defective. These procedures would assure that miners will not rely for their protection on equipment which no longer retains its protective characteristics.

Under paragraph (d), surplus trailing cables serving shovels, cranes and similar equipment would be required to be stored in cable boats, on reels mounted on the equipment, or in some other manner which would protect them from mechanical damage. Compliance with this provision would assure that when surplus cables are put into use, they will not expose miners to shock or fire hazards. One commenter recommended that paragraph 1(b) of the preproposal draft dealing with storage of surplus cables be combined with preproposal draft §§ 56/57.12–65. This suggestion was not adopted, because preproposal draft standard §§ 56/57.12–65 dealt with guarding.

Sections 56/57.12204 Access

This section would revise existing §§ 56/57.12019. Its purpose is to prevent electric shock by providing for the minimum amount of safe working space around energized electric equipment. Under paragraph (a), working space would be required around installations and equipment constructed after the effective date of the rule, where access to exposed energized electric equipment is necessary.

The proposed rule would clarify the term "suitable clearance" in the existing standard by including a table of minimum working spaces derived from the National Fire Protection Association, Inc. (NFPA), 70 E. Table 56/57.12204 would accompany the standard, along with explanatory materials. Some commenters suggested that the table should not apply to stationary, mobile or portable installations. However, the Agency believes that the proposed table incorporates safe working area clearances for all types of equipment.

Commenters also suggested that the table should only apply to new installations, because "suitable clearance" has been accepted in the past. In response, the proposal would apply only to equipment installations constructed after the effective date of the proposal. This would minimize the economic impact of the requirement, while upgrading overall safety. For existing installations, the standard would provide for an alternative to compliance with Table 2, by allowing the use of precautionary measures which protect persons from electric shock or burns. Examples of such measures would be deenergization or the use of insulated gloves or insulated blankets.

Guarding; Insulation; Separation

Sections 56/57.12300 Connections and Grids

Existing §§ 56/57.12023 would be revised under this section. It would require insulation of exposed electric connections and resistor grids. Where insulation would be impractical, they would be required to be guarded to prevent inadvertent contact by persons or equipment. The existing standard contains specific language that permits protection by location as an acceptable means of compliance. The preproposal draft revision deleted this language. Several commenters requested that it be retained in the proposed rule to provide an alternative method of compliance. This language was not retained because parts protected by location are not considered exposed and would not be addressed under the standard.

For purposes of this section, a connection or resistor grid would be considered to be exposed if it is bare and inadequately protected by guarding, isolation or insulation. Under the proposal, insulating or guarding would only be required for exposed electric connections and resistor grids that are not otherwise protected by their location. Insulation would be preferred to guarding. However, guarding may be used to comply with this standard where insulation would be impractical. The existing standard applied to all connections and grids and needed specific language to allow for the alternative of protection by location. Requiring guarding of connections and grids which are located so as to prevent contact would be unnecessarily redundant.

Some commenters recommended that the term "bare" be substituted for the term "exposed." This recommendation was not adopted because exposed more accurately describes the hazardous conditions addressed by the standard.

Sections 56/57.12301 Communication Conductors

This standard would revise existing §§ 56/57.12010 and 56/57.12048. Paragraph (a) would require all communication conductors to be isolated or insulated to prevent them from contacting bare energized parts. The provision would apply only to bare energized parts, while existing §§ 56/57.12010 applies to all energized power conductors and sources. The Agency's view is that proper insulation or isolation would address the shock hazard.

Paragraph (b) would require communication conductors carried on

poles supporting insulated power conductors to be located below the power conductors. Persons working on communication conductors are exposed to shock hazards from power conductors located on the same pole. The preproposal draft standard encompassed insulated and uninsulated power conductors, and would have required a space of at least 30 inches between conductors to provide access to the higher conductors. In response to comments, the proposal would apply only to uninsulated power conductors, and the 30-inch spacing requirement has been deleted.

Paragraph (c) would prohibit attachment of communication conductors to a crossarm that carries uninsulated power conductors. Several commenters suggested insertion of the phrase "if located below power conductors." This recommendation was not adopted because paragraph (b) would require all communication conductors to occupy the lower pole position when the pole is shared by a power conductor. The proposed rule would delete incorporation by reference to the NEC in existing §§ 56/57.12048, and would instead include specific compliance requirements.

Sections 56/57.12302 Lights, Guarding

This standard would revise existing §§ 56/57.12034 and would require guarding of portable extension lights and lights less than eight feet above travelways and working places to prevent a hazard to persons. The existing standard contains a height reference of seven feet, which was changed to eight feet in the preproposal draft. The eight-foot height reference would be retained, despite commenters concerns that it may not be possible in all mines.

Lights which are seven feet or less above travelways and working places are within easy reach of individuals of average height. An eight-foot clearance would place lights out of the reach of most persons, and assure that they would not be injured by inadvertent contact with lighting components. In mines where an eight-foot clearance is not attainable, the alternative protection of guarding to prevent hazards would be available under the proposal.

Paragraph (b) would require guarding of other types of lights when they present a hazard to persons, and paragraph (c) would prohibit lamps from contacting combustible materials. One commenter suggested the standard should require guarding of lamps to provide protection against falling glass from a broken lamp or one that has exploded. A broken or exploded lamp could create a shock or burn hazard and would be covered under paragraph (b) of the proposed standard. Additionally, the standard would address the risk of fire from mine lighting.

Sections 56/57.12330 Transformers

This standard would revise existing §§ 56/57.12026, 56/57.12067 and 56/57.12068. Paragraph (a) would require compliance with one of four equally protective alternative methods of preventing persons from inadvertently contacting energized transformer parts. Transformers would be required to be of the totally enclosed type, or installed so that exposed energized parts are at least eight feet above the ground. An eight-foot elevation of these parts would be permitted as an alternative to an enclosure because it exceeds the height of the tallest person, and inadvertent contact with the bare energized parts would be difficult.

Additionally, guarding could be achieved by installing the equipment in a transformer house or surrounding it by a sturdy fence at least six feet high and separated by at least three feet from any parts, casings or energized conductors. Any of these four methods of isolating or separating transformer parts from contact would be acceptable to the Agency. Some commenters recommended that transformers of 650 volts or less, line-to-line be specifically excepted from the requirements of the proposed standard because compliance would be difficult. The Agency believes that the allowance of four alternative methods of compliance would remove the need for such an exception.

Paragraph (b) would require gates or doors of transformer enclosures to be locked to prevent unauthorized access to exposed energized parts which are less than eight feet above ground. Locking would minimize the risk of unqualified persons gaining access to the transformer enclosure and being shocked or electrocuted. The phrase "gates or doors" was added to the provision, and the term "exposed" was substituted for "bare" to clarify the standard's intent. Finally, paragraph (c) would require metallic transformer houses and fences to be connected to the metallic case of the safety grounded transformer. This would assure that fault conditions would not energize the metallic structure of the equipment.

Sections 56/57.12331 Substations

This standard is derived from existing §§ 56/57.12026 and 57.12085, and would contain guarding requirements for substations. The proposed rule was revised to require enclosure of substations containing exposed energized parts subject to inadvertent contact by persons. Additionally, when the enclosure is a metallic fence or structure, it would be required to be connected to the substation's safety grounding system to minimize shock hazards.

Connections; Switches; Controls

Sections 56/57.12400 Identification

This standard would revise existing §§ 56/57.12018. It would require circuit breakers, trolley taps, fuse switchboxes and other disconnecting devices to be legibly, durably and distinctively marked to show which electric equipment they supply. This standard would assure accurate identification of equipment and their protective devices, and reduce the risk of inadvertent energization of equipment or circuits being worked on. Devices which can be identified by their proximity to the equipment would be exempted from the requirement. The recommendation of one commenter to remove the exception from the standard was not adopted, as it would result in requiring unnecessary labeling of all circuit breakers and disconnect devices.

The proposal adopts commenters suggestions for substituting the term "devices" for "switches" to allow for state-of-the-art equipment. The word "other" was added for clarity since circuit breakers are also disconnecting devices.

Sections 56/57.12401 Insulating Mats

This standard is derived from existing §§ 56/57.12020. It would prevent electric shocks and electrocutions by requiring insulating mats at all switchboards and power-control switches where energized parts create shock hazards. The existing standard requires protective insulation at all switchboards and power-control switches, including on units of mobile equipment, where shock hazards exist. The proposal would apply only to switchboards and control switches where a hazard exists due to exposed energized parts, including on mobile equipment. The broader scope of the existing standard was not retained because the hazard to persons is far less when energized parts are not exposed and cannot be contacted.

Several commenters suggested changing the term "exposed" to "bare." However, IEEE Standard 100–1977 defines exposed parts as live parts "that can be inadvertently touched or approached nearer than a safe distance by a person." The preproposal draft wording has been retained because it clarifies the intent of the standard and

achieves consistency with the other proposed standards.

Some commenters recommended that the standard allow for the use of grounded metallic plates as an alternative to insulating mats. With the use of metallic plates, if a person contacts a live part or an internal component of equipment, an electrical path is completed to ground through the person, resulting in an electrical injury or electrocution. Use of an insulating mat may prevent this type of occurrence. Other commenters expressed concern about the effectiveness of the mat when covered with water. Under this condition the mat is no longer insulating and would not meet the requirements of the proposed rule. One commenter expressed concern that the revision, unlike the existing standard, would fail to provide protection for persons exposed to electrical fault conditions. This hazard would be addressed in the proposed safety grounding provisions of this subpart.

Sections 56/57.12402 Undervoltage Protection

This proposed standard would be new, and would prevent the unintentional start-up of electrically-powered equipment such as mine hoists, elevators, tool heads, arc welders and conveyor belts. Starting of such machinery without warning can expose persons to crushing and pinning accidents, as well as entanglement in equipment parts. To prevent these occurrences, electric powered machinery must be equipped with undervoltage protection.

The proposed standard would require that upon loss of voltage, the equipment remain deenergized until manually restarted. Undervoltage devices are designed to detect the voltage of the circuit and cause the circuit breaker to open and deenergize the circuit upon a sudden loss of voltage, and keep it deenergized until manually reset. Otherwise, unexpected start-up of belts or equipment could injure miners.

Several commenters requested clarification of the term "undervoltage." Some commenters indicated the use of undervoltage is much broader than the phrase "loss of power," and recommended the title be changed to "loss of power protection." This recommendation was not adopted because the term undervoltage more clearly expresses the Agency's intent.

The concept of "undervoltage protection" is based on the *IEEE Dictionary of Electrical and Electronics Terms*, Standard 100–1977, definition as "the effect of a device, operative on the reduction or failure of voltage, to cause and maintain the interruption of power to the main circuit. Note: The principal objective of this device is to prevent automatic restarting of the equipment. Standard undervoltage or low-voltage protection devices are not designed to become effective at any specific degree of voltage reduction."

One interpretation of the term characterizes undervoltage as a large percentage drop in system voltage, as opposed to a total loss of voltage. The proposed language would eliminate the occurrence of circuit trips when there is a sudden load on the system resulting in a normal voltage drop. For example, use of a high-voltage continuous miner can create a heavy load on the system, with no resultant hazard. Pumps, level control circuits and equipment that by design can automatically start and stop safely would not be required to have undervoltage protection. Such a requirement would be unnecessarily restrictive.

Section 57.12460 Branch Circuit Disconnecting Devices

This standard would revise existing § 57.12084, applicable to underground metal and nonmetal mines. It would require the use of disconnecting devices underground at all branch circuits extending from primary power circuits. This provision would allow main power circuits to remain energized, while permitting deenergization of branch circuits to perform work or repairs. It would eliminate the need for the dangerous practice of performing work on energized circuits.

Paragraph (a) would require such devices to be designed to be opened under load without hazard to persons. This would limit the occurrence of electrical injuries caused by arcing or sparking when devices are opened under load. Some commenters suggested the words "designed to be opened under load" be substituted for "that can be opened under load," used in the preproposal draft. This recommendation was adopted, because all disconnecting devices designed to be opened under load without hazard by necessity can be opened under load without hazard.

Paragraph (b) would require disconnecting devices for underground branch circuits to be located as close as practical to shafts, adits, levels and boreholes. Compliance with the provision would facilitate quick access to the devices in case of an emergency situation.

Under paragraph (c), disconnecting devices would be required to be provided with a means of visually showing that the branch circuit is disconnected when the device is open. Compliance with the standard would eliminate the risk of unknowingly working on an energized circuit. Several commenters suggested substituting "indicate" for "visually show" to allow the use of molded case circuit breakers, vacuum breakers and others. This recommendation was not adopted because the possibility exists that an indication could give a false signal that the device is open, when it is not open. The proposal was revised to require visual disconnects only for disconnecting devices at branch circuits extending from primary power circuits and to allow alternate means of compliance.

Safety Grounding

Sections 56/57.12500 Grounding

This section would revise existing §§ 56/57.12025 and 56/57.12027. It would require mines that use electricity to have safety grounding systems, and give performance objectives for such systems. From 1978 through 1988, MSHA estimates that there were 150 grounding-related accidents in metal and nonmetal mines, including 14 fatal injuries. These figures indicate the need for reliable safety grounding systems for the protection of miners.

The proposed standard does not specify design criteria for the grounding system. The methods and designs used to achieve this goal would be left to the designer of the system. The preproposal draft contained an equation, ($V^2t=30375$), that some commenters objected to. It has been deleted from the proposal and placed in Appendix 1 as a reference. The performance objective of the proposal can be obtained by using the equation or other methods.

The equation was derived from IEEE Standard 80–1976, § 4.3 (Duration); $I^2t=0.0135$. The equation used in the proposal's appendix differs from the IEEE equation because it relates voltage to time with an assumed body resistance of 1500 ohms whereas, the IEEE equation relates current to time without assuming body resistance. The body resistance factor may make the proposal equation easier to use.

The 1500 ohm value is based on Underwriters Laboratories, Inc., "Standard for Ground-Fault Circuit Interrupters" (UL 943). This value is 50 percent higher than the recommended value of 1000 ohms in IEEE Standard 80–1976, § 5, but safety would not be diminished because the 1000 ohm value does not factor in contact resistance to Earth.

Some commenters suggested that the standard should apply only to fault

conditions of more than 100 volts. However, information available to the Agency indicates that a shock hazard could exist using this voltage. This has been shown by C.F. Dalziel, a recognized authority on shock hazards, using the equation $I^2t=0.0135$, developed by Dalziel. (Ref. IEEE Standard 80–1976). According to Dalziel, values below this curve, for current and time, will provide protection for 99.5 percent of the population against ventricular fibrillation.

IEEE Standard 80, § 4.3 (Duration), used this equation as a basis for determining shock hazards and designing substation ground grids. One hundred volts can be tolerated for approximately 3 seconds, if the assumption is made that the person's total resistance is 1500 ohms. Therefore, to achieve compliance with the standard, a voltage of 100 volts, for example, would have to be cleared within three seconds, so as not to present a disabling or fatal shock. In addition, MSHA fatality data documents that persons have been killed through exposure to voltages less than 100 volts. For example, a welder was killed when his neck came into contact with the electrode of an electric welder energized at approximately 80 volts.

In response to some commenters, the proposal was modified to limit the number of faults that must be used to determine if a shock hazard exists. On grounded systems, a line-to-ground fault would be used to determine if a shock hazard exists. On ungrounded systems, a double line-to-ground fault with one of the faults at the source would be used. The operation of lightning arresters and faults in the utility system have been removed from the proposal.

Paragraph (b) would require the voltage on non-current carrying metallic parts of equipment to be controlled by limiting the magnitude or the duration of the voltage, or a combination of both. Appendix I, following the proposed rule, would be a useful guide for compliance purposes. Using the formula in the appendix, a voltage of 100 volts, for example, should be cleared within three seconds. This would limit the possible exposure time to voltages capable of causing injury or death to persons.

Some commenters questioned the method to be used to limit step and touch potentials. Using IEEE Standard 80, ground grids can be designed around any substation for the purpose of limiting step and touch potentials. The resistivity, or resistance of a volume of Earth, of the soil in which the grid is placed is a minor factor in determining the grid design.

Sections 56/57.12501 Alternating-Current Equipment

General grounding requirements for a-c equipment would be addressed by this standard, which is derived from §§ 56/57.12025, 56/57.12027 and 56/57.12033. Paragraph (a) lists structures to be connected to the safety grounding system by equipment safety grounding conductors. For reasons discussed in connection with the proposed definitions, the term "equipment safety grounding conductor" is employed by the proposal. The format of the preproposal draft has been altered in response to recommendations made by commenters. Alternating-current and d-c equipment are addressed in separate sections, and portable, mobile and stationary equipment are addressed within those standards.

Metallic frames, enclosures and other exposed non-current-carrying metallic parts of electric equipment would be required to be connected to the safety grounding system by equipment safety grounding conductors. Therefore, a common safety grounding system would be shared by the unit of equipment and exposed non-current-carrying metallic parts associated with it. In case of insulation failure on a power conductor, which can allow contact between the energized conductor and some portion of a metallic enclosure, the enclosure may become energized with the voltage of the conductor. Anyone contacting the enclosure would then be exposed to the voltage of the conductor. A common safety grounding system would assure that no difference in voltages capable of injuring or electrocuting miners would exist between the structures.

Metallic fences and barriers around high-voltage equipment and installations would also have to be connected to the safety grounding system by equipment safety grounding conductors. This would prevent the occurrence of abnormal voltages on the structures due to contact with an energized conductor. A person who brushes against or leans upon an energized fence, for example, could otherwise be exposed to a serious shock hazard if the fence is not properly connected to the safety grounding system.

Metallic enclosures of a-c conductors would also be required to be connected to the safety grounding system by equipment safety grounding conductors. Therefore, a complete grounding path would be provided for enclosures of a-c conductors, to minimize the risk of harm to persons contacting them. Equipment safety grounding conductors would also be required to connect metallic messenger wires to the safety grounding system. Messenger wires are sometimes used to support single-conductor energized cables in mines. If a splice in such a cable should become damaged where it is supported by messenger wire, the messenger wire could become energized with the voltage of the cable. This would present shock and fire hazards where energized messenger wires contact other structures.

Metallic structures or racks which support electric equipment or conductors would be addressed under the provision. Cable trays which hold energized power cables would be an example of structures addressed by the standard. A breakdown in the cable's insulation could cause the metallic tray to become energized with the voltage of the conductor, presenting a possibly lethal hazard to persons unknowingly coming into contact with the tray. Under the proposal, the tray would be required to be connected to the safety grounding system in order to limit the voltage which could occur on it.

Paragraph (b) would require metallic cable shielding to be connected to the safety grounding system by equipment safety grounding conductors at each termination. This provision would ensure a complete, low-impedance path to the safety grounding system, to prevent stray voltages from energizing the shielding and creating a shock hazard.

Before batteries on battery-powered equipment are connected to a battery charger, paragraph (c) would require the metallic battery trays to be connected to the grounded metallic frame of the charger by equipment safety grounding conductors. Trays would be required to remain connected to the frame until the batteries have been disconnected from the charger. A primary to secondary fault could energize the entire equipment frame. Under the proposed standard, this occurrence would be prevented, since faults would be cleared by the safety grounding system. This standard is intended to apply only to battery-powered equipment, and not all equipment which is started by the use of a battery.

Over the last twenty years, accidental energization of equipment being serviced by battery chargers has occurred, with resulting death to persons who unknowingly contacted the energized equipment frame. The proposed grounding standard would help to reduce the occurrence of similar accidents in the future by assuring that battery trays are properly connected to the safety grounding system during operations which pose a risk of electrical injury. In response to one

commenter's concern, it should be noted that the proposal is not intended to apply to automobiles and trucks, since it addresses battery-powered, rather than battery-started, equipment.

Paragraph (d) would require metallic cable hangers or supporting structures to be connected to the safety grounding system or insulated from the cable. These precautions would protect persons from shock and fire hazards should damage to the cable occur.

Under paragraph (e), exposed metallic enclosures of hand-held electric equipment would be required to be connected to the safety grounding system, except in three instances. Equipment which is double insulated, as determined by an independent testing laboratory, and which does not present a shock hazard, or equipment which is operated at a maximum of 40 volts would not be required to be connected to the safety grounding system.

Hand-held equipment which is double insulated would be exempted from the standard, because two independent insulation systems would provide adequate protection against shock hazards. Damage to one of the insulation systems would not expose miners to energized parts. Some nationally recognized private concerns perform insulation testing to assure that dangerous leakages of current will not occur. Equipment which has been listed by such groups as double-insulated, and which would not present a shock hazard would be acceptable to the Agency for purposes of the exception.

Some commenters stated that even double insulated tools should be grounded with a safety grounding conductor. However, the Agency believes that this would place an unnecessary restriction on the use of equipment that is generally accepted as being safe to operate without an equipment safety grounding conductor. Tests conducted by MSHA contained in Publication U.S.D.O.L. IR–1081 (1978), support the position that double insulation is a safe alternative to equipment safety grounding for hand-held tools. Other commenters expressed concern that the use of double insulated tools would be unsafe in wet locations. However, requiring an equipment safety grounding conductor would not make double insulated tools any safer to use in wet locations. The majority of hand-held electric equipment, with or without equipment safety grounding conductors, is not designed to be used in wet locations.

Under paragraph (f), generator powered equipment mounted on the same metallic frame as the generator would not be required to be connected to the mine's safety grounding system. This would exempt the specified equipment from the requirements of the standard, as it is a self-contained unit. Therefore, there is no likelihood of the occurrence of differing potentials on the metallic frame. No safety advantage would be gained by connecting such equipment to the safety grounding system.

Sections 56/57.12502 Direct-Current Equipment

This standard would revise existing §§ 56/57.12025 and 56/57.12027, and would contain grounding requirements for d-c equipment. The terms "grounded" and "equivalent protection" in the existing standards have been replaced with specific requirements. Mine operators have expressed their opinion that these terms are vague and subject to varying interpretation and misunderstanding. Accidents have resulted where the standard has been interpreted to mean that any connection to earth provides acceptable safety grounding. The proposal also sets necessary exceptions to the requirement for equipment that must be connected to the mine's safety grounding system.

This section would also list several types of equipment and structures which would be required to be connected to the mine safety grounding system by equipment safety grounding conductors. It would address metallic frames, enclosures and other exposed non-current-carrying metallic parts of conductors and equipment, metallic messenger wires used to support d–c conductors, metallic racks and structures used to support trolley wires and trolley feeder wires, and metallic overcasts in trolley systems.

For reasons discussed in connection with the previous section, shock and fire hazards would be prevented by the proposed requirements. Several commenters expressed their view that it is not necessary to require grounding of all d–c systems or rubber-tired trolley assist systems. However, in MSHA's view, metallic frames that enclose or are subject to becoming energized by electric circuits must be safety grounded to prevent injuries or fatalities to persons who contact them. The same hazards to miners exist on this type of equipment as any other equipment frame. Therefore, the same necessity for effective safety grounding exists.

Paragraph (b) would require silicon diode grounding systems to be installed in accordance with proposed §§ 56/57.12504, which would detail safety requirements for that method of grounding. Paragraph (c) would require that component parts of complete units of equipment be solidly connected to the frames of the equipment for grounding purposes, to assure a common connection to the safety grounding system.

Under paragraph (d), equipment which is double insulated, as determined by an independent testing laboratory, and which does not present a shock hazard, or equipment powered by internal batteries which are an integral part of the equipment, or equipment which is operated at a maximum of 40 volts, would not be required to be connected to the safety grounding system. These types of equipment would be exempted from the requirements of the standard for reasons discussed in connection with paragraph (e) of the previous section.

Paragraph (e) would be an exception to the proposed standard. Generator-powered equipment mounted on the same metallic frame as the generator would not be required to be connected to the mine's safety grounding system. As discussed in connection with the previous section, no safety advantage would be gained by connecting such equipment to the safety grounding system.

Sections 56/57.12503 Equipment Safety Grounding Conductors

Design and performance requirements for equipment safety grounding conductors would be addressed in this proposed section, which is derived from existing §§ 56/57.12025 and 56/57.12027. Equipment safety grounding conductors are an essential part of grounding systems in that they are used to connect non-current-carrying exposed metallic parts of equipment and structures to the mine safety grounding system. They are the means of preventing the appearance of dangerous voltages on equipment frames and structures by providing a path from the equipment to the safety grounding system. Proper performance and design of these conductors are essential to the prevention of electrical accidents related to inadequate or ineffective grounding conductors.

Paragraph (a) would require that equipment safety grounding conductors for portable and mobile electric equipment be one or more stranded copper conductors contained within the cable or flexible cord supplying the equipment. Grounding conductors should be enclosed inside cables serving heavily-used portable or mobile electric equipment in order to protect them from physical damage and deterioration. Stranded copper conductors would provide the necessary flexibility and

strength for use within cables or flexible cords.

Paragraph (b) would set requirements for equipment safety grounding conductors for stationary equipment. They would be required to be contained together with the circuit conductors in the raceways, cables, or cords, or wrapped around the raceways, cables or cords containing the circuit conductors, or a continuous metal framework, conduit, or metallic conducting medium that complies with the voltage exposure requirements of proposed §§ 56/57.12500. The closer the grounding conductor is located to the power conductor, the less impedance exists between the two. Thus, fault currents will follow the conductor to the safety grounding system, and not directly to earth. Minimum impedance would facilitate effective operation of the equipment safety grounding conductor.

Paragraph (c) would detail the required cross-sectional area of equipment safety grounding conductors. When the circuit conductor is No. 6 AWG (American Wire Gauge) or larger, the combined cross-sectional area would be required to be equal to or greater than one half of the cross-sectional area of the circuit conductor. When the circuit conductor is smaller than No. 6 AWG, the combined cross-sectional area of the equipment safety grounding conductor would have to be equal to that of the circuit conductor.

These conductor sizes, at a minimum, would assure that they are capable of safely carrying the currents to which they may be exposed, and also provide the necessary mechanical strength. The sizes are consistent with the recommendations made in the Bureau of Mines Final Report, No. G0155102, entitled "Open-Pit Metal Mining Grounding Systems." The report resulted from work done by the Pennsylvania State University on behalf of the Bureau of Mines.

Paragraph (d), would require equipment safety grounding conductors installed outside of raceways, cables or cords, and used to ground stationary equipment to be No. 6 AWG or larger. Equipment safety grounding conductors of this size would be able to withstand physical damage and deterioration from the harsh mining environment. Otherwise, the flexing and movement to which such cables are subjected could cause damage to the grounding conductor without damaging the larger phase conductors.

Under paragraph (e), switches, fuses, circuit breakers, ground-fault devices and overcurrent devices would be prohibited from being installed in equipment safety grounding conductors. This would be a preventative measure to ensure that the devices specified could not interfere with the operation of the grounding conductor.

