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An Analysis of Current Intersection Support and Falls in United States Coal Mines and Recommendations to Improve Safety

Allen Robert Mueller
Southern Illinois University Carbondale, allenrmueller@gmail.com

AN ANALYSIS OF CURRENT INTERSECTION SUPPORT AND FALLS IN UNITED STATES COAL MINES AND RECOMMENDATIONS TO IMPROVE SAFETY

by

Allen R. Mueller

B.S. in Mining Engineering
Southern Illinois University – Carbondale, IL

A Thesis
Submitted in Partial Fulfillment of the Requirements for the
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in the Graduate School
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THESIS APPROVAL

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Approved by:

Dr. A.J.S. Spearing (Chair)

Dr. Bradley Paul

Graduate School

Southern Illinois University Carbondale

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MAJOR PROFESSOR: Dr. A.J.S. Spearing, Associate Professor
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RESOURCES ENGINEERING

Background: The support of intersections in coal mines is an important safety issue in the U.S., as intersections are by far the most common area for unplanned falls of ground. A relatively comprehensive, nation-wide study of falls of ground is coupled with a national survey to mines about their support methods to determine common characteristics of failure and recommend changes to improve stability, and recommendations for future research.

Methods: Over 600 fall of ground reports were collected from nine of the 11 Mine Safety and Health Administration (MSHA) District offices, and data was compiled to determine common characteristics of these unplanned falls. Statistical analysis was conducted on the data to examine which variables affected fall dimensions. To obtain data on current support usage, mail and phone surveys were collected with responses from 70 underground coal mines, representing approximately 235 million tons of annual production, or 66% of the U.S. total. These surveys provided a national snapshot of what support mines are using as well as typical extraction height, intersection width, and other details. Rocscience's Phase^2 software was used to model a typical coal mine intersection and examine possible stability changes with different support options.

Results: Surveys from underground mines revealed that the current industry average for intersection width is 20ft, average bolt length is 6ft, average distance from pillars to the first row of bolts is 3 to 4 ft, and a great majority of mines do not angle bolts over pillars. The fall of ground study confirmed that most falls are thicker than the average bolt length of 6 ft. and tend to be massive, extending past the intersection width of 20ft. The study also showed that falls with longer roof bolts installed typically had thicker falls which broke above the anchorage zone. Statistical analysis found a few questionably significant interactions, with the most prominent being the effect of roof type on fall height. Immediate roof geologies of dark shale and thinly laminated shale resulted in higher roof falls than other types. 2D modeling was unsuccessful at replicating the type of massive shear failures that have been commented on by MSHA personnel and that the study data suggests. It is the author's opinion that Phase^2 and 2-D modeling in general may not be powerful or comprehensive enough to capture the true shear behavior of the rock strata in the roof beam because it cannot effectively model failure and dilation.

Conclusions: Increasing bolt length may not be the most effective solution to reducing massive intersection failures. Rather, installing angled bolts over pillars may increase the strength of the system at the crucial roof-pillar edge. Weathering of bolts and/or rock are likely contributing to the significant number of cutter failures happening months or years after excavation. Recommendations for future action include 3D modeling of cutter failure and benefits of angled bolts over pillars. More consistent and thorough MSHA 7000 50a forms will enable more accurate statistical analysis and a better understanding of massive failure characteristics.

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CHAPTER 1

INTRODUCTION

1.1 Statement of Objective

The objective of this thesis was to identify common characteristics of unplanned roof falls and support methods currently used, and to make recommendations to improve rock fall related safety.

1.2 Significance of the Problem

1.2.1The Important Role of Underground Coal Production

Coal is a vital element in the United States' energy production and is actively mined in 33 states. Approximately 90% of this coal production is used to generate electric power, and coal is used to generate almost half of the country's electricity needs. Coal mining is responsible for over $60 billion in annual revenue and the industry directly and indirectly supports over 750,000 jobs in the U.S (U.S. Energy Information Administration, 2009). As Figure 1.1 shows, annual production has risen at a steady rate since 1958 with approximately three times the amount of coal being mined in recent years compared to fifty years ago.

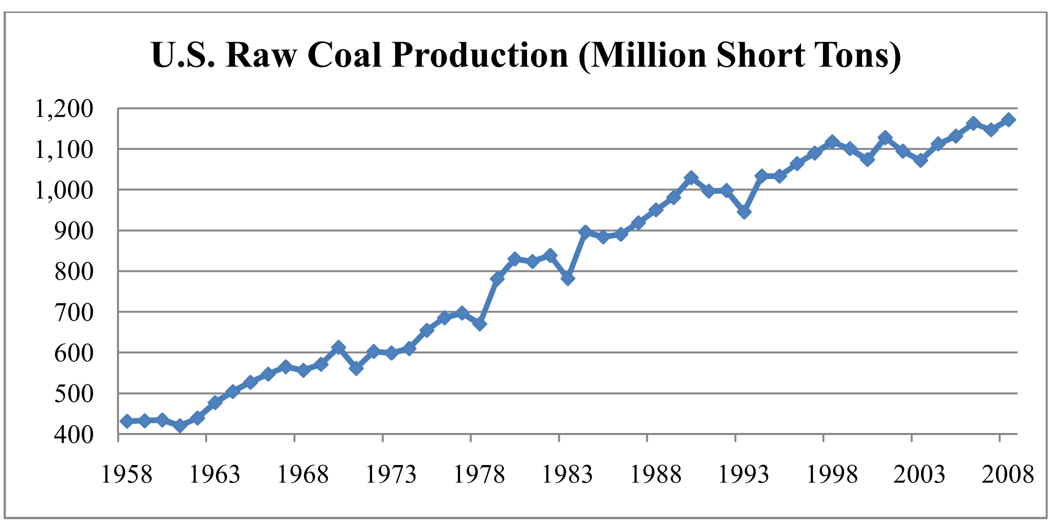

Figure 1.1: U.S. Raw Coal Production (Energy Information Administration, 2008)

