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AUTOMATIC FIRE SENSOR AND WARNING DEVICE SYSTEMS USING CARBON MONOXIDE SENSORS AND ATMOSPHERIC MONITORING SYSTEM INSPECTION PROCEDURE

PREFACE

This handbook sets forth inspection procedures to follow when conducting inspections of automatic fire sensor and warning device systems using carbon monoxide sensors and atmospheric monitoring systems. Previously issued procedural instruction letters and administrative instructions and handbooks for this subject material are superseded by this handbook. Compliance related policies that are contained in the Mine Safety and Health Administration (MSHA) Program Policy Manual are not superseded by this handbook.

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Chapter 1
INTRODUCTION

A. Purpose

This revised handbook sets forth procedures for inspection of atmospheric monitoring systems (AMS) and automatic fire sensor and warning device systems conducted by Mine Safety and Health Administration (MSHA) compliance specialists who are trained to conduct in-depth inspections of these systems (salient portions of E01 inspection duties related to AMS and automatic fire sensor and warning device systems conducted by regular inspectors are contained in the Inspection Procedures Handbook). An AMS is a network consisting of hardware and software meeting the requirements of § 75.351. An automatic fire sensor and warning device system is a network consisting of hardware and software meeting the requirements of § 75.1103-4. Both are capable of measuring atmospheric parameters; transmitting the measurements to a designated surface location; providing alert, alarm, or warning signals and processing atmospheric data. An AMS system meeting the requirements of § 75.351 would satisfy the requirements of an automatic fire sensor and warning device system under § 75.1103-4. However, an automatic fire sensor and warning device system may not satisfy the requirements of an AMS system.

Chapter 2 contains pre-inspection guidance and lists the information and documentation enforcement personnel need for inspection activities. Chapters 3, 4, and 5 discuss details of evaluating parameters and functions of AMS and automatic fire sensor and warning device systems required by health and safety standards, granted petitions for modification (PFM), Emergency Response Plans (ERP), and mine ventilation plans. Chapter 6 addresses training requirements. Appendix I contains an inspection checklist an MSHA inspector may use for reference. Appendix II is a list of questions an MSHA inspector can use to verify the qualifications of an AMS operator in accordance with § 75.156.

Examples included in this handbook are provided for clarification purposes.

B. Authority

Enforcement authority depends on the purpose of the installation. An AMS may be required; under 30 CFR § 75.323(d)(1)(ii) to monitor for methane in the return split alternative; under § 75.340(a)(1)(ii) and (a)(2)(ii), to monitor intake air used to ventilate electrical installations; under § 75.350(b) to use air from the belt entry to ventilate working sections or areas where mechanized mining equipment is being installed or removed; under § 75.350(d), to monitor point-feed regulators;

or § 75.362(f), to continuously monitor for methane in return splits. Where an AMS is used to meet the above requirements, the AMS must meet the requirements contained in 30 CFR §§§ 75.350, 75.351 and 75.352.

An automatic fire sensor and warning device system that uses carbon monoxide sensors to provide identification of fire along belt conveyors as required by § 75.1103-4 must meet the requirements contained in 30 CFR §§ 75.1103-1 through 75.1103-8.

Additional details of the AMS may be contained in the approved mine ventilation plans. Failure to follow requirements set forth in that plan should be cited under § 75.371.

The Approval and Certification Center (A&CC) evaluates AMS and automatic fire sensor and warning device systems to ensure that the electric circuit feeding the sensors will not ignite methane. Components installed in areas where permissible equipment is required must be intrinsically safe or in explosion-proof enclosures. Systems evaluated and accepted by A&CC must be installed and maintained as evaluated. The failure to maintain the system in permissible condition should be cited under §§ 75.503, 75.507, or § 75.1002 as appropriate.

Chapter 2
PRE-INSPECTION INFORMATION

A. Review the applicable standards of 30 CFR, as well as any applicable provisions in a § 101(c) PFM, Ventilation Plan, Evacuation Plan, Training Plan, and Emergency Response Plan to determine:

1. The mandatory standards that govern the installation and use of the AMS which include the following: the installation requirements specified by §§ 75.350 and 75.351; the actions required in response to the AMS malfunction, alert and alarm signals specified by § 75.352; system requirements in the mine ventilation plan specified by § 75.371; the fire detection and calibration requirements of § 75.351, and any other applicable standard. Some petitions for modification include additional AMS requirements.

2. The mandatory standards that govern the installation and use of an automatic fire sensor and warning device system include the following: the installation requirements specified in § 75.1103-4; the actions required in response to malfunction and warning signals specified in § 75.1103-5; the measurement and calibration requirements contained in § 75.1103-8; and any other applicable standards.

3. The required locations of all sensors, the maximum spacing between sensors, and maximum distance allowed between the downwind sensor and the belt drive, belt tailpiece, transfer point, belt take-up and electrical installations. In belt entries, the maximum spacing between sensors for both systems must not exceed 1,000 feet. Areas where sensor spacing is reduced to 500 feet or less when air velocities are between 50 and 100 feet per minute (fpm) for an AMS system; and areas where sensor spacing is reduced to 350 feet when air velocities are less than 50 fpm for AMS and automatic fire sensor and warning device systems. Velocities less than 50 fpm can only be used if approved by the district manager (DM) in the mine ventilation plan.

4. Whether the air velocities required in belt entries are compatible with the fire detection and fire suppression systems used in the belt entry as specified in § 75.350(a)(2);

5. The ambient, warning, alert and alarm levels, as applicable, for carbon monoxide or other gases being monitored by the system.

6. Procedures to be followed in the event of a partial or complete monitoring system failure.

7. Requirements specific to the mine, such as respirable dust sampling, use of diesel equipment, etc.

8. Required examinations, tests, calibrations, and records.

9. Locations where visual and audible signals are required.

10. Any special requirements as specified in the mine ventilation plan.

11. Locations of point-feed regulators approved in the ventilation plan ("point-feeding" is the process of providing additional intake air to the belt air course or another intake air course through a regulator).

12. The designated AMS operators and the designated surface location and the manned surface location where personnel have an assigned post of duty for an automatic fire sensor and warning device system.

13. If the approved training plan includes the following:

    a. Response to malfunctions, warning and other action levels.

    b. Annual training for AMS operators in the following subjects:

        i. Familiarity with underground mining systems;

        ii. Basic atmospheric monitoring system requirements;

        iii. The Mine Emergency Response Plan (ERP) and the Mine Firefighting and Evacuation Plan Program of Instruction;

        iv. The mine ventilation system including planned air directions;

        v. Appropriate response to alert, alarm and malfunction signals

        vi. Use of mine communication systems including emergency notification procedures; and

        vii. AMS recordkeeping requirements.

    c. A requirement that all AMS operators will travel to all working sections at least once every six months.

d. Task training for the personnel at the manned surface location for an automatic fire sensor and warning device system.

14. Map or schematic of the system.

Chapter 3
SURFACE INSPECTIONS

A. Check the mine operator's records for the following:

1. Calibration of CO Sensors.

   a. CO sensors are calibrated at intervals not to exceed 31 calendar days in accordance with §§ 75.351(n)(3) and 75.1103-8(c);

   b. Calibration records identify the date of each sensor calibration in accordance with §§ 75.351(o) and 75.1103-8(c). The specific sensor address or identifying number must be specified in the calibration record. For example, "sensor number 71, 72, 73, 74, 75 and 76 calibrated on 05-21-2012" would be acceptable.

   c. Records for AMS calibration must include the name, date, and signature of the individual entering the record; and

   d. AMS and automatic fire sensor and warning device system calibration records are to be retained for a period of one year and AMS records must not be susceptible to alteration and must be kept separate from other mine records in a secure book or electronically in a computer system that is secure.

2. Examination and testing.

   a. Visual examinations of the system are performed at least once each coal-producing shift in accordance with §§ 75.351(n) and 75.1103-8(a). The examination may be conducted as part of the on-shift or preshift examinations. Any system deficiencies identified should be recorded as hazardous conditions in the examination record books.

   b. A functional test is performed at least once every 7 days in accordance with §§ 75.351(n)(2) and 75.1103-8(a). This test requires the application of gas with a known concentration of CO sufficient to activate the alert, alarm, or warning signals as applicable. Gas only needs to be applied to a sufficient number of sensors to activate every alarm or warning signal.

c. Records of functional tests for AMS and automatic fire sensor and warning device system must be retained for a period of at least one year. AMS functional test records must not be susceptible to alteration, must be identifiable by a title, and must be kept separate from other mine records in a secure book or electronically in a computer system that is secure.

3. Designated AMS operators and other appropriate personnel.

a. Verify that the names of designated AMS operators and other appropriate personnel, including the designated person responsible for initiating emergency mine evacuation, and the methods to contact these persons, are provided at the designated surface locations, as specified by § 75.351(b)(4). Appropriate personnel are those miners who take required actions depending on the type of signal received.

b. Verify that AMS operators and personnel responsible for responding to automatic fire sensor and warning device system signals have received task training. Verify that AMS operators are trained annually in accordance with § 75.351(q)(1) and travel to all working sections is completed at least every six months in accordance with § 75.351(q)(2). If an AMS operator is not properly trained he must be immediately withdrawn from the mine in accordance with section 104(g)(1) of the Act.

c. Verify that the records of the training, the person conducting the training, and the date the training was conducted are maintained at the mine for at least one year by the mine operator as specified in § 75.351(q)(3).

B. <u>Check mine maps or schematics for the following</u>:

1. A map or schematic is provided at designated surface locations.

a. Verify the locations and type of sensors are provided on the map or schematic required by §§ 75.351(b)(3) and 75.1103-5(a)(2)(ii).

b. Verify that the locations of CO sensors are indicated on the mine maps required by §§ 75.1200 and 75.1505, as specified in § 75.1103-4(a)(1)(iv). The § 75.1200 map is required to be located in a fireproof repository. The § 75.1505 map is required to be located at each working section, where mechanized equipment is installed or removed, at refuge alternatives, and at a surface location where miners congregate.

c. Verify the intended air flow direction at sensor locations are provided on the map or schematic as specified by §§ 75.351(b)(3) and 75.1103-5(a)(2)(ii).

2. The map or schematic is accurate.

   a. Verify the accuracy of the map or schematic by using information obtained through inspection of the mine and by using a current list of active sensors.

   b. Verify that maps or schematics are updated within 24 hours of any change in the information as specified in §§ 75.351(b)(3) and 75.1103-5(a)(2)(ii).

NOTE: The underground inspection of the system can be facilitated by obtaining a hard copy of the map or schematic. If a copy is not available, the inspector should draw a schematic of the system for the areas where travel is anticipated.

C. <u>Observe operation of the system.</u>

1. Check video display terminal for the following:

   a. All outstations and sensors are scanned by the system (compare with map or schematic showing location of sensors). Determine the operational status of the sensors. Sensors indicating communication failures should be noted and examined during underground inspection.

   b. Abnormal levels, high or low, in sensor readings. These levels may indicate a sensor calibration drift or an older sensor beginning to fail. High readings can also indicate an actual level of the gas being monitored. If there is any abnormality, ensure that the system operator is aware of it and is following the appropriate procedures.

   c. The sensor levels indicated on the display terminal are stable and are not fluctuating over a wide range each time a sensor is scanned. Erratic readings are not normal and may indicate a malfunctioning sensor. Note the locations of sensors with abnormal or erratic readings for follow-up during the inspection.

   d. Ensure that the CO readings shown on the display reflect the established ambient level in the Ventilation Plan, § 75.371(hh). If the ambient level is not set properly, a violation should be issued under § 75.371.

   e. Determine that the malfunction, alert, alarm, warning signal or other action level are indicated on the surface display when a sensor is activated.

