COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Bureau of Deep Mine Safety
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December 12, 1989

TO: ALL COAL OPERATORS

FROM: THOMAS J. WARD, JR., DIRECTOR

SUBJECT: MINE WIDE MONITORING SYSTEM GUIDELINES

On October 28, 1983, a Section 334 Commission was appointed to consider approval of mine wide monitoring systems. The Commission approved certain requirements which were adopted by the Bureau. However, numerous operators and system manufacturers complained to the Bureau about the requirements and the inability to obtain a system approval in the years since the requirements were adopted. Consequently, under the authority of Section 124 of the Bituminous Coal Mine Act, on November 7, 1988, I appointed another Commission. Their task was to investigate the requirements and determine what modifications were necessary in order for this technological improvement to be implemented, and make their recommendations to me.

Attached are the requirements recommended by the Section 124 Commission and adopted by the Bureau which are now applicable to all underground bituminous coal mines in Pennsylvania. Also enclosed is a copy of inspection procedures for Mine Wide Monitoring systems.

If you have any questions, please feel free to contact me.

TJW/mjr
Attachments

cc: BDMS File (Hbg)
BDMS File (Utwn)
Section 124 Commission Members
Pennsylvania Coal Association
U.M.W.A.

GUIDELINES FOR MINE WIDE MONITORING SYSTEMS (MWMS)

System plans (4) must be submitted, which comply with these guidelines. The plans must include a request letter with a system description, a line diagram of the system, a manufactures installation and maintenance manual and the guidelines. Tentative approval must be given before a MWMS can be placed into operation. Final approval will follow a complete system inspection by the Bureau of Deep Mine Safety and a MWMS number will be issued on a mine by mine basis. Failure to comply with any provision of the approved system plan, will result in plan revocation.

(1) All electrical cables used with this system underground shall have the "P" number embossed or indicated on the jacket at intervals not to exceed twelve feet (12) and approved by the Secretary as flame-resistant cable.

(2) All out-stations, which will be marked blue or red, shall only be located in intake air and shall not be extended beyond the last permanent stopping or within 150 feet of pillar workings. All out-stations with sensors in hazardous areas shall be completely blue in color. Blue out-stations will enclose all required components needed to insure all sensors are intrinsically safe.

(3) Monitoring systems shall be so designed that all their circuits and components, including battery systems, installed underground shall be de-energized immediately upon loss of mine ventilation. Manual de-energization from a centralized surface control area is acceptable. Manual re-energization at each individual battery back-up circuit is required.

(4) A separate map of the mine of sufficient size shall be posted in the central control room showing the locations of all power conductors, out-stations, sensors, etc., associated with the system. Detailed installation, maintenance and operating instructions, with the approved plan must also be available at the mine in a specified location.

(5) Acceptable check lists shall be provided to the district mine inspector and district electrical inspector by the manufacturer as to how to inspect, calibrate, and maintain the complete system.

(6) All sensors located in return airways, or inby the last permanent stopping and in other hazardous areas shall be used in conjunction with a monitored methane sensor. If a methane sensor is not used, the area shall be examined every *twenty (20)* minutes as described in Section 316 (H)(3) of the Bituminous Coal Mining Laws of Pennsylvania. The power to these sensors shall be automatically disconnected in the event of an accumulation of methane exceeding one percent (1%).

When the CH_4 sensors are located in the face area (inby the last open crosscut or within 150' of second mining) and an accumulation of methane exceeding one percent (1%) is detected, power will be automatically de-energized from the face area.

(7) All sensors in hazardous areas shall be inspected and checked with the appropriate gas weekly by a qualified person according to the manufacturer's specifications. All sensors in non-hazardous areas shall be inspected and checked not to exceed 30 days. Reports shall be kept of all checks.

(8) All intrinsically-safe cables shall be shielded, and all intrinsically-safe cables shall be maintained and hung not less than twelve (12) inches from all other cables.

(9) All blue out-stations shall include physical barriers to separate ISC circuits (components, wires and cables) from non-ISC circuits. The physical barriers may be either formica board, grounded metal or a fire-proof insulating material such as fiberglass. Enclosures shall be opened and inspected every thirty (30) days, and records kept of this inspection.

