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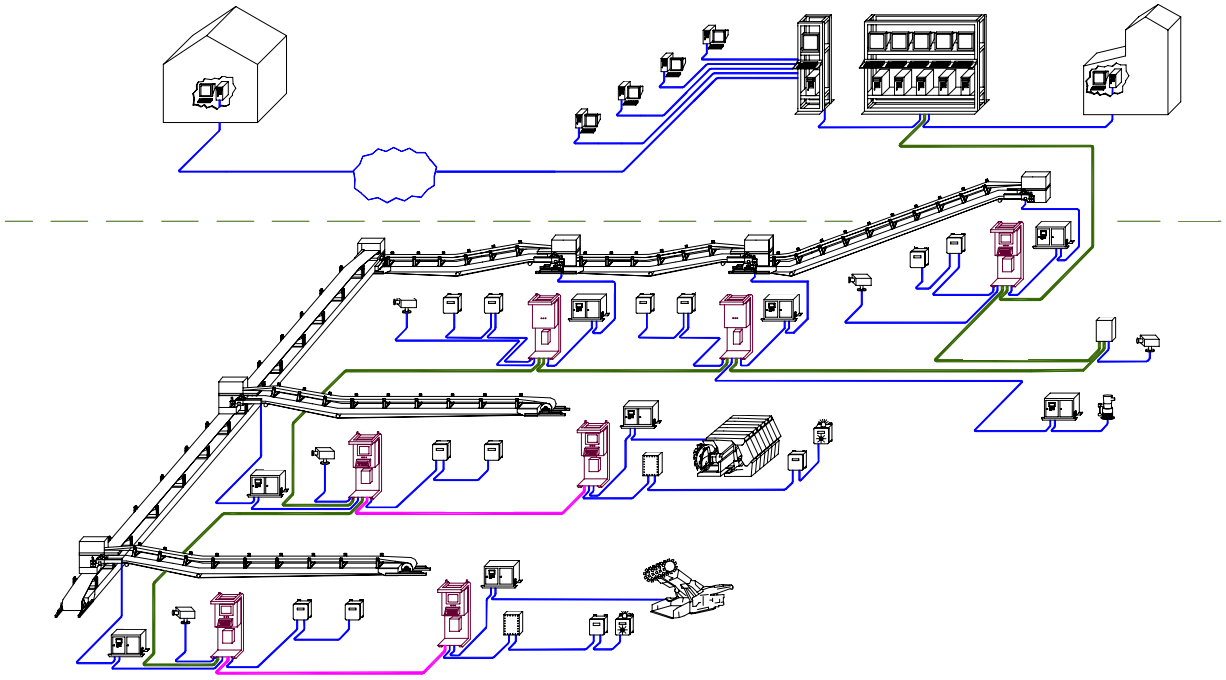

CARBON MONOXIDE AND ATMOSPHERIC MONITORING SYSTEMS INSPECTION PROCEDURES

PREFACE

This handbook sets forth inspection procedures to follow when conducting inspections of carbon monoxide monitoring systems 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issued procedural instruction letters and administrative instructions and handbooks for this subject material are superseded by this handbook.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related policies that are contained in the Mine Safety and Health Administration (MSHA) Program Policy Manual are not superseded by this handbook. Additional guidance may be found in the Compliance Guide for the use of Belt Air to ventilate working sections and areas where mechanized mining equipment is being installed or removed.

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(February 2008)

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Chapter 1
INTRODUCTION

A. Purpose

This revised handbook sets forth the Mine Safety and Health Administration's (MSHA) procedures for inspection of carbon monoxide (CO) monitoring systems and atmospheric monitoring systems (AMS) conducted by compliance specialists and inspectors. A CO monitoring system simply measures the levels of CO at specified locations throughout the mine, in lieu of a point-type heat sensor system, and indicates levels in excess of established alert and alarm levels so that appropriate actions can be initiated. An AMS is defined as a network consisting of hardware and software capable of measuring atmospheric parameters, transmitting the measurements to a designated surface location, providing alert and alarm signals, processing and cataloging atmospheric data, and providing reports. Early-warning fire detection systems using newer technology that provide equal or greater protection, as determined by the Secretary, will also be considered an AMS.

Chapter 2 contains the pre-inspection preparation and lists the information and documents needed by enforcement personnel to use as the basis for enforcement actions. Chapters 3, 4, and 5 specify details of evaluating the parameters and functions of the monitoring systems required by the regulations, granted petitions for modification (PFMs), Mine Ventilation Plans (Approved Ventilation Plans), and Mine Emergency Evacuation and Firefighting Programs of Instruction (Evacuation Plans). Chapter 6 specifies the training. Appendix II contains a summarized inspection checklist for quick reference.

B. Authority

Enforcement authority depends on the purpose of the installation. In most cases a CO monitoring system is installed to comply with 30 C.F.R. § 75.1103 as an equivalent system to point-type heat sensors for fire detection along belt entries. These CO systems do not require a petition for modification, but in many instances petitions have been filed and granted for such use. CO systems may also be installed to monitor direct-fired intake air heaters as specified in § 75.341, and compressors as specified in § 75.344. In some cases an AMS is installed to allow air ventilating the belt entry to be used, as specified in § 75.350, as intake air on working sections or in areas where mechanized mining equipment is being installed or removed as specified in § 75.351. An AMS is also required for purposes related to mine ventilation to comply with §§ 75.323(d)(1)(ii),

75.340(a)(1)(ii), 75.340(a)(2)(ii), or 75.362(f). Monitoring systems used to comply with other standards, such as §§ 75.1101 and 75.1107, may also be used.

Systems installed to provide protection equivalent to point-type heat sensors as specified in § 75.1103-4(a)(2) must satisfy the requirements of § 75.1103 at all times. Equivalency tests conducted by MSHA have determined the spacing of CO sensors to be 2,000 feet when air velocity within the belt entry is 50 feet or more. In cases where lower velocities are maintained, more recent National Institute for Occupational Safety and Health tests have indicated the spacing of sensors can be reduced to 350 feet (this spacing and reduced velocity would be equivalent to fire detection by CO sensors spaced at 1,000 feet with 50 fpm minimum air velocity in the belt entry. Although it may seem logical to do so, there is no research to support allowing spacing of 700 feet as an equivalent to 2,000 foot sensor spacing with velocities less than 50 fpm.)

The most recent PFMs require that details of the system be included in the Approved Ventilation Plan. For equivalent protection, these PFMs require CO sensors to be spaced a maximum of 1,000 feet apart with a minimum air velocity of 50 feet per minute (fpm). In areas where air velocities cannot be maintained at 50 fpm or more, reduced sensor spacing of no more than 350 feet is required. In those petitions, alert and alarm levels are required to be set at no more than 5 and 10 parts per million (ppm) above ambient.

Requirements for the CO monitoring system contained in a PFM or in an approved Ventilation Plan are enforceable as mandatory standards. In instances of noncompliance with the PFM, citations should be issued under the standard modified by the petition. In instances of noncompliance with the Approved Ventilation Plan, citations should be issued under § 75.371. When belt air is used to ventilate the working section, provisions of §§ 75.350, 75.351, and 75.352 apply and citations should be issued under these standards. Likewise, if the system is used to comply with a specific standard, as specified above, such standard should be cited in instances of noncompliance.

If a PFM or Approved Ventilation Plan references the Evacuation Plan for required responses to AMS alert and alarm signals, § 75.1502 should be cited for failure to follow the prescribed procedures in the plan.

Section 75.351 and some PFMs for modifying § 75.1103-4 delegate authority to the district manager to require additional measures, such as additional sensors or to set the alert and alarm levels. The district manager has the authority to reduce alert and alarm levels when higher air volumes cause CO dilution and reduce fire detection capability in certain areas. Details of the monitoring system are

usually specified in the Approved Ventilation Plan. Failure to follow requirements set forth in that plan should be cited under § 75.371.

The Approval and Certification Center (A&CC) evaluates the Mine-Wide Monitoring Systems (monitoring systems) to ensure that the circuits and components installed in areas where permissibility is required will not ignite methane. Components installed in areas where permissible equipment is required must be intrinsically safe or housed in explosion proof enclosures. Mine-wide monitoring systems will have components in outby areas and areas where permissibility is required. Systems evaluated and accepted by A&CC must be installed and maintained as evaluated and must have an MSHA acceptance label attached to the blue outstations, classified sensors, and classified barriers. Noncompliance with the MSHA accepted systems should be cited under the appropriate permissibility standard depending on the location and purpose of the installation (§§ 75.503, 75.507, 75.1002, or 75.1103-7).