In the year 2008, there were about 1.15 billion short tons of coal produced from 1,438 mines. 612 of these mines were underground operations, and they accounted for about 31% of the total coal produced (U.S. Energy Information Administration, 2009).

1.2.2 Importance of Roof Falls to Coal Mine Safety

Each year, approximately 35,000 coal miners work in underground mines (U.S. Energy Information Administration, 2008). Annual fatalities have been declining steadily (while production has been rising), and in 2005 the number of fatalities was 23, the safest year of U.S. coal mining in history. Recently, the fatality rate for these miners has been around 20 deaths per 100,000 workers. This rate is significantly higher than the overall private industry fatality rate of 4.2, but is still a lower fatality rate than occupations such as airline pilots, truck drivers, farmers, and fishing workers (U.S. Bureau of Labor Statistics, 2007). The downward trend in annual fatalities through 2005 can be seen in Table 1.1. The year 1911 is included for comparison because that was the year of the most recorded fatalities.

Table 1.1: Historical Fatality Data for U.S. Coal Mines

Year	Number of Miners	Production (Tons x 10^6)	Fatalities	Year	Number of Miners	Production (Tons x 10^6)	Fatalities
1911	666,552	±461	2,821	1996	126,451	1066	39
1984	208,160	897	125	1997	126,429	1092	30
1985	197,049	885	68	1998	122,083	1120	29
1986	185,167	892	89	1999	114,489	1102	35
1987	172,780	920	63	2000	108,098	1076	38
1988	166,278	952	53	2001	114,458	1130	42
1989	164,929	983	68	2002	110,966	1097	28
1990	168,625	1032	66	2003	104,824	1074	30
1991	158,677	998	61	2004	108,734	1114	28
1992	153,128	1000	55	2005	116,436	1134	23
1993	141,183	947	47	2006	122,975	1164	47
1994	143,645	1036	45	2007	N/A	1150	33
1995	132,111	1035	47	2008	N/A	1170	29

Source: Annual Coal Report for 2008, Energy Information Administration.

In 2006 there were two major disasters – Sago and Darby, which caused the unusually high spike in the number of fatalities. Sago was a methane explosion in a West Virginia mine in which 12 miners perished, and the prevailing theory for an ignition source is from a lightning strike in the area. The disaster at Darby in Kentucky was also a methane explosion, but was ignited with an acetylene cutting torch. This mine accident claimed the lives of 5 men.

Roof and rib control problems account for about 30% of the underground coal fatality rate (Mine Safety and Health Administration, 2006). Coal mine intersections, including the ribs immediately around those intersections, account for approximately 71% of all roof falls, even though they only form 20-25% of the total development. This shows that a fall is several times more likely to occur in an intersection than an entry on a unit length basis (Molinda, 1998). Clearly the objective of this thesis, in detecting causes and suggesting mitigating responses that coal operators may take to reduce the incidence of unexpected falls, will improve worker safety in one of the U.S. most vital industries.

1.2.3 The Importance of Roof Falls to Coal Mine Productivity

According to C. Mark, there are over 1,500 roof falls that occur every year in U.S. coal mines (Mark, 2001). As mentioned in the previous section, a large majority of these falls occur in intersection areas. To be reportable to the Mine Safety and Health Administration (MSHA) as an unplanned fall of ground, a roof fall must be at or above the anchorage zone in active workings where roof bolts are in use; or, an unplanned roof or rib fall in active workings that impairs ventilation or impedes passage. The roof falls that meet these criteria clearly have the ability to create unsafe conditions, disrupt production, and shift resources away from necessary tasks.

Coal from areas except the Powder River Basin currently sells for upwards of $40 per ton, or about $2.29 per million BTU. This cost can be compared with petroleum ($11/million BTU) and natural gas ($7.50/million BTU) to see that coal is one of the most inexpensive forms of energy (Energy Information Administration, 2009). While the cost per unit may be less for coal, the infrastructure to burn it can cost substantially more. As an example, a coal-fired power plant costs about $1200 per kWh to construct, while a simple cycle natural gas plant can cost as little as $400/kWh (JC Miras, 2008). Underground coal mines must compete on a cost/BTU basis against surface mined coal. Powder River Basin coal sells for about $9 per ton, and while there can be significant transportation costs to move the coal to other parts of the country, keeping production and efficiency up in underground coal mines is critical to maintaining a competitive stance in the industry (Energy Information Administration, 2009).