(10) Alarms which provide audible and visual notification must be provided at all loading points in each section where a MWMS is in use. A permissible or intrinsically safe audible and visual alarm will be provided at the stageloader controls on each longwall where a MWMS is in use since this area is within 150 ft. of the gob (hazardous area).

(11) In all mines where mine wide monitoring systems include environmental sensors, the operator of each mine shall see that properly trained and qualified persons are on duty at all times. It shall be necessary to have continuous monitoring seven (7) days a week, three (3) shifts per day.

(12) In all mines where mine wide monitoring is used, such a system shall not supercede the Bituminous Coal Mining Laws of Pennsylvania.

(13) The system shall have been evaluated by the MSHA Approval and Certification Center and a copy of the MSHA evaluation letter shall be submitted to the Bureau of Deep Mine Safety.

III. RECOMMENDED PRACTICE

INSTALLATION AND MAINTENANCE OF INTRINSICALLY SAFE FIELD WIRING IN GASSY MINES

A. Installation of Intrinsically Safe Field Cables and Wires

1.1 Copper conductors shall be used and sized such that their maximum surface temperature shall not exceed 150°C when carrying the maximum current that could flow in the circuit under fault conditions. Table I lists the maximum current versus conductor size to ensure meeting this requirement.

Table I
Maximum Current/Cross Sectional Area Relationship

Max. Current (amps)	Cross Sectional Area (mm)	Equivalent AWG No.
1.0	0.017	34
1.65	0.03	32
3.3	0.09	27
5.0	0.19	24
6.6	0.28	22
8.3	0.44	20

(14) All electrical systems must be adaptable to the Pennsylvania Coal Mining Laws for electrical lock-out when machinery is being repaired or inspected.

ATTACHMENTS:

(1) Installation and maintenance of intrinsically safe field wiring in a gassy mine.

The cross sectional area for stranded conductors is the total cross sectional area of all the strands of the conductor.

1.2 Conductors shall be covered with an insulation thickness of 0.25 mm, minimum.

1.2.1 The insulation shall be capable of withstanding an rms AC test voltage of twice the nominal voltage of the intrinsically safe circuit with a minimum of 500 V.

1.3 Multiconductor cables shall contain all conductors within an insulative outer jacket having a minimum thickness of 0.25 mm.

1.4 Cables between machine components shall have flame-resistant properties and MSHA acceptance markings indicating they meet the flame resistance test requirements of Title 30, Code of Federal Regulations, Section 18.64 (30 CFR 18.64), or be enclosed within flame-resistant hose conduit having a minimum wall thickness of 3/16 inch and MSHA acceptance markings indicating it meets the flame test requirements of 30 CFR 18.65.

1.4.1 Cables and wires containing intrinsically safe circuits where conductor size is smaller than AWG No. 14 shall be accepted as meeting MSHA flame-resistant requirements if they pass the MSHA flame test for fiber optic cables, MSHA Program Policy Letter No. 88-II-1.

1.5 Cables and wires containing intrinsically safe circuits shall be so identified. The use of a bright blue color on the outer jacket is the preferred method for identification. Alternative methods of identification are the use of a bright blue band around the cable or wire, 0.5 inch minimum width, at intervals not exceeding 3 feet, or the marking "IS" impressed or durably printed on the cable jacket at intervals not exceeding 3 feet. The means of identification shall be visible after installation.

1.6 Intrinsically safe circuits from different intrinsically safe systems shall not be run in the same multiconductor cable. Multiple intrinsically safe circuits from a single intrinsically safe system or apparatus shall not be run in the same multiconductor cable unless allowed in the MSHA acceptance drawings for that system or apparatus. When allowed, each intrinsically safe circuit will be required to be shielded with the shields connected to ground at one end unless combinations of cable faults have been found to not create a safety hazard.

1.7 Cables and wires containing intrinsically safe circuits shall not be positioned close to intense magnetic fields, power distribution lines, heavy current carrying single conductor cables or wires, or high voltage uninsulated conductors to avoid electro-magnetic induction effects that might allow the energy level of intrinsically safe circuits to become capable of producing an ignition. When physical separation is not possible, attention should be given to twisting or shielding of the intrinsically safe conductors.