Examples included in this handbook are excerpted from assorted approved plans, including Ventilation and Evacuation Plans, and are used to provide clarifying existing requirements or as an explanation of the inspection procedures.

Chapter 2
PRE-INSPECTION INFORMATION

A. Review the applicable standards of 30 CFR, applicable PFMs, Ventilation Plan, Evacuation Plan, and Training Plan to obtain the information outlined in sections 2 through 15, below:

1. Review the mandatory standards that govern the installation and use of the monitoring system which include the following: the installation requirements specified in §§ 75.350 and 75.351; the actions required in response to AMS malfunction, alert and alarm signals specified in § 75.352; automatic fire warning devices required in § 75.1103; system requirements in the Ventilation Plan specified in § 75.371; installation requirements specified governing the use of the monitoring system(s) at the mine in the Evacuation Plan required in § 75.1502; the measurement and calibration requirements of § 75.341; the calibration and test requirements of § 75.344, and any other applicable standard;

2. The required locations of all sensors, the maximum spacing permitted between sensors, and the maximum distance allowed between the downwind sensor and the belt drive, belt tailpiece, belt take-up and electrical installations. The areas where sensor spacing is reduced to 350 feet or less to permit air velocities less than 50 feet per minute in these areas;

3. The minimum and maximum, if applicable, air velocities permitted in the belt entry. The air velocity is required to be compatible with the fire detection and fire suppression systems used in the belt entry as required by § 75.350(a)(2);

4. The alert, alarm, and ambient levels for the CO sensors in ppm and the required action levels of any other sensors;

5. The procedures to be followed in the event of a partial or complete monitoring system failure;

6. The required responses to alert and alarm signals and other action levels;

7. The requirements specific to the mine, such as respirable dust sampling, use of diesels, etc;

8. The required examinations, tests, calibrations, and records;

9. The locations where visual and audible alert and alarm signals are required;

10. Any special requirements in the Ventilation Plan related to a PFM;

11. The specific area(s) required to be monitored in the Ventilation Plan;

12. The location of point-feed regulators specified 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, such as point feeding from the primary escapeway to an alternate escapeway);

13. The designated system operator(s) and the designated location;

14. The Training Plan to determine that the following is included:

    a. Response to malfunctions, alert, alarm, and other action levels;

    b. Whether all system operators are trained annually in the proper operation of the monitoring system;

    c. Whether a record of the training provided the person conducting the training, and the date the training was conducted, is maintained at the mine for at least one year by the mine operator; and

    d. The duties and responsibilities of the system operator.

15. Any map or schematic requirements.

B. <u>Hybrid systems</u>

A hybrid system is typically comprised of a combination of two or more different types of sensors. The system is often:

1. Installed to supplement point-type heat sensors installed in accordance with § 75.1103. Some systems also incorporate point-type heat sensors in areas where air velocities in the belt entry cannot be maintained at or above 50 fpm, and CO sensors are used in all other areas;

2. Not required to be a complete CO monitoring system or AMS; however, all conveyor belts are required to be monitored for fire;

3. Installed to provide protection equivalent to point-type heat sensors and to comply with all applicable provision of § 75.1103; and

4. Required to be included in the Ventilation Plan and to be maintained.

Chapter 3
SURFACE INSPECTIONS

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

1. Calibration.

   a. Sensors are calibrated at intervals not to exceed 31 calendar days;

   b. Calibration records, required by § 75.351(o), identify the date of each sensor calibration. Identification of a group of sensor calibrations is not an acceptable record. For example, if the calibration record indicates "calibration of longwall sensors" for a particular date, it would not be acceptable;

   c. Records include the name, date, and signature of the individual designated by the operator to perform the calibration; and

   d. Calibration records are maintained for 1 year in a secure book or electronically in a computer system that is secure. Records are not susceptible to alteration and are kept separate from other mine records.

2. Testing and inspection.

   a. A visual examination of the AMS monitoring conveyor belts is performed on each coal-producing shift in accordance with § 75.351(n). The examination can be included as part of the pre-shift examination.

   b. A functional test of the AMS is performed at least every 7 days in accordance with § 75.351(n)(2). A functional test typically includes the application of calibration gas to sensors to activate section alarms.

   c. A weekly inspection of the CO monitoring system is performed in accordance with § 75.1103-8(a).

   d. A functional test of the CO monitoring system is performed annually in accordance with § 75.1103-8(a). Some PFMs, Ventilation Plans, and Evacuation Plans may require weekly functional tests.

   e. Records of these tests and examinations required by § 75.351(o) are maintained for 1 year in a secure book or electronically in a computer system

that is secure. Records are not susceptible to alteration and are kept separate from other mine records.

3. Designated AMS operators and other personnel.

   Verify that the names of designated AMS operators and other 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 in § 75.351(b)(4).

4. Review training records for AMS operators in the actions required during alerts, alarms, and malfunctions.

B. <u>Check the map or schematic, if required by regulation, PFMs or approved plans, for the following</u>:

1. A map or schematic is available for review.

   a. Maps are posted at designated surface locations.

   b. The map or schematic identifies the affected areas of the mine when a sensor is in alert or alarm status or when an action level is exceeded.

   c. The map or schematic includes the following: the locations of all sensors as well as all active sections; the areas where mechanized mining equipment is being installed or removed; and the other locations identified in the Ventilation Plan or Evacuation Plan.

   d. The map for the AMS includes the intended air flow direction at sensor locations.

   e. If the map or schematic is on a console (video display terminal), the AMS operator on the surface can display it when an alert or alarm signal, or other action level is indicated.

2. The map or schematic is accurate.

   a. Accuracy of the map or schematic can be determined by information obtained through inspection of the mine or by using a current list of active sensors.

   b. Maps or schematics are updated promptly after making a change in the mine. Updates are required to be made within 24 hours of any change.

3. If a copy of the map is not available, draw a schematic of the AMS in the areas you plan to inspect to help you in the inspection.

Note: The map posted at the designated location must have the same information as the § 75.1200 map posted at the mine. If there are discrepancies between these maps, the inspector should determine if the differences are due to changes made within the last 24 hours. The operator has 24 hours to update the AMS map or schematic. If changes are not reflected within 24 hours, a violation for failure to maintain the map up-to-date is warranted.

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

1. Check video display terminal for the following:

   a. All outstations and sensors are being scanned by the system (compare with map or schematic showing location of sensors). Determine the operational status of CO sensors. Sensors with 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 required response.

   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.

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

   e. Compare the established ambient level for the mine with the CO readings shown on the display. If the ambient level is not set properly, appropriate action shall be taken.

   f. Determine the locations where the sensors will indicate an alert, alarm, or other action level.

   g. Ensure that the system is programmed to activate section alarm signals in all locations specified in the regulations, PFM, or plans.

2. Review sensor readings.

   Evaluate the number of sensor alarms triggered by sensor or system malfunction or by other gasses, such as hydrogen, that may affect the function of CO sensors. Where alarms are excessive due to hydrogen, the inspector should cite § 75.340(a)(1)(ii) and require the mine operator to replace the sensor with one that can discriminate the gasses. Also, evaluate the number of occurrences of alarms due to diesel CO. Where alarms are excessive due to diesel CO, the inspector can recommend the use of diesel discriminating sensors. Also, check for the following:

   a. Records of abnormal readings. Readings of sensors over extended time periods can determine abnormalities.

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

   c. The number of sensors and locations monitored is consistent with those specified in the map or schematic, if required.

   d. Records of the following: malfunctions; maintenance performed; alerts, alarms and action level readings; the cause for activation; and corrective action taken, as applicable. These records should include alert and alarm signals reported by personnel monitoring the belt entry with a CO detector during system malfunction. This requirement is applicable when belt air is used to ventilate the working section.

3. Determine and evaluate the means of de-energizing the monitoring system upon loss of ventilation due to a main mine fan stoppage ("kill feature"). The “kill feature” is defined as 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 stoppage that are intrinsically safe. In some monitoring systems, the de-energization of the outstations can be accomplished from the main console and observed on the monitor screen or digital readout. After the "kill feature" has been initiated, all batteries must be manually reset after power has been restored to the fan. Examination of the main console would reveal the disconnect method used.