2. Review sensor records.

   Where possible, evaluate the number of AMS sensor alarms due to sensor or system malfunction, or due to interfering gasses such as hydrogen, that may affect the function of CO sensors. Where sensor alarms are caused by hydrogen interference, the inspector should cite § 75.340(a)(1)(ii) and require the mine operator to replace the sensor(s) with a type that is not affected by hydrogen. Also, evaluate the number of occurrences of alarms due to CO produced by diesel engine exhaust. Where alarms are excessive due to diesel exhaust, the district manager may require the use of diesel-discriminating sensors in the mine ventilation plan. Also, check for the following:

   a. Records of abnormal readings. Readings from sensors over extended time periods can be used to detect abnormalities.

   b. Records that identify communication failures between the sensors and computer.

   c. The number of sensors indicated in the record is consistent with those specified on the map or schematic.

   d. AMS records for malfunctions, maintenance performed, alerts, alarms, and action level readings; the cause for activation; and corrective action taken. These records should include alert and alarm reports from personnel monitoring the belt entry with a CO detector during system malfunction.

   e. Records of CO sensor calibrations and functional tests.

3. Determine and evaluate the means of de-energizing the monitoring system during a main mine fan stoppage ("kill feature"). The “kill feature” is the means of de-energizing non-permissible battery–powered circuits from a surface location. Section 75.313 requires removal of power from underground circuits upon a fan stoppage, except for AMS circuits operated during fan stoppages that are intrinsically safe. In some monitoring systems, the de-energization of the outstations can be accomplished from the main console on the surface and observed on the monitor screen or digital readout. After the "kill feature" has been initiated, all batteries must be manually reset at each underground battery location after power has been restored to the fan. The method used to de-energize the underground batteries can be determined by examination of the system operator’s station; this may be an automatic action or it may require input from the system operator. The system operator should be able to explain the “kill feature.” A system with battery backup power supplies that cannot be

disconnected remotely from the surface must be intrinsically safe or be provided with means, such as a relay, to disconnect the battery power supply to comply with the requirements of §§ 75.313, 75.323(b)(1)(i), and 75.1103-7. A manually operated switch actuated by a miner leaving the section is not an acceptable means to disconnect the batteries.

4. Ensure that the system can provide the 4-hour fire detection capability as specified by § 75.1103-4(e). If the system does not have the capability, review the mine operator's established procedure for examining the belt haulageways for hot rollers and fire.

5. Determine the means of disconnecting the data line because it is considered a power circuit on all systems.

6. Obtain a copy of the installation and maintenance check-list provided by the manufacturer to the mine operator. A copy of the check-list can also be requested from A&CC for any MSHA-evaluated systems. Inspectors can use the equipment manufacturers' installation and maintenance check-lists to familiarize themselves with system operation and aid in the inspection and testing of the system.

7. Verify that the AMS operator is properly trained. A list of additional questions that can be used to evaluate the system operator's knowledge is included in Appendix II.

    a. Verify whether AMS operators and the person trained to respond to warning signals for automatic fire sensor and warning device systems have received task training. Verify that AMS operators received annual training in the following subjects:

        i. Familiarity with underground mining systems;

        ii. Basic atmospheric monitoring system requirements;

        iii. The mine emergency evacuation and firefighting program of instruction;

        iv. The mine ventilation system including planned air directions;

        v. Appropriate response to alert, alarm and malfunction signals;

        vi. Use of mine communication systems including emergency notification procedures; and

vii. AMS recordkeeping requirements.

b. Verify that all AMS operators have traveled to all working sections at least once every six months.

c. Verify whether a record of the training, the person conducting the training, and the date the training was conducted are maintained at the mine for at least one year by the mine operator as required under § 75.351(q)(3).

d. Verify that the AMS operator is qualified as required under § 75.156. Determine if appropriate personnel as defined in § 75.301, understand the actions that must be taken when an alarm level or malfunction has been indicated.

e. Ensure that the designated system operator is trained to initiate the "kill feature" to disconnect all battery circuits and the data line.

f. Verify that the system operator is notified prior to sensor calibration if calibration causes alarms, and that the system operator is informed when calibration is completed. Other activities such as cutting and welding may also require prior notification to the system operator. Verify that the system operator notifies miners in affected areas when these activities are taking place. See §§ 75.351(n)(3)(iv) and 75.1103-5(g).

g. Verify if the AMS operator is trained to monitor and promptly respond to all AMS signals. The AMS operator must have as a primary duty the responsibility to monitor the malfunction, alert and alarm signals of the AMS, and to notify appropriate personnel of these signals. In the event of an emergency, the sole responsibility of the AMS operator shall be to respond to the emergency as required in § 75.351(b)(2).

D. <u>Check visual and audible alarms on the surface.</u>

Check locations of alarms, and duties of the designated system operator.

1. Verify that the visual and the audible signals, caused by malfunction or elevated concentrations of contaminants, can be seen or heard at all designated work areas, as required by § 75.351(c) and provide an effective warning as required by § 75.1103-5(a)(2).

2. Verify that the visual and audible alarm signals from the AMS are distinguishable from the alert signals. Determine if methane signals are also distinguishable from all other signals for the AMS as required by § 75.351(c)(4).

3. Verify an automatic fire sensor and warning device system is provided with a manual reset for the fire warning device as required in § 75.1103-5(c). A system with an automatic reset feature does not ensure that the operator is aware of malfunction or warning signals.

E. <u>Check the communication system between the surface and underground.</u>

1. Verify that a two-way communication system is provided at the designated location to allow communication with all working sections, areas where mechanized equipment is being installed or removed, and other areas designated in the Evacuation Plan as required by §§ 75.351(b)(1) and 75.1103-5(a)(2)(i).

F. <u>Check for lightning arrestors.</u>

Verify that exposed ungrounded data line conductors and exposed telephone wires are provided with suitable lightning arresters located within 100 feet of the point where the they enter the underground portion of the mine as required by § 75.521. Conductors that are: provided with metallic shields; jacketed by a grounded metal covering or enclosure; installed under grounded metal framework; or buried in the earth, are not considered "exposed" for the length so protected.

Chapter 4
UNDERGROUND INSPECTIONS

A. Direction of air flow in belt entries.

Check the direction of the air flow to ensure compliance with the requirements of §§ 75.351(b)(3), 75.1103-5(a)(2)(ii), and the approved Ventilation Plan. Verify that conditions found underground are consistent with air flow directions indicated on the surface map or schematic.

B. Air velocities in belt entries.

1. For automatic fire sensor and warning device systems that use carbon monoxide sensors to provide identification of fire along all belt conveyors, verify that the air velocities are at least 50 fpm along all belt conveyors unless a lower velocity is approved in the mine Ventilation Plan. Verify that the sensor spacing is not greater than 350 feet in areas where the air velocity is less than 50 fpm. For AMS verify that the air velocity is at least 100 fpm. In areas where lower velocities are approved in the Ventilation Plan, assure sensor spacing is compatible with the air velocity (not greater than 350 feet in areas where the air velocity is less than 50 fpm, not greater than 500 feet where the air velocity is between 50 and 100 fpm). A system is considered to be inoperative if the air velocity is less than 100 fpm for AMS or where the velocitry is less than 50 fpm for automatic fire sensor and warning device systems and the sensor spacing has not been reduced. The system would be operative once the air velocity is re-established or decreased sensor spacing is approved and established.

2. Verify that the air velocities are no greater than the maximum allowable velocities (1000 fpm for mines using air from the belt entry to ventilate a working section). If air velocities are higher than 500 fpm, dilution of the fire contaminants that affect the fire detection capabilities may occur. The inspector should note the areas and associated air volumes/velocities and report them to his/her supervisor. Generally, velocities less than 500 fpm, but greater than 50 fpm, should not be a concern.

3. When determining air velocities, representative cross-sectional areas of the entries should be used. Large areas such as belt channels, boom holes or fall areas should not be used, nor should restricted areas such as overcasts be used for determination of air velocities.

C. <u>Installation of sensors and cables.</u>

1. Verify that CO sensors and cables are installed as follows:

    a. In the upper third of the entry (height), near the center of the entry (width) as required by §§ 75.351(d)(2) or 75.1103-4(b), see Figures 1 and 2;

    b. In a manner that will provide protection to the sensor from roof falls and the moving belt and its load in accordance with § 75.1103-4(b);

    c. In a manner that does not expose personnel working on the system to unsafe conditions, including calibration and examination as required by §§ 75.351(d)(2) or 75.1103-4(b), see Figure 2;

    d. Not in abnormally high areas or in other locations where the air flow patterns do not permit products of combustion to be carried to the sensors as required by §§ 75.351(d)(2) or 75.1103-4(b); and

2. Verify that methane sensors are installed near the center of the entry, at least 12 inches from the roof, ribs, and floor in a location that would not expose personnel working on the system to unsafe conditions in accordance with § 75.351(d)(3).

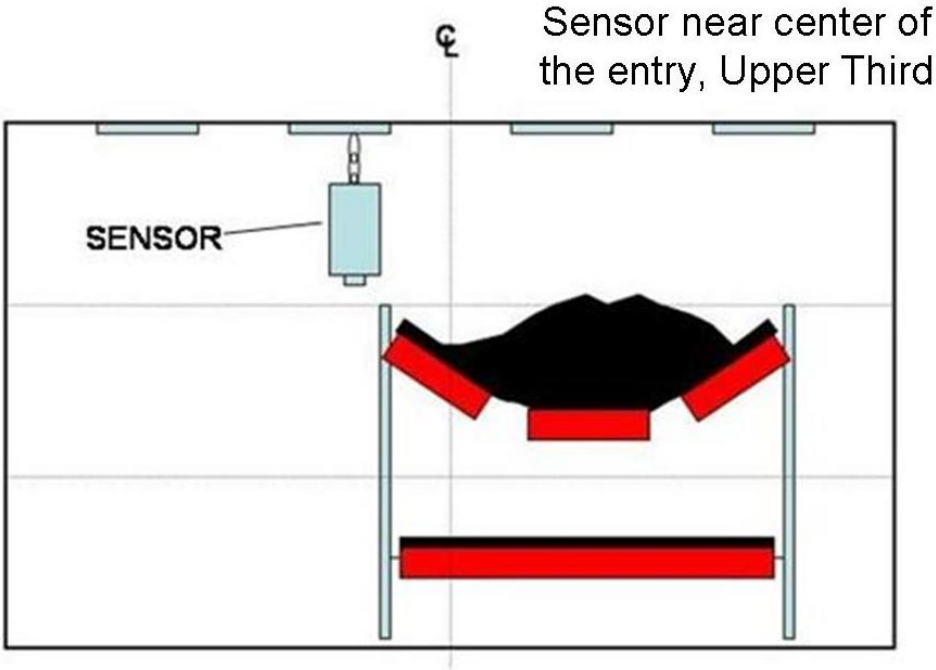


Figure 1 - Proper location of sensor

Figure 2 - Properly installed CO sensor

D. Installation of AMS communication system.

Since the enactment of the 2006 MINER Act, two-way communications are covered under the approved Emergency Response Plan. Communication systems that are installed in accordance with the approved ERP will be considered to meet the requirements of § 75.351(r).

