

COAL MINER'S HANDBOOK FOR ROOF AND RIB CONTROL

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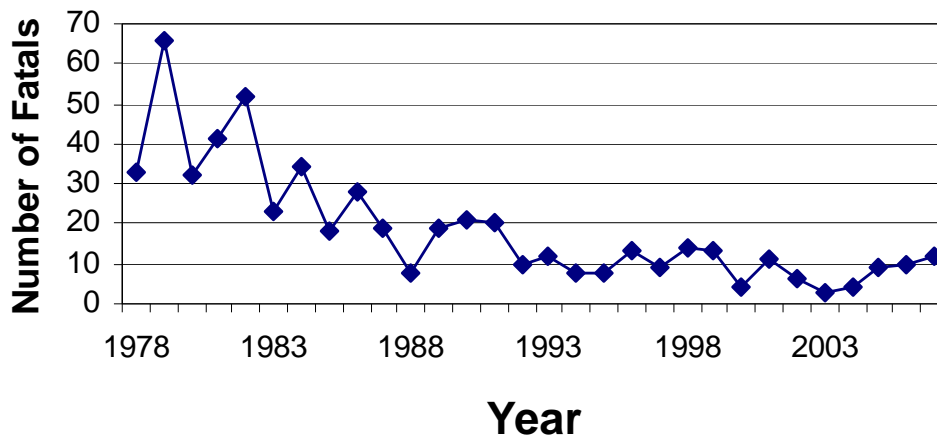
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INTRODUCTION

Over the past thirty years, improvements in roof control technology such as new bolting systems, automated temporary roof support systems, use of cabs and canopies, and mobile roof supports have led to a significant reduction in roof/rib fall fatalities.

Total Roof/Rib Fall Fatalities 1978-2007



Although the overall trend is toward fewer roof and rib fall fatalities, the number of fatalities has increased recently. During the three year period 2005 - 2007, 31 miners lost their lives in underground coal mines due to falls of roof or rib (including coal outbursts). This was a large increase from the previous three year period, 2002 – 2004, during which 13 miners perished due to falls of roof or rib. MSHA's Preventive Roof/Rib Outreach Program (PROP) is intended to increase awareness among coal mine operators and miners of the hazards that can lead to roof/rib fall accidents, and the precautions necessary to prevent these accidents. This handbook is part of the PROP initiative.

PERSISTENCE OF ROOF/RIB HAZARDS

Historically, falls of roof and rib have been the single greatest cause of fatalities in underground coal mines. Roof and rib hazards are still the single greatest safety problem in underground coal mining. Why is this so?

- Roof and rib conditions vary from mine to mine (and in some instances from section to section within a mine). The type of sedimentary rock (such as shale, sandstone, and limestone) overlying the coal seam dictates the strength of the mine roof. Combine this variable roof rock with other geologic factors, such as faults, ancient stream channels, slips, joints, and fossils, one can see why roof control is the most challenging safety problem in underground coal mines.

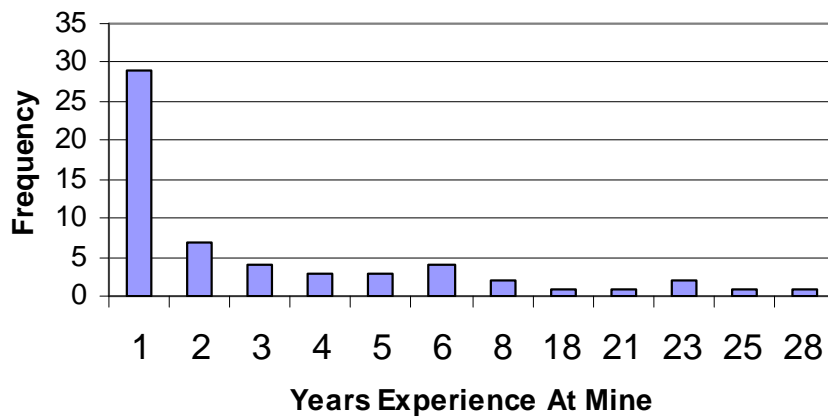
Mining personnel have to cope with constantly changing geologic conditions every day. A cut of coal taken from the mining face opens up new territory and potentially new hazards. Therefore, it's important to understand that every coal mine has a unique set of conditions. What works to control roof and rib conditions in one mine may not work at another operation. Figure 1 depicts rapid geological change that may require supplemental roof support.



