MSHA HANDBOOK SERIES

ROOF CONTROL PLAN APPROVAL AND REVIEW PROCEDURES:
APPENDICES
The Administrator should direct that a Roof Control Plan Approval handbook be developed to consolidate the numerous PILs, PIBs, and CMS&H memoranda. This will provide plan reviewers with a discrete set of guidelines and instructions for evaluating and processing roof control plans."
Appendices To Handbook

- Incorporates and supersedes PIBs, PILs, PPLs, and HQ memos for policy guidance.
- Provide background technical information for all aspects of plan evaluation.
- All are readily accessible electronically.
Appendices: Guidance for Plan Reviewers

B. Checklists for Use in Plan Reviews

C. Approval of Complex and/or Non-Typical Roof Control Plans and Revisions

D. Guidelines for Conducting Pillar Stability Analyses
I. Guidelines for Evaluating a Mine’s Historical Record (roof falls, injuries, bursts, accident reports, citations, and past review forms)

J. Underground Inspections For Roof Control Plan Approvals and Reviews
E. Precautions for the Use of the NIOSH Pillar Analysis Computer Programs

F. General Guidelines for the Use of Numerical Modeling to Evaluate Ground Control Aspects of Proposed Coal Mining Plans

G. Pillar Recovery Design, Technologies, and Procedures in Roof Control Plan Reviews

K. Tensioned Cable Bolts
Appendices: Background Material

L. Best Practices for Turning Crosscuts with Remote Controlled Continuous Mining Machines

M. Use of Mobile Roof Supports for Retreat Mining

O. Protecting Miners from Hazards Related to Rib Falls
Appendices:
Background Material (NEW)

H. Guidelines for Geotechnical Assessments Prior to Retreat Mining

N. Essential Elements of a Roof Fall Accident Investigation
Revised Checklists

- Help ensure that all required information is submitted
- Include regulatory requirements, safety precautions and best practices
- Provide documentation explaining the rationale behind the approval of roof control plans.
Checklists contain three types of items:

- Mandatory standards
- Items that should be addressed in the plan on a mine-by-mine basis
- Suggested plan language (to be considered on a mine-by-mine basis)

Only those checklists that are appropriate to a given review need be completed. Items that are not applicable may be marked N/A.
Checklist Topics

- Active Mine Plan Review Preliminary Items
- New Mine Openings
- General Plan Information
- Mine Layout
- Roof Support (General)
- Tensioned Roof Bolts
- Resin Grouted Roof Bolts
Supplemental Support
Mining Equipment
Extended Cuts
Pillar Retreat Mining
Mobile Roof Supports
Longwall Mining (new)
30 CFR 75.215 (a) and (b) requires that the roof control plan specify “[t]he methods that will be used to maintain a safe travelway out of the section through the tailgate side of the longwall,” and “[t]he procedures that will be followed if a ground failure prevents travel out of the section through the tailgate side of the longwall.”
In addition, the following items should be addressed in the roof control plan on a mine by-mine basis:

- Specify the support installation sequences and the supplemental supports to be used in the:
  - setup room,
  - recovery room,
  - adjoining crosscuts, and
  - notches mined for conveyor drives and other equipment.
Specify the **maximum widths** of the setup and recovery rooms.

Specify the procedures that will be used during **longwall face recovery**, including:

- Meshing prior to the recovery point
- Shield recovery
- Safety precautions for wire ropes, slings, chains, fastenings, fittings, and attachments
Specify procedures to be used when a shield cannot be pressurized against the mine roof due to cavities. It should also specify procedures to be used when a shield cannot be pressurized against the mine roof due to hydraulic or other problems.

Specify safety precautions for using internal controls to advance and reposition shields.
A geological assessment of the headgate and tailgate entries should be conducted prior to longwall mining, to include (a) a review of past experience and geological data, and (b) underground mapping of geologic features, existing ground conditions, roof support installed, and unusual mining dimensions. The assessment should result in a hazard map that identifies actions to be taken prior to during longwall mining, such as monitoring more closely or installing extra support.
Complex and/or Non-Typical Roof Control Plans
Room and pillar retreat mining at overburden depths of 1,000 feet or greater.

Design criteria that do not meet or exceed the stability factors calculated using one of the three NIOSH software programs, or do not meet or exceed minimum safety criteria for other computer models used.

Mines with a history of bounces or bumps, regardless of the amount of overburden cover.

Other criteria considered unusual by the District Manager.
The assistance of MSHA's Technical Support Roof Control Division should be sought and their recommendations considered in all complex or non-typical plan approvals and revisions.

