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ROOF CONTROL PLAN AND GROUND SUPPORT REVIEW PROCEDURES

PREFACE

This handbook establishes guidelines and procedures for Mine Safety and Health Administration (MSHA) personnel when evaluating and reviewing coal mine roof control plans and revisions**.** MSHA personnel may also use portions of these guidelines and procedures to evaluate the suitability of ground support materials and rock burst control plans when applicable at individual M/NM mines.

This handbook addresses procedural, administrative, and technical aspects of plan review and evaluation, and serves as an organizational and technical aid for MSHA personnel. Guidance for evaluating ground conditions in underground mines is also provided for both coal and M/NM mines. The handbook provides general guidance that must be applied with the recognition that circumstances associated with specific mines and roof control methods vary, such that individualized approaches consistent with the mandate of the Federal Mine Safety and Health Act of 1977(Mine Act), as amended by the Mine Improvement and New Emergency Response (MINER) Act of 2006, may be appropriate in various situations. This handbook does not create legal obligations or confer legal rights for any persons or entities.

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CHAPTER 1 - INTRODUCTION

A. Purpose and General Requirements of Roof Control Plans

A sound roof control plan is essential for controlling the roof, face and ribs, including coal or rock bursts, in underground coal mines. Each underground coal mine operator is required by 30 CFR 75.220(a)(1) to develop and follow a roof control plan approved by the Mine Safety and Health Administration (MSHA) District Manager. The plan must be suitable to the prevailing geological conditions and the mining system used at the mine. The mine operator must take additional measures to protect persons if unusual hazards are encountered. Section 75.220(a)(2) requires an operator to submit a proposed plan and any revisions to the District Manager in writing. Under section 75.220(c), the mine operator may not implement a proposed roof control plan or revision to a roof control plan before the District Manager approves it.

An effective roof control plan addresses information and criteria that mine operators must consider when establishing roof control for working environments. Section 75.221 specifies information that the mine operator must include in each roof control plan. Section 75.222 sets forth the criteria that the mine operator and MSHA must consider on a mine-by-mine basis in the formulation, review and approval of plans and revisions.

While M/NM mines are not required to have a ground support plan, MSHA personnel may use portions of these guidelines and procedures to evaluate the suitability of ground support materials and rock burst control plans where applicable.

B. Authority

30 U.S.C. 811; 30 CFR 75.220–75.223, 57.3360 and 57.3461.

C. Responsibility

Only the District Manager or those designated to act in the District Manager's absence are authorized to approve or deny roof control plans.

D. Directives Affected

This handbook incorporates and supersedes MSHA Program Information Bulletin No. P15–03 "Assessing Coal Burst Hazards in Deep Cover Underground Coal Mines," Dated June 30, 2015.

E. Records Retention

All documents and written materials, including emails and attachments, related to the roof control plan review and approval process must be maintained in accordance with the Federal Records Act.

CHAPTER 2 - EVALUATING GROUND CONDITIONS IN UNDERGROUND MINES

Evaluating the ground conditions and the effectiveness of existing ground support and/or controls is an important part of any mine inspection, and it can be an integral part of determining the adequacy of an approved roof control plan. This chapter describes the essential elements of such an evaluation.

A. Prior to the Onsite Inspection

Before conducting a ground control evaluation, the inspector should review materials specific to the mine being inspected. For a coal mine, the inspector will review the most current approved roof control plan and any supplemental material. Coal mines may also have a ground control plan established in compliance with 30 CFR 77.1000 for the surface areas, which also should be reviewed. For metal and non-metal (M/NM) mines, the inspector should be familiar with the type of mining method employed at the mine. The inspector will also need to identify any applicable requirements for ground support or control methods employed in compliance with 30 CFR 57.3360. This effort may entail a review of previous enforcement actions, accident history, review of plans (including a rock burst control plan, if applicable, under 30 CFR 57.3461) and procedures established by the operator, and discussions with previous inspectors.

B. Arrival at the Mine

Upon arrival at the mine, the inspector should review the mine map, taking note of such items as the depth of cover, pillar dimensions, over/undermining, and any potential bodies of water that overlay the mine workings. For a coal mine, the inspector should also review the mine map for the locations of previous roof falls, keeping in mind that the operator may document the locations of roof falls on a separate mine map.

The inspector should use the information observed on the mine map while conducting the underground inspection to identify the detrimental effects of increased cover, such as rib sloughing, excessive loading of mine pillars, or bottom heave. In low cover areas, localized weakening of the immediate mine roof (back) can occur.

Since pillar dimensions are crucial to both the global and local stability of a mine, a thorough ground control evaluation should look for changes from designed mine pillar dimensions. Changes resulting from narrowing, shortening, or changing crosscut angles to accommodate mine structures, or changes in the direction of mining, can result in the destabilization of the mine roof and or pillars.

The presence of over/undermining each have the potential to affect the active mine workings and should be considered when evaluating ground conditions. The inspector should note any changes identified within the areas of known over or undermining (such as roof deterioration, excessive sloughing of ribs, or heaving of mine floor) and determine whether the support systems and ground control procedures in such areas are effective.

The inspector should determine whether bodies of water overlay the mine workings and, if so, whether appropriate actions have been taken. Overlying bodies of water may be from abandoned mine workings or from streams, ponds, or lakes. The inspector should determine whether plans are in place and being followed. While underground, the inspector should pay close attention to areas where known bodies of water or streams overlay the mine workings, noting changes in the mine conditions such as deteriorating strata and any inflows of water. The inspector should question mine personnel concerning these areas to identify any changes in mine conditions which may have occurred.

C. Start of Ground Control Evaluation

For drift and slope mines, the evaluation of ground conditions should begin at the portals leading underground. The inspector should inspect the highwalls for loose unconsolidated strata, rock or soil overhangs, and trees or other vegetation that could fall onto miners entering the portals or working and traveling in the vicinity of the highwalls. The highwall also provides an opportunity to view a cross section of the strata that represents the mine roof.

The inspector should verify safe access is being provided where miners enter and exit the mine. Where structures are used for miners to enter, such as portal arches or canopies, the inspector should evaluate them to determine whether they have been installed according to the manufacturer's recommendations and are being maintained to serve their purpose. The inspector should look for rust and deterioration of metal structures, as well as decaying or dry rotting of wooden structures.

The ground just inside the portal entrances is highly susceptible to weathering and deterioration. This portion of the mine is subject to extreme changes in temperature and humidity, often resulting in damage from freeze and thaw events, as well as deterioration of moisture sensitive shales. The inspector should pay close attention to the ground conditions in these areas to identify adverse conditions.

D. Travel to Active Areas of the Mine

While traveling to the active areas of the mine, the inspector should look for indications of deterioration, such as fresh cutters, loose, rib sloughage, excessive loading on roof bolt plates or standing supports, or other indications of changes in the ground conditions. The outby and worked out areas of the mine are susceptible to weathering and deterioration as they age and can be used as an indicator for future conditions of developing faces. This evaluation may indicate that additional supplemental support and/or scaling is necessary in past-mined areas so that miners have safe access to and from the active working areas. In areas treated with shotcrete or gunite, the inspector should closely examine for deterioration, such as cracking or water damage. Loose sections of shotcrete pose the same hazard as loose strata and may indicate deterioration in the underlying rock. The inspector should hold discussions with mine personnel to determine whether conditions observed are normal or changing. The inspector should also attempt to identify areas where rehabilitation activities have been (or are being) conducted and evaluate those areas.

E. Arrival in the Working Areas

Upon arrival in the active working areas, the inspector should make contact with mine personnel to ascertain the mining cycles and the locations where equipment is being operated. For their own safety as they begin to move through the working areas, the inspector should also identify the active travelways being used by the mobile equipment.

The inspector should examine all areas of the working section, as well as the working faces, verifying that required ground support materials were installed and are being maintained. The inspector should examine the roof, back, ribs, and hanging walls for strata deterioration, rib sloughage, unstable faces, and indications of excessive loading of pillars or roof supports.

In coal mines, the approved Roof Control Plan (RCP) will list limitations for cut depths, minimum roof and rib support lengths and spacing, sequencing of support installations, and proper equipment operation. The inspector should determine whether the support systems and practices comply with the approved RCP. The inspector should also determine whether the minimum parameters of the RCP are sufficient to address the conditions encountered. If the minimum plan parameters are deemed inadequate, the inspector should alert their supervisor so that further evaluation of the plan can be undertaken.

In M/NM mines, the inspector should determine the effectiveness of the support materials and practices in place for back, hanging wall, and rib control. The inspector should observe all areas of the back, ribs, and hanging walls to determine whether proper scaling of loose material is being conducted. In some M/NM mines, overbreak, stope design, mining method, and backfill design and emplacement can have significant effects on ground stability. The inspector should evaluate all ground support/control programs, policies, and design diagrams established by the M/NM operator to determine whether they are appropriate for the conditions encountered.

The inspector should determine whether primary and supplemental supports are being installed in a timely manner at the required intervals and are appropriately sized for the application. If mesh or other devices are used to provide additional skin control, the inspector should determine whether the mesh is appropriate for the loads applied by the loose rock, coal, or ore being supported. The inspector should also examine tell-tales, test holes or any other ground monitoring devices (where available) used to identify separations or other hazards in the mine roof.

The inspector should take every opportunity to discuss ground conditions, support methods, and work practices with the miners as they are observed and encountered. These discussions should be conducted to evaluate miners' knowledge and understanding of the mine plans, procedures, and policies in place for the operation.

When evaluating ground conditions on a working section engaged in retreat mining or pillar recovery, the inspector should focus on the changing ground conditions near the mining front. The support installed should be sufficient to protect the miners from roof deterioration or rib sloughage caused by the retreat mining. Since the sequence of mining is vital to controlling the ground behavior, the inspector should determine whether the cuts taken are in compliance with the maximum depths and widths depicted in the mine's specific plan. In deep cover, burst-prone mines, the inspector should determine if precursor burst events have occurred on the section.