Paragraph (f) of the proposed rule would require ground-wire devices installed in the equipment safety grounding conductor for the purpose of suppressing inter-machine arcing, or in conjunction with ground-wire monitoring systems, to be substantially designed and constructed to withstand the maximum amount of phase-to-phase current to which they may be exposed from simultaneous ground-faults. The effect of this provision would be to permit the use of arc suppression devices, which can minimize shock hazards, if they are substantially designed and constructed to perform their intended function despite elevated fault currents. The proposal would provide standards designed to assure that the use of such devices would not increase the possibility of electric shock hazards.

Paragraph (g) of the proposed standard would require that when ground-wire devices addressed by paragraph (f), such as arc traps and ground-wire monitor filters and diodes, are used, they would have to be connected to the safety grounding system by two separate equipment safety grounding conductors. A single ground-wire monitor is not capable of detecting both the integrity of the ground-wire and whether ground-wire devices are properly connected to the safety grounding system. The proposed standard would provide for a back-up equipment safety grounding conductor connection in case one should fail or become damaged. A second conductor would ensure that the grounding conductors will not become open, without the expense associated with a second ground-wire monitor. MSHA solicits comment on the necessity of a second equipment safety grounding conductor, and the safety benefits thereof.

Under paragraph (h), separate connections to the mine track, the grounded return-feeder conductor, or the metallic frame or enclosure used as the safety grounding system would be required for the equipment safety grounding conductor and the return power conductor on d-c powered equipment. If the equipment safety grounding and return conductors are attached to the safety grounding system by the same connection, both could easily be dislodged or damaged. If both are simultaneously dislodged, the frame of the equipment could become energized, creating a risk of electrical injury to miners. Separate connections would assure the integrity of the safety grounding system, and address the hazards.

Paragraph (i) would require equipment safety grounding conductors for draw-out equipment or plugs and receptacles to be the first conductors connected when making connections, and the last conductors broken when breaking connections. In this way, the safety grounding system for the equipment would remain intact while draw-out units, such as circuit breakers, are being installed or removed. Therefore, ground-fault protection against arcing and ignitions would be provided while devices are being withdrawn or separated.

Under paragraph (j), when power is supplied between separate metallic parts of equipment, the parts would be required to be connected together through an equipment safety grounding conductor. Compliance with this provision would assure that hazardous potentials do not develop between the component parts of the equipment. For example, a person contacting the metallic headlight enclosure of a unit of equipment which is not properly connected to the frame of the unit could receive an electrical shock if the voltage which exists on the headlight enclosure differs from that of the equipment frame. Grounding through a common safety grounding system would serve to minimize the possibility of such an occurrence.

Paragraph (k) would require the frame of a portable or mobile generator supplying remote loads to have equipment safety grounding conductors connecting the frames of each remote load to the frame of the generator. This standard would address power take-off equipment, for example. It would assure that remote loads and the equipment supplying them are connected to a common safety grounding system.

Finally, paragraph (l) would require equipment safety grounding conductors to be bare or properly identified. The effect of this provision would be to identify the conductors that are the connection to the safety grounding system. This section would assure that persons would not mistake the equipment safety grounding conductor for a power conductor. The standard would minimize the possibility of an equipment safety grounding conductor being connected to an incoming power conductor and energizing the equipment frame.

Sections 56/57.12504 Silicon Diode Grounding

This section of the proposal would govern the use of silicon diode grounding, and is derived from §§ 56/57.12025 and 56/57.12027. It would make clear under what conditions silicon diode grounding would be permitted. The proposed standard would contain specific design and performance standards for silicon diode grounding of metallic frames, enclosures, or other exposed non-current-carrying metallic parts of off-track equipment.

Under the proposed standard, when the metallic frames of off-track equipment are grounded by silicon diodes, the diode grounding system would have to meet several requirements. The standard would allow for the compliance alternative of silicon diode grounding, but only if proper safety precautions are taken. These proposed requirements are similar to the conditions typically included in petitions for modification of mandatory standards granted by the Agency on the grounds that the alternative compliance scheme provides equivalent miner protection.

Under paragraph (a), the polarity of each grounding diode would be required to be compatible with the grounded polarity of the d-c system. When the polarity of the grounding diode is proper, current will only flow from the frame of the equipment to the grounded power conductor during faults. However, if the polarity is reversed, dangerous voltages would remain on the frame of the equipment. Further, the overcurrent devices which would be required by paragraph (c) of the standard would be unable to detect the occurrence of a ground-fault if polarity was reversed. Reversed polarity could therefore defeat the safety grounding system, and expose miners to electrocution hazards.

Under paragraph (b), each grounding diode would be required to have a threaded base used to solidly connect the diode to the machine frame. This provision would also serve to ensure a proper, complete grounding path for off-track equipment. It would prohibit the use of "hockey-puck" style connections, which utilize a pressure connector. Unlike hockey-puck connections, a threaded base diode would screw into the frame of equipment, keeping debris from interfering with the connection and the correct functioning of the diode. The standard would also preclude the use of welding for such connections, as the heat involved with the process could destroy the diode.

Under paragraph (c), an overcurrent device would be required to be installed between grounding diodes and the grounded power conductor when a silicon diode grounding system is used. The overcurrent device would have to be designed to cause the main contactor or the circuit interrupting device to deenergize all circuits on the machine when 50 amperes or more flows through the grounding diode. The proposal would therefore require the circuit breaker to trip when a current of 50 amperes or more passes through the diode. A current of less than 50 amperes, in MSHA's view, represents a safe cut-off value. However, methane monitors would be permitted to remain functional to continuously test for dangerous gas levels despite deenergization of a circuit.

Paragraph (d) of the standard would require installation of a polarizing diode in the control circuit which prevents the unit of equipment from being operated when the polarity of the supply conductors is reversed. As discussed previously, improper polarity of the diode can defeat the grounding system. Under this provision, operation of equipment would be made impossible if the supply diode's polarity is reversed, thus preventing unanticipated energization of the frame of the equipment. The standard imposes a precautionary condition on the use of an alternative method of silicon diode grounding.

Under paragraph (e) of the proposal, the forward current rating of each grounding diode would have to be equal to or greater than 750 amperes when used to ground a continuous mining machine, or equal to or greater than 400 amperes when used to ground other equipment, regardless of the voltage of the equipment. Lower forward current ratings, in MSHA's view, could cause the grounding diode to open and fail to trip the circuit breaker during a fault, leaving the equipment frame ungrounded. The proposal would assure a safe and dependable safety grounding circuit which will not fail under overcurrent conditions for all equipment, without reference to voltage. The provision refers to the current or size of the diode, which is an alternative to requiring a grounding conductor, instead of the equipment voltage.

Paragraph (f) of the standard would require the peak reverse voltage rating of the grounding and polarizing diodes to be equal to or greater than 1,200 volts. This provision would help to prevent failure of the solid state device. Electric equipment can be subjected to severe overvoltages, which can cause the grounding or polarizing diode junction to rupture, short circuit, or open, leaving equipment frames exposed to energization. If the polarizing diode ruptures, its ability to retard the function of the control circuit would be lost. This could allow the equipment frame to be energized if polarity is reversed. The proposed standard would address these hazards.

Sections 56/57.12505 Low-Resistance Ground Fields

This proposed standard would set requirements for the design and construction of low-resistance ground fields. It is derived from §§ 56/57.12025, 56/57.12027 and 56/57.12028. Paragraph (a) of the proposal would require low-resistance ground fields used in the safety grounding system to be designed and installed in a manner to assure that the maximum exposure voltage under fault conditions does not create hazardous step and touch potentials. In evaluating ground field safety, the standard would require consideration of the parameters of the system, including soil resistivity, available fault currents, ground field construction, and the operating times of protective devices.

Under paragraph (b), low-resistance ground fields used in the safety grounding system would be required to be maintained at 25 ohms or less. Electric current follows the path of lowest resistance that it encounters. Therefore, the lower the resistance of a ground field, the more likely it is that protective devices can operate to remove ground faults and minimize the possibility of energization of equipment frames. A maximum 25-ohm resistance to earth would serve to maintain resistance at a low level to facilitate the proper operation of ground-fault protective devices.

The system resistance value may deviate from the 25-ohm maximum only if evaluation of the system in accordance with the safety considerations of paragraph (a) indicates that a lower value of resistance is necessary, or a higher value of resistance may safely be used. In this manner, some flexibility would be added to the rule to take into consideration the special circumstances of each mine and its ground-fault protection system.

Paragraph (c) would be a new requirement that the surface area of ground field materials have at least four square feet of contact with soil. For example, the use of three grounding rods measuring 5/8-inch in diameter and eight feet in length would be one method of achieving compliance with the proposed standard, since they would provide at least four square feet of contact with soil. Typically, many more

than three grounding rods are presently used in the construction of ground fields. In MSHA's view, four square feet would be a suitable minimum surface contact area to ensure that the ground field has a low resistance to earth. The proposed requirements for ground fields would aid in protecting miners from shock and burn hazards due to voltages appearing between frames or enclosures of electric equipment and earth. A safe, dependable safety grounding system would be provided for under this proposed standard.

Sections 56/57.12506 Testing

This standard would revise existing §§ 56/57.12028, and would detail procedures for testing of the safety grounding system. Existing recordkeeping requirements would be deleted under the proposal, as past experience has shown that records in this case do not give an indication of the safety of the grounding system. Other revisions are based on the results of a study of Electrical Accidents Relating to Grounding Systems at Surface and Underground Metal and Nonmetal Mines, 1978–1983, conducted by MSHA.

The study attributed at least 80 electrical accidents, including five fatalities in that time period, to either a faulty grounding system or the lack of a grounding system.[2] Additionally, the study concluded that, "Most of the accidents could have been prevented if a well designed grounding system were installed and maintained. Maintaining the integrity of the ground circuit is of paramount importance for safe operation of electrical equipment." The testing procedures outlined in the proposal would assure that problems arising in mine safety grounding systems are identified and dealt with in a prompt manner to avoid the occurrence of future injuries and fatalities.

Paragraph (a) would require continuity tests to assure the integrity of the system on all installations made after the effective date of the rule, and when repairs are made to the safety grounding system. The safety grounding system would additionally be required to be reviewed at intervals not to exceed twelve months to assure that the maximum voltage exposure under fault conditions complies with the requirements of subpart K. Initial testing and annual review of the safety grounding system would assure that installation and maintenance of the system are being properly performed, and that a complete, low-impedance ground path is available to prevent occurrence of lethal voltages on equipment frames. The standard would also simplify and clarify the testing required under the existing standard.

For mine power systems utilizing a-c voltage of less than 650 volts, paragraph (c) would require the resistance to earth of the safety grounding system's connection to earth to be maintained at 25 ohms or less, and be physically separated from the substation grounding system. The separation would be required to be the larger of 25 feet or five times the largest dimension of the safety grounding system's connection to earth. As discussed earlier, a resistance value of 25 ohms or less would provide a low-impedance path to ground for fault currents, instead of energizing equipment frames.

The standard would also take into consideration the practical necessities at each mine. It would allow deviation from the value of 25-ohms or less when such a value could not be attained, but only if the operator assures that the system complies with the ground field requirements of proposed §§ 56/57.12505. The voltage level was raised from 600 volts to 650 volts in the proposal to be consistent with other standards in subpart K.

Physical separation from the substation grounding system would prevent transmission of fault current occurring on the substation system to the safety grounding system and energizing equipment frames. Several commenters suggested that separation of the safety grounding system from the substation ground contradicts IEEE Standard 80–1976, § 16.5, which addresses separate grounds, and interconnected grounds in a substation. The IEEE Standard states that these grounds should be interconnected, but should not be used to provide safety grounding for equipment outside the substation.

This is clearly supported by IEEE Standard 142–1982, § 2.6, and accompanying figures 20 and 21(a) and (b). Figures 21(a) and 21(b) show the shock hazard that can occur when the safety grounding system is tied to the substation ground. IEEE Standard 142–1982, requires at least a 50-foot separation of ground beds. The proposal requires at least a 25-foot separation. The separation distance would increase as a function of the size of the safety grounding system's connection to earth. The required separation would be a physical separation and not a complete electrical isolation.

Paragraph (d), would contain requirements for reviewing mine power systems utilizing a-c voltages greater than 650 volts line-to-line. Review would be required to include determinations of the safety grounding system's resistance to earth at its connection to earth. Some commenters to the preproposal draft were not certain of where the resistance measurement of the grounding system would be required to be taken. The proposal would clarify that tests must be conducted where the equipment safety grounding conductor is intentionally connected to earth.

A determination of the maximum fault current able to flow into the safety grounding system, and the impedance of the safety grounding system at electric loads or sources of 500 kVA or larger would also be required. Several commenters wanted to know how to obtain the voltage exposure. There are several acceptable methods including calculations, measurements, or a combination of the two, dependent upon the configuration of the system. The voltage determinations do not have to be conducted if the system has not changed since the effective date of this standard. Some commenters suggested referencing the NEC. The proposal is largely performance-oriented, and is not intended to provide design criteria. However, the NEC could be used as a source for obtaining compliance with the proposed standard.

Paragraph (e) would require a weekly check to be made of the continuity of all mobile equipment safety grounding conductors, except when they are continuously monitored with an MSHA tested ground-wire monitoring device. The preproposal draft referenced a fail safe grounding system as a testing alternative, which generated confusion on the part of some commenters. For clarity, the proposal has been altered to allow the use of a ground-wire monitoring device tested by MSHA. These devices are available and have been required and used in mines for several years. The proposal would not require ground-wire monitors, but would permit their use as an alternate means of compliance.

Additionally, commenters requested that the interval for checking the continuity of equipment safety grounding conductors be increased from a weekly check to a monthly check on mobile equipment. In MSHA's view, a monthly interval would be too infrequent for checking equipment safety grounding conductors. Mobile equipment is constantly in motion, causing flexing and potential damage to the cables serving it, as well as equipment safety grounding conductors. Unlike phase conductors, equipment

[2] As previously noted, MSHA estimates that from 1984 through 1988, an additional 60 nonfatal and six fatal grounding-related accidents have occurred.

safety grounding conductors will not prevent a machine from operating if broken. Additionally, most mines use a weekly electrical maintenance schedule, during which the section is shut down to perform examinations and repairs. The continuity check could be done coincidentally with the maintenance shut down, under the proposal. Without frequent checks, it would be impossible to tell whether the conductor is broken or damaged, rendering the safety grounding system ineffective for preventing electric shocks. MSHA solicits comments on the appropriateness of the interval.

Power Cables and Conductors

Sections 56/57.12600 Installation

This proposed standard would revise existing §§ 56/57.12004, 56/57.12011 and 57.12082, and would address installation of cables and insulated conductors and prevention of mechanical damage to them. Paragraph (a) would require that they be installed so that they are protected against physical damage, adverse ambient conditions and failure of adjacent mechanical systems.

Several commenters expressed the view that it is impossible to protect cables from all physical damage because of the nature of mining operations and the difficulty of achieving sufficient protection. The Agency continues to believe that it is possible and necessary to protect cables from physical damage in order to assure a safe work place. IEEE Standard 242 (1975), "IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems," addresses this subject in Chapter 11 on Conductor Protection. The IEEE Standard 242 Section 11.6, "Physical Protection of Cables" addresses mechanical hazards, adverse ambient conditions and damage by foreign elements. The proposed standard would reflect the philosophy of IEEE Standard 242 by requiring protection from damage caused by vehicles, falling objects, misdirected excavation, water, chemicals, bursting pipelines and broken conveyor belts. Minor or cosmetic damage that does not reduce the protective function of the jacket would not be cited under the proposal.

Paragraph (b) of the proposal would minimize the hazard of inadvertent energization of pipelines by prohibiting their use for the support of cables and insulated conductors. However, the proposal would allow cables and pipelines to be installed on the same support, provided work can be performed on pipelines without creating a shock hazard. The preproposal draft would also have prohibited cables and insulated conductors from contacting pipelines. Several commenters indicated that no hazard is created when cables contact pipelines because cables are equipped with shielding or jackets which would protect them from damage from pipelines. In response to those comments, paragraph (c) would prohibit only insulated conductors from contacting pipelines.

Sections 56/57.12601 Ampacity

The proposed standard for cable and conductor ampacities is derived from existing §§ 56/57.12004. New ampacity tables, derived from the NEC and ICEA standards, for proper sizing of conductors would accompany the standard. Paragraph (a) would require electric conductors to be of a size and current-carrying capacity to assure that a rise in temperature resulting from normal operating conditions does not exceed the rating of the insulation and conductors. Exceeding the rating assigned by the manufacturer could expose persons to electric shock or electrocution hazards by causing deterioration of the insulation and conductors. Therefore, conductor sizes and ampacities should be compatible with the current level rated for and used in the circuit.

Under paragraph (b), branch circuit conductors supplying electric equipment would be required to have ampacities of at least 125 percent of the full-load current rating of the equipment. The 125 percent value would provide a buffer, and take the occurrence of higher than normal currents into consideration. For similar reasons, paragraph (c) would require the ampacity of feeder circuit conductors which supply multiple loads to be at least the sum of the full-load current ratings of all the loads plus 25 percent of the highest full-load current of the largest load.

Under paragraph (d), the size of conductors for electric equipment would be required to conform to ampacity Tables 56/57.12601–1 through 56/57.12601–10, or other tables appropriate for the conditions where the conductors are used. Several commenters to the preproposal draft expressed concern about being limited to using the tables supplied. The tables included in the standard are intended to be used as a reference to aid in compliance efforts. However, the use of other appropriate tables would be acceptable to the Agency, provided no safety hazards are introduced.

Some commenters requested derating factors for ambient temperatures. Under paragraph (e), conductor ampacities would be required to be corrected according to the ambient temperature where the conductor is used, if this temperature is other than the temperature at which the conductor was rated. Deterioration of conductor insulation due to a higher ambient temperature than the insulation rating could present a shock hazard. Table 56/57.12601–11 was included because the derating factors vary as a function of the rated temperature of the conductor. The determination of what value is to be used would be left to the operator.

Paragraph (f) would require that when four or more conductors are contained in the same raceway, conduit, or cable, the maximum allowable load current must be reduced according to Table 56/57.12601–12 accompanying the standard. Some commenters recommended that derating factors be included when three or more conductors are contained in a raceway. In response to these commenters the proposal includes derating factors from Article 310 of the NEC.

Some commenters expressed concern that the preproposal draft did not specify the length of conductors. Lengths were not specified, because this would impose design criteria for installations where conductors are used. These revisions are intended to be performance- rather than design-oriented where possible, while preserving a high level of miner safety.

Sections 56/57.12602 Insulation, Termination and Shielding

This section is derived from existing §§ 56/57.12008, and would specify insulation requirements for power cables and conductors. Paragraph (a) would require power cables and conductors to have insulation rated for at least the voltage of the circuit in which the conductor is applied. Trolley wires and uninsulated surface overhead conductors of more than 650 volts line-to-line would be exempted from the insulation requirement due to their use and accessibility.

A potential hazard is created when the conductor insulation rating is below the nominal impressed voltage, possibly causing the insulation to break down and result in damage to the cable. Damaged cable would present a readily available ignition source for a mine fire or explosion, as well as produce a potential shock hazard to persons handling the cable or working on or near the equipment served by the cable. The conductor insulation voltage rating is usually identified on the outer jacket of the cable. Operators could, by looking at this identification, determine the

adequacy of the cable for use in a particular circuit.

Some commenters suggested that paragraph (a) refer to insulated conductors instead of all conductors. "Insulated" was excluded because the only conductors at a mine that can be bare are trolley wires and overhead conductors of more than 650 volts, line-to-line. In underground mines, only trolley wires below 2kV can be bare. Commenters also expressed concern that field testing in the preproposal draft was dictating design standards, with no increase in miner safety. In response to these concerns, the proposal has been revised to delete reference to insulation performance requirements.

Under paragraph (b), a new provision, power cables and conductors installed on the surface in circuits with line-to-line voltages above 2,000 volts and subject to contact by persons would be required to have metallic shielding around each power conductor. Some commenters indicated the preproposal draft did not recognize "approved" use of unshielded conductors and stated that the use of metallic shielding is unnecessary in some protected locations. In response to commenters, the proposal has been modified to require shielding of cables and conductors in underground areas of mines, and on surface areas of mines only where they are accessible to persons.

"The IEEE Recommended Practice for Electric Power Distribution for Industrial Plants," standard 141–1976, recommends shielding be provided on cables between 2kV and 8kV. Shielding is required by the NEC (310–6, 400–31(b), 1984) on cables above 2kV. Cables in all underground and some surface mine areas would be subjected to conditions stated in IEEE Standard 141–1976, and would require shielding. Under a provision solely applicable to underground mines, § 57.12602(b) would require all power cables and conductors installed underground in circuits with line-to-line voltages above 2,000 volts to have insulation and metallic shielding around each power conductor. The exception for inaccessible cables and conductors would not apply underground due to the limited clearances and the increased risk of damage to cables and conductors in the underground environment.

Under paragraph (c), metallic enclosed power cables and conductors would not be required to be shielded, provided the enclosure is continuous and connected to the safety grounding system. This provision would give an alternative to shielding which offers equal protection. A continuous enclosure, solidly connected to the safety grounding system would assure an efficient grounding path, and added physical protection for cables and conductors.

Paragraph (d) would require cables to enter metallic frames of electric enclosures through fittings sized for the cables, which prevent damage to the cable jackets and the insulation of the internal conductors. The standard would lead to secure fittings which would cause minimal strain on the connections. Under paragraph (e), insulated conductors would be required to enter metallic frames of electric enclosures through fittings with insulated bushings sized for the conductors. Insulated bushings would offer physical protection for the insulation of conductors not protected by a jacket.

Paragraph (f) is new, and would contain an exception to the proposed requirements of paragraphs (d) and (e). It would state that cables and conductors in conduit that enter metallic frames of electric enclosures would not be required to be equipped with fittings or bushings when protection against damage by sharp edges is provided. This provision would offer a compliance alternative designed to provide the same measure of protection.

Paragraph (g) is new, and would require conductors to be secured so as to prevent mechanical strain on electrical connections. Hazards resulting from improper conductor and cable fittings include electric shock and electrocution from energized equipment frames. By requiring fittings at locations where cables and insulated conductors enter electric compartments to be designed to prevent strain on electrical connections, chaffing and damage to the cable or conductors would be prevented, and the number of injuries to persons from these conditions would be reduced.

Some commenters felt jackets would not be proper protection for cables and conductors where they enter frames. The proposal would not allow jacketing to serve as protection under these conditions. Cables should enter frames through proper fittings to prevent damage to the jacket and internal conductors. Commenters also suggested elimination of insulated bushings. This recommendation was not adopted because conductors having only an outer protective jacket are not sufficiently protected from damage where they enter metal boxes.

Sections 56/57.12603 Splices and Repairs

This standard is derived primarily from existing §§ 56/57.12013 and 57.12088, and would set safety requirements for splicing and repair of cables. Existing practices on splices and splicing methods were researched by the Bureau of Mines (Mine Trailing Cables and Cable Splices, Contract #J0199106). The results show a high failure rate of splices. The proposal would define the type of cable splices permitted and is intended to reduce the number of accidents involving splice failures and burning cables. The proposal does not limit the number of splices in a cable.

Paragraph (a) is new, and would require that cables be spliced, terminated or repaired by a qualified electrician, defined in the proposal as an individual who has met the requirements of an operator's qualification program in accordance with proposed §§ 56/57.12100. This would assure that persons are protected against shock and fire hazards created by improperly-spliced cables. By requiring that cables be attended to by qualified electricians, the knowledge and training of such individuals would be brought to bear on a difficult and potentially hazardous task.

Paragraph (b) would require splices in trailing cables to contain only one connection point in each conductor. A single connection of two severed ends of trailing cable would provide the best possible electrical conductivity. The introduction of more than one connection point would reduce the electrical conductivity of the splice to an unacceptable level which could lead to inadequate electrical protection for the circuit and a shock and fire hazard on the circuit and the equipment it serves.

Paragraph (c) would require terminations of cable shielding to be connected to equipment safety grounding conductors at each splice and termination. This would assure that shielding is connected to the safety grounding system to prevent individuals from contacting dangerous voltages under fault conditions.

Paragraph (d) would set standards for splices and repairs of cables. They would be required to have conductivity and current-carrying capacity sufficient to prevent insulation damage from heating of conductors. This provision would require a splice or repair to match the ampacity of the rest of the cable as closely as possible, which would reduce the risk of damage to the insulation from overheating of the connection. Damaged insulation could place miners at risk of contacting energized cable components.

It would also require severed conductors to be joined by welding or compression-type connectors. The Agency is aware of the use of some unsafe splicing methods in the industry.

For instance, square knot splices and soldering, which create high-resistance areas within the cable, are sometimes used. High resistance can lead to excessive heating and arcing at the location of the splice or repair and cause the connection to open.

The NEC recommends exothermic welding, pressure connectors and clamps for joining severed grounding conductors to assure an electrically efficient and mechanically strong splice. The NEC standard would not allow soldering for that purpose. The proposed rule would adopt the NEC treatment of grounding conductors for all components of trailing cables. It would require tight-fitting connections formed by welding or compression-type connectors. The proposal would prohibit the use of unsafe splicing methods which can give rise to shock and fire hazards.

Each power, control, and ground-check conductor would be required to be individually re-insulated with insulation having at least the same thickness, temperature rating, and dielectric strength as that of the original insulation. By requiring replacement insulation to have the same protective characteristics as the original insulation, the proposal would assure that the integrity of the cable insulation is maintained. Phase-to-phase and phase-to-ground short-circuits from weaker insulation could also be prevented under the provision.

Splices and repairs would be required to have semiconducting tape replaced over the insulation of each power conductor within shielded cable. This would help to seal the point of joinder to assure an efficient electrical connection. Within shielded cable, shielding in the form of metallic braid or serving (wrap), or metallic tape applied in half-lapped layers replaced over each power conductor would be required.

The outer jacket of the cable would be required to be replaced to provide at least the same thickness and protection as that of the original jacket. Therefore, the proposal would require the repaired jacket to have physical strength equal to the original jacket. Finally, the outer jacket would have to be sealed, vulcanized, molded, or fused to the cable's original jacket to prevent the moisture of the underground environment from causing sparking at the splice or repair.

Several commenters objected to use of the word "bonding" to describe joining the spliced outer jacket to the original cable jacket. Some commenters believed that "bonding" means only vulcanizing. The proposed standard is now more specific about the process of connecting the replacement jacket to the original jacket. These provisions would preserve, as nearly as possible, the dielectric and mechanical strength of the original cable in making splices and repairs. Therefore, the likelihood of electrical arcing or heating at the point of connection would be reduced.

Paragraph (e) of the proposal would allow the use of one trailing cable splice which does not meet the requirements of paragraph (d) for the time period necessary to move the equipment for repair of the cable, provided the splice is mechanically strong and insulated to prevent shock. Although the terms "permanent" and "temporary" would not be employed by the proposal, this standard would provide for safe movement of equipment using one short-term splice to facilitate repair work if precautions are taken to prevent shock hazards.