E. Location of sensors.

Determine if the sensors are installed as shown on the map or schematic located at the designated surface location. Check the locations and types of sensors at each of the following areas:

1. For Belt Entries—

   a. Verify that the sensors are installed in accordance with the locations specified in the Ventilation Plan, PFM, and §§ 75.351(e) and 75.1103-4 as applicable:

      i. For an AMS, at or near the working section belt tailpiece in the air stream ventilating the belt entry. In longwall mining systems using air from the belt entry to ventilate the section, the sensor must be located upwind in the belt entry at a distance no greater than 150 feet from the mixing point where intake air is mixed with the belt air at or near the tailpiece, § 75.351(e)(1)(i). See Figure 3. This mixing point is not considered a point-feed. For automatic fire sensor and warning device systems that use carbon monoxide sensors to provide identification of fire along belt conveyors, a sensor is required not more than 100 feet downwind of each section loading point, § 75.1103-4(a)(1)(ii);

      ii. Upwind, a distance no greater than 50 feet from the point where the belt air course is combined with another air course or splits into multiple air courses, § 75.351(e)(ii). See Figure 4;

      iii. For a mine not using air from the belt entry to ventilate the working section, at intervals not to exceed 1,000 feet along each belt entry in areas where air velocities are maintained at 50 fpm or higher. In areas along each belt entry where air velocities are less than 50 feet per minute, the sensor spacing must not exceed 350 feet, § 75.1103-4(a)(1)(iii). See Figure 5;

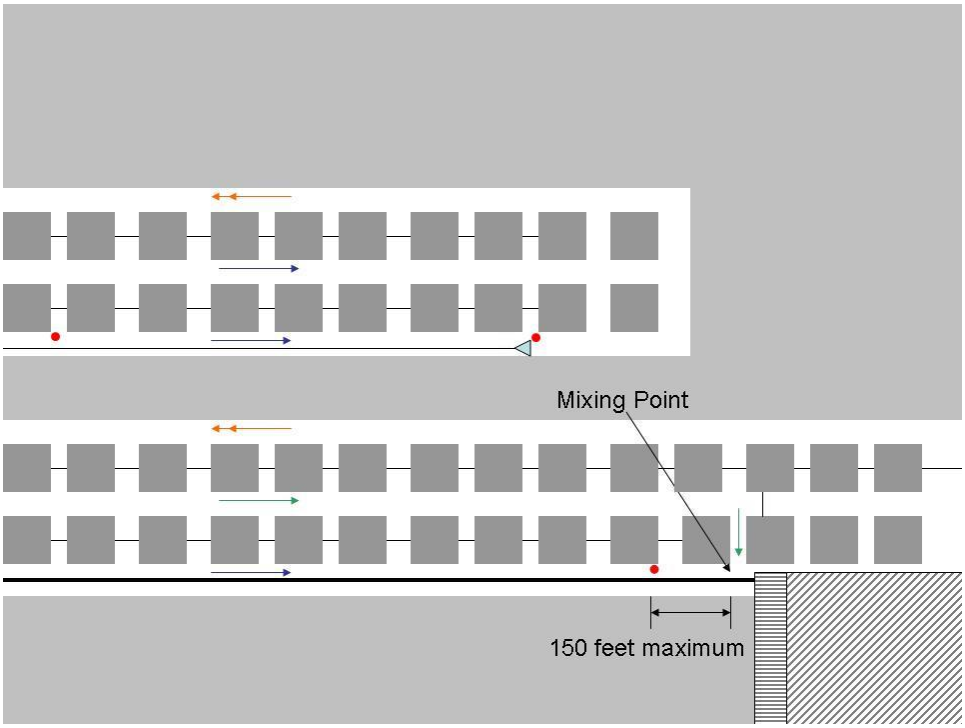


Figure 3 - Sensor installations near section loading point.

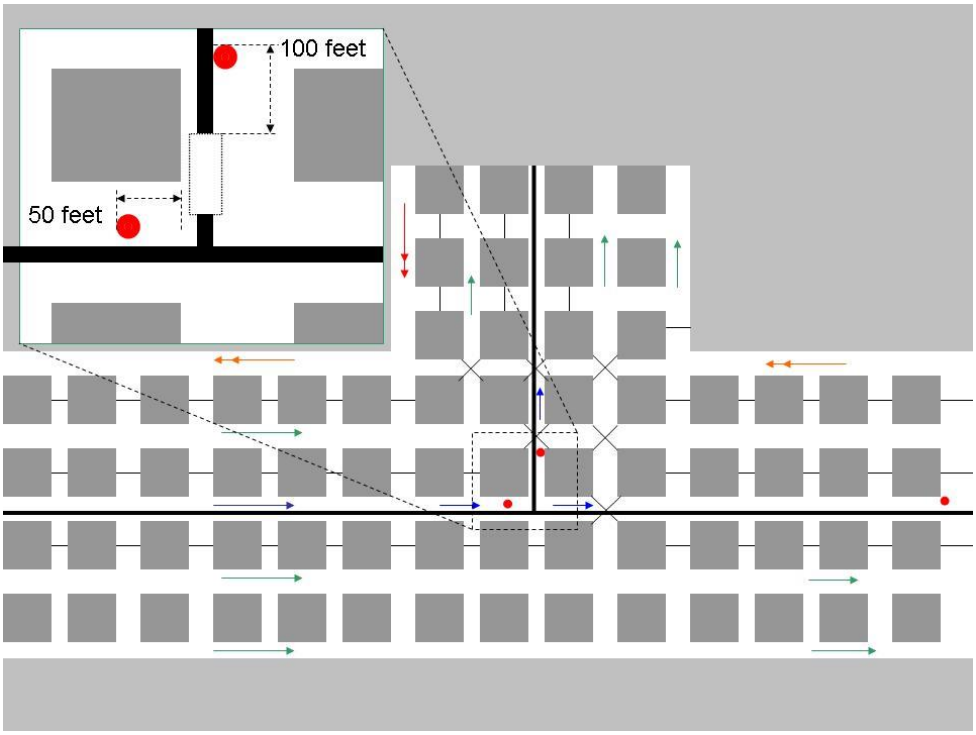


Figure 4 - Location of required CO sensors where air split.

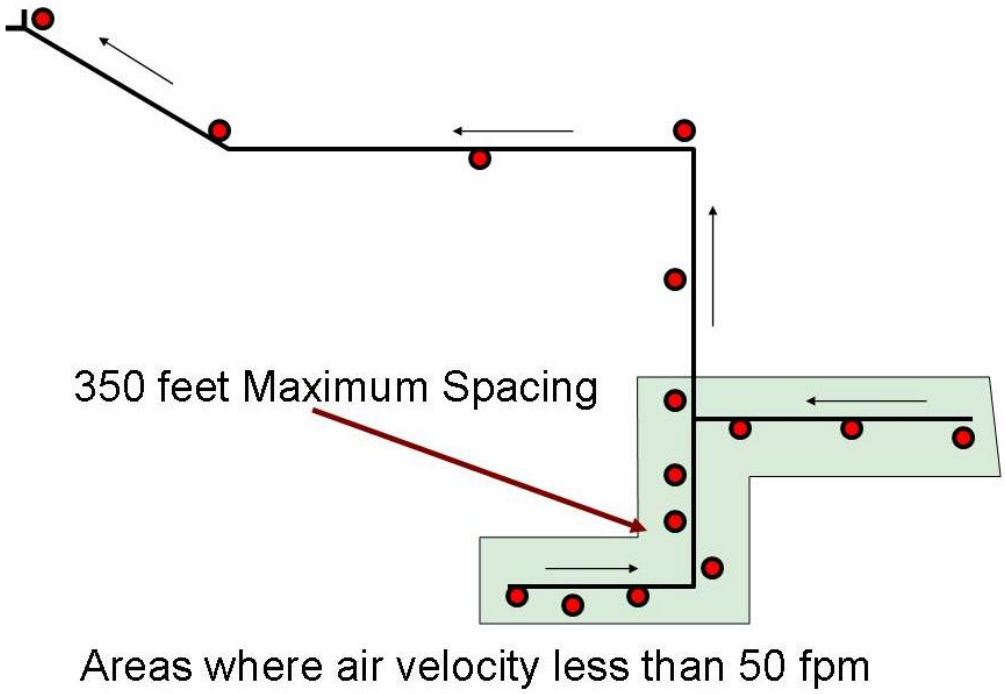


Figure 5 - Sensor spacing – Mine not using air from belt entry to ventilate working sections

iv. For a mine using air from a belt entry to ventilate a working section, at intervals not to exceed 1,000 feet along each belt entry in areas where air velocities are maintained at 100 fpm or higher, and at or below 500-foot intervals where the velocity is between 50 and 100 fpm. In areas along each belt entry where air velocities are approved to be less than 50 fpm, the sensor spacing must not exceed 350 feet, § 75.351(e)(1)(iii). See Figure 6;

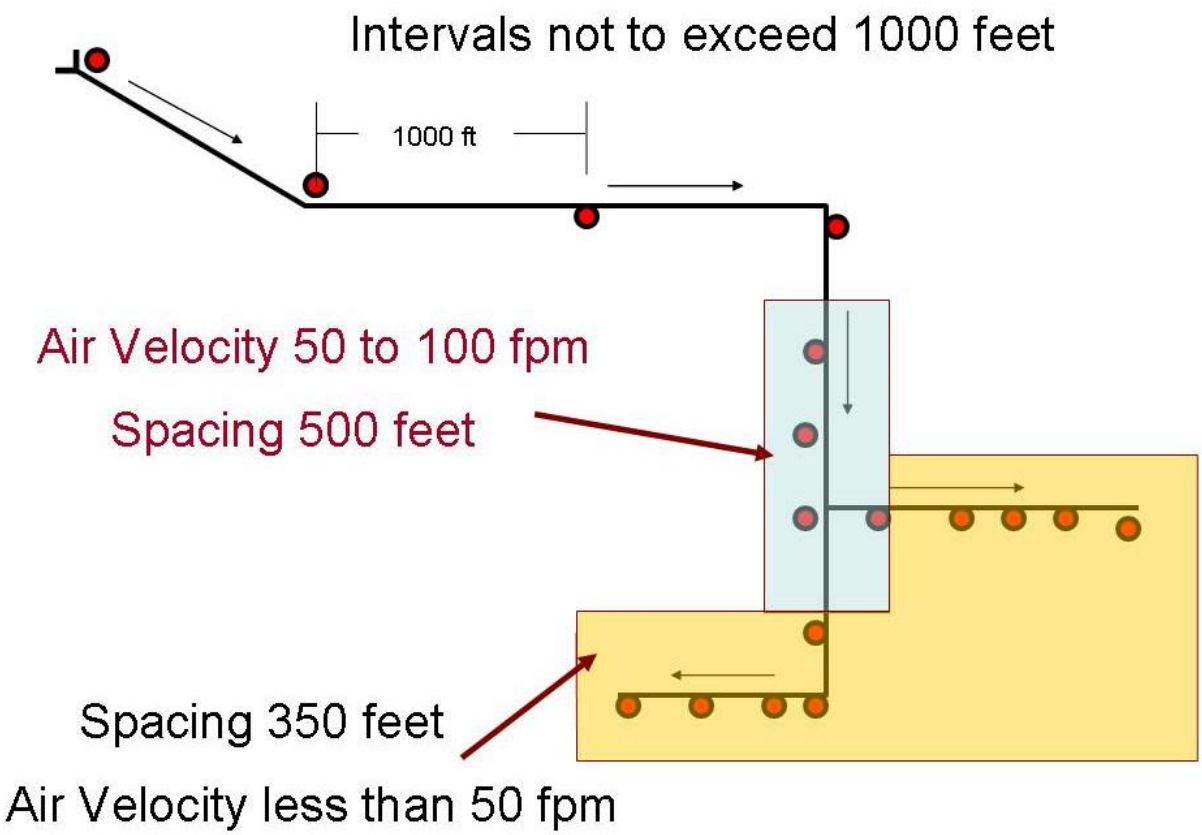


Figure 6- Sensor spacing – Mine using air from belt entry to ventilate working sections

v. Not more than 100 feet downwind of each belt drive unit, each tailpiece, transfer point, and each belt take-up. If the belt drive, tailpiece, and/or take-up for a single transfer point are installed in the same air course and the distance between the units is less than 100 feet, they may be monitored with one sensor not more than 100 feet downwind of the last component. If the distance between the units exceeds 100 feet, additional sensors are required downwind of each belt drive unit, each tailpiece, transfer point, and each belt take-up, § 75.351(e)(2)(ii) or § 75.1103-4(a)(1)(i). See Figures 7, 8 and 9;

