Considerations for Underground Coal Mines That Operate Near Coalbed Methane Wells

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CONSIDERATIONS FOR UNDERGROUND COAL MINES THAT OPERATE NEAR COALBED METHANE WELLS

INFORMATIONAL REPORT 1346

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ABSTRACT
The extraction of methane from coal seams and surrounding strata is a rapidly growing component of the domestic natural gas supply. Several types of wells and production methods have been developed to exploit coalbed methane (CBM) resources. This informational report presents an overview of CBM production methods, examines potential hazards to underground coal miners who intersect wells, lists methods to mitigate these potential hazards and identifies considerations for inclusion in approved ventilation plans to address mine-specific CBM-related hazards.

INTRODUCTION
This informational report is provided to inform and assist the mining community as CBM wells increasingly intersect underground coal mines. Mining into a pressurized well may result in serious injury. District Manager approval is required in the mine’s ventilation plan before mining within a specified barrier around CBM wells under MSHA’s Program Information Bulletin (PIB) 05-10. Additionally, a petition for modification is required before mining within a specified barrier around surface directionally drilled CBM wells (PIB 08-20). This informational report provides examples of commonly used CBM techniques. These examples are intended for information and guidance only. This information only applies to CBM wells; conventional oil and gas well barriers are specified in 30 C.F.R. § 75.1700. Please contact the appropriate Coal District Office with any questions concerning CBM wells.

New production technologies and a strong natural gas market have made coalbed methane, also known as coal seam gas, occluded natural gas, and gob gas, one of the fastest growing sources of domestic energy. In 2007, 1.8 trillion cubic feet (TCF) of CBM was produced in the United States (U.S. Department of Energy, EIA, 2008). This CBM represented approximately 9.1% of the domestic natural gas production in 2007.

The Mine Safety and Health Administration (MSHA) supports and encourages CBM extraction because it can significantly reduce methane emissions in coal mines and has been proven to decrease the incidence of face ignitions in gassy coal mines. However, procedures to address the potential hazards presented by CBM wells must be developed and implemented to protect the coal miners who will be exposed to these wells. A long history of methane-related coal mine disasters in the United States underscores the potential hazards that unplugged or incorrectly plugged CBM wells could present during mine intersection.

MSHA is concerned about the intersection of underground coal mines and CBM wells. When underground coal mines intersect inadequately plugged CBM wells, methane inundations, ignitions and explosions are possible. To avoid these significant hazards, the coal mine operator shall take reasonable measures to locate all CBM wells on the
mine property. Once the location and specifics of the active or unplugged wells are known, the mine operator may elect to leave a suitable barrier around the wells or may take specific steps to plug or prepare the wells for safe mine intersection. The minimum barrier size, plugging criteria or other means to prepare for safely mining near or through the wells must be included in the approved mine ventilation plan.

There are several different types of CBM wells and production systems including degasification systems located in active coal mines. These different CBM systems present unique hazards to underground coal miners and will require specific precautionary measures in the approved ventilation plan to address these hazards.

MSHA formed a committee to study the issues associated with CBM production and develop recommendations to address these issues. This study concluded that there are no functional differences between CBM wells and methane drainage systems. This study determined that CBM reservoirs are significantly different from conventional oil and gas reservoirs (subsurface accumulations of oil or gas). This study also indicated that the existing ventilation plan and mapping regulations for methane drainage systems could be used to help protect miners from CBM well hazards. MSHA issued PIB 05-10 on May 10, 2005, giving notice that CBM wells are subject to the ventilation plan and mapping requirements that apply to methane degas wells (see Appendix A). A significant methane inundation occurred in 2008 when a development section intersected an inadequately plugged surface directionally drilled CBM well. The similarity between this inundation and the intersection of an inadequately plugged conventional gas well resulted in the publication of PIB 08-20 in 2008. This informational report (IR) provides guidance to mine operators, consultants, District Managers and ventilation plan reviewers on considerations for CBM wells that should be addressed in ventilation plans. New technologies or alternative approaches that provide the same level of protection to the miners should be carefully considered during plan reviews.

CBM WELLS
The following is a general overview of the types of CBM wells and production systems that extract methane from coal seams and surrounding strata. There are several proprietary CBM processes that are approximated by these generic systems.

VERTICAL WELLS
Vertical wells are one of the most common CBM production methods. As shown in Figure 1, the vertical hole consists of a drill hole that extends below the coal seam a sufficient distance to provide a sump for a dewatering pump and to allow coal particles and proppant sands to accumulate below the pump. The casing is perforated in the coal seam and may be perforated in multiple coal seams or adjacent sandstones.
Alternatively, the hole may be left open (uncased) at the coal seam. Hydraulic fracturing is often used to stimulate methane production. Vertical wells are typically developed several years in advance of mining to maximize CBM recovery. Virtually all methane produced from vertical wells is delivered to pipelines for commercial sales. Compressors and pipelines are often connected to the wellhead.