Figure 1. Variable Roof Rock – Sandstone, Shale, and Coal Interspersed

- Today's miners often move from mine to mine, which exposes them to new geologic conditions and new roof and rib hazards. Often, the miners are required to operate different equipment and utilize different mining methods, which expose experienced miners to greater risk when they move from one mine to another. The following chart shows that a large number of recent fatalities involved miners who had very little time at the mine where the accident occurred; 50% of victims had less than two years' experience at the mine.

Roof/Rib Fall Fatalities 2000-2007 Victims' Experience At Mine



- Coal has been mined in the United States for more than 200 years. Most of today's mines are in coal reserves that had previously been avoided because of poor roof conditions. These mines are frequently deeper and may have abandoned mines above and/or below them which often exert additional stress on the roof and ribs.

As a result, the roof and rib conditions encountered in many of today's mines require the use of the latest, high-strength roof support systems in an effort to reduce hazards and prevent accidents.

By recognizing and understanding these issues and conditions that continue to make coal mine roof and ribs so hazardous, we can begin to make progress in finding better ways to prevent injuries due to roof and rib falls.

TIPS FOR AVOIDING INJURIES

Be Alert and Share Information

Miners need to be constantly aware of the potential dangers posed by movement of roof and rib. Today, coal is being produced at a record-breaking pace in our nation's mines.

“When you actually see someone you know and see the life go out of their body in a place like that - it leaves something with you.”

Due to the ever-increasing rate of advance and retreat mining, it's your responsibility to be alert to changing roof/rib conditions. Although the mine operator is responsible for providing you with tools, supplies, equipment, and training to perform your daily tasks, you must ask yourself, “What can I do to ensure my safety and the safety of my co-workers?”

- Make frequent and thorough roof and rib evaluations.
- Take corrective action immediately if you observe an unsafe condition.
- Get help if you need it and take the time to get the proper tools and materials.
- Discuss any roof control concern with your supervisor. Remember that conditions change and your supervisor may not be aware of the change; don't take for granted that he or she knows.
- Share information about changes in roof/rib conditions with fellow miners.

Know Your Roof Control Plan

Why is it important for you to know and understand the roof control plan at your mine?

“The plan was followed, but it pulled 3 foot resin bolts out of the top.”

Someone evaluated your mine's roof conditions long before you installed the first roof bolt, set the first timber, or built the first crib. This evaluation revealed the type of rock strata that makes up your immediate and main roof, the maximum and minimum cover over mining projections, and any other nearby active or abandoned mines. A roof control plan for your mine was developed based on an analysis of this data and a review of the proposed mining method(s).

Your mine's roof control plan specifies the minimum requirements under normal conditions necessary to support the roof. It's imperative that you know what the minimum requirements are in your plan. If you fail to install the proper supports required by your plan, then the roof is inadequately supported and you jeopardize the safety of yourself and your co-workers at the mine. Shortcuts and lack of knowledge put EVERYONE at risk. Remember, the roof control plan specifies the *minimum* roof support required under normal roof conditions. Minimum support requirements no longer apply when you encounter adverse conditions. Additional

supports have to be installed to maintain the degree of safety needed for your protection and the safety of other miners.

Speak to mine management if you and your fellow miners have any concerns regarding the adequacy of your roof control plan. The plan should be revised when prevailing conditions indicate that the plan is not suitable to control the roof and ribs. A roof control plan should also be revised when accident and injury history indicates that the plan is inadequate.

Don't Go Inby

During the last seven years, there have been 43 fatalities as a result of roof falls. One-fifth (21%) of all roof fall fatalities occurred because a miner traveled inby or was positioned inby permanent roof supports. In some cases miners travel inby to mark bolt holes, scale the roof, get a better view of the face when turning a crosscut, or just to take a straight-line shortcut instead of "going around." In other instances we can only guess why victims went inby supports. What was going through their mind? Why were they so sure nothing would happen to them?