1.2.3 Importance of Roof Falls to Regulatory Compliance and Cost

The U.S. Congress passed the Federal Mine Safety and Health Act of 1977 (Mine Act), and this amended the 1969 Coal Act in several significant ways. It also consolidated all the federal health and safety regulations of the mining industry under a single statutory scheme. It strengthened and expanded the rights of miners, and enhanced the protection of miners from retaliation for exercising those rights (such as the right to refuse to work in dangerous conditions). The Mine Act also transferred responsibility for enforcement from the Department of the Interior (U.S. Bureau of Mines) to the Department of Labor, and renamed the new agency the Mine Safety and Health Administration (MSHA). Under this Mining Act, safety continued to improve steadily.

Following the Sago and Darby mine accidents in 2006, Congress rapidly passed the Mine Improvement and New Emergency Response (MINER) Act. The main relevant provisions of this Act according to MSHA are:

- Require each mine to develop and continuously update a written emergency preparedness plan, which must be recertified by MSHA every 6 months.
- Use equipment and technology that is commercially available if it can improve safety.
- Require every mine to have 2 experienced rescue teams capable of responding within 1 hour if required.
- Require mine operators to report dangerous incidents and accidents within 15 minutes to MSHA or face fines of up to $60,000.
- Raising the criminal penalty cap to $250,000 for the first offence and a maximum civil penalty of $220,000 for flagrant violations.
- Direct that within 3 years, mines will have wireless two-way communication and an electronic personnel tracking system in place.
- Empower MSHA to shut down a mine when it has refused to pay a final order penalty.

While these provisions have little to do directly with accidents associated with falls of ground, these still remain a cause of concern with mine operators and MSHA. One of the provisions of the MINER Act that does impact rock related safety is the requirement for all unplanned roof falls to be reported to a central MSHA office by telephone within 15 minutes of being discovered (30 CFR § 50.10). After reporting an unplanned roof fall within the timeframe specified, the mine must submit a 7000-1 form to MSHA. These reports include the following information relevant to roof falls: time of accident, location, steps taken to prevent a recurrence, and full details and description of the accident. In response to roof or ground control problems, MSHA inspectors have the option to investigate roof falls and fill out 7000-50a reports which commonly include details on the length, width, and height of the roof fall as well as the length and type of bolts used. Other parameters that are inconsistently reported from district to district are: stand-up time before the fall, immediate roof thickness and geology, and the presence of water or cutters in the roof. These plans and information feedback system provide initial data to MSHA for use in evaluating roof falls and possible ways of addressing them. This information can be also be used to evaluate the adequacy of roof control plans, modification requirements, and resulting compliance costs.

Under the law, each mine is required to submit a roof control plan to MSHA explaining how and specifying what materials they will use to ensure that the roof and ribs of their coal mines are maintained safe and controlled (30 CFR § 75.220). These plans generally contain information on topics such as overlying roof strata, support materials used, installation sequence, drill hole size, and others. These details can be compared to performance results in preventing roof falls, and MSHA can require modifications to the roof control plan as a result of falls.

As an example, 30 inch fully grouted roof bolts on a 5ft. x 5ft. pattern (the minimum allowed under regulation – 30 CFR § 75.204) for a 6 foot coal seam would impose a direct materials cost of about $2.12 per foot mined. Roof fall incidents make it common for MSHA district managers to require 4ft. x 4ft. patterns with longer roof bolts. The direct cost of materials for 7 foot fully grouted roof bolts on 4 foot centers is about

$6.91 per foot for the same 6 foot coal seam (Oldsen, 2009). While the difference in cost may be justified if it will increase stability, simply using bigger and more frequent bolting may not be the best option for fall prevention and can be rather costly.

1.3 Information Available Through Regulatory Reports

MSHA's coal oversight and enforcement is broken up into 11 Districts as shown in Figure 1.2. These Districts tend to correspond to coal basins and unique ground control conditions in different parts of the country.