Section 57.12603 would contain a paragraph (f), applicable only to underground areas of metal and nonmetal mines. It would require splices and repairs in trailing cables used underground to be made with splice and repair kits that meet the flame-resistance tests in 30 CFR 18.64. Flame-resistance tests are made on assembled specimens by MSHA's Approval and Certification Center. Acceptance markings appear on the outer jacket of the repair or splice, indicating that it has passed the tests and was found to be acceptable by MSHA. This would ensure that, when the splice and repair kit was assembled in accordance with the manufacturer's instructions, the kit would have fire-resistant properties similar to those of the cable's original components. MSHA is considering proposing an approval regulation for splice and repair kits. Under such a proposal, a splice and repair kit for trailing cables would have to be approved by MSHA prior to its use in a mine.

Sections 56/57.12604 Lightning Protection

This standard would revise existing §§ 56/57.12065 and 56/57.12069. It would provide requirements intended to prevent transmission of lightning voltages to the mine electrical system. Information available to MSHA indicates that 12 lightning-related accidents, one of them fatal, occurred from 1978 through 1988. The proposal would require surge arresters to be provided for exposed ungrounded power conductors and telephone wires in order to prevent similar accidents in the future. Several commenters suggested that the term "surge arrester" should be changed to "lightning arrester." The IEEE defines "surge arrester" and does not define "lightning arrester." The proposal would continue use of the term "surge arrester," which would be defined in proposed §§ 56/57.12000.

Paragraph (b) contains new provisions which would no longer require surge arresters to be installed on power conductors and telephone wires, provided they are buried, installed beneath a protective metallic covering, or enclosed within grounded metallic shielding, coverings, or enclosures throughout their entire length. These types of conductors would be, in MSHA's view, sufficiently protected against transmittal of dangerous voltages caused by surface electrical lightning surges. The proposed change would eliminate the need to cut into these cables solely to install surge arresters. Thus, persons would not be unnecessarily exposed to the hazards involved in the installation process.

Use of the term "suitable lightning arresters" in the existing rule would be replaced and clarified in the proposal by a requirement that surge arresters be rated for the voltage and current of the circuit they protect. The proposal would no longer require that surge arresters be of an approved type, since performance parameters have been included in the standard.

Some commenters indicated that surge arresters are not sized according to current rating. The Bureau of Mines conducted a study in 1981 in conjunction with the Pennsylvania State University on power systems. Their report, Contract No. J0155009, showed four important parameters for the proper application of surge arresters. These parameters were: voltage rating, sparkover voltage, discharge current and the IR discharge voltage. The report describes the classes of arresters with typical voltage rating ranges and current withstand voltages for each class. To clarify MSHA's intent, the proposal would be revised to require proper sizing according to the class of application. For example, the "Distribution Class" is typically rated for 1kV to 18kV, and they can withstand a 65kA current surge.

Proposed § 57.12604 would contain additional requirements for surge arresters at underground metal and nonmetal mines. Surge arresters for conductors that enter an underground mine would be required to be located on the surface within 100 feet of the point where the conductors enter the mine, are buried, installed beneath a protective metallic covering, enclosed within grounded metallic shields, coverings or enclosures, or supported by

grounded metallic messenger wires. Although the location of a lightning strike can clearly not be controlled, a 100-foot distance would severely limit the distance in which lightning could strike inby a surge arrester, possibly transmitting a voltage surge underground and energizing equipment frames. Lightning strikes outby the arrester would cause excess voltage to be transmitted to ground.

At underground mines, surge arresters for conductors extending underground would be required to be connected to a low-resistance ground field that is separated from neutral ground fields by a distance of not less than 25 feet. This would separate the underground grounding circuit from the surface distribution grounding circuit, thereby reducing the likelihood of a lightning surge being transmitted underground from the surface power system.

Some commenters claimed that separation of surge arrester grounds from equipment grounds would be dangerous. The separation of arrester grounds from equipment grounds provides protection by shunting the lightning transient energy to the arrester grounds. The 1972 and 1982 publications of the "IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems," Standard 142, § 2.6, describes proper separation. The separation of ground fields for surface mines would be addressed by proposed § 56.12506(c).

Sections 56/57.12630 Support Structures and Guy Wires

This section would revise existing §§ 56/57.12047, and provide requirements for support structures and guy wires. The incorporation by reference to the NESC was deleted, and replaced by the inclusion of specific requirements, using NESC standards as a reference guide. Paragraph (a) would require guy wires attached to structures supporting uninsulated overhead power conductors, other that phone wires, to be electrically connected to the equipment safety grounding conductor at the supporting structure end of the guy wire.

Alternatively, such guy wires could be provided with one or more insulators which have a dry flashover voltage at least double the nominal voltage, and a wet flashover voltage at least as high as the nominal voltage. The insulators, in this case, would be required to be at least eight feet from the ground. Commenters requested clarification of this provision. It means that the insulator cannot be less than 8 feet from the earth, regardless of degree or direction of slope of the earth around the base of the guy wire where persons could walk. Several commenters expressed objection to the specificity of the insulator rating included in the preproposal draft. Ratings are needed to provide safety, and are consistent with those in ANSI C29.1–1976, "Electrical Power Insulators."

Some commenters believed that the preproposal standard intended to encompass guy wires supporting telephone lines. However, telephone lines are not considered to be power conductors for purposes of this standard. Commenters also expressed uncertainty about the voltages which would be addressed by the standard. It would cover all power conductor voltages.

Additionally, commenters questioned the effect of the preproposal draft on public utility equipment installed on mine property. Where guy wires supporting overhead power conductors are present on public utility lines, they are typically and routinely provided with grounding or insulation. Any guy wires which support uninsulated overhead power conductors installed on mine property, which have the potential for causing injury to miners would fall within the coverage of the standard, although the rule would not require installation of guy wires. Enforcement of the standard under MSHA jurisdiction would depend upon the circumstances and location of the guy wires. The proposed requirement is adopted from NESC standards, used as a guideline by operators as well as utilities for many years. The proposal provides for two equivalent performance-oriented compliance alternatives intended to achieve the same safety objective.

Sections 57.12660 Support in Shafts and Boreholes

This standard would specify requirements for providing support for power cables and insulated conductors in shafts and boreholes, and is derived from existing § 57.12083, applicable to underground metal and nonmetal mines. Paragraph (a) would require power cables and insulated conductors in shafts and boreholes to be supported by clamping or strain relief devices which prevent strain on the conductors and functional damage to the jacket and insulation. Several commenters suggested that damage to the outer jacket cannot be avoided since one function of the jacket is to protect the internal conductors from physical damage. A small amount of physical damage, which does not affect the function of the jacket, will not create a hazard. The word "functional" has been added to the proposal to accommodate this situation.

The preproposal draft would have addressed power cables alone, but in response to commenter suggestions, the phrase "or insulated conductors" was added. Several commenters recommended adding "or other methods" to provide for other means of cable support. This recommendation is not adopted, but paragraph (c) of the proposal would allow for other methods when the cable is designed to be self-supported.

Paragraph (b) would require clamp or strain relief devices to be installed as close to the top of the cable or conductor run as practical. Under paragraph (c), additional support devices would be required to be installed in vertical shafts and boreholes along the cable or conductor run at distances not greater than the values specified in Table 57.12660, accompanying the standard. Some commenters objected that the table of spacing for conductor supports cannot be applied to all mining conditions. However, the table would provide only the maximum permitted distances between supports, allowing for shorter distances where necessary. It would not require additional supports for specially designed cables such as steel wire armor cables.

Commenters suggested that "shaft" be defined in the proposal. The term has not been defined because the Agency believes that it is readily understood by persons in the mining community, but the term "vertical" was added for clarity. The proposal would adopt the commenter suggestion that the proposal apply to boreholes as well as shafts.

Trailing Cables

Sections 56/57.12700 Insulation; Shielding

This section would revise existing § 57.4057, applicable only to underground cables, and transfer the standard from Subpart C, Fire Prevention and Control, to Subpart K. The proposed standard would include requirements for trailing cables in all mine electrical systems, including surface mines and mills. Under the proposal, trailing cables would be required to have conductor insulation rated for at least the line-to-line voltage of the circuit, and shielding for the purpose of confining the voltage stresses when used to supply equipment over 2,000 volts line-to-line. Trailing cables used in underground mines would also be required to have flame resistant qualities in accordance with existing 30 CFR § 18.64 due to the confined space in

underground mines and the possibility of smoke and fires.

Several commenters objected to parts of the preproposal draft which they interpreted as setting forth design criteria. The proposal is not intended to impose unnecessary design criteria. For instance, it would not specify the name or type of conductor insulation or shielding. It would only require conductor insulation to be rated for at least the line-to-line voltage.

One commenter stated that requiring shielding for cables that carry voltages greater than 2,000 volts would be unnecessary, because there are cable designs that do not need shielding above 2,000 volts. However, the need for cable shielding under these voltage conditions is supported by the NEC [Article 400, "Flexible Cords and Cables"]. A shielding requirement is also supported by research conducted at the Pennsylvania State University for the Bureau of Mines, Final Report, Contract No. G015512, "Open Pit Metal Mining Grounding Systems," August, 1976. MSHA is persuaded that shielding is needed for cable voltages greater than 2,000 volts by the conclusions arrived at by these recognized bodies. Therefore, the suggestion of the commenter has not been implemented.

Sections 56/57.12701 Overcurrent Protection.

This standard would revise existing §§ 56/57.12003, and provide requirements for overcurrent protection for trailing cables of portable and mobile electric equipment. The term "mobile equipment" in existing §§ 56/57.12003 has been expanded to include "portable electric equipment". Paragraph (a) would require trailing cables serving portable and mobile equipment to have short-circuit and ground-fault protection for each ungrounded conductor that will safely interrupt all ungrounded conductors under fault conditions. A new ground-fault protection provision for trailing cables was included in the preproposal draft, and would be retained in the proposal in order to prevent explosion and shock hazards. Without such protection, faults could energize equipment frames and expose persons to contact with lethal voltages.

Under paragraph (b), ungrounded trailing cable conductors energized at voltages of 1,040 volts or less would be required to be protected by an inverse-time circuit breaker with a maximum current rating as specified in Table 56/57.12701-1, accompanying the standard. The table was derived from an IEEE publication.

Alternatively, such cables could be protected by an instantaneous-trip or short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds. Such protective devices would be required to have a maximum instantaneous setting of not more than the values listed in Table 56/57.12701-2 for 480-, 600-, and 1,040-volt trailing cables. The values in Table 56/57.12701-3 would be applicable to 300- and 600-volt d-c trailing cables.

Another option would be protection by an instantaneous-trip or short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds, and a setting that does not exceed the lower value of either 115 percent of the maximum starting current for the unit of electric equipment, or 60 percent of the lowest value of bolted phase-to-phase short circuit current at any point in the circuit. This protection option would apply only when the circuit to be protected does not function properly using values listed in the tables, and a circuit analysis assures that the circuit does not present a hazard to miners. If the circuit breaker won't function properly, the operator would be permitted to set a higher or lower trip level after determining that it would not pose a hazard.

Under paragraph (c), ungrounded conductors of trailing cables energized at voltages greater than 1,040 volts would be required to have instantaneous short-circuit protection. The setting of such devices would be prohibited from exceeding the lower of either 175 percent of the maximum starting current for the unit of electric equipment, or 75 percent of the minimum phase-to-phase short-circuit current available at any point in the circuit.

Some commenters expressed concern that the proposal would prohibit the use of fuses. The use of fuses would not be prohibited, but when used, they would have to be provided with a means for opening all ungrounded phases during a fault. The requirements of paragraphs (a) and (b) would apply to the use of fuses to protect trailing cables and when applying circuit breakers at voltages other than those specified in the tables.

Several commenters objected to the standard, indicating that overcurrent protection only protects equipment. A fire from electric equipment however, especially underground equipment, could endanger the lives of miners. An underground mine is a confined area where a fire could expose miners to smoke and toxic gasses. Therefore, the protective measures which would be required under the proposal are necessary.

Some commenters suggested that the NEC be incorporated by reference, instead of placing ground-fault protection requirements and tables in the proposal. This recommendation has not been adopted due to the difficulty of ascertaining compliance requirements when incorporation by reference is used. The Agency believes that including the relevant portions of such documents in the standard facilitates an accurate understanding of its requirements. The tables and other proposals in this Subpart are based on accepted industry standards, and would provide necessary protection against hazards that are unique to the mining industry.

Several of the commenters supported the need for short-circuit and ground-fault protection. The Bureau of Mines, Final Report, No. G0155102, "Open Pit Metal Mining Grounding Systems," August, 1976, recommended the use of short-circuit and ground-fault protection.

Sections 56/57.12702 Attachment

This section is derived from existing §§ 56/57.12038. It would require trailing cables to be attached to equipment so that functional damage to the cable jacket and damage to the insulation of the internal conductors is prevented and strain does not occur on electric connections. The performance-oriented language of the standard is intended to assure proper protection of cables from chaffing and other damage which can defeat the protective function of the jacket, as well as offer support for the cable. The use of devices such as strain clamps or cable grips would be suitable for compliance with the proposed standard.

Several commenters to the preproposal draft suggested that damage to the outer jacket cannot be prevented, because one function of the jacket is to protect the conductors from physical damage. A small amount of damage or abrasion which does not affect the protective function of the jacket would not create a hazard. The word "functional" has been added to the proposal to reflect this intent.

Sections 56/57.12703 Portable Distribution Boxes

This section would provide standards for protective devices on portable distribution boxes, and is derived from existing §§ 56/57.12006. The proposal would require portable distribution boxes to have a disconnecting device for each branch circuit, and a means to clearly show that each circuit has been physically disconnected. For purposes of this standard, indications such as a plug removed and separated from its

receptacle would suffice. Several commenters suggested that visual indications, such as lights, alone would not ensure disconnection of a circuit and could result in a worker being exposed to electric shock. MSHA agrees, because of the unreliability of light indicators. They may burn out and fail to function when needed. The intent of the standard is to ensure disconnection, and to clearly indicate whether the circuit has been disconnected. The standard has been altered to clarify this intent.

Under a new provision in paragraph (c), portable distribution boxes would be required to have a means which identifies each disconnecting device and cable with its related load, and a means of preventing connection of a cable to the wrong protective device when two or more cables connect to the same distribution box. Accidental or inadvertent energization of circuits and equipment being worked on has been the cause of many electrical accidents in metal and nonmetal mines. The standard would require proper use and identification of circuit protective devices to prevent such injuries.

Several commenters recommended that paragraph (c) be revised by substituting the phrase "higher rated circuit breaker" for "wrong circuit breaker". This recommendation has not been adopted, because the intent of the proposal is to prevent accidents which occur because of an improper cable connection. The phrase "wrong protective device" was used in the proposal to allow for compliance alternatives.

Sections 56/57.12704 Guarding

This section would require trailing cables and power conductors to be protected against physical damage from mobile equipment or other loads by bridges, trenches, suspension, or by location. It is derived from existing §§ 56/57.12005. The method of protection, from among these alternatives, is left to the discretion of the operator. In underground mines, trailing cables would be permitted to be protected from damage by suspension from the mine roof or rib.

The adequacy of the protection supplied by the bridge, or other method would be measured by how well it protected the trailing cable from physical damage. For example, where a trailing cable is located in a trench, but has been damaged by mobile equipment running over the trench, an MSHA inspector might conclude that there was a violation, even though there was a trench constructed, since damage to the cable had not been prevented.

Sections 56/57.12705 Disconnecting Devices

This standard would be new, and would require that disconnecting devices for trailing cables be equipped with a means for installing a padlock. As discussed in connection with proposed §§ 56/ 57.12200, miners have been injured and killed by contact with inadvertently or prematurely energized equipment or circuits. The proposed standard would strengthen existing rules to assure that electrical and mechanical work is performed with minimum risk, and that involved circuits and equipment remain deenergized while work is being performed.

Each trailing cable disconnecting device, in MSHA's view, should be equipped with a means for installing a padlock, so that miners would not be able to disconnect the circuit at a location that could not be locked out. For instance, if a circuit with several disconnecting devices could only be locked out at the device nearest the power source, a miner might choose to disconnect at a device nearer to his or her work station. If that device had no means of locking-out, the possibility of mistaken reenergization of the circuit would exist. As previously noted, MSHA's accident and injury data for 1978 through 1988 shows that 330 accidents, 21 of them fatal, were attributable to the failure to lock out. Miners should not be exposed to that hazard. The procedure involved in providing a means to install a padlock might be drilling a hole in the device or attaching a hasp and staple. Many of the disconnecting devices being manufactured are currently equipped with means for installing a padlock.

Trolley Circuits for Track Haulage

Sections 56/57.12800 Installation and Maintenance

This section would revise existing §§ 56/57.12050 and 57.12086. Its intent is to minimize the risk of persons contacting bare trolley conductors, and the risk of injury resulting from trolley pole dewirements. The proposed standard would require trolley wires and exposed trolley-feeder wires to be installed opposite the clearance side of haulageways, except where such installation would create a greater hazard. The specified installation location would help to prevent persons or equipment from contacting energized trolley wires.

Trolley wires and exposed trolley feeder wires would be required to be suspended at least seven feet above the track. Compliance with the seven-foot clearance provisions would make inadvertent contact with the trolley wire and resulting shock difficult. Finally, trolley wires would be required to be aligned and maintained to provide for smooth tracking of trolley collectors on trolley wires. This would reduce arcing and sparking, thereby minimizing the risk of electrical injuries and fires.

Some commenters expressed concern about the application of this section to cranes. Cranes would not be addressed by this section and this is reflected in the section title. Commenters also recommended that the proposal apply to "exposed" trolley feeder wires. The opening phrase of the proposal has been altered to reflect that position.

Sections 56/57.12801 Circuit Protection and Isolation

This standard would revise existing §§ 56/57.12065. It would require trolley wires and trolley-feeder wires to be protected against overcurrent by an automatic circuit interrupting device which deenergizes the circuit if a short-circuit occurs at any point in the system. Several commenters objected to this provision as being too design-oriented. However, the proposal allows for compliance alternatives; any automatic circuit interrupting device that can accomplish the requirement would be acceptable.

The trip setting of such devices would be required not to exceed 50 percent of the minimum available bolted short-circuit current when the current is less than 800 amperes. When the current is 800 amperes or more, the device's trip setting could not exceed 75 percent of the minimum available bolted short-circuit current. Above 800 amperes, there is more available fault current. Therefore, the trip setting of the device need not be as sensitive at this level as with currents below 800 amperes.

The protective device must be adjusted to open at a fault current value that is less than the minimum expected fault current. The proposal would require that the trip setting interrupting devices not exceed 50 percent of the maximum (bolted) fault current available at the point in the system which yields least (minimum) short-circuit current.

Some commenters considered the values specified in the preproposal draft to be too high, and suggested that values should not be established. Values have been included in the proposal, but they would not be fixed values. They are expressed as upper limits for the minimum expected fault current, and lower values would be acceptable. For example, if an operator considers the 50 percent value hazardous, a lower setting

would still achieve compliance with the standard.

The proposal would require that trolley wires and trolley feeder wires be provided with a means of isolation at intervals of not more than 2,000 feet and near the beginning of each branch line. Compliance with this provision would minimize the risks of fire and shock. Without an accessible means of isolation, miners could be tempted to work on or near an exposed, energized trolley circuit, subjecting themselves to the hazards of shock or electrocution. A nearby means of isolation could also be useful for deenergizing the circuit in the event of an accident or emergency. The 2,000-foot distance has been in wide use in the mining industry for many years without adverse effects. The proposed spacing is comparable to that which has been recommended by the Bureau of Mines (Miners' Circular, Bureau of Mines, Electrical and Mechanical Hazards and Falls of Persons at Metal and Nonmetallic Mines, March, 1955).

Sections 56/57.12802 Track Bonding

This section would consolidate and clarify existing §§ 56/57.12042 and 57.12081, which address track bonding and bonding of metal pipelines to ground return circuits. Paragraph (a) would require track serving as the trolley circuit return to be bonded at every joint and crossbonded at intervals not exceeding 200 feet. Paragraph (b) would require metallic pipelines and structures installed less than ten feet from track serving as the trolley circuit return to be insulated or guarded, or bonded to the track at intervals not exceeding 1,000 feet, to prevent shock hazards. The provision has been clarified to indicate that it would not apply to other materials temporarily lying alongside the track.

A suggestion by some commenters that "structures" not be covered by the revision was not adopted because of the hazards associated with structures installed near tracks. Shock and fire hazards would arise if the trolley wire should contact structures which are not bonded, insulated or guarded. By contrast, if the trolley line contacts a bonded structure, operation of the short-circuit device would remove these hazards.

The preproposal draft contained a provision for insulating or guarding safety grounding conductors near the track. Several commenters indicated that this requirement may conflict with other requirements contained in paragraphs (b) and (c), and should be deleted. MSHA agrees with this recommendation, and the language has been deleted from the proposal.

Paragraph (c) would specify that when rails are moved or replaced, or when broken bonds are discovered, they shall be rebonded within three working shifts. Several commenters objected to the preproposal draft, which would have required immediate repair of broken bonds. As with existing §§ 56/57.12042, the preproposal draft would have required repairs to be made when the break occurs. The proposed change to a three shift maximum would allow adequate time to perform the necessary work, yet assure that rebonding is done in a prompt manner.

MSHA's present policy on enforcement of the three shift repair requirement in existing §§ 56/57.12042 would remain in effect under the proposal. A citation for a violation of the standard would not be issued until the end of the third working shift after rails are moved, replaced or a broken bond is discovered. That is, assuming a three shift operation, if a broken bond is discovered on a day shift, the citation would be issued at the end of the next day shift if the broken bond is still not repaired. A citation would not be issued if the bond has been repaired within this period of time.

Since mine track is used as an electrical conductor in conjunction with trolley wires and trolley feeder wires, compliance with the proposal would assure that the track is mechanically and electrically efficient by setting specific bonding requirements at regular intervals on the track. This would ensure adequate electrical conductivity of return circuits. These proposed requirements are based on accepted industry practice and MSHA's experience with trolley systems.

Sections 56/57.12803 Trolley Guarding

This section is derived from existing §§ 56/57.12066 and 57.12080, and would designate specific locations and conditions for guarding of energized trolley wires and bare trolley feeder wires to prevent accidental contact. The requirements in the proposal emphasize that guarding is required not only where miners work, but at other locations where they are exposed on a frequent or regular basis to the shock hazards of exposed energized trolley circuits. Specific locations are addressed in the proposal to clarify where guarding would be required.

Paragraph (a) would require guarding at all points where supplies are stored, loaded or unloaded, at mantrip stations, on each side of doors and stoppings through which wires pass, where persons other than those operating rail-mounted haulage equipment work within three feet of the wire, at track switches, and where persons regularly pass under the wire. Protection from energized trolley circuits is necessary not only where persons perform their normal work tasks, but also where they load, unload or generally work with supplies transported by rail.

Paragraph (b) of the proposal would require trolley wires and trolley feeder wires to be deenergized when guarding is installed or removed. An exception to this provision would allow the installation and removal of temporary guarding designed to minimize shock hazards while work is being conducted in the area while the trolley system is energized. This temporary guarding would allow operators to continue operation of trolley systems while installing or removing guarding. This type of guarding is designed to protect the persons from exposure to the bare energized trolley circuit wires.

Some commenters recommended that guarding by location be permitted in the rule. MSHA agrees. Installation of guards would not be necessary if location would prevent persons or metallic tools and equipment from contacting trolley wires. Installation of guards would only be required under the proposal where persons can contact energized trolley wires. When persons work in close proximity to exposed trolley wires, temporary trolley wire guarding may be used to prevent electric shock.

Sections 56/57.12804 Circuits Powered from Trolley Wires

This standard is derived from existing §§ 56/57.12053. It would address the hazards of electric shock from loose or disconnected return wires and from fires caused by high-resistance connections. It would require the return wire of all circuits powered from trolley wires to be connected to the trolley wire return circuit to assure continuity and prevent arcing. Some commenters to the preproposal draft expressed concern that the word "securely" was omitted from the draft proposal. The proposal substitutes performance language for the word "securely".

G. Derivation Table

The following derivation table lists the number of each proposed standard, and the number of the existing standard from which it is derived. Standards that uniformly appear in 30 CFR parts 56 and 57 are designated in this table as 56/57.

DERIVATION TABLE

Proposed number	Existing number
56/57.12100	New
56/57.12101(a)	56/57.12002
	56/57.12030
	56/57.12040
	56/57.12041
56/57.12101(b)	56/57.12035
	56/57.12041
56/57.12102	56/57.12012
56/57.12103(a)	56/57.12001
	56/57.12065
56/57.12103(b)	56/57.12001
56/57.12103 (c) through (k).	56/57.12001
	56/57.12065
56/57.12103(1)	New
56/57.12104	56/57.4011
56/57.12105	56/57.12032
56/57.12106	56/57.12021
	56/57.12022
56/57.12130	56/57.12045
	56/57.12071
56/57.12200 (a) and (b)	56/57.12016
	56/57.12017
56/57.12200(c)(1)	56/57.12017
56/57.12200(c)(2)	New
56/57.12200(c)(3)	56/57.12017
56/57.12200(c)(4)	New
56/57.12201	56/57.12007
56/57.12202	56/57.12036
	56/57.12037
56/57.12203 (a), (b) and (c).	56/57.12014
56/57.12203(d)	56/57.12039
56/57.12204	56/57.12019
56/57.12300	56/57.12023
56/57.12301	56/57.12010
	56/57.12048
56/57.12302	56/57.12034
56/57.12330(a)	56/57.12067
56/57.12330(b)	56/57.12068
56/57.12330(c)	56/57.12026
56/57.12331	56/57.12026
	56/57.12085
56/57.12400	56/57.12018
56/57.12401	56/57.12020
56/57.12402	New
57.12460	57.12084
56/57.12500	56/57.12025
	56/57.12027
56/57.12501 (a) through (d).	56/57.12025
	56/57.12027
56/57.12501(e)	56/57.12033
56/57.12501(f)	56/57.12025
	56/57.12027
56/57.12502	56/57.12025
	56/57.12027
56/57.12503	56/57.12025
	56/57.12027
56/57.12504	56/57.12025
	56/57.12027
56/57.12505	56/57.12025
	56/57.12027
	56/57.12028
56/58.12506	56/57.12028
56/57.12600	56/57.12004
	56/57.12011
	56/57.12082
56/57.12601	56/57.12004
56/57.12602(a)	56/57.12008
56/57.12602 (b) and (c) New.	
56/57.12602 (d) and (e)	56/57.12008
56/57.12602(f)	New
56/57.12602(g)	56/57.12008
56/57.12603(a)	New
56/57.12603 (b) through (e).	56/57.12013
	57.12088
57.12603(f)	New

DERIVATION TABLE—Continued

Proposed number	Existing number
56/57.12604	56/57.12065
	56/57.12069
56/57.12630	56/57.12047
57.12660	57.12083
56/57.12700 (a) and (b)	New
57.12700(c)	57.4057
56/57.12701	56/57.12003
56/57.12702	56/57.12038
56/57.12703 (a) and (b)	56/57.12006
56/57.12703(c)	New
56/57.12704	56/57.12005
56/57.12705	New
56/57.12800	56/57.12050
	57.12086
56/57.12801	56/57.12065
56/57.12802 (a), (b) and (c).	56/57.12042
	57.12081
56/57.12803(a)(1)	56/57.12066
56/57.12803(a)(2)	57.12080
56/57.12803(a)(3)	New
56/57.12803(a)(4)	57.12080
56/57.12803(a)(5)	New
56/57.12803(a)(6)	57.12080
56/57.12803(b)	56/57.12066
56/57.12804	56/57.12053

H. Distribution Table

For the convenience of the reader, the following distribution table has been added as a cross-reference guide. Standards that uniformly appear in 30 CFR parts 56 and 57 are designated in this table as 56/57.

