## OMB No.: 1219-0026, Expiration: 10/31/12

## Dear Mine Operator, Contractor, Other Interested Parties;

Public reporting burden for this form is estimated to average 6.2 hours including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. This is a mandatory collection of information. Send comments regarding this burden estimate and any suggestions for reducing the burden to DOL/MSHA, OSRV, 1100 Wilson Blvd., Arlington, VA 22209, Paperwork Reduction Project (1219-0026). NOTE: Do not send your completed form to this address. Persons are not required to respond to this collection of information unless it displays a currently valid OMB control number.

Sixty Two highwall accidents have occurred in our nation's mine since 2002. In order to reduce these accidents, MSHA District 2 has compiled guidelines and templates from across the nation to provide the Western Pennsylvania coal mines a tool in developing a Ground Control Plan for safe working conditions within current prudent engineering design.

The fundamentals to a safe Ground Control Plan is to recognize the hazards and reduce the miner's exposure to the hazards. To assist in this process, two documents are attached, ground control guidelines and a working template. These documents provide numerous safety precautions that may or may not be applicable to your specific mine. Since each mine and associated pit is unique (i.e. mining methods, geology, topography, hydrology, etc), each Ground Control Plan will be evaluated independently for the health and safety of the miners.
Therefore, the submitted Ground Control Plan shall be site specific.

Respectfully,

William Ponceroff

# Guidelines
# for
# Submittal and Evaluation of Ground Control Plans
**(Submitted for Compliance with 30 CFR 77.1000 and 77.1000-1)**

# GROUND CONTROL PLAN GUIDELINES

**The ground control plan for the safe control of all highwalls, pits, and spoil banks at the mine should contain information for each type of production equipment used at the mine. This information should show the methods of mining employed to ensure highwall and spoil bank stability so as to provide for safe working conditions. The methods used should be consistent with prudent engineering design in that actual mining processes will provide safety for workers exposed to highwall and spoil bank hazards. These hazards include the ground failing to support persons or equipment in a work area or material falling or sliding into a work area from above**.

## 1. GROUND SLOPE

If the original ground slope exceeds 27 degrees, it becomes more difficult to operate a dozer on the ground to effectively strip loose, hazardous material a safe distance from the top of proposed highwalls when benching for first cuts and to slope any loose, unconsolidated material to the angle of repose. In these instances it is usually practical to establish a bench or diversion ditch for first cuts to protect workers. Work to be performed during later development of the pit could be curtailed if the width of these benches is not capable of keeping any loose, hazardous material from falling into the work areas to be developed below.

If these types of benches are to be used, the plan will have to reflect this (show in the engineered drawing).

## 2. HIGHWALLS

The highwall height is based on stability.

The height of a highwall should not exceed a safe reach of the type of equipment available at the mine to clean (scale) the highwall unless special precautions are taken. These precautions could include blasting practices that shoot the face of the highwall clean, using equipment that is capable of working out a safe distance from the base of the highwall while removing material to the toe (such as a shovel), using equipment to clean the wall from the top edge, breaking the wall down into benches that are spaced so as to allow for cleaning of the wall immediately above the work area, or providing a buffer (such as a berm of material) at the base of the highwall that keeps workers out a safe distance from the wall.

The angle of a highwall (slope) is usually determined by the type of blasting used to develop the wall. When drilling vertically, the wall typically shoots out between 5 and 10 degrees unless presplit. Angle drilling at 10 to 20 degrees is being done in some instances where cast blasting occurs. The angle at which the highwall is developed should be included in the consideration of pit widths. If an unsafe condition should exist or develop after a wall is established, the area to be barricaded will be determined by the extent of the unsafe area in the wall and the angle of the wall. Typically, material falling out of a vertical wall will land on the pit floor within the drop zone (see Item #3& #7) near the toe of the wall, whereas material falling out of an angled wall will kick out from the wall and would require a barricade to be established a greater distance from the base of the wall.

Historically in District 2, highwalls or lowwalls over 60 feet in height were benched. However, highwall's and lowwall's should be judged on a pit to pit bases, based on past mining conditions of seam or area and sound engineering practices.