The District Manager should not approve the proposed plan or revision until the operator has provided the data and evaluation supporting the proposal and MSHA has completed a confirming evaluation.
GUIDELINES FOR CONDUCTING PILLAR STABILITY ANALYSES

- Upper seam
- Lower seam
“Pillar dimensions shall be compatible with effective control of the roof, face and ribs and coal or rock bursts.”

To comply with this standard, the retreat mining portion of the roof control plan submittal should include an engineering design and supporting analysis. The analysis method is at the discretion of the mine operator.
Submitted roof control plans should include:

- The pillar design analysis method used,
- The calculated pillar stability factors (SF),
- A pillar design that meets or exceeds the generally accepted design criteria, or
- Meets mine-specific design criteria that is supported by sufficient documentation and mining history.
NIOSH Pillar Design Software

ALPS 5

ARMPS v6 (2010)

ANALYSIS OF MULTIPLE SEAM STABILITY (AMSS)
ARMPS is used for any development mining, retreat mining, and most bleeder pillar analyses.
ALPS is used only for the tailgate corner of longwall panels.
AMSS is for multiple seam interactions, and it incorporates ARMPS and ALPS evaluations.
Other pillar analysis programs...call Technical Support.
To check that an analysis submitted by an operator was conducted properly, it may only be necessary to ensure that the proper input data was employed.

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, then MSHA need not conduct a new analysis.
Look for the lowest SF ("most severe conditions")

- Deepest cover
- Greatest mining height
- Smaller pillars
- Greatest abutment loads
- Thinnest interburden
- Isolated remnant pillars

Often, the Reviewer should select several sites to analyze because it may not be immediately evident which condition is the "most severe."
Mine map should include depth of cover contours

Mining projections show pillar dimensions, ARMPS loading condition, barrier pillar widths, the type of remnant pillar, gob dimensions, and other such parameters.
Use 30 CFR 75.372 ventilation map, the 30 CFR 75.1200 mine map, or other documented sources. If necessary, the District Manager should exercise his authority under 30 CFR 75.1203 to require an operator to furnish a current 30 CFR 75.1200 mine map with mining projections and depth of cover contours.
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.

“Coal sections” from mine map that provide information on the thicknesses of the coal and rock layers mined underground.
The ARMPS 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.
If MSHA’s analysis of mining projections indicates that the calculated SF do not meet the NIOSH design criteria, then the results of the analysis should be discussed with the operator.

If the operator subsequently proposes changed mining projections, then MSHA should analyze those new projections.

If the operator does not propose new projections, then the procedures for “Complex and/or Non-Typical Roof Control Plans and Addendums,” should be followed.
Documentation of pillar stability analyses should be maintained 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.
If MSHA conducted a pillar stability analysis concurrently with the review of the ventilation plan at any time during the six months prior to the roof control plan review, then it is not necessary to conduct another analysis, but in every case the results of the pillar stability analysis should be documented.
UNDERGROUND INSPECTIONS FOR SIX-MONTH PLAN REVIEWS
A thorough underground safety inspection is normally an essential part of the six-month roof control plan review. 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) or it may be conducted as part of a regular inspection (E01).
The accident and injury experience 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.

Training issues.

Current mine maps on which roof falls are plotted should be reviewed. In addition, the plan should be discussed with a representative of the miners.
Where to Inspect

At least one section that is representative of each of the different mining systems used at the mine should be inspected:

- CM section on advance
- CM section on retreat
- Longwall section

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.
Underground Inspections

- Evaluate compliance with MSHA’s standards and with any approved roof control plan.
- Evaluate the suitability of the plan to the prevailing geological conditions and the mining method in use.
- Conditions at critical areas (such as longwall tailgates, pillar retreat sections, and long-term entries) are particularly important.
Roof conditions and the adequacy of roof support, including skin control.
Underground Inspections: Items to Check

- 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.
Underground Inspections: Items to Check

- Mobile Roof Support operation.
- Longwall support system.
- Roof bolting pattern.
- Supplemental roof support materials.
- ATRS and canopies.
Underground Inspections:
Roof Bolting Items to Check

- Roof bolt assemblies.
- Material specifications.
- Installation sequence.
- Resin bolt installation practice.
- Torque on tensioned bolts.
The MSHA CMI should discuss and question miners on current mining activities and conditions, and ask them questions to determine their understanding of the existing roof control plan protections.
Does the mine’s roof control plan address:

- 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

If not, should it?