   A system with battery backup power supplies that cannot be disconnected remotely from the surface must be intrinsically safe or have a relay to disconnect the battery power supply in order to comply with the requirements of §§ 75.313

and 75.1103-7. A manually operated switch actuated by a miner leaving the section is not acceptable to de-energize individual batteries.

4. Ensure that the system is provided with 4 hour backup power as specified in § 1103-4(e).

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

6. Obtain an installation and maintenance check-list provided by the manufacturer to the mine operator. The A&CC can provide information on MSHA-Evaluated systems upon request.

7. Determine the duties of the designated system operator assigned to monitor the system at a designated surface location.

    a. Determine that the designated system operator can see or hear the alert and alarm signals from any of his work locations, and that he notifies the appropriate personnel when an emergency situation arises.

    b. Determine if the designated system operator is adequately trained on the actions that must be taken when an alert or alarm level has been indicated, ventilation plan requirements, fire fighting and evacuation requirements, mine communications and record keeping requirements.

    c. Determine if the designated system operator is adequately trained on the actions that must be taken when a partial or complete system malfunction occurs.

    d. Determine if the designated system operator is notified when activities, which may cause alarms, such as cutting, welding, or calibrating are to be performed.

    e. Ensure that the designated system operator is trained to initiate the "kill feature" to disconnect all battery circuits associated with the system.

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

Check locations of alarms, and duties of the designated system operator. For automatic fire sensor and warning device systems installed to meet § 75.1103-5(a), the manned location may be underground.

1. Determine if the visual and the audible signals, caused by malfunction or elevated concentrations of contaminants, can be seen or heard by the system operator at all designated work areas.

2. Determine if the visual and audible alarm signals are distinguishable from the alert signals. Determine if methane signals are also distinguishable from all other signals.

3. Verify the operation of the manual reset for the automatic warning device as specified in § 75.1103-5(c).

E. Check the communication system between the surface and underground.

1. Verify that the designated location~~s~~ have two-way communications with all working sections, areas where mechanized equipment is being installed or removed, and other areas designated in the Evacuation Plan, and that the designated system operator has access to promptly respond to all signals.

2. Ensure that the designated system operator will be able to receive signals while at locations other than the designated location.

F. Check for lightning arrestors.

Verify that ungrounded data line conductors and exposed telephone wires are provided with suitable lightning arresters of approved type and located within 100 feet of the point where the they enter the underground portion of the mine as required by § 75.521.

Chapter 4
UNDERGROUND INSPECTIONS

A. Air currents in conveyor belt entries.

Check the direction of the air flow to ensure compliance with the map required in § 75.351(b)(3), the Ventilation Plan, Evacuation Plan, or PFM. Conditions found underground must be reflected on applicable documentation.

B. Air velocities in conveyor belt entries.

1. Verify that air velocities are at least 50 fpm along all belt conveyors unless a lower velocity is approved in the Ventilation Plan. For AMS verify that sensor spacing is not greater than 350 feet if the air velocity is less than 50 fpm. For early warning fire detection systems verify that the spacing is in accordance with PFM or the Ventilation Plan. For mines using belt air, if the air velocity is less than 50 fpm, and the sensor spacing has not been reduced, this is considered to be a system failure and monitoring with hand-held instruments is required to continue operation of the belt conveyor. Continuous patrolling of the affected area is required unless the air velocity is re-established or decreased sensor spacing is approved and established, see § 75.352(f).

2. Verify that the air velocities are equal to or less than the maximum velocities, if maximum velocities are specified. 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 it to his/her supervisor. Generally, velocities less than 500 fpm, but greater than 50 pfm, should not be a concern.

3. Verify that the fire detection systems and fire suppression systems are compatible with air velocities. Generally velocities less than a 1,000 fpm do not adversely affect fire detection with CO or smoke sensors. Higher velocities have been reported to negatively affect dry chemical fire suppression systems.

4. Ensure that representative cross-sectional areas of the entries are used when determining air velocities**.** Neither large areas, such as belt channels, boom holes, and fall areas, nor restricted areas, such as overcasts, should be used for determination of air velocities.

C. Installation of sensors.

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

a. In the air stream for optimum CO or smoke detection, in the upper third of the entry height, and near the center of the entry, see figure 1;

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

c. In a location that does not expose personnel working on the system, including calibration and examination, to unsafe conditions;

d. Not located 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;

e. In an area where sensors and cables will not be affected by water sprays, fire suppression systems, direct application of rock dust, or near battery-charging stations where hydrogen can interfere with the CO sensors; and

f. Methane sensors are installed near the center of the entry at least 12 inches from the roof, ribs, and floor.

Figure 1 – Example of a properly installed CO sensor.

2. When an AMS is installed to meet the requirements of §§ 75.350(b) and 75.351(r), verify that communication system cables are installed in entries separate from the entry where the AMS is installed. It should be noted that if the mine operator installs a redundant two-way communication system in a separate entry the operator may install the pager phone line in the same entry as the AMS cable. Mines are allowed to use a common cable bundle for both systems. A personal emergency device (PED) does not qualify as a redundant system because it is not a two-way communication system.

D. <u>Location of sensors.</u>

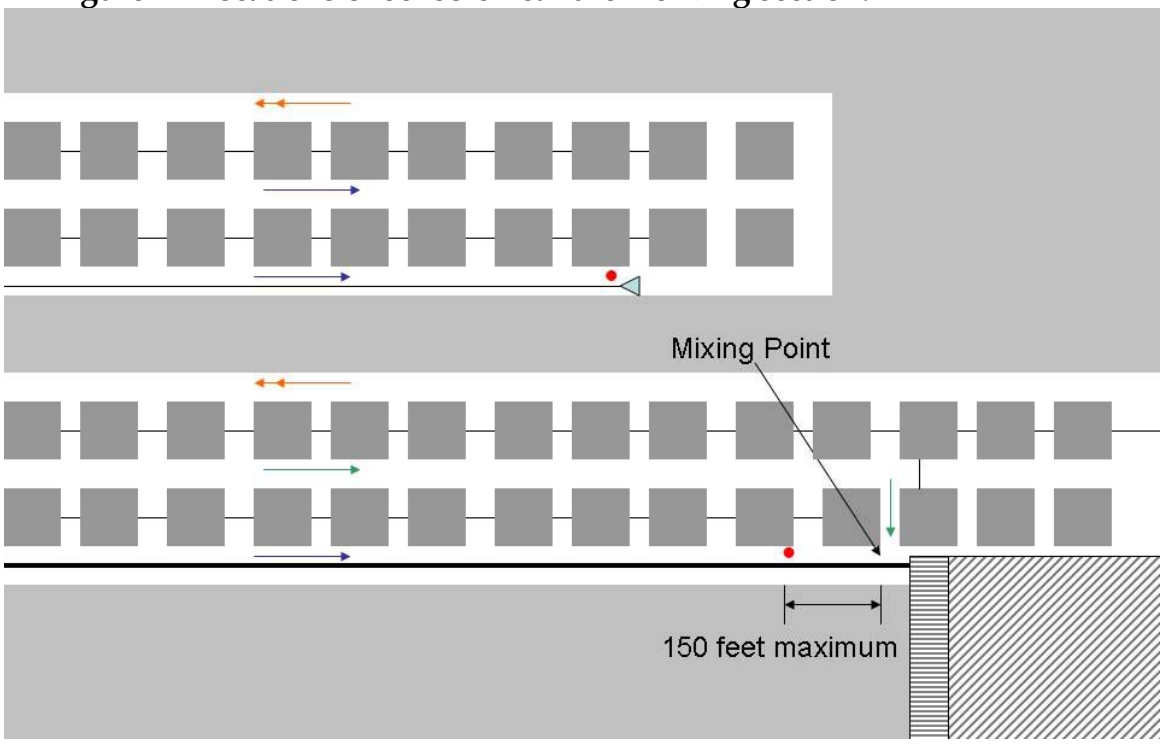
Determine if sensors are installed at the locations identified on the mine map maintained at the designated surface location. Check the locations and types of sensors at each of the following areas:

1. For Belt Entries—

   a. Verify that the sensors are installed at the locations specified in the Ventilation Plan, PFM, or the § 75.351(e) locations listed below:

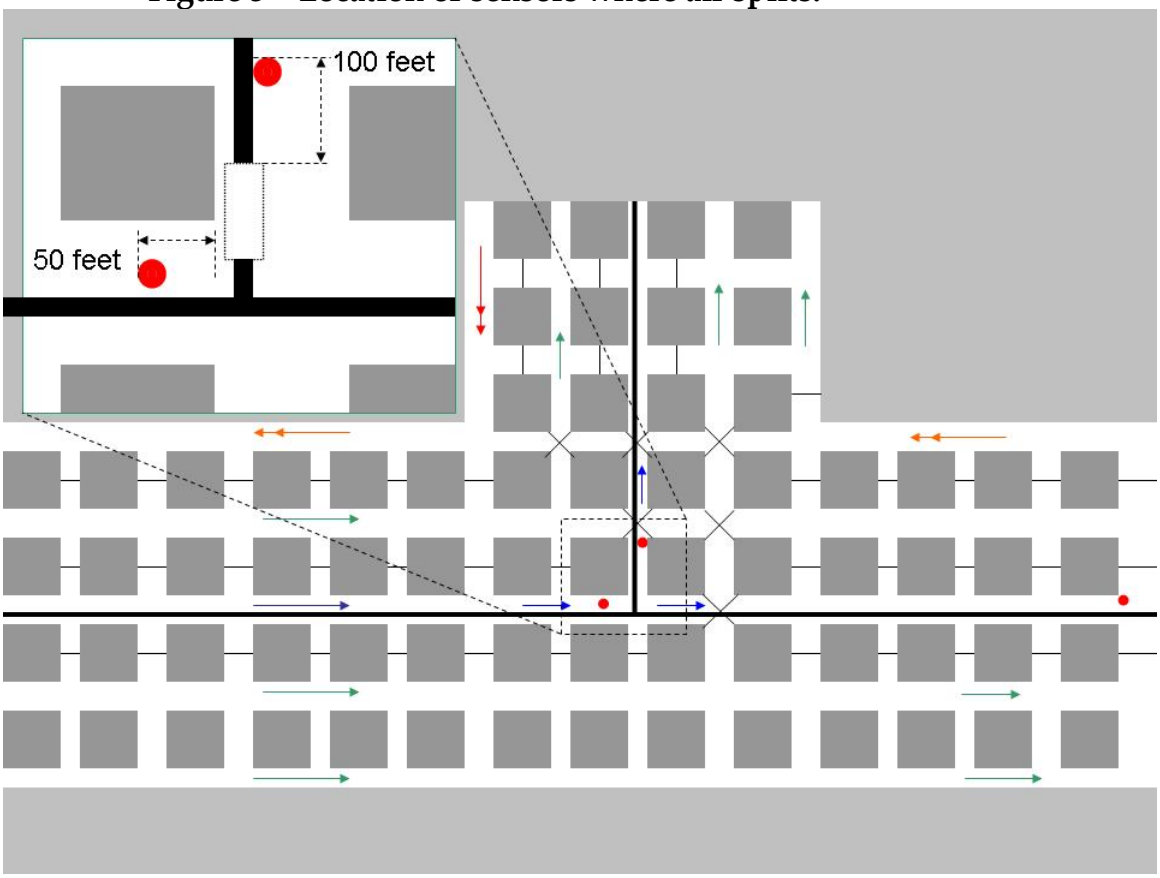
      i. At or near the working section belt tailpiece in the air stream ventilating the belt entry. In longwall mining systems the sensor is required to be located upwind in the belt entry at a distance not greater than 150 feet from the mixing point where intake air is mixed with the belt air at or near the tailpiece. The point-feed sensor required by § 75.350(d)(1) is not required at this location, see figure 2;

Figure 2 - Locations of sensors near the working section.



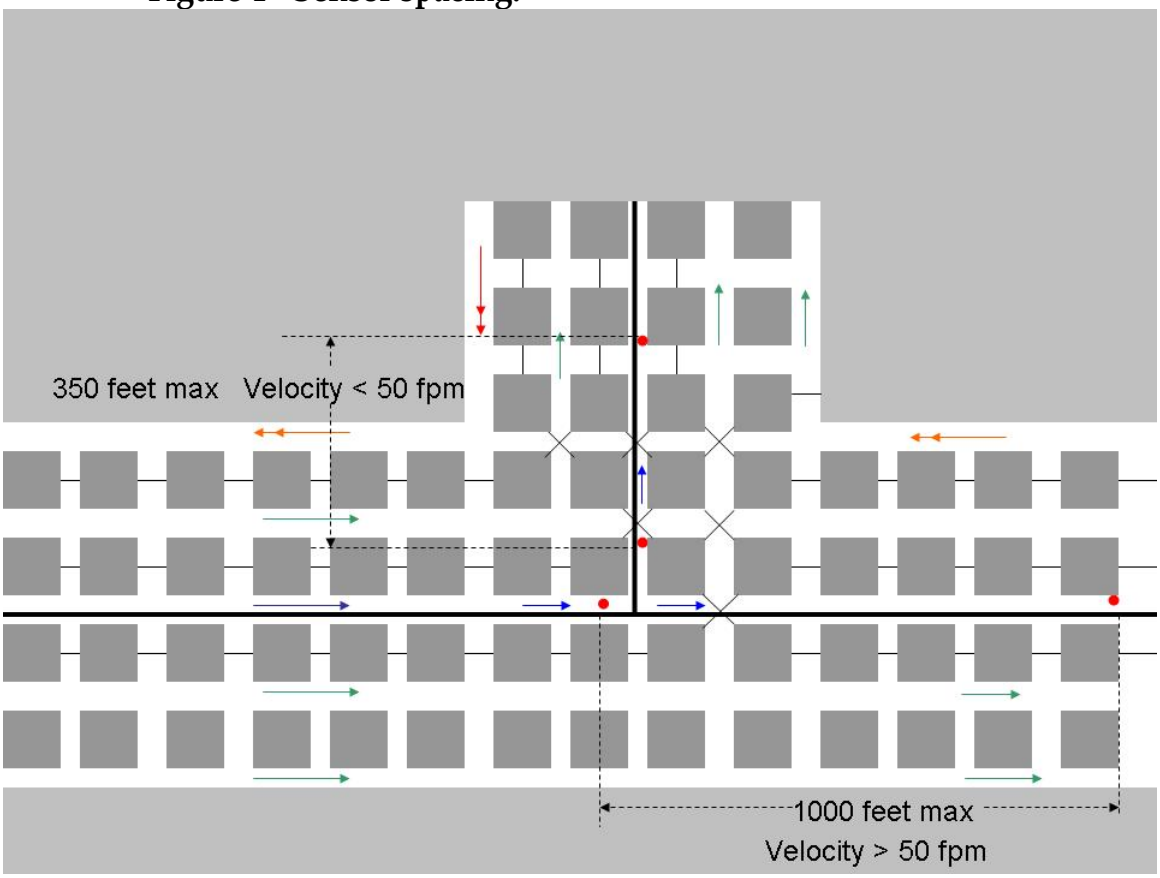
ii. Upwind, at a distance not greater than 50 feet from the point where the belt air course is combined with another air course or splits into multiple air courses, see figure 3;

Figure 3 – Location of sensors where air splits.



iii. At intervals not to exceed 1,000 feet along each belt entry in areas where air velocities are maintained at 50 feet per minute or higher. In areas along each belt entry where air velocities are less than 50 feet per minute, the sensor spacing may not exceed 350 feet, see figure 4;

Figure 4 - Sensor spacing.