![Figure 1, Vertical CBM Well](image)

**GOB WELLS**

Gob wells are simple variations on the vertical well. Vertical wells may be converted to gob wells prior to longwall extraction. When surface access is problematic, inclined or directionally drilled gob wells have been used. The gob hole, as shown in Figure 2, is a cased or uncased hole that stops approximately 30 to 100 feet above the coal seam. There is no connection between the gob hole and the mine atmosphere until caving over the longwall panel propagates up to the gob hole. Wells may be drilled into active or sealed gobs but additional precautions are necessary to protect the miners. Methane stratification in the gob can result in high methane concentrations. Gob wells may be vented to the atmosphere or connected to commercial pipelines. Vacuum blowers are often used to increase the methane extraction rate.
SURFACE DIRECTIONAL DRILLED CBM WELLS

Several different directional drilling processes have been developed and proprietary names have been given to some of these processes. For the purposes of this report, all of these proprietary processes will be referred to as the generic "surface directional drilled" (SDD) wells. Drill holes may be deviated in both the horizontal and vertical planes using these techniques. By branching off of horizontal holes in the coal seam, increased CBM recovery can often be achieved in a shorter time period and at a lower cost than conventional vertical holes with hydraulic fracturing stimulation. As Figures 3 and 4 illustrate, one deviated drill hole may produce CBM from an area that would require at least 16 conventional vertical wells. These wells may be completed in multiple coal seams. The environmental footprint of the drilling site, access roads and gathering pipelines is significantly reduced for the SDD system.
Figure 3, Directional Drill Hole

Figure 4, Directionally Drilled Branches
HORIZONTAL IN-MINE HOLES

The initial coalbed methane degasification studies done by the former U.S. Bureau of Mines in the late 1960's were based on horizontal drill holes in the coal seam that were drilled from a shaft sunk into a coal seam (Fields, H.H., et. al, 1973). Several underground coal mines currently use horizontal in-seam techniques to extract CBM from locations inside the mine. A cross-panel horizontal hole system is shown in Figure 5. Because of high labor costs to develop and plumb numerous cross-panel holes, the directional in-seam drilling method has been developed and used at some mines as shown in Figure 6. Degasification holes drilled from within the mine have been used to successfully reduce methane emissions from adjacent coal seams and sandstone strata that may be disturbed during mining. Some mines have utilized methane drainage holes that are angled up from the mine entries into adjacent longwall gobs. Improvements in drilling technology have made long hole drilling from within the mine feasible. This long hole in-seam drilling may include directional deviations and side branches as shown in Figure 7.

Figure 5, Horizontal Cross-panel Holes
Figure 6, Horizontal Directional Holes

Figure 7, Long Horizontal Holes
CBM HAZARDS

The primary hazard from CBM wells, holes and systems is the potential inundation of the mine by methane. The escaping methane can overpower the ventilation of the mine workings and result in an explosive atmosphere. If the escaping methane is under sufficient pressure, coal dust may be suspended. An explosion is a possible outcome of mining into an unplugged CBM well. It is imperative that mining into pressurized wells and boreholes be eliminated to protect the miners. The prevention of leakage from in-mine methane piping systems is addressed in an MSHA Informational Report (Tisdale, Jack E., et. al., Piping Methane In Underground Coal Mines, IR-1094, 1978).

Additional, CBM-related hazards include the possible inundation of water or drilling fluids when holes are intersected, drilling and well completion hazards, wellhead hazards, and surface access road hazards. Another potential hazard presented by CBM wells is the potential for metallic casing to conduct lightning strikes into the mine environment. If explosive levels of methane are in the vicinity of the well casing, the possibility of an ignition or explosion is a grave potential hazard (NIOSH, 2001). This potential hazard is not limited to CBM wells. Conventional oil and gas wells, deep water wells, power boreholes, rockdust holes, etc., may also act as lightning conductors if metallic casing, tubing, wiring, etc. are present in the holes.

Generally, MSHA does not have jurisdiction over pipelines, gathering lines, other production equipment, facilities, or lands that are used for the commercial production of natural gas. Due to the complex circumstances that may be associated with these wells, MSHA's jurisdiction for CBM wells and systems is determined on a case-by-case basis. In determining its jurisdiction, MSHA will consider the following questions:

(1) Are CBM holes, wells, and systems on mine property?
(2) Are CBM holes, wells, and systems associated with mining, i.e., a precursor to mining or done for mining purposes?

MSHA's jurisdiction is defined in section 4 of the Federal Mine Safety and Health Act of 1977, as amended, (Mine Act) and the definition of a mine is found in section 3(h)(1) of the Mine Act. Because MSHA considers CBM wells and systems functionally the same as degasification holes and methane drainage systems, the time period (how close in time) between the commercial production of CBM (degasification) and the mining activities may influence whether MSHA has jurisdiction. All persons working on mine property must be trained as specified in 30 C.F.R. Part 48.
HAZARD MITIGATION

The hazards associated with CBM wells, holes and systems must be adequately addressed and remedied before intersection by the mining operation to protect the miners. The mine ventilation plan and mine maps are required to contain provisions and information to adequately address CBM hazard mitigation issues under:

30 C.F.R. § 75.371(dd) The location of all horizontal degasification holes that are longer than 1,000 feet and the location of all vertical degasification holes;

30 C.F.R. § 75.371(ee) If methane drainage systems are used, a detailed sketch of each system, including a description of safety precautions used with the systems;

30 C.F.R. § 75.372(b)(5) The locations of all known oil and gas wells and all known drill holes that penetrate the coalbed being mined;

30 C.F.R. § 75.372(b)(15) The locations of existing methane drainage systems; and

30 C.F.R. § 75.1200-1(d) All drill holes that penetrate the coalbed being mined.

District Manager approval is required before mining within a specified barrier around CBM wells (PIB 05-10). Under 30 C.F.R. § 75.371(ee), the requirements for barrier dimensions, plugging the wells, or other means for mitigating the potential hazards must be detailed in the approved ventilation plan.