1.8 Intrinsically safe cables and wires between machine components shall be clamped in place to prevent undue movement, protected from mechanical damage, isolated from hydraulic lines and protected from abrasion by removing all sharp edges which they might contact.

1.8.1 Protection from mechanical damage may be by position, flame-resistant hose conduit, armoring, metal tubing, or troughs and trays. The armoring of armored cables shall be grounded at both ends of the cables.

1.8.2 Intrinsically safe machine remote control cables are not required to be protected by conduit.

1.9 Since the intrinsic safety of apparatus and systems may be dependent on cable length; distributed capacitance, inductance and resistance; or

inductance to resistance ratio (L/R), cables and wires containing intrinsically safe circuits must be selected and installed in accordance with the MSHA acceptance drawings and conditions in regard to these parameters.

1.10 Intrinsically safe cables and wires interconnecting intrinsically safe apparatus, associated apparatus, or systems may be intermingled and routed together in the same bundle, conduit, or wiring tray when the likelihood of mechanical damage is low and the insulation integrity of all cables and wiring is assured through regular maintenance.

1.10.1 Where the likelihood of mechanical damage cannot be ignored, some form of additional mechanical protection shall be provided for each cable or wire, such as the use of flame-resistant hose conduit or armoring.

1.11 Cables and wires containing intrinsically safe circuits shall not be intermingled with cables and wires containing non-intrinsically safe circuits.

1.11.1 Intrinsically safe circuits and non-intrinsically safe circuits should not be included within the same cable.

1.11.2 Intrinsically safe wires and cables shall not be included in the same bundle as non-intrinsically safe wires and cables.

1.11.3 Intrinsically safe wires and cables shall not be included within the same conduit with non-intrinsically safe wires and cables.

1.11.4 Intrinsically safe wires and cables shall be positively separated from non-intrinsically safe wires and cables by at least 50 mm spacing with the wiring separately tied down. Where machine design precludes maintaining a 50 mm spacing, intrinsically safe wires and cables may be routed together with non-intrinsically safe wires and cables if each are enclosed in MSHA accepted flame-resistant hose conduit having a minimum wall thickness of 3/16 inch.

1.11.5 The installation of wires and cables shall preclude excessive slack that might permit intrinsically safe wires and cables to contact non-intrinsically safe wires and cables.

1.11.6 Intrinsically safe wires and cables shall not be included within the same wiring tray with non-intrinsically safe wires and cables unless separated by a non-combustible physical barrier.

B. Maintenance of Intrinsically Safe Field Cables and Wires

2.1 All intrinsically safe cables and wires shall be periodically examined by qualified personnel to ensure that no damage, change, or deterioration has occurred that may degrade intrinsic safety. Replacement or repair is to be accomplished in a timely fashion.

2.1.1 Each cable and wire shall be examined to ensure its outer insulation or insulating jacket is intact with no exposed conductors, burns, cracks, or splits.

2.1.2 An examination shall be made that each cable is adequately supported and unstressed.

2.1.3 An examination shall be made that segregation is maintained between all intrinsically safe and non-intrinsically safe cables and wires and that all cables and wires are installed according to the recommended installation practice.

2.1.4 An examination shall be made that all replacement cables and wires are in accordance with the recommended installation practice and the applicable requirements of the MSHA acceptance drawings and conditions included in the equipment manufacturer's installation instructions.

2.1.5 An examination shall be made that the interconnection of all intrinsically safe apparatus and systems is in accordance with the applicable requirements of the MSHA acceptance drawings and conditions included in the equipment manufacturer's installation instructions, and that no connectors or connections have been interchanged.

2.1.6 When necessary for maintenance, cables shall be disconnected from intrinsically safe equipment in such a way that live terminals or conductors are not left exposed. Cables shall not be left unconnected and repairs shall be made in a timely fashion.

2.2 Since some intrinsically safe circuits operate at voltage and current levels sufficient to constitute a shock hazard, the same safe precautions against shock hazard shall be observed when installing or servicing intrinsically safe circuits as are observed with non-intrinsically safe circuits.