"We were only 2 to 3 feet inby the bolts when it fell. I lay there looking at the bolts hoping they would hold."

Too many times we test the laws of probability. We rationalize going inby by telling ourselves "I'm only going to be in there for just a few seconds" or "it's only a foot or two inby" or by asking ourselves "What are the chances that a rock is going to fall while I'm there?" You take the chance but did you ask yourself the important questions? What's going to happen to my family? Who is going to raise my children? Is it worth the risk? For nine miners in the last seven years, it just wasn't worth the risk.

The reflector in figure 2 is a reminder that, "INBY IS OUT".

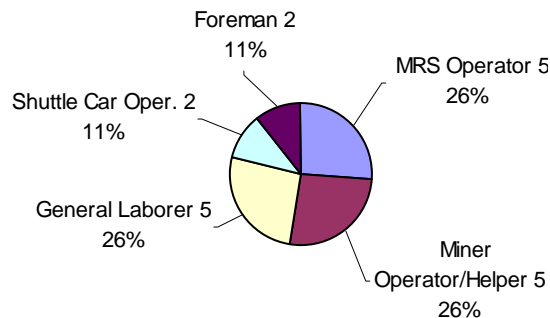


Figure 2. Reflector Marking Last Row of Roof Bolts

Room and Pillar Retreat Mining

From January 2000 through December 2007, falls of roof or rib (including coal outbursts) accounted for 59 fatalities in underground coal mines. Nineteen of these 59 fatalities (32%) occurred during room-and-pillar retreat mining operations. The number of fatal accidents occurring on room-and-pillar retreat sections appears high when you consider that retreat mining accounts for about 10 percent of all underground coal production. This statistic indicates that more precautions must be taken when doing this type of mining.

**Roof/Rib Fall Fatals By Activity
Room-and-Pillar Retreat Mining
2000 - 2007**



Historically, the miner operator/helper occupations have been the most hazardous. The continuous miner operator and the helper are frequently the closest miners to the pillar line, which is more prone to roof/rib falls. The additional stress caused by second mining is typically placed on the roof and ribs in the immediate area where coal is being removed. However, other miners with different occupations, working on retreat sections, are not excluded from the hazards of roof/rib falls. The chart above shows that fourteen miners, other than miner operators/helpers, were fatally injured by falls of roof or rib (including coal outbursts) on retreat sections. The occupations of these miners included mobile roof support (MRS) operator, general laborer, shuttle car operator and foreman. The chart above shows that the MRS operators and general labor occupations were just as hazardous as the miner operator/helper occupations.

The past 15 years have seen a significant increase in the use of mobile roof support (MRS) units during pillaring operations. MRS units limit a miner's exposure on the pillar line by reducing or eliminating the need for roadway timbers and radius turn posts. MRS operators should not, however, be lulled into complacency or a false sense of security. As you can see in the previous chart, 5 of the 19 victims (26%) were performing the duties of an MRS operator at the time of the accident. To realize the safety advantages afforded by MRS units, you must follow the

operating procedures and safety precautions listed in your mine's roof control plan. Also, keep in mind that the majority of MRS fatalities have occurred because miners were within 20 feet of the MRS when it was being repositioned in an active pillaring area. The MRS trailing cables in Figure 3 were secured to the roof with telephone wire. Break away cable hangers must be used on MRS units.



Figure 3. Mobile Roof Supports on a Retreat Mining Section

Listed below are work practices that can help reduce the risk of a roof/rib fall accident when second mining is being conducted:

- **CONSTANTLY MONITOR** roof and rib conditions. Watch breaker and radius post condition, pressure gauges on Mobile Roof Support units, geologic anomalies, floor heaving and rib sloughing. All miners on the section should monitor these conditions. If a hazardous condition is found, immediately inform the other miners in the area and the section foreman so that a prudent course of action can be taken. This is particularly important when mining the last lift or final push. If the push out is to be mined, significantly more roof support should be added for this critical phase of retreat mining.
- **ALWAYS** place yourself in a safe position. Make sure there's no loose roof or rib near your work position. Miners who operate remote controlled continuous miners must make sure they are positioned under safe roof and ribs before mining since they aren't protected by a canopy.