DISTRIBUTION TABLE

Existing No.	Proposed No.
56/57.12001	56/57.12103
56/57.12002	56/57.12101
56/57.12003	56/57.12701
56/57.12004	56/57.12600
	56/57.12601
56/57.12005	56/57.12704
56/56.12006	56/57.12703
56/57.12007	56/57.12201
56/57.12008	56/57.12602
56/57.12010	56/57.12301
56/57.12011	56/57.12600
56/57.12012	56/57.12102
56/57.12013	56/57.12603
56/57.12014	56/57.12203
56/57.12016	56/57.12200
56/57.12017	56/57.12200
56/57.12018	56/57.12400
56/57.12019	56/57.12204
56/57.12020	56/57.12401
56/57.12021	56/57.12106
56/57.12022	56/57.12106
56/57.12023	56/57.12300
56/57.12025	56/57.12500
	56/57.12501
	56/57.12502
	56/57.12503
	56/57.12504
	56/57.12505
56/57.12026	56/57.12330
	56/57.12331
56/57.12027	56/57.12500
	56/57.12501
	56/57.12502
	56/57.12503
	56/57.12504
	56/57.12505

DISTRIBUTION TABLE—Continued

Existing No.	Proposed No.
56/57.12028	56/57.12506
56/57.12030	56/57.12101
56/57.12032	56/57.12105
56/57.12033	56/57.12503
56/57.12034	56/57.12302
56/57.12035	56/57.12101
56/57.12036	56/57.12202
56/57.12037	56/57.12202
56/57.12038	56/57.12702
56/57.12039	56/57.12203
56/57.12040	56/57.12101
56/57.12041	56/57.12101
56/57.12042	56/57.12802
56/57.12045	56/57.12130
56/57.12047	56/57.12630
56/57.12048	56/57.12301
56/57.12050	56/57.12800
56/57.12053	56/57.12804
56/57.12065	56/57.12103
	56/57.12604
	56/57.12801
56/57.12066	56/57.12803
56/57.12067	56/57.12330
56/57.12068	56/57.12330
56/57.12069	56/57.12604
56/57.12071	56/57.12130
57.12080	56/57.12803
57.12081	56/57.12802
57.12082	56/57.12600
57.12083	57.12660
57.12084	57.12460
57.12085	56/57.12331
57.12086	56/57.12800
57.12088	56/57.12603
56/57.4011	56/57.12104
57.4057	56/57.12700
New	56/57.12100
New	56/57.12402
New	56/57.12705

II. Executive Order 12291 and the Regulatory Flexibility Act

MSHA has prepared an initial analysis in accordance with Executive Order 12291, to identify potential costs and benefits associated with the proposed revisions to the electrical standards for metal and nonmetal mines. The Agency has incorporated this analysis into the Regulatory Flexibility Analysis required by the Regulatory Flexibility Act. In the analysis, MSHA has determined that the proposed rule would not result in major cost increases, nor have an economic effect of $100 million or more. The proposed rule does not meet the criteria for a major rule and, therefore, a Regulatory Impact Analysis is not necessary.

The Regulatory Flexibility Act requires that, in developing regulatory proposals, agencies should evaluate and include, wherever possible, compliance alternatives which minimize any adverse impact on small businesses. This proposed rule contains many alternatives to the existing regulations which would especially benefit small mining operations. In addition, the

proposal adopts performance-oriented requirements and clarifies compliance responsibilities.

In the following summary of the Regulatory Flexibility Analysis, MSHA has compared the costs and benefits associated with the proposal with those of the existing requirements. In developing cost estimates, MSHA has taken into consideration industry-wide safety practices. Current compliance costs are related to the following requirements: labor, equipment purchase and maintenance, and recordkeeping. In calculating the costs of the proposed rule, the Agency projected capital expenditures and recurring costs. A copy of the complete analysis is available upon request.

The proposed regulations would affect about 11,700 metal and nonmetal mining operations. MSHA estimates that approximately 9800 (84 percent) of these mines are small businesses. For purposes of the Regulatory Flexibility Act, MSHA has defined small business entities as mines with fewer than 20 employees.

MSHA estimates that the total initial cost of the revised safety standards for electricity is $1.27 million, compared to $1.53 million for the existing standards, representing a cost decrease of $0.3 million, or 17 percent. The total annually recurring costs of the proposed rule is $18.2 million, compared to $14.7 million for the existing standards, representing a cost increase of $3.5 million, or 24 percent. The largest cost decrease is due to the proposed reduction in the frequency of resistance testing, which should reduce costs by $2.5 million annually. This decrease is totally offset, however, by annual cost increases of $2.9 million for qualified electricians and $2.5 million for metallic shielded cables.

MSHA estimates that the total initial cost of the revised standards for electricity at small mines is $0.66 million, compared to $0.82 million for the existing standards, a cost decrease of $0.17 million, representing a cost decrease of 21 percent. The total annually recurring costs of the proposed rule at small mines is $7.9 million, compared to $7.4 million for existing standards, representing a cost increase of $0.48 million, or 7 percent. The proposed rule does not represent a significant economic impact on a substantial number of small businesses under the Regulatory Flexibility Act.

The proposed rule reorganizes, clarifies and upgrades existing provisions. The primary benefit of the proposed rule is the protection that would be provided to the nation's metal and nonmetal miners against electrical hazards. It would allow for advances in mining technology and grandfathering of existing equipment. The proposed rule would increase compliance flexibility, while ensuring the safety of persons who work at the nation's mines. Some costs are reduced because the Agency has eliminated recordkeeping requirements and allowed for increased flexibility through compliance alternatives.

III. Paperwork Reduction Act

There are no paperwork requirements contained in these proposed standards. The paperwork reduction is due to the elimination of the recordkeeping requirement in proposed § 56/57.12506 for resistance testing of safety grounding systems.

List of Subjects in 30 CFR Parts 56 and 57

Mine safety and health, Metal and nonmetal mining, Electricity.

Dated: November 22, 1989.

William J. Tattersall,

Assistant Secretary for Mine Safety and Health.

It is proposed to amend subparts A, C and K of part 56 and subparts A, C and K of part 57, subchapter N, chapter I, title 30 of the Code of Federal Regulations to read as follows:

PART 56—SAFETY AND HEALTH STANDARDS—SURFACE METAL AND NONMETAL MINES

1. The authority citation for part 56 is proposed to be revised to read as follows:

Authority: 30 U.S.C. 811.

Subpart A—General

§ 56.2 [Amended]

2. In § 56.2, the definitions of "distribution box," "electrical grounding," "high potential," "insulation," "low potential," "major electrical installation," and "reverse-current protection" are removed.

Subpart C—Fire Prevention and Control

3. The authority citation for subpart C continues to read as follows:

Authority: Sec. 101, Federal Mine Safety and Health Act of 1977, Pub. L. 91-173, as amended by Pub. L. 95-164, 91 Stat. 1291 (30 U.S.C. 811).

4. Section 56.4011 is removed.

5. Subpart K is revised to read as follows:

Subpart K—Electricity

Sec.
56.12000 Definitions.

General
56.12100 Qualified electricians.
56.12101 Electric equipment and conductors.
56.12102 Bare conductors.
56.12103 Overcurrent protection.
56.12104 Unused conductors.
56.12105 Doors and cover plates.
56.12106 Danger signs.
56.12130 Clearance of equipment.

Work on Electric Equipment and Circuits
56.12200 Lockout procedures.
56.12201 Plugs and receptacles.
56.12202 Fuses.
56.12203 Cable handling.
56.12204 Access.

Guarding; Insulation; Separation
56.12300 Connections and grids.
56.12301 Communication conductors.
56.12302 Lights, guarding.
56.12330 Transformers.
56.12331 Substations.

Connections; Switches; Controls
56.12400 Identification.
56.12401 Insulating mats.
56.12402 Undervoltage protection.

Safety Grounding
56.12500 Grounding.
56.12501 Alternating-current equipment.
56.12502 Direct-current equipment.
56.12503 Equipment safety grounding conductors.
56.12504 Silicon diode grounding.
56.12505 Low-resistance ground fields.
56.12506 Testing.

Power Cables and Conductors
56.12600 Installation.
56.12601 Ampacity.
56.12602 Insulation, termination and shielding.
56.12603 Splices, repairs and terminations of conductors and cables.
56.12604 Lightning protection.
56.12630 Support structures and guy wires.

Trailing Cables
56.12700 Insulation; shielding.
56.12701 Overcurrent protection.
56.12702 Attachment.
56.12703 Portable distribution boxes.
56.12704 Guarding.
56.12705 Disconnecting devices.

Trolley Circuits for Track Haulage
56.12800 Installation and maintenance.
56.12801 Circuit protection and isolation.
56.12802 Track bonding.
56.12803 Guarding.
56.12804 Circuits powered from trolley wires.

Appendix I for Subpart K—Electricity

Subpart K—Electricity

§ 56.12000 Definitions.

The following definitions apply in this subpart.

"Ampacity" means the current-carrying capacity of electric conductors expressed in amperes.

"Branch circuit" means the circuit conductors extending beyond the final short-circuit device protecting the circuit.

"Cable" means an assembly of one or more insulated conductors enclosed by an additional abrasion resistant covering or jacket. A cable may also contain one or more uninsulated equipment safety grounding conductors. A power cable is any cable except communication, instrumentation and control cables.

"Circuit breaker" means a device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined overcurrent value without damage to the device when operated within its rating.

"Circuit breaker setting" means the value of current or time at which an adjustable circuit breaker is set to trip.

"Conductor" means a bare or insulated wire or combination of wires not insulated from one another, suitable for carrying an electric current.

"Equipment safety grounding conductor" means a conductor used to connect the non-current-carrying metallic parts of electric equipment, raceways and other metallic enclosures to the safety grounding system.

"Feeder-circuit" means the conductors between the power source and the final branch-circuit short-circuit protective device.

"Fuse" means an overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it.

"Ground-fault" means an unintentional connection between an electric circuit and the safety grounding system.

"Ground-wire monitor" means a device having the primary function of monitoring the equipment safety grounding conductor of a circuit and causing the affected circuit breaker to trip when a change in the impedance of the grounding circuit presents a potential electrical shock hazard.

"Instantaneous-trip circuit breaker" means a circuit breaker with no intentional time delay designed in its tripping action.

"Insulated" means separated from other conducting surfaces by insulation which is a dielectric substance that offers a high resistance to the passage of current and to a disruptive discharge through the substance.

"Inverse-time circuit breaker" means a circuit breaker with an intentional time delay in its tripping action, which delay decreases as the magnitude of the current increases.

"Jacket" means a continuous nonmetallic protective outer covering provided on cables. The primary function of the covering is to provide protection of the internal components against physical, chemical, and thermal damage, and to exclude moisture.

"Mobile electric equipment" means electric equipment capable of movement from one location to another by power supplied from a source located on the machine or transmitted to the machine by means of a trailing cable.

"Nominal voltage" means the phase-to-phase or line-to-line root-mean-square value assigned to a circuit or system for designation of its voltage class, such as 480 or 4160 volts. Actual voltage at which the circuit or system operates may vary from the nominal voltage within a range that permits satisfactory operation of equipment.

"Overcurrent" means any current in excess of the rated current of equipment or the ampacity of a conductor, which may result from overload, short-circuit, or ground-fault conditions.

"Overload" means operation of equipment in excess of normal full-load rating, or loading of a conductor in excess of rated ampacity, which would cause damage or dangerous overheating if allowed to continue.

"Portable electric equipment" means electric equipment which is designed and constructed to facilitate frequent movement from one location to another and which does not normally remain at a fixed location for extended periods of time.

"Qualified electrician" means an individual who has met the requirements of 30 CFR 56.12100.

"Rated" means marked to certify that according to established test procedures, electric equipment will perform its functions without presenting a burn, fire or shock hazard when applied within the maximum limits of its marked electrical parameters.

"Safety grounding system" means a complete installation consisting of one or more ground electrodes, grids, equipment safety grounding conductors and interconnected grounding connections. The purpose is to provide a low impedance fault current path to the system's protective device for all non-current-carrying metallic parts enclosing electric conductors or circuits.

"Short circuit" means an abnormal connection of relatively low impedance, whether made accidentally or intentionally, between two points of different potential.

"Splice" means the mechanical and electrical connection of one or more severed conductors in a single length of conductor or cable.

"Stationary electric equipment" means electric equipment other than mobile or portable that is fastened, secured or installed such that it cannot be readily moved from one location to another during normal use.

"Surge arrester" means a protective device which is used to provide protection against lightning surges.

"Trailing cable" means a portable cable or flexible cord through which electrical energy is transmitted to any mobile electric equipment, or a portable cable or flexible cord which receives electrical energy from a section power center, section distribution box or section rectifier.

"Undervoltage protection" means the effect of a device which operates on failure of voltage to cause and maintain the interruption of power to a circuit so as to prevent automatic restarting of the equipment.

General

§ 56.12100 Qualified electricians.

(a) Work required by this subpart to be performed by a qualified electrician shall be performed by an individual who has met the requirements of an operator's qualification program.

(b) Operator's programs shall include conducting their own qualification training or testing, or participation in training or testing conducted by MSHA, other Federal agencies, a state, associations of mine operators, other mine operators, national labor organizations, private associations, or educational institutions.

§ 56.12101 Electric equipment and conductors.

(a) Electric equipment and conductors shall be installed, and maintained by a qualified electrician, and used in a manner which prevents shock and burn hazards to persons. Electric equipment and conductors which present a hazard to persons due to improper installation, maintenance, misuse or damage shall be tagged as a hazard until corrected.

(b) All electric equipment and conductors installed after [Insert the effective date of this rule] shall be selected and located in surroundings compatible with their design and intended use.

§ 56.12102 Bare conductors.

The voltage of bare conductors, other than trolley conductors, accessible to inadvertent contact by persons shall not exceed 40 volts.

§ 56.12103 Overcurrent protection.

(a) Electric equipment and conductors, other than trailing cables, shall be protected against overloads and short circuits with fuses or automatic circuit interrupting devices. Such fuses and devices shall be of a type and capacity to safely interrupt the circuit under all overload and short circuit fault conditions.

(b) Motors shall be protected against overload at no more than 125 percent of the full load current of the motors.

(c) Short-circuit protection of motors shall be provided as specified in Tables 56.12103–1 and 56.12103–2.

(d) Where the protection specified in Tables 56.12103–1 and 56.l2103–2 is not sufficient for the starting current of the motor—

(1) A higher rated non-time-delay fuse shall be permitted, but shall in no case exceed 400 percent of the full-load current of the motor or 600 amperes;

(2) A higher rated standard (dual element) fuse shall be permitted, but shall in no case exceed 225 percent of the full-load current of the motor;

(3) A higher rated inverse time circuit breaker shall be permitted, but shall in no case exceed 400 percent of the full-load current of the motor;

(4) A higher rated fuse in the 601–6000 ampere classification shall be permitted, but shall in no case exceed 300 percent of the full-load current of the motor; or

(5) A higher rating or adjustment of an instantaneous trip circuit breaker shall be permitted, but shall in no case exceed 1300 percent of the full-load current of the motor.

(e) All three-phase motors shall be protected with overcurrent devices so that an overcurrent in any phase will deenergize all ungrounded phases.

(f) Transformers shall be protected on the primary side with overcurrent protection rated at no more than 250 percent of their rated full-load current.

(g) When the required rating of a fuse or circuit breaker without an adjustable trip unit does not correspond to a standard rating for a fuse or circuit breaker, the protective device used shall not exceed the next higher standard device rating.

(h) Circuit breakers or fuses providing short-circuit protection shall be installed where the circuit conductors are connected to the supply, except for feeder tap conductors that—

(1) Do not exceed 25 feet in length;

(2) Have ampacities of at least one-third of the ampacity of the feeder conductors; and

(3) Terminate at a circuit breaker or fuse with a current rating that does not exceed the ampacity of the feeder tap conductors.

(i) Wiring shall be protected against overcurrent at no more than the ampacity specified in 30 CFR 56.12601.

(j) Overcurrent protection shall not be required on incandescent lamps supplied from direct-current systems, provided the length of ungrounded conductors does not exceed eight feet.

(k) Where interruption of a circuit presents a hazard to persons, the overload protection requirement of this section does not apply if measures are taken to warn persons when an overload occurs.

(l) Fuses, circuit breakers, or a combination of both shall not be connected in parallel.

TABLE 56.12103–1.—MAXIMUM RATING OR SETTING OF MOTOR BRANCH—CIRCUIT SHORT-CIRCUIT PROTECTIVE DEVICES FOR THREE-PHASE MOTORS

Type of motor	Percent of full-load current			
	Non-time delay fuse	Dual element (time-delay fuse)	Instantaneous trip breaker	Inverse time breaker
Squirrel-cage and synchronous motors with full-voltage, resistor or reactor starting:				
No code letter	300	175	700	250
Code letter F to V	300	175	700	250
Code letter B to E	250	175	700	200
Code letter A	150	150	700	150
All AC squirrel-cage and synchronous motors with autotransformer starting:				
Not more than 30 amps:				
No code letter	250	175	700	200
More than 30 amps:				
No code letter	200	175	700	200
Code letter F to V	250	175	700	200
Code letter B to E	200	175	700	200
Code letter A	150	150	700	150
High-reactance squirrel-cage:				
Not more than 30 amps:				
No code letter	250	175	700	250
More than 30 amps:				
No code letter	200	175	700	200
Wound-rotor—No code letter	150	150	700	150

TABLE 56.12103-2.—MAXIMUM RATING OR SETTING OF MOTOR BRANCH—CIRCUIT SHORT-CIRCUIT PROTECTIVE DEVICES FOR SINGLE-PHASE MOTORS AND DIRECT-CURRENT MOTORS

Type of motor	Percent of full-load current			
	Non-time delay fuse	Dual element (Time-delay) fuse	Instantaneous trip breaker	Inverse time breaker
Single-phase, all types:				
No code letter	300	175	700	250
All AC single-phase with full-voltage, resistor or reactor starting:				
No code letter	300	175	700	250
Code letter F to V	300	175	700	250
Code letter B to E	250	175	700	200
Code letter A	150	150	700	150
Direct-current (constant voltage):				
No more than 50 HP:				
No code letter	150	150	250	150
More than 50 HP:				
No code letter	150	150	250	150

§ 56.12104 Unused Conductors.

Conductors that are not supplying power to electric equipment shall be deenergized and shall—

(a) Be removed from their supply source; or

(b) Have their supply source locked out and any exposed ends insulated.

§ 56.12105 Doors and cover plates.

Doors and cover plates on electric equipment, which allow access to electric connections, shall be closed at all times except during installation, testing and repair.

§ 56.12106 Danger signs.

Visible danger signs shall be posted at all substations, switchyards and control centers to warn persons against entry who have not been specifically assigned to perform duties in those locations.

§ 56.12130 Clearance of equipment.

(a) Bare overhead conductors of more than 650 volts, line-to-line which are installed parallel along a roadway and under which haulage trucks have access shall be suspended at a height at least 10 feet higher than the raised bed of any haulage truck used at the mine.

(b) When equipment is moved or operated near energized bare overhead conductors of less than 69,000 volts (other than trolley conductors) and the clearance is less than 10 feet, the conductors shall be deenergized or other precautionary measures shall be taken to prevent the equipment frames from being energized.

(c) When equipment is moved or operated near energized bare overhead conductors of 69,000 volts or more, the conductors shall be either deenergized or the minimum distance of the conductors from the equipment shall be as in Table 56.12130.

(d) Supplies or materials shall not be stored or stockpiled under bare overhead conductors of more than 650 volts, line-to-line.

TABLE 56.12130 [1]—MINIMUM DISTANCE FROM ENERGIZED CONDUCTORS

Conductor voltage	Distance (in feet)
69 to 114 kV	12
115 to 229 kV	15
230 to 344 kV	20
345 to 499 kV	25
500 kV or more	35

[1] Derived from *National Electrical Safety Code* Table 124-1.

Work on Electric Equipment and Circuits

§ 56.12200 Lockout procedures.

(a) Before electrical or mechanical work is performed on electric circuits or equipment, electric power to the circuits or equipment shall be deenergized except when electric power is a necessary part of the work procedure for accomplishing the mechanical work.

(b) Individual padlocks and identifying tags for each person performing work shall be installed to prevent the power circuit from being energized and the equipment set in motion without the knowledge of persons working on the circuits and equipment. Padlocks and tags shall only be removed by the persons who installed them.

(c) When testing circuits to locate an electrical problem, or adjusting electric circuits, the circuits do not have to be deenergized if—

(1) The circuit voltage is 1040 volts or less;

(2) Testing or adjusting is performed by a qualified electrician in accordance with 30 CFR 56.12100.

(3) The person uses procedures, tools and equipment to assure personal safety when in close proximity to energized parts; and

(4) It would be impractical to deenergize.

§ 56.12201 Plugs and receptacles.

Power cable plugs and receptacles for circuits greater than 150 volts, line-to-ground, shall not be connected or disconnected under load unless they are of the load-break type.

§ 56.12202 Fuses.

Fuses shall be installed or removed using tools or procedures that prevent electric shock or burns.

§ 56.12203 Cable handling.

(a) Power cables energized to a voltage in excess of 150 volts, line-to-ground, shall not be moved by other equipment unless sleds, or slings insulated from that equipment are used. This does not prohibit pulling or dragging of a trailing cable by the equipment it powers.

(b) When power cables energized to a voltage in excess of 150 volts, line-to-ground, are moved manually, insulated hooks, tongs, slings, gloves, mitts, aprons or other insulated personal protective equipment capable of protecting against shock, shall be used.

(c) Insulated handling equipment shall be—

(1) Examined before each use for visible signs of damage or defects; and

(2) Removed from use when damaged or defective.

(d) Surplus trailing cables serving shovels, cranes and similar equipment shall be stored—

(1) In cable boats;

(2) On reels mounted on the equipment; or

(3) In a manner which would protect them from mechanical damage.

§ 56.12204 Access.

(a) For installations and equipment constructed after [Insert the effective date of this rule], working space shall be provided in accordance with Table 56.12204 where access to exposed energized electric equipment is necessary.

(b) For existing installations and equipment, working space in accordance with Table 56.12204 shall be provided where access to exposed energized electric equipment is necessary, unless other precautionary measures are used to protect persons from electric shock or burns.

TABLE 56.12204.[1]—MINIMUM WORKING SPACE

Nominal voltage to ground	Minimum clear distance for condition (ft) [2]		
	(A)	(B)	(C)
0 to 150 V	3	3	3
151 to 600 V	3	3½	4
601 to 2,500 V	3	4	5
2,501 to 9,000 V	4	5	6
9,001 to 25,000 V	5	6	9
25,001 to 75 kV	6	8	10
Above 75 kV	8	10	12

[1] NFPA, 70 E. Tables 110–16A and 110–34A

[2] As used in Table 56.12204, conditions (A), (B), (C) are as follows:

(A) Exposed energized parts on one side and no energized or grounded parts on the other side of the working space, or exposed energized parts on both sides guarded by wood or other insulating materials. Insulated conductors operating at not over 300 volts are not considered energized parts.

(B) Exposed energized parts on one side and grounded parts on the other side. Concrete, brick or rock walls will be considered as grounded surfaces.

(C) Exposed energized parts on both sides of the work space.

Guarding; Insulation; Separation

§ 56.12300 Connections and grids.

Exposed electric connections and resistor grids that are not protected by location shall be insulated. Where this is impractical they shall be guarded to prevent inadvertent contact by persons or equipment.

§ 56.12301 Communication conductors.

(a) Communication conductors shall be isolated or insulated to prevent them from contacting bare energized parts.

(b) Communication conductors carried on poles supporting uninsulated power conductors shall be located below the power conductors.

(c) Communication conductors shall not be attached to a crossarm that carries uninsulated power conductors.

§ 56.12302 Lights, guarding.

(a) Portable extension lights and lights less than 8 feet above travelways and working places shall be guarded to prevent a hazard to persons.

(b) Other lights shall be guarded when they present a hazard.

(c) Lamps shall not contact combustible materials.

§ 56.12330 Transformers.

(a) Transformers shall be—

(1) Totally enclosed;

(2) Installed so exposed energized parts are at least 8 feet above the ground; or

(3) Installed in a transformer house.

(4) Surrounded by a sturdy fence at least 6 feet high and at least 3 feet from any parts, casings or energized conductors.

(b) Gates or doors of transformer enclosures shall be locked to prevent unauthorized access to exposed energized parts which are less than 8 feet above the ground.

(c) Metallic transformer houses and fences shall be connected to the metallic case of the safety grounded transformer.

§ 56.12331 Substations.

Substations containing exposed energized parts that can be inadvertently contacted by persons shall be enclosed. When the enclosure is a metallic structure or fence it shall be connected to the substation's safety grounding system.

Connections; Switches; Controls

§ 56.12400. Identification.

Circuit breakers, trolley taps, fuse switchboxes and other disconnecting devices shall be legibly, durably, and distinctively marked to show which electric equipment they supply, except where the circuit breakers and devices can be identified by their proximity to the equipment.

§ 56.12401 Insulating mats.

Insulating mats shall be provided at all switchboards and power control switches where shock hazards exist due to exposed energized parts.

§ 56.12402 Undervoltage protection.

(a) Electric powered machinery shall include undervoltage protection to prevent shocks, burns, unwanted motion or unintentional starting. When voltage is lost, the equipment shall remain deenergized until manually restarted.

(b) Pumps, level control circuits and other equipment that by their design can automatically start and stop safely are not required to have undervoltage protection.

Safety Grounding

§ 56.12500 Grounding.