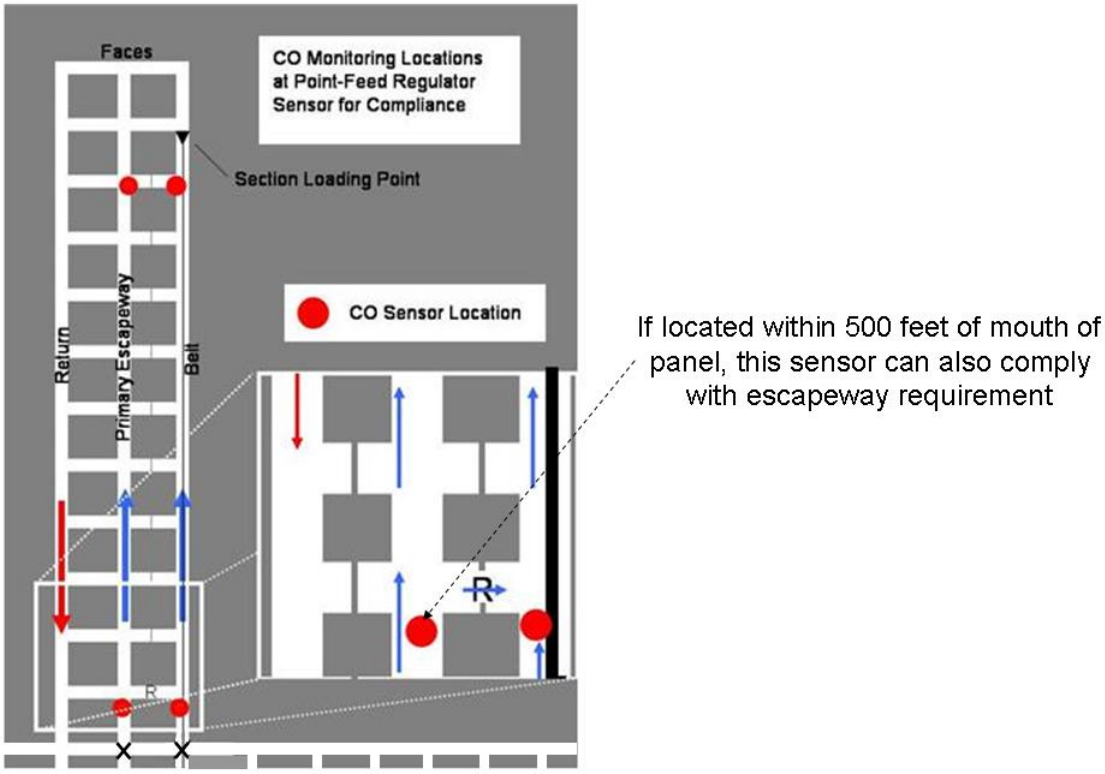


iv. Downwind, at a distance not more than 100 feet from each belt drive unit, each tailpiece transfer point, and each belt take-up. If the belt drive, tailpiece, and/or take-up for a single transfer point are installed together in the same air course they may be monitored with one sensor located not more than 100 feet downwind from the last component; and

v. At other locations in any entry that is part of the belt air course as required and specified in the Ventilation Plan.

b. Determine if additional sensors are required. For example, in accordance with § 75.350(d) sensors are required to monitor point-feed regulators and air velocities through these regulators are required to be at least 300 fpm in accordance with § 75.350(d).

Figure 5 - Location of sensors for monitoring point-feed regulators.



2. For Primary Escapeways—

When belt air is used to ventilate the working section, CO or smoke sensors must be located:

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

b. Within 500 feet inby the beginning of the panel.

The point-feed sensor required by § 75.350(d)(1) may be used as the sensor at the beginning of the panel as long as it is within 500 feet of the beginning of the panel. If the panel is 1,000 feet or less, one sensor may be used to comply with (a) and (b). See figure 5.

3. For Return Air Splits—

If used to monitor return air splits to comply with the onshift requirements in § 75.362(f), a methane sensor is required in the return air split from each working

section 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.

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), at least one sensor is required downwind and not greater than 50 feet from the electrical installation to monitor the mine atmosphere for carbon monoxide or smoke. Monitoring of intake air ventilating battery 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 by intake air coursed directly into a return air course or to the surface, sensors are required to monitor for heat and for CO or smoke. 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 or the smoke density reaches 0.022 per meter, as required by §§ 75.340(a)(i) (iii)(A) and (B).

5. For Intake Air Heaters --

   As specified in § 75.341(f), when sensors are used to measure CO concentrations in intake shafts where air is being heated as specified in § 75.341(f), the heater causing elevated CO level shall be shut down when the concentration at the monitoring location reaches 50 ppm.

E. <u>Inspection/Calibration of CO sensors.</u>

Note: The inspector should have the agent of the operator notify the AMS operator that the sensors will be inspected, calibrated and checked for malfunctions. The AMS operator should verbally confirm the time and location of each alert, alarm and malfunction signal when received.

1. Visually check sensors for blockage of airflow, and assure the 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 for visible damage to the sensor and/or the cable to the sensor.

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

4. Have the agent of the operator simulate a malfunction at the sensor unit. Verify that malfunctions are recorded at the designated surface location. It should be noted that disconnection of wiring at the sensor unit that results in failure of the system to provide the required alert and alarm signals is considered a malfunction.

5. If sensors and associated current-carrying conductors are installed where permissible equipment is required, ensure that the AMS has been evaluated by MSHA. Verify that the sensors are identified by an MSHA classification label attached to them and that the sensor circuit is protected by a barrier on the outby end of the sensor circuit cable located at a blue outstation. Verify that the barrier displays an MSHA classification label with the same letter designation as the sensor classification.

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

7. Observe a function test on 10% of the total sensors but not less than 5 sensors by applying a known concentration of CO. Record the reading of the sensor and compare it with the known concentration. If the system utilizes less than 5 sensors, all five should be calibrated.

8. Observe calibration of one sensor to ensure that manufacturer's guidelines for calibration are used. Some systems have a means to temporarily bypass the sensor during calibration to avoid false alarms to the section or main control center, so use the bypass when available.

The following is an example of a generic CO Sensor Calibration Procedure:

1. Once you are ready to begin the calibration of the sensor, notify the AMS operator at the designated surface location that you are going to calibrate the sensor at that particular location;

2. Apply the zero air calibration gas to verify proper zero reading. Some zero settings are manually set at 1-2 ppm to

prevent zero or negative readings at the surface readout. A note of the sensor reading should be taken;

3. Apply a known CO-air mixture of calibration gas (25 ppm, 50 ppm, 95 ppm, etc.) and make a note of the time the gas was applied to compare with the printout on the surface. Leave the calibration gas on for the specified time (usually two minutes) and observe and note the sensor or meter reading. The response should be within plus or minus 10%; and

4. When calibrating the sensor on a section while a section alarm is nearby, note the level at which the visual and audible alarms were activated, and the time of the alarm signals.

F. <u>Outstations.</u>

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

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 6 and 7.

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

Figure 6 - Examples of red outstations.

b. Blue outstations are used with sensors located in fresh air and areas where permissible equipment is required. Blue outstations are required to have –

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.

Figure 7 - Examples of blue outstations.

3. For blue outstations connected to a sensor in an area where permissible equipment is required verify the following:

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

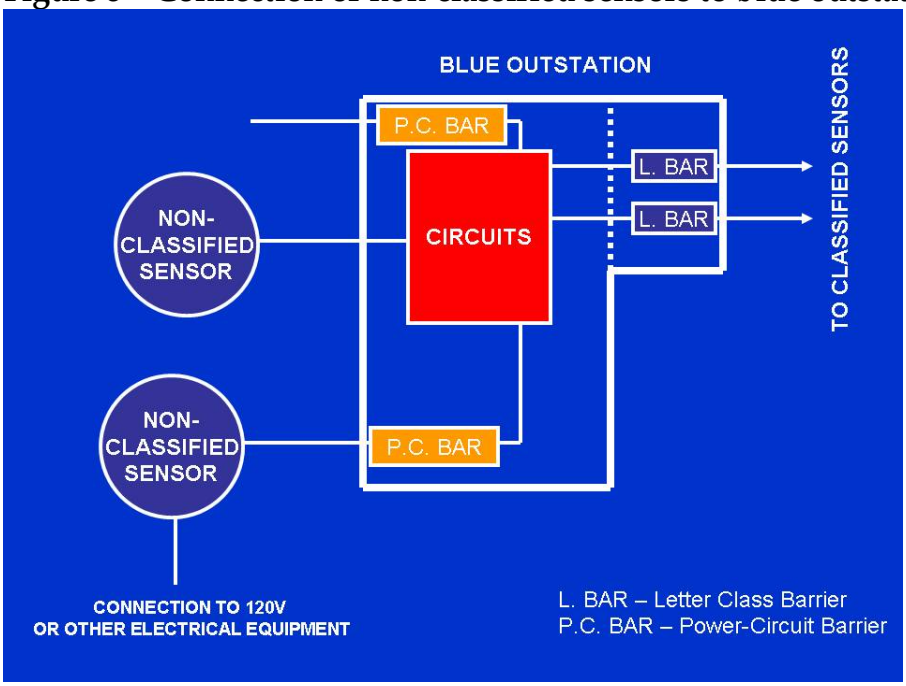
b. PC barriers and LTR barriers are housed in separate compartments or enclosures;

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;

d. LTR barriers can be used in parallel if acceptable to the Approval and Certification Center (A&CC). Contact A&CC at (304) 547-0400 for evaluation. When contacting A&CC, please have the barrier letter class and issue number;

e. Wiring of any non-classified sensors and alarm units connected directly to a blue outstation do not enter the classified (LTR) barriers compartment of the blue outstation. Non-classified sensors and alarm units are not to be connected to any electrical equipment other than the blue outstation, unless a PC barrier is used, see figure 8;

Figure 8 – Connection of non-classified sensors to blue outstation.