“It happened so fast I didn't see it fall - all at once I couldn't see for the dust.”

- **ALWAYS** follow the roof control plan. There are many safety precautions in the plan regarding such things as breaker and radius turn post locations, mining sequences, depth of cut, and operator location. These safety precautions should be specifically tailored to your mine and to your mining conditions.
- **EVALUATE** the competency of the outby intersection of the pillar being extracted before and during mining of the pillar. This can be accomplished with the use of a test hole. Separations in the test hole indicate that the roof is failing.
- **AVOID** going inby the last active intersection whenever possible. If you don't need to be in this area, then stay away from this potentially hazardous area.

Longwall Mining

In general, longwall mining is the safest underground mining method. Because of the longwall shield canopies that protect miners from roof falls during normal mining operations. However, there are instances when miners have to work near the shield canopy tips or between the tips and the longwall face. This activity generally occurs when performing maintenance on the shearer or the face conveyor and during longwall recovery operations. During 2006 there were two longwall-related fatalities. One occurred during longwall recovery operations and the other was due to a coal outburst (bounce) on the longwall face. These two fatal accidents are a grim reminder of the potential hazards on a longwall section. Figure 4 shows the installation of cribs and wire mesh during longwall recovery.



Figure 4. Longwall Recovery

SOURCES OF ROOF/RIB HAZARDS IN UNDERGROUND COAL MINES

There are two broad categories of roof/rib hazards: natural and mining related.

Natural Sources of Roof/Rib Hazards

Natural sources of roof/rib hazards are caused by the local geology and the local stress field. For the most part, these natural sources are pre-existing conditions that can't be changed. Natural sources of roof/rib hazards, of course, vary from mine to mine. You need to take the time to learn what types of geological hazards are common in your mine. Once you recognize the hazards normally encountered in your mine, it's much easier to identify and properly support them.

“In my 30 years I have never seen a rock shaped that large in one piece. It had a slick surface - came to a point - shaped like a battleship.”

Geological hazards include: faults, slips, joints, kettlebottoms, horsebacks, thinly-laminated rock, and weak or brittle rock. The overburden (vertical stress) and horizontal stress also can be the source of roof/rib hazards.

Since the natural sources of roof/rib hazards cannot be changed, it is important that we identify them through frequent and thorough roof/rib examinations, so that we can take appropriate action. This appropriate action is to take down the hazard or install additional support. The open joint in figure 5 has additional supports, steel straps and timbers in the affected area.



Figure 5. Open Joint in Mine Roof

Deep Cover Roof /Rib Hazards

Coal mines in many regions of the United States are operating under increasingly greater depths. These greater depths translate to higher stress levels that require special precautions to ensure ground stability.

Vertical stress in coal measure rocks tends to increase at a rate of about 1.1 psi for every foot of overburden. Thus, at a depth of 1500 feet, the vertical stress before mining is about 1650 psi. The development of mine entries disturbs the original stress distribution and at greater depths concentrates a high stress in the rock surrounding the entries and in the coal pillars.

Geology - high stresses associated with deep cover can create a variety of unstable ground conditions. The nature of the instability is largely dependent on local geologic conditions.

□ If the roof and/or floor geology is weak, roof falls or excessive floor heave are likely to occur. Mine planning can mitigate some problems but additional roof support (e.g. bolts and surface control measures) also may be required.

□ If the roof and floor geology is strong, conditions may be conducive to coal bumps or bounces. Mine planning is important in all deep cover operations but it is critical in strong strata and even more so in multiple seam and/or retreat mining scenarios.

□ If the coal seam is high, pillars are prone to rib sloughing. The direction of the face cleat with respect to entries and crosscuts often influences the type of failure, creating for example, vertical slabs of coal along pillar ribs or triangular slabs from pillar corners.

Multiple Seam Mining – mine entries that are developed above or below other workings may be exposed to vertical stress concentrations. These concentrations are most prevalent when gob-solid boundaries or isolated barriers associated with retreat mining are encountered.

□ Deeper cover translates to higher total vertical stress levels that can create multiple seam interactions even when interburden thickness is substantial.