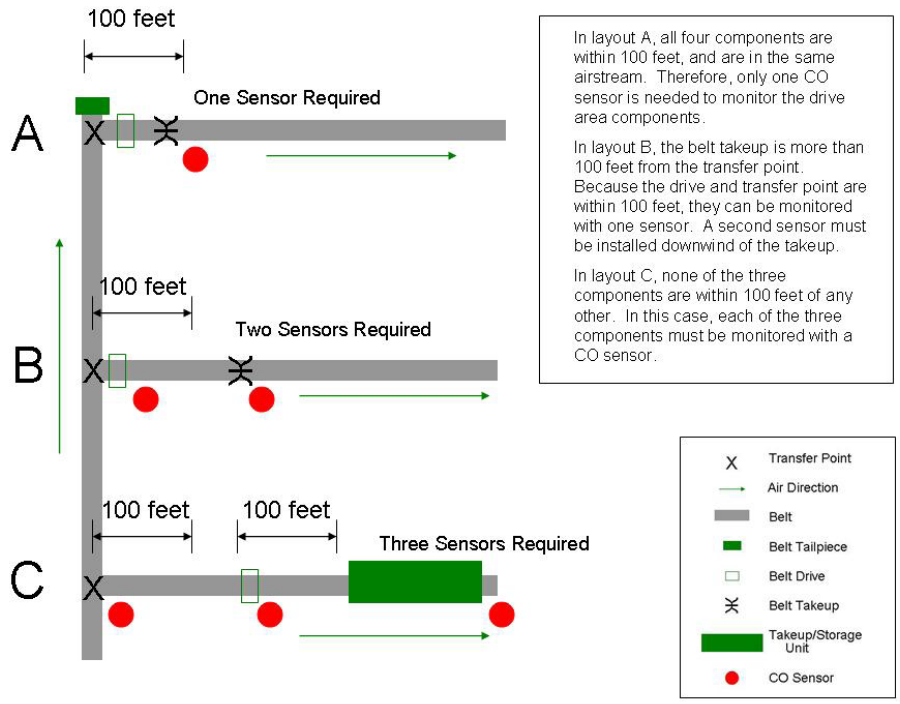


Figure 7 – Sensors required at belt drives - Multiple components

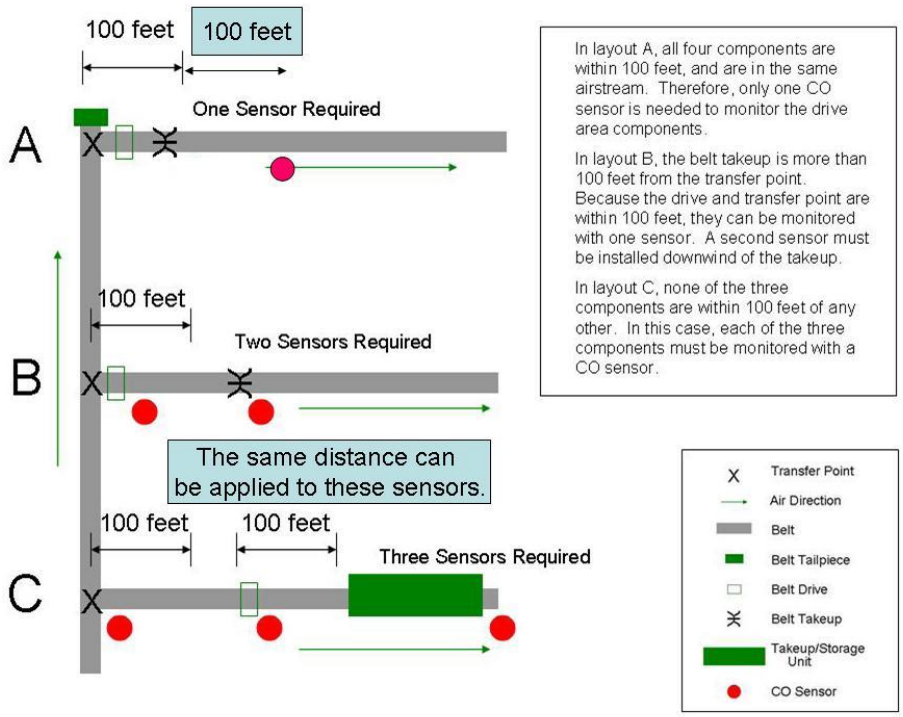


Figure 8 - Sensors required at belt drives - Multiple components

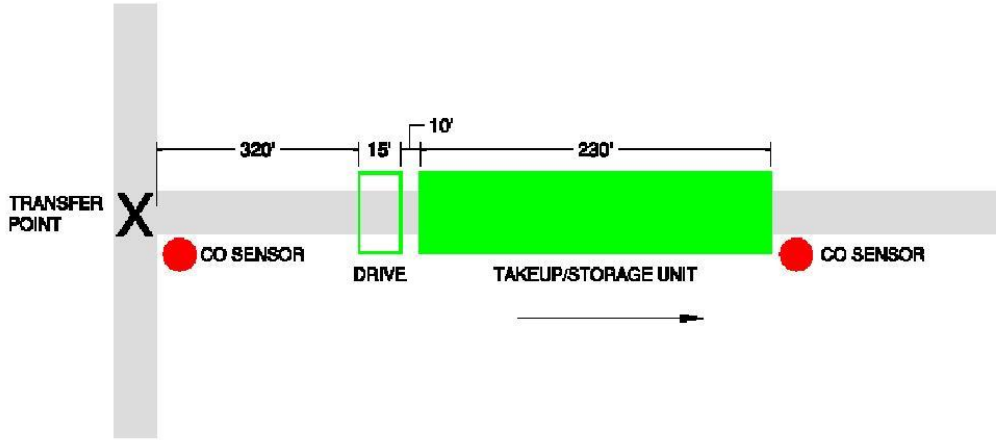


Figure 9 - Sensors required at belt drives - Multiple components

vi. At other locations in any entry that is part of the belt air course as required and specified in the Ventilation Plan, § 75.351(e)(1)(v);

vii. In the intake entry at a location 50 feet upwind of the point-feed regulator if the air through the point-feed regulator enters a belt air course which is used to ventilate a working section or an area where mechanized mining equipment is being installed or removed. A second sensor must be located 1,000 feet upwind of the point-feed regulator unless a lesser distance has been approved by the district manager, § 75.350(d)(1). See Figure 10;

viii. In the belt entry at a location upwind of the mixing point point-feed regulator if the air through the point-feed regulator enters a belt air course which is used to ventilate a working section or an area where mechanized mining equipment is being installed or removed. This sensor must be in the belt air course within 50 feet of the mixing point where air flowing through the point-feed regulator mixes with the belt air, § 75.350(d)(2). See Figure 10;

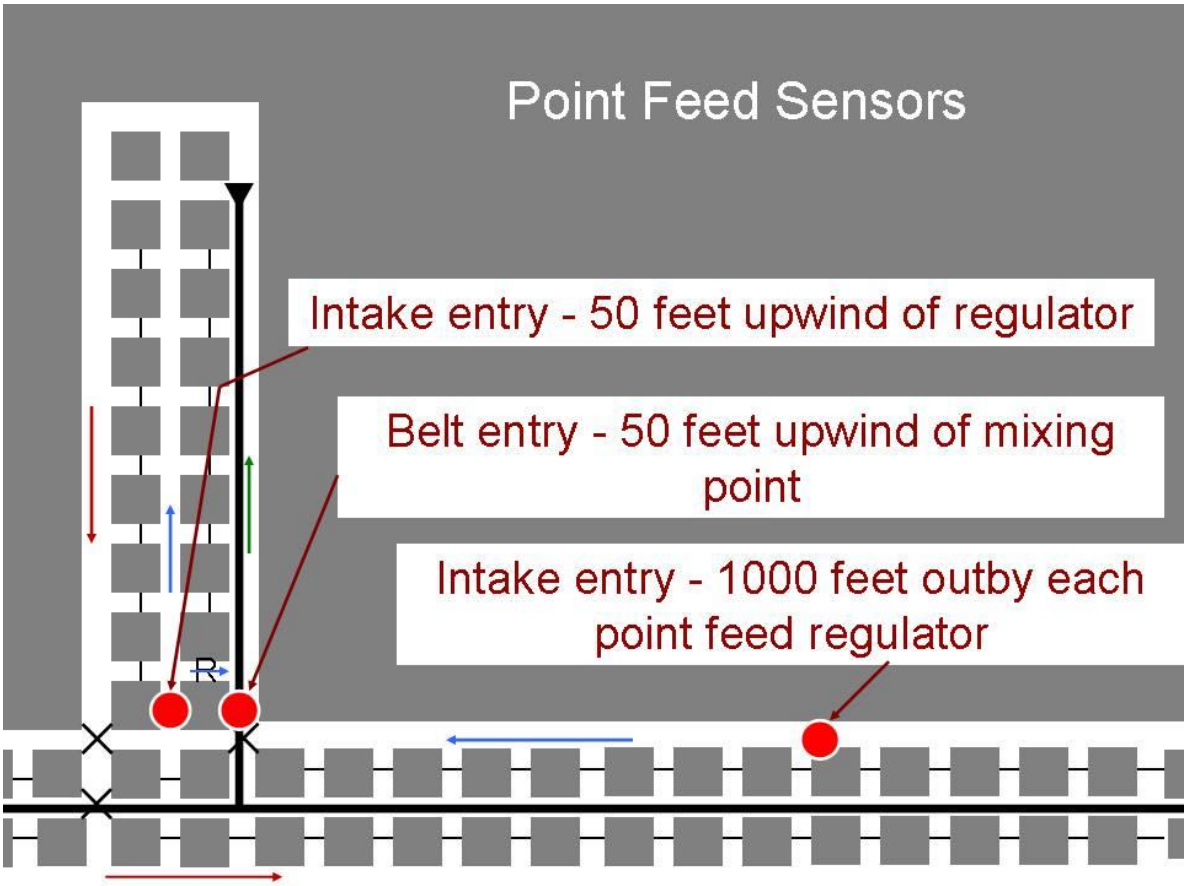


Figure 10 - Point-feed regulator and CO sensor locations

b. Determine if additional sensors are required.

If during an inspection it is determined that additional sensors are needed to fully monitor the belt entry for fire, the concern should be discussed with the field office supervisor or ventilation specialist for further action.

2. For Primary Escapeways—

When air from the belt entry is used to ventilate the working section, CO sensors must be located in accordance with § 75.351(f) as follows:

a. In the primary escapeway within 500 feet of the working section and areas where mechanized equipment is being installed or removed. See Figure 11.

b. Within 500 feet inby the beginning of the panel. The point-feed sensor required by § 75.350(d)(1) may also serve as the sensor at the beginning of the panel if it is within 500 feet of the beginning of the panel. See Figure 11.

If the panel is 1,000 feet or less, one sensor may be sufficient to meet (a) and (b).