At a longwall mine, the inspector should verify that the tailgate entry and the headgate corner of the longwall are sufficiently supported to maintain egress for miners working on the face and an open-air course for proper airflow across all portions of the face being mined. They should also observe the placement of the shields to determine whether they are being set properly to prevent failures of the roof between the shield tips and the face. The inspector should ask the miners about indications of excessive face pressure, like excessive face sloughage, roof cavities in front of the shield tips, or coal/rock forcefully being projected from the face. If high face pressure is suspected, the inspector should alert their supervisor and/or roof control supervisor.

The inspector should also ask miners about what support measures are implemented and what precautions are taken anytime a miner is required to enter the face conveyor (pan line) to perform any maintenance or repairs.

In older portions of the mine, the inspector should look for loose rock, rib sloughage, deterioration of ground supports (such as rusting of metal structures or decay and dry rotting of wooden structures). When evaluating areas where weathering has resulted in guttering of the mine roof (back) either along the rib lines or between the rows of supports, the inspector should consider the effects of the missing strata on the roof's integrity and support capacity. As rib sloughage occurs over time, entry widths can increase resulting in a larger spans for the roof to bridge. This condition may also result in wide unsupported areas between the outside rows of roof supports and the pillar.

The inspector should speak with mine personal who are normally assigned tasks within the air courses of the mine to determine changes in conditions and locations where rehabilitation activities have been or are being conducted. These discussions should be conducted to determine whether the air courses are serving the purpose for which they were established, as well as to verify that ground control measures are not impeding miners' ability to work and travel throughout them.

F. Definitions

Back: A term used in M/NM mines referring to the strata making up the overhead portion of the mine (equivalent to the "roof" in a coal mine).

Cutter Roof/Cutter Back: A condition in which the roof or back breaks in response to high levels of horizontal stress. Cutter roof typically displays shearing or buckling where the roof meets the rib, although cutters may appear anywhere within the entry. Cutters can propagate for long distances and may extend well up into the roof.

Drift: A horizontal entrance to a coal mine. In a M/NM mine, any horizontal passage underground, including development drifts, production drifts, access drifts, and laterals.

Ground: A general term used to define the rock surrounding the mine opening, including the roof, back, rib, face, or wall.

Hanging Wall / Foot Wall: In an inclined orebody, the overhead side of a mine or mine opening is called the hanging wall. The opposite side is the foot wall.

Loose: Any rock material that is detached from the back or ribs, but is still in its original place. Loose can be scaled down or controlled with larger bearing plates, straps, or wire mesh.

Overbreak: Fractured, weakened rock in the periphery of the mine opening that results from blasting.

Primary Support: Support that is routinely installed during the initial mining process.

Rib: The rock forming the walls that run parallel to the entry, tunnel, or drift. In mines with arched drifts, the rib is everything below the springline.

Stope: A block of ore of specified dimensions delineated for extraction, or, the opening from which ore has been extracted.

Supplemental Support: Support that is installed later in the mining process, typically in response to an observed or anticipated deterioration in ground conditions.

CHAPTER 3 - MANAGEMENT SYSTEM CONTROLS

MSHA District Offices must log each plan submittal into the MSHA Standardized Information System (MSIS)/ MSHA Centralized Application System (MCAS) system, which will assign a tracking number. Other data that must be entered into the system include: the date the District receives the submittal, the mine identification number, and the person assigned to review the plan. An MSHA District Office may use the MSIS/MCAS system to track a mine operator's response to a District Manager's request for plan revisions and to identify overdue responses.

A District Manager may allow mine operators to submit plans to other locations, such as an MSHA Field Office, provided the District logs them into the MSIS/MCAS system.

Districts should manage roof control plan or revision review to meet the goals in MSHA's current Fiscal Year Operating Plan.

The District Manager or designee, Assistant District Manager, or Roof Control Supervisor may contact the mine operator for additional information necessary to the review process. If the mine operator does not provide the information within in the requested timeframe, the District should deny the plan in a letter to the mine operator.

The Assistant District Manager or his/her designee should coordinate the progress of the plan submittal and/or revision. After the submittal has been entered into the MSIS/MCAS system and a tracking number has been assigned, the following sequence of events should occur. However, when the mine operator proposes changes or revisions that address only specific portions of the approved plan, all the following steps may not be necessary, and the Assistant District Manager may expedite the review process.

1. The original submittal and the District's Plan Transmittal Sheet should be given to the Roof Control Supervisor, who forwards it to the plan reviewer.

2. After receiving the plan submittal and/or revision, the plan reviewer conducts a thorough review in accordance with Chapters 4 and 5 of this handbook.

3. The plan reviewer uses the Plan Transmittal Sheet to document the plan coordination and review, together with his/her recommendations and any comments. The plan reviewer then returns the submittal to the Roof Control Supervisor.

4. The Roof Control Supervisor documents his/her recommendations and comments on the Plan Transmittal Sheet and forwards the submittal to the

Assistant District Manager.

5. The Assistant District Manager documents his/her recommendations and comments on the Plan Transmittal Sheet and forwards the submittal to the District Manager for final determination.

Upon receipt of the submittal and accompanying recommendations, the District Manager makes his/her determination and notifies the mine operator of the final disposition of the submittal.

1. If the District Manager approves the proposed plan or revision, written notification is sent to the operator (and the miners' representative, if applicable), stating that the roof control plan/revision is approved.

2. If the District Manager determines that the proposed plan or revision is deficient, written notification is sent to the operator (and the miners' representative, if applicable) that:

   - addresses the deficiencies of the proposed plan or revision for which approval is denied;
   - provides the operator an opportunity to discuss with the District Manager the problems identified and potential solutions; and
   - sets a reasonable time for the operator to submit any revised plan provisions.

   If the mine operator addresses the deficiencies, the District prepares approval correspondence. If provisions cannot be approved, MSHA procedures established in the Program Policy Manual, Volume V, V.G–4 apply.

The date the District Manager signed the letter of approval or denial is entered into the MSIS/MCAS system.

One copy of the approved plan and/or revision (with approval letter) is placed in the Mine Plan Section of the Electronic Mine File at the same time that the approval letter is sent to the operator. Copies of the approved plan/revision (with approval letter) should also be sent to any appropriate state agency and to any designated miners' representatives.

The District office should retain one copy of the approved plan/revision with the approval letter as part of a file that also includes all documentation of the plan reviews and evaluations (including MSHA Form 2000–204 (if applicable), checklists, drawings, sketches, correspondence between the operators and plan reviewers, etc.) that support the approval decision. The District should retain this file for at least as long as the plan is in effect and in compliance with the Federal Records Act.

MSHA is required to review all roof control plans every 6 months per section 75.223(d). The plan approval date becomes the date of record for that plan. A 6-month review must be completed within 6 months of the date of record, and subsequent reviews must be completed within 6 months of the previous review.

CHAPTER 4 - PLAN REVIEWS

MSHA has established criteria and guidance for assessing the quality of, and potential safety risk associated with, proposed plans. Districts should document the basis for their conclusion that approved plans will provide effective roof control.

The plan review process should include the following:

1. The plan reviewer determines whether the operator has submitted all information mandated by 30 CFR 75.221.

2. The plan reviewer contacts the assigned Inspector and/or Field Office Supervisor to solicit comments on the appropriateness of the plan and documents any comments on the Plan Transmittal Sheet.

3. The plan reviewer considers written comments from the representatives of miners and documents whether comments were received on the Plan Transmittal Sheet.

4. If the plan review is for an existing mine, the plan reviewer checks the mine file for information relating to plan adequacy, including: roof fall history, injury experience, accident reports, relevant citations, and plan review forms (MSHA Form 2000–204). Appendix F contains guidance for evaluating a mine's roof control history, and Appendix I contains guidance regarding the information that should be collected during a roof fall investigation.

5. The plan reviewer determines whether assistance from MSHA's Directorate of Technical Support (Technical Support) Roof Control Division is warranted. Appendix B, "Complex Roof Control Plans and Revisions (Addenda)," offers guidance for determining when Technical Support assistance is appropriate. When the District Office forwards a plan submittal, or any portion thereof, to Technical Support for assistance with the review, the District Office records the transmittal in the comments section of the MSIS/MCAS system. This record should include the transmission date and pertinent information regarding the plan that was sent to Technical Support, as well as the date and summary of subsequent Technical Support recommendations.

6. If Technical Support's assistance is not requested, the plan reviewer uses Analysis of Coal Pillar Stability (ACPS) or other applicable software to conduct development and/or retreat pillar stability analysis (see Appendix C for guidance for conducting pillar stability analyses). If the plan reviewer's evaluation shows that the stability factors calculated do not meet the design

criteria required by the ACPS program, the District may deny the plan or forward it to Technical Support for further review in accordance with Appendix B.

7. The plan reviewer communicates with other such approval groups concerning common issues in a plan. The plan reviewer reviews overlay and underlay maps of coal mine workings above and below projected mining. The plan reviewer should pay particular attention to the possible presence of impounded water above projected mining either in overlying mines or on the surface. If the plan reviewer determines that such impoundments may exist, a permit may be required in accordance with 30 CFR 1716–2.

8. MSHA has created optional roof control plan checklists to assist the plan reviewer in reviewing plans and documenting the rationale supporting plan approvals. MSHA's standards, interpretive guidance, safety precautions and best practices are included in the checklists. The checklists are not intended to be a "one size fits all" approach because roof control plans are developed and revised on a mine-by-mine basis considering the prevailing geological conditions and the mining system used at the mine. Consequently, not all items on the checklists are applicable for every mine. If an item on a checklist is not applicable during a review, the plan reviewer should mark the item "N/A."

   The checklists are summarized in Appendix A, and are available via this link: Optional Checklists. Other appendices provide additional information that can aid the plan reviewer in determining which checklist items may be appropriate on a mine-by-mine basis. Specifically, retreat mining is addressed in Appendices D and E, rib control is addressed in Appendix J, and roof supports to be listed in the roof control plan are addressed in Appendix H.

