

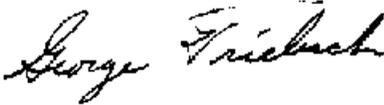


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SUBJECT: Report on Coal Pillar Recovery under Deep Cover

**Scope**

This Program Information Bulletin (PIB) applies to operators of underground bituminous coal mines, miners' representatives, Mine Safety and Health Administration (MSHA) enforcement personnel, and other interested parties.

**Purpose**

The purpose of this PIB is to provide information on the findings contained in the National Institute for Occupational Safety and Health (NIOSH) report to Congress<sup>1</sup> relating to the safety of miners working on retreat mining pillar extraction operations, particularly those working under deep cover (defined by NIOSH to include depths greater than 1000 ft). MSHA will be considering these findings when evaluating roof control plans involving pillar recovery under deep cover.

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<sup>1</sup> NIOSH, February 2010, Research Report on Coal Pillar Recovery under Deep Cover, available at <http://www.cdc.gov/niosh/mining/pubs/pubreference/outputid3470.htm>

## **Information**

Significant findings discussed in the NIOSH report include:

Nearly all of the 42 deep-cover mines in the U.S. that have extracted pillars under depths greater than 1000 ft are located in the central Appalachian coalfields of eastern KY, western VA, and southern WV, with a few others located in UT and CO.

The most significant hazards faced by deep cover retreat miners are:

- Ground falls, including large “roof falls,” smaller “rock falls” that occur between roof supports, and “rib falls” that come from the side walls of the mine,
- Pillar failures that can affect large areas of a mine, but are usually non-violent “squeezes” that occur slowly and seldom result in injuries to mine workers, and
- Coal bursts, which are violent seismic events that cause coal to be ejected into the mine with enough energy to injure or kill miners.

Since 2007 there have been no fatal roof falls during pillar recovery in the US (at any depth), compared with an average of about two per year during the previous dozen years. The three key technologies for improving the safety during pillar retreat mining are (1) Leaving an engineered final stump, (2) Using Mobile Roof Supports (MRS), and (3) Using longer and stronger roof bolts, particularly in intersections. Other best practices for retreat mining safety include:

- Conducting a geologic assessment of the entire panel before retreat mining commences.
- Measuring intersection spans, and installing additional support in any that are significantly wider than usual.
- Conducting pre-shift and on-shift examinations that include thorough assessments of geologic conditions.
- Using test holes to determine if there is roof separation, and monitoring them during mining to see if conditions worsen.
- Monitoring the pressures and loading rates of MRS to provide information on roof stability.

Roof control plans for retreat mining should also incorporate work procedures, including the location of miners while coal is being mined or loaded, and best practices for using MRS units.<sup>2</sup>

Pillar design, including the use of properly sized barrier pillars, is the most effective technique for minimizing the risks of pillar failure and coal bursts under deep cover. The NIOSH report states that the current MSHA guidelines regarding the technical and

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<sup>2</sup> See Use of Mobile Roof Supports (MRS) Units for Retreat Mining, re-issued as MSHA Program Information Bulletin (PIB) P11-30, <http://www.msha.gov/regs/complian/PIB/2011/pib11-30.pdf>

engineering data related to pillar design that mine operators must submit as part of their Roof Control Plans<sup>3</sup> have been successful in placing pillar design practice in U.S. underground coal mines on a solid engineering foundation that significantly reduces the risk of pillar failure and its attendant hazards to coal miners.

The NIOSH ground control software packages Analysis of Retreat Mining Pillar Stability (ARMPS) and Analysis of Multiple Seam Stability continue to provide a high level of protection against pillar failure. The LaModel program also has a long history of successful application at coal mines throughout the world. Under a NIOSH contract, researchers at West Virginia University developed standardized LaModel procedures that are closely linked to ARMPS and its comprehensive case history database. Other pillar design methods have been successfully employed, but to be reliable they must be thoroughly validated for the underground environments to which they are applied.