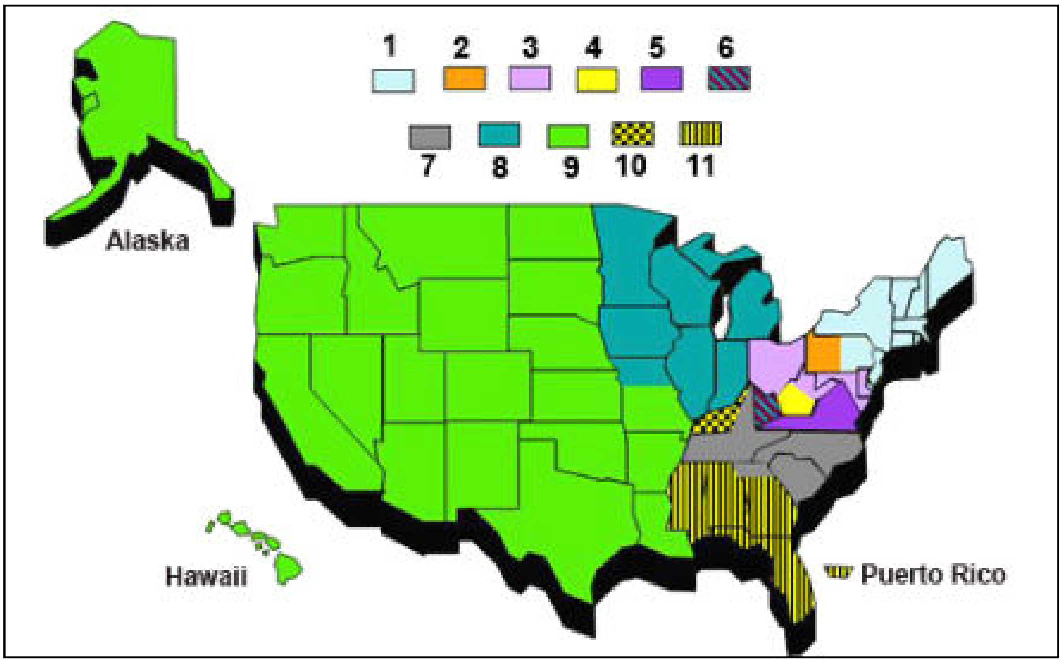

Figure 1.2: MSHA Districts by Location (MSHA.gov, 2009)

MSHA is largely a mine safety law enforcer. MSHA's budget for 2008 was $313.5 million, which included a $16.6 million increase specifically for the enforcement of coal mines. The breakdown in Figure 1.3 shows that most of the money was spent on enforcement.

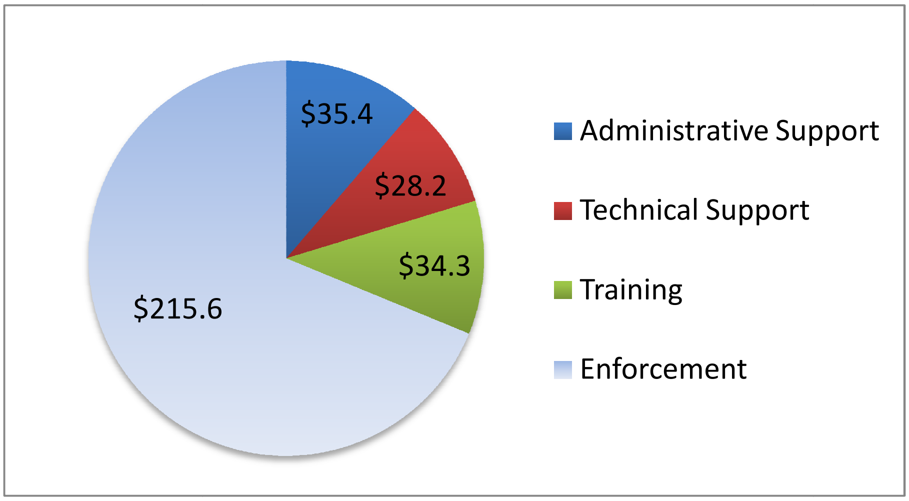

Figure 1.3: 2008 MSHA Budget Allocations (in Millions of Dollars (MSHA, 2009)

The amount of money in fines assessed by MSHA totaled $194.3 million in 2008, and citations are the primary source of income for the organization (MSHA, 2009).

MSHA has a major facility in Beckley, West Virginia called the National Mine Health and Safety Academy. The primary purpose for this academy is to train MSHA staff, new miners and retrain and update experienced miners on safety related aspects of ground control, mine rescue, ventilation, and other topics. Unlike the U.S. Bureau of Mines which was replaced as a safety enforcer in 1969, MSHA does not have a direct research and development arm. Thus, while MSHA has a Tech Support Group and may generate much data that could be used to evaluate roof fall problems, it does not have research capability of its own. This work, funded in part through the National Institute for Occupational Safety and Health (NIOSH), looks to fill some of the need of coupling roof control plans and roof fall data into a systematically reviewed and analyzed response. Information from both studies can be used by a wide variety of people including: safety personnel at mines, rock mechanics researchers, MSHA, and NIOSH.

CHAPTER 2

LITERATURE REVIEW

2.1 Coal Mine Layouts and Intersections.

In room and pillar coal mining, parallel entries are driven through the coal seam and are joined together at regular intervals by crosscuts. This is to maximize extraction by creating a checker board pattern of pillars and assists with ventilation. One standard pattern runs the crosscuts and entries at 90 degrees to each other with the crosscuts spaced such that the pillars are rectangular, as shown in Figure 2.1.