9. Mine inspections may be conducted to evaluate the mine's roof and rib conditions to determine the appropriateness of the proposed roof control plan and/or revision. The results of the evaluation should be discussed with the operator and miners' representatives, if applicable. Guidance for conducting underground inspections for a roof control plan approval or review is contained in Appendix G.

10. The District Manager or their designee determines whether an on-site inspection should be conducted at a new highwall and/or pre-existing highwall that is developed as a portal area for new underground mine openings.

11. The plan reviewer should evaluate all plan requests for making extended cuts with remote controlled continuous mining machines in accordance with MSHA

PIL "Procedures for Evaluation of Requests to Make Extended Cuts With Remote Controlled Continuous Mining Machines," available on the MSHA website.

12. Depending on the depth of cover and other geologic conditions, the plan reviewer should consider whether a coal burst hazard assessment should be conducted (see Guidelines in Appendix K). If the mine is considered at risk of hazardous coal bursts, the plan reviewer should consider whether the plan should address coal burst training, monitoring, record keeping, and reporting as discussed in Appendix L.

Upon completion of the review, the plan reviewer recommends whether the plan should be approved and marks the appropriate box on the Plan Transmittal Sheet. Following his/her review, the Roof Control Supervisor and the Assistant District Manager review the plan reviewer's recommendation and note their own recommendations on the Transmittal Sheet prior to transmission to the District Manager.

CHAPTER 5 - PLAN REVISION REVIEWS

The procedures for reviewing plan revisions (addenda) are similar to those for reviewing plans. The key difference is that most proposed plan revisions only address specific portions of the approved plan. Therefore, the plan reviewer will consider the steps in Chapter 4 for reviewing plan revisions, but may omit steps and/or checklist items, as appropriate.

The mine operator does not need to revise the roof control plan each time they add equipment; however, they should revise their plan for significant equipment changes that affect the mining system. These type of changes may include:

- adding a roof bolter with a different roof bolt installation pattern or a different type of Automated Temporary Roof Support system,
- adding new mining equipment that would require a change to the depth of an extended cut or pillar lift depth (e.g., center drive shuttle car or continuous mining machine with deck),
- changing from shuttle cars to continuous haulage, or
- adding a roof bolter with rib bolting capability.

When the mine operator proposes revisions, only the revised pages need to be submitted unless otherwise specified by the District Manager. When the number of revisions to an approved plan makes it difficult to determine the operative provisions of the plan, the District Manager should instruct the operator in writing to submit a revised plan that (1) clearly sets forth all previously approved revisions and any proposed revisions and (2) deletes provisions that are no longer applicable.

CHAPTER 6 - SIX-MONTH REVIEWS

In accordance with 30 CFR 75.223(d), the roof control plan must be reviewed every 6 months by an Authorized Representative of the Secretary (AR). A Roof Control Specialist should conduct 6-month reviews of more complex/non-typical plans; however, inspectors may conduct 6-month reviews of less complex/typical plans. Refer to Appendix B for additional guidance on complex or non-typical plans and addenda. The following are the basic steps in the 6-month review:

1. Prior to the underground inspection, the following items should be reviewed by the plan reviewer:

   - Detailed historical record of relevant safety conditions at the mine including: roof fall accident data, roof control citations, roof and rib fall injuries, roof falls, and coal or rock outbursts for at least the prior 6 months (see Appendix F).

   - Previous MSHA Form 2000–204 comments, or other documentation of deficiencies.

2. The plan reviewer communicates with other plan approval groups concerning common issues in a plan. The plan reviewer reviews overlay and underlay maps of coal mine workings above and below projected mining. The plan reviewer should check for the presence of impounded water above projected mining in overlying seams or on the surface. If the plan reviewer determines that such impoundments may exist, a permit may be required in accordance with 30 CFR 75.1716–2.

3. The plan reviewer should also evaluate mining projections using ACPS or other applicable software for development and/or retreat pillar stability analysis. Appendix C contains guidance on conducting pillar stability analyses.

4. If the plan reviewer's evaluation shows that the stability factors calculated do not meet the design criteria required by the ACPS program, the District may deem the plan deficient and instruct the mine operator to address the deficiencies. If necessary, the District may request further review from Technical Support in accordance with Appendix B, "Complex Roof Control Plans and Revisions (Addenda)". If MSHA conducted a pillar stability analysis concurrently with the review of the ventilation plan at any time during the 6 months prior to the roof control plan review, the plan reviewer may determine that it is unnecessary to conduct another analysis, but the results of the applicable pillar stability analysis should be documented.

5. Limited mine inspections may be conducted to evaluate the mine's roof and rib conditions to determine the appropriateness of the roof control plan. The results of the evaluation should be discussed with the operator and miners' representatives, if applicable. Guidance for conducting underground inspections for a roof control plan approval or review is contained in Appendix G. The Roof Control Group should contact the assigned Inspector and/or Field Office Supervisor to solicit comments on the appropriateness of the plan.

6. The Roof Control Specialist or Inspector conducting the six-month review should document any plan deficiencies. (At the District Manager's discretion the Plan Review Form, MSHA Form 2000-204, may be used for this purpose) Documentation of any deficiencies must be sent to the Roof Control Supervisor for evaluation.

If the 6-month review identifies deficiencies in the roof control plan, the Roof Control Supervisor or Roof Control Specialist must prepare correspondence for the District Manager's consideration that: (1) informs the operator of the findings of the review and the need for revisions to the approved plan; (2) provides the operator with an opportunity to discuss the deficiencies and potential solutions with the District Manager; and (3) sets a reasonable time for the operator to submit any revised plan provisions. If the District Manager concurs with the finding of deficiencies and the deficiencies are not corrected, MSHA procedures established in the Program Policy Manual, Volume V, V.G–4 apply. A copy of the deficiency letter and subsequent communications should be sent to the appropriate field office and must be retained in the District's files.

APPENDIX A - OPTIONAL CHECKLISTS FOR USE IN PLAN REVIEWS

(« back to chapter 4) (« back to chapter 6)

The following checklists have been developed to assist plan reviewers during their plan reviews. These checklists are optional and can be used at the discretion of each District.

- Preliminary Items
- New Mine Openings and Punchouts
- General Information
- Mine Layout
- Roof Support
- Tensioned Roof Bolts
- Resin Grouted Roof Bolts
- Supplemental Support
- Mining Equipment
- Extended Cuts Safety Precautions
- Retreat Mining Precautions
- Mobile Roof Support Precautions
- Longwall Mining

APPENDIX B - COMPLEX ROOF CONTROL PLANS AND REVISIONS (ADDENDA)

(« back to chapter 4) (« back to chapter 6)

All new roof control plans and revisions that are complex and/or non-typical should be evaluated with particular attention to the adequacy of support systems and pillar dimensions.

Roof control plans or revisions are considered complex or non-typical if they meet one or more of the following criteria:

(a) Room and pillar retreat mining at overburden depths of 1,000 feet or greater.
(b) Design criteria that do not meet the stability factors listed in the "Analysis of Coal Pillar Stability (ACPS) Computer Program," or do not meet minimum safety criteria for other computer models used.
(c) Mines with a history of bounces or bumps, regardless of the amount of overburden cover.
(d) Other criteria considered unusual by the District Manager.

For complex and/or non-typical plans or revisions, the mine operator should provide the data and engineering evaluations that support their determination that systems provide safe work environments for miners and that pillar dimensions are compatible with effective control of the roof, face, and ribs, as well as coal or rock bursts.

The mine operator should submit with any complex and/ or non-typical plan or revision the following:

(a) A risk assessment specific to the particular mining operation that includes depth of overburden, coal seam geology and strength properties, pillar recovery method and development and retreat stability factors. The risk assessment should contain a statement detailing the basis on which the operator has determined that the plan is appropriate and suitable to the mining conditions.
(b) Where recommendations are made by consulting engineers, the operator should provide the reports upon which the assertion of adequacy depends and direct the consultants to cooperate fully with the MSHA plan reviewers in verifying their conclusions.
(c) Data from currently available tools such as ACPS, LaModel, RocScience, or other applicable software. MSHA may compare the proposed plan evaluation method against a different evaluation system developed by third parties.
(d) Where plans are based in any part on empirical information, the operator should provide information sufficient to permit field evaluations of the installed systems and verification of the similarity in mining conditions. Such plans are those using

a support system or pillar dimensions proven to work under similar mining conditions—e.g., similar mining depth and roof conditions. This information can be included with the operator's statement in (a) above that the plan is appropriate and suitable to the mining conditions.

(e) A detailed and comprehensive review of technical and engineering data submitted in support of the proposed plan, and an analysis of potential hazards and other relevant factors.

When and where site- or mine-specific pillar size and pillar stress loading design tools have generated reliable design parameters and reliable minimum safety factors, those validated parameters may be used as a basis for plan approvals for mining under the same or less severe conditions.

APPENDIX C - PILLAR STABILITY ANALYSES

(« back to chapter 4) (« back to chapter 6)

MSHA's standard 30 CFR 75.203(a) states that "[p]illar dimensions shall be compatible with effective control of the roof, face and ribs and coal or rock bursts." To comply with this standard, the roof control plan submission should include an engineering design and supporting analysis. The analysis method is at the discretion of the mine operator. Roof control plans submitted to MSHA for approval should include:

- A brief description of the pillar design analysis method used, including design software version (release number).
- The listing or identification of pillar stability factors or safety factors for the analysis method used.
- A pillar design that meets or exceeds the generally accepted, or recommended, design criteria for the analysis method used or meets mine-specific design criteria that is supported by sufficient documentation and mining history.

Pillar stability analyses for plan reviews can be either:

- *Generic:* using the maximum depth of cover, typical mining height, and other input parameters contained within the roof control plan, or
- *Site-specific:* using actual input parameters obtained from mine maps, mining projections, and/or underground measurements.