## 3. BENCHES

**Bench spacing**

Benches perform two important functions. **First,** they provide stability to a highwall by increasing the safety factor of the highwall. Where a highwall contains numerous discontinuities (joint sets, bedding planes, etc.), providing benches at select spacings can increase the stability of the wall. **Second**, where sloughing rock and dirt are a problem, benches can be used to keep these materials from falling into the pit. One of the factors used to determine bench spacings would be their ability to perform the above functions.

Where bench spacings have been decreased to a minimum at surface mines and sloughing material is still not contained (smaller size material), it would be necessary to determine if a hazard is created by the sloughing material. It is likely that the bench spacing is such that the drop zone is minimal (the angle of the wall will affect the drop zone) and the material is simply falling at the base of the wall. This material may not be a hazard because it does not fall into a travel or work area. Assignment of work duties near the wall will be considered in determining if a hazard is created.

Another factor used to determine bench spacings would be the ability to maintain the exposed face of the highwall. If access is provided to both the top and base of a wall to make it possible for equipment such as end loaders and excavators to clean the wall, bench spacings up to 50 feet are practical. This is important to consider for the development of highwalls that will be exposed indefinitely, such as deep mine face-ups.

Highwalls developed for surface mining operations are normally not exposed for long periods of time, and the equipment used allows workers to minimize their exposure to these types of walls. This allows for extended bench spacings. Blasting techniques are selected to shoot the wall clean initially. Excavators are used to clean the lip of the wall and any developed bench before the shot is brought down. Dozers then clean the wall as the shot is brought down. The effectiveness of these cleaning operations, the shortened exposure of the wall to weathering, and the stability of the wall determine the extent of the bench spacings used. As long as the strata in the wall remains stable and workers in the pit are not subjected to material sloughing out of the wall, these methods are acceptable.

**If the configuration of the highwall or techniques being used do not keep material from falling into the pit where workers are exposed, changes to the ground control methods are necessary.** Providing a bench or additional benches in the wall, widening bench widths, modifying blasting techniques, changing the orientation of mining, and more effective cleaning methods would be some of the changes to consider.

Developing benches at equal spacings in a wall and maintaining bench widths to equal those bench spacings provide for the best protection against shear plane failure. It may not be practical to break the wall down in this manner. Increased bench spacings may be necessary. Establishing a bench at 50 feet above the pit floor and having the next spacing occur at 70 or more feet increases the possibility that shear plane failure in the upper section of the wall would result in rock vaulting the bench at the 50-foot elevation in the wall and landing on the pit floor. For this reason it is important to maintain wider benches (sometimes exceeding the drop zone for the immediate wall above the bench) in order to contain material that may fall out of the wall above the bench.

When highwalls are not presplit, they usually shoot out at an angle (5-10 degrees). Because of this, bench widths will need to be wider than the drop zone width for the particular height of the wall in question. Bench widths less than 20 feet should not be used.

Whenever bedding planes exist running along in the wall parallel with the pit floor, consideration should be given to the possibility that the plane strikes at an upward angle back into the wall. This condition causes shear plane failure. Joint sets that intersect back in a wall in such a way that the intersection dip at an upward angle are the cause of wedge failures. The direction that these joint sets run back into a wall can usually be determined. The strike direction of the intersection of these joint sets usually cannot be determined. When these discontinuities are exposed to changes in weather (freeze-thaw) and/or vibration (the detonation of a shot), failure of the material can occur with very little warning.

Protection against these hazards can be achieved by the strategic placement of benches in the wall at the elevation where these discontinuities are exposed in the face of the wall. This increases the safety factor of the strata where they exist. When a shot that was drilled deep is brought down, these conditions may show up high on the wall. The opportunity to provide a bench at the elevation of the discontinuities is no longer available. Either extending the width of the next bench to be established below these discontinuities, or limiting exposure to these hazards at the pit level by barricading (or a buffer), should be considered.