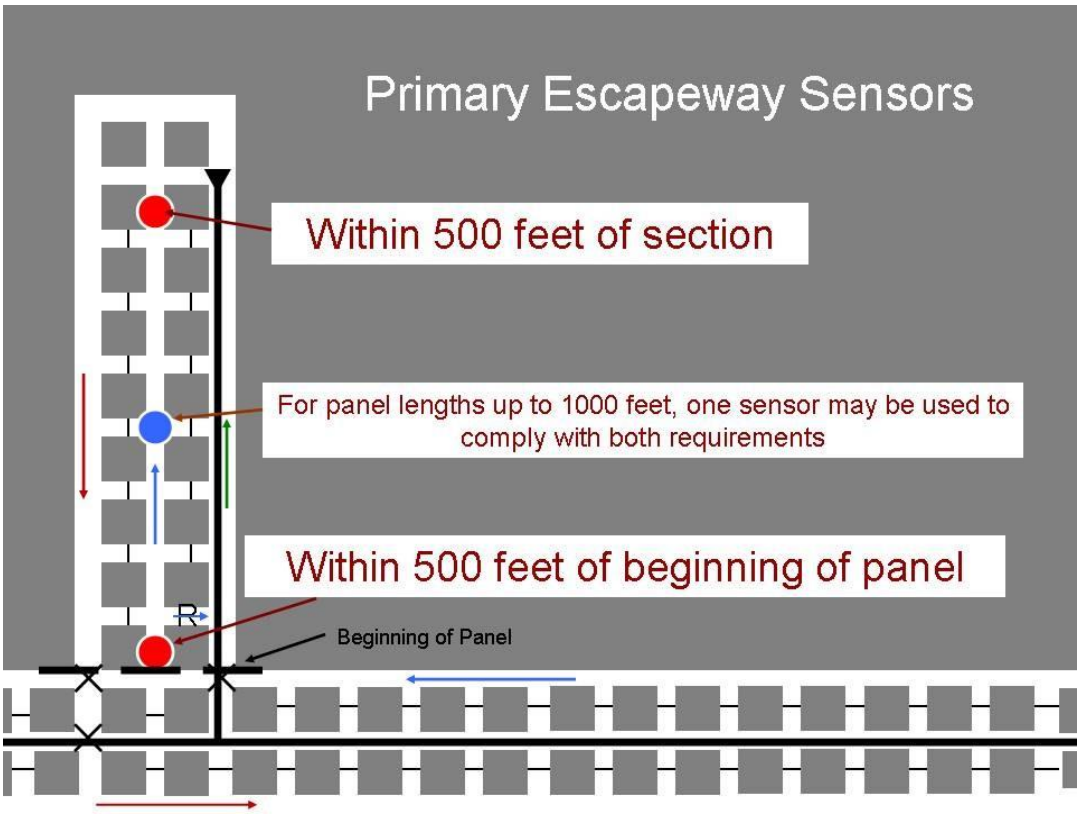


Figure 11 – Primary escapeway sensor locations – Mines using air from belt entry to ventilate working sections

3. For Return Air Splits—

If an AMS is used to monitor return air splits to comply with the on-shift requirements in § 75.362(f), verify that a methane sensor is installed in the return air split between the last working place, longwall or shortwall face ventilated by that air split, and the junction of the return air split with another air split, seal, or worked out area, § 75.351(g)(1).

a. If used to monitor a return air split under § 75.323(d)(1)(ii), verify that the methane sensors installed in the return air course opposite the section loading point, or, if exhausting auxiliary fan(s) are used, in the return air course no closer than 300 feet downwind from the fan exhaust and immediately upwind from the location where the return air split meets another air split or immediately upwind of the location where an air split is used to ventilate seals or worked-out areas, § 75.351(g)(2).

4. For Electrical Installations -

   a. When monitoring the intake air ventilating underground transformer stations, battery charging stations, substations, rectifiers, or water pumps under § 75.340(a)(1)(ii) or § 75.340(a)(2)(ii), verify that at least one sensor is located downwind and not greater than 50 feet from the electrical installation, as specified in § 75.351(h). Monitoring of intake air ventilating battery charging stations is to be done by sensors not affected by hydrogen as specified in § 75.340(a)(2)(ii).

   b. When monitoring unattended air compressors enclosed in a noncombustible structure or area which is ventilated with intake air coursed directly into a return air course or to the surface, verify that sensors are installed to monitor for heat and for carbon monoxide. The sensors are also required to de-energize power to the compressor, activate a visual and audible alarm located outside of and on the intake side of the enclosure, and activate doors to automatically enclose the noncombustible structure or area when the temperature reaches 165°F, or CO reaches 10 ppm above the ambient level for the area as specified in § 75.344(a)(2).

5. For Intake Air Heaters –

   As specified in § 75.341(f), when CO sensors are used to monitor intake air heaters, verify that any heater causing an elevated CO level is shut down when the concentration at the monitoring location reaches 50 ppm.

F. **Inspection/Calibration of CO sensors.**

Before inspection or calibration of sensors, the inspector should have the agent of the mine operator notify the system operator that sensors will be inspected, calibrated and checked for malfunctions. The system operator should verbally confirm the time and location of each alert, alarm, and malfunction signal, as applicable, when received.

1. Visually check sensors for blockage of airflow to assure that airflow patterns within the belt entry are not obstructed by objects such as cribs and posts that may interfere with contaminants reaching the sensors.

2. Check the sensor, the cable, and hose to the sensor for visible damage.

3. Compare sensor readings with hand-held CO detector readings.

4. Have the agent of the mine operator simulate a malfunction at the sensor unit. Verify that malfunctions for AMS are recorded at the designated surface location. A disconnection of wiring at the sensor unit that results in failure of the system is considered a malfunction.

5. Ensure that sensors and associated current-carrying conductors installed where permissible equipment is required have been evaluated by MSHA. Verify that the sensors are identified by an MSHA classification label, and that the barrier located at the blue outstation to protect the sensor circuit is also identified by an MSHA classification label that has same letter designation as the sensor classification.

6. Ensure that calibration gas is of sufficient concentration to activate all alarms. Sensors should respond within plus or minus 10% of the known concentration of the calibration gas.

7. Observe a function test of 10% of the total number of CO sensors, but not less than 5 sensors, using a known concentration of CO. Record the test reading and compare it to the known gas concentration.

8. Observe the calibration of at least one CO sensor to assure that the manufacturer's guidelines for calibration are followed. Some systems have a means to temporarily bypass the sensor during calibration to avoid false alarms. This feature should be used when available.

G. Outstations

While many systems use outstations for power and data acquisition, not all systems use outstations. Labeling requirements only apply if the system includes components located in areas where permissibility is required. If outstations are used, verify the following:

1. All outstations are located in intake air.

2. Outstations are identified as "RED" or "BLUE". If the outstation is not painted, verify that other means of identification are used to identify the outstation as red or blue. See Figures 12 and 13. Both red and blue outstations must be located in intake air.

   a. Red outstations are used only when sensors are located in intake air. Wiring passing into or through an area where permissible equipment is required may not be connected to a red outstation. Sensors used in an area requiring permissible equipment must not be connected to a red outstation.

   b. Blue outstations are used when sensors are located in either fresh air or areas where permissible equipment is required. Blue outstations are required to have the following:

      i. An evaluation label on the outstation,

      ii. A classification label on each power circuit (PC) barrier, and

      iii. A classification label on each letter class (LTR) barrier.

3. Verify the following if a blue outstation is connected to a sensor located in an area where permissible equipment is required:

   a. The system is wired in accordance with the acceptance drawing.

   b. The PC and LTR barriers are housed in separate compartments or enclosures.

   c. Intrinsically safe circuits are separated from non-intrinsically safe circuits as required by § 18.68(c)(3). Failure to maintain this separation is a violation of §§ 75.503, 75.507, or 75.1002, as appropriate.

   d. If LTR barriers are connected in parallel, note the barrier letter class and issue number and contact A&CC at (304) 547-0400 for evaluation.

Figure 12 – Examples of red outstations

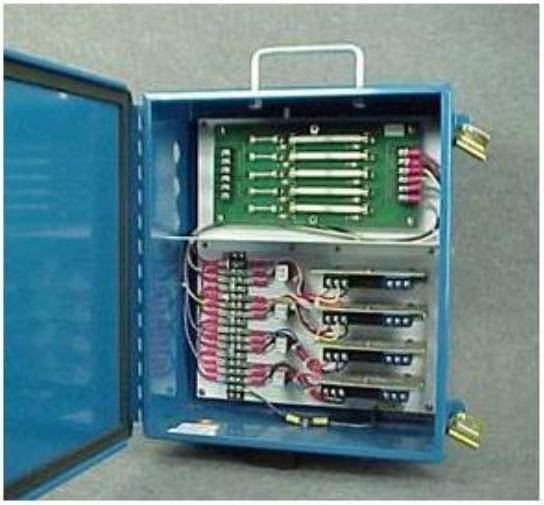


Figure 13 - Examples of blue outstations

e. The wiring of any non-classified sensors and alarm units connected to a blue outstation do not enter the classified (LTR) barriers compartment of the blue outstation. These non-classified sensors and alarm units that are connected to a blue outstation must not be connected to any electric equipment other than the blue outstation, unless a PC barrier is used, as shown on Figure 14.

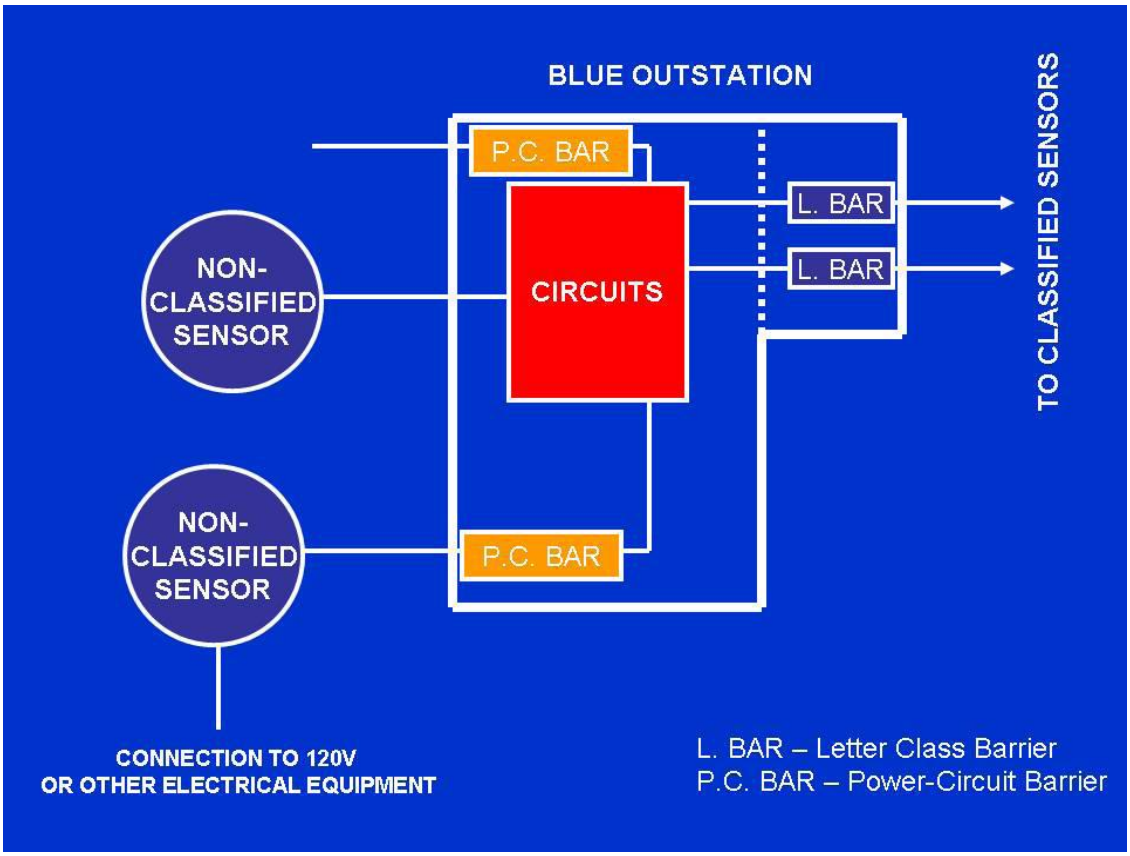


Figure 14 - Connection of non-classified sensors to blue outstation.

f. All sensors and alarm units connected to barriers have the same classification as the barrier.