Generic analyses are most appropriate for new mines submitting their initial roof control plans. Site-specific analyses should be conducted for base plans submitted for operating mines, 6-month reviews, and addendums involving proposed mining. The discussion below applies primarily to site-specific analyses.

The first step is normally to review the results of analyses submitted by the operator or conducted by MSHA as part of previous reviews. These analyses can help in the selection of the most appropriate software and input parameters. Also, when and where previous site-specific pillar stability analyses have generated reliable design parameters and minimum stability factors, those validated features may be used as a basis for plan approvals for mining under the same or less severe conditions. For example, if a previous analysis shows that a satisfactory stability factor was obtained where the depth of cover was greater than it is now, and no other parameters have changed significantly, it may not be necessary to conduct a new analysis.

The next step is to select the pillar analysis software. ACPS is the program that MSHA traditionally has used to analyze pillar sufficiency. Detailed instructions for using ACPS can be found in the program's Help files, and in the published technical papers that are included in the ACPS Help/Resource Files. If a plan was developed using other pillar analysis programs, such as LaModel or RocScience, Technical Support's assistance should normally be requested.

In determining which mine layouts are to be analyzed, the Reviewer typically looks for the "most severe" conditions, defined as the conditions that will generate the lowest pillar stability factors. Often, these will be found under the deepest cover. However, they may also occur where the mining height is greatest, where smaller pillars are used, or where abutment loads are the greatest. In the case of multiple seam interactions, the most severe conditions can occur where the interburden is thinnest, where isolated remnant pillars are present in previously mined seams, and/or where the active seam has been undermined. Often, the Reviewer should select several sites to analyze because it may not be immediately evident which condition is the "most severe."

A critical step is the collection of the input data. The depth of cover is often the most important parameter. It is normally obtained from a mine map that includes depth of cover contours. Alternatively, it can be obtained by subtracting the coal seam elevation from the surface elevation. The Help files included with ACPS contain further guidance on determining the depth of cover. Mine maps are also essential for evaluating the ACPS loading condition, barrier pillar widths, type of remnant pillar, gob dimensions, and other such parameters.

The mining height is also extremely important. Inspectors' notes can be a very valuable source of data, since the "total mining height" should be measured at the site of each air reading. Also, some mine maps contain "coal sections" that provide information on the thicknesses of the coal and rock layers mined underground. The ACPS Help file provides guidance determining the input mining height when rock is mined with the coal. Also, it is normally appropriate to input the *average* mining height over the area to be analyzed.

Nominal dimensions for entry centers, crosscut centers, and entry widths are normally used in the analyses. The nominal entry and crosscut centers are the projected planned mining dimensions with slight variation expected from the actual mining procedures. The nominal entry width is the typical initial mining width before rib spall. Nominal dimensions are used so that the results can be directly compared with the ACPS case history databases that were used to calibrate the program. In exceptional cases, it may be appropriate to make adjustments for excessive rib sloughage or off-center mining. When using ACPS, the default values for parameters such as the in situ coal strength and the abutment angle should also be employed.

Pillar stability analysis with ACPS software should be conducted using guidance contained in the program Help files, and the professional literature published by National Institute for Occupational Safety and Health (NIOSH) and MSHA authors. Inhouse resources, such as Technical Support experts, are also good sources of information. To check that an analysis submitted by an operator was conducted properly, it may only be necessary to verify that the proper input data was employed.

If a pillar stability analysis of mining projections indicates that the calculated stability factors do not meet the ACPS design criteria listed in the ACPS Help file, or do not meet minimum safety criteria for other computer models used, the results of the analysis should be discussed with the operator. If the operator subsequently proposes changed mining projections, those new projections should be analyzed using the procedures just described. If changes to the mining projections are not subsequently proposed by the operator, the procedures described in Appendix B on "Complex and/or Non-Typical Roof Control Plans and Revisions (Addenda)," should be followed.

Documentation of pillar stability analyses should be maintained. This may be accomplished by printing the output file and including it in the mine file, saving the input file to a network drive, entering the information into a spreadsheet, or some other method to reliably maintain the information.

APPENDIX D - Pillar Recovery Design, Technologies, and Procedures

(« back to chapter 4) (« back to chapter 6)

MSHA's standard at 30 CFR 75.203(a) states in part that "[t]he method of mining shall not expose any person to hazards caused by ... faulty pillar recovery methods." MSHA plan reviewers should pay particular attention, including examining inputs and other factors used to support the proposed plan, when pillar recovery provisions of a roof control plan are submitted under either of the following conditions:

- Pillar recovery at depths exceeding 2,000 feet may not be appropriate due to the heightened risk of bursts at such unusual and extremely deep cover. In most cases, when an entire pillar is over 2,000 feet deep, careful analysis may determine that the pillar should be a "Leave Pillar" that should not be retreat mined. When any portion of a pillar is less than 2,000 feet deep (i.e., any portion of pillar is outside the 2,000 foot depth of cover contour), and the overall pillar design is judged to have a stability factor or safety factor that meets design criteria, it may be technically sound to allow the pillar to be recovered by retreat mining following an approved roof control plan.
- At depths exceeding 1,000 feet, the practice of pillar splitting may be particularly problematic, due to the extremely high stresses and burst-prone conditions existing in the core of pillars adjacent to the gob. Plans including such a proposal should be carefully examined.

Instructions Pertaining to Roof Control Technologies

MSHA plan reviewers should pay special attention to the following roof control technologies when evaluating roof control plans or amendments for coal mine room and pillar retreat mining:

- Whether the plan leaves an appropriately sized final stump rather than extracting the entire pillar. The final stump that is not to be mined should be clearly marked on the pillar rib or mine roof.
- For room and pillar retreat mining sections, whether supplemental roof bolts that are longer and stronger than the mine's primary roof bolting system are to be installed on advance, particularly in intersections.
- Whether the plan calls for mechanized Mobile Roof Support (MRS) units, rather than traditional wood timbers, for the roof-to-floor standing support for the mining of cuts or lifts into the pillar.

Instructions Pertaining to Pillar Recovery Procedures

MSHA plan reviewers evaluating roof control plans for coal mine room and pillar retreat mining should pay particular attention to the following pillar recovery procedures:

- Whether the plan for pillar recovery describes a cut and support sequence that maximizes ground stability and safety.
- Whether the mine site ground conditions warrant limiting access to just one roadway into the intersection when the last lifts for a pillar are taken.
- Whether the mine site ground conditions warrant having supplemental support installed in the entry and/or crosscut in addition to being installed in the intersections.
- Whether the plan describes safe work locations for miners while coal is being mined or loaded.
- Whether the plan incorporates best practices for using Mobile Roof Support (MRS) units identified in the Checklist "Mobile Roof Support Precautions."

Instructions Pertaining to Communication with the Mine Operator
When roof control plans for room and pillar retreat mining are being reviewed for approval, MSHA should discuss the following items with the mine operator so that the mine operator can develop a suitable roof control plan:

- Preshift and on-shift examinations should include a thorough assessment of geologic conditions, and hazards should be reported and dangered off, or appropriately supported. Examinations should include areas outby the pillar line to anticipate geologic conditions prior to pillar recovery. Roof fall accident studies reveal that in more than one-third of the fatal incidents, poor conditions were observed in the area before the fatality occurred, but no action was taken.
- Conducting a geologic assessment of the entire panel before retreat mining begins is a prudent practice. The assessment should identify major roof fractures, which can then be marked, mapped, and supported (see Appendix E for guidance on conducting geologic assessments). It is good practice to plan to skip lifts or not recover pillars so as to avoid such adverse features.
- Test holes are useful to determine if there are roof separations, and, if so, they can be monitored during retreat mining to see if conditions worsen.
- The pressures and loading rates of MRS units can provide information on roof stability. Mine-specific trigger points indicating unusually high loads or loading rates can be identified and procedures developed to respond to loading.
- Where retreat mining is proposed and the depth of cover exceeds 1,000 feet, mine operators should assess areas of high burst likelihood in advance of mining. The assessments should identify these areas of high burst likelihood based on the depth of cover, the geological conditions, the potential for multiple seam interactions, and recent ground control experience (see Appendix K for more details).

APPENDIX E - GEOTECHNICAL ASSESSMENTS PRIOR TO RETREAT MINING

(« back to chapter 4) (« back to chapter 6)

Retreat mining, whether longwall or pillar recovery, increases the stress and deformation experienced by mine openings adjacent to the retreated areas. These changes can result in instability and roof falls. Roof that is already weak is most likely to become unstable when affected by retreat mining. A geotechnical assessment can identify the roof that is at greatest risk so that precautions can be taken.

The assessment should begin with a review of experience and available geologic data. The geotechnical factors associated with roof falls, coal and rock bursts, rib falls, floor heave, and other problems encountered on previous retreat panels should be noted. Available surface borehole logs can provide information on the roof rock likely to be encountered, as well as the possible presence of sandstone channels, rider seams, transition zones, and other potentially troublesome features. Mine maps are essential for identifying areas of deeper cover, stream valley influence, and potential multiple seam interaction.

Underground mapping is the most important part of the geotechnical assessment. The mapping should not try to record every feature that is observed, but rather should focus on those features that are most significant to roof control at the mine. The following types of information should be collected:

- ***Geologic features*** that could create roof instability during retreat mining, such as major joints or slips, faults, drag folds, etc.
- ***Current ground conditions***, including the presence of sagging roof, open fractures, cutters, excessive rib slough, groundwater inflows, and floor heave.
- ***Roof support installed*** and any evidence of unusual weight on the supports.
- ***Unusual mining dimensions***, such as wide intersection diagonals and locations where the height may exceed the reach of the Mobile Roof Supports.

Test holes should also be checked using a scratch tool (such as a tape measure) or borescope to locate major cracks and features such as rider seams. It is a good practice to log and record the crack data so that any new cracks can be identified when the holes are monitored during retreat mining.