2.3 When troubleshooting tests are conducted on intrinsically safe cables, wires and connectors, installed in hazardous locations, only MSHA approved test instruments shall be used. The instruments shall be used in accordance with all MSHA approval conditions.

2.3.1 Before a test instrument is taken into a hazardous area, it shall be checked to ensure that it is working properly and is not physically damaged.

2.3.2 When troubleshooting multiconductor cables containing energized multiple intrinsically safe circuits or separate cables carrying energized intrinsically safe circuits, the test instrument shall not be connected simultaneously to separate energized intrinsically safe circuits. Connection shall be restricted to one circuit at a time.

PENNSYLVANIA BUREAU OF DEEP MINE SAFETY
MINE WIDE MONITORING SYSTEM

INSPECTION PROCEDURES

I. **Pre-inspection information gathering**

A. Review the approved guidelines, plans, installation and maintenance manual and system map.

B. Requirements of evaluated systems for intrinsically safe systems should be reviewed, since they apply when sensors are used where permissible equipment is required.

C. Review the Evacuation Plan for specific reference to the CO Monitoring System.

1. Response to alert (warning) and alarm signal.

II. **Surface inspections**

A. Check required calibration and inspection records for compliance with the applicable CO system approval.

1. **Calibration.**

a. Sensors in non-hazardous area shall be checked every 30 calendar days. Sensors in hazardous areas shall be inspected weekly.

b. Company inspection records shall show the date of sensor calibrations.

2. **Testing and inspection.**

a. A weekly test of the system is required to ensure that system and alarms are functioning properly.

b. A visual examination of the CO monitoring system is required on each coal-producing shift.

c. Records of these tests and examinations are required.

B. **Check map showing location of CO sensors.**

1. A map is required to be readily available at the mine.

a. The map should identify affected areas of the mine when a CO sensor is in alert (warning) or alarm status.

b. The map should be located to allow a responsible person on the surface to determine quickly which area of the mine to notify first in case of an alert or alarm.

2. Map must be accurate.

a. Accuracy of the map can be determined based on information learned through inspections of the mine.

b. Map accuracy may also be determined using a current list of active sensors.

3. Determine how map is updated.

a. Maps should be updated promptly after a change. Updates made within 24 hours of changes can be accepted, otherwise the map should be considered out of date.

b. The map on the video display terminal should be updated by mine personnel and not dependent on the manufacturer's representative to make changes.

4. Obtain copy of map.

a. A copy can be an aid in underground inspection and identification of sensors.

b. A copy can be used to record inspection notes of sensors.

C. Observe operation of system.

1. Check video display terminal.

a. Observe that all outstations and sensors are being scanned by the system (compare with map showing location of sensors).

b. Check levels of CO displayed for abnormally high readings (greater than 5 ppm) and abnormally low readings (negative). These may indicate a sensor calibration drift or an older sensor beginning to fail. Abnormally high readings can also be true CO measurements.

c. Check that levels indicated are stable and are not fluctuating over a wide range (more than 2

b. Check if duties of the responsible person require that person to be away from the surface readout station and, if so, determine if the visual and audible signals can be remotely seen by the responsible person.

2. Ask operator to activate the surface alarms.

E. Check communication system between the surface and underground.

1. Responsible person on surface must have two-way communications with all working sections.

2. The responsible person on the surface alerting sections must have current information as to CO levels shown by sensors.

III. Underground inspections.

A. Air velocities in conveyor belt entries.

1. The intake airflow velocities should be equal to or greater than the minimum requirements of the plan (usually 50 fpm), and re-directed towards the interior of the mine.

2. The airflow velocities should be equal to or less than the maximum velocities (usually 100 fpm).

3. Representative cross-sectional areas of the entries should be used when determining the air velocities. Large areas such as belt channels, boom holes or fall areas should not be used, nor should restricted areas such as overcast be used.

B. Installation of CO sensors.

1. The low-level carbon monoxide detection system shall be installed according to the approved guidelines in all belt entries where this system is used.