Specific hazard mitigation techniques vary with the type of CBM recovery systems, the coal mining methods, the characteristics of the CBM reservoir, and other site-specific factors. These specific hazard mitigation requirements must be included in the approved ventilation plan.

Potential CBM hazard mitigation techniques include:

- Avoidance of CBM wells by the mine operation - The mine plan can be designed to leave adequate barriers around the CBM wells.
- Timing of CBM extraction and subsequent mining - The time period that the CBM well is in operation affects the CBM reservoir pressure and the reservoir gas quantity.
- Pressure management - Horizontal holes may be safely intersected if connected to a vacuum system to reduce the hole pressure below the mine atmospheric pressure. This technique may be limited to shorter holes in coal seams where the walls of the holes tend to cave.
- Plugging - An adequately plugged well will help isolate the mine from the CBM reservoir and eliminate methane accumulations.
• Permeability reduction – Slurries or gels may be injected into the CBM reservoir to reduce methane inflow to the well prior to abandonment.

These techniques, as well as the applicable training regulations in 30 C.F.R. Part 48, and the equipment operation, examination, and ventilation regulations in 30 C.F.R. Part 75, can be used to protect coal miners who will intersect, travel, or work near CBM wells and production systems.

Lightning Protection

Lightning strikes have been associated with several coal mine explosions (Checca and Zuchelli, 1995; Geldenhuys, et al. 1985; NIOSH, 2001; and MSHA 2006). Metallic cased boreholes have been associated with many of these incidents (Checca and Zuchelli, 1995; and NIOSH, 2001). Conventional lightning protection using static wires and grounding beds were ineffective in preventing explosions under metallic cased boreholes (MSHA, 1996, p 13). These boreholes also had the upper 100 ft. of casing milled out. Various electrical models have been proposed to help quantify this lightning transmission (Novak, 2001, and Sacks, 2005). The mitigation of lightning strike hazards in underground coal mines is an area that needs additional research and testing to better protect coal miners.

Mapping

The accurate location of CBM wells is vital for not only existing coal mines but for mines that may be developed in the future. Wellhead locations should be accurately surveyed and mapped. The registered engineer or registered land surveyor who certifies the maps under 30 C.F.R. §§ 75.372(a)(1) and 75.1201 is responsible for the accurate location of all CBM wells. If deviated wells are used, downhole surveys should be performed or measurement-while-drilling (MWD) information should be shown on the maps to depict the coal seam intersections and within-seam extents of the well. The location of all CBM wells should be plotted as specified by 30 C.F.R. § 75.1200-1(d) and 30 C.F.R. § 75.372(b)(5). Adjacent or upper seam mines that are near active CBM wells are advised to obtain this location information in a timely fashion so that the CBM wells may be avoided or plugged. The state agency that issues oil and gas well permits is usually a good source of information on oil and gas well development near specific mines. Before abandonment, the surveying system used to locate the CBM wells should be tied into permanent monuments or high-resolution (0.5 meter accuracy) geographic positioning system (GPS) locations of the wells should be determined. The timely communication of any changes in planned mine development, CBM hole locations, and CBM well status is essential to protect the safety of the miners.

Prior to submitting a 30 C.F.R. § 75.1204 abandonment map to the mine map repository, the District Office should confirm that CBM wells are plotted and the statuses of these wells are accurately shown on the map. If a final map cannot be obtained from the operator, the latest ventilation map (30 C.F.R. § 75.372) should be submitted to the mine
map repository with an annotation that "THIS IS NOT A FINAL MAP" and an explanation of the map deficiencies. CBM operators, mine operators, and landowners should realize that unmapped or unreliably mapped CBM wells, unacceptable well plugs, or inadequate abandonment records may result in the loss of mineable coal reserves in that area. These mine operators, landowners, and CBM operators are encouraged to preserve this critical well data to help protect future coal miners.

**Barriers Around CBM Wells**

Mine operators must identify and locate CBM wells penetrating coalbeds or any underground area of a coal mine. When identified, reasonable barriers around active, unplugged or inadequately plugged CBM wells should be established and maintained. The District Manager should not approve any plan to mine through or close to a CBM well until the mine operator presents records that the well was adequately plugged or other mitigation measures are sufficient to protect the miners. State regulations may also specify minimum barrier requirements.