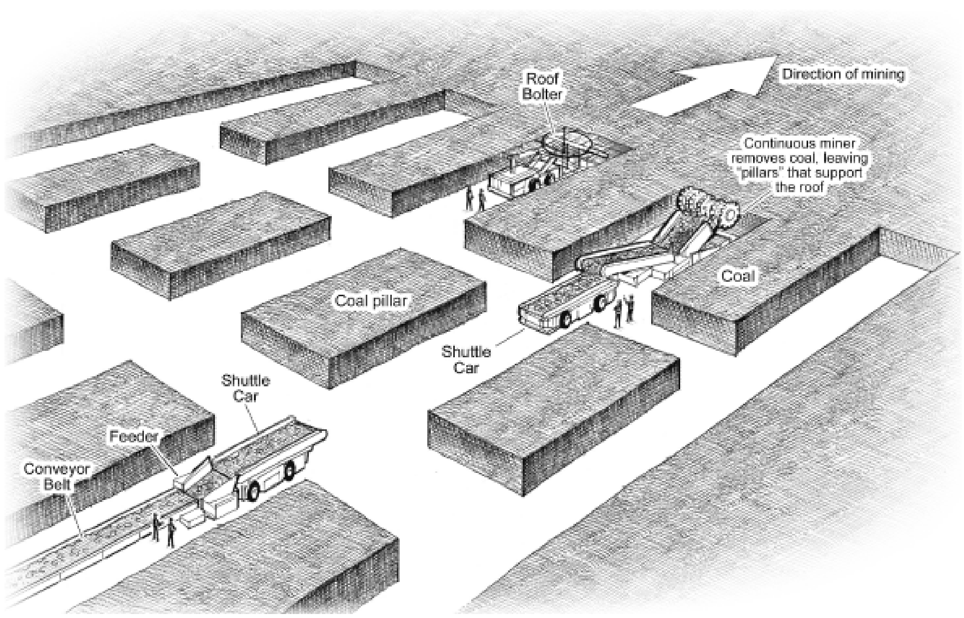

Figure 2.1: Rectangular Pillar Pattern (Arch Coal, 2008)

Another similar pattern orients the crosscuts perpendicular to the entries, but spaces them so that pillars are square. Still another layout that is used in coal mines orients the crosscuts at approximately 60 degrees to the entries, which can provide better visibility for the continuous miner operator. This oblique angled pattern can also reduce conveyor spillage compared to a 90 degree pattern which requires a sharper angle for the conveyor to turn (Ganguli, 2009). The angled crosscut pattern is shown in Figure 2.2.

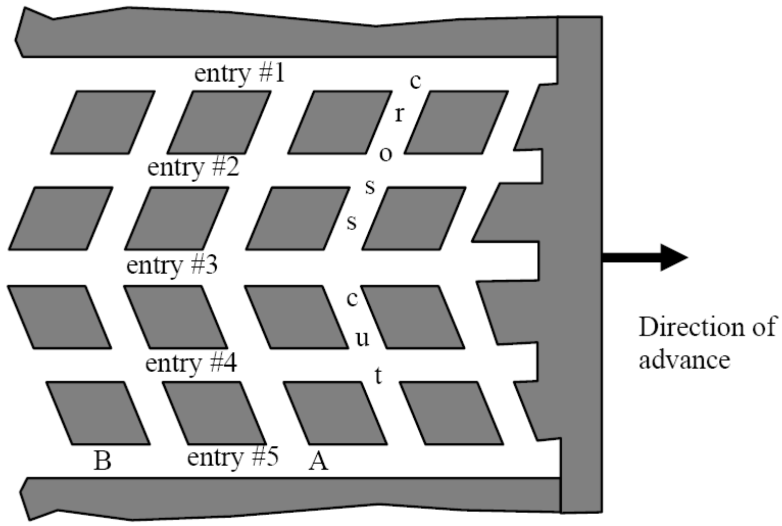

Figure 2.2: Angled Crosscut Pattern (Ganguli, 2009)

Room and pillar style entries are also used for the development of head and tailgates on longwall panels. The pillars on either side of the longwall panel support an increasing amount of weight as the panel advances and extracts coal. Supplemental yielding support (such as timbers and cribs) is often required in these areas due to the extremely high stresses placed on the pillars and the consequent high and often non-uniform roof convergences. A typical longwall layout can be seen in Figure 2.3.

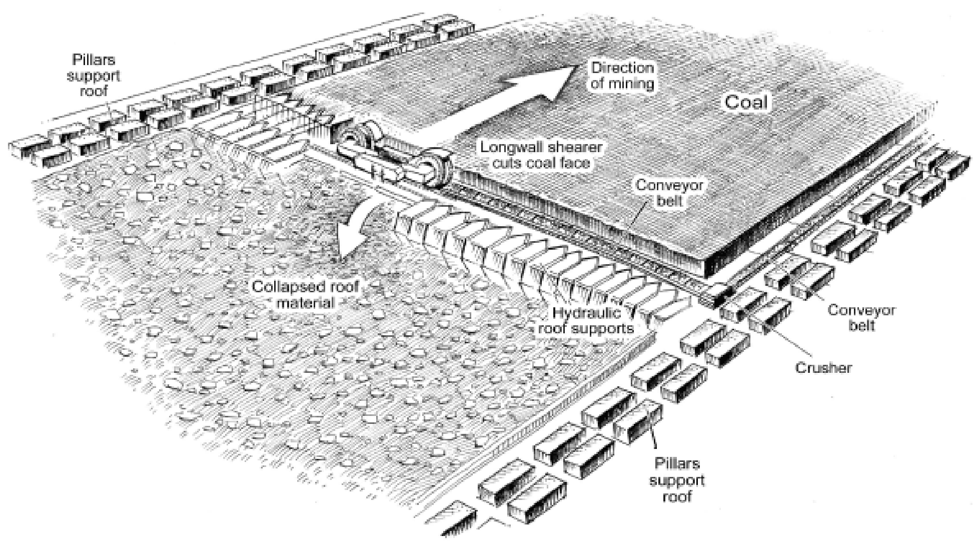

Figure 2.3: Longwall Mining Diagram (Arch Coal, 2008)

2.2 Typical Geology Above Coal Seams

The overlying roof strata above coal deposits is a widely varying, depending on regional and local geology, as well as the depth of the coal seam being mined. The roof conditions can also be affected by the presence of water and high horizontal stresses, in addition to the particular geology in that area. The types of deposits immediately above coal can range from massive thick layers of sandstone or limestone, to strong laminated layers of siltstone and sandstone, to thin weak layers of shale or mudstone (Jeremic, 1985). One of the most frequently seen overlying strata in coal mines is a laminated shale roof that is prone to immediate skin failure. In many mines, it is necessary to bolt wire mesh to the roof to prevent flaking and progressive failure of the weak shale layer, due in part to weathering and lateral confinement.