The assessment creates a hazard map of the area to be retreat mined, whether it is a longwall headgate or a pillar recovery panel. The hazard map integrates the significant information obtained from the core logs, mine maps, and underground mapping. It should be presented in a format that is most useful to the miners who will be using it.

The hazard map should also clearly define the actions to be taken prior to or during retreat mining, such as:

- More closely monitoring,
- Installing extra support, or
- Not mining—skipping pillars or portions of pillars.

APPENDIX F - A MINE'S HISTORICAL RECORD

(« back to chapter 4) (« back to chapter 6)

The MSHA standard at 30 CFR 75.223(d) requires that "[t]he roof control plan for each mine shall be reviewed every 6 months by an authorized representative of the Secretary" and that "[t]his review shall take into consideration any falls of the roof, face and ribs and the adequacy of the support systems used at the time."

MSHA's review should include the following:

Roof Fall Injuries

- The **number** of roof fall injuries at the mine during at least the last 6 months.
- The **injury rates** (number of roof fall injuries per 200,000 hours worked) for at least the last two quarters. The rate is important because a large mine that has had several injuries may actually be safer than a smaller one with fewer injuries. The injury rate should be compared to the national and District rates. (Note: Injury rates are less meaningful when small numbers are involved. For example, a very small mine that experiences one injury in a decade will have a relatively high rate in the year when the injury occurs, but it will also have an injury rate of zero during the other 9 years.)
- The **severity** of these injuries, including the body part injured and number of workdays lost. This information is normally available in the narrative for the accident.
- The **location in the mine and worker activity.** The goal is to determine whether the injuries occurred primarily in the face area or outby and whether a particular activity (such as roof bolting) is more likely to cause injury.

When the accident and injury experience at the mine indicates that the plan is inadequate, MSHA's standard at 30 CFR 75.223 (a) requires that "[r]evisions of the roof control plan shall be proposed by the operator."

Research has shown that the vast majority of roof fall injuries are caused by pieces of rock that fall out from between the bolts. Improved roof skin control is generally the solution. By far, the most effective skin control technique is to install screen wire mesh when the roof is first bolted. Roof support devices such as headers, mats, and pizza pans also can help, as can various protective devices that can be fitted to the roof bolting machine.

Rib Fall Injuries

- The **number** of rib fall injuries at the mine during at least the last 6 months.

- The **injury rate** (number of rib fall injuries per 200,000 hours worked) for at least the last two quarters.
- The **severity** of these injuries, including the body part injured and number of workdays lost.
- The **location in the mine and worker activity.** The goal is to determine whether the rib injuries occurred primarily in the face area or outby and whether a particular activity (such as roof bolting) is more likely to cause injury.

As discussed in Appendix J, "Rib Fall Hazards," the mines most at risk for rib falls are those with greater mining heights operating under deeper cover. Rib bolting on cycle is the most effective rib control technique. Inside-control, walkthrough, roof bolters are also desirable.

Non-injury Roof Falls

- The **number** of roof falls at the mine during at least the last 6 months.
- The **roof fall rate** (number of non-injury roof falls per 200,000 hours worked) for at least the last two quarters.
- The **location in the mine** where the roof fall occurred (e.g., intersection or straight, face area or outby, etc).
- The **age** of the roof when the fall occurred (the length of time between when the area was developed and when the roof fall occurred.)

A wide variety of strategies are available for reducing the risk of roof falls, including:

- Longer, stronger, and/or more closely spaced primary supports.
- Increased use of supplemental supports (cable bolts, trusses, standing support).
- Narrowed entry widths and reduced intersection diagonals.
- Shorter cut depths and reduced time that the roof remains unbolted.
- Mine layout changes, particularly entry or panel orientation.
- Focused support in areas where specific geologic factors are present.

MSHA's regulations at 30 CFR 50.10 and 50.11 requires each operator to report and investigate each accident because the information obtained may prevent future accidents. Under 30 CFR 50.2, an "accident" includes an unplanned roof fall at or above the anchorage zone in the active workings where roof bolts are being used. It also includes an unplanned roof or rib fall in active workings that impairs ventilation or impedes travel. Knowledge of the geology, mining parameters, and roof support associated with prior unplanned roof falls should be an essential element of any plan to improve the roof control system at a mine. Appendix I provides guidance on elements important to a roof fall investigation so that the relevant information is obtained.

The mine map on which roof falls are plotted should also be reviewed. Under 30 CFR 75.223(b), underground coal mine operators must plot on a mine map each unplanned roof fall and coal or rock burst that occurs in the "active workings." (The term "active workings" is defined in 30 CFR 75.2.) Program Policy Letter (PPL) No. P12–V–3, which addresses Reporting of Unplanned Roof Falls In Accordance With 30 CFR 50.10), provides examples of what constitutes "active workings" for the purpose of reporting a roof fall.

The history of unplanned roof falls as plotted on the mine map assists mine operators and MSHA in evaluating the effectiveness of the roof control system and identification of hazardous trends, preferred orientations, or other common characteristics of the roof falls. This evaluation may require information beyond that available in accordance with 30 CFR 75.223(b) depending on site-specific geologic conditions and accident experience at the mine. Thus, the District Manager should consider using the authority granted in 30 CFR75.222(a) to require, on a mine-by-mine basis, that specified categories of unplanned roof falls, beyond those identified in 30 CFR 75.223(b), be investigated and plotted on a mine map. The map must be made available to any Authorized Representative of the Secretary upon request. Maintenance of this map could be required as part of the approved roof control plan, and failure of the operator to maintain this map could be considered as a violation of 30 CFR75.220(a)(1).

Violation History—violations involving the requirements of 30 CFR, Part 75, Subpart C–Roof Support should be evaluated as follows:

- The **number** of roof/rib control violations at the mine during at least the last 6 months.
- The **violation rate**—number of roof/rib control violations per 200,000 hours worked—for at least the last two quarters, compared to the district and national rates.
- The **standards, by subpart,** most often cited.
- The **issues** most often involved in the citations—roof, ribs, support, equipment, etc.

Past Roof Control Inspection and Plan Review Forms (MSHA Form 2000–204): Particularly close attention should be paid to whether concerns raised in past reviews continue to be adequately addressed. For example, if past reviews identified rib conditions as a concern and the mine's recent history indicates a high rate of rib fall injuries or violations, changes to the roof control plan might be needed to protect the miners from rib hazards.

A **Roof and Rib Evaluation** (RRE) application has been developed to assist Districts with the historical review. The RRE application is easily accessed from the MSHA intranet using this hyperlink: Roof and Rib Evaluation Application.

Because the RRE application is linked directly to the MSHA Data Warehouse, it will generate reports using the most recent injury and accident data. While much of the same information is available on the MSHA Data Retrieval System, the advantages of the RRE application are that it:

- Separates the roof-related data from other data, and
- Calculates individual mine roof/rib injury and accident rates, and provides District and national rates for quick comparison.

Five different reports can be generated using the RRE application. The first is a summary that includes the number and rates of roof fall injuries, rib fall injuries, non-injury roof falls, roof-related citations, and S&S citations. The other four reports provide narratives obtained from the 7000–1 forms or citations. The default timeframes are 6 months or 2 years for numbers of incidents and two quarters or eight quarters for rates, because rates must be calculated using the data for hours worked, which is only available quarterly. The user may also define different time periods to analyze. The user may print the results, or export them in a variety of file formats.

APPENDIX G - UNDERGROUND INSPECTIONS FOR ROOF CONTROL PLAN REVIEWS

(« back to chapter 4) (« back to chapter 6)

A thorough underground safety inspection is normally essential to the roof control plan approval process. The inspection is designed to evaluate the effectiveness of a proposed or approved plan and to ascertain compliance with an approved plan. This inspection may be a limited inspection (E20, E02, etc.) or it may be conducted as part of a regular inspection (E01).

Onsite inspections begin with a pre-inspection conference. Items to be discussed include:

- The accident and injury experience and rates at the mine.
- The roof control violation history.
- Preshift and on-shift examinations.
- Roof control plan content and revisions since the last review, if any.
- Roof and rib conditions.
- Issues with current support systems.
- Mining projections.
- Training issues.

Current mine maps on which roof falls are plotted should be reviewed. In addition, the plan should be discussed with the miners' representative and may be discussed with one or more miners where there is no authorized miners' representative at the mine.

At least one section that is representative of each of the different mining systems used at the mine should be inspected—i.e., a CM section on advance and on retreat, a longwall section, etc. The inspection should focus on those sections known to have adverse roof conditions or a recent history of roof and rib falls, both injury and non-injury.

The underground inspection should evaluate compliance with MSHA's standards and with the approved roof control plan. It should also evaluate the suitability of the plan to the prevailing geological conditions and the mining method in use. The conditions at critical areas (such as longwall tailgates, pillar retreat sections, and long-term entries) are particularly important. The following items should be checked during these underground mine inspections:

- Roof conditions and the adequacy of roof support, including skin control.
- Rib conditions and the adequacy of rib support.
- Opening dimensions, including entry heights, entry widths, and intersection diagonals as applicable.

- Sequence of advance mining.
- Sequence of retreat mining and dimensions of final stumps.
- Mobile Roof Support operation.
- Longwall support system.
- Roof bolting pattern.
- Supplemental roof support materials.
- ATRS and canopies.

The roof bolting operation is a critical part of the inspection. Items to check include:

- Roof bolt assemblies.
- Material specifications.
- Installation sequence.
- Resin bolt installation practice.
- Torque on tensioned bolts.

The Inspector should discuss current mining activities and conditions with a representative number of miners, and ask them questions to determine their understanding of the existing roof control plan protections. For example, Inspectors should ask roof bolt operators whether the mine's roof control plan addresses issues such as soft layers or cracks while drilling the roof, bolts that don't anchor properly, or groundwater dripping or running out of holes during bolt installation and, if not, whether they believe that addressing such issues would yield safety benefits. They should also ask miners about the plan's effectiveness regarding roof skin control in protecting them from loose rocks.