□ The direction of mining can influence the degree of multiple seam interaction. Mining from the gob to the solid generally results in lower stress concentrations than from the solid to the gob.

□ The type of remnant pillar structure (gob-solid boundary or isolated barrier) in overlying or underlying workings influences the degree of multiple seam interaction. Isolated barriers cause more ground control problems than gob-solid boundaries.

Retreat Mining – the extraction of coal pillars/panels in retreat mining operations creates abutment stresses adjacent to gob areas. **Under deep cover**, special precautions are required to accommodate these elevated stress levels. Precautions for room and pillar retreat mining can be divided into two main categories: global stability (prevention of pillar failure due to bumps, collapses and squeezes) and local stability (prevention of roof falls in the working area). Global stability is addressed through proper mine design. Local stability is addressed through the installation of roof bolts, use of standing support such as mobile roof supports or posts, and an adequately sized final pillar stump.

□ In room-and-pillar retreat mining operations, it is imperative to consider the stability of barriers that separate panels in addition to the stability of pillars adjacent to the retreating gob

line. MSHA has issued PIB No. P08-08 entitled “Precautions for the Analysis of Retreat Mining Pillar Stability (ARMPS) Computer Program”.

- Geologic features such as faults, sandstone channels and zones of increased jointing that concentrate stresses or fracture the roof should be mapped on development prior to retreat mining activity. This will allow for the timely installation of additional roof support or changes to the retreat mining plan.
- Since retreat sections are subjected to abutment stresses just like longwall headgate and tailgate entries, the level of roof support installed should be enhanced (e.g. longer bolts, stronger bolts and/or a denser pattern).
- As cover increases, the magnitude of the stress increases and the distance that front abutment stresses transfer outby the pillar line also increases. It is important that supplemental roof support be installed prior to any stress increase, ideally upon development.

Mine Planning/Pillar Design – mine planning is important in all mines but especially so in deep cover operations. The use of empirical design programs such as the Analysis of Retreat Mining Pillar Stability (ARMPS) and the use of numerical modeling software such as LAMODEL can be a great asset.

- Regardless of the particular software employed, care must be taken to ensure that appropriate input values are used. Some programs have “built-in default input values” (e.g. coal strength and rock density). A decision to use mine specific information instead of the defaults should be weighed carefully. In addition, actual in-mine conditions and ground control history should be used to validate/calibrate any analysis.
- A review of the ground control history of nearby mining operations under similar ground conditions can be invaluable, especially for new mines or for existing mines expanding into new reserves.

Longwall Mining – longwall mining under deep cover also requires special precautions to be taken in response to the elevated stress levels encountered.

- Gate entry chain pillars must be properly designed to achieve roof/floor stability and mitigate bumps. In some instances, yield pillars have been effective to deter bumps. However, in the deepest operations, **barrier pillars** have been required between panels to limit stress levels in the work areas.
- **Installing guards** on longwall face equipment has proven effective in reducing injuries due to forcible ejection of coal from the face. This added protection includes belt guarding hung from the longwall shields, metal guarding attached to the panline, face sprags on longwall shields, and deflector plates installed on the shearer.
- **Personal protective equipment** such as helmets with face shields and body armor (e.g. chest protector and shin guards) can provide personnel with an additional level of protection.

- **Administrative controls** that keep personnel out of certain bump prone locations during the mining cycle can be implemented. One example of such a precaution is to not allow personnel in the headgate or tailgate entry (for a specified distance outby the longwall face) when the shearer is cutting within a designated distance of the headgate or tailgate entry. Another example is to keep personnel on the longwall face a specified distance away from the shearer while it is cutting, unless they are located behind the shearer, as in the case of the shearer operator.
- **Relocation of operator control stations** or the installation of additional control stations can reduce exposure of personnel to high-risk locations during regular operations and maintenance procedures by allowing tasks to be performed from a remote (safer) location.

Mining Related Sources of Roof/Rib Hazards

Mining-related sources of roof/rib hazards are often under our direct control.

Examples of mining related sources of roof/rib hazards include: excessive entry width, excessive cut depth, excessive mining height, inadequate temporary support, excessive intersection spans, poor roof bolt installation procedures, inadequately installed roof support (not following the bolting plan), lack of test holes, installing bolts out of sequence, and improper pillar dimensions. Your mine’s roof control plan covers most (if not all) of these items.