Joint sets that intersect back in the wall with the intersection extending vertical form what is termed "chimneys." If the toe supporting this strata is solid and failure occurs, the "chimney" will usually tip out of the wall. If the toe is weak, a "chimney" can slide out into the pit bringing the material in the toe with it. These conditions should be corrected as they are exposed bringing the shot down. At no time should any person work below the top of a "chimney" in an attempt to dislodge it from the wall.

Where discontinuities present shear plane, wedge, or "chimney" failure concerns, changing the orientation of lifts (panels) can be a solution. Drilling on an angle or obtaining some angle with production shots that are not presplit can be a solution to the "chimney" problem if a solid toe is supporting the "chimney." The weight of the rock causes it to lie back into the wall.

The **width of benches** should be determined by two factors:

**First,** the bench should be wide enough to contain any material that sloughs out of the wall from above the bench. It should be at least as wide as the drop zone width if the wall above is presplit or wider to contain material kicked out from the angle of any wall drilled on angle or developed without presplitting. It is recommended that benches be at least 20 feet wide. The drop zone for falling material is the area at the base of the highwall (on the bench or pit floor) within which most of the material falling out of the wall lands. The distance that this area extends out from the base of the wall is usually determined by measuring out from the base of the highwall a distance of approximately 25 percent of the highwall height. The drop zone for a 100-foot highwall would be approximately 25 feet. The width of the bench should accommodate this distance.

**Second,** the extended exposure of the wall can cause sloughing material to accumulate on the bench and may require cleaning to maintain the bench's effectiveness. If cleaning benches will be a function of the ground control plan, the bench width will have to be able to accommodate the width of any equipment used on the bench and safe access to the bench will have to be provided**.** Equipment with a track width of 12 feet should not be used on a bench less than 30 feet wide. This is determined by doubling the track width and allowing a margin for irregularity of widths caused by blasting. The effects of weather increases the potential for bench failure or changes in the wall located above and below the bench. An evaluation would be necessary to determine the stability of any bench and the wall above the bench before putting any type of equipment on the bench.

When developing a bench, its width is determined by the location of the drilled blast holes and the type of blasting to be done. Back break from the detonation of the blast can extend back into the bench as much as 10 feet. Presplitting can reduce back break if the holes are spaced close enough and plugged as near the top of the hole as possible to reduce the amount of stemming in the hole. Back break weakens the cap rock at the bench level. Explosive suppliers may offer other techniques that could be used to handle back-break problems.

When a drill sets up to drill a 30-foot bench, the holes will need to be drilled at least 40 feet from the base of the wall unless drilling presplit holes. As the shot is taken down, the back-break material will pull, leaving an approximate 30-foot bench. If holes are drilled 30 feet from the base of the wall, the result will likely be an approximate 20-foot bench, which does not give enough width to use equipment on the bench later to clean the bench. It is likely that some sloughing material will also vault the bench. **If this occurs, the ground control plan must be revised to provide for wider benches or other effective changes.**

Because of hidden conditions and extended exposure of some highwalls, it would be prudent to allow for bench widths that allow for continued maintenance of the bench if ground failure occurred at the bench level. This would require more pit width and is not always an option. The use of 40-foot bench widths is not uncommon where pit widths allow. Consideration should be given to this when determining widths of benches that will be expected to function over a long period of time to ensure that mining operations are not curtailed at some later time because of highwall conditions.

## 4. SPOIL BANKS

The Spoil shall be at the angle of repose or less.

Definition:
Angle of repose: The maximum slope at which a heap of any loose or fragmented solid material will stand without sliding or come to rest when poured or dumped in a pile or on a slope. *U.S. Department of the Interior, Bureau of Mines 1968*

Dragline, pushed, and end dump spoil piles should not have bank slopes that exceed the natural angle of repose of the spoil existing in the pile. This angle of repose should be determined for the spoil being handled at a specific mine because spoil consistency can change from one site to another. If this angle varies for different work sites at a mine, the ground control plan will have to identify spoil angles specific to the work sites.

Any movement or bulging of the pile would indicate that the margin of safety is not acceptable and the slope would have to be cut down to a lesser angle.