Coal bursts, which involve the sudden, violent ejection of rock or coal into mine openings, are relatively rare events. High stress is a universal feature of burst-prone conditions, which is why the incidence of bursts increases as the depth of cover increases.

In addition to the depth of cover, potential zones of significantly elevated burst likelihood can be identified based on geologic factors that have been associated with past bursts, the potential for multiple seam interactions, and recent ground control experience. Geologic factors that have contributed to a heightened burst risk include strong roof and/or floor, faults, rapid changes in the depth of cover, sandstone channels, and seam rolls. Underground test holes, supplemented by underground core holes, can be used to locate geologic features that can increase the risk of bursting.

The practice of pillar splitting, which requires mining into the highly stressed pillar core, has historically been associated with a disproportionate number of burst incidents. When all other factors are the same, longwall mining is less burst-prone than room-and-pillar retreat mining.

MSHA agrees with the recommendation made in the NIOSH report that operators of deep cover room-and-pillar retreat coal mines should conduct regular burst hazard assessments for any areas where retreat mining is proposed and the depth of cover

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<sup>3</sup> See Technical Support Assistance in Reviewing Roof Control Plans, re-issued as MSHA Procedure Instruction Letter No. I11-V-01 <http://www.msha.gov/regs/complian/PILS/2011/PIL11-V-1.pdf>; General Guidelines for the Use of Numerical Modeling to Evaluate Ground Control Aspects of Proposed Coal Mining Plans, MSHA PIB No. P09-03, <http://www.msha.gov/regs/complian/PIB/2009/pib09-03.pdf>; and Precautions for the Use of the Analysis of Retreat Mining Pillar Stability (ARMPS) Computer Program, Re-issued as MSHA PIB No. P10-23, <http://www.msha.gov/regs/complian/PILS/2011/PIL11-V-1.pdf>

exceeds 1,000 ft. These assessments should be guided by an experienced ground control professional. Once zones of elevated risk of bursts have been identified, the risk can be reduced by limiting mining within that zone. The NIOSH report concluded that, within an identified zone of elevated burst risk, no combination of currently available mining sequences, administrative procedures, or monitoring techniques can be relied upon to reduce the risk posed by coal bursts during pillar recovery to an acceptable level. MSHA also agrees with the three specific recommendations made in the NIOSH report to limit the risk of violent coal bursts during retreat mining operations:

- At depths exceeding 1,000 ft, retreat mining should not be conducted without properly designed barrier pillars.
- At depths exceeding 1,000 ft, pillar splitting should not be conducted on the pillar line.
- At depths exceeding 2,000 ft, pillar recovery should not be conducted.

### **Background**

The 2007 Crandall Canyon mine disaster resulted in the deaths of six miners engaged in coal pillar retreat mining operations under more than 1600 ft of cover. In addition, two mine employees and one MSHA inspector received fatal injuries during mine rescue efforts, and six additional rescue workers (including another inspector) were injured. Subsequently, Congress directed NIOSH<sup>[1]</sup> to conduct a study of the recovery of coal pillars, particularly at depths greater than 1500 ft. The NIOSH report, released in 2010, discusses the conditions under which retreat mining is used in the US, and the procedures currently used to ensure miner safety during retreat mining. The report also includes recommendations to enhance the safety of miners working where retreat mining is utilized.

### **Authority**

The Federal Mine Safety and Health Act of 1977, as amended, 30 U.S.C. § 801 et seq., and 30 C.F.R. §§ 75.203, 75.220, and 75.223.

### **Internet Availability**

This PIB may be viewed on the Internet by accessing the MSHA home page ([www.msha.gov](http://www.msha.gov)) then choosing "Compliance Info" and "Program Information Bulletins."

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<sup>[1]</sup> FY 2008 Appropriation (Public Law 110-161).

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**Distribution**

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