There are several reports of explosions and fires that occurred when coal mines were developed near oil and gas wells during the early 1900's. Three explosions and fires resulted in the deaths of six miners. In 1913, the U.S. Bureau of Mines organized a committee that included coal operators, well drillers, state mine inspectors, state geologists, and U.S. Bureau of Mines representatives to examine this problem. The recommendations that were developed by this committee (Rice, George S., Ozni P. Hood, Lewis M. Jones, and Alfred G. Heggem, 1913) were successfully adopted by the coal-producing states. The committee's primary recommendation was to create a barrier around oil and gas wells to prevent mining within a certain distance. This limitation was included in the Federal Coal Mine Health and Safety Act of 1969 [sec. 317(a)] and later codified as 30 C.F.R. § 75.1700. MSHA requires a barrier of 300 feet in diameter around oil and gas wells unless the District Manager determines that a lesser barrier will be adequate to protect the miners or requires a greater barrier where the depth of the mine, geologic conditions, or other factors warrants a greater barrier.

Due to problems with leaving barriers in longwall coal mining systems, the U.S. Bureau of Mines, Mine Enforcement and Safety Administration (MESA), developed and tested well plugging techniques in the 1970's. MESA developed a detailed protocol for re-drilling and plugging abandoned oil and gas wells. The protocol was developed to protect miners from methane ignition, crude oil inundation, and water inundation while allowing wells to be mined through. (Componation, Paul J., Jack E. Tisdale, and Joseph Pasini, III, 1977). This MESA protocol is the basis for all granted petitions for modification of 30 C.F.R. § 75.1700 that allow mining through properly plugged oil and gas wells. MSHA has granted numerous petitions for modification of 30 C.F.R. § 75.1700 since 1979, and many oil and gas wells have been successfully re-drilled,
plugged and safely mined through (no reported oil or gas inundations) using the MESA techniques.

When a mine operator proposes to mine within the specified barrier of an active well or a well that has not been adequately plugged, the District Manager should consider the accuracy of the well location and the possible effect of mine subsidence on the well casing before permitting this encroachment. Any well location is subject to the normal inaccuracies and errors inherent in surveying. The instrumentation used in directionally drilled wells typically has a measurement error of approximately one degree [± 17.5 feet (ft.) per 1,000-ft. of hole length].

In addition to wellhead surveying errors, wells may deviate significantly from vertical. Most drilling contracts specify that a well must be within 4 or 5 degrees of vertical. Rotary bits tend to drift into shallow-dipping strata and deflect along steeper-dipping strata. The torque on the drill string also causes most rotary drilled holes to spiral. A 5 degree deviation from vertical would result in an 87.5-foot offset at the bottom of a 1,000-foot well. Some wells contain sidetracks and other intentional deviations from vertical. Drilling logs should show these specific deviations. Down-hole deviation surveys may be used to quantify the actual well location at depth. Non-rotary drilling methods usually exhibit less down-hole drift. A prudent margin of error should form the safety barrier approved by the District Manager for approaching an unplugged CBM well when subsidence is not an issue. The determination of the GPS coordinates of the wellhead is recommended. These GPS coordinates should be listed on the mine maps. GPS locations provide a cross-check of the well locations and help preserve the location of the hole when monuments or survey markers are lost or destroyed.

The 300 foot barrier that was developed by the Bureau of Mines is based on subsidence protection of a well casing for a 600-ft. deep Pittsburg seam mine with a 14 degree angle-of-draw. Subsequent subsidence research has documented average angles-of-draw of 15 to 35 degrees in relatively flat-lying coal strata (Singh, "Mine Subsidence," 1992). Many mines will have site-specific angle-of-draw data from subsidence surveys. The National Coal Board prudently recommends a 35 degree angle-of-draw be used for subsidence-related planning in the Subsidence Engineers Handbook (1977) when specific measurements are unavailable. The District Manager may require that a qualified professional engineer design and certify minimum barrier diameters where subsidence may be an issue. SDD wells may deviate significantly from the locations provided by the driller due to the accuracy limitations inherent to downhole directional monitoring systems. Barrier dimensions should include the maximum probable error component for SDD holes.
CBM WELL CONSIDERATIONS

MSHA should carefully consider the nature of the CBM reservoir, the type(s) of CBM wells, the type of mining system and other conditions that may affect the safety of miners. These issues should be adequately addressed in the approved ventilation plan.

VERTICAL CBM WELLS

Plugging

Prior to mining within the safety barrier specified by the District Manager, vertical CBM wells should be plugged. Prior to plugging, all tubing and free casing should be removed from the hole. If there are any questions about the integrity of the cement in the annulus of the hole, the well casing should be perforated and squeeze cemented. Cement bond logs or well completion records may be required by the District Manager to establish the annulus condition. Mud, grease or any other material that might compromise the strength and integrity of the cement plug should be cleaned from the hole prior to plugging. A cement plug should be placed from the bottom of the hole or at least 50 feet below the lowest mineable coal seam. Expanding cement is required to reduce micro-annuli development in cased holes. If gas or fluid flow from the well may compromise the integrity of the cement, a suitable bridge plug or packer should be installed. This cement plug should extend at least 50 feet above the highest mineable coal seam or to the ground surface. The cement should be placed at a pressure of at least 100 pounds per square inch. Suitable mud and spacer gels may be used to control formation pressure and facilitate cement placement. Steel turnings or other small magnetic particles should be embedded in the top of the cement near the surface to serve as a permanent magnetic monument of the well. As an alternative, a 5 inch or larger casing, set in cement, should extend at least 36 inches above the ground level. If the top of the plugged hole is buried or not marked with a physical monument (i.e. prime farmland), high-resolution GPS coordinates are recommended to preserve the well location. If CBM well intersections are anticipated, MSHA recommends that the well casing be cut or milled at mineable coal seam levels prior to plugging. Circular cuts through the well casing spaced at 18 to 24 inch intervals starting approximately one foot below the floor of the coal seam and extending to approximately one foot above the roof of the coal seam (or the section of the coal seam that will be mined) have been successfully used to eliminate the need for cutting torches in the coal face. The removal of the metallic casing using a milling bit from the area around the coal seam is another recommended technique. Alternatively, nonmetallic casing or open-hole completions may be used in the coal seam areas to facilitate mine intersection.