The MSHA inspector should question the miners to determine whether their training with respect to the roof control plans is completed and adequate, focusing especially on training involving retreat mining activities. Guidance on documenting the information from miners during these discussions can be found in the Mine Safety and Health Enforcement General Inspection Procedures Handbook.

Appendix H - Roof Supports listed in the roof control plan

(« back to chapter 4) (« back to chapter 6)

MSHA has determined that roof supports play a vital role in ensuring miner safety; thus roof control plans must address the use of appropriate roof supports that are properly installed. The regulation 30 CFR 75.221(a)(9) requires a list of all support materials used in the roof, face, and rib control system in each roof control plan. MSHA standards (e.g., 30 CFR 75.204) reference ASTM F432, "Standard Specification for Roof and Rock Bolts and Accessories." ASTM F432 is an international industry consensus standard that addresses the manufacturing, testing, and identification of ground support products used in the mining industry.

Roof Control Products Addressed by ASTM F432
MSHA requires mine operators using roof bolts and accessories addressed in ASTM F432–95 to (1) obtain a manufacturer's certification that the material was manufactured and tested in accordance with ASTM F432–95 and (2) make this certification available to MSHA Authorized Representatives and to miners' representatives.

ASTM F432 has been updated several times since the last amendment to 30 CFR 75.204. ASTM F432–19, the current version, covers a broader range of roof control products than ASTM F432–95 (e.g. cable bolts). Other updates include specifications for enhanced bolt head markings, resin label information, and bolt thread dimensions. In order to realize the gains to miner safety from the updated version of the ASTM specification, roof control plans should include a statement indicating that products meet ASTM F432–19 specifications. This would make Roof Control Plans exempt from requirements for detailed drawings and specifications for the covered products. Roof support products not covered in the version of ASTM F432 listed in the roof control plan should have detailed drawings and specifications along with demonstrations or tests for such components, in accordance with 30 CFR 75.204(b). These details should be included for all components that are not covered in the referenced ASTM F432 version.

Meeting ASTM F432 specifications does not necessarily eliminate the need for consideration of whether the product is appropriate and effective for a particular location or application. For example, before mechanically anchored, resin assisted bolts are approved for use as a required support, key elements, such as substantial anchorage capacity and consistency of tensioning of these supports, should be considered. These aspects may be evaluated through underground testing, which may include the following:

> *Pull Tests*: Underground pull tests can determine the anchorage capacity and displacement characteristics of the support for the anchor length used. Any time

the anchor horizon changes or the anchorage type is modified, additional anchorage tests should be considered.

Tension Tests: Underground tests can determine the installed load range of the supports and verify that the required tension level can be achieved and maintained (30 CFR 75.204(f)). These tests should be done with a load-measuring device that indicates the installed load of the support. Any anomalies that occur during the test, e.g., spring-back, should be reviewed in order to determine the effect on the installed load and the effect on compliance with regulations.

Depending on the roof conditions at a specific mine, a test area may be warranted to demonstrate the effectiveness of the subject bolts. A test area can range in sophistication from an area of the mine where a number of bolts are installed for observational purposes to a fully instrumented area with monitoring for roof sag and bolt loading.

Based on the results obtained in the test area, the District may then review the bolts for possible inclusion in the mine's Roof Control Plan. Technical Support is available to assist in the evaluation of products.

Additional factors that need to be considered may be present at a specific mine, such as highly corrosive mine water in the roof strata. The results of such evaluations could require the operator to take measures to arrest or slow the resulting corrosion or to limit the expectations as to the safe, useful life expectancy of a specific roof support product.

Roof Control Products Not Addressed by ASTM F432
The MSHA standard at 30 CFR 75.204(b) states that roof bolts and accessories not addressed in ASTM F432–95 may be used, provided that the use of such materials is approved by the District Manager based on:

(1) Demonstrations that the materials have successfully supported the roof in an area of a coal mine with similar strata, opening dimensions and roof stresses; or

(2) Tests showing the efficacy of the materials for supporting the roof in an area of the affected mine which has similar strata, opening dimensions and roof stresses as the area where the roof support products are to be used. During the test process, access to the test area shall be limited to persons necessary to conduct the test.

If the District Manager bases approval of non-ASTM products on underground tests, the information described above regarding pull tests, tension tests and test areas should be considered.

Roof Control Plan Information

In order for the District Manager to properly evaluate roof support material not addressed by ASTM F432, the Roof Control Plan listing of such products should include all relevant efficacy and suitability information for the support, as shown in these examples:

- Non-steel, cuttable rib bolts should specify a minimum ultimate strength.
- Surface control pans should include basic dimensions including thickness.
- Steel roof mesh should include a gage thickness.
- Synthetic geogrid mesh products should include the product manufacturer and specific product identification (e.g., model and serial numbers).

APPENDIX I - Essential Elements of a Roof Fall Accident Investigation

(« back to chapter 4) (« back to chapter 6)

Roof falls that are reportable under 30 CFR Part 50 are considered accidents, even when there is no injury. Under 30 CFR 50.11(b), each operator of a mine shall investigate each accident at the mine and develop a report of each investigation. MSHA may also conduct an investigation. With limited exception, an operator may not use Form 7000–1 in lieu of an investigation or use an investigation report conducted or prepared by MSHA. The operator shall submit a copy of any investigation report at MSHA's request.

The regulation 30 CFR 50.11(b) also lists a number of items that each report prepared by the operator shall include, of which some of the most significant for a roof fall accident investigation are:

(1) A description of the site;
(2) An explanation of the accident, including any explanation of the cause of any accident;
(3) A sketch, where pertinent, including dimensions depicting the occurrence; and
(4) A description of steps taken to prevent a similar occurrence in the future.

MSHA's standards require an operator to investigate each accident because the information obtained may prevent future accidents. Knowledge of the geology, mining parameters, and roof support associated with prior roof falls is an essential element in any effort to improve the roof control system at a mine.

A comprehensive investigation involving a roof fall often will include:

1. A ***sketch in plan view***, showing:
    a. Approximate dimensions of the fall, including intersection diagonals if available, and
    b. Widths of entries leading into the fall.

2. A ***cross-section sketch***, showing the approximate shape and height of the fall.

3. ***Geologic information***, which also may be shown on sketches, including:
    a. Thickness and rock type of the roof beds involved,
    b. Noticeable geologic structures such as clay veins, slips, or drag folds, and
    c. Approximate rate of groundwater inflow, if present.

4. The ***roof support*** installed, including:
    a. Type, pattern, diameter, and length of the primary roof bolts,
    b. Type, pattern, and other characteristics of any supplemental support, and

   c. Timing of the installation of any supplemental support.

5. The ***sequence of events*** leading to the fall, if known, and the general condition of the area. Answers to the following should be provided:
   a. Were the roof bolts or standing supports taking weight?
   b. Was the roof sagging?
   c. Had tension fractures appeared?
   d. Were roof cutters, rib spall, or floor heave noted?
   e. Was water present, and, if so, when was it first noticed?
   f. Did anyone witness the failure?
   g. What was the duration of failure?

6. ***Other critical information***, including:
   a. When the area was developed,
   b. Orientations of the headings and the roof fall,
   c. Any workings above or below,
   d. Depth of cover, and
   e. Local topographic features such as stream valleys.

The information listed under item 6 should be available from the mine maps.

If the fall is to be cleaned up, items 1–3 are usually best investigated once the fall cavity is visible.

While an operator’s obligation to investigate accidents is defined in 30 CFR 50.11(b), a sample one-page roof fall accident investigation form is attached as an illustration of how the information may be collected and presented. Additional pages may be needed to fully document the conditions relevant to the investigation.

Roof Fall Investigation Data

Date and Time of Fall: ________ Fall Location: __________ Date of Investigation: ________

Cross Section of Roof Fall. Show approximate shape and height of the fall, and also the geology (type and thickness of the rock beds observed).

Plan View of Roof Fall. Show approximate dimensions of the fall, including intersection diagonals if available, and the widths of entries leading into the fall.

Other geologic factors: ____

____

Primary roof support: ____

____

Supplemental support: ____

____

Groundwater inflow? ____

Depth of cover: ____________ Multiple seam? ____________________________

Sequence of events leading to the fall, general condition of the area, and other comments: ____

____

Steps to prevent recurrence: ____

____

Name, occupation and experience of all miners involved:

____

Investigation conducted by:

____

Identification of Accident or Injury Reports filed under section 50.20

____

APPENDIX J - RIB FALL HAZARDS

(« back to chapter 4) (« back to chapter 6)

MSHA standard 30 CFR 75.202(a) requires in part that "[t]he roof, face, and ribs of areas where persons work or travel shall be supported or otherwise controlled to protect persons from hazards related to falls of … ribs …." The roof control plan, which is developed by the mine operator and approved by the District Manager, must be "suitable to the prevailing geological conditions and the mining system to be used at the mine" (30 CFR 75.220(a)(1)). The mine operator is required to propose revisions to the roof control plan "[w]hen conditions indicate that the plan is not suitable for controlling…the ribs…." (30 CFR 75.223(a)(1)).

The two most significant geologic conditions that contribute to hazards related to falls of ribs are the *seam height* and the *depth of cover*. Analysis of the fatal accident reports from the 25 rib fall fatalities that occurred during 2000–2019 indicates that 22 (88%) occurred where the mining height was at least 7 feet and 19 (76%) occurred where the depth of cover was at least 700 feet. The reports indicate that rock partings (rock layers contained within the coal seam) or rock brows (rock layers above the coal seam) were present in nearly every instance.

Other conditions that have contributed to rib fall fatalities include:

- additional rib stress due to multiple seam interactions or retreat mining,
- large slickensides in the coal,
- unusually high places prepared for overcasts or belt drives, and
- unstable pillar corners.

