EFCOG Best Practice – #250
Mining and Underground Facilities, Electrical

Facility: DOE Complex

Best Practice Title: Mining and Underground Facilities, Electrical

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Brief Description of Best Practice: Information for Mining and Explosives Electrical Safety was previously included in DOE-HDBK-1092, Electrical Safety under Special Occupancies. Information on use of explosives is best covered in DOD Ammunition and Explosives Standards. Mining activities are covered under 30 CFR 57 for Metal and Non-Metal Underground Mines, with Subpart K being the Electrical section. This Best Practice covers interpretations and descriptions of specific 30 CFR 57 references to General Applications, Grounding and Power Cables/Conductors.

Why the best practice was used: Mining is a specific activity that relatively few DOE Facilities participate in. Having a section of DOE-HDBK-1092 devoted entirely to "Special Occupancies" was not needed. Information in this area was directly taken from both DOD Standards for Explosives and 30 CFR 57, Metal and Non-Metal Underground Mines with the Best Practices now incorporating interpretations and more detailed information.

What are the benefits of the best practice: MSHA Program Policy Manual interpretations of the 30 CFR 57, Metal and Non-Metal Mines are outlined in this Best Practice.

What problems/issues were associated with the best practice: N/A (New Best Practice)

How the success of the Best Practice was measured: N/A (New Best Practice)

Description of process experience using the Best Practice: Electrical work performed with Mining or Underground applications should view this Best Practice as applicable for both surface and underground facilities.

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INTRODUCTION

DOE does not engage in "mining," as it relates to the extraction of minerals for profit. However, DOE does have underground facilities that consist of electrical equipment and wiring installed underground that pose unique hazards. Working conditions underground can present hazards to electrical workers which are different from those presented above ground. This section aids in dealing with such problems.

The applicable OSHA regulations set forth in 29 CFR 1910, *Occupational Safety and Health Standard* and 29 CFR 1926, *Safety and Health Regulations for Construction* are required as incorporated by reference in 10 CFR 851, *Worker Safety and Health Program.* The codes related to mining, 30 CFR 57, *Safety and Health Standards Underground Metal and Nonmetal Mines*~~;~~ shall be followed, where applicable.

BACKGROUND AND DISCUSSION

1 General Applications

A. All electrical installations of underground facilities are to meet the requirements as outlined in 30 CFR 57, *Metal and Non-Metal Underground Mines* and the National Fire Protection Association 70, *National Electrical Code* as applicable. When the work is not covered by these codes, reference the applicable section of 29 CFR 1910, Subpart S, *Electrical*

B. Electrical equipment and conductors are to be used in a manner that prevents shocks and burns to people. Electrical equipment and conductors that present a hazard to people because of improper installation, maintenance, misuse, or damage, should be tagged out and/or locked out, until fixed, 30 CFR 57.12030, *Correction of Dangerous Conditions*. All electrical equipment and conductors should be chosen and situated in environments conducive to their design and intended use, or as tested by an NRTL for the purpose intended. All cables shall meet the standards by the Insulated Power Cable Engineers Association (IPCEA), where only approved materials for insulation are used.

C. When access is necessary, suitable clearance shall be provided at stationary electrical equipment or switchgear, 30 CFR 57.12019. This requirement generally will defer to the NEC and OSHA requirements for distances to be maintained for servicing and maintenance activities. Areas around stationary electrical equipment or switch gear should be restricted to authorized personnel. Normal travel by or through such equipment should not be allowed unless no other travel way is available. If a person(s) are required to travel by stationary electrical equipment, then 30 CFR 57.1101 requires that a safe means of access be provided.

D. Dry wooden platforms, insulating mats, or other electrically non-conductive material

shall be kept in place at all switchboards and power-control switches or other approved controls established, where a shock hazard exists. Switchgear, regardless of voltage, which has exposed energized parts should have insulating platforms or mats. The circuits may be ground fault monitored rather than relying on rubber mats or wood platforms. The use of ground fault monitoring circuits will allow an engineering mitigation for the shock potential hazard.

E. High voltage (> 650 volts) switchgear should be completely enclosed in grounded rated material enclosures and provided with grounded operating handles and grounded metal plates, because of the increased hazard presented by the higher voltages. Insulating mats or platforms should be used where shock hazard exists, and where physical conditions (wet, damp, and outdoor locations, etc.) warrant their use. Normally dry and well-kept indoor installations (substations or switchgear) with grounded metal plates, insulating mats or platforms would NOT provide additional protection.

F. Portable extension lights, and other lights that by their location present a shock or burn hazard, shall be guarded (30 CFR 57.12034). The general acceptable practice of no exposure exists if the item is not readily accessible, such as by distance, is not applicable under the MSHA standard. A guard around the light must be present to prevent contact with any electrical, burn, or broken glass hazard if contact were made.

2. Work on Electrical Equipment and Circuits

Before any work is performed on electrical equipment or circuits, the power source or sources should be de-energized, unless power is a necessary part of the work procedure, per 30 CFR 57.12016. In addition, the following rules apply for energized work:

A. Power-cable plugs and receptacles for circuits greater than 150 V potential to ground should not be connected or disconnected under load unless they are of the load-break type. Energized power cables more than 150 V potential to ground should be handled in accordance with 30 CFR 57.12014. Care should be taken to prevent damage or shock and burn from the energized cable.