Tang (1984) in a paper on bolt design states that immediate roof geologies can be divided into three types: (A) the deflection of each strata is larger than that of its overlying strata, and each strata deflects independently, (B) some strata deflect more than the overlying strata, and (C) the deflection of each strata is larger than or equal to that of its underlying strata. The immediate roof of case A is most critical to stability; therefore an adequately designed roof bolting system is crucial. Additionally, the effect of axial loading due to horizontal stresses should be considered in the design of support systems.

2.3 Stress Fields Around Coal Seams

Stress fields occur naturally in the ground prior to mining, and these effects are important when considering ground control issues. The horizontal and vertical stress fields can cause major stability problems if they are not controlled through adequate pillar design, room spacing, entry orientation, and support design. Vertical stress magnitudes increase with depth and are a result of the overburden weight above the excavation. Horizontal stress magnitudes and directions vary primarily with geographic location, and can exceed the vertical stress by a factor of 3 or more, particularly in shallower deposits. Research suggests that plate tectonics are responsible for the magnitude and direction of horizontal stress fields, which can cause roof buckling and bed separation among other problems. As early as the 1940's, researchers recognized that large horizontal stresses were responsible for much of the roof damage experienced underground (Mark, 2008). In addition to the magnitude of horizontal and vertical stress, the ratio of horizontal stress to vertical stress (σ_{hmax}/σ_v) can influence roof stability as well. This effect will be discussed further later.

2.4 Devices Used to Support Coal Mine Roof

2.4.1 Primary Support Devices

Roof bolting is a legally required practice in U.S. coal mines, and is referred to as primary support because it occurs concurrently with development. Depending on the particular roof geology and the type of bolt used, the system can help support the roof by providing skin control, suspension, or beam building. C. Mark suggests that regardless of the type of bolt used (mechanical, grouted, tensioned) the local geology has the largest role in determining which mode the bolt system is required for support. The intensity of support provided by a bolt system is determined by load bearing capacity of individual bolts, density of the bolting pattern, and the length of bolts (Mark, 2001). The bolt grade and stiffness, as well as the anchoring mechanism could also be considered as factors within support intensity.

Two frequently used bolt types in the U.S. are mechanical anchor and fully resin grouted bolts. Mechanical anchor bolts usually pass through thinly layered rock located above the coal into thicker or massive rock layers located above. They anchor into the thick strata and are tensioned at the bottom of the thin strata, effectively pinning the thin strata to the massive roof above. Because they are tensioned upon installation, they can be referred to as active bolts. Indeed the model used to size mechanical anchor roof bolts assumes that each roof bolt supports an independent block of rock half way to its nearest neighbor and that the block is essentially hanging from the massive roof above by the bolt.

Grouted roof bolt systems can be divided into two categories: passive and active bolts. Active bolts are tensioned upon installation, and can be anchored by either using a two speed resin or a mechanical shell with resin; Passive bolts are un-tensioned on installation and are usually fully grouted with resin cartridges. The high stiffness of this system is accomplished due to the full contact grout anchor, and the ability of the small resin grout annulus to quickly transfer the loads back into the rock mass. Grouted roof bolts, which are completely anchored to the rock over their entire length, are regarded as transforming thin individual rock layers into a single massive beam – in effect, the resin forms a laminated beam. In 2000, Dennis Dolinar conducted a study which found that a strong shift in the coal industry's bolt preference has occurred in the last two decades, with fully grouted bolt usage increasing from 40% to over 80%, and mechanical anchor bolt usage decreasing from 35% to 8%. A decreasing trend in roof fall rates has been observed during this shift in preference from mechanical to fully-grouted bolts, although there are many factors that may be contributing to this effect (Dolinar, 2000). Resin-grouted rebar can be considered a superior system to the mechanical anchor bolt because of the load transfer capabilities, and the higher anchorage capacity.

Load transfer between the support and the rock is imperative to all bolt systems, so the annulus distance in fully grouted bolts (the distance between the bolt and the surrounding rock that is filled with grout) and effective resin mixing are important factors in the performance of the system. Dolinar also states that experimental research has shown that the optimum annulus is about 0.125", so the best system for use in a 1" hole is using 0.75" diameter #6 rebar. Despite this fact, a majority (80%) of the resin-grouted bolts in use today are the smaller 0.625" size, thus causing the annulus distance in the typical 1" hole to exceed the optimum (Dolinar, 2000). This situation merits attention, because it is not known to what degree the increase in annulus and 30% decrease in steel affects the performance of systems in 1" holes.

Resin quality is another area where further research can be implemented; a common percentage of filler is around 75%, however some resins contain up to 85% filler. It is not yet known what degree of impact this has on bolt performance (Dolinar, 2000).