(a) All electric circuits shall have a safety grounding system. The system's performance shall limit the voltage on non-current-carrying metallic parts of electric equipment that a person can contact to a value that shall not cause a disabling or fatal shock under the following fault conditions—

(1) Single line-to-ground on grounded power systems; or

(2) Double line-to-ground on ungrounded power systems, with one of the faults at the source.

(b) The voltage on non-current-carrying metallic parts of electric equipment shall be controlled by—

(1) Limiting the magnitude of the voltage;

(2) Limiting the duration of the voltage; or

(3) A combination of these two.

See Appendix I for Subpart K.

§ 56.12501 Alternating-current equipment.

(a) The following equipment shall be connected to the safety grounding system by equipment safety grounding conductors:

(1) Metallic frames, enclosures, and other exposed non-current-carrying metallic parts of electric equipment.

(2) Metallic fences and barriers around high-voltage equipment and installations.

(3) Metallic enclosures of alternating-current conductors.

(4) Metallic battery trays.

(5) Metallic messenger wires.

(6) Metallic structures or racks that support electric equipment or conductors.

(b) Metallic cable shielding shall be connected to the safety grounding system at each termination by equipment safety grounding conductors.

(c) Before batteries on battery-powered equipment are connected to a battery charger, the metallic battery trays shall be connected to the grounded metallic frame of the battery charger, and shall remain connected until the batteries have been disconnected from the charger.

(d) Metallic cable hangers or supporting structures shall either be connected to the safety grounding system or insulated from the cable.

(e) Exposed metallic enclosures or portions of hand-held electric equipment shall be connected to the safety grounding system, except when the equipment is—

(1) Double insulated as determined by an independent testing laboratory and does not present a shock hazard; or

(2) Operated at a maximum of 40 volts.

(f) Generator powered equipment mounted on the same metallic frame as the generator is not required to be

connected to the mine's safety grounding system.

§ 56.12502 Direct-current equipment.

(a) The following shall be connected to the mine safety grounding system by equipment safety grounding conductors

(1) Metallic frames, enclosures, and other exposed non-current-carrying metallic parts of conductors and equipment.

(2) Metallic messenger wires used to support direct-current conductors.

(3) Metallic racks and structures used to support trolley wires and trolley feeder wires.

(4) Metallic overcasts in trolley entries.

(b) Silicon diode grounding systems shall be installed in accordance with 30 CFR 56.12504.

(c) Component parts of complete units of equipment shall be solidly connected to the frames of the equipment.

(d) Exposed metallic enclosures or portions of hand-held electric equipment shall be connected to the safety grounding system, except when the equipment is—

(1) Double insulated as determined by an independent testing laboratory and does not present a shock hazard;

(2) Operated at a maximum of 40 volts; or

(3) Powered by internal batteries which are a integral part of the equipment.

(e) Generator powered equipment mounted on the same metallic frame as the generator is not required to be connected to the mine's safety grounding system.

§ 56.12503 Equipment safety grounding conductors.

(a) Equipment safety grounding conductors for portable and mobile electric equipment shall be one or more stranded copper conductors contained within the cable or flexible cord supplying the equipment.

(b) Equipment safety grounding conductors for stationary equipment shall be—

(1) Contained together with the circuit conductors in the raceways, cables, or cords;

(2) Wrapped around the raceways, cables, or cords containing the circuit conductors; or

(3) A continuous metal conduit or metallic raceway that complies with the voltage exposure requirements of 30 CFR § 56.12500.

(c) The combined cross-sectional area of equipment safety grounding conductors shall be equal to or greater than—

(1) One-half the cross-sectional area of one circuit conductor when the circuit conductor is No. 6 AWG or larger; or

(2) The cross-sectional area of one circuit conductor when the circuit conductor is smaller than No. 6 AWG.

(d) Equipment safety grounding conductors installed outside of raceways, cables, or cords and used to ground stationary equipment shall be No. 6 AWG or larger.

(e) Switches, fuses, circuit breakers, ground-fault devices and overcurrent devices shall not be installed in equipment safety grounding conductors.

(f) Ground-wire devices installed in the equipment safety grounding conductor for the purpose of inter-machine arc suppression or in conjunction with ground-wire monitoring systems shall be designed and constructed to withstand the maximum amount of phase-to-phase fault current to which they may be exposed without creating an electrical shock or fire hazard.

(g) When used, ground-wire devices specified in paragraph (f) of this section shall be connected to the safety grounding system with two separate conductors.

(h) On direct-current powered equipment, the equipment safety grounding conductor and the return power conductor shall be separately connected to the mine track, grounded return-feeder conductor, or metallic frame or enclosure used as the safety grounding system.

(i) Equipment safety grounding conductors for draw-out equipment or plugs and receptacles shall be the first conductors made when making connections and the last conductors broken when breaking connections.

(j) When power is supplied between separate metallic parts of equipment, the parts shall be connected together through an equipment safety grounding conductor.

(k) The frame of a portable or mobile generator supplying remote loads shall have equipment safety grounding conductors connecting the frames of each remote load to the frame of the generator.

(l) Equipment safety grounding conductors shall be bare or shall be properly identified.

§ 56.12504 Silicon diode grounding.

When the metallic frames of off-track equipment are grounded by silicon diodes, the diode grounding system shall meet the following conditions:

(a) The polarity of each grounding diode shall be compatible with the grounded polarity of the direct-current systems.

(b) Each grounding diode shall have a threaded base used to solidly connect the diode to the machine frame.

(c) An overcurrent device shall be installed between the grounding diode(s) and the grounded power conductor, and shall cause the main conductor or the circuit interrupting device to deenergize all circuits on the machine when 50 amperes or more flows through the grounding diode, except that methane monitor circuits may remain energized.

(d) A polarizing diode that prevents the unit of equipment from being operated when the polarity of the supply conductors is reversed shall be installed in the control circuit.

(e) The forward current rating of each grounding diode shall be equal to or greater than 750 amperes when used to ground a continuous mining machine or equal to or greater than 400 amperes when used to ground other equipment.

(f) The peak reverse voltage rating of the grounding and polarizing diodes shall be at least 1,200 volts.

§ 56.12505 Low-resistance ground fields.

(a) Low-resistance ground fields used in the safety grounding system shall be designed and installed in a manner which assures that the maximum exposure voltage under fault conditions does not create hazardous step and touch potentials. The following parameters shall be considered in evaluating ground field safety—

(1) Soil resistivity;

(2) Available fault current;

(3) Ground field construction; and

(4) Operating times of protective devices.

(b) Low-resistance ground fields used in the safety grounding system shall be maintained at 25 ohms or less unless an evaluation of the system in accordance with paragraph (a) indicates that—

(1) a lower value of resistance is necessary; or

(2) a higher value of resistance can be used.

(c) Materials used for ground fields shall have at least four square feet of surface area in contact with soil.

§ 56.12506 Testing.

(a) On all installations made after [Insert the effective date of this rule], and when repairs or modifications are made to the safety grounding system, continuity tests shall be made to assure the integrity of the system.

(b) The safety grounding system shall be reviewed at intervals not to exceed twelve months to assure that the maximum voltage exposure under fault conditions complies with requirements of this subpart.

(c) For mine power systems utilizing an alternating-current voltage of less than 650 volts, line-to-line, the resistance to earth of the safety grounding system's connection to earth shall be maintained at 25 ohms or less and be physically separated from the substation grounding system. This separation shall be either 25 feet or 5 times the largest dimension of the safety grounding system's connection to earth, whichever is larger. When 25 ohms or less cannot be obtained, the operator shall assure that the system complies with 30 CFR 56.12505.

(d) When reviewing a mine power system utilizing an alternating-current voltage greater than 650 volts, line-to-line, the review shall include determinations of the—

(1) Safety grounding system's resistance to earth at its connection to earth;

(2) Maximum fault current that can flow into the safety grounding system at electric loads or sources of 500 kVA or larger; and

(3) Impedance of the safety grounding system at electric loads or sources of 500 kVA or larger.

(e) A weekly check of continuity shall be made of all mobile equipment safety grounding conductors, except when they are continuously monitored with an MSHA tested ground-wire monitoring device.

Power Cables and Conductors

§ 56.12600 Installation.

(a) Cables and insulated conductors shall be installed so that they are protected against physical damage, adverse ambient conditions and failure of adjacent mechanical systems.

(b) Cables and insulated conductors shall not be supported from pipelines.

(c) Insulated conductors shall not contact pipelines.

(d) When cables and pipelines are supported from the same supports, clearance to prevent shock hazards during maintenance to pipelines shall be provided.

56.12601 Ampacity.

(a) Electric conductors shall be of a size and currentcarrying capacity to assure that a rise in temperature resulting from normal operating conditions does not exceed the rating of the insulation and conductors.

(b) Branch circuit conductors supplying electric equipment shall have ampacities of at least 125 percent of the full-load current rating of the equipment.

(c) Feeder circuit conductors supplying multiple loads shall have ampacities of at least the sum of the full-load current ratings of each load plus 25 percent of the highest full load current rating of the largest load.

(d) The size of conductors for electric equipment shall be at least that specified in ampacity Tables 56.12601–1 through 56.12601–10 below, or other tables that are appropriate for the conditions under which the conductors are used.

(e) Ampacity of conductors shall be corrected according to Table 56.12601–11, if the ambient temperature is other than the temperature at which the conductor was rated.

(f) When four or more conductors are contained in the same raceway, conduit or cable, the maximum allowable load current shall be reduced according to Table 56.12601–12.

TABLE 56.12601–1. ALLOWABLE AMPACITIES OF 300- AND 600-VOLT FLEXIBLE CORDS; COPPER CONDUCTORS

Conductor size AWG	Types S, SO, SJO ST, STO, SJT, SJTO, SOO, SJOO, STOO, SJTOO—Current-carrying conductors		Types AFS, AFSJ, HSJ, HSJO, HS, MSO—Current-carrying conductors
	2	3	3
14	18	15	20
12	25	20	30
10	30	25	35
8		35	

TABLE 56.12601–2—ALLOWABLE AMPACITIES OF SHIELDED AND UNSHIELDED 0- TO 2000-VOLT PORTABLE POWER CABLES; COPPER CONDUCTORS (BASED ON AMBIENT AIR TEMPERATURE OF 20.C (68.F))

Conductor size AWG Or MCM	Ampacities—Number of Current-Carrying Conductors in Cable Or Raceway						
	1		2		3		
	75 °C [1]	90 °C [1]	75 °C [1]	90 °C [1]	75 °C [1]	90 °C [1]	90 °C [2]
8	75	98	63	85	63	70	
6	106	128	81	112	81	93	110
4	138	171	113	150	106	123	144
3	163	197	131	171	125	142	165
2	188	227	150	197	144	163	188
1	213	263	175	225	163	190	217
1/0	250	304	213	256	181	219	249
2/0	294	352	244	295	213	254	287
3/0	344	407	281	337	244	294	329
4/0	394	472	325	387	275	339	379
250	438	525	356	428	306	378	419
300	494	590	388	472	344	421	470
350	556	651	419	514	381	465	513
400	600	708	450	555	406	507	555
500	681	820	519	618	469	575	632

[1] 0–2000 Volt Insulation, Unshielded Portable Power Cable.
[2] 0–2000 Volt Insulation, Shielded Portable Power Cable.

TABLE 56.12601-3.—ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS RATED 0 TO 2000 VOLTS, 60 °C TO 90 °C, NOT MORE THAN THREE CURRENT-CARRYING CONDUCTORS IN RACEWAY OR CABLE (BASED ON AMBIENT AIR TEMPERATURE OF 20 °C (68 °F))

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				15					
16			20	19					
14	20	20	27	25					
12	25	25	33	30	20	20	27	25	12
10	35	35	43	40	29	30	33	35	10
8	46	55	60	59	35	44	43	49	8
6	64	72	76	81	46	55	60	65	6
4	81	94	103	103	64	72	82	81	4
3	98	111	120	119	75	83	92	92	3
2	110	127	136	140	87	99	109	108	2
1	127	144	158	162	98	111	120	124	1
0	144	166	179	184	116	133	141	146	0
00	167	193	207	211	133	149	158	162	00
000	191	221	234	243	150	171	185	189	000
0000	225	254	272	281	173	199	212	221	0000
250	248	282	299	313	196	227	239	248	250
300	277	315	337	346	219	254	272	275	300
350	299	343	370	378	243	276	294	302	350
400	323	370	397	410	260	298	321	329	400
500	370	420	451	464	300	343	364	378	500
600	410	464	500	513	329	376	402	416	600
700	445	508	544	562	358	414	440	454	700
750	462	525	560	578	370	425	457	470	750
800	474	541	582	599	381	436	467	486	800
900	502	575	614	632	410	470	506	518	900
1000	526	602	641	664	433	492	527	540	1000
1250	572	652	696	718	468	536	571	589	1250
1500	601	691	739	761	502	575	614	632	1500
1750	629	718	766	794	526	602	647	664	1750
2000	647	735	788	810	543	619	663	680	2000

TABLE 56.12601-4— ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2000 VOLTS (BASED ON AMBIENT AIR TEMPERATURE OF 20° C (68° F))

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				19					
16			25	26					
14	25	30	33	35					
12	30	35	43	40	25	30	33	35	12
10	40	50	60	55	35	40	43	40	10
8	69	77	82	86	52	61	65	65	8
6	92	105	109	113	69	83	87	86	6
4	121	138	147	151	92	111	114	119	4
3	139	160	174	178	110	127	136	140	3
2	162	188	201	205	127	149	158	162	2
1	191	215	234	238	150	171	179	189	1
0	225	254	272	281	173	199	212	221	0
00	260	293	315	324	202	232	245	254	00
000	300	343	364	378	231	265	288	297	000
0000	347	398	424	437	271	309	332	340	0000
250	393	448	478	491	306	348	375	383	250
300	433	492	527	545	335	387	413	427	300
350	485	558	598	616	381	436	467	481	350
400	526	602	647	664	410	470	505	518	400
500	595	685	734	756	468	536	571	589	500
600	664	762	815	842	526	597	647	664	600
700	728	834	897	923	578	657	707	729	700
750	757	867	929	956	595	685	734	756	750
800	785	901	962	994	618	713	761	783	800
900	843	961	1033	1064	670	774	826	848	900
1000	901	1033	1109	1139	722	829	886	913	1000
1250	1028	1177	1261	1296	820	945	1011	1037	1250
1500	1132	1298	1386	1431	918	1050	1125	1161	1500
1750	1236	1414	1516	1561	1010	1160	1245	1280	1750
2000	1334	1531	1636	1685	1109	1271	1359	1442	2000

TABLE 56.12601-5—ALLOWABLE AMPACITIES OF SHIELDED, THREE CONDUCTOR, 2,001-15,000 VOLT, MINE POWER CABLE; COPPER CONDUCTORS

[Based on Ambient Temperature of 20 °C]

Ampacities	Conductor size (AWG or MCM)			
	2,001-8,000 volts		8,001-15,000 volts	
	75 °C	90 °C	75 °C	90 °C
6	99	110	.....	.....
4	130	144	.....	.....
2	170	188	175	194
1	196	217	200	221
1/0	226	249	230	254
2/0	260	287	263	290
3/0	299	329	301	334
4/0	343	379	346	384
250	379	419	383	424
300	423	470	426	473
350	465	513	468	517
400	500	555	501	558
500	571	632	571	632

TABLE 56.12601-6—ALLOWABLE AMPACITIES OF SHIELDED, THREE CONDUCTOR, 2,001-15,000 VOLT MINE POWER CABLES; ALUMINUM CONDUCTORS

[Based on Ambient Temperature of 20 °C]

Ampacities	Conductor size (AWG or MCM)			
	2,001-8,000 volts		8,001-15,000 volts	
	75 °C	90 °C	75 °C	90 °C
4	101	112	.....	.....
2	133	146	136	.....
1	153	.....	156	.....
1/0	176	195	179	198
2/0	203	223	205	227
3/0	234	257	236	261
4/0	269	296	271	300
250	298	328	300	332
350	366	404	367	406
400	396	425	397	433
500	458	502	453	500

TABLE 56.12601-7—AMPACITY OVERHEAD COPPER CONDUCTORS

Conductor AWG [1]	CM [2]	Copper, ampacity in amperes
.....	6,400	51
10	10,380	68
.....	10,820	71
9	13,090	79
8	16,510	92
6	26,240	124
4	41,740	166
3	52,620	193
2	66,360	223
1	83,700	260
1/0	105,600	301
2/0	133,100	350
3/0	167,800	406
4/0	211,680	472
	250,000	547
	300,000	615
	350,000	680
	400,000	730
	450,000	787
	500,000	842
	600,000	945
	700,000	1042
	750,000	1087
	800,000	1131

TABLE 56.12601-7—AMPACITY OVERHEAD COPPER CONDUCTORS—Continued

Conductor AWG [1]	CM [2]	Copper, ampacity in amperes
	1,000,000	1295

[1] AWG means American Wire Gage.
[2] CM means Circular Mils.

TABLE 56.12601-8—AMPACITY OVERHEAD ACSR [1] CONDUCTORS

Conductor Size AWG [2]	CM [3]	ACSR, ampacity in amperes
6	.....	104
4	.....	139
2	.....	184
1	.....	210
1/0	.....	240
2/0	.....	275
3/0	.....	316
4/0	.....	360
	266,800	452
	300,000	492
	336,400	534

TABLE 56.12601-8—AMPACITY OVERHEAD ACSR [1] CONDUCTORS—Continued

Conductor Size AWG [2]	CM [3]	ACSR, ampacity in amperes
	397,500	593
	477,000	665
	556,500	732
	605,000	772
	636,000	797
	666,600	805
	715,500	858
	795,000	881
	874,500	935
	900,000	926
	954,000	960
	1,033,500	1010
	1,113,000	1060
	1,182,500	1099
	1,192,500	1108
	1,272,000	1148
	1,351,500	1198
	1,431,000	1237
	1,510,500	1278
	1,590,000	1313
	1,780,000	1434

[1] Aluminum Cable Steel Reinforced.
[2] AWB means American Wire Gage.

[3] CM means Circular Mils.

TABLE 56.12601-9—ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS RATED 0 TO 2000 VOLTS, 60 °C TO 90 °C, NOT MORE THAN THREE CURRENT-CARRYING CONDUCTORS IN RACEWAY OR CABLE

[Based on Ambient Air Temperatures of 30 °C (86 °F)]

Conductor size AWB or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				14					
16			18	18					
14	20	20	25	25					
12	25	25	30	30	20	20	25	25	12
10	30	35	40	40	25	30	30	35	10
8	40	50	55	55	30	40	40	45	8
6	55	65	70	75	40	50	55	60	6
4	70	85	95	95	55	65	75	75	4
3	85	100	110	110	65	75	85	85	3
2	95	115	125	130	75	90	100	100	2
1	110	130	145	150	85	100	110	115	1
1/0	125	150	165	170	100	120	130	135	1/0
2/0	145	175	190	195	115	135	145	150	2/0
3/0	165	200	215	225	130	155	170	175	3/0
4/0	195	230	250	260	150	180	195	205	4/0
250	215	255	275	290	170	205	220	230	250
300	240	285	310	320	190	230	250	255	300
350	260	310	340	350	210	250	270	280	350
400	280	335	365	380	225	270	295	305	400
500	320	380	415	430	260	310	335	350	500
600	355	420	460	475	285	340	370	385	600
700	385	460	500	520	310	375	405	420	700
750	400	475	515	535	320	385	420	435	750
800	410	490	535	555	330	395	430	450	800
900	435	520	565	585	355	425	465	480	900
1000	455	545	590	615	375	445	485	500	1000
1250	495	590	640	665	405	485	525	545	1250
1500	520	625	680	705	435	520	565	585	1500
1750	545	650	705	735	455	545	595	615	1750
2000	560	665	725	750	470	560	610	630	2000

TABLE 56.12601-10—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2000 VOLTS

[Based on Ambient Air Temperatures of 30 °C (86 °F)]

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				18					
16			23	24					
14	25	30	30	35					
12	30	35	40	40	25	30	30	35	12
10	40	50	55	55	35	40	40	40	10
8	60	70	75	80	45	55	60	60	8
6	80	95	100	105	60	75	80	80	6
4	105	125	135	140	80	100	105	110	4
3	120	145	160	165	95	115	125	130	3
2	140	170	185	190	110	135	145	150	2
1	165	195	215	220	130	155	165	175	1
1/0	195	230	250	260	150	180	195	205	1/0
2/0	225	265	290	300	175	210	225	235	2/0
3/0	260	310	335	350	200	240	265	275	3/0
4/0	300	360	390	405	235	280	305	315	4/0
250	340	405	440	455	265	315	345	355	250
300	375	445	485	505	290	350	380	395	300
350	420	505	550	570	330	395	430	445	350
400	455	545	595	615	355	425	465	480	400
500	515	620	675	700	405	485	525	545	500
600	575	690	750	780	455	540	595	615	600
700	630	755	825	855	500	595	650	675	700
750	655	785	855	885	515	620	675	700	750
800	680	815	885	920	535	645	700	725	800
900	730	870	950	985	580	700	760	785	900
1000	780	935	1020	1055	625	750	815	845	1000
1250	890	1065	1160	1200	710	855	930	960	1250
1500	980	1175	1275	1325	795	950	1035	1075	1500
1750	1070	1280	1395	1445	875	1050	1145	1185	1750

TABLE 56.12601-10—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2000 VOLTS—Continued

[Based on Ambient Air Temperatures of 30 °C (86 °F)]

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
2000	1155	1385	1505	1560	960	1150	1250	1335	2000

TABLE 56.12601-11.—AMPACITY CORRECTION FACTORS

[For Ambient Temperatures other than 20 °C, Multiply the Ampacities from Tables 56.12601-2 Through 56.12601-6 by the Appropriate Factor Shown Below]

Ambient temperature °C	Correction factor				Ambient temperature °F
	60°	75°	85°	90°	
21-25	.91	.94	.95	.96	70-77
26-30	.82	.88	.90	.91	79-86
31-35	.71	.82	.85	.87	88-95
36-40	.58	.75	.80	.82	97-104
41-45	.41	.67	.74	.76	106-113

[For Ambient Temperatures other than 30 °C, Multiply the Ampacities from Tables 56.12601-1, 56.12601-11 and 56.12601-12 by the Appropriate Factor Shown Below]

Ambient temperature °C	Correction factor				Ambient temperature °F
	60°	75°	85°	90°	
21-25	1.08	1.05	1.04	1.04	70-77
26-30	1.00	1.00	1.00	1.00	79-86
31-35	.91	.94	.95	.96	88-95
36-40	.82	.88	.90	.91	97-104
41-45	.71	.82	.85	.87	106-113

TABLE 56.12601-12.—AMPACITY DERATING FACTORS

Number of conductors	Percent of ampacity value
4 through 6	80
7 through 24	70
25 through 42	60
43 and above	50

Derived from notes to NEC Tables 310-16 through 310-19.

§ 56.12602 Insulation, termination and shielding.

(a) Power cables and conductors, other than trolley wires and uninsulated surface overhead conductors of more than 650 volts, line-to-line, shall have insulation rated for at least the voltage of the circuit in which the cable or conductor is applied.

(b) Power cables and conductors installed on the surface in circuits with line-to-line voltages above 2,000 volts and subject to contact by persons shall have metallic shielding around each power conductor.

(c) Metallic enclosed power cables and conductors are not required to be shielded provided the enclosure is continuous and connected to the safety grounding system.

(d) Except as provided in paragraph (f) of this section, cables shall enter metallic frames of electric enclosures through fittings sized for the cables which prevent damage to the cable jackets and the insulation of the internal conductors.

(e) Except as provided in paragraph (f) of this section, conductors shall enter metallic frames of electric enclosures through fittings with insulated bushings sized for the conductors.

(f) Cables and conductors in conduit that enter metallic frames of electric enclosures need not be equipped with fittings or bushings when protection against damage by sharp edges is otherwise provided.

(g) Cables and conductors shall be secured to prevent mechanical strain on electrical connections.

§ 56.12603 Splices, repairs and terminations of conductors and cables.

(a) Cables shall be spliced, terminated, or repaired by a qualified electrician.

(b) A splice in a trailing cable shall contain only one connection point in each conductor.

(c) Terminations of shields in cables shall be connected to equipment safety grounding conductors at each splice and termination.

(d) Except as provided in paragraph (e) of this section, each splice and repair shall have—

(1) Conductivity and current-carrying capacity that prevents insulation damage due to heating of conductors;

(2) The severed conductors joined by welding or compression-type connectors;

(3) Each power, control, and ground check conductor individually reinsulated with insulation having a thickness, temperature rating, and dielectric strength of at least that of the original insulation;

(4) Semiconducting tape replaced over the insulation of each power conductor within shielded cables;

(5) Metallic shielding in the form of metallic braid or serving (wrap), or metallic tape replaced over each power conductor and applied in half-lapped layers, on shielded cables;

(6) The outer jacket replaced to provide at least the same thickness and protection as that of the original jacket; and

(7) The outer jacket sealed, vulcanized, molded, or fused to the cable's original jacket to exclude moisture.

(e) One trailing cable splice which does not meet the requirements of paragraph (d) of this section shall be permitted for the time period necessary to move the equipment for repair of the cable, provided the splice is mechanically strong and insulated to prevent shock.

§ 56.12604 Lightning protection.

(a) Surge arresters shall be provided for exposed ungrounded power conductors and telephone wires.

(b) Power conductors and telephone wires that are buried, installed beneath a protective metallic covering, or enclosed within grounded metallic shields, coverings, or enclosures, throughout their entire length need not be equipped with surge arresters.

(c) Surge arresters shall be rated for the voltage and current of the circuit they protect.

§ 56.12630 Support structures and guy wires.

Guy wires attached to structures supporting uninsulated overhead power conductors, other than telephone wires, shall be—

(a) Electrically connected to the equipment safety grounding conductor at the supporting structure end of the guy wire; or

(b) Provided with one or more insulators which have a dry flashover voltage at least double the nominal voltage and a wet flashover voltage at least as high as the nominal voltage. The insulators shall be at least 8 feet from the ground.

Trailing Cables

§ 56.12700 Insulation; shielding.

Trailing cables used in mine electrical systems shall have—

(a) Conductor insulation rated for at least the line-to-line voltage; and

(b) Shielding for the purpose of confining the voltage stresses when used to supply equipment at over 2,000 volts line-to-line.

§ 56.12701 Overcurrent protection.

(a) Each trailing cable of portable and mobile equipment shall have short-circuit and ground-fault protection for each ungrounded conductor that shall safely interrupt all ungrounded conductors under fault conditions.

(b) Ungrounded conductors of trailing cables energized at voltages of 1040 volts or less shall be protected by one of the following—

(1) An inverse-time circuit breaker with a maximum current rating as specified in Table 56.12701–1.