## 5. PIT WIDTHS

To determine pit widths, consideration should be given to the type of equipment and the method of mining that will exist in the pit. Standards require that persons not be allowed to work near or under dangerous highwalls or banks and that unsafe ground conditions be corrected promptly, or the area posted. If pit widths are too narrow to allow for the barricading of unsafe ground conditions that may occur or for the safe staging of trucks while being loaded or the room for a roadway located away from the highwall, then mining operations may be curtailed.

A safe means to design a pit width is to incorporate the distance from the highwall (W) TABLE 3 Item 6.

## 6. WORKING NEAR HIGHWALLS

The plan should take into consideration the location of persons in relation to spoil banks and highwalls when they perform their duties of drilling, blasting, working a shot, cleaning wall, chopping coal, and loading out coal.

The plan should not allow persons to work directly against a highwall. Traveling or working near a highwall should not be done. Then, the highwall should be thoroughly inspected for hazards including loose rock and either loose rock should be scaled off of the highwall or the area beneath the loose rock should be cordoned off. Benching and providing rock catching berms both effectively reduce miners' exposure to the highwall by moving travelways and work areas farther out from the base of the highwall. In addition, equipment should be worked perpendicular to the base of the highwall thereby moving the equipment operator further out from the highwall and providing the operator with a better view of the highwall face.

When working near highwalls the following safety precautions must be followed.

h. A bench is located in the highwall directly above the work area. The bench should be spaced so as to make it possible to clean the face of the immediate wall (the section of wall from the pit floor up to the first bench) with equipment available at the mine (see Item 3-Benches)

i. The worker is not positioned between the highwall and any part of any equipment that would hinder their escape from falls or slides

j. Safe access to the top of the highwall is provided to allow for examinations of ground conditions

k. The top of the highwall is cleaned of loose, hazardous material. This should be done before the shot material exposing the highwall is brought down. This work should be done with a machine such as an excavator that can reach the edge of the wall from safe staging and use the outward force of the bucket to remove loose material from the top edge of the wall.

l. A buffer is provided that locates the workers out a safe distance from the toe of the wall

m. All equipment shall work perpendicular to the face of the highwall and or toe while in the impact zone.

**Rock Fall Potential**

Eliminating hazards from the individual rocks falling from a highwall is done through a combination of four techniques: supporting or controlling the fall path of potentially loose rock, scaling the loose rock, providing rock catching benches or berms or both, and limiting miners' exposure to areas where loose rock is on the highwall.

**Notes on small area or individual rock fall:**

The destructive power that a falling rock has upon impact depends on its weight and the distance it falls. A heavier the rock or a longer fall will increase the energy the rock has at impact. The force a rock impacts with is inversely proportional to the distance that the impact surface yields. Examples of relatively small rocks falling various vertical distances, in terms of kinetic energy (ft-lbs) and approximate impact force (lbs-force) are given in Table 1.

**TABLE 1**

| Height of Rock Fall (feet) | Size of Rock[1] (inches) | Approx. Weight (lbs) | Kinetic Energy (ft-lbs) | Approx. Force of Impact[2] (lbs) |
|---|---|---|---|---|
| 100 | 3 | 2.5 | 250 | 1,000 |
| 120 | 3 | 2.5 | 300 | 1,200 |
| 150 | 3 | 2.5 | 375 | 1,500 |
| 160 | 3 | 2.5 | 400 | 1,600 |
| 50 | 6 | 20 | 1,000 | 4,000 |
| 100 | 6 | 20 | 2,000 | 8,000 |
| 150 | 6 | 20 | 3,000 | 12,000 |
| 20 | 12 | 160 | 3,200 | 12,800 |
| 50 | 12 | 160 | 8,000 | 32,000 |

[1] Assuming the rock is cubic, the "Size of Rock" is the dimension along a single side of a cube.

[2] Assuming the surface the rock strikes yields enough to allow the rock to penetrate 3-inches upon impact. (A smaller amount of penetration will result in a larger force of impact).