Another significant factor associated with nearly all of the fatal rib falls during 2000–2019 is that no rib support had been installed at the accident location.

Rib bolts provide the best protection against rib falls. Since most rib fall incidents occur on the working section, rib bolts are most effective when they are installed in a consistent pattern while the roof is being bolted. Where the ribs are highly stressed, the rib bolts can be more closely spaced and supplemented by additional surface coverage such as straps or mesh. Control of taller ribs (e.g., 9 feet or higher) may be best achieved if two or more rows of rib bolts are installed. Rib bolts should always be long enough to anchor securely beyond the disturbed portion of the rib.

Outside-control, non-walkthrough roof bolting machines place the machine operators between the machine and the rib where they may be exposed to rib hazards. Every one of the roof bolt operators killed by rib falls during 2000–2019 was operating an outside-control machine. Inside-control, walkthrough roof bolting machines significantly reduce the worker's exposure to hazardous ribs. These machines also are commonly configured to provide horizontal rib bolt hole drilling capability. Operators of mines where conditions create rib fall hazards are strongly encouraged to use inside-control, walkthrough roof bolting machines with horizontal rib bolting capability.

Where rib bolting is not feasible, the rib fall hazard can be mitigated by other techniques including roof channels fabricated with angled extensions that buttress the pillar rib, straps or cables for wrapping the pillar rib, or standing supports. When standing supports are used for rib control, it is essential that they be secured in such a manner that a hazard is not created should a support be dislodged.

Mine safety programs and procedures should include methods for preventing, detecting, reporting, posting, and correcting hazardous conditions related to falls of the roof, face, and ribs. These conditions can be detected during applicable preshift, supplemental, or on-shift examinations (refer to Sections 30 CFR 75.360, 75.361 and 75.362). Hazardous conditions found during such examinations must be corrected immediately or remain posted with a conspicuous danger sign until corrected, pursuant to 30 CFR 75.363(a) and 75.211(c).

APPENDIX K - COAL BURST HAZARDS IN DEEP COVER UNDERGROUND COAL MINES

(« back to chapter 4) (« back to chapter 6)

Coal bursts involve the sudden, violent ejection of coal or rock into the mine workings. They are almost always accompanied by a loud noise, like an explosion, and ground vibration. Bursts are a particular hazard for miners because they typically occur without warning. Despite decades of research, the sources and mechanics of bursts are not well understood, and therefore are difficult to predict and control. Experience has shown, however, that certain risk factors are associated with an increased likelihood of a coal burst. In addition, some control techniques are effective in reducing the likelihood of coal bursts or protecting miners from their effects. A coal burst risk assessment consists of evaluating the degree to which these risk factors are present and identifying control measures that can be implemented to mitigate the risk.

Because of their complicated nature, burst risk assessments should be conducted by experienced ground control professionals. Site-specific assessments should be conducted at deep cover mines as mining conditions or experience warrant, but at least on an annual basis.

Factors contributing to the risk of coal bursts

The universal characteristic of burst prone environments is the presence of highly stressed coal. The overburden depth is responsible for the overall level of stress, but pillar design or multiple seam interactions can concentrate stresses in distinct locations. Geology is also important. Strong roof and floor are characteristic of most, but not all, burst prone environments. Geologic features, including sandstone channels, faults, and seam dips, have also been associated with coal bursts. Certain mining layouts and practices also increase the burst risk, as does a past history of bursts. Each of these factors is discussed in more detail below.

Depth of cover: Very few bursts have occurred at depths less than 1,000 feet, although there were two incidents during pillar recovery with less than 750 feet of cover during the early 1980s. Experience shows that the burst risk increases with depth.

Pillar design: Pillars become highly stressed when they are too small to properly distribute the loads that they carry, but too large to yield. Barrier pillars are particularly important in room and pillar mining because they protect each new panel from the abutment loads arising from previously mined areas. In longwall mining, two-entry yield pillar layouts have been effective in reducing the hazard of pillar bursts, but they can result in higher stresses near the tailgate corner of the longwall face.

Multiple seam interactions: The severity of a multiple seam stress concentration typically depends on two factors:

- The thickness of the interburden between the active seam and the previously-mined seams. In general, the thicker the interburden, the less likely that the interaction will result in a severe stress concentration.
- The type of remnant structure present in the previous seam. Isolated remnants, with worked out areas on two or more sides, are the most hazardous.

Remnant structures are typically created when coal is left in place adjacent to areas of full extraction. However, bursts have occurred above and beneath large remnants adjacent to smaller developed pillars that transferred much of their load to the larger pillar.

Interactions between all previously mined seams should be considered in the assessment. Mine workings in several seams may overlap, creating very high stress zones, particularly if the interburdens separating the older workings from the active seam are thin.

Empirical or numerical computer models should be a part of a thorough burst risk assessment. Models such as the ACPS multiple seam module or LaModel can identify potentially high stress zones due to multiple seam mining. However, these programs are designed to prevent pillar squeezes or roof instability, and may require special adjustments for burst risk evaluation. Specialized analysis techniques, such as Energy Release Rate (ERR), may be useful in some applications.

Accurate identification of remnant structures requires reliable maps of older workings. The burst risk assessment should also include an evaluation of the adequacy of the available maps. If mapping detail does not exist or is incomplete, then consider the potential for encountering unexpected remnants.

Not all multiple seam mining increases the risk of coal bursts. The risk can actually be reduced when mining is conducted in de-stressed ground above or below an area that has been mined out.

***Geology*:** Strong sandstone or siltstone roof and floor have been associated with coal bursts, particularly in the eastern US and in Utah. In evaluating whether the roof or floor geology may contribute to the burst risk, it is important to consider:

- The thickness of the strong sandstone or siltstone unit. Thicker units are more likely to be associated with bursts.
- The distance between the strong unit and the coal seam. Strong units close to the seam pose the greatest risk of coal bursts.
- The strength of the rock. Surrounding rock units associated with coal bursts typically have uniaxial compressive strengths of at least 10,000 pounds per square inch (psi).

- The characteristics of the rock. Massive units with minimal bedding, jointing, or other discontinuities are more likely to be associated with coal bursts.

While there is no proven definition of burst-prone geology, the following are two examples developed from experience in different regions:

- A 15-foot thick unit of strong sandstone in the first 30 feet above the mining horizon, or a 6-foot thick unit of strong sandstone within the first 15 feet of the floor.
- A massive sandstone unit at least 5 feet thick is found within 4.25 feet above the coal seam.

Core logs, combined with rock mechanics testing, may be used to identify when burst-prone geology might be present. However, since surface core holes are generally spaced too far apart to identify all zones of burst prone ground, supplemental underground test holes may be necessary.

Sandstone channels may simply be a special case of the strong sandstone described above. Because sandstone channels may be limited in extent, they may be particularly difficult to identify in widely spaced surface boreholes.

Faults or joint systems have been associated with increased burst risk. When mining approaches a highly-stressed fault or joint system, the ground may suddenly shift, releasing seismic energy that results in a burst. Faults or joints may also partition the overburden, resulting in an unexpected concentration of overburden load.

The presence of steep *seam dips* has been observed at a number of burst sites, and rapid changes in the depth of cover due to steep topography have also been associated with bursts.

Coal strength is one factor that does not seem to play a significant role in the burst risk. Bursts have occurred in at least 25 different U.S. coalbeds, varying from strong, blocky seams to the very friable Pocahontas No. 3 and No. 4 Seams. Laboratory studies have also shown that most bituminous coals can be made to burst if they are highly stressed and the confinement is suddenly released.

Mining layouts and practices: Historically, more than 80% of bursts have been reported during retreat mining, with less than 20% occurring on development. *Retreat mining* increases the likelihood of bursts because it concentrates abutment loads on the pillar line, gate pillars, or longwall face, and caving overburden releases seismic energy as it breaks. Of the two widely used retreat mining methods, pillar recovery is significantly more burst prone than longwall mining.

Wider panels are a factor that increases the burst risk during pillar recovery. A wider panel results in a greater front abutment load, and mobilizes more overburden. ERR modeling indicates that the risk may increase in proportion to the square of the panel width.

Certain pillar recovery practices can increase the burst risk. In particular, many bursts have occurred during *barrier pillar extraction*, a practice that was once wide-spread but is now seldom employed. *Pillar splitting*, during which coal is mined from the most highly stressed part of the pillar core, has been another high-risk procedure, and pillar splitting should not be conducted on the pillar line at depths exceeding 1,000 feet. Mining in *pillar points*, where pillars are surrounded on two or more sides by extracted pillars, also adds to the risk of bursts. Pillar points can be created when the center pillars in a row are mined last, as occurs with some cut sequences used with continuous haulage.

A history of bursts: Major bursts have often been preceded by smaller ones. These precursors have occurred at the same stage in the mining process as the subsequent large event (i.e., in the same pillar in the row and pillar lift). Also, once a mine has experienced bursts, future mining operations with similar geology and mining methods should also be considered high risk.

Conducting the risk assessment

Based on the evaluation of the burst risk factors listed above, an overall relative risk level can be assigned to future mining areas. For example, those areas with negligible burst risk might be considered *green zones*, areas with slightly higher risk could be *yellow zones*, and the areas of greatest risk might be *orange zones*.

The initial risk assessment should be conducted before an area is developed, using available borehole logs and maps of previous mining in overlying and underlying seams. During development, underground test hole drilling may be employed to provide more detailed information on the geologic conditions. Underground mapping should be conducted prior to any retreat mining (see Appendix E). The mapping should attempt to use rib conditions to identify the locations of significant multiple seam interactions. At each step, as new data becomes available, burst potential zones should be re-evaluated and updated.