The interaction effects of rock bolts is another interesting area to examine. Figure 2.4 is an explanation of how rock bolts operate in a granular medium according to Tom Lang and demonstrated by E. Hoek to students (Hoek, 2007). Particularly thinly laminated roof strata that are very weak could be considered to have similar behavior to granulated material. A zone of compression is induced in the red zone, generally as long as the bolt spacing is less than the bolt length. The smaller the bolt spacing, the larger the reinforced "compression" beam developed in the excavation roof. Installing bolts closer to pillar edges may result in more stability, as the compression zone is effectively transferred from the roof to the pillar.

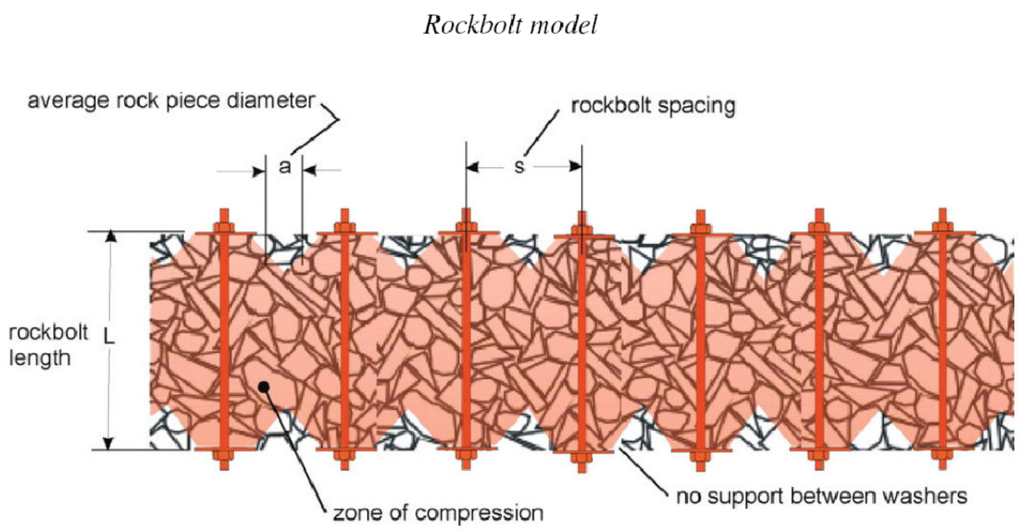

Figure 2.4: Model for granular material supported using rock bolts (Hoek)

Bolt length is more of an issue for mechanical-anchor bolts than fully-grouted (although is important for both types), because resin bolts can achieve the capacity of the support with about 2 feet of length. Mechanical bolts need to be long enough to anchor in a stable bed, which may be 6 or more feet above the immediate roof (Dolinar, 2000). The highest bolt loads typically occur at the center of the intersection so if the roof is failing in tension, it may be beneficial to increase bolt length (mechanical) or to increase rebar diameter to #6 (resin) in these areas to strengthen the contact area and anchorage to resist the greater bolt load (Mark, 2000).

2.4.2 Secondary and Supplemental Support Devices

Additional support that is installed after excavation may be installed routinely throughout the mine as part of the ground control plan, in intersections for stability, or used exclusively in local areas where geological problems are occurring. Roof fall history in a particular area and industry experience are two of the contributing factors affecting the usage and placement of various types of secondary and supplemental support.

Support systems such as cable bolts and truss bolts are installed in the roof for support in addition to the primary bolting pattern. Similar to a standard roof bolt, cable bolts have an anchored end in resin typically with an effective length of 4ft of grout that is attached to a cable within the rock, attached to a roof plate. A bulb or birdcage twisted within the cable helps the resin grip and mixture, and increases the back pressure of insertion. Typically cable bolts can deform more than traditional bolts under the same load, but varying the resin length can increase stiffness to a desirable level for a particular geology (Mucho, 1998). Additionally, the flexibility of cable bolts is an advantage because long cables can be easily installed in narrow coal seams. Cable bolts generally have a higher yield and failure strength than rebar bolts, but they will eventually fail, unlike most properly installed yielding free standing support and they also cover less area. They do have advantages over standing support however, they cost less in materials/labor, are transported more easily, eliminate injuries from workers handling and constructing cribs, and reduce ventilation resistance (Mucho, 1998).

Truss intersection support systems started appearing in the late 1980's and have been gaining popularity as a method of supplementary support, or even primary support in some cases. Specialty systems such as the Intersection Truss are designed to support an entire intersection, using compressive forces in three dimensions. Keyblocks or laminations that lie between two truss bolts can cause stability problems, however. To add stability, the systems can be placed before crosscuts are excavated, putting the intersection in compression before it is even created (Seegmiller, 1990). Figure 2.5 shows the Intersection Truss product by Western Support Systems.