(continued)

**Notes on small area or individual rock fall (continued):**

30 CFR 77.403 requires Falling Object Protective Structures (FOPS) when necessary to protect mobile equipment operators. The FOPS must comply with Society of Automotive Engineers (SAE) Standard J231, a testing procedure to establish the minimum structural strength of a FOPS. In this test, a 500-pound steel cylinder is dropped from 17 feet to create an impact force (kinetic energy level) of 8,500 ft-lb. From Table 1, this energy is approximately equivalent to a 160-pound rock falling about 50 feet. If equipment with only a standard FOPS structure is working directly beneath a highwall in a zone that could be impacted by falling rock, the FOPS standard could be exceeded with a rock if the wall height is more than 50 feet. Rocks falling from much shorter distances can cause significant damage if the rock strikes the equipment in a vulnerable location such as the windshield. The table shows that small rocks falling short distances can generate large impact forces.

Rock catchments, either benches or catch areas behind berms, can be used to control the falling rock. Berms serve a second function by keeping personnel out of potential impact zones. Research has been conducted and guidelines have been developed originally by Ritchie, A.M. (1963) "The evaluation of rock fall and its control," Stability of Rock Slopes, Highway Research RECORD #17, and more recently by the Oregon Department of Transportation and Federal Highway Administration (2001), "Rockfall Catchment Area Design Guide." These researchers conducted tests to determine the falling rock impact zones, runout distances, and berm parameters. Table 2 provides a summary of the results from the Oregon study and Table 3 from the Ritchie study.

**TABLE 2**

| Slope Height (ft) | Slope (Angle) | Impact Distance from Toe of Slope on Flat Ground (ft) | Roll Out Distance from Toe of Slope On Flat Ground (ft) |
|---|---|---|---|
| 40 | Vertical (90°) | 14 | 30 |
| | 0.50H:1V (63°) | 6 | 48 |
| | 1.0H:1.0V (45°) | 0 (no freefall) | 60 |
| 60 | Vertical (90°) | 16 | 30 |
| | 0.50H:1V (63°) | 15 | 66 |
| | 1.0H:1.0V (45°) | 8 | 67 |
| 80 | Vertical (90°) | 21 | 30 |
| | 0.50H:1V (63°) | 19 | 68 |
| | 1.0H:1.0V (45°) | 10 | 80 |

Table based on 99% retention of generally spherical, intact blocks of rock with an average diameter of 1 to 3 feet.

(continued)

**Notes on small area or individual rock fall (continued):**

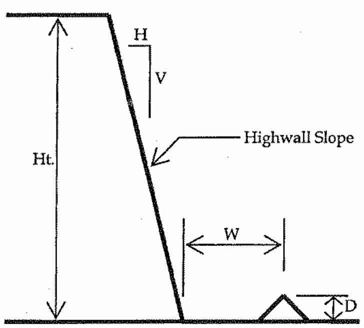


**TABLE 3**

| Highwall Slope | Ht. | W | D |
|---|---|---|---|
| Near Vertical | 15-30 | 10 | 3 |
| Near Vertical | 30-60 | 15 | 4 |
| Near Vertical | over 60 | 20 | 4 |
| 0.25H to 0.3H:1V | 15-30 | 10 | 3 |
| 0.25H to 0.3H:1V | 30-60 | 15 | 4 |
| 0.25H to 0.3H:1V | 60-100 | 20 | 6 |
| 0.25H to 0.3H:1V | over 100 | 25 | 6 |
| 0.5H:1V | 15-30 | 10 | 4 |
| 0.5H:1V | 30-60 | 15 | 6 |
| 0.5H:1V | 60-100 | 20 | 6 |
| 0.5H:1V | over 100 | 25 | 8 |
| 0.75H:1V | 15-30 | 10 | 3 |
| 0.75H:1V | 30-60 | 15 | 4 |
| 0.75H:1V | over 60 | 15 | 6 |

The berm height (D) and distance from the highwall (W) are based on rocks falling, bouncing, or rolling off of a face. A large number of full scale tests where rocks were dropped off of highwalls of various heights and configurations were used in the derivation of the dimensions in Table 3. As the slope angle flattens, there becomes a point where the berm may need to be directly against the toe. This positioning helps ensure the rock rolling down the slope impacts the berm at a right angle and the rock won't just roll over the berm.