B. Fuses shall not be removed or replace by hand in an energized circuit. They shall not be otherwise removed or replaced in an energized circuit unless equipment and techniques especially designed to prevent electrical shock are provided and used for such purpose.30 CFR 57.12036, 30 CFR 57.12037

C. Communication conductors shall be protected by isolation or suitable insulation, or both, from contacting energized power conductors or other power source 30 CFR 57.12010, *Isolation or Insulation of Communication Conductors*. Additionally, the potential on bare signal wires accessible to contact shall not exceed 48 volts 30 CFR 57.12012*, Bare Signal Wires*.

3. Power Cables and Conductors

A. Cables and insulated conductors should be protected against physical damage, adverse environmental conditions, and failure of adjacent mechanical equipment in accordance with 30 CFR 57.12004 and NFPA 70E.

Electrical conductor splices are to the follow the requirements outlined in 29 CFR 1910.303(c), *Working on or near exposed energized parts.* The allowance and further information on splices, terminations, and repairs of electric conductors and power cables are outlined in 30 CFR 57.12013, *Splices.* Conductors shall be spliced or joined with splicing devices suitable for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be so spliced or joined as to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device suitable for the purpose.

B. Surge arresters and lightning protection are necessary for underground facilities and should conform to 30 CFR 57.12069. These documents state that lightning arresters should be inspected for damage, at least annually, or after each electrical storm.

C. Overcurrent protection of each ungrounded conductor should be in accordance with 30 CFR 57.12003 Each trailing cable of portable and mobile equipment should have short- circuit and ground fault protection for each ungrounded conductor. Protective devices shall safely interrupt all ungrounded conductors under fault conditions.

4. Trailing Cables

A. Information for the installation of trailing cables is found in 30 CFR 57.12006 According, trailing cables should be attached to equipment so that strain on electrical connections does not occur and damage to cable jacket and internal conductor insulation is prevented. Portable distribution boxes are permitted to be used, however should be in accordance with 30 CFR 57.12006 and 30 CFR 57.12007. Trailing cables and power conductors should be protected against physical damage from mobile equipment by using bridges, trenches, or suspension from the mine roof.

B. Disconnecting devices for trailing cables should be equipped with means for attaching a padlock for lockout/tagout purposes per 30 CFR 57.12016, 30 CFR 57.12017

5. Trolley Circuits for Track Haulage

A. Trolley wires and exposed trolley-feeder wires should be installed and maintained in accordance with the requirements in 30 CFR 57.12050, and 30 CFR 57.12086.

B. Trolley wires and trolley-feeder wires should be protected against overcurrent in accordance with the requirements of 30 CFR 57.12001

C. Track serving as the trolley circuit return should be bonded or welded, in accordance with 30 CFR 57.12042. Energized trolley wires and exposed trolley-feeder wires should be guarded in places where accidental contact with them is possible. This includes areas where supplies are stored, loaded, or unloaded.

6. Grounding

The intent is to ensure that continuity and resistance tests of grounding systems are

conducted on a specific schedule. These tests will alert the mine operator if a problem exists in the grounding system which may not allow the circuit protective devices to quickly operate when a fault occurs.

A. Grounding systems typically include the following:

i. Equipment grounding conductors – the conductors used to connect the metal frames or enclosure or electrical equipment to the grounding electrical equipment to the grounding electrode conductor,

ii. Grounding electrode conductors – the conductors connecting the grounding electrode to the equipment grounding conductor,

iii.. Grounding electrodes – usually driven rods connected to each other by a suitable means, buried metal, or other effective methods located at the source.

B. Testing of Grounding Systems

i. Equipment Grounding Conductors – continuity and resistance must be tested immediately after installation, repair, or modification, and annually if conductors are subjected to vibration, flexing or corrosive environments,

ii. Grounding Electrode Conductors – Continuity and resistance must be tested immediately after installation, repair, or modification, and annually if conductors are subjected to vibration, flexing, or corrosive environments,

iii. Grounding Electrodes – resistance must be tested immediately after installation, repair, or modification and annually thereafter.

iv. This requirement does not apply to double insulated tools, or circuits protected by ground-fault-circuit interrupters that trip at 5 milli-amperes or less.

v. Testing of grounding conductors and grounding electrode conductors is not required if a fail-safe ground wire monitor is used to continuously monitor the grounded circuit, and which will cause the circuit protective devices to operate when the grounding conductor continuity is broken.

vi. A record of the most recent resistance tests conducted must be kept and made available to the Secretary of Labor or authorized representative upon request. The testing results shall be recorded in resistance values in ohms.

vii. Conductors in fixed installations, such as rigid conduit, armored cable, raceways, cable-trays, and cables with approved jacket for use, that are not subjected to vibration, flexing or corrosive environments may be examined annually by visual observation to check for damage in lieu of the annual resistance test. It is recommended a direct grounding to the grounding grid for the facility be used and tested using grounding grid test program. A record is maintained of the most recent annual visual examination for inspector reviews.

CONCLUSION AND RECOMMENDATIONS

REFERENCES

1. 30 CFR 57, "*Safety Regulations for Metal and Non-Metal Mines*"
2. Program Policy Manual Volume IV, "*Interpretation, Application and Guidelines on Enforcement of 30 CFR*" Mine Safety and Health Administration
3. MSHA Handbook PH20-V-5 Volume 1 and Volume 2, "*Electrical Inspection Procedure Handbook*", 2020