“I saw some chips fall, I turned to tell someone to watch the top, but the fall came fast - before I could crank up my shuttle car.”

Other mining-related sources of roof/rib hazards arise through mine design. These include: number of entries, panel length and width, direction of mining, undersized or oversized pillars, crosscut spacing and orientation, roof support type and installed spacing, and overmining or undermining.

Most of the decisions involving the mine design issues (pillar size, direction of mining, etc.) are usually made by mine management. However, there are several critical areas in which you can make a difference. Let’s take a look at these now.

Entry/Crosscut Width. The mined width is one of the most important factors influencing the stability of an entry or crosscut. The maximum entry and crosscut widths listed in your roof control plan have been selected based on conditions at your mine. It is essential that continuous miner operators adhere to these maximum widths.

Mining an entry or crosscut just a foot or two wider than allowed can create a substantial increase in the stress in the immediate roof and increase the chance of a roof fall.

Pay special attention to entry and crosscut widths for initial development in drift mines. These openings need to be held to a minimum because of the roof strata conditions associated with the coal outcrop. History tells us that the roof rock near an outcrop is usually weathered and weakened by the presence of mountain breaks, mud seams, surface cracks, and other geologic

anomalies. As a result, additional roof support will have to be installed to effectively support the mine roof.

The approved roof control plan should address how the roof will be supported when these conditions are encountered. If an entry or crosscut is developed wider than the maximum listed in the plan, then additional roof supports will have to be installed in conjunction with the primary roof support, so miners won't be exposed to unsupported roof.

When larger than normal entry and crosscut widths are planned for such areas as a belt/track entry or longwall set-up entry, additional supports will have to be installed due to the added width. The spacing and type of supports used in these instances will be addressed in the approved roof control plan.

Intersections. During the last 7 years, over 30 percent of the miners who died in roof falls and rib rolls were located in intersections. This is significant because intersections account for only 10 to 20 percent of the developed area in a coal mine.

“Came so fast I couldn't jump.”

Miners should pay special attention to their surroundings while creating, supporting, or examining an intersection. It's critical that openings that create an intersection should be mined to the minimum possible widths that will allow the safe operation of extraction and haulage equipment. If the continuous miner operator rounds off the corners when cutting crosscuts, those intersections will be excessively wide and more unstable. A maximum width should be specified in the roof control plan. Supplemental support must be installed if these maximum widths are exceeded.

Mines that have a history of subnormal roof/rib conditions in intersections should systematically install additional roof support in these areas. This additional intersection support should be incorporated into the roof control plan. In addition, openings leading to subnormal intersections should have timbers installed across them when they are no longer needed for haulage equipment or supplies.

Mine examiners must pay particular attention to roof/rib conditions at intersections as roof stresses will be greatest in these areas because of the larger spans. The corrective action in Figure 6 included additional roof bolts with half headers, metal straps, and meshing.



Figure 6. Intersection With Supplemental Roof Support

Cut Depth. Another critical factor that influences the stability of an entry or crosscut is the cut depth.

The maximum allowable cut depth is listed in your roof control plan and is based on the mines' roof conditions and the type of mining equipment at your mine. You should always remember that the maximum cut depth is based on "normal" roof conditions at your mine and the type of mining equipment used at your operation. When abnormal roof conditions are encountered, the depth of cut should be reduced.

In today's underground coal mines with remote control continuous miners, it's quite common to have an approved roof control plan which allows for a "deep-cut" or "extended-cut", which is a cut greater than 20 feet deep.

The roof control plan for most mines with deep-cut approval lists some general roof conditions where cut depth should be reduced. The roof control plan can't anticipate and doesn't list every condition or instance where the depth of cut should be limited. Since cut depth plays such an important role in the stability of a mine opening, extra safety precautions are included in roof control plans containing deep-cut approval. These safety precautions include the installation of extra roof support and place additional restrictions on miner location with regard to the last row of bolts. Following these additional safety precautions will help ensure that the level of safety is not diminished when deep-cut mining is being conducted.