The type of material at the base between the berm and the highwall has a significant effect on the motion of a rock after if strikes the ground. A layer of soft material at the base of the wall tends to absorb energy from the falling rock and thus may allow for narrower widths and lower berms. When combined with a rock catching berm, placing a flat, loose, or soft layer of material at the base of a highwall will further reduce exposure by reducing the amount of rock rolling/bouncing into the pit. However, when fallen material has accumulated too high or if there are large rocks near the base of the highwall, additional falling rocks may be deflected farther out than if the area at the base of the highwall were clean. Similarly, piling material against the base of the highwall can cause falling rock to be deflected further from the highwall where it may enter a work area. The dimensions shown in Tables 2 and 3 will be affected due to the presence of material at the base of the highwall.

(continued)

## 7. END DUMP VALLEY FILLS

These fills are spoil piles that are unique in that they are established on inclined, original ground that typically has been altered by clearing operations that result in variable coefficients of friction between the material being placed and the original ground. This can result in slips on the face of the fill that do not usually occur in typical spoil piles. Because of the different friction coefficients existing in the pile, movement on the face of the pile does not always show up at the top of the fill as tension cracks. Until the material being placed keys into the valley floor or the opposing slope of the valley, the fill is unstable and movement on the face of the pile is normal.

Ground control plans should establish what the angle of repose of the outer slope of the end dump valley fills is for a specific mine or area of the mine. The method of mining used at these dump areas would include dumping a safe distance (not less than one truck length) back from the outer edge at the top of these fills where the slope of the outer bank becomes steepened beyond the established angle of repose and pushing the material to the edge of the fill. Double load the blade to push the material over the top edge of the fill. A track-mounted dozer should be used because it distributes the weight of the machine over a greater area than a rubber-tired dozer.

The method of mining used at end dump valley fills should require dumping back from tension cracks that exist in the top of the fill, leaving enough room for the dozer to cut a horizontal lift off the top of the fill beginning a safe distance back from the crack. Push the material over the outer slope to increase the safety factor for the slope. Then another lift consisting of the dumped material can be placed where the material was removed. This procedure will be less likely to top-load the edge of the fill and cause the edge to fail. After that material is placed, dumping near the edge could continue as long as tension cracks do not exist.

The method of mining used at end dump valley fills should include examinations made by a person experienced in ground control (this could be the dozer operator working the fill) often enough to determine that hazards do not exist at the dump site. The examiner would determine that the outer slopes of the fill are not steepened beyond the established angle of repose, that tension cracks do not exist, that adequate berms are maintained, that trucks or end loaders dumping over the edge do not roll against berms, and that water does not impound on the fill. When any of these hazards exist, supervision should be informed immediately and corrective action taken.

## 8. DEEP MINE FACE UP

### Highwalls

When developing a highwall for facing up a deep mine, consideration should be given to the extended exposure of the highwall and the necessity for persons to work near the highwall. Even though canopies are provided, they can fail if a massive collapse of the highwall occurs. During initial development of the highwall, it is practically impossible to know with certainty what the integrity of the strata overlying the entries will be after the wall is developed. Development should be planned to compensate for hidden faults that may exist in the strata.

Benching will provide stability for a wall containing hidden discontinuities (bedding planes, joint sets), as well as contain sloughing material that can fall out of the wall above the bench due to exposure. A bench should be provided in the highwall immediately above the pit floor with a spacing not to exceed 50 feet. Bench spacings greater than 50 feet increase the likelihood that shear plane failure would result in material falling into the pit below. Establishing a bench at not more than 50 feet above the pit floor also makes it easier to clean the face of the wall with available equipment.

Developing benches at equal spacings in a wall provides for the best stability. A bench spacing of 30 feet would provide for better protection against shear plane failure if the wall is broken down into equal (30-foot) bench spacings. It may not be practical to break the wall down into 30-foot spacings. Increased bench spacings may be necessary. **The benefits of this configuration cannot be overstated and should be considered if the pit room is available.**

**Unequal bench spacings are not recommended for deep mine face-ups**. Establishing a bench at 30 feet above the pit floor and having the next spacing occur at 50 or more feet increases the possibility that shear plane failure in the upper section of the wall would result in rock vaulting the bench at the 30-foot elevation in the wall and landing on the pit floor.