(2) An instantaneous-trip or short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds with a maximum instantaneous setting not more than—

(i) The values listed in Table 56.12701–2 for 480-, 600-, and 1040-volt trailing cables; or

(ii) The values listed in Table 56.12701–3 for 300- and 600-volt direct-current trailing cables.

(3) An instantaneous-trip or short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds with a setting that does not exceed the lower value of either 115 percent of the maximum starting current for the unit of electric equipment or 60 percent of the lowest value of bolted phase-to-phase short-circuit current at any point in the circuit when—

(i) The circuit to be protected does not function properly using values listed in the tables; and

(ii) A circuit analysis assures that the circuit does not present a hazard to the miners.

(4) Fuses which provide no less protection than that specified above.

(c) Ungrounded conductors of trailing cables energized at voltages greater than 1040 volts shall be provided with instantaneous short-circuit protection with a setting that does not exceed the lower value of either 175 percent of the maximum starting current for the unit of electric equipment or 75 percent of the minimum phase-to-phase short-circuit current available at any point in the circuit.

TABLE 56.12701–1.—MAXIMUM RATINGS OF FUSES PROTECTING DIRECT-CURRENT TRAILING CABLES AND INVERSE-TIME CIRCUIT BREAKERS PROTECTING ALTERNATING-CURRENT TRAILING CABLES

[Maximum Inverse-Time Circuit Breaker or Fuse Rating (Amperes)]

Conductor size (AWG or MCM)	1 Ungrounded power conductor	2 Ungrounded power conductors	3 Ungrounded power conductors
14	15	15	15
12	20	20	20
10	30	30	25
8	60	50	50
6	90	70	70
4	110	110	110
3	150	150	150
2	150	175	175
1	175	200	200
1/0	200	225	225
2/0	250	250	250
4/0	350	350	350
250	350	350	350
300	400	350	350
350	450	350	350
400	500	400	400
500	600	450	400

TABLE 56.12701–2.—Maximum Settings of Instantaneous and Electronic Circuit Breakers Protection 480, 600, and 1040–Volt Alternating Current Trailing Cables

Conductor size (AWG or MCM)	Cable length (feet)	Maximum circuit breaker setting (amperes)		
		480V	600V	1040V
14	0–500	75	100	.....
	501–750	50	75	.....
12	0–500	125	175	.....
	501–750	100	125	.....
10	0–500	200	250	.....
	501–750	150	200	.....
8	0–500	300	400	.....
	501–750	200	300	.....
6	0–550	450	550	850
	501–750	350	450	700
4	0–500	750	900	1250

TABLE 56.12701-2.—Maximum Settings of Instantaneous and Electronic Circuit Breakers Protection 480, 600, and 1040-Volt Alternating Current Trailing Cables—Continued

Conductor size (AWG or MCM)	Cable length (feet)	Maximum circuit breaker setting (amperes)		
		480V	600V	1040V
	501-600	650	800	1100
	601-750	550	650	1000
3	0-500	900	1100	1400
	501-650	700	900	1200
	651-750	650	800	1100
2	0-500	1100	1250	1500
	501-600	950	1100	1400
	601-750	800	950	1250
1	0-500	1300	1450	1650
	501-600	1100	1300	1550
	601-750	950	1100	1400
1/0	0-500	1500	1650	1750
	501-600	1300	1500	1650
	601-750	1100	1300	1500
	751-800	1050	1250	1500
2/0	0-500	1700	1800	1850
	501-600	1500	1650	1750
	601-750	1350	1450	1650
	751-850	1200	1350	1550
3/0	0-500	1900	1950	1900
	501-600	1700	1800	1800
	601-750	1500	1650	1700
	751-900	1300	1450	1650
4/0	0-500	2100	2100	1950
	501-600	1900	1950	1900
	601-750	1700	1800	1800
	751-1000	1400	1550	1650
250	0-500	2150	2150	2000
	501-600	2000	2050	1900
	601-750	1750	1850	1850
	751-1000	1500	1650	1700
300	0-500	2300	2250	2000
	501-600	2100	2100	1950
	600-750	1900	1950	1900
	751-1000	1600	1750	1750
350	0-500	2350	2300	2050
	601-750	2000	2000	1900
	751-1000	1700	1800	1800
400	0-500	2450	2350	2100
	501-600	2250	2250	2000
	601-750	2050	2100	1950
	751-1000	1800	1850	1850
500	0-500	2500	2400	2100
	501-600	2350	2300	2050
	601-750	2150	2150	1950
	751-1000	1900	1950	1850

TABLE 56.12701-3—MAXIMUM SETTINGS OF INSTANTANEOUS CIRCUIT BREAKERS PROTECTING 300- AND 600-VOLT DIRECT CURRENT TRAILING CABLES

Conductor size (AWG or MCM)	Cable length (feet)	300VDC Maximum instantaneous circuit breaker setting (amperes)		600 VDC Maximum instantaneous circuit breaker setting (amperes)	
		Line-line [1]	Line-ground [2]	Line-line [1]	Line-ground [2]
14	0-500	50	50	50	50
12	0-500	75	75	125	125
10	0-500	75	75	200	200
8	0-500	100	100	300	300
6	0-500	200	100	450	300
4	0-500	450	250	600	500
	501-600	350	200	550	400
3	0-500	450	350	700	550
	501-650	400	250	600	450
2	0-500	600	450	750	600
	501-600	550	400	700	550
	601-700	450	300	650	500
1	0-500	900	600	1400	1050
	501-600	750	500	1250	950
	601-750	600	400	1050	800
1/0	0-500	1100	750	1600	1250
	501-600	950	650	1450	1100
	601-750	750	550	1250	950
	751-800	700	500	1200	900

TABLE 56.12701-3—MAXIMUM SETTINGS OF INSTANTANEOUS CIRCUIT BREAKERS PROTECTING 300- AND 600-VOLT DIRECT CURRENT TRAILING CABLES—Continued

Conductor size (AWG or MCM)	Cable length (feet)	300VDC Maximum instantaneous circuit breaker setting (amperes)		600 VDC Maximum instantaneous circuit breaker setting (amperes)	
		Line-line [1]	Line-ground [2]	Line-line [1]	Line-ground [2]
2/0	0-500	1350	950	1800	1450
	501-600	1150	800	1650	1300
	601-750	950	650	1450	1100
	751-850	850	600	1350	1050
3/0	0-500	1550	1150	2000	1650
	501-600	1400	1000	1850	1500
	601-750	1150	800	1650	1300
	751-900	1000	700	1500	1150
4/0	0-500	1850	1400	2200	1850
	501-600	1600	1200	2050	1700
	601-750	1400	1000	1850	1500
250	0-500	2050	1550	2350	2000
	501-600	1800	1350	2200	1850
	601-750	1550	1150	2000	1650
	751-1000	1250	900	1750	1400
300	0-500	2300	1750	2450	2150
	501-600	2050	1550	2350	2000
	601-750	1750	1300	2150	1800
	751-1000	1450	1050	1900	1550
350	0-500	2550	1950	2600	2300
	501-600	2250	1700	2450	2150
	601-750	1950	1500	2300	1950
	751-1000	1600	1200	2050	1700
400	0-500	2750	2150	2650	2400
	501-600	2450	1900	2550	2250
	601-750	2150	1600	2400	2050
	751-1000	1750	1350	2150	1800
500	0-500	3050	2450	2800	2550
	501-600	2800	2200	2700	2400
	601-750	2450	1900	2550	2250
	751-1000	2050	1550	2350	2000
600	0-500	3250	2650	2850	2650
	501-600	3000	2400	2750	2500
	601-750	2650	2050	2650	2350
	751-1000	2250	1700	2400	2100
700	0-500	3500	2900	2950	2750
	501-600	3250	2600	2850	2600
	601-750	2900	2300	2750	2450
	751-1000	2450	1900	2550	2250
800	0-500	3700	3100	3000	2800
	501-600	3450	2800	2900	2700
	601-750	3100	2500	2800	2500
	751-1000	2650	2050	2650	2350
900	0-500	3900	3300	3050	2850
	501-600	3650	3000	3000	2850
	601-750	3300	2650	2850	2650
	751-1000	2850	2250	2700	2450
1000	0-500	4050	3450	3100	2900
	501-600	3800	3150	3000	2850
	601-750	3450	2800	2900	2700
	751-1000	3000	2400	2750	2500

[1] The line-to-line instantaneous circuit breaker settings shall be used for trailing cables supplying power to diode grounded equipment and for trailing cables containing a separate equipment safety grounding conductor if the circuit is provided with separate ground-fault protection.

[2] The line-to-ground instantaneous circuit breaker settings shall be used for trailing cables containing a separate equipment safety grounding conductor when the circuit is not provided with separate ground-fault protection.

§ 56.12702 Attachment.

Trailing cables shall be attached to equipment so that functional damage to the cable jacket and damage to the insulation of the internal conductors is prevented, and strain does not occur on electric connections.

§ 56.12703 Portable distribution boxes.

Portable distribution boxes shall have—

(a) A disconnecting device for each branch circuit and a means to clearly show that each circuit has been physically disconnected;

(b) A means which identifies each disconnecting device and cable with its related load; and

(c) A means to prevent connecting a cable to the wrong protective device when two or more cables connect to the same distribution box.

§ 56.12704 Guarding.

Trailing cables and power conductors shall be protected against physical damage from mobile equipment by bridges, trenches, suspension, or by location.

§ 56.12705 Disconnecting devices.

Disconnecting devices for trailing cables shall be equipped with a means for installing a padlock.

Trolley Circuits for Track Haulage

§ 56.12800 Installation and Maintenance.

Trolley wires and exposed trolley-feeder wires shall be—

(a) Installed opposite the clearance side of haulageways, except where such installation creates a greater hazard;

(b) Suspended at least 7 feet above the track; and

(c) Aligned and maintained to provide for smooth tracking of trolley collectors on trolley wires.

§ 56.12801 Circuit protection and isolation.

(a) Trolley wires and trolley-feeder wires shall be protected against overcurrent by an automatic circuit interrupting device which deenergizes the affected circuit if a short circuit occurs at any point in the system.

(b) The trip setting of the device required by paragraph (a) of this section shall not exceed 50 percent of the minimum available bolted short-circuit current when that current is less than 800 amperes; or 75 percent of the minimum available bolted short-circuit current when that current is 800 amperes or more.

(c) Trolley wires and trolley-feeder wires shall be provided with a means of isolation at intervals of not more than 2,000 feet and near the beginning of all branch lines.

§ 56.12802 Track bonding.

(a) Track serving as the trolley circuit return shall be bonded or welded at every joint and crossbonded at intervals not exceeding 200 feet.

(b) Metallic pipelines and structures installed less than 10 feet from track serving as the trolley circuit return shall be insulated or guarded, or bonded to the track at intervals not exceeding 1000 feet to prevent shock hazards.

(c) When rails are moved or replaced, or when broken bonds are discovered, they shall be rebonded within three working shifts.

§ 56.12803 Guarding.

(a) Energized trolley wires and bare trolley-feeder wires shall be guarded where accidental contact with them is possible, including:

(1) Where supplies are stored, loaded, or unloaded.

(2) At mantrip stations.

(3) On each side of all doors and stoppings through which wires pass.

(4) Where a person works within three feet of the trolley wire except for a person operating rail-mounted haulage equipment.

(5) At track switches.

(6) Where persons regularly pass under the wires.

(b) Trolley wires and trolley feeder wires shall be deenergized when guarding is installed or removed, unless the guarding is temporary guarding designed to minimize shock hazards while work is being conducted in the area.

§ 56.12804 Circuits powered from trolley wires.

The return wire of all circuits powered from the trolley wires shall be connected to the trolley wire return circuit to assure continuity and prevent arcing.

Appendix I for Subpart K-Electricity

Mine operators seeking further information may consult the following national consensus standards:

MSHA Standard	National Consensus Standard
56/57.12101 56/57.12103 56/57.12130 56/57.12204 56/57.12301 56/57.12400	NFPA 70 (NEC)
56/57.12500 [1] to 56/57.12506	NFPA 70 (NEC), IEEE Stds. 80-1976, 81-1983, 277-1983 142-1982, UL-943 and ANSI C-2 (NESC).
56/57.12600	IEEE Std. 242
56/57.12601	NEC, ICEA P-50-431, S-19-81 and P-48-426
56/57.12602	IEEE Std. 141-1976 and NEC
56/57.12604	IEEE Std. 142-1982
56/57.12630	NESC
57.12660	NEC
56/57.12700	NEC

[1] A method that may be used for protection of persons from disabling or fatal electric shock, under ground-fault conditions, is to limit voltage exposure. The term voltage exposure refers to a combination of voltage and the length of time that the voltage exists.

Voltage exposure should not exceed

$V^2t = 30375$

where v = voltage in volts

t = time in seconds

This equation is based on IEEE Std. 80-1976 using 1500 ohms as a person's body resistance. This would allow a combination of system grounding, ground-fault protection and overcurrent protection to be used to provide protection from disabling or fatal shocks.

PART 57—SAFETY AND HEALTH STANDARDS-UNDERGROUND METAL AND NONMETAL MINES

6. The authority citation for part 57 continues to read as follows:

Authority: 30 U.S.C. 811.

Subpart A—General

§ 56.2 [Amended]

7. In § 57.2, the definitions of "distribution box," "electrical grounding," "high potential," "insulation," "low potential," "major electrical installation," and "reverse-current protection" are removed.

Subpart C—Fire Prevention and Control

8. The authority citation for subpart C continues to read as follows:

Authority: Sec. 101, Federal Mine Safety and Health Act of 1977, Pub. L. 91-173 as amended by Pub. L. 95-164, 91 Stat. 1291 (300.S.C.811).

9. Sections 57.4011 and 57.4057 are §§ 57.4011 and 57.4057 [Removed] removed.

10. Subpart K is revised to read as follows:

Subpart K—Electricity

Sec.

57.12000 Definitions.

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57.12100 Qualified electricians.
57.12101 Electric equipment and conductors
57.12102 Bare conductors.
57.12103 Overcurrent protection.
57.12104 Unused conductors.
57.12105 Doors and cover plates.
57.12106 Danger signs.
57.12130 Clearance of equipment.

WORK ON ELECTRIC EQUIPMENT AND CIRCUITS

57.12200 Lockout procedures.
57.12201 Plugs and receptacles.
57.12202 Fuses.
57.12203 Cable handling.
57.12204 Access.

GUARDING; INSULATION; SEPARATION

57.12300 Connections and grids.
57.12301 Communication conductors.
57.12302 Lights, guarding.
57.12330 Transformers.
57.12331 Substations.

CONNECTIONS; SWITCHES; CONTROLS

57.12400 Identification.
57.12401 Insulating mats.
57.12402 Undervoltage protection.
57.12460 Branch Circuit Disconnecting Devices

SAFETY GROUNDING

57.12500 Grounding.
57.12501 Alternating-current equipment.
57.12502 Direct-current equipment.
57.12503 Equipment safety grounding conductors.
57.12504 Silicon diode grounding.
57.12505 Low-resistance ground fields.
57.12506 Testing.

POWER CABLES AND CONDUCTORS

57.12600 Installation.
57.12601 Ampacity.
57.12602 Insulation, termination and shielding.
57.12603 Splices, repairs and terminations of conductors and cables.
57.12604 Lightning protection.
57.12630 Support structures and guy wires.
57.12660 Support in shafts and boreholes.

TRAILING CABLES

57.12700 Insulation; flame resistance; shielding.

Sec.
57.12701 Overcurrent protection.
57.12702 Attachment.
57.12703 Portable distribution boxes.
57.12704 Guarding.
57.12705 Disconnecting devices.

TROLLEY CIRCUITS FOR TRACK HAULAGE

57.12800 Installation and maintenance.
57.12801 Circuit protection and isolation.
57.12802 Track bonding.

Appendix I to Subpart K—Electricity
Subpart K—Electricity

57.12803 Guarding.
57.12804 Circuits powered from trolley wires.

§ 57.12000 Definitions.

The following definitions apply in this subpart.

"Ampacity" means the current-carrying capacity of electric conductors expressed in amperes.

"Branch circuit" means the circuit conductors extending beyond the final short-circuit device protecting the circuit.

"Cable" means an assembly of one or more insulated conductors enclosed by an additional abrasion resistant covering or jacket. A cable may also contain one or more uninsulated equipment safety grounding conductors. A power cable is any cable except communication, instrumentation and control cables.

"Circuit breaker" means a device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined overcurrent value without damage to the device when operated within its rating.

"Circuit breaker setting" means the value of current or time at which an adjustable circuit breaker is set to trip.

"Conductor" means a bare or insulated wire or combination of wires not insulated from one another, suitable for carrying an electric current.

"Equipment safety grounding conductor" means a conductor used to connect the non-current-carrying metallic parts of electric equipment, raceways and other metallic enclosures to the safety grounding system.

"Feeder-circuit" means the conductors between the power source and the final branch-circuit short-circuit protective device.

"Fuse" means an overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it.

"Ground-fault" means an unintentional connection between an electric circuit and the safety grounding system.

"Ground-wire monitor" means a device having the primary function of monitoring the equipment safety grounding conductor of a circuit and causing the affected circuit breaker to trip when a change in the impedance of the grounding circuit presents a potential electrical shock hazard.

"Instantaneous-trip circuit breaker" means a circuit breaker with no intentional time delay designed in its tripping action.

"Insulated" means separated from other conducting surfaces by insulation which is a dielectric substance that offers a high resistance to the passage of current and to a disruptive discharge through the substance.

"Inverse-time circuit breaker" means a circuit breaker with an intentional time delay in its tripping action, which delay decreases as the magnitude of the current increases.

"Jacket" means a continuous nonmetallic protective outer covering provided on cables. The primary function of the covering is to provide protection of the internal components against physical, chemical, and thermal damage, and to exclude moisture.

"Mobile electric equipment" means electric equipment capable of movement from one location to another by power supplied from a source located on the machine or transmitted to the machine by means of a trailing cable.

"Nominal voltage" means the phase-to-phase or line-to-line root-mean-square value assigned to a circuit or system for designation of its voltage class, such as 480 or 4160 volts. Actual voltage at which the circuit or system operates may vary from the nominal voltage within a range that permits satisfactory operation of equipment.

"Overcurrent" means any current in excess of the rated current of equipment or the ampacity of a conductor, which may result from overload, short-circuit, or ground-fault conditions.

"Overload" means operation of equipment in excess of normal full-load rating, or loading of a conductor in excess of rated ampacity, which would cause damage or dangerous overheating if allowed to continue.

"Portable electric equipment" means electric equipment which is designed and constructed to facilitate frequent movement from one location to another and which does not normally remain at a fixed location for extended periods of time.

"Qualified electrician" means an individual who has met the requirements of 30 CFR 57.12100.

"Rated" means marked to certify that according to established test procedures, electric equipment will perform its functions without presenting a burn, fire or shock hazard when applied within the maximum limits of its marked electrical parameters.

"Safety grounding system" means a complete installation consisting of one or more ground electrodes, grids, equipment safety grounding conductors and interconnected grounding connections. The purpose is to provide a low impedance fault current path to the system's protective device for all non-current-carrying metallic parts enclosing electric conductors or circuits.

"Short circuit" means an abnormal connection of relatively low impedance, whether made accidentally or intentionally, between two points of different potential.

"Splice" means the mechanical and electrical connection of one or more severed conductors in a single length of conductor or cable.

"Stationary electric equipment" means electric equipment other than mobile or portable that is fastened, secured or installed such that it cannot be readily moved from one location to another during normal use.

"Surge arrester" means a protective device which is used to provide protection against lightning surges.

"Trailing cable" means a portable cable or flexible cord through which electrical energy is transmitted to any mobile electric equipment, or a portable cable or flexible cord which receives electrical energy from a section power center, section distribution box or section rectifier.

"Undervoltage protection" means the effect of a device which operates on failure of voltage to cause and maintain the interruption of power to a circuit so as to prevent automatic restarting of the equipment.

General

§ 57.12100 Qualified electricians.

(a) Work required by this subpart to be performed by a qualified electrician shall be performed by an individual who has met the requirements of an operator's qualification program.

(b) Operator's programs shall include conducting their own qualification training or testing, or participation in training or testing conducted by MSHA, other Federal agencies, a state, associations of mine operators, other mine operators, national labor organizations, private associations, or educational institutions.

§ 57.12101 Electric equipment and conductors.

(a) Electric equipment and conductors shall be installed, and maintained by a

qualified electrician, and used in a manner which prevents shock and burn hazards to persons. Electric equipment and conductors which present a hazard to persons due to improper installation, maintenance, misuse or damage shall be tagged as a hazard until corrected.

(b) All electric equipment and conductors installed after [Insert the effective date of this rule] shall be selected and located in surroundings compatible with their design and intended use.

§ 57.12102 Bare conductors.

The voltage of bare conductors, other than trolley conductors, accessible to inadvertent contact by persons shall not exceed 40 volts.

§ 57.12103 Overcurrent protection.

(a) Electric equipment and conductors, other than trailing cables, shall be protected against overloads and short circuits with fuses or automatic circuit interrupting devices. Such fuses and devices shall be of a type and capacity to safely interrupt the circuit under all overload and short circuit fault conditions.

(b) Motors shall be protected against overload at no more than 125 percent of the full-load current of the motors.

(c) Short-circuit protection of motors shall be provided as specified in Tables 57.12103–1 and 57.12103–2.

(d) Where the protection specified in Tables 57.12103–1 and 57.12103–2 is not sufficient for the starting current of the motor—

(1) A higher rated non-time-delay fuse shall be permitted, but shall in no case exceed 400 percent of the full-load current of the motor or 600 amperes;

(2) A higher rated standard (dual element) fuse shall be permitted, but shall in no case exceed 225 percent of the full-load current of the motor;

(3) A higher rated inverse time circuit breaker shall be permitted, but shall in no case exceed 400 percent of the full-load current of the motor;

(4) A higher rated fuse in the 601–6000 ampere classification shall be permitted, but shall in no case exceed 300 percent of the full-load current of the motor; or

(5) A higher rating or adjustment of an instantaneous trip circuit breaker shall be permitted, but shall in no case exceed 1300 percent of the full-load current of the motor.

(e) All three-phase motors shall be protected with overcurrent devices so that an overcurrent in any phase will deenergize all ungrounded phases.

(f) Transformers shall be protected on the primary side with overcurrent protection rated at no more than 250 percent of their rated full-load current.

(g) When the required rating of a fuse or circuit breaker without an adjustable trip unit does not correspond to a standard rating for a fuse or circuit breaker, the protective device used shall not exceed the next higher standard device rating.

(h) Circuit breakers or fuses providing short-circuit protection shall be installed where the circuit conductors are connected to the supply, except for feeder tap conductors that—

(1) Do not exceed 25 feet in length;

(2) Have ampacities of at least one-third of the ampacity of the feeder conductors; and

(3) Terminate at a circuit breaker or fuse with a current rating that does not exceed the ampacity of the feeder tap conductors.

(i) Wiring shall be protected against overcurrent at no more than the ampacity specified in 30 CFR 57.12601.

(j) Overcurrent protection shall not be required on incandescent lamps supplied from direct-current systems, provided the length of ungrounded conductors does not exceed eight feet.

(k) Where interruption of a circuit presents a hazard to persons, the overload protection requirement of this section does not apply if measures are taken to warn persons when an overload occurs.

(l) Fuses, circuit breakers, or a combination of both shall not be connected in parallel.

TABLE 57.12103–1.—MAXIMUM RATING OR SETTING OF MOTOR BRANCH-CIRCUIT SHORT-CIRCUIT PROTECTIVE DEVICES FOR THREE-PHASE MOTORS

Type of motor	Percent of full-load current			
	Non-time delay fuse	Dual element (time delay) fuse	Instantaneous trip breaker	Inverse time breaker
Squirrel-cage and synchronous motors with full-voltage, resistor or reactor starting:				
No code letter	300	175	700	250
Code letter F to V	300	175	700	250
Code letter B to E	250	175	700	200
Code letter A	150	150	700	150
All AC squirrel-cage and synchronous motors with autotransformer starting:				
Not more than 30 Amps—No code letter	250	175	700	200
More than 30 Amps—No code letter	200	175	700	200
Code letter F to V	250	175	700	200
Code letter B to E	200	175	700	200
Code letter A	150	150	700	150
High-reactance squirrel cage:				
Not more than 30 amps—No code letter	250	175	700	250
More than 30 amps—No code letter	200	175	700	200
Wound-Rotor—No code letter	150	150	700	150

TABLE 57.12103–2.—MAXIMUM RATING OR SETTING OF MOTOR BRANCH-CIRCUIT SHORT-CIRCUIT PROTECTIVE DEVICES FOR SINGLE-PHASE MOTORS AND DIRECT-CURRENT MOTORS

Type of motor	Percent of full-load current			
	Non-time delay fuse	Dual element (time delay) fuse	Instantaneous trip breaker	Inverse time breaker
Single-Phase, All Types—No Code Letter	300	175	700	250
All AC Single-Phase with Full-Voltage, Resistor or Reactor Starting:				
No Code Letter	300	175	700	250
Code Letter F to V	300	175	700	250
Code Letter B to E	250	175	700	200
Code Letter A	150	150	700	150
Direct-Current (Constant Voltage):				
No More than 50—HP No Code Letter	150	150	250	150
More than 50 HP—No Code Letter	150	150	250	150

§ 57.12104 Unused conductors.

Conductors that are not supplying power to electric equipment shall be deenergized and shall—

(a) Be removed from their supply source; or

(b) Have their supply source locked out and any exposed ends insulated.

§ 57.12105 Doors and cover plates.

Doors and cover plates on electric equipment, which allow access to electric connections, shall be closed at all times except during installation, testing and repair.

§ 57.12106 Danger signs.

Visible danger signs shall be posted at all substations, switchyards and control centers to warn persons against entry who have not been specifically assigned to perform duties in those locations.

§ 57.12130 Clearance of equipment.

(a) Bare overhead conductors of more than 650 volts, line-to-line which are installed parallel along a roadway and under which haulage trucks have access shall be suspended at a height at least 10 feet higher than the raised bed of any haulage truck used at the mine.

(b) When equipment is moved or operated near energized bare overhead conductors of less than 69,000 volts, other than trolley conductors, and the clearance is less than 10 feet, the conductors shall be deenergized or other precautionary measures shall be taken to prevent the equipment frames from being energized.

(c) When equipment is moved or operated near energized bare overhead conductors of 69,000 volts or more, the conductors shall be either deenergized or the minimum distance of the conductors from the equipment shall be as in Table 57.12130.

(d) Supplies or materials shall not be stored or stockpiled under bare overhead conductors of more than 650 volts, line-to-line.

TABLE 57.12130 [1] MINIMUM DISTANCE FROM ENERGIZED CONDUCTORS

Conductor voltage	Distance
69–114 kV	12
115–229 kV	15
230–344 kV	20
345–499 kV	25
500 kV or more	35 ft.