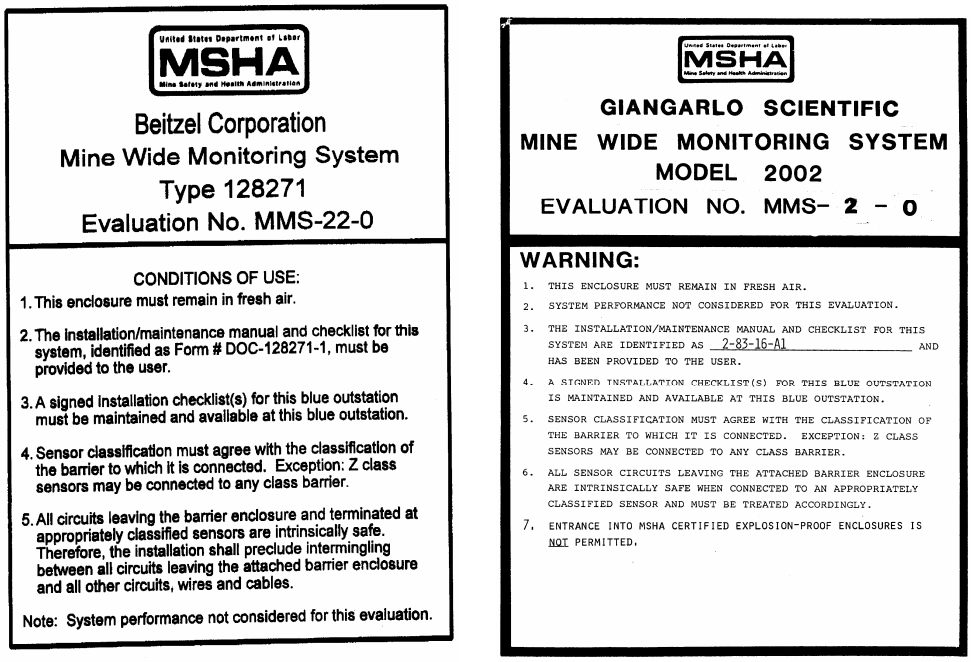


f. All sensors and alarm units have the same classification as the barrier to which they are connected; and

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

i. The evaluation label on the blue outstation indicates that connection to X/P equipment is permitted. See figure 9.

Figure 9 - Examples of blue outstation labels. Note the restriction on explosion-proof equipment in label on right.



United States Department of Labor
MSHA
Mine Safety and Health Administration

Beitzel Corporation
Mine Wide Monitoring System
Type 128271
Evaluation No. MMS-22-0

CONDITIONS OF USE:

1. This enclosure must remain in fresh air.
2. The installation/maintenance manual and checklist for this system, identified as Form # DOC-128271-1, must be provided to the user.
3. A signed installation checklist(s) for this blue outstation must be maintained and available at this blue outstation.
4. Sensor classification must agree with the classification of the barrier to which it is connected. Exception: Z class sensors may be connected to any class barrier.
5. All circuits leaving the barrier enclosure and terminated at appropriately classified sensors are intrinsically safe. Therefore, the installation shall preclude intermingling between all circuits leaving the attached barrier enclosure and all other circuits, wires and cables.

Note: System performance not considered for this evaluation.

United States Department of Labor
MSHA
Mine Safety and Health Administration

GIANGARLO SCIENTIFIC
MINE WIDE MONITORING SYSTEM
MODEL 2002
EVALUATION NO. MMS- 2 - 0

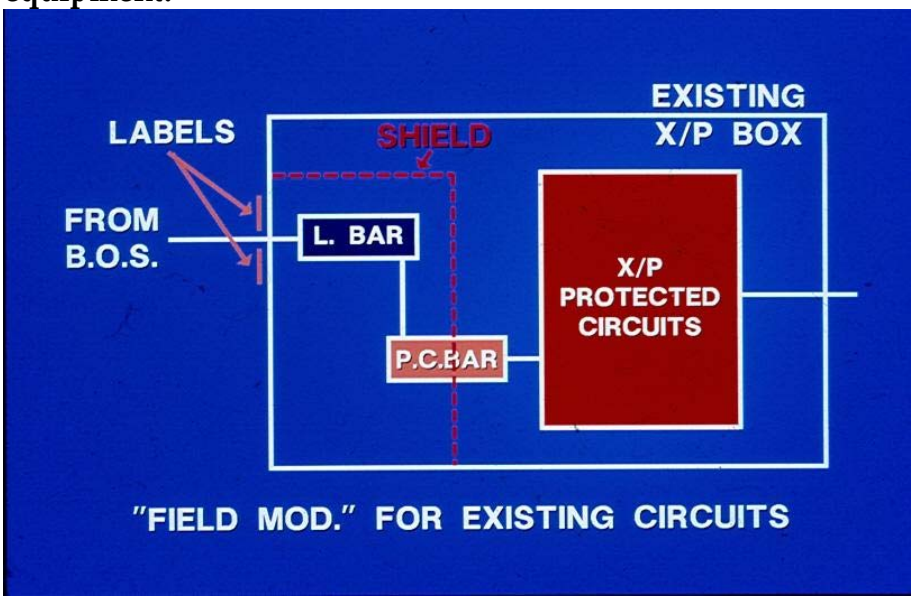
WARNING:

1. THIS ENCLOSURE MUST REMAIN IN FRESH AIR.
2. SYSTEM PERFORMANCE NOT CONSIDERED FOR THIS EVALUATION.
3. THE INSTALLATION/MAINTENANCE MANUAL AND CHECKLIST FOR THIS SYSTEM ARE IDENTIFIED AS 2-83-16-A1 AND HAS BEEN PROVIDED TO THE USER.
4. A SIGNED INSTALLATION CHECKLIST(S) FOR THIS BLUE OUTSTATION IS MAINTAINED AND AVAILABLE AT THIS BLUE OUTSTATION.
5. SENSOR CLASSIFICATION MUST AGREE WITH THE CLASSIFICATION OF THE BARRIER TO WHICH IT IS CONNECTED. EXCEPTION: Z CLASS SENSORS MAY BE CONNECTED TO ANY CLASS BARRIER.
6. ALL SENSOR CIRCUITS LEAVING THE ATTACHED BARRIER ENCLOSURE ARE INTRINSICALLY SAFE WHEN CONNECTED TO AN APPROPRIATELY CLASSIFIED SENSOR AND MUST BE TREATED ACCORDINGLY.
7. ENTRANCE INTO MSHA CERTIFIED EXPLOSION-PROOF ENCLOSURES IS NOT PERMITTED.

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 10.

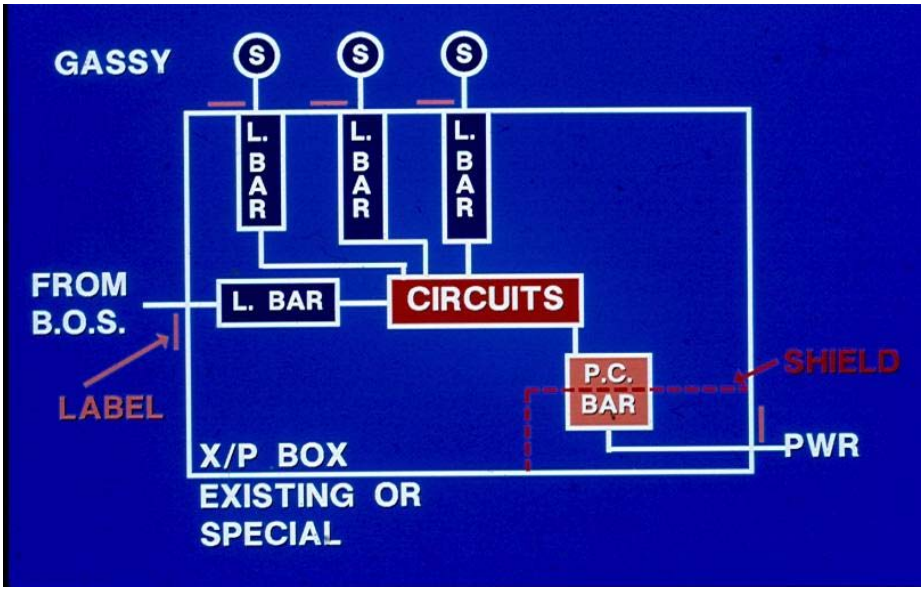
iii. The interconnection of the monitoring system with X/P equipment is shown on the machine approval documentation on file at the A&CC or on an accepted Field Modification.