The operator may elect to use the upper portion of the vertical CBM well for gob CBM purposes. If used for gob CBM production, the well should be plugged with cement for an adequate distance above the coal seam being mined prior to mining within the safety
barrier specified by the District Manager. The provisions of the gob CBM well ventilation plan requirements would then apply to the converted vertical wells.

**Mapping and Diagrams**

All completed vertical CBM wells and projected wells that are located within 500 feet of the active mining area and the next 12 months of proposed mine development should be shown on the mine ventilation map [30 C.F.R. §§ 75.371(dd) and (ee), 75.372((b)(5), 75.1200(k) and 75.1200-1(d)]. The diameter and depth of the CBM wells should be shown on the ventilation map. The status of all wells should also be shown on the ventilation map (planned, active, plugged, etc.).

A sketch showing the typical well completion is required in the approved ventilation plan by 30 C.F.R. § 75.371(ee). Typical and maximum hole depths and the hole sizes (diameter) should be included in the plan. Geologic sections may be required in the plan.

**Abandonment**

Before the vertical CBM well is abandoned, the hole should be plugged using the techniques specified in the “Plugging” section above to protect future underground coal mining operations. Some states have CBM plugging and abandonment regulations that may be applicable. Wells that do not have acceptable plugging documentation will require redrilling and installing an acceptable plug prior to mine intersection or an adequate barrier must be maintained around the well.

**GOB WELLS**

**Drill Holes**

When drilled and completed in advance of mining, gob wells will typically stop 30 to 100 feet above the coal seam. If the bottom of the hole intersects the coal seam, the well should be backfilled with cement to an acceptable level above the coal seam. If a well is converted to a gob hole, the bottom portion of the hole should be plugged with cement above the coal seam prior to mining through the well. The length of this plug above the coal seam should be based on the local conditions but should be sufficient to resist the hydrostatic head that would be developed if the hole was filled with water.

If the well is drilled into a gob, MSHA recommends that inert drilling media (water, mud or nitrogen foam) be used. The hole should stop at least 100 feet above the coal seam elevation or immediately after drilling medium circulation is lost. The mine should be evacuated when the hole reaches an elevation that is at least 25 times the seam thickness above the coal seam. The mine evacuation should continue until the well is completed and all tools are out of the hole. An examination of the gob and
bleeders near the gob well should be required before the mine resumes normal operations.

A suitable surface casing should be cemented into bedrock. If there are no active or abandoned upper seam coal mines, the rest of the hole may be cased or uncased as required by state regulations. If upper seam mines are active, a suitable steel casing is required. The annulus of all casings should be cemented. The well completion into the gob may be an open hole, slotted casing, or perforated casing, as appropriate for the application.

Maps and Diagrams

All completed gob wells and projected gob wells that are located within 500 feet of the active mining area and the next 12 months of proposed mine development should be shown on the mine ventilation map [30 C.F.R. §§ 75.371(dd) and (ee), 75.372((b)(5), 75.1200(k) and 75.1200-1(d)]. The diameter and depth of all wells should be shown on the ventilation map. The current status of all wells should also be shown on the ventilation map (planned, active, plugged, etc.).

A sketch showing the typical well completion is required by 30 C.F.R. § 75.371(ee). Typical and maximum hole depths and the hole sizes (diameter) should be included in the plan. Geologic sections may be required in the plan.

Wellhead

Suitable fencing should be installed around the wellhead and equipped with a gate and lock to prevent unauthorized entry. At least two warning signs should be attached to this fence. Weeds and other combustible accumulations should be prohibited within this fenced area.

The wellhead should be equipped with a shut-in valve, flame arrester, sampling port and a non-conducting vent stack that extends at least 10 feet above the ground. If the coal seam makes water, a water separator may be needed. If the mine uses exhausting fans or exhausting bleeder fans, the wellhead should be equipped with a one-way check valve. If a blower or compressor is used, the wellhead should be equipped with an automatic bypass valve (see Figure 8). All blowers or compressors should be rated by the manufacturer for use with methane or natural gas.

All wellhead equipment and the fenced enclosure should be electrically bonded and suitably grounded. All wellhead equipment should be maintained according to manufacturer’s specifications. A sketch of the typical wellhead is required to be included in the approved ventilation plan as specified in 30 C.F.R. § 75.371(ee).
**Operation**

Gob degas wells are often critical components of mine ventilation systems. Problems with gob wells and blowers have resulted in gassed off longwall faces, returns, and bleeders. A weekly examination of active gob wells by a qualified person is required and is subject to the 30 C.F.R. § 75.363 hazardous conditions reporting requirements. The well and wellhead condition, the direction of flow, and the methane levels of the wells should be examined, measured and recorded. The District Manager may require more frequent examinations of specific gob wells. A gob well should be shut-in if the methane content drops below 25%.