Where total highwall heights exceed 100 feet and equal bench spacings are not an option, it would be better to break the wall down into two benches with not more than 50-foot spacings immediately above the pit floor and establish any greater bench spacings in the upper portions of the wall. This will provide better containment for material falling out of the upper portions of the wall. Highwalls that exceed 100 feet in height are more difficult to examine, and early indicators of failure (dribbling, shifts in strata, loosened material) may fail to be recognized.

Changes in highwall integrity at the upper bench levels of underground mine face-ups involving highwall heights exceeding 100 feet will likely be impractical to correct after development. If the highwall is configured with equal bench spacings in the lower portion of the wall that don't exceed 50 feet, broken down into at least two bench levels, and provided with bench widths that will allow for equipment access (30-foot minimum), it will be more likely that these upper level changes will not affect mining operations. This is because most failures at the upper level should be contained by the developed benches and not be a hazard to workers in the pit. (Bench width is critical--see the guidelines on drilling blast holes for benches in Item 3.)

Benches should be wide enough to contain sloughing material falling out of the face of the wall above. The extended exposure of the wall can cause sloughing material to accumulate on the bench and may require cleaning to maintain the bench's effectiveness. Cleaning benches should be considered a function of any ground control plan for underground face-ups. To facilitate this, bench widths will have to be able to accommodate the width of any equipment used on the bench, and safe access to the bench must be provided. Equipment with a track width of 12 feet should not be used on a bench less than 30 feet wide. This is determined by doubling the track width and allowing a margin for irregularity of bench widths caused by blasting.

The effects of weather increases the potential for bench failure or changes in the wall located above and below the bench. An evaluation would be necessary to determine the stability of any bench and the wall above the bench before putting any type of equipment on the bench. Consideration should be given to this when determining widths of benches that will be expected to function over a long period of time.

Because of these hidden conditions and extended exposure of the wall it would be prudent to allow for bench widths that allow for continued maintenance of the bench if ground failure occurred at the bench level. This would require more pit width and is not always a option. The use of 40-foot bench widths is recommended where pit widths allow.

The use of angled drilling can help control highwalls containing mud seams (joint sets) or where presplitting will not take effect because of intersecting discontinuities (bedding planes, joint sets). (See Item 2–HIGHWALLS.) This method causes unconsolidated material to lie back into the wall. This is not recommended for strata that weathers excessively (such as some shales) because a highwall developed in this material will continually slough, and the angled wall tends to kick the sloughing material farther out into the pit. In addition, the wall will not shed water as well, which leads to more deterioration of the wall.

Presplitting highwalls at underground face-ups can be a good way to shoot a clean wall and controls bench development better (see Item 3--BENCHES). Caution should be used where vertical joint sets run parallel with the wall. If these occur near the face of the wall, a very dangerous condition can be developed in that the material from the face to the joint set can tip out into the pit or slide out into the pit. If tension cracks show up on top of the wall and are running parallel with the wall, it is likely that they are the result of this type of joint set. They can be the result of a shift in the cap rock. This can be determined by checking their depth. If they exceed 15 feet in depth (normally below the stemming depth of the blast holes), or are too deep to measure, it is likely they are indicating a joint set.

**Failure to presplit highwalls at underground face-ups can result in problems with highwall conditions after blasting that are hard to correct. Taking additional lifts may not be practical. Barricading in the pit near the underground mine openings is not a solution for conditions other than sloughing of loose material. Where excessive back break occurs, overhangs can exist in the wall after the blast. These overhangs can cause highwall failure**

**that will not be contained by a canopy (the weight of the material will exceed the capacity of the canopy).**

The method used to presplit should be discussed with the explosives manufacturer. The strata will dictate the method to use for effective presplit. The use of presplit explosives, closer drill hole spacings, and smaller diameter holes usually provide for the best results. This is not to say that using 8-foot spacings with a 6½-inch-diameter hole and air decking will not give good results. It is one of the most common methods used. Using a 2½-inch-diameter bit on 4-foot spacings and presplit explosives will usually provide for very effective presplit. At the other extreme, drilling with a 10_-inch bit on 10-foot spacings and using air deck usually does not shoot effective presplits.