Figure 10 - Example of connection to existing explosion-proof equipment.



iv. Barriers (LTR and PC) installed inside the X/P enclosure correspond with the label on the outside of the enclosure. See figure 11.

Figure 11 - Connection of blue outstation and sensors to explosion-proof enclosure; labels shown at the cable entrances match corresponding barrier.



4. The battery backup will function properly. This can be done by asking a representative of the operator to disconnect the incoming power to the outstation.

G. Section alarms (where required).

Ensure that alarm units are located at all working sections, affected areas where mechanized equipment is being installed or removed, and other locations specified in the Evacuation Plan, PFM, and Ventilation Plan. For automatic fire sensor and warning device systems installed to meet § 75.1103-5(a), the alarm unit may be at the working section or a manned location. See figure 12.

1. Verify the following:

    a. Alarm units located within permissible areas, within 150 feet of pillar workings or longwall faces, or in return air, have an LTR classification label attached. Electrical and data circuit cables for the alarm units originate from a blue outstation through an LTR barrier with a classification identical to the LTR classification of the alarm unit.

    b. Alarm units are located where they can be seen or heard by miners on all affected working sections, all affected working areas where mechanized mining equipment is being installed, and any other specified locations when—

        i. An alarm condition exists for CO, smoke or methane as required by §§ 75.323(d)(i)(ii) and 75.351(i). Methane signals are distinguishable from other signals; and

        ii. CO levels at two consecutive sensors alert at the same time.

If a signal is required on a section, it is important that the signal be seen or heard. If the signal cannot be seen or heard on a section during mining, the location of the alarm unit is not appropriate for that section and a citation should be issued under §§ 75.351(c)(4) or 75.1103-5(a), PFM, Ventilation Plan, or Evacuation Plan. The signal is required to be seen or heard by at least one miner but not required to be seen or heard by all miners.

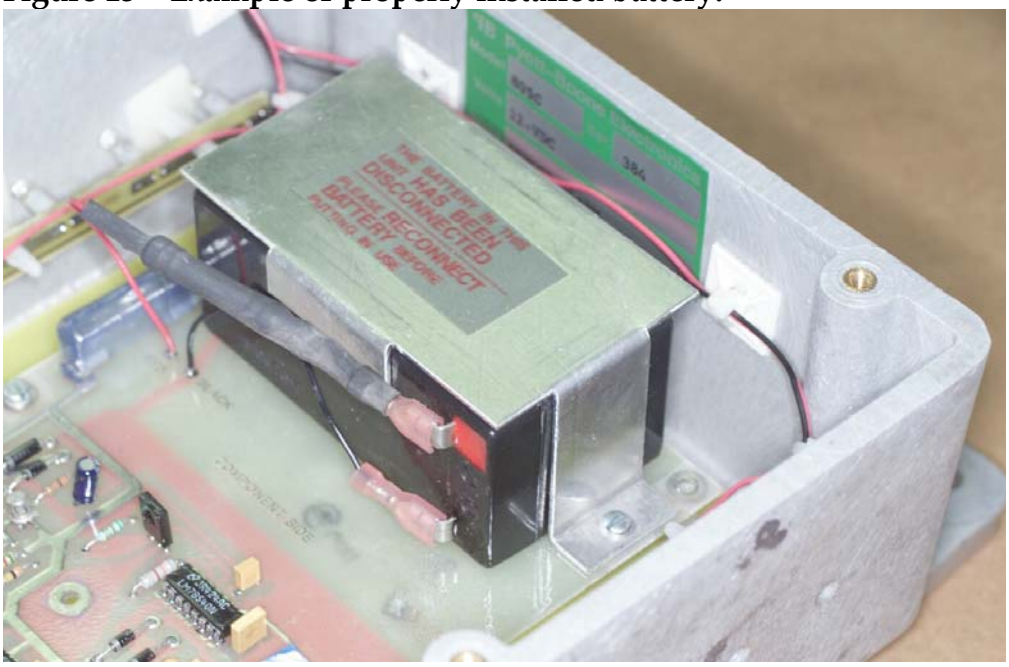
2. Check the operation of section alarms by requesting that a representative of the operator activate section alarms by applying calibration gas to an outby CO sensor. Ensure that the system is programmed to activate section alert and alarm signals in all affected areas as specified in the regulations, PFMs, or plans.

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

Figure 12 - Examples of alarm units.

4. Check for proper installation of internal batteries. See figure 13.

Figure 13 – Example of properly installed battery.



Chapter 5
RESPONSE TO ALERTS, ALARMS, AND MALFUNCTIONS

When an alert, alarm, or malfunction signal is received from an AMS, the system operator is required to notify the appropriate personnel as specified in § 75.352(a). The appropriate personnel are required to initiate an investigation to determine the cause of the signal and take the action required by § 75.352(c), (d), or (e). The AMS operator may also be designated as one of the appropriate personnel.

The identification of appropriate personnel by the AMS operator depends upon the type of signal received. For example, if a malfunction signal is received it is most appropriate to contact the person responsible for installing and maintaining the AMS or another electrician trained to work on the system. For an alert signal, it may be most appropriate to call a belt attendant to investigate the source of CO at a nearby sensor. For an alarm signal, it may be most appropriate to call a section foreman in an affected area to initiate an investigation and withdraw miners, as well as calling the designated responsible person identified pursuant to § 75.1501. In some mines, AMS operators may be instructed to report all alarms to the responsible person identified pursuant to § 75.1501. This is not a regulatory requirement; only a withdrawal of miners from affected areas is required when an alarm activates unless a fire is confirmed as a result of an investigation, when miners must be evacuated from the mine unless they're needed for fire fighting activities. In summary, the appropriate personnel identified pursuant to § 75.352 may have a wide range of duties, abilities and responsibilities. The AMS operator must be properly trained by the mine operator in identifying the appropriate personnel in response to the various signals received from the AMS.

If an inspector is at a mine when the monitoring system activates an alert, alarm, or a malfunction signal, an inspector should determine whether the response is in accordance with the applicable regulations, Ventilation Plan, Evacuation Plan, or PFM**. Do not** initiate alarms to observe the reaction of personnel.

The following is an example of a response to alert and alarm signals:

1. If any CO sensor indicates an alert, an investigation as to the source of the alert must be initiated. If an alarm signal occurs during this investigation, or if a second consecutive sensor indicates an alert condition, miners in affected areas are to be withdrawn to a safe location.

   If it is determined during an investigation that a fire exists, all personnel not required for firefighting activities shall be evacuated from the mine.

2. If any CO sensor indicates an alarm level, all personnel in the affected areas, unless assigned other duties under § 75.1502, are to be withdrawn to an outby location in intake air. 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 shall be evacuated from the mine.

3. When an activity that may result in CO concentrations above the alarm levels being produced, such as cutting, welding, etc., is planned, the person in charge of the activity should notify the system operator of the following:

   a. Location and type of activity;

   b. Time activity begins; and

   c. Time activity is completed.

The following is an example of a response to malfunction signals:

If the monitoring system or any portion of the system has been de-energized for reasons such as routine maintenance or failure of a sensor unit, the belt conveyor may continue to operate provided—

   a. The miners in the affected areas are notified; and

   b. The affected portion of the belt conveyor is continuously patrolled and monitored for CO as follows:

      i. The trained person(s) performing monitoring shall be provided with a two-way communication device enabling the person(s) to communicate with the surface;

      ii. Each of these trained persons shall be provided with a hand-held CO detection device. A CO detection device shall also be available for use on each working section;

      iii. If one sensor becomes inoperative, the trained person shall monitor at that sensor location;

iv. If two or more adjacent sensors become inoperative, a trained person shall patrol and monitor the affected area;

v. If the complete system becomes inoperative, a sufficient number of trained persons shall patrol and monitor the affected entries of the mine so that the affected entries are traveled in their entirety once each hour; and

vi. The mine operator shall begin corrective action immediately and continue until the defective equipment causing the malfunction is repaired or replaced.