2. The carbon monoxide monitoring devices shall be located so that the air is monitored at each belt drive and tailpiece and at intervals not to exceed 2,000 feet along each conveyor belt entry. Where belt air is used to ventilate the working faces, the monitoring devices shall be spaced at intervals not to exceed 1,000 feet along each conveyor belt entry. The monitoring device located at the

ppm each time sensor is scanned). Erratic readings are not normal and indicate a malfunctioning sensor.

d. Make a note of sensors with abnormal readings for follow-up during the inspection.

2. Review printout of sensor readings.

a. A printout provides record of abnormal readings.

b. Printouts can be used to compare readings of sensors over extended time periods.

c. Printouts can be used to compare sensors monitored with the map or schematic of sensor locations.

3. Determine duties of responsible person.

a. Determine if the monitoring system activates underground alarms. For the CO monitoring systems that do not activate the section alarms automatically, the responsible person must always be located where he/she can manually activate the section alarm if an emergency situatin arises.

b. Ask the responsible person about what actions must be taken when alert (warning) and alarm levels have been indicated and compare the response to thos actions required by the evacuation plan.

c. Determine if problems with the monitoring system are reported and corrected immediately.

d. Determine if the responsible person, on the surface, is notified when activities such as welding, cutting, or calibration, which may cause alarms, are to be performed.

D. Check visual and audible alarms on surface.

1. Check location of alarms and duties of responsible person.

a. The responsible person must be located so the visual alert signal can be seen and the audible alarm can be heard when the CO concentration at any sensor reaches the levels established.

tailpiece shall be at the tailpiece or not more than 50 feet inby the tailpiece.

3. Where a belt drive or booster drive discharges onto a belt conveyor tailpiece as a continuation of belt conveyor haulage system without a change of direction of the belt conveyor and the belt conveyor drive, belt take-up and belt conveyor tailpiece, only one low-level carbon monoxide sensor shall be required. It shall be installed not more than 100 feet inby the drive, belt take-up, and tailpiece. Where the belt haulage system changes direction, if the tailpiece is located outside the rib line of the dumping belt entry, an additional sensor will be required at the tailpiece.

4. Determine if additional sensors are required to provide protection in the event of a fire.

5. Sensors, cables, and hoses should be located as follows:

   a. In the airstream for optimum CO detection.

   b. In a manner that will provide protection from physical damage.

   c. In an area that will enable calibration and examination of the system to be performed safely.

   d. Sensors, cables, and hoses should not be located where they will be affected by water sprays, fire suppression systems, or direct application of rock dust, or near battery-charging statins where hydrogen gas can interfere with CO sensors.

6. The low-level carbon monoxide system shall be capable of giving warning of a fire for a minimum of 4 hours after the source of power to the belt is removed, except when power is removed during a fan stoppage.

7. The low-level carbon monoxide monitoring devices shall be capable of providing both visual and audible alarm signals. A visual alert signal shall be activated when the carbon monoxide level at any sensor is 10 ppm above the ambient level for the mine and an audible signal when the carbon monoxide level is 15 ppm above the ambient level for the mine. When the carbon monoxide system gives a visual signal at 10 ppm above the established ambient level, all persons shall be withdrawn to a safe area outby the working places and appropriate action shall be taken

to determine the cause of the actuation. When the carbon monoxide system gives an audible signal at 15 ppm above the established ambient level, the mine evacuation plan shall be implemented.

8. The carbon monoxide system shall be capable of monitoring electrical continuity and detecting electrical malfunctins such as electrical shorts and open circuits and ground-faults.

9. The carbon monoxide monitoring system shall initiate the fire alarm signals at a surface locatin where a responsible person is always on duty at all times. The person shall be located so that the signal can be seen if carbon monoxide reaches 10 ppm above the established ambient level and heard at 15 ppm above the ambient. This person shall have two-way communications will all working sectins. When the established alert and alarm levels are reached, the person shall notify all working sections and other personnel who may be endangered. The person shall be trained in the operation of the carbon monoxide monitoring system and in the proper procedures to follow in the event of an emergency or malfunction and, in that event, shall take appropriate action immediately.

10. The carbon monoxide monitoring system shall be capable of identifying any activated sensor. A map identifying each belt flight and the details for the monitoring system shall be posted at the mine.