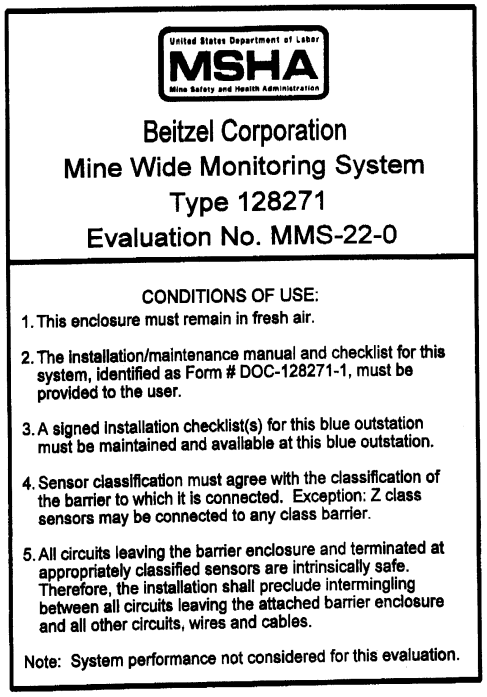
g. Verify the following when a blue outstation is connected to an explosion-proof (X/P) enclosure:

i. The evaluation label on the blue outstation indicates that connection to X/P equipment is permitted. See Figure 15.

ii. The barrier classification label is located on the exterior of the X/P enclosure and in close proximity to each and every barrier cable entrance. See Figure 16.

iii. The interconnection of the monitoring system with an X/P enclosure is shown on the equipment approval documentation on file at the A&CC or on an accepted Field Modification.

iv. Barriers (LTR and PC) installed inside the X/P enclosure correspond with the labels on the outside of the enclosure. See Figure 17.



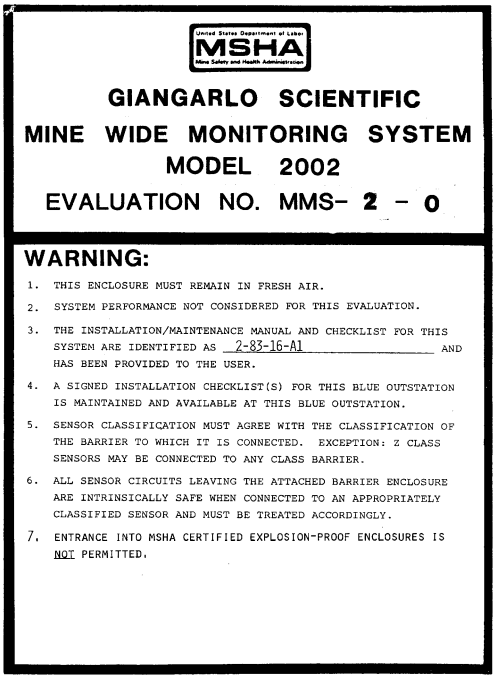


Figure 15 – Examples of blue outstation labels. Note the restriction on explosion-proof equipment in label on right.

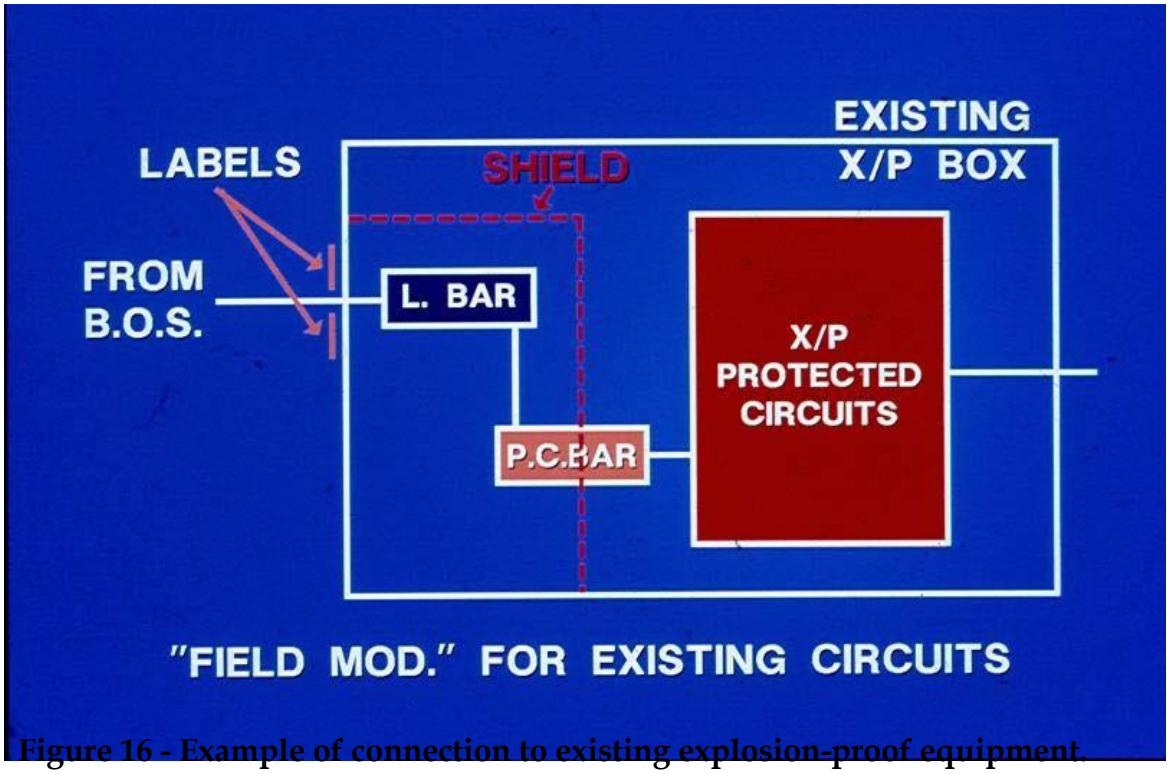


Figure 16 - Example of connection to existing explosion-proof equipment.

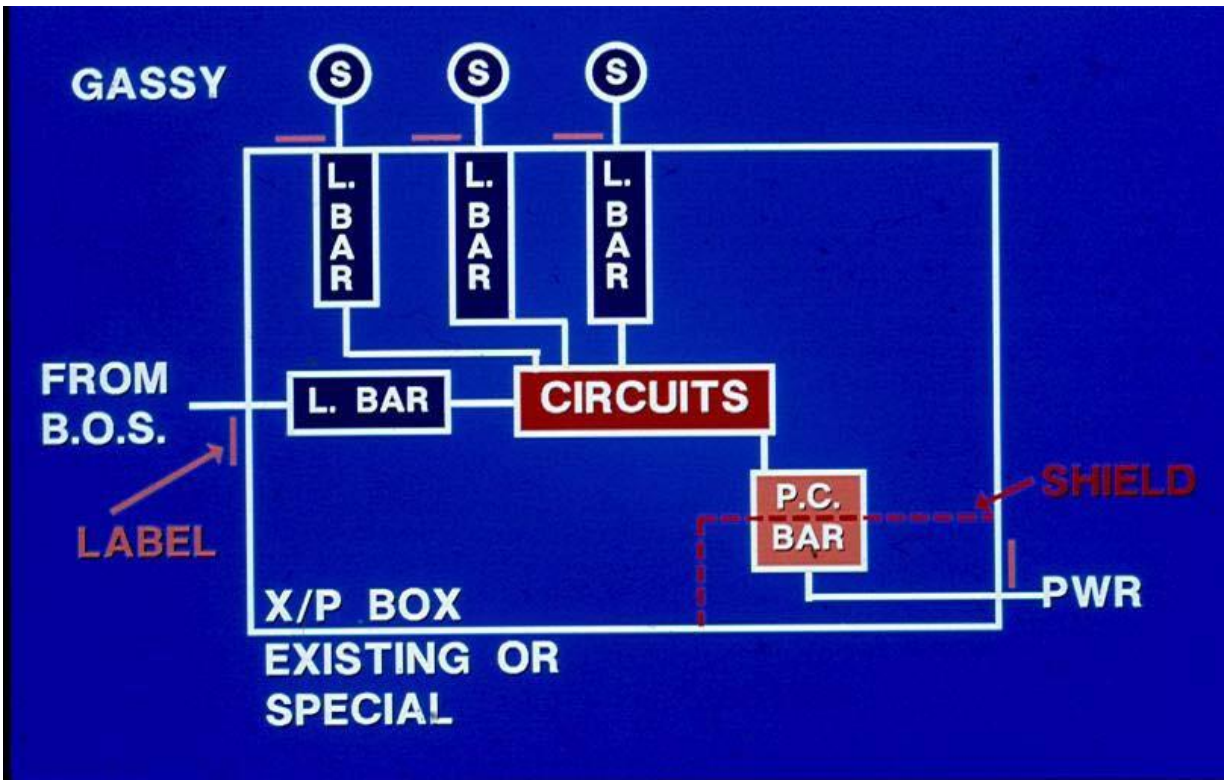


Figure 17 - Connection of blue outstation and sensors to explosion-proof enclosure. Labels shown at the cable entrances should match corresponding barrier.

H. Section alarms

Ensure that alarm units are located at all working sections, affected areas where mechanized equipment is being installed or removed, at other specified locations (Evacuation Plan, granted PFM, and Ventilation Plan), and at a manned location on the surface as required by §§ 75.351(c) and 75.1103-5. Examples of alarm units are shown in Figure 18.

Note: The carbon monoxide sensor can be up to 100 feet away from the section loading point for an automatic fire sensor and warning device system, but the alarm unit should be located to provide an effective warning signal. An AMS is required to have the sensor located at or near the section belt tailpiece.

1. Verify the following:

   a. Alarm units located in areas where permissible equipment is required (inby the last open crosscut, within 150 feet of pillar workings or longwall faces, or in return air) have a LTR classification label attached.

   b. Power and data cables for the alarm units originate from a blue outstation through a LTR barrier with a classification identical to the LTR classification of the alarm unit.

   c. An alarm unit has been installed in the belt entry to provide a signal at the locations specified in § 75.352 when carbon monoxide concentrations reach (1) the alert level at both point-feed intake sensors, or (2) the alarm level at either point-feed intake monitoring sensor.

   d. Alarm units are located where they can be seen <u>or</u> heard by miners on all affected working sections, all affected working areas where mechanized mining equipment is being installed or removed, and at any other specified locations, as required by § 75.351(c) and automatic fire sensor and warning device systems provide an effective warning signal as required by § 75.1103-5 when —

      i. An alarm or warning condition exists for CO or methane as required by §§ 75.323(d)(ii), 75.351(i) and 75.1103-5(a). Methane signals for an AMS are distinguishable from other signals; and

      ii. Two consecutive sensors in the belt entries alert at the same time as required under § 75.351(c)(7).

Figure 18 - Examples of alarm units.

Note: The signal is required to be seen or heard by at least one miner. If none of the miners on a working section can see or hear an alarm while mining, the alarm unit or its location is not effective, and a violation of either § 75.351(c) or § 75.1103-5(a) exists.

2. Check the section alarm by requesting that a representative of the operator apply calibration gas to an outby CO sensor to activate it.

    a. Ensure that the system is programmed to activate section alert and alarm signals or warning signals in all affected areas as specified in § 75.351(i) or § 75.1103-5 or approved plans.

    b. Verify that section alarms and warning signals are indicated in all affected areas as required in § 75.351(c) or § 75.1103-5.