Using breaker holes is not recommended. Shooting presplit holes with the production shot is not recommended.

When deep mine entries are developed at the base of preexisting highwalls where loose material (small sized material where wall stability is not in question) cannot be controlled, and it is impractical to take additional lifts to establish benches in the wall, areas between the canopies will need to be barricaded or the highwalls supported with draping or other equivalent means to control the loose material.

The use of earthen barricading is recommended (piled high enough to limit the access of persons or equipment). In addition to limiting access, the barricade (or buffer) will help control material sloughing into the pit. It is the most practical solution.

If draping is done it should be heavy wire mesh (chain link is sometimes used). This will allow for water to escape out of the wall and better observation of the wall for indications of failure. If gunite is used, weep holes need to be provided for the escape of water. The location of these weep holes does not always ensure that water escapes, and this can lead to deterioration of the draping. An additive should be added to the gunite to prevent acid damage.

Another justification for the use of spraying (normally to a depth of 1-2 inches) gunite draping is to keep surface weathering from occurring. A problem with the use of gunite is that water can accumulate in the strata of the wall at a later time and cause the draping to deteriorate.

Substantially constructed canopies of steel, reinforced concrete, or the equivalent have to be provided at all intended drift and slope openings prior to those openings being used by workers to enter or exit the mine. A 10-foot cut may be taken with a remote-controlled continuous mining machine for the purpose of installing the canopies under the edge of the highwall. The canopy must be installed and secured against movement prior to installing roof supports. The canopy has to extend from the highwall for a distance which will provide for adequate protection from falling highwall material. It is recommended that the canopy extend at least 30 feet from the highwall. This takes into consideration the drop zone for vertical walls and the effect angled walls have in kicking falling material farther out into the pit.

**Auger Hole Penetration from Outside the Highwall or from Inside a Mine**

a. Where auger holes penetrate the coal seam from outside the highwall, they must be filled with concrete grout or the equivalent for a distance of 25 feet along the highwall on each side of all drifts and the entire area between the drifts for the entire length of the auger holes. This has to be done before underground mining begins. Once coal is removed for the development of the entries, the safety factor will be less (failure of the wall could occur) unless additional support is provided by grouting the auger holes as described above.

b. Once the auger holes have been grouted, normal mining will take place using the steel arch system or equivalent for support to at least 25 feet inby the end of the auger holes in each drift.

c. If auger holes are encountered underground, then safety precautions must address support of the roof and ribs in these auger holes. If an opening is to be taken outside through auger holes, then a plan will be required to be submitted as part of the Roof Control Plan.

**Note: Items b and c above will be addressed in the roof control plan required by 30 CFR 75.220 and should not be part of any Ground Control plan required by 30 CFR, 77.1000.**

# Other Information Where Appropriate

## SURFACE BLASTING

Describe the blasting procedures and type of explosives used:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Describe the drilling equipment:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Drill Hole diameter: ______________________ Hole Depth: ______________________

Hole Spacing: ___________ ft. by __________ ft.

Angle of hole: _______________ degrees

Is pre-splitting to be done? [ ] Yes [ ] No

When remote firing devices are used, the manufacturer's safety precautions shall be followed.

## AUGER MINING OPERATIONS

1. Type of Mining Machine ______________________________________________
2. Manufactured by ___________________________________________________
3. Serial Number _____________________________________________________
4. Model Number _____________________________________________________

5. Is the Auger Mining in the Vicinity of Abandoned or Active Underground Mines?
______________________________________________________________________
______________________________________________________________________

6. Coal Seam(s) to be Auger Mined:
______________________________________________________________________
______________________________________________________________________

7. Coalbed Height for Each Seam Mined: ______ inches ______ inches ______ inches

8. Maximum Depth of Penetration: ________ feet

9. Distance Between Auger Miner Holes: _______ inches

10. Diameter/Width of Holes: _______ inches

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DIAGRAM OF HOLES AND WEBBING