[1] Derived from National Electrical Safety Code Table 124–1.

Work on Electric Equipment and Circuits

§ 57.12200

Lockout procedures.

(a) Before electrical or mechanical work is performed on electric circuits or equipment, electric power to the circuits or equipment shall be deenergized except when electric power is a necessary part of the work procedure needed for accomplishing the mechanical work.

(b) Individual padlocks and identifying tags for each person performing work shall be installed to prevent the power circuit from being energized and the equipment set in motion without the knowledge of persons working on the circuits and equipment. Padlocks and tags shall only be removed by the persons who installed them.

(c) When testing circuits to locate an electrical problem, or adjusting electric circuits, the circuits do not have to be deenergized if

(1) The circuit voltage is 1040 volts or less;

(2) Testing or adjusting is performed by a qualified electrician in accordance with 30 CFR 57.12100.

(3) The person uses procedures, tools and equipment to assure personal safety when in close proximity to energized parts; and

(4) It would be impractical to deenergize.

§ 57.12201 Plugs and receptacles.

Power cable plugs and receptacles for circuits greater than 150 volts, line-to-ground, shall not be connected or disconnected under load unless they are of the load-break type.

§ 57.12202 Fuses.

Fuses shall be installed or removed using tools or procedures that prevent electric shock or burns.

§ 57.12203 Cable handling.

(a) Power cables energized to a voltage in excess of 150 volts, line-to-ground, shall not be moved by other equipment unless sleds, or slings insulated from that equipment are used. This does not prohibit pulling or dragging of a trailing cable by the equipment it powers.

(b) When power cables energized to a voltage in excess of I50 volts, line-to-ground, are moved manually, insulated hooks, tongs, slings, gloves, mitts, aprons or other insulated personal protective equipment capable of protecting against shock, shall be used.

(c) Insulated handling equipment shall be

(1) Examined before each use for visible signs of damage or defects; and

(2) Removed from use when damaged or defective.

(d) Surplus trailing cables serving shovels, cranes and similar equipment shall be stored—

(1) In cable boats;

(2) On reels mounted on the equipment; or

(3) In a manner which would protect them from mechanical damage.

§ 57.12204 Access.

(a) For installations and equipment constructed after [Insert the effective date of this rule], working space shall be

provided in accordance with Table 57.12204 where access to exposed energized electric equipment is necessary.

(b) For existing installations and equipment, working space in accordance with Table 57.12204 shall be provided where access to exposed energized electric equipment is necessary, unless other precautionary measures are used to protect persons from electric shock or burns.

TABLE 57.12204 [1]—MINIMUM WORKING SPACE

	Minimum clear distance for condition (ft)		
Nominal voltage to ground	(A)	(B)	(C)
0–150 V	3	3	3
151–600 V	3	3½	4
601–2,500 V	3	4	5
2,501–9,000 V	4	5	6
9,001–25,000 V	5	6	9
25,001–75 kV	6	8	10
Above 75 kV	8	10	12

[1] NFPA, 70 E. Tables 110–16A and 110–34A.

As used in Table 57.12204, conditions (A), (B), (C) are as follows:

(A) Exposed energized parts on one side and no energized or grounded parts on the other side of the working space, or exposed energized parts on both sides guarded by wood or other insulating materials. Insulated conductors operating at not over 300 volts are not considered energized parts.

(B) Exposed energized parts on one side and grounded parts on the other side. Concrete, brick or rock walls will be considered to be grounded surfaces.

(C) Exposed energized parts on both sides of the work space.

Guarding; Insulation; Separation

§ 57.12300 Connections and grids.

Exposed electric connections and resistor grids that are not protected by location shall be insulated. Where this is impractical they shall be guarded to prevent inadvertent contact by persons or equipment.

§ 57.12301 Communication conductors.

(a) Communication conductors shall be isolated or insulated to prevent them from contacting bare energized parts.

(b) Communication conductors carried on poles supporting uninsulated power conductors shall be located below the power conductors.

(c) Communication conductors shall not be attached to a crossarm that carries uninsulated power conductors.

§ 57.12302 Lights, guarding.

(a) Portable extension lights and lights less than 8 feet above travelways and working places shall be guarded to prevent a hazard to persons.

(b) Other lights shall be guarded when they present a hazard.

(c) Lamps shall not contact combustible materials.

§ 57.12330 Transformers.

(a) Transformers shall be—

(1) Totally enclosed;

(2) Installed so exposed energized parts are at least 8 feet above the ground; or

(3) Installed in a transformer house.

(4) Surrounded by a sturdy fence at least 6 feet high and at least 3 feet from any parts, casings or energized conductors.

(b) Gates or doors of transformer enclosures shall be locked to prevent unauthorized access to exposed energized parts which are less than 8 feet above the ground.

(c) Metallic transformer houses and fences shall be connected to the metallic case of the safety grounded transformer.

§ 57.12331 Substations.

Substations containing exposed energized parts that can be inadvertently contacted by persons shall be enclosed. When the enclosure is a metallic structure or fence it shall be connected to the substation's safety grounding system.

Connections; Switches; Controls

§ 57.12400 Identification.

Circuit breakers, trolley taps, fuse switchboxes and other disconnecting devices shall be legibly, durably, and distinctively marked to show which electric equipment they supply, except where the circuit breakers and devices can be identified by their proximity to the equipment.

§ 57.12401 Insulating mats.

Insulating mats shall be provided at all switchboards and power control switches where shock hazards exist due to exposed energized parts.

§ 57.12402 Undervoltage protection.

(a) Electric powered machinery shall include undervoltage protection to prevent shocks, burns, unwanted motion or unintentional starting. When voltage is lost, the equipment shall remain deenergized until manually restarted.

(b) Pumps, level control circuits and other equipment that by its design can automatically start and stop safely are not required to have undervoltage protection.

§ 57.12460 Branch circuit disconnecting devices.

Disconnecting devices shall be provided underground at all branch circuits extending from primary power circuits and shall be—

(a) Designed to be opened under load without hazard to persons;

(b) As close as practical to shafts, adits, levels and boreholes; and

(c) Provided with means to visually show that the branch circuit is disconnected when the device is open.

Safety Grounding

§ 57.12500 Grounding.

(a) All electric circuits shall have a safety grounding system. The system's performance shall limit the voltage on non-current-carrying metallic parts of electric equipment that a person can contact to a value that shall not cause a disabling or fatal shock under the following fault conditions—

(1) Single line-to-ground on grounded power systems; or

(2) Double line-to-ground on ungrounded power systems, with one of the faults at the source.

(b) The voltage on non-current-carrying metallic parts of electric equipment shall be controlled by—

(1) Limiting the magnitude of the voltage;

(2) Limiting the duration of the voltage; or

(3) A combination of these two.

See Appendix I to Subpart K.

§ 57.12501 Alternating-current equipment.

(a) The following equipment shall be connected to the safety grounding system by equipment safety grounding conductors:

(1) Metallic frames, enclosures, and other exposed non-current-carrying metallic parts of electric equipment.

(2) Metallic fences and barriers around high-voltage equipment and installations.

(3) Metallic enclosures of alternating-current conductors.

(4) Metallic battery trays.

(5) Metallic messenger wires.

(6) Metallic structures or racks that support electric equipment or conductors.

(b) Metallic cable shielding shall be connected to the safety grounding system at each termination by equipment safety grounding conductors.

(c) Before batteries on battery-powered equipment are connected to a battery charger, the metallic battery trays shall be connected to the grounded metallic frame of the battery charger, and shall remain connected until the

batteries have been disconnected from the charger.

(d) Metallic cable hangers or supporting structures shall either be connected to the safety grounding system or insulated from the cable.

(e) Exposed metallic enclosures or portions of hand-held electric equipment shall be connected to the safety grounding system, except when the equipment is—

(1) Double insulated as determined by an independent testing laboratory and does not present a shock hazard; or

(2) Operated at a maximum of 40 volts.

(f) Generator powered equipment mounted on the same metallic frame as the generator is not required to be connected to the mine's safety grounding system.

§ 57.12502 Direct-current equipment.

(a) The following shall be connected to the mine safety grounding system by equipment safety grounding conductors—

(1) Metallic frames, enclosures, and other exposed non-current-carrying metallic parts of conductors and equipment.

(2) Metallic messenger wires used to support direct-current conductors.

(3) Metallic racks and structures used to support trolley wires and trolley feeder wires.

(4) Metallic overcasts in trolley entries.

(b) Silicon diode grounding systems shall be installed in accordance with 30 CFR 57.12504.

(c) Component parts of complete units of equipment shall be solidly connected to the frames of the equipment.

(d) Exposed metallic enclosures or portions of hand-held electric equipment shall be connected to the safety grounding system, except when the equipment is—

(1) Double insulated as determined by an independent testing laboratory and does not present a shock hazard;

(2) Operated at a maximum of 40 volts; or

(3) Powered by internal batteries which are an integral part of the equipment.

(e) Generator powered equipment mounted on the same metallic frame as the generator is not required to be connected to the mine's safety grounding system.

§ 57.12503 Equipment safety grounding conductors.

(a) Equipment safety grounding conductors for portable and mobile electric equipment shall be one or more stranded copper conductors contained within the cable or flexible cord supplying the equipment.

(b) Equipment safety grounding conductors for stationary equipment shall be—

(1) Contained together with the circuit conductors in the raceways, cables, or cords;

(2) Wrapped around the raceways, cables, or cords containing the circuit conductors; or

(3) A continuous metal conduit or metallic raceway that complies with the voltage exposure requirements of 30 CFR 57.12500.

(c) The combined cross-sectional area of equipment safety grounding conductors shall be equal to or greater than—

(1) One-half the cross-sectional area of one circuit conductor when the circuit conductor is No. 6 AWG or larger; or

(2) The cross-sectional area of one circuit conductor when the circuit conductor is smaller than No. 6 AWG.

(d) Equipment safety grounding conductors installed outside of raceways, cables, or cords and used to ground stationary equipment shall be No. 6 AWG or larger.

(e) Switches, fuses, circuit breakers, ground-fault devices and overcurrent devices shall not be installed in equipment safety grounding conductors.

(f) Ground-wire devices installed in the equipment safety grounding conductor for the purpose of inter-machine arc suppression or in conjunction with ground-wire monitoring systems shall be designed and constructed to withstand the maximum amount of phase-to-phase fault current to which they may be exposed without creating an electrical shock or fire hazard.

(g) When used, ground-wire devices specified in paragraph (f) of this section shall be connected to the safety grounding system with two separate conductors.

(h) On direct-current powered equipment, the equipment safety grounding conductor and the return power conductor shall be separately connected to the mine track, grounded return-feeder conductor, or metallic frame or enclosure used as the safety grounding system.

(i) Equipment safety grounding conductors for draw-out equipment or plugs and receptacles shall be the first conductors made when making connections and the last conductors broken when breaking connections.

(j) When power is supplied between separate metallic parts of equipment, the parts shall be connected together through an equipment safety grounding conductor.

(k) The frame of a portable or mobile generator supplying remote loads shall have equipment safety grounding conductors connecting the frames of each remote load to the frame of the generator.

(l) Equipment safety grounding conductors shall be bare or shall be properly identified.

§ 57.12504 Silicon diode grounding.

When the metallic frames of off-track equipment are grounded by silicon diodes, the diode grounding system shall meet the following conditions:

(a) The polarity of each grounding diode shall be compatible with the grounded polarity of the direct-current systems.

(b) Each grounding diode shall have a threaded base used to solidly connect the diode to the machine frame.

(c) An overcurrent device shall be installed between the grounding diode(s) and the grounded power conductor, and shall cause the main conductor or the circuit interrupting device to deenergize all circuits on the machine when 50 amperes or more flows through the grounding diode, except that methane monitor circuits may remain energized.

(d) A polarizing diode that prevents the unit of equipment from being operated when the polarity of the supply conductors is reversed shall be installed in the control circuit.

(e) The forward current rating of each grounding diode shall be equal to or greater than 750 amperes when used to ground a continuous mining machine or equal to or greater than 400 amperes when used to ground other equipment.

(f) The peak reverse voltage rating of the grounding and polarizing diodes shall be at least 1,200 volts.

§ 57.12505 Low-resistance ground fields.

(a) Low-resistance ground fields used in the safety grounding system shall be designed and installed in a manner which assures that the maximum exposure voltage under fault conditions does not create hazardous step and touch potentials. The following parameters shall be considered in evaluating ground field safety—

(1) Soil resistivity;

(2) Available fault current;

(3) Ground field construction; and

(4) Operating times of protective devices.

(b) Low-resistance ground fields used in the safety grounding system shall be maintained at 25 ohms or less unless an evaluation of the system in accordance with paragraph (a) indicates that—

(1) a lower value of resistance is necessary; or

(2) a higher value of resistance can be used.

(c) Materials used for ground fields shall have at least four square feet of surface area in contact with soil.

§ 57.12506 Testing.

(a) On all installations after [Insert the effective date of this rule], and when repairs or modifications are made to the safety grounding system, continuity tests shall be made to assure the integrity of the system.

(b) The safety grounding system shall be reviewed at intervals not to exceed twelve months to assure that the maximum voltage exposure under fault conditions complies with requirements of this subpart.

(c) For mine power systems utilizing an alternating-current voltage of less than 650 volts, line-to-line, the resistance to earth of the safety grounding system's connection to earth shall be maintained at 25 ohms or less and be physically separated from the substation grounding system. This separation shall be either 25 feet or 5 times the largest dimension of the safety grounding system's connection to earth, whichever is larger. When 25 ohms or less cannot be obtained, the operator shall assure that the system complies with 30 CFR 57.12505.

(d) When reviewing a mine power system utilizing an alternating-current voltage greater than 650 volts, line-to-line, the review shall include determinations of the—

(1) Safety grounding system's resistance to earth at its connection to earth;

(2) Maximum fault current that can flow into the safety grounding system at electric loads or sources of 500 kVA or larger; and

(3) Impedance of the safety grounding system at electric loads or sources of 500 kVA or larger.

(e) A weekly check of continuity shall be made of all mobile equipment safety grounding conductors, except when they are continuously monitored with an MSHA tested ground-wire monitoring device.

Power Cables and Conductors

§ 57.12600 Installation.

(a) Cables and insulated conductors shall be installed so that they are protected against physical damage, adverse ambient conditions and failure of adjacent mechanical systems.

(b) Cables and insulated conductors shall not be supported from pipelines.

(c) Insulated conductors shall not contact pipelines.

(d) When cables and pipelines are supported from the same supports, clearance to prevent shock hazards during maintenance to pipelines shall be provided.

§ 57.12601 Ampacity.

(a) Electric conductors shall be of a size and current-carrying capacity to assure that a rise in temperature resulting from normal operating conditions does not exceed the rating of the insulation and conductors.

(b) Branch circuit conductors supplying electric equipment shall have ampacities of at least 125 percent of the full-load current rating of the equipment.

(c) Feeder circuit conductors supplying multiple loads shall have ampacities of at least the sum of the full-load current ratings of each load plus 25 percent of the highest full load current rating of the largest load.

(d) The size of conductors for electric equipment shall be at least that specified in ampacity Tables 57.12601–1 through 57.12601–10 below, or other tables that are appropriate for the conditions under which the conductors are used.

(e) Ampacity of conductors shall be corrected according to Table 57.12601–11, if the ambient temperature is other than the temperature at which the conductor was rated.

(f) When four or more conductors are contained in the same raceway, conduit or cable, the maximum allowable load current shall be reduced according to Table 57.12601–12.

TABLE 57.12601–1.—ALLOWABLE AMPACITIES OF 300- AND 600-VOLT FLEXIBLE CORDS; COPPER CONDUCTORS

Conductor Size AWG	Types S, SO, SJO, ST, STO, SJT, SJTO, SOO, SJOO, STOO, SJTOO		Types AFS, AFSJ, HSJ, HSJO, HS, HSO
	Current-Carrying Conductors		Current-Carrying Conductors
	2	3	3
14	18	15	20
12	25	20	30
10	30	25	35
8		35	

TABLE 57,12601–2—ALLOWABLE AMPACITIES OF SHIELDED AND UNSHIELDED 0- TO 2000-VOLT PORTABLE POWER CABLES; COPPER CONDUCTORS (BASED ON AMBIENT AIR TEMPERATURE OF 20 °C (68 °F))

Ampacities	Conductor Size AWG or MCM						
	Number of Current-Carrying Conductors in Cable or Raceway						
	1		2		3		
	75 °C [1]	90 °C [1]	75 °C [1]	90 °C [1]	75 °C [1]	90 °C [1]	90 °C [2]
8	75	98	63	85	63	70	
6	106	12	81	112	81	93	110
4	138	171	113	150	106	123	144
3	163	197	131	171	125	142	165
2	188	227	150	197	144	163	188
1	213	263	175	225	163	190	217
1/0	250	304	213	256	181	219	249
2/0	294	352	244	295	213	254	287
3/0	344	407	281	337	244	294	329
4/0	394	472	325	387	275	339	379
250	438	525	356	428	306	378	419
300	494	590	388	472	344	421	470
350	556	651	419	514	381	465	513
400	600	708	450	555	406	507	555
500	681	820	519	618	469	575	632

[1] 0–2000 Volt Insulation, Unshielded Portable Power Cable.
[2] 0–2000 Volt Insulation, Shielded Portable Power Cable.

TABLE 57.12601-3—ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS RATED 0 TO 2000 VOLTS, 60 °C TO 90 °C, NOT MORE THAN THREE CURRENT-CARRYING CONDUCTORS IN RACEWAY OR CABLE (BASED ON AMBIENT AIR TEMPERATURE OF 20 °C (68 °F))

Copper					Aluminum or copper- clad aluminum				
Conductor size AWG or MCM	Insulation temperature rating				Insulation temperature rating		Conductor size AWG or MCM		
	60°	75°	85°	90°	60°	75°	85°	90°	
18				15					
16			20	19					
14	20	20	27	25					
12	25	25	33	30	20	20	27	25	12
10	35	35	43	40	29	30	33	35	10
8	46	55	60	59	35	44	43	49	8
6	64	72	76	81	46	55	60	65	6
4	81	94	103	103	64	72	82	81	4
3	98	111	120	119	75	83	92	92	3
2	110	127	136	140	87	99	109	108	2
1	127	144	158	162	98	111	120	124	1
0	144	166	179	184	116	133	141	146	0
00	167	193	207	211	133	149	158	162	00
000	191	221	234	243	150	171	185	189	000
0000	225	254	272	281	173	199	212	221	0000
250	248	282	299	313	196	227	239	248	250
300	277	315	337	346	219	254	272	275	300
350	299	343	370	378	243	276	294	302	350
400	323	370	397	410	260	298	321	329	400
500	370	420	451	464	300	343	364	378	500
600	410	464	500	513	329	376	402	416	600
700	445	508	544	562	358	414	440	454	700
750	462	525	560	578	370	425	457	470	750
800	474	541	582	599	381	436	467	486	800
900	502	575	614	632	410	470	506	518	900
1000	526	602	641	664	433	492	527	540	1000
1250	572	652	696	718	468	536	571	589	1250
1500	601	691	739	761	502	575	614	632	1500
1750	629	718	766	794	526	602	647	664	1750
2000	647	735	788	810	543	619	663	680	2000

TABLE 57.12601-4.—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2000 VOLTS

[Based on Ambient Air Temperature of 20 °C (68 °F)]

Copper					Aluminum or copper-clad aluminum				
Conductor size AWG or MCM	Insulation temperature rating				Insulation temperature rating				Conductor size AWG or MCM
	60°	75°	85°	90°	60°	75°	85°	90°	
18				19					
16			25	26					
14	25	30	33	35					
12	30	35	43	40	25	30	33	35	12
10	40	50	60	55	35	40	43	40	10
8	69	77	82	86	52	61	65	65	8
6	92	105	109	113	69	83	87	86	6
4	121	138	147	151	92	111	114	119	4
3	139	160	174	178	110	127	136	140	3
2	162	188	201	205	127	149	158	162	2
1	191	215	234	238	150	171	179	189	1
0	225	254	272	281	173	199	212	221	0
00	260	293	315	324	202	232	245	254	00
000	300	343	364	378	231	265	288	297	000
0000	347	398	424	437	271	309	332	340	0000
250	393	448	478	491	306	348	375	383	250
300	433	492	527	545	335	387	413	427	300
350	485	558	598	616	381	436	467	481	350
400	526	602	647	664	410	470	505	518	400
500	595	685	734	756	468	536	571	589	500
600	664	762	815	842	526	597	647	664	600
700	728	834	897	923	578	657	707	729	700
750	757	867	929	956	595	685	734	756	750
800	785	901	962	994	618	713	761	783	800
900	843	961	1033	1064	670	774	826	848	900
1000	901	1033	1109	1139	722	829	886	913	1000
1250	1028	1177	1261	1296	820	945	1011	1037	1250
1500	1132	1298	1386	1431	918	1050	1125	1161	1500
1750	1236	1414	1516	1561	1010	1160	1245	1280	1750

TABLE 57.12601-4.—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2000 VOLTS—Continued

[Based on Ambient Air Temperature of 20 °C (68 °F)]

Copper					Aluminum or copper-clad aluminum				
Conductor size AWG or MCM	Insulation temperature rating				Insulation temperature rating				Conductor size AWG or MCM
	60°	75°	85°	90°	60°	75°	85°	90°	
2000	1334	1531	1636	1685	1109	1271	1359	1442	2000

TABLE 57.12601-5—Allowable Ampacities of Shielded, Three Conductor, 2,001-15,000 VOLT, MINE POWER CABLE; COPPER CONDUCTORS (BASED ON AMBIENT TEMPERATURE OF 20 °C)

	Conductor size (AWG or MCM)		Ampacities	
	2,001-8,000 volts		8,001-15,000 volts	
	75 °C	90 °C	75 °C	90 °C
6	99	110		
4	130	144		
2	170	188	175	194
1	196	217	200	221
1/0	226	249	230	254
2/0	260	287	263	290
3/0	299	329	301	334
4/0	343	379	346	384
250	379	419	383	424
300	423	470	426	473
350	465	513	468	517
400	500	555	501	558
500	571	632	571	632

TABLE 57.1260l-6.—ALLOWABLE AMPACITIES OF SHIELDED, THREE CONDUCTOR, 2,001-15,000 VOLT MINE POWER CABLES; ALUMINUM CONDUCTORS (BASED ON AMBIENT TEMPERATURE OF 20 °C)

	Conductor size (AWG or MCM)		Ampacities	
	2,001-8,000 volts		8,001-15,000 volts	
	75 °C	90 °C	75 °C	90 °C
4	101	112		
2	133	146	136	
I	153		156	
1/0	176	195	179	198
2/0	203	223	205	227
3/0	234	257	236	261
4/0	269	296	271	300
250	298	328	300	332
350	366	404	367	406
400	396	425	397	433
500	458	502	453	500

TABLE 57.12601-7.—AMPACITY OVERHEAD COPPER CONDUCTORS

Conductor size AWG [1]	CM [2]	Copper, ampacity in amperes
—	6,400	51
10	10,380	68
—	10,820	71
9	13,090	79
8	16,510	92
6	26,240	124
4	41,740	166
3	52,620	193
2	66,360	223
1	83,700	260
1/0	105,600	301
2/0	133,100	350
3/0	167,800	406
4/0	211,680	472

TABLE 57.12601-7.—AMPACITY OVERHEAD COPPER CONDUCTORS—Continued

Conductor size AWG [1]	CM [2]	Copper, ampacity in amperes
	250,000	547
	300,000	615
	350,000	680
	400,000	730
	450,000	787
	500,000	842
	600,000	945
	700,000	1042
	750,000	1087
	800,000	1131
	1,000,000	295

[1] AWG means American Wire Gage.
[2] CM means Circular Mils.

TABLE 57.12601-8.—AMPACITY OVERHEAD ACSR [1] Conductors

Conductor size AWG [2]	CM [3]	ACSR, ampacity in amperes
6		104
4		139
2		184
1		210
1/0		240
2/0		275
3/0		316
4/0		360
	266,800	452
	300,000	492
	336,400	534
	397,500	593
	477,000	665
	556,500	732
	605,000	772

TABLE 57.12601-8.—AMPACITY OVERHEAD ACSR [1] Conductors—Continued

Conductor size AWG [2]	CM [3]	ACSR, ampacity in amperes
	636,000	797
	666,600	805
	715,500	858
	795,000	891
	874,500	935
	900,000	926
	954,000	960

TABLE 57.12601-8.—AMPACITY OVERHEAD ACSR [1] Conductors—Continued

Conductor size AWG [2]	CM [3]	ACSR, ampacity in amperes
	1,033,500	1010
	1,113,000	1060
	1,182,500	1099
	1,192,500	1106
	1,272,000	1148
	1,351,500	1198
	1,431,000	1237

TABLE 57.12601-8.—AMPACITY OVERHEAD ACSR [1] Conductors—Continued

Conductor size AWG [2]	CM [3]	ACSR, ampacity in amperes
	1,510,500	1278
	1,590,000	1313
	1,780,000	1434

[1] Aluminum Cable Steel Reinforced.
[2] AWG means American Wire Gage.
[3] CM means Circular Mils.