3. Examine alarm units to determine that the visual alarm indicator and audible alarm speaker are clear of obstructions.

4. Check for proper installation of internal batteries. See Figure 19.

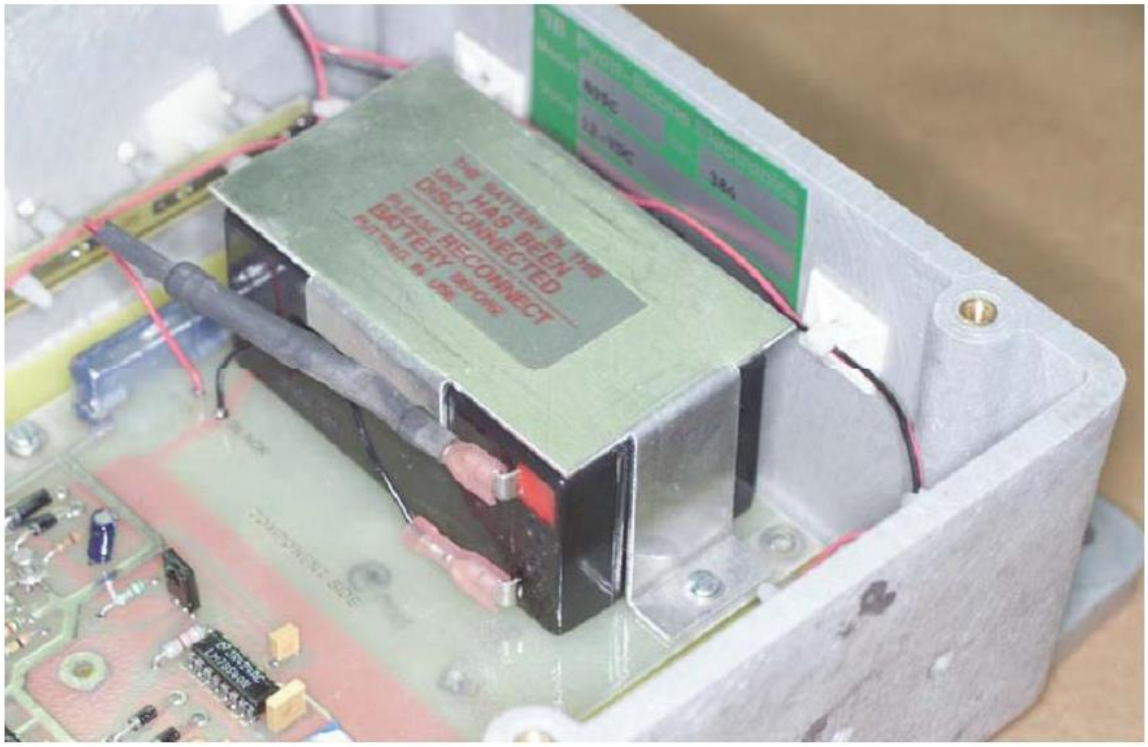
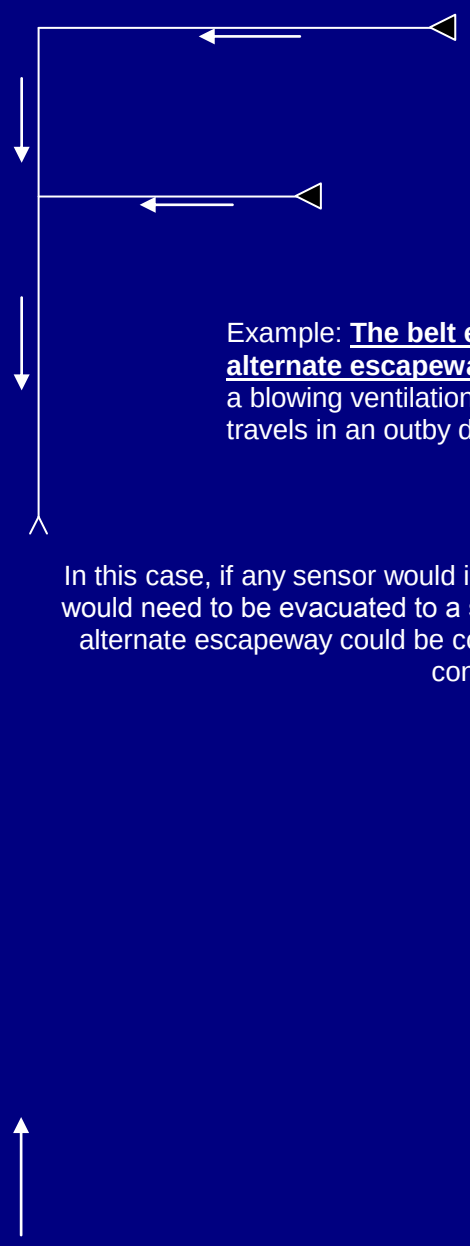


Figure 19 - Example of Properly Installed Battery.

I. **<u>Determining affected working sections; affected areas.</u>**

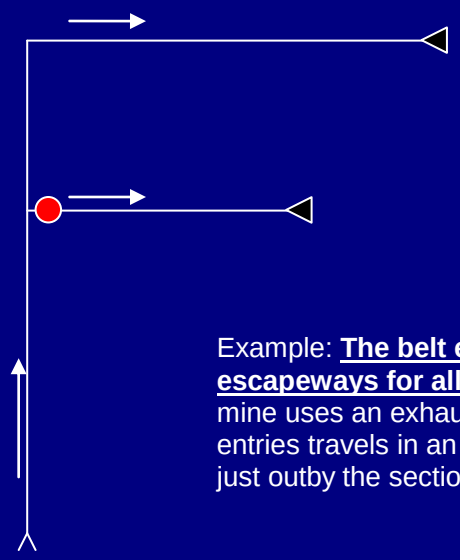
Alert, alarm, or warning signals for carbon monoxide must be provided automatically to working sections and at other locations as specified in the Mine Emergency Evacuation and Firefighting Program of Instruction (§ 75.1502), as required under § 75.351(c), and other locations where miners may be endangered from a fire in the belt entry, as required under § 75.1103-5(a)(1).

To identify locations where miners may be endangered, consider the following factors: location of the sensor with respect to work areas; ventilation (the direction of air) in the belt entry; and escapeways designation. The following diagrams (Figures 20 – 24) are provided as guidance in determining areas that could be affected by an activated sensor in the event of a fire.



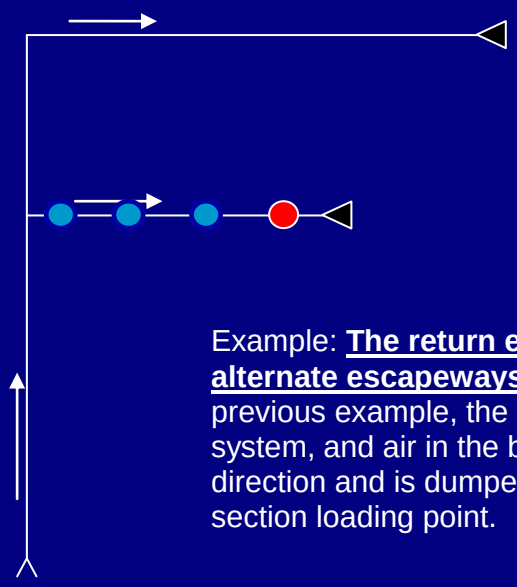
Example: **<u>The belt entries are designated as the alternate escapeways for all sections.</u>** The mine uses a blowing ventilation system, and air in the belt entries travels in an outby direction.

In this case, if any sensor would indicate a warning signal, all sections would need to be evacuated to a safe location because each section's alternate escapeway could be contaminated by a fire along any belt conveyor.



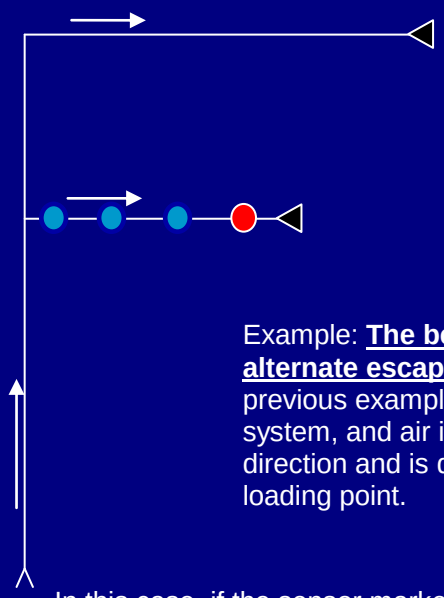
Example: **<u>The belt entries are designated as the alternate escapeways for all sections.</u>** As in the previous example, the mine uses an exhaust ventilation system, and air in the belt entries travels in an inby direction and is dumped to the return just outby the section loading point.

In this case, if the sensor marked in red would indicate a warning signal, both sections would need to be withdrawn to a safe location, because the CO source could be along the outby belt. In this case, the inby section's alternate escapeway could be contaminated with smoke and CO.



Example: **<u>The return entries are designated as the alternate escapeways for all sections.</u>** As in the previous example, the mine uses an exhaust ventilation system, and air in the belt entries travels in an inby direction and is dumped to the return just outby the section loading point.

In this case, if the sensor marked in red would indicate a warning signal, both sections would need to be withdrawn to a safe location since the alternate escapeways could become contaminated by smoke and CO from a fire.



Example: **<u>The belt entries are designated as the alternate escapeways for all sections.</u>** As in the previous example, the mine uses an exhaust ventilation system, and air in the belt entries travels in an inby direction and is dumped to the return just outby the section loading point.

In this case, if the sensor marked in red would indicate a warning signal, the outby section would need to be withdrawn to a safe location. In this case, the inby section would not be immediately affected but may need to be later evacuated once the warning signal is investigated.

Chapter 5
RESPONSE TO ALERT, ALARM, WARNING AND MALFUNCTION SIGNALS

The system operator is required to notify the appropriate personnel when an alert, alarm, warning, or malfunction signal is received from an AMS, as specified in §75.352(a) or an automatic fire sensor and warning device system, as specified in §75.1103-5(d). The appropriate personnel are required to initiate an investigation to determine the cause of the signal and take required actions, as specified in § 75.352(b) or § 75.1103-5(e). For purposes of investigation or response, the system operator may also be designated as one of the appropriate personnel. When an automatic fire sensor and warning device system indicates a warning, an AMS indicates an alarm, or any two consecutive AMS sensors indicate an alert at the same time, specific actions must be taken unless appropriate personnel reliably determine the signal does not present a hazard to miners, under § 75.352(c) or § 75.1103-5(f). The actions required consist of notifying miners in affected areas and the immediate withdrawal to a designated safe location, unless miners are assigned emergency response duties, § 75.352(c) or § 75.1103-5(f).

Identification of appropriate personnel by the AMS operator depends upon the type of signal received. For example, if a malfunction signal is received, it may be most appropriate to contact the person responsible for installing and maintaining the AMS or an electrician trained to work on the system. For an alert signal, the appropriate person may be the belt attendant. For an alarm signal, the appropriate person may be the section foreman for any of the areas affected.

If an inspector is at a mine when the monitoring system activates an alert, alarm, warning, or a malfunction signal, the inspector should determine whether the response is in accordance with the applicable standards, Ventilation Plan, Evacuation Plan, or PFM as applicable**.** Inspectors must not initiate alarms to determine whether the response is appropriate.

In response to alert and alarm signals, the following are required at a mine using air from a belt entry to ventilate a working section:

1. If any CO sensor indicates an alert, the AMS operator must promptly alert appropriate personnel who then must promptly initiate an investigation to determine the cause of the signal (e.g. source of the alert). If an alarm signal occurs during this investigation, or if a second sensor indicates an alert condition at the same time, appropriate personnel must notify miners in affected areas who then must be withdrawn to a safe location. If it is determined that a fire exists, all personnel not needed for firefighting activities must be evacuated from the mine.

2. If any CO sensor indicates an alarm level, the AMS operator must promptly alert appropriate personnel who must notify miners in affected areas, and all personnel in the affected areas, unless assigned other duties under § 75.1502, must be withdrawn to a safe location. All personnel shall remain at that location until the reason for the alarm has been determined and action has been taken to correct the condition. If it is determined that a fire exists, all persons not required for firefighting activities must be evacuated from the mine.

3. During calibration and testing of sensors and alarms the AMS operator must be notified prior to and upon completion of calibration and testing.

Note: A warning signal from an automatic fire sensor and warning device system should be handled the same way as an alarm for an AMS.