Any time a well in an active gob is shut-in, the blower is stopped or flow from the well is significantly altered, the mine foreman or designated person should be notified. When the oxygen level of an active gob well is too high to put in a commercial pipeline, the well should be exhausted to the atmosphere. The flow from such wells may be reduced, but must not be reduced to the point where the mine ventilation is compromised.

![Diagram of gob well systems](image)

*Figure 8, Typical Gob Wellheads*
Maintenance of wellhead equipment is inherently dangerous because explosive levels of methane may be present in piping and equipment. Before starting any maintenance activity that could result in an ignition, the well should be shut in and all piping and equipment that will be affected should be purged with inert gas. Tests for methane leakage by a certified person should be made prior to any work on the wellhead and associated equipment.

Abandonment
As soon as practicable, all gob wells should be plugged to the surface with cement. Some wells into a sealed gob may remain open for commercial methane production or for pressure relief on seals. However, these wells should be plugged when commercial methane production ceases or, if used for barometric pressure relief, these wells should be plugged when the mine is abandoned. State regulations on coalbed methane well abandonment (if applicable) should be followed.

If there are no state regulations, gob wells should be plugged using the following procedures:

A. A tube or drill steel should be inserted as close as practicable to the bottom of the drill hole.
B. A cement plug should be set in the well by pumping Portland cement or a lightweight cement mixture down the tubing to fill the borehole to the surface.
C. Steel turnings or other small magnetic particles should be embedded in the top of the cement near the surface to serve as a permanent magnetic monument of the well. As an alternative, a 5 inch or larger casing, set in cement, should extend at least 36 inches above the ground level. If the top of the plugged hole is buried or not marked with a physical monument (e.g. prime farmland), high-resolution GPS coordinates are recommended to preserve the well location.

SURFACE DIRECTIONAL DRILLED (SDD) CBM WELLS

Due to the size and nature of these SDD CBM wells, large quantities of methane may be contained in the well and significant methane inflows have been associated with intersections of these wells. Conventional cement plugs can be difficult to place in these wells due to the undulating horizontal nature of the holes, water cutting, gas cutting, numerous branches, length of the holes, and logistics of cement setting times. Plugging is further complicated by potential caving of the hole. Any plug that does not completely fill the system of holes could result in pressurized methane reservoirs in the remaining voids.
Due to the large potential hole volume, the potential for methane inundation and the potential hazard to miners, MSHA has determined that the barrier specified in 30 C.F.R. § 75.1700 must be maintained by the mine operator to protect miners. This barrier must be maintained around all vertical and horizontal extents of the gas well that are within the coal seam (see PIB 08-20).

HORIZONTAL IN-MINE WELLS

Drill Holes
Drilling holes into the coal seam from mine entries for CBM wells may involve hazards that are associated with the underground coal mine environment. Precautions should be taken to protect underground drillers and any other miners who may be exposed to these hazards.

The drilling equipment and associated components located near the hole collar should be permissible and maintained permissible even if used in intake air since it could be exposed to potentially explosive concentrations of methane during the drilling process. The drill should be equipped with a methane monitor that is installed and maintained as specified in 30 C.F.R. § 75.342. The type of drill and support equipment should be specified in the ventilation plan.

A suitable collar or casing should be set and cemented prior to any other drilling of the hole. This casing should be designed to contain the maximum shut-in pressure of the hole. The hole collar design and a sketch of the hole completion should be included in the ventilation plan as specified in 30 C.F.R. § 75.371(ee). The maximum hole length should also be specified and any hole in excess of 1000 feet in length should be mapped.

The control of methane during the drilling process is critical for the safe operation of an underground drill. Typically, a stuffing box is installed on the hole collar to direct methane, coal cuttings and drilling fluids to separation and drainage systems. Appropriate seals for the drilling system (smooth rods or augers) should be installed and maintained on the stuffing box. All materials that contact the drill rods or augers should be non-sparking. Long holes or high in-situ pressures may require the use of appropriate blow-out preventers.

Methane produced during drilling may be discharged into the mine atmosphere or directed into a pipeline system that will carry the methane out of the mine. All methane piping should be designed and maintained to the specifications detailed in MSHA IR-1094, (Tisdell, Jack E., et. al., Piping Methane In Underground Coal Mines, 1978). Diffusion zones may be used to dilute this methane to the levels specified in 30 C.F.R. § 75.323. Diffusion zones should be fenced off or protected and at least two warning signs should be posted. The discharge pipe should be protected by a suitable flame.
arrester. All combustible materials should be removed or covered within the diffusion zone and no ignition sources will be allowed within 150 feet of the diffusion zone. The entry in which the diffusion zone is located should be well rock dusted. A permissible atmospheric monitoring system (AMS) sensor for methane should be installed within 50 feet outby the diffusion zone in a location where it is in the unaltered air stream from the diffusion zone. This AMS sensor should be installed, operated, and maintained as specified in 30 C.F.R. § 75.351. A sketch of the dilution zone should be included in the ventilation plan. Maximum methane limits at fences around the diffusion zone should be specified in the ventilation plan. Methane readings will be taken at the outby end of the diffusion zone prior to start-up of the drill and at 20-minute intervals, or more often if required in the approved ventilation plan, during drill operation.