The matrices shown in Tables 1 and 2 may be used to assist with the risk assessment. Each of the significant known risk factors can be rated as low, moderate, or high. Note that it is the level of the factor that is being rated, not the burst risk associated with it. While all the factors should be considered when assessing overall burst risk, there is no standard method for combining the individual factor ratings into an overall burst risk rating. The matrix is intended as a generic guide that can be tailored for each site-specific burst assessment. The assessment should clearly state the assumptions made in the process (including any ratings and weightings of individual factors) and the procedure used to estimate the overall burst risk. An experienced ground control professional can use the matrix to assist in evaluating the overall burst risk.

Control techniques that can reduce the risk of coal bursts

Once zones at elevated risk of bursts are identified, appropriate control techniques should be used within each zone. The most effective way to reduce a risk is to eliminate the hazard. In the context of burst control, this would be achieved by not mining in the areas of greatest risk.

Where avoidance is not possible, mining may be limited to development only. For example, within a pillar recovery panel, a few pillars or rows of pillars might be left in place beneath a remnant structure that was considered to be at an *orange* level of risk.

Pillar design is the primary engineering control for minimizing the risk of pillar failures and coal bursts during retreat mining under deep cover. Engineered barrier pillars that isolate each new panel from the abutment loads arising from previously mined ones are a critical design element for pillar recovery. In longwall mines, inter-panel barriers have successfully reduced the burst risk under the deepest cover (greater than 2,000 feet). Appendices C and D discuss other aspects of pillar design.

Keeping panels narrow is another design technique that can reduce the burst risk during pillar recovery. The extraction front also may be narrowed by leaving pillars in place.

Several operational techniques may be used to reduce the burst risk during the process of pillar extraction:

- ***Narrow lifts:*** The risk of extracting highly stressed coal is reduced by taking lifts that are just one-half the width of the continuous mining machine cutting head, and the remaining pillar is given more time to yield and redistribute the load.

- ***Avoid mining directly into the core of a highly stressed pillar:*** Start pillar recovery at the most inby portion of the pillar and progressively work in the outby direction.

- ***Don't "close out" in the center of the panel:*** When continuous haulage is used to recover pillars, the most convenient cut sequence closes out in the belt entry in the center of the panel. This cut sequence should not be used in burst prone ground because it creates a highly stressed "pillar point." Instead, the pillars should be extracted in sequence from left-to-right or right-to-left.

Some mines have employed *bump cuts* that are taken from pillars that are one or even two rows outby the pillar line. Only thin, yielded fenders are left to be recovered on the pillar line as the pillar recovery progresses. The technique was judged to be successful in controlling bursts, but was difficult to implement because it required mining operations to be sequenced over two or three rows of pillars at a time.

Operational techniques used by longwall mines include reducing the depth of the web, reducing the speed of the shearer, unidirectional cutting, and avoiding double cuts at the gate ends.

Underground observations and monitoring are critical components of a burst risk management program. Mining crews should be trained to observe coal burst warning signs, particularly the occurrence of small bursts, which are often the best indication that an area is becoming more burst prone. A record-keeping system should be maintained, and management processes developed, to make certain that warning signs receive appropriate responses.

TABLE 1.—Coal Burst Risk Analysis Matrix for Pillar Recovery.

Risk Factor	**Level of Factor**		
	Low	**Moderate**	**High**
Depth of Cover	<1,200 feet (365 m)	1,200–1,500 feet (365–450 m)	>1,500 feet (450 m)
Pillar Design	Meets NIOSH or other criteria, including barrier pillars		Does not meet NIOSH or other criteria
Multiple Seam Interaction	Stress shadow or ACPS Multiple Seam Module Condition = "Green"	ACPS Multiple Seam Module Condition = "Yellow"	Inadequate maps or remnant surrounded by gob (ACPS Multiple Seam Module Condition = "Red")
Roof Condition	Weak shale or similar, no massive strata within 50 feet	Typical Western U.S. or Central Appalachian stratigraphy	Strong, thick, and massive strata near the seam
Floor Condition	Claystone or similar, no massive strata within 50 feet	Typical Western U.S. or Central Appalachian stratigraphy	Strong, thick, and massive strata near the seam
Other Geologic Factors			Sandstone channels, faults or fracture zones, seam dips, rapid topographic changes
Pillar Recovery Method	Development Only or Partial Pillar Recovery	Typical Christmas Tree or Outside Lift Pillar Recovery	Closing in center (continuous haulage), barrier pillar extraction, split-and-fender pillar recovery
Panel Width	<350 feet (110 m)	350–500 feet (110–150 m)	>500 feet (150 m)
Past History of Bursts	No burst history in the seam	Burst history in the seam	Burst history in the mine

TABLE 2.—Coal Burst Risk Analysis Matrix for Longwall Mining.

Risk Factor	**Level of Factor**		
	Low	**Moderate**	**High**
Depth of Cover	<1,200 feet (365 m)	1,200–2,000 feet (365–600 m)	>2,000 feet (600 m)
Pillar Design	Development only, meets NIOSH or other criteria	Longwall mines should use yield, abutment-yield, or interpanel barrier pillars as appropriate for depth and geology	
Multiple Seam Interaction during Gate Development	ACPS Multiple Seam Module Condition = “Green”	ACPS Multiple Seam Module Condition = “Yellow”	Inadequate maps or remnant surrounded by gob (ACPS Multiple Seam Module Condition = ”Red”)
Roof Condition	Weak shale or similar, no massive strata within 50 feet	Typical Western U.S. or Central Appalachian stratigraphy	Strong, thick, and massive strata near the seam
Floor Condition	Claystone or similar, no massive strata within 50 feet	Typical Western U.S. or Central Appalachian stratigraphy	Strong, thick, and massive strata near the seam
Other Geologic Factors			Sandstone channels, faults or fracture zones, seam dips, rapid topographic changes
Past History of Bursts	No burst history in the seam	Burst history in the seam	Burst history in the mine

APPENDIX L - COAL BURST TRAINING, MONITORING, RECORD KEEPING, AND REPORTING

(« back to chapter 4) (« back to chapter 6)

***Introductory Note**: Experience has shown that small, "precursor" coal bursts are often an indication that a major burst is more likely (see Appendix K). Miners and mine operators should be aware of the warning signs and notify MSHA if a serious "precursor" event occurs. The following paragraphs are intended as examples of language that may be included in Roof Control Plans on a mine specific basis, based on the prevailing geological conditions and mining systems in use. In general, such language is likely to be appropriate for mines that engage in pillar recovery at overburden depths exceeding 1,000 feet. However, coal bursts have also occurred during development or longwall mining at depths exceeding 1,200 feet in some coalfields, and this language may be appropriate for such mines as well. District Managers must make the determination whether the following language, or some form of the following language, is appropriate given the prevailing geological conditions and the mining system (or given unusual hazards encountered) at the specific mine before requesting its inclusion in a mine's roof control plan.*

Training will be provided to all miners involved in the extraction or production process in areas of the mine where either:

- Pillar recovery will be conducted and the overburden (cover) exceeds 1,000 feet, or
- Development or longwall mining will be conducted and the cover exceeds 1,200 feet.

Training will be provided to persons that normally work on the sections that meet the criteria above prior to conducting any such mining activity in such areas. The training will cover the potential hazards associated with mining in deep cover areas, including coal bursts. Special emphasis will be placed on indications of an increased potential for coal bursts and the actions to be taken when these indicators are present. An instructor knowledgeable about these potential hazards and indicators, but who does not have to be an MSHA Approved Instructor, will conduct the training. Upon completion of the training, the instructor shall complete a 5000–23 form as documentation as required by 30 CFR 48.29. Refresher training on the potential hazards associated with mining in deep cover areas, including coal bursts will be conducted at least annually and may be part of the roof control topic required in annual retraining. This refresher training will only be required when pillar recovery is taking place in areas of the mine where the overburden is greater than 1,000 feet, or when development mining is taking place where the overburden exceeds 1,200 feet.

When conducting pillar recovery in any area where the amount of overburden (cover) is greater than 1,000 feet, or development or longwall mining where the cover exceeds

1,200 feet, the mining section will be monitored for indications of an increased potential for coal bursts, including:

a. The occurrence of small coal bursts, during which coal (and/or rock) is forcibly ejected from the coal seam accompanied by a loud noise and ground vibration.

b. When the roof bolter operators experience significantly increased strength in the immediate mine roof while drilling during the advancement.

c. A significant change in the amount of seismic activity (noises and/or vibrations) emanating from the roof or floor.

d. Unusual red dust observed at a coal/rock interface.

Upon the completion of any shift during which coal burst indicators were observed, a certified foreman shall make a record of them. The record will include the nature and location of the condition and any corrective action taken. The records will be maintained on the surface at the mine, either in a secure record book (Pre-Shift, On-Shift Book) that is not susceptible to alteration or electronically in a computer system that is secure and not susceptible to alteration. The records will be made available for inspection by MSHA upon request.

The MSHA District Office will be immediately notified if any of the following occur:

a. A forcible ejection of coal or rock that strikes a miner and causes an injury as defined in 30 CFR 50.2(e), or is severe enough to cause the individual to leave the section to seek medical attention.
b. A forcible ejection of coal or rock that causes damage to equipment.
c. A forcible ejection of coal or rock that impedes passage or impairs ventilation.

Concluding Note: *Notification assures MSHA an opportunity to investigate such bursts, and, following any investigation, district officials should assess whether it is then safe for miners to continue working in the affected area and whether additional measures are required to protect miners in the affected area. Until the potential for additional bursts and the appropriateness of additional protective measures can be determined, it often will be necessary to cease mining and to withdraw personnel. MSHA's authority to respond appropriately after such bursts is accorded in sections 103(j) and (k) of the Mine Act. Where experience or conditions at a particular mine suggest the value of including explicit provisions regarding actions to be taken by the operator after such bursts in the roof control plan, the District Manager may instruct the operator to include such provisions as a condition of plan approval. If the roof control plan specifies that mining will be halted and/or personnel withdrawn while conditions are evaluated, the plan also should specify the conditions required for return to normal operation (e.g., District Manager approval or the operator's notification of actions taken to safely resume operations).*