In response to a malfunction signal, the **following is required:**

1. If any fire detection components of the AMS malfunction or are inoperative, the mine operator must take immediate corrective actions to return the system to proper operation (e.g. repair or replace the equipment causing the malfunction)

2. While repairs are being made, the belt conveyor may continue to operate provided the affected portion of the belt conveyor is continuously patrolled and monitored for CO by a trained person(s) provided with a two-way communication device to allow communication with the surface as follows:

   a. Each person monitoring must be provided with a hand-held CO detection device;

   b. If one sensor becomes inoperative, the person must monitor for CO at that sensor location;

   c. If two or more adjacent sensors become inoperative, the person(s) must patrol and monitor for CO or smoke so that the affected areas are traveled each hour in their entirety, and;

   d. If the complete system becomes inoperative, a sufficient number of persons must patrol and monitor the affected areas for CO or smoke so that these entries are traveled in their entirety once each hour.

When the air velocity is less than the minimum velocities required the following actiosn are required:

1. Immediate action must be taken to return the ventilation system to proper operation; and

2. While the ventilation system is being corrected, operation of the belt may continue only while a trained person(s) patrols and continuously monitors for CO or smoke, as stated above, so that the affected areas will be traveled each hour in their entirety.

Note: The mine operator may elect to program an alert level for an automatic fire sensor and warning device system using carbon monoxide sensors. This can be advantageous to the operator by providing a signal that can be investigated prior to reaching a CO level that requires miner evacuation. This extra precaution is not required by the standard.

Chapter 6
TRAINING

The effectiveness of the monitoring system is dependent upon the effort made to maintain the system and training provided to system operators and other miners to properly respond to all system signals. Appropriate and timely responses can be the difference between life and death. It is important that inspectors determine if the training provided is adequate to assure prompt and proper responses.

AMS operators are required to be qualified as specified in § 75.156. They must be trained in accordance with the provisions of § 75.351(q). When a malfunction, alert or alarm signal is received at the designated surface location, the sensor(s) that are activated must be identified, and the AMS operator must promptly notify the appropriate personnel as specified in § 75.352(a). AMS operators should be able to determine the appropriate personnel they need to contact in response to various signals. Appropriate personnel designated to investigate alert and alarm signals may be different from appropriate personnel needed to investigate a malfunction condition. At some mines, the AMS operator may also be responsible for initiating withdrawals and evacuations of miners. The level of training should be consistent with the expectations and responsibilities of the system operator. Enforcement personnel should determine:

A. Whether the AMS operator is qualified, and has been adequately trained in accordance with the standard and his duties and responsibilities. Such determination can be made through discussions with system operators and other miners. Discussions should include how system operators respond to alert, alarm and malfunction signals to determine the adequacy of training concerning:

   1. Response to CO alert signals.

   2. Response to CO or smoke alarm signals.

   3. Response to a malfunction.

   4. Response to methane alert or alarm signals.

   5. The process of evacuation of miners in case of a fire.

   6. Adequacy of the AMS operator's training in understanding their responsibilities in the event of an emergency. While an AMS operator may be assigned tasks other than monitoring the AMS during normal mining operations, in the event of

an emergency, the AMS operator's only responsibility is to respond to the emergency.

B. Whether the AMS operator is trained in the procedure to initiate the "kill feature" to disconnect all non-permissible battery circuits associated with the monitoring system upon loss of ventilation due to main mine fan stoppage.

C. Whether the persons responsible for maintaining and installing components of monitoring systems are trained in the requirements of these duties. Adequacy of the training can be determined during the underground testing and calibration of the system.

D. Whether miners are trained in the evacuation requirements when an alarm signal is seen or heard. Inspectors should determine the adequacy of miners training through discussions with them during the inspection.

E. Whether appropriate personnel required to be identified under § 75.351 are trained in the actions specified in § 75.352(e) and the Evacuation Plan.

F. Whether the persons monitoring for CO in the affected areas during a malfunction are trained in the requirements specified in §75.352(e) or §75.1103-5(h).

Appendix I
INSPECTION CHECKLIST

A. Pre-inspection

Review the following:

1. Applicable Standards of 30 CFR
2. All applicable PFMs
3. Training Plan
4. Ventilation Plan
5. Emergency Evacuation and Firefighting Program of Instructions
6. Emergency Response Plan

B. Surface Inspection

Mine Records

1. Review records of sensor calibrations.
2. Determine if a visual examination of the system monitoring conveyor belts is performed on each coal-producing shift. The examination can be included as part of the pre-shift examination.
3. Review records of weekly functional test.
4. Verify that the names of designated AMS operators are provided at the designated surface locations.
5. Review training records for AMS operators.

Check the map or schematic

6. Determine if the schematic and other maps are properly displayed and are properly updated. The maps include those specified in §§ 75.351(b)(3) (AMS), 75.372 (ventilation map), 75.1103-5(a)(2)(ii) (automatic fire sensor and warning

device system), 75.1200 (mine map) and 75.1505 (escapeway map). The requirement for including sensor locations on mine maps and escapeway maps is included in § 75.1103-4(a)(1)(iv).

Observe operation of system

7. Determine the operational status of CO sensors. Sensors with communication failures should be noted and examined during underground inspection.

8. Review the AMS printout to determine any unusual history of sensors' malfunctions, alert and alarm signals, and abnormal readings.

9. Unless the belt haulageway is examined for hot rollers and fire as required by 75.1103-4(e), ensure that the system is provided with 4 hour backup power.

10. Determine the means of disconnecting the data line.

11. Obtain an installation and maintenance check-list provided by the manufacturer to the mine operator.

12. Verify that the AMS operator is properly trained on the actions that must be taken when an alert, alarm, or malfunction occur. Ensure that the designated system operator is trained to initiate the "kill feature" if applicable.

13. Determine appropriate personnel are notified when activities such as cutting, welding, or calibrating, which may cause alarms, are to be performed.

Visual and audible alarms on the surface

14. Verify that the AMS signals can be seen or heard by the AMS operator and from all assigned work locations when miners are underground.

15. Determine if the visual and audible alarm signals are distinguishable from the alert signals, and that the methane signals are distinguishable from all other signals.

16. Verify the operation of the manual reset for automatic warning devices.

Communications

17. Determine if the designated system operator has means of two-way communication with all working sections.

Lightning arrestors

18. Verify that ungrounded data line conductors and exposed telephone wires are provided with lightning arresters.

C. <u>Underground Inspection</u>

Air currents

1. Check the direction and velocity of the air flow and verify that the velocity complies with the minimum and maximum velocity allowed.

Air velocities

2. Verify that sensor spacing does not exceed allowable limits specified in the applicable standard, plans or PFM.

Installations of sensors

3. Verify that sensors are installed near the center in the upper third of the entry, at a location where miners are not exposed to unnecessary hazards when maintaining, testing or calibrating the sensor.

Locations of sensors

5. If the sensors are installed in a manner and at the locations that comply with the standards, but locations are not accurate on the maps, then the maps should be cited for not being properly updated.

6. Assure belt drives and electrical installations are properly monitored in belt entries, primary escapeway, and return air splits as appropriate.

Inspection/Calibration of sensors

7. Visually check sensors for damage and assure air flow patterns are not blocked.

8. Compare sensor readings with hand-held detector readings.

9. Have the agent of the operator simulate a malfunction at a sensor unit. For AMS systems verify that malfunctions are recorded at the designated surface location.

10. Check permissibility of AMS sensors and alarm units. Each barrier classification must match associated component classification.

11. Ensure that the manufacturer calibration procedures are used. Check calibration of at least 10 percent, but no less than five of the CO sensors.

Outstations

12. Verify that all outstations are located in intake air.

13. Verify that outstations are identified as "red" or "blue". If the outstation is not painted, verify that other means of identification are used to identify the outstation as red or blue.

14. For blue outstations connected to a sensor in an area where permissible equipment is required, verify that the system is wired in accordance with the acceptance drawing.

15. Have a representative of the operator disconnect the incoming power to the outstation to demonstrate that the battery backup will function properly.

16. Verify compliance with the requirements of §§ 75.313 and 75.1103-7.

Alarm units

17. Verify that underground alarm units are installed at locations where they can be seen or heard by miners working in those areas.

D. Response to alerts, alarms, warnings and malfunctions

1. Verify the actions taken by the system operator when an alert, alarm, warning or malfunction signal is received.

2. Verify that proper procedures are followed during a malfunction when the belts are running.

E. Training

1. Verify that system operators have been adequately trained in accordance with their duties and responsibilities.

2. Verify that persons responsible for maintaining and installing components of the monitoring systems are trained in the requirements of these duties.

3. Verify that miners are trained in the evacuation requirements when an alarm or warning is activated.

4. Verify that appropriate personnel required to be identified by § 75.351 are trained.

5. Verify that persons monitoring for CO or smoke in the affected areas during a malfunction are trained.

APPENDIX II
EXAMPLES OF QUESTIONS FOR DESIGNATED AMS OPERATORS

(Note: only AMS systems require a designated AMS operator)

30 CFR § 75.156 requires that an AMS operator be trained on duties and responsibilities in accordance with the mine operator's approved Part 48 training plan to be qualified as an AMS operator.

In addition, an AMS operator must be able to demonstrate to an MSHA inspector that he/she is qualified to perform in the assigned position. To facilitate this demonstration, MSHA inspectors will be asking AMS operators a series of questions to assure these miners are properly trained and able to respond to the signals given by the AMS. The following list (although not inclusive) is a representative sample of the type of information an AMS operator may be required to understand. As all mines are not the same, and the use of an AMS is tailored to the needs of particular mines, the inspector may ask questions regarding details specific to the mine's operations.

General Questions

1. What types of sensors are used in the mine?
2. Who is the responsible person on the current shift?
3. Do you have a list of emergency phone numbers posted at the designated surface location?
4. What is the maximum sensor spacing for CO sensors installed along the belt conveyor?
5. What are the alert, alarm, and ambient CO levels in the mine?
6. How are alert and alarm signals indicated by the AMS?
7. Please explain how a typical work shift would take place.
8. What duties other than AMS operator are you permitted to perform?
9. If there is a fire underground, what duties are you permitted to perform?
10. Are you required to perform any duties that interfere with responding to the AMS?
11. Has the AMS ever had alert and alarm signals caused by diesel exhaust? If so, how often?
12. Has the AMS ever had alert and alarm signals caused by hydrogen produced at a battery charging station? If so, how often?
13. When did you last travel to all of the working sections?

Response to Alert and Alarm Signals – Carbon Monoxide

1. When an alert signal is indicated on the AMS, what actions must you take?
2. When an alarm signal is indicated, what actions must you take?

3. If an alarm is indicated at (sensor a), which miners would be working in affected areas?
4. How would you primarily communicate with these miners?
5. Is there a second communication system available for contacting miners in the event of an emergency? Are you able to use this system?
6. How do you acknowledge an alert or alarm signal?
7. What records must you make for alert and alarm signals?
8. Have you had any recent alert or alarm signals? Fires?

Response to Alarm Signals – Methane

1. Where are sensors located underground for monitoring methane?
2. What actions must you take when a methane sensor indicates an alarm condition?

Determining System Malfunctions

1. What would a carbon monoxide level of -5 ppm for a sensor on the AMS display indicate? Would you need to take any action if you discovered such a reading?
2. What would you do if the system indicates a sensor is no longer communicating with the computer?
3. Explain what the weekly functional test is intended to confirm.

Point-Feed Regulators

1. What is the purpose of a point-feed regulator?
2. Where are the point-feed regulators located in this mine?
3. Is there a means installed for you to remotely close the regulator in the event of a fire in the primary escapeway?
4. When should the regulator be closed?

System Maintenance

1. Are you required to take any special precautions when CO sensors are calibrated?
2. How often must CO sensors be calibrated?
3. Where are records for CO sensor calibrations and weekly functional tests maintained?