Does the plan provide skin control and protect them from loose rocks?
Ensure that training with respect to the roof control plans is completed and adequate, focusing especially on training involving retreat mining activities.
Guidelines For Evaluating A Mine’s Historical Record
Guidelines For Evaluating A Mine’s Historical Record

MSHA standard **30 CFR 75.223 (d)** requires that the six-month review “shall take into consideration any falls of the roof, face and ribs and the adequacy of the support systems used at the time.”
Historical Record: Elements to be Considered

- Roof falls,
- Injuries,
- Bursts,
- Accident reports,
- Citations, and
- Past review forms
“Roof Rib Evaluation Report Manager” is available on the MSHA Intranet.
Historical Record: Report Manager Overview

Home > DW Production Reports

MSHA Reporting Services

Roof and Rib Evaluation

- Roof and Rib Evaluation
- Roof and Rib Injuries
- Roof Falls
- Violations

Violations S and S
## Roof and Rib Evaluation

**Mine Id:** 1102632  
**Operator:** Springfield Coal Company LLC  
**Mine Name:** Crown III Mine

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**Customize Data Parameters**

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<tr>
<td>End_Date</td>
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**Data Parameters**

- **6 Months:** 07/22/2013 to 01/21/2014
- **2 Years:** 01/22/2012 to 01/21/2014
- **Last 2 Qtrs:** 07/01/2013 to 12/31/2013
- **Last 4 Qtrs:** 01/01/2013 to 12/31/2013

**Roof/Rib fatal injuries at mine since 1995:** 0
The injury rates (number of roof fall injuries per 200,000 hours worked) are 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.

It should be noted, however, that injury rates are less meaningful for small mines. For example, a small mine that experiences one injury in a decade will seem to have a very high rate in the year when the injury occurs, but it will have a zero rate during the other 9 years.
Historical Record: Roof and Rib Injuries
Roof Control Accident 2 Years History, 1/22/2012 to 1/21/2014

Mine Id: 1102632  Operator: Springfield Coal Company LLC
Mine Name: Crown III Mine  Report Date 1/22/2014

Degree 03, DAYS AWAY FROM WORK ONLY

Doc Number: 220130450021  Location: FACE
Accident Date: 2/8/2013  Days Restrict:
Classification: 07 - FALL OF ROOF OR BACK
Days Lost: 7
Type: STRUCK BY FALLING OBJECT
Ret to Work: 2/18/2013
Inj Source: CAVING ROCK, COAL, ORE, WSTE

WHILE ATTEMPTING TO BOLT #4 ENTRY A BROW BROKE LOOSE STRIKING EE ON THE HEAD AND NECK.
The severity of these injuries, including the body part injured and number of days 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 injury occurred primarily in the face area or outby, and whether a particular activity (such as roof bolting) is 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 skin control can be provided by roof support devices such as headers, mats, and pizza pans can help, as can various protective devices that can be fitted to the roof bolting machine. By far, the most effective skin control technique is to install screen wire mesh when the roof is first bolted.
The greatest rib fall risk usually occurs at mines with greater mining heights operating under deeper cover. Rib bolting on cycle is by far the most effective rib control technique. Inside-control, walk-through, roof bolters are also highly desirable.
Historical Record: Non-Injury Roof Falls
Roof Control Accident 2 Years History, 1/22/2012 to 1/21/2014

Mine Id: 1102632          Operator: Springfield Coal Company LLC
Mine Name: Crown III Mine

Degree 00, ACCIDENT ONLY

Doc Number: 220120370099          Location: OTHER
Accident Date: 2/3/2012          Days Restrict:
Classification: 07 - FALL OF ROOF OR BACK          Days Lost:
Type: ACC TYPE, WITHOUT INJURIES          Ret to Work:
Inj Source: NO VALUE FOUND

A ROOF FALL WAS FOUND IN THE MAIN WEST ENTRIES BETWEEN # 5 AND # 6 Entries. A K order was issued and a plan was agreed upon to start renovating the fall area.
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.
Strategies for reducing of roof falls (con’t):

- 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.
# Historical Record: Citations