TABLE 57.12601-9—ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS RATED 0 TO 2000 VOLTS, 60°C TO 90°C, NOT MORE THAN THREE CURRENT-CARRYING CONDUCTORS IN RACEWAY OR CABLE

[Based on Ambient Air Temperatures of 30 °C (86 °F)]

Conductor size AWG or MCM	Copper				Aluminum or copper-clad aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				14					
16			18	18					
14	20	20	25	25					
12	25	25	30	30	20	20	25	25	12
10	30	35	40	40	25	30	30	35	10
8	40	50	55	55	30	40	40	45	8
6	55	65	70	75	40	50	55	60	6
4	70	85	95	95	55	65	75	75	4
3	85	100	110	110	65	75	85	85	3
2	95	115	125	130	75	90	100	100	2
1	110	130	145	150	85	100	110	115	1
1/0	125	150	165	170	100	120	130	135	1/0
2/0	145	175	190	195	115	135	145	150	2/0
3/0	165	200	215	225	130	155	170	175	3/0
4/0	195	230	250	260	150	180	195	205	4/0
250	215	255	275	290	170	205	220	230	250
300	240	285	310	320	190	230	250	255	300
350	260	310	340	350	210	250	270	280	350
400	280	335	365	380	225	270	295	305	400
500	320	380	415	430	260	310	335	350	500
600	355	420	460	475	285	340	370	385	600
700	385	460	500	520	310	375	405	420	700
750	400	475	515	535	320	385	420	435	750
800	410	490	535	555	330	395	430	450	800
900	435	520	565	585	355	425	465	480	900
1000	455	545	590	615	375	445	485	500	1000
1250	495	590	640	665	405	485	525	545	1250
1500	520	625	680	705	435	520	565	585	1500
1750	545	650	705	735	455	545	595	615	1750
2000	560	665	725	750	470	560	610	630	2000

TABLE 57.12601-10.—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2,000 Volts (Based on Ambient Air Temperature of 30°C (86°F))

Conductor size AWG or MCM	Copper				Aluminum or Copper-Clad Aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
18				18					
16			23	24					
14	25	30	30	35					
12	30	35	40	40	25	30	30	35	12
10	40	50	55	55	35	40	40	40	10
8	60	70	75	80	45	55	60	60	8
6	80	95	100	105	60	75	80	80	6
4	105	125	135	140	80	100	105	110	4
3	120	145	160	165	95	115	125	130	3
2	140	170	185	190	110	135	145	150	2
1	165	195	215	220	130	155	165	175	1
1/0	195	230	250	260	150	180	195	205	1/0
2/0	225	265	290	300	175	210	225	235	2/0
3/0	260	310	335	350	200	240	265	275	3/0

TABLE 57.12601-10.—ALLOWABLE AMPACITIES OF SINGLE CONDUCTORS RATED 0 TO 2,000 Volts (Based on Ambient Air Temperature of 30°C (86°F))—Continued

Conductor size AWG or MCM	Copper				Aluminum or Copper-Clad Aluminum				Conductor size AWG or MCM
	Insulation temperature rating				Insulation temperature rating				
	60°	75°	85°	90°	60°	75°	85°	90°	
4/0	300	360	390	405	235	280	305	315	4/0
250	340	405	440	455	265	315	345	355	250
300	375	445	485	505	290	350	380	395	300
350	420	505	550	570	330	395	430	445	350
400	455	545	595	615	355	425	465	480	400
500	515	620	675	700	405	485	525	545	500
600	575	690	750	780	455	540	595	615	600
700	630	755	825	855	500	595	650	675	700
750	655	785	855	885	515	620	675	700	750
800	680	815	885	920	535	645	700	725	800
900	730	870	950	985	580	700	760	785	900
1000	780	935	1020	1055	625	750	815	845	1000
1250	890	1065	1160	1200	710	855	930	960	1250
1500	980	1175	1275	1325	795	950	1035	1075	1500
1750	1070	1280	1395	1445	875	1050	1145	1185	1750
2000	1155	1385	1505	1560	960	1150	1250	1335	2000

TABLE 57.12601-11.—AMPACITY CORRECTION FACTORS

[For Ambient Temperatures other than 20 °C, Multiply the Ampacities from Tables 57.12601-2 Through 57.12601-6 by the Appropriate Factor Shown Below]

Ambient temperature °C	Correction Factor				Ambient temperature °F
	60°	75°	85°	90°	
21-25	.91	.94	.95	.96	70-77
26-30	.82	.88	.90	.91	79-86
31-35	.71	.82	.85	.87	88-95
36-40	.58	.75	.80	.82	97-104
41-45	.41	.67	.74	.76	106-113

[For Ambient Temperatures other than 30 °C, Multiply the Ampacities from Tables 57.12601-1, 57.12601-11, and 57.12601-12 by the Appropriate Factor Shown Below]

Ambient temperature °C	Correction factor				Ambient temperature °F
	60°	75°	85°	90°	
21-25	1.08	1.05	1.04	1.04	70-77
26-30	1.00	1.00	1.00	1.00	79-86
31-35	.91	.94	.95	.96	88-95
36-40	.82	.88	.90	.91	97-104
41-45	.71	.82	.85	.87	106-113

TABLE 57.12601-12.—AMPACITY DERATING FACTORS

Number of conductors	Percent of ampacity value
4 through 6	80
7 through 24	70
25 through 42	60
43 and above	50

Derived from notes to NEC tables 310-16 through 310-19.

§ 57.12602 Insulation, termination and shielding.

(a) Power cables and conductors, other than trolley wires and uninsulated surface overhead conductors of more than 650 volts, line-to-line, shall have insulation rated for at least the voltage of the circuit in which the cable or conductor is applied.

(b) Power cables and conductors:

(1) Installed on the surface in circuits with line-to-line voltages above 2,000 volts and subject to contact by persons shall have metallic shielding around each power conductor.

(2) Installed underground in circuits with line-to-line voltage above 2,000 volts shall have insulation and metallic shielding around each power conductor.

(c) Metallic enclosed power cables and conductors are not required to be shielded provided the enclosure is continuous and connected to the safety grounding system.

(d) Except as provided in paragraph (f) of this section, cables shall enter metallic frames of electric enclosures through fittings sized for the cables which prevent damage to the cable jackets and the insulation of the internal conductors.

(e) Except as provided in paragraph (f) of this section, conductors shall enter metallic frames of electric enclosures through fittings with insulated bushings sized for the conductors.

(f) Cables and conductors in conduit that enter metallic frames of electric enclosures need not be equipped with fittings or bushings when protection against damage by sharp edges is otherwise provided.

(g) Cables and conductors shall be secured to prevent mechanical strain on electrical connections.

§ 57.12603 Splices, repairs and terminations of conductors and cables.

(a) Cables shall be spliced, terminated, or repaired by a qualified electrician.

(b) A splice in a trailing cable shall contain only one connection point in each conductor.

(c) Terminations of shields in cables shall be connected to equipment safety grounding conductors at each splice and termination.

(d) Except as specified in paragraph (e) of this section, each splice and repair shall have—

(1) Conductivity and current-carrying capacity that prevents insulation damage due to heating of conductors;

(2) The severed conductors joined by welding or compression-type connectors;

(3) Each power, control, and ground check conductor individually reinsulated with insulation having a thickness, temperature rating, and dielectric strength of at least that of the original insulation;

(4) Semiconducting tape replaced over the insulation of each power conductor within shielded cables;

(5) Metallic shielding in the form of metallic braid or serving (wrap), or metallic tape replaced over each power conductor and applied in half-lapped layers, on shielded cables;

(6) The outer jacket replaced to provide at least the same thickness and protection as that of the original jacket; and

(7) The outer jacket sealed, vulcanized, molded, or fused to the cable's original jacket to exclude moisture.

(e) One trailing cable splice which does not meet the requirements of paragraph (d) of this section shall be permitted for the time period necessary to move the equipment for repair of the cable, provided the splice is mechanically strong and insulated to prevent shock.

(f) Splices and repairs in trailing cables used underground shall be made with splice and repair kits that meet the flame-resistance tests in 30 CFR 18.64.

§ 57.12604 Lightning protection.

(a) Surge arresters shall be provided for exposed ungrounded power conductors and telephone wires.

(b) Power conductors and telephone wires that are buried, installed beneath a protective metallic covering, or enclosed within grounded metallic shields, coverings, or enclosures, throughout their entire length need not be equipped with surge arresters.

(c) Surge arresters for conductors that enter an underground mine shall be located on the surface within 100 feet of the point where the conductors—

(1) Enter the mine;

(2) Are buried;

(3) Are installed beneath a protective metallic covering;

(4) Are enclosed within grounded metallic shields, coverings, or enclosures; or

(5) Are supported by grounded metallic messenger wires.

(d) Surge arresters shall be rated for the voltage and current of the circuit they protect.

(e) Surge arresters for conductors that extend underground shall be connected to a low-resistance ground field that is separated from neutral ground fields by a distance of not less than 25 feet.

§ 57.12630 Support structures and guy wires.

Guy wires attached to structures supporting uninsulated overhead power conductors, other than telephone wires shall be—

(a) Electrically connected to the equipment safety grounding conductor at the supporting structure end of the guy wire; or

(b) Provided with one or more insulators which have a dry flashover voltage at least double the nominal voltage and a wet flashover voltage at least as high as the nominal voltage. The insulators shall be at least 8 feet from the ground.

§ 57.12660 Support in shafts and boreholes.

(a) Power cables and insulated conductors in shafts and boreholes shall be supported by clamping or strain relief devices which prevent strain on the conductors and functional damage to the jacket and insulation;

(b) A clamp or strain relief device shall be installed as close to the top of the cable or conductor run as practical; and

(c) In vertical shafts and boreholes, additional support devices shall be installed along the cable or conductor run at distances not greater than the values specified in Table 57.12660 unless the cable is a self-supporting type.

Table 57.12660—Spacing for Conductor Supports

Conductor size [1]	Aluminum or copper-clad aluminum, feet	Copper, feet
No. 18 through No. 8	100	100
No. 6 through No. 0	200	100
No. 00 through No. 0000	180	80
211,601 through 350,000 CM	135	60
350,001 through 500,000 CM	120	50
500,001 through 750,000 CM	95	40
Above 750,000 CM	85	35

Derived from NEC Table 300-19(a).

[1] American wire gage or circular mils.

Trailing Cables

§ 57.12700 Insulation; flame resistance; shielding.

Trailing cables used in mine electrical systems shall have—

(a) Conductor insulation rated for at least the line-to-line voltage;

(b) Shielding for the purpose of confining the voltage stresses when used to supply equipment at over 2,000 volts line-to-line; and

(c) Flame resistance qualities in accordance with 30 CFR 18.64 when used underground.

§ 57.12701 Overcurrent protection.

(a) Each trailing cable of portable and mobile equipment shall have short-circuit and ground-fault protection for each ungrounded conductor that shall safely interrupt all ungrounded conductors under fault conditions.

(b) Ungrounded conductors of trailing cables energized at voltages of 1040 volts or less shall be protected by one of the following—

(1) An inverse-time circuit breaker with a maximum current rating as specified in Table 57.12701–1.

(2) An instantaneous-trip or short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds with a maximum instantaneous setting not more than—

(i) The values listed in Table 57.12701–2 for 480-, 600-, and 1040-volt trailing cables; or

(ii) The values listed in Table 57.12701–3 for 300- and 600-volt direct-current trailing cables.

(3) An instantaneous trip or short-time delay electronic circuit breaker having a time delay not to exceed 0.1 seconds with a setting that does not exceed the lower value of either 115 percent of the maximum starting current for the unit of electric equipment or 60 percent of the lowest value of bolted phase-to-phase short-circuit current at any point in the circuit when—

(i) The circuit to be protected does not function properly using values listed in the tables; and

(ii) A circuit analysis assures that the circuit does not present a hazard to the miners.

(4) Fuses which provide no less protection than that specified above.

(c) Ungrounded conductors of trailing cables energized at voltages greater than 1040 volts shall be provided with instantaneous short-circuit protection with a setting that does not exceed the lower value of either 175 percent of the maximum starting current for the unit of electric equipment or 75 percent of the minimum phase-to-phase short-circuit current available at any point in the circuit.

TABLE 57.12701-1.—MAXIMUM RATINGS OF FUSES PROTECTING DIRECT CURRENT TRAILING CABLES AND INVERSE-TIME CIRCUIT BREAKERS PROTECTING ALTERNATING CURRENT TRAILING CABLES

[Maximum Inverse-Time Circuit Breaker or Fuse Rating (Amperes)]

Conductor Size (AWG or MCM)	1 Ungrounded power conductor	2 Ungrounded power conductors	3 Ungrounded power conductors
14	15	15	15
12	20	20	20
10	30	30	25
8	60	50	50
6	90	70	70
4	110	110	110
3	150	150	150
2	150	175	175
1	175	200	200
1/0	200	225	225
2/0	250	250	250
3/0	300	300	300
4/0	350	350	350
250	350	350	350
300	400	350	350
350	450	350	350
400	500	400	400
500	600	450	400

TABLE 57.12701-2.—MAXIMUM SETTINGS OF INSTANTANEOUS AND ELECTRONIC CIRCUIT BREAKERS PROTECTION 480, 600, AND 1040- VOLT ALTERNATING-CURRENT TRAILING CABLES

Conductor size (AWG or MCM)	Cable length (feet)	Maximum circuit-breaker setting (amperes)		
		480V	6000	1040V
14	0-500	75	100	.....
	501-750	50	75	.....
12	0-500	125	175	.....
	501-750	100	125	.....
10	0-500	200	250	.....
	501-750	150	200	.....
8	0-500	300	400	.....
	501-750	200	300	.....
6	0-550	450	550	850
	501-750	350	450	700
4	0-500	750	900	1250
	501-600	650	800	1100
	601-750	550	650	1000
3	0-500	900	1100	1400
	501-650	700	900	1200
	651-750	650	800	1100
2	0-500	1100	1250	1500
	501-600	950	1100	1400
	601-750	800	950	1250
1	0-500	1300	1450	1650
	501-600	1100	1300	1550
	601-750	950	1100	1400
1/0	0-500	1500	1650	1750
	501-600	1300	1500	1650
	601-750	1100	1300	1500
	751-800	1050	1250	1500
2/0	0-500	1700	1800	1850
	501-600	1500	1650	1750
	601-750	1350	1450	1650
	751-850	1200	1350	1550
3/0	0-500	1900	1950	1900
	501-600	1700	1800	1800
	601-750	1500	1650	1700
	751-900	1300	1450	1650

TABLE 57.12701-2.—MAXIMUM SETTINGS OF INSTANTANEOUS AND ELECTRONIC CIRCUIT BREAKERS PROTECTION 480, 600, AND 1040- VOLT ALTERNATING-CURRENT TRAILING CABLES

Conductor size (AWG or MCM)	Cable length (feet)	Maximum circuit breaker setting (amperes)		
		480V	600V	1040V
4/0	0-500	2100	2100	1950
	501-600	1900	1950	1900
	601-750	1700	1800	1800
	751-1000	1400	1550	1650

TABLE 57.12701-2.—MAXIMUM SETTINGS OF INSTANTANEOUS AND ELECTRONIC CIRCUIT BREAKERS PROTECTION 480, 600, AND 1040- VOLT ALTERNATING-CURRENT TRAILING CABLES—Continued

Conductor size (AWG or MCM)	Cable length (feet)	Maximum circuit breaker setting (amperes)		
		480V	600V	1040V
250	0–500	2150	2150	2000
	501–600	2000	2050	1900
	601–750	1750	1850	1850
	751–1000	1500	1650	1700
300	0–500	2300	2250	2000
	501–600	2100	2100	1950
	600–750	1900	1950	1900
	751–1000	1600	1750	1750
350	0–500	2350	2300	2050
	501–600	2200	2200	2000
	601–750	2000	2000	1900
	751–1000	1700	1800	1800
400	0–500	2450	2350	2100
	501–600	2250	2250	2000
	601–750	2050	2100	1950
	751–1000	1800	1850	1850
500	0–500	2500	2400	2100
	501–600	2350	2300	2050
	601–750	2150	2150	1950
	751–1000	1900	1950	1850

TABLE 57.12701-3.—MAXIMUM SETTINGS OF INSTANTANEOUS CIRCUIT BREAKERS PROTECTING 300- AND 600-VOLT DIRECT-CURRENT TRAILING CABLES

Conductor size (AWG or MCM)	Cable length (feet)	300VDC Maximum instantaneous circuit breaker setting (amperes)		600VDC Maximum instantaneous circuit breaker setting (amperes)	
		Line-line [1]	Line-ground [2]	Line—line [1]	Line—ground [2]
14	0–500	50	50	50	50
12	0–500	75	75	125	125
10	0–500	75	75	200	200
8	0–500	100	100	300	300
6	0–500	200	100	450	300
4	0–500	450	250	600	500
	501–600	350	200	550	400
3	0–500	450	350	700	550
	501–650	400	250	600	450
2	0–500	600	450	750	600
	501–600	550	400	700	550
	601–700	450	300	650	500
1	0–500	900	600	1400	1050
	501–600	750	500	1250	950
	601–750	600	400	1050	800
1/0	0–500	1100	750	1600	1250
	501–600	950	650	1450	1100
	601–750	750	550	1250	950
	751–800	700	500	1200	900
2/0	0–500	1350	950	1800	1450
	501–600	1150	800	1650	1300
	601–750	950	650	1450	1100
	751–850	850	600	1350	1050
3/0	0–500	1550	1150	2000	1650
	501–600	1400	1000	1850	1500
	601–750	1150	800	1650	1300
	751–900	1000	700	1500	1150
4/0	0–500	1850	1400	2200	1850
	501–600	1600	1200	2050	1700
	601–750	1400	1000	1850	1500
250	0–500	2050	1550	2350	2000
	501–600	1800	1350	2200	1850
	601–750	1550	1150	2000	1650
	751–1000	1250	900	1750	1400
	751–1000	1100	750	1600	1250
300	0–500	2300	1750	2450	2150
	501–600	2050	1550	2350	2000
	601–750	1750	1300	2150	1800
	751–1000	1450	1050	1900	1550
350	0–500	2550	1950	2600	2300
	501–600	2250	1700	2450	2150
	601–750	1950	1500	2300	1950
	751–1000	1600	1200	2050	1700
400	0–500	2750	2150	2650	2400

TABLE 57.12701-3.—MAXIMUM SETTINGS OF INSTANTANEOUS CIRCUIT BREAKERS PROTECTING 300- AND 600-VOLT DIRECT-CURRENT TRAILING CABLES—Continued

Conductor size (AWG or MCM)	Cable length (feet)	300VDC Maximum instantaneous circuit breaker setting (amperes)		600VDC Maximum instantaneous circuit breaker setting (amperes)	
		Line-line [1]	Line-ground [2]	Line—line [1]	Line—ground [2]
	501-600	2450	1900	2550	2250
	601-750	2150	1600	2400	2050
	751-1000	1750	1350	2150	1800
500	0-500	3050	2450	2800	2550
	501-600	2800	2200	2700	2400
	601-750	2450	1900	2550	2250
	751-1000	2050	1550	2350	2000
600	0-500	3250	2650	2850	2650
	501-600	3000	2400	2750	2500
	601-750	2650	2050	2650	2350
	751-1000	2250	1700	2400	2100
700	0-500	3500	2900	2950	2750
	501-600	3250	2600	2850	2600
	601-750	2900	2300	2750	2450
	751-1000	2450	1900	2550	2250
800	0-500	3700	3100	3000	2800
	501-600	3450	2800	2900	2700
	601-750	3100	2500	2800	2500
	751-1000	2650	2050	2650	2350
900	0-500	3900	3300	3050	2850
	501-600	3650	3000	3000	2850
	601-750	3300	2650	2850	2650
	751-1000	2850	2250	2700	2450
1000	0-500	4050	3450	3100	2900
	501-600	3800	3150	3000	2850
	601-750	3450	2800	2900	2700
	751-1000	3000	2400	2750	2500

[1] The line-to-line instantaneous circuit breaker settings shall be used for trailing cables supplying power to diode grounded equipment and for trailing cables containing a separate equipment safety grounding conductor if the circuit is provided with separate ground-fault protection.

[2] The line-to-ground instantaneous circuit breaker settings shall be used for trailing cables containing a separate equipment safety grounding conductor when the circuit is not provided with separate ground-fault protection.

§ 57.12702 Attachment.

Trailing cables shall be attached to equipment so that functional damage to the cable jacket and damage to the insulation of the internal conductors is prevented, and strain does not occur on electric connections.

§ 57.12703 Portable distribution boxes.

Portable distribution boxes shall have—

(a) A disconnecting device for each branch circuit and a means to clearly show that each circuit has been physically disconnected;

(b) A means which identifies each disconnecting device and cable with its related load; and

(c) A means to prevent connecting a cable to the wrong protective device when two or more cables connect to the same distribution box.

§ 57.12704 Guarding.

Trailing cables and power conductors shall be protected against physical damage from mobile equipment by bridges, trenches, suspension from the mine roof or rib, or by location.

§ 57.12705 Disconnecting devices.

Disconnecting devices for trailing cables shall be equipped with a means for installing a padlock.

Trolley Circuits for Track Haulage

§ 57.12800 Installation and maintenance.

Trolley wires and exposed trolley-feeder wires shall be—

(a) Installed opposite the clearance side of haulageways, except where such installation creates a greater hazard;

(b) Suspended at least 7 feet above the track; and

(c) Aligned and maintained to provide for smooth tracking of trolley collectors on trolley wires.

§ 57.12801 Circuit protection and isolation.

(a) Trolley wires and trolley-feeder wires shall be protected against overcurrent by an automatic circuit interrupting device which deenergizes the affected circuit if a short circuit occurs at any point in the system.

(b) The trip setting of the device required by paragraph (a) of this section shall not exceed 50 percent of the minimum available bolted short-circuit current when that current is less than 800 amperes; or 75 percent of the minimum available bolted short-circuit current when that current is 800 amperes or more.

(c) Trolley wires and trolley-feeder wires shall be provided with a means of isolation at intervals of not more than 2,000 feet and near the beginning of all branch lines.

§ 57.12802 Track bonding.

(a) Track serving as the trolley circuit return shall be bonded or welded at every joint and crossbonded at intervals not exceeding 200 feet.

(b) Metallic pipelines and structures installed less than 10 feet from track serving as the trolley circuit return shall be insulated or guarded, or bonded to the track at intervals not exceeding 1000 feet to prevent shock hazards.

(c) When rails are moved, or replaced, or when broken bonds are discovered, they shall be rebonded within three working shifts.

§ 57.12803 Guarding.

(a) Energized trolley wires and bare trolley-feeder wires shall be guarded where accidental contact with them is possible, including:

(1) Where supplies are stored, loaded, or unloaded.

(2) At mantrip stations.

(3) On each side of all doors and stoppings through which wires pass.

(4) Where a person works within three feet of the trolley wire except for a person operating rail-mounted haulage equipment.

(5) At track switches.

(6) Where persons regularly pass under the wires.

(b) Trolley wires and trolley feeder wires shall be deenergized when guarding is installed or removed, unless the guarding is temporary guarding designed to minimize shock hazards while work is being conducted in the area.

§ 57.12804 Circuits powered from trolley wires.

The return wire of all circuits powered from the trolley wires shall be connected to the trolley wire return circuit to assure continuity and prevent arcing.

Appendix I to Subpart K—Electricity

Mine operators seeking further information may consult the following national consensus standards:

MSHA standard	National consensus standard
56/57.12101; 56/57.12103, 56/57.12130, 56/57.12204, 56/57.12301, 56/57.12400.	NFPA 70 (NEC).
56/57.12500[1] to 56/57.12506.	NFPA 70 (NEC), IEEE Stds. 80-1976, 81-1983, 277-1983, 142-1982, UL-943 and ANSI C-2 (NESC).
56/57.12600	IEEE Std. 242.
56/57.12601	NEC, ICEA P-50-431, S-19-81 and P-48-426.
56/57.12602	IEEE Std. 141-1976 and NEC.
56/57.12604	IEEE Std. 142-1982.
56/57.12630	NESC.
57.12660	NEC.
56/57.12700	NEC.

[1] A method that may be used for protection of persons from disabling or fatal electric shock, under ground-fault conditions, is to limit voltage exposure. The term voltage exposure refers to a combination of voltage and the length of time that the voltage exists.

Voltage exposure should not exceed

$V^2t=30375$

where v = voltage in volts

t = time in seconds

This equation is based on IEEE Std. 80-1976 using 1500 ohms as a person's body resistance. This would allow a combination of system grounding, ground-fault protection and overcurrent protection to be used to provide protection from disabling or fatal shocks.

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30 CFR Parts 56, 57, 70, and 71

RIN 1219-AA53

Noise

AGENCY: Mine Safety and Health Administration, Labor.

ACTION: Advance notice of proposed rulemaking.

SUMMARY: The Mine Safety and Health Administration (MSHA) is proposing to revise its standards for coal and metal/nonmetal mines to reduce the incidence of noise-induced hearing loss among miners.

Members of the mining community have asked MSHA to revise its standards to provide one noise standard covering all mines, citing the differences among MSHA's standards for coal and metal/nonmetal mines, and between MSHA's standards and those set by the Occupational Safety and Health Administration (OSHA). This notice seeks comments on various aspects of the issues that the Agency will review in developing a proposed rule. In revising its standards, MSHA will consider the requirements of the Federal Mine Safety and Health Act of 1977 (Mine Act), the comments received in response to this notice, OSHA's standards, the uniqueness of the mining industry, and recent technological developments.

DATE: Submit comments and information by March 5, 1990.

ADDRESS: Submit comments to Office of Standards, Regulations, and Variances, MSHA; 4015 Wilson Boulevard, Room 631; Arlington, Virginia 22203.

FOR FURTHER INFORMATION CONTACT: Patricia W. Silvey, Director, Office of Standards, Regulations, and Variances, MSHA; (703) 235-1910.

SUPPLEMENTARY INFORMATION:

I. Background

Permanent hearing loss can result from overexposure to many sources of noise in mining. To prevent such loss, MSHA has standards for noise exposure in coal mines (30 CFR 70.500 and 71.800) and metal/nonmetal mines (30 CFR 56.5050 and 57.5050). Despite MSHA's efforts, hearings loss among miners continues to be a problem. Workers' compensation awards for hearing loss among miners have increased over the past 10 years. In addition, since 1981, mine operators have reported to MSHA 1216 hearing loss cases among miners. Among these, 424 have received all their noise exposure since MSHA implemented its noise standards. The Agency is reassessing whether its noise standards provide adequate protection to miners.

Although MSHA's noise standards are based on a 90 decibels, A-weighting (dBA), 8-hour permissible exposure limit (PEL), and require engineering or administrative controls to reduce the miner's exposure to within the PEL, substantial differences exist among the other provisions in MSHA's standards for coal and metal/nonmetal mines. Under MSHA's standards for coal mines, for example, such controls may include hearing protection devices (HPDs). MSHA standards also require coal mine operators to monitor miners' noise exposure. In determining whether a miner's exposure exceeds the PEL, coal mine inspectors make allowances for attenuation provided by HPDs. When a miner's exposure exceeds the PEL, coal mine operators must implement a hearing conservation plan. The plan must include provisions for instituting engineering or administrative controls to reduce noise levels. Such controls may include personal HPDs. Coal operators also must implement preemployment and periodic audiograms. MSHA's standards for metal/nonmetal mines do not permit the use of HPDs instead of feasible engineering or administrative controls, nor do they contain provisions for a hearing conservation program (HCP).

MSHA's standards also differ from the OSHA noise standard (29 CFR 1910.95). In 1983, OSHA revised its noise standard to include requirements for an HCP to reduce the incidence of hearing loss in general industry. OSHA's HCP provisions reflect more recent developments in hearing conservation than MSHA's hearing conservation plan for coal mines.

II. Specific Issues

Because an MSHA standard would affect all of the mining industry, commenters should provide specific rationale to support their positions based upon particular mining methods, practices, and conditions. Mine operators should identify and discuss both the quantifiable and non-quantifiable benefits and costs of compliance. Economic information should include capital, maintenance, and on-going costs. While MSHA requests comments on all relevant noise standard issues, the Agency is interested particularly in comments on the following specific issues.

A. Definition of Problem

(1) Definition of Hearing Loss

MSHA's noise standards and reporting requirements do not define noise induced hearing loss or the