Discuss with your supervisor any concerns you might have regarding cut depth. Since roof conditions can change quickly, you should keep your supervisor informed of any abnormal roof conditions as you encounter them.

Installation of Roof Supports. Roof bolter operators often have to install a wide variety of high quality roof support systems. Gone are the days when the only types of bolts available were mechanically anchored bolts and fully-grouted resin bolts. The use of resin-anchored combination bolts, tensioned rebar, mechanically-anchored resin-assisted systems, cable bolts, and other specialty bolts has dramatically increased.

The big advantage of such a variety is that a mine can customize its roof support system to specific roof conditions. A drawback is that each bolting system used may have its own unique installation procedure, placing an additional burden on roof bolter operators.

Since proper installation procedure is essential to good roof bolt performance, it is imperative that roof bolter operators know and follow manufacturers' recommendations. With all the bolting systems currently available it can become confusing. Immediately contact your supervisor if you have any questions or concerns regarding the roof bolts that you are installing. The bolter operator in Figure 7 is in the process of installing supplemental support.



Figure 7. Drilling a Roof Bolt Hole

In addition to knowing the various installation procedures, roof bolter operators must be very familiar with the approved roof control plan, especially the section on roof bolt installation sequence and spacing. Again, as with most items in the roof control plan, the maximum bolt spacing listed is for normal roof conditions. The bolt spacing should be reduced by installing additional support when you encounter adverse conditions or geologic anomalies.

Because a mine roof begins to sag as soon as the coal is removed from below it, the roof bolting cycle should commence as soon as possible after a face has been mined. Some roof materials such as shale are weak and are likely to fall if excessive sag occurs. Installing the roof bolts on cycle helps to reduce sag by anchoring or bonding the roof materials.

Roof bolter operators are not the only miners who have been impacted by advancements in roof support systems. Any miner who installs roof-to-floor standing support, such as posts or cribs, has probably seen dramatic changes to this type of support as well. Wood posts and cribs are being replaced in many mines by a wide variety of alternatives. These new products include: “engineered” wood posts and cribs, cementitious foam cribs, metal containers filled with pumice, and steel-fiber-reinforced concrete cribs. Each support system usually has a unique installation procedure that varies from the traditional wood post and crib installations. As with bolting systems, the actual performance of these new supports is dictated by the quality of the installation, and you should discuss any questions or concerns with your supervisor. The engineered wood cribs in Figure 8 have been installed according to manufacturer recommendations.



Figure 8. An “Engineered” Wood Crib

Automated Temporary Roof Support (ATRS). Automated Temporary Roof Support systems were first introduced to the mining industry in the early 1970s. The use of ATRS systems with roof bolting machines and continuous miners equipped with integral bolters has all but eliminated fatal roof accidents associated with the manual setting of temporary support.

ATRS systems as shown in Figure 9 are required on all bolting machines operated in mining heights of 30 inches or more. The use of ATRS systems in mining heights below 30 inches is addressed in the roof control plan. MSHA District Managers routinely require the use of ATRS systems in mining heights below 30 inches.



Figure 9. T-Bar type ATRS System

Here are some guidelines for roof bolter operators to follow to maximize the protection that an ATRS system can provide:

- **REPORT** any mechanical or hydraulic problems with the ATRS system to your supervisor.
- **FOLLOW** the bolt installation sequence listed in your roof control plan. Failure to follow the approved sequence can result in roof bolter operators being exposed to unsupported roof. Following the approved bolting sequence is extremely critical when operating a single boom (squirmer) roof bolting machine. However, MSHA recommends that the cut depth be limited to 12 feet when using single boom roof bolters.
- **OBSERVE** the maximum distance that an ATRS system can be set beyond the last row of bolts. This distance can vary and is listed in the roof control plan. Setting an ATRS system beyond this maximum distance greatly reduces its effectiveness.
- **USE** extra caution when bolting a wider-than-normal entry, such as a belt/track entry. A T-Bar type ATRS system may need to be repositioned in order to safely complete the installation of a full row of bolts in a wider-than-normal entry.
- **PAY** special attention to the bolting sequence when installing five bolts per row with a T-Bar type ATRS system. Often a five-bolt pattern requires that a T-Bar type ATRS system be positioned closer to one rib to start the bolt row and then be repositioned to complete the row.