## MSHA Reporting Services

### Roof and Rib Evaluation

- Roof and Rib Evaluation
- Roof and Rib Injuries
- Roof Fails
- Violations

### Violations S and S
### Roof Control Accident 6 Months History, 7/22/2013 to 1/21/2014

**Mine ID:** 1102632  
**Operator:** Springfield Coal Company LLC  
**Mine Name:** Crown III Mine

<table>
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<th>Vio Number</th>
<th>8443794</th>
<th>Likelihood</th>
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The company is not following its approved roof control plan on page 11 which states that when entry widths are over 2 feet too wide a standing support such as jacks, props, cribs, or crib alternatives will be installed. In unit #2 at cross-cut #22 between entries 2 and 3 the cross-cut is 21 feet to 20 feet 2 inches for 11 feet. The roof in this area is fractured and a hazard when wide widths are not supported. Standard 75.220(a)(1) was cited 23 times in two years at mine 1102632 (23 to the operator, 0 to a contractor).
Historical Record: Citations

- The **number** of roof/rib control citations at the mine during at least the last six months.
- The **citation rate**—number of roof/rib control citations per 200,000 hours worked—for at least the last two quarters, compared to the district and national rates.
- The **standards** 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 citations, then changes might be needed to protect the miners from rib hazards.
Historical Record: Roof Fall Map
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.

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 and discussed in PPL No. P12-V-3).
However, the roof fall evaluation may be incomplete unless all known roof falls, both within and outside of “active workings,” are plotted on the mine map. Accurate plotting of all roof falls may also be highly valuable during a mine emergency, because rescuers need to be aware of blocked travelways.

The District Manager may require, under 30 CFR 75.222 (a), and based on the site-specific geologic conditions and accident experience at the mine, that all unplanned roof falls, whether they occur in active workings or not, be investigated and plotted on a mine map.
Roof Fall Accident Investigations
Roof Fall Accident Investigations

- Under 30 CFR50.11 (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.

- An operator may not use Form 7000-1 or an investigation report conducted or prepared by MSHA.

- The operator shall submit a copy of any investigation report at MSHA’s request.
30 CFR 50.11 (b) lists items that the operator’s report shall include, such as:

(4) A description of the site;
(5) An explanation of the accident, including any explanation of the cause of any accident,
(7) A sketch, where pertinent, including dimensions depicting the occurrence; and
(8) A description of steps taken to prevent a similar occurrence in the future.
Items to Include:

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

- A **cross-section sketch**, showing the approximate shape and height of the fall.
Items to Include:

- **Geologic information**, including:
  - Thickness and rock type of the roof beds involved,
  - Noticeable geologic structures such as clay veins, slips, or drag folds
  - Approximate rate of groundwater inflow, if present.

This information may be shown on the sketches.
Items to Include:

The *roof support* installed, including:

- Type, pattern, diameter, and length of the primary roof bolts,
- Type, pattern, and other characteristics of any supplemental support, and
- Timing of the installation of any supplemental support.
The sequence of events leading to the fall, if known, and the general condition of the area. Answers to the following should be provided:

- Were the roof bolts or standing supports taking weight?
- Was the roof sagging?
- Had tension fractures appeared?
- Were roof cutters, rib spall, or floor heave noted?
- Was water present, and when was it first noticed?
- Did anyone witness the failure?
- What was the duration of failure?
Items to include

**Other critical information**, including:

- When the area was developed,
- Orientations of the headings and the roof fall,
- Any workings above or below,
- Depth of cover, and
- Local topographic features such as stream valleys.

(The information listed above should be available from the mine map(s).)
Roof Fall Investigation Data Form

Date of Fall: _______ Fall Location: _________________________ Date of Investigation: _______

Cross Section of Roof Fall. Show approximate shape and height of the

Plan View of Roof Fall. Show approximate dimensions of the fall, including intersection
Roof Fall Investigation Form

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 re-occurrence: ____________________

Investigation conducted by: ______________________
Geotechnical Assessments Prior To Retreat Mining
Geotechnical Assessments Prior To Retreat Mining

- Retreat mining (longwall or pillar recovery) increases the stress and deformation near the retreated areas.
- Instability and roof falls can result.
- Weak roof that is most likely to be affected.
- A geotechnical assessment identifies at-risk areas so that precautions can be taken.
Review past experience, including roof falls, coal and rock bursts, rib falls, and floor heave.

Use available surface borehole logs to identify roof rock geology and the presence of sandstone channels, rider seams, transition zones, and other features.

Use mine maps to identify areas of deeper cover, stream valley influence, and potential multiple seam interactions.
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.

- **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 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 that will be using it.
The hazard map should also clearly define the actions to be taken prior to or during retreat mining, such as:

- Monitor more closely,
- Install extra support, or
- Do not mine—skip pillars or portions of pillars
Questions?

Contact Information

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