Hand-held CO detectors used during malfunction (if applicable).

When all or any portion of the AMS fails, the following should be verified:

1. Whether a sufficient number of trained persons and hand-held detectors are available to permit continued operation of the conveyor belts. For mines using belt air, if the air velocity is less than 50 fpm, and the sensor spacing has not been reduced, this would be considered a system failure and monitoring with hand-held instruments would be required to continue operation of the belt conveyor. Continuous patrolling of the affected area would also be required until the air velocity is re-established or decreased sensor spacing is approved by the district manager and established, as specified in § 75.352(f).

2. Whether the Evacuation Plan or PFM requires CO detectors.

3. Whether surface records include alert and alarm reports from personnel monitoring the belt entry with CO detectors because of system malfunction.

4. Whether persons designated to monitor for CO with hand-held detectors are properly trained in the following:

   a. The use of the hand-held detectors used at the mine;

   b. Definition of alert, alarm, and ambient levels; and

   c. Responsibilities to communicate with the surface regarding detection of any contaminant. The designated person should understand that he is responsible for immediately reporting contaminant levels reaching alert and alarm levels, as well as reporting at intervals not to exceed 60 minutes when contaminant levels are less than the alert levels.

Chapter 6
TRAINING

The effectiveness of the monitoring system depends upon the effort made to maintain the system and training provided to system operators and other miners to properly respond to alert, alarm, and malfunction 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 ensure proper responses.

Responses to alert, alarm and malfunction signals are dependent upon the requirements of the regulations, PFMs, and the Ventilation and Evacuation Plans. Therefore, system operators are required to be trained in these provisions.

System operators are required to report signals to appropriate personnel. The appropriate person designated to investigate alert and alarm signals is likely to be different from the person investigating a malfunction condition. System operators should be able to determine the most appropriate person(s) they need to contact in response to various signals.

At some mines, the system 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 system operators have been adequately trained in accordance with their duties and responsibilities. The 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 whether they have been properly trained on the following:

    1. The actions taken as a result of CO alert signals. If a CO sensor indicates an alert signal, appropriate personnel are notified to initiate an investigation. A PFM or an Evacuation Plan may require additional notifications.

    2. The actions taken as a result of CO or smoke alarm signals. If a CO or smoke sensor indicates an alarm signal or if two consecutive sensors indicate an alert level at the same time, miners in affected areas, except for miners assigned other duties under the Evacuation Plan, are to be withdrawn to the safe location identified in the plan.

    3. The actions taken as a result of a malfunction. If the system indicates a malfunction, the system operator is to notify appropriate personnel to initiate an

investigation, and immediate action is taken to return the system to proper operation. Hand-held CO detectors are used to monitor the locations of the malfunction to allow continued operation of the belt.

4. The actions taken as a result of methane alert or alarm signals. If a methane sensor indicates an alert or alarm signal, appropriate personnel are to be notified to initiate an investigation, and when methane reaches 1.5%, if miners in affected areas are withdrawn to a safe location.

5. The process of evacuation of miners if a fire is discovered. All miners are to be evacuated, except for miners assigned other duties under the Evacuation Plan.

B. Whether the system 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 fan stoppage.

C. Whether the persons responsible for maintaining and installing components of the 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 is activated. Inspectors should determine the adequacy of training through discussions with miners during the inspection.

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

F. Whether the persons monitoring for CO or smoke in the affected areas during a malfunction are trained in the provisions of § 75.352(e).

Appendix I

Equivalency of Fire Detection Systems –Monitoring System used in lieu of Point-Type Heat Sensor (PTHS) Systems under § 75.1103-4(a)(2).

To clarify the intent of the provision in § 75.1103-4(a)(2), the following guidelines are provided to determine compliance with the standard for equivalency. This appendix is not intended to be applied for compliance with § 75.350 for using belt air on working sections.

Spacing of sensors

Equivalency tests conducted by MSHA have determined the spacing of CO sensors to be 2,000 feet when air velocity within the belt entry is 50 fpm or more. In cases where lower velocities are maintained, more recent NIOSH tests have indicated the spacing of sensors can be reduced to 350 feet (this spacing and reduced velocity would be equivalent to fire detection by CO sensors spaced at 1,000 feet with 50 fpm minimum air velocity in the belt entry). Although it may seem logical to allow spacing of 700 feet with velocities less than 50 fpm as an equivalent to 2,000 foot sensor spacing, there is no research to support it. It should be noted that recent PFMs require 1,000 feet sensor spacing when air velocity within the belt entry is 50 feet or more.

When air velocities exceed 100 fpm, § 75.1103-10 requires the spacing of heat sensors to be reduced from 125 feet to 50 feet. The equivalent CO system sensor spacing does not need to be reduced due to increased air velocity, although possible reductions in alert and alarm levels may need to be considered as previously discussed. If smoke sensors are used by a mine operator, contact MSHA Technical Support for additional guidance.

Belt drives

For many years, compliance with § 75.1103-4(a) required that two sensors be installed near each belt transfer at the end of the belt flight (tailpiece) and the beginning of the belt flight (belt drive) to identify a fire within each belt flight. Experience has shown that one CO sensor on the downwind side of the belt transfer point is adequate for detection of a fire and that a second sensor on the upwind side of the same transfer point is of little additional benefit as compared to PTHS systems. However, spacing requirements for all sensors must still be met.

Location of sensors within the entry

It has been determined through many years of experience and testing that sensors should be installed in the upper third of the entry to take advantage of the buoyancy effect of fire contaminants. Sensors should be located so that the air stream passes over the sensor, and should not be located behind obstructions such as posts or cribs. Sensors should not be located in cavities or other locations which may inhibit the flow of contaminants to the sensor.

Sensors are most effective when located near the belt. Sensors should not be installed along the coal rib because typical airflow patterns along the rib do not provide optimal fire detection. The location of any sensor should not subject miners to unnecessary hazards.

Alert and alarm levels

Tests have indicated that alert and alarm levels of 10 and 15 parts per million (ppm) CO are equivalent to PTHS. Reduced alert and alarm levels should be considered when air velocities exceed 500 fpm. In most cases where high air velocities ventilate the belt air course, the monitoring system is used to comply with regulations allowing belt air on working sections and not just to comply with § 75.1103.

Maintenance

Sensors should be calibrated in accordance with manufacturer specifications at intervals not to exceed 31 days.

Appendix II
CHECKLIST

A. Pre-inspection

Review the following:

1. Applicable Standards of 30 CFR,
2. All applicable PFMs,
3. Training Plan
4. Ventilation Plan, and
5. Evacuation Plan

B. Surface Inspection

Mine Records

1. Review records of sensor calibrations and records of alert, alarm and malfunction signals.
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. Review records of weekly inspections for the CO monitoring system.
5. Review records of annual functional test of the CO monitoring system.
6. Verify that the names of designated AMS operators and other appropriate personnel, including the designated person responsible for initiating emergency mine evacuation, and methods to contact these persons, are provided at the designated surface locations.
7. Review training records for AMS operators for the actions required during alerts, alarms, and malfunctions.

Check the map or schematic

8. Determine if the schematic or map is properly displayed at the designated surface location and is properly updated.

Observe operation of system

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

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

11. Ensure that the system is provided with 4 hour backup power.

12. Determine the means of disconnecting the data line.

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

14. 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.

15. Determine if system operators 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

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

17. 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.

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

Communications

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

Lightning arresters

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

C. Underground Inspection

Air currents

1. Check the velocity (minimum and maximum) and direction of the air flow and velocity (minimum and maximum).

Air velocities

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

Installations of sensors

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

4. Ensure AMS and mine phone cables are installed in separate entries.

Locations of sensors

5. Determine if sensors are installed at the locations identified on the mine map maintained at the designated surface location.

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

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 the sensor unit. 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 5 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 section alarm units are installed at locations where they can be seen or heard by miners working in the area. For § 75.1103 installations, alarm signals may be received at work locations where miners may be endangered or at a manned location on the surface or underground.

18. When an alarm unit is installed at a manned location underground, verify that a means on two-way communication is established between the manned location and all areas where miners may be endangered.

D. Response to alerts, alarms, and malfunctions

1. Verify the actions taken by the system operator when an alert, alarm, 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 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.