**Drill Cuttings**
Drill cuttings must be removed from the mine or treated to eliminate the accumulation of fine coal in the mine. Bentonite and/or Portland cement may be used to inert the cuttings. The treated cuttings should not be left in any haulageway. A thick coating of rockdust should be maintained over all treated drill cuttings that are left in the mine.

**Drill Operation**
Pre-operational checks of all drilling equipment and methane removal/diffusion systems should be made prior to start-up for each shift that the drill is operated. Methane readings should be taken at the stuffing box prior to start-up of the drill and at 20-minute intervals, or more often if required in the approved ventilation plan, during drilling operation. A thick coating of rock dust should be applied and maintained in the entry where the drill is located for a distance of at least 200 feet inby and outby the drill.

**Well Operation**
All wells and methane piping located in intake aircourses should be examined during preshift examinations. All other wells and methane piping should be examined during the weekly examination.

**Mine-Through Requirements**
Cross-panel Holes:
Cross panel holes should be vented to the mine atmosphere when the longwall is within 20 feet of the hole. The process for intersection of the holes should be detailed in the ventilation plan and may entail water infusion to control dust.

Horizontal Directional Holes:
Horizontal directional holes may be safely intersected by mining if a sufficient vacuum is applied to the hole during the intersection process. The pressure drop to a diffusion zone in the returns is not sufficient for this option. Long holes in caving coal seams may not be amenable to this method. Alternatively, the holes may be plugged using cement
or gel. The methods used to control methane emissions in the mining face should be
detailed in the ventilation plan.

Long Horizontal Holes:
Reliable plugging methods need to be developed and demonstrated for long horizontal
holes.

FLARING

If methane produced by CBM wells or degasification wells is not captured for local use
or for sale to a commercial pipeline, the methane may be flared rather than released to
the atmosphere. Any flaring system should contain liquid seal flash-back protection, an
appropriately designed flare stack, independent pilot light system, appropriate flame
arresters, and a fail-safe monitoring and control system. The EPA has published a
conceptual guide for a flaring system (EPA, Conceptual Design for a Coal Mine Gob
Well Flare, 1999). The flaring system should be included in the ventilation plan for gob
holes, and the outlet of in-mine drainage systems. Flaring systems that are not operated
during mining, such as advance methane drainage, do not have to be included in the
ventilation plan.
REFERENCES


Marino, Gennaro G., Pipelines Exposed to Coal Mine Subsidence Face Risk of Serious Damage, Pipeline & Gas Journal, November 2000.


Appendix A

U.S. Department of Labor  Mine Safety and Health Administration
1100 Wilson Boulevard
Arlington, Virginia 22209-3939

ISSUE DATE: May 10, 2005

PROGRAM INFORMATION BULLETIN NO. P05-10

FROM: RAY MCKINNEY
Administrator for
Coal Mine Safety and Health

SUBJECT: Coalbed Methane Wells

Who needs this information?
Underground coal mine operators, miner's representatives, coalbed methane (CBM) producers, independent contractors, state mining agencies, Coal Mine Safety and Health (CMS&H) enforcement personnel and other interested parties need this information.

What is the purpose of this bulletin?
The bulletin is intended to inform the mining industry that the Mine Safety and Health Administration (MSHA) has determined that CBM wells are subject to the ventilation plan and mapping requirements that apply to methane degas holes. These measures are necessary to protect underground coal miners from the potential hazards that may be associated with CBM wells that are near active coal mines. The ventilation plan and map requirements that affect CBM wells are:

30 CFR 75.371 (dd) The location of all horizontal degasification holes that are longer than 1,000 feet and the location of all vertical degasification holes;

30 CFR 75.371 (ee) If methane drainage systems are used, a detailed sketch of each system, including a description of safety precautions used with the systems;

30 CFR 75.372(b)(5) The locations of all known oil and gas wells and all known drill holes that penetrate the coalbed being mined;

30 CFR 75.372(b)(15) The locations of existing methane drainage systems; and

30 CFR 75.1200-1(d) All drill holes that penetrate the coalbed being mined.
These provisions apply to active and inactive coalbed methane wells, coalbed methane holes, degasification holes, degas holes, methane drainage systems and coalbed methane production systems. Coalbed methane is defined as methane that is produced from a coal seam and surrounding strata. There are no functional differences between degasification holes and CBM holes or methane drainage systems and CBM production systems. District manager approval is necessary before mining near or through CBM wells or installing a methane drainage system in an active mine.

What is the background for this bulletin?
Initially, methane in coal seams was extracted to reduce the quantity of potentially explosive methane gas that was liberated when the coal was mined. In 1974, the first commercial sale of CBM was made from a U.S. Bureau of Mines test shaft to a commercial natural gas pipeline in northern West Virginia. In 2003, CBM constituted approximately 8 percent of the domestic U.S. natural gas supply. Recent increases in natural gas prices have further accelerated the growth of this industry. The growing number of CBM production wells is resulting in more intersections with active underground coal mines. Unless adequate safety precautions are taken for these CBM wells, methane ignitions or explosions may occur when underground coal mines intersect these holes. MSHA has determined that these potential hazards can be adequately addressed through the ventilation plan approval process.