AVAILABLE TECHNICAL ASSISTANCE ON ROOF CONTROL

MSHA conducts inspections, accident investigations, and provides technical assistance to the mining industry on issues or concerns relating to roof control. Our Technical Support personnel can assist you with a variety of specialized laboratory and field services. Geologists can conduct remote-sensing linear analyses to help identify areas of potentially poor roof conditions. Technical Support staff perform laboratory and in-mine testing to evaluate roof support systems. They do in-mine evaluations of ATRS systems and canopies on mining equipment. Contact your MSHA District Office to request technical assistance.

“If it hadn’t been for the canopy, I wouldn’t have been here today.”

TRAINING

MSHA has determined that injuries from falls of roof, face, and rib are more than eight times as likely to be fatal as underground injuries from other causes. Miners need to know about the specific roof and rib hazards they are potentially exposed to at their mine. This can be done through a combination of formal and informal training, written materials, and through posting of safety bulletins, MSHA Alerts, and fact sheets. Everyone covered by a roof control plan should be instructed on the interpretation and significance of the plan. Regulations specify that any changes in a roof control plan shall be discussed with all miners before implementation.

MINERS’ RIGHTS

By law, miners have the right to:

- Refuse to work in areas of unsafe roof or ribs.
- Notify MSHA of any suspected roof/rib violations or imminent dangers call 800-746-1553 or use www.msha.gov.
- Expect that all necessary roof control related equipment is in place, used, and properly maintained.
- Review the roof control plan.
- Receive training in provisions of the roof control plan, including any revisions, prior to implementation.
- Contact your local MSHA office with questions or concerns.

MINE OPERATORS' RESPONSIBILITIES

Mine operators must:

- Provide a safe workplace by supporting or controlling the roof, face, and ribs in areas where persons work or travel.
- Develop and follow an MSHA-approved roof control plan suitable to the prevailing geological conditions and the mining systems used at the mine.
- Install additional roof/rib support when needed.
- Propose revisions to the roof control plan when:
 - prevailing conditions indicate that the current plan is not suitable; and
 - accident or injury experience at the mine indicates the plan is inadequate.
- Provide miners with adequate training covering the provisions of the roof control plan.
- Provide an alternative means of temporary support when mining conditions or circumstances prevent the use of an ATRS system.
- Provide adequate machines, tools, and materials to safely install roof support.
- Report to MSHA:
 - unplanned roof falls at or above the anchorage zone in active workings where roof bolts are in use;
 - a roof or rib fall on active workings that impairs ventilation or impedes passage; and
 - a coal outburst that causes withdrawal of miners or which disrupts regular mining activities for more than one hour.
- Conduct frequent and thorough examinations of roof, face, and ribs.

SUMMARY

Now that you've read this booklet, you might be wondering about your role in the roof control program at your mine. What can you do?

Take Five and Stay Alive!

1. **Never go under unsupported roof!**
2. Make frequent and thorough roof/rib evaluations.
3. Know and follow the roof control plan.
4. Be alert to changing conditions.
5. Discuss any roof control concerns with your supervisor.

QUESTIONS? WANT TO FIND OUT MORE?

Listed below are MSHA offices and services you can use to find out more about mine safety and health concerns:

MSHA
COAL MINE SAFETY DIVISION
(202) 693-9521

MSHA
TECHNICAL SUPPORT
Pittsburgh Safety and Health Technology Center
(412) 386-6902

MSHA
TECHNICAL INFORMATION CENTER AND LIBRARY

Telephone: (304) 256-3531
FAX: (304) 256-3372
E-mail: library@msha.gov

To get a copy of our latest training materials catalog:

NATIONAL MINE HEALTH AND SAFETY ACADEMY
Department of Instructional Materials
Printing and Property Management Branch
1301 Airport Road
Beaver, West Virginia 25813-9426

Telephone: (304) 256-3257
FAX: (304) 256-3368
E-mail: MSHADistributionCenter@dol.gov

Visit our website at <http://www.msha.gov>