11. The carbon monoxide monitoring system shall be examined visually at least once each coal producing shift and tested for functional operation at intervals no exceeding 7 days to ensure the monitoring system is functioning properly and that required maintenance is being performed. The monitoring system shall be calibrated with known concentrations of carbon monoxide and air mixtures. A record of all inspections shall be maintained on the surface. The inspection record shall show the time and date of each weekly inspection, monthly inspection, and all maintenance performed on the system.

12. If at any time the carbon monoxide monitoring system or any portion of the system has been deenergized for reasons such as routine maintenance or failure of a sensor unit, the belt conveyor may continue to operate provided the affected portion of the belt conveyor entry shall be patrolled twice each shift and monitored for carbon monoxide by a qualified

person. Each of these qualified persons shall be provided with a hand-held carbon monoxide detection device to detect the presence of excessive levels of CO while the monitoring system is not functioning. That person shall immediately establish two-way communication, by telephone, with the working section(s) and the responsible person on the surface, to notify them of any problem or malfunction on the belt conveyor. A carbon monoxide detection device shall also be made available for use on each working section in the event the monitoring system is deenergized or fails.

13. The procedure outlined in paragraph 12 above is applicable only for a short period of time and is to be determined by the reasonable amount of time it takes to repair or replace the equipment causing the malfunction. The mine operator shall begin corrective action immediately and continue until the defective equipment causing the malfunction is replaced or repaired. The responsible person on the surface shall immediately establish two-way communication by telephone with all working sections and notify them of the particular malfunction or problem.

C. Inspection of CO sensors

1. Pump-type (pneumatic) CO sensors have filters and dust covers and should be checked for dust build-ups that can cause blockage of air flow.

2. Diffusion-type CO sensors should be visually checked for blockage of air flow.

3. Check for visible damage to the sensor and/or the cable and hose to the sensor.

4. Determine if classification labels are attached to sensors located in an area where permissible equipment is required.

D. Outstations.

1. All outstations must be located in intake air.

2. Outstations must be identified as "RED" or "BLUE".

   a. Red outstations are designed for sensors located in intake air only.

   b. Blue outstations are designed for sensors in both fresh air and areas were permissible equipment is

required.

c. Blue outstations are painted completely blue.

d. Other means of identificatin must readily identify the outstation at a distance (for example, wide reflective tape or very large lettering).

e. No wiring into or through permissible areas may be connected to red outstations.

E. Section alarms

1. Check alarm locatin for compliance.

   a. Alarms within 150 feet of longwalls, pillar lines, or in return air, must have a classification label attached and must originate from a blue outstation.

   b. Alarms must be located where they can be seen and heard when an alert (warning) or alarm condition exists.

2. Test the section alarm.

   a. If a test button is available, have section mechanic or other management-designated person activate alarm.

   b. If a test button is not available, have management activate alarm by any method availabe (from surface station, by applying carbon monoxide calibration gas, etc.).

F. Hand-held CO detectors (if applicable).

1. Hand-held detectors must be used to enable the belts to continue to operate when all or part of the CO monitoring system fails.

2. Check if persons designated to monitor for CO with hand-held detectors are properly trained.

   a. Persons designated should know when monitoring is required and know what steps must be taken when CO is detected.

   b. Persons designated should be trained in the use of the specific instrument used at the mine.

c. If the operator intends on operating the belt conveyor when a malfunction of the entire system occurs, determine if a sufficient number of persons are trained to comply with the requirements for operation of the belt conveyors.

3. Hand-held detectors should be readily available for use at the mine.

   a. Determine if a sufficient number of instruments are available, and calibrated for use so that the operator can hand monitor as his/her procedures indicate.

IV. Response to observed alarms

If an inspector is at the mine when the carbon monoxide monitoring system activates an alarm signal, he/she should determine if the response was in accordance with the approved plan. (Note: Do not initiate alarms to observe the reaction of personnel.)

V. Training and instruction of personnel

A. Determine if personnel have been trained in procedures to be followed when an alarm activates.

B. Check approved Training Plan to determine if the CO monitoring system alarm response is included.