What is MSHA's authority for this Program Information Bulletin?
The Federal Mine Safety and Health Act of 1977; 30 CFR Parts 75.371(dd) and (ee), 75.372(b)(5) and (b)(15), and 75.1200-1(d).

Is this Program Information Bulletin on the Internet?
This information bulletin may be viewed on the World Wide Web by accessing MSHA's home page (http://www.msha.gov), choosing "Compliance Info" and "Program Information Bulletins."

Who is the MSHA contact person for this bulletin?
Coal Mine Safety and Health
Erik Sherer, (202) 693-9523
sherer.hubert@dol.gov

Who will receive this bulletin?
MSHA PPM holders
Underground Mine Operators-Coal
Miner's Representatives-Coal
Independent Contractors
Special Interest Groups
Appendix B

From: KEVIN G. STRICKLIN
Administrator for
Coal Mine Safety and Health

Subject: Surface Drilled Coalbed Methane Wells with Horizontal Branches in the Coal Seam

Who needs this information?
Underground coal mine operators, miner’s representatives, coalbed methane producers, independent contractors, state mining agencies, Coal Mine Safety and Health enforcement personnel and other interested parties need this information.

What is the purpose of this bulletin?
The bulletin is intended to inform the mining industry and coalbed methane industry of a methane inundation hazard that may occur if unplugged or inadequately plugged horizontal coalbed methane well systems are intersected during coal mining. Directionally drilling coalbed methane wells from the surface is a relatively new technology and plugging or other methods that will protect coal miners have not been established.

Information
Due to the potential methane inundation hazard to miners, the Mine Safety and Health Administration (MSHA) has determined that the barrier specified in 30 C.F.R. § 75.1700, i.e., 300 feet in diameter, must be maintained by the mine operator to protect miners. This barrier must be maintained around all vertical and horizontal legs and branches of the gas well that are within the coal seam.

Recent coalbed methane extraction technological developments include directionally drilled wells that utilize a vertical well drilled from the surface connecting to multiple horizontal legs that are located within coal seams. The horizontal legs can be developed over large areas (up to 2 square miles) and may contain many interconnected branches. The legs and branches in the coal seam can contain large volumes of pressurized methane.
that may inundate the coal mine if intersected during mine development. Plugging
tools that have been attempted include injecting gel or cement into the well and its
horizontal legs and branches. Plugging with gel, however, may not be safe because the
gel can blow-out as the pressure builds up. Plugging the well with cement may be a safer,
though a more costly, alternative. Conventional cement plugs can be difficult to place in
these wells due to the undulating horizontal nature of the holes, water cutting, gas
cutting, numerous branches, length of the holes, and logistics of cement setting times.
Plugging is further complicated by potential caving of the hole. Any plug that does not
completely fill the system of holes can result in pressurized methane reservoirs in the
remaining voids.

Non-plugging methods to control the methane output from the well have been proposed.
A system of water infusion seems to work well for the initial intersection. Water is infused
at the full hydrostatic head for several months and then is pumped out immediately prior
to intersection. The well is left open to the atmosphere or put on vacuum for the
intersection. Problems develop when rubber packers are used to seal the holes to prevent
the development entries from gassing off after intersection. Recharge pressures build
back up and subsequent intersections often involve pressurized voids and methane influx.
In-mine degas pipelines and vacuum systems may be useful to control subsequent
intersections. Another non-plugging proposal is to "kill" the formation around the wellbore
with bentonite slurry infused at hydrostatic or higher pressures. This could reduce the coal
seam permeability for some distance around the wellbore and limit the inflow of methane.

If a mine operator proposes to mine within the 300 ft. barrier near a well, the District
Manager should consider the accuracy of the well location before permitting this
encroachment. Any well location is subject to the normal inaccuracies and errors inherent
in surveying of the well head location and the surveying of the mine. In addition, the
instrumentation used in directionally drilled wells has a measurement error of
approximately one degree [± 17.5 feet (ft.) per 1,000-ft. of hole length]. A petition for
modification will be required to mine through the well or mine within the safe barrier as
determined by the District Manager.

What is the background for this bulletin?
A development section in an underground coal mine was recently inundated with methane
after mining into an inadequately plugged directionally drilled gas well. This well was
approximately 700 feet from the surface and had two 4,000-foot horizontal legs in the
coal seam. The gel that was intended to plug this well did not contain the gas pressure.

The Mine Safety and Health Administration (MSHA) supports and encourages CBM
extraction because it can significantly reduce methane emissions in coal mines and has
been proven to decrease the incidence of face ignitions in gassy coal mines. However,
procedures to address the potential hazards presented by CBM wells must be developed
and implemented to protect the coal miners who will be exposed to these wells. A long
history of methane-related coal mine disasters in the United States underscores the
potential hazards that unplugged or incorrectly plugged CBM wells could present during
mine intersection.

What is MSHA's authority for this Program Information Bulletin?

Is this Program Information Bulletin on the Internet?
This information bulletin may be viewed on the World Wide Web by accessing MSHA's home page (http://www.msha.gov), choosing "Compliance Info" and "Program Information Bulletins."

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