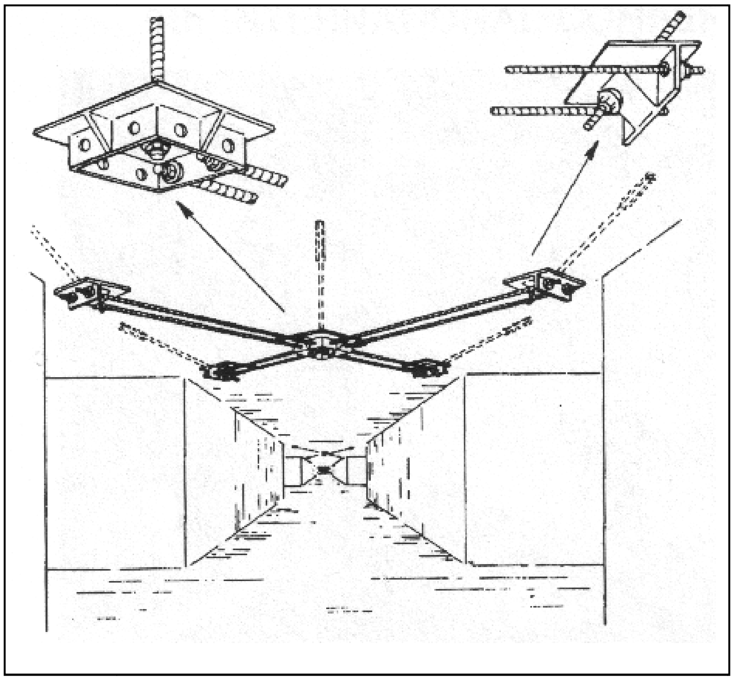

Figure 2.5: Intersection Truss system (Seegmiller, 1990).

There are many types of free standing support available for use in the mining industry. Timber posts and cribs have historically been the dominant products, however their relatively low early stiffness and relatively high total installed cost has necessitated the development of alternative support systems (Barczak, 2005). Dozens of different types of free standing support have been created, including pumpable cribs, steel cans and props, and engineered cribs from materials such as coal combustion byproducts. The selection of which product to use depends on the geology and loading characteristics of the roof, the pillar strength, and other site-specific factors. Resources such as the ground reaction curve, if available, can be utilized in the selection of roof support products. The ground reaction curve concept will be discussed in Section 2.6.4. It is important to note that floor heave and pillar yielding cannot be completely eliminated by standing roof support system. The convergence associated with these problems should be considered "uncontrollable" and the support product needs to be able to survive that deformation without being damaged to the point of losing required roof support capacity (Barczak, 2001).

2.5 Mathematical Models of Roof Stresses and Failures

2.5.1 The Beam Model

In the beam model, the roof is considered to be a single piece beam supported at both ends by the pillars as shown in Figure 2.6.

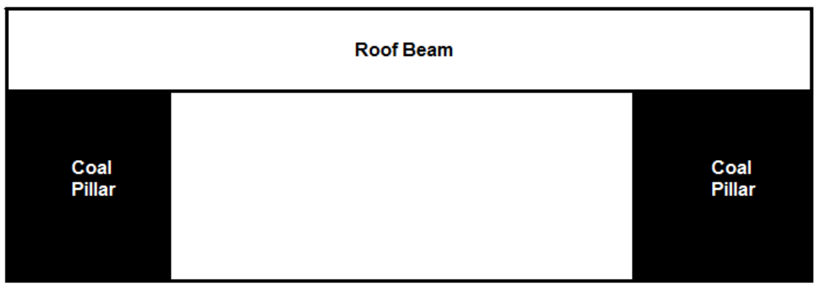

Figure 2.6: Beam Theory Model

The beam is considered to be rigidly clamped at the ends so that no rotation or motion is possible. In a classic beam theory model, the load on the beam comes from its own weight and depends on the thickness of the beam. Load forces are considered to be the vertical downward force of the beam's own weight. In understanding what features of a real coal mine setting are captured by beam theory, one considers that the stiffness and resistance to bending of a rock layer is proportional to the rock layer thickness and modulus of elasticity. In an unsupported setting, some subset of the rock layers between the mine opening and the surface will be less stiff than the rock layers above. These rock layers will sag away from the rock above causing bed separation as shown in Figure 2.7.

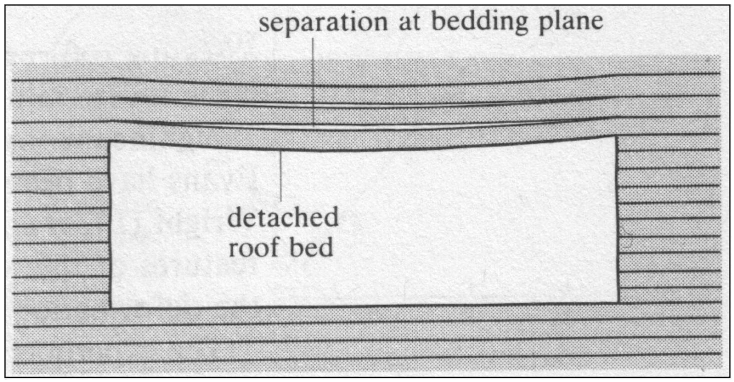

Figure 2.7: Separation of Roof Strata (Brady, 1985).

If fully grouted roof bolts are used, then the rock layers are often considered as if they were held together in a single beam and one might consider the units that separate from the rocks above to form the beam as having the thickness of the length of the roof bolts. In still another case, some of the rock layers above the beam formed by the roof bolts may be less stiff than the rock layers above, causing rock strata above to rest and apply an extra load to the beam beyond its own weight. In all cases, the coal below and the rock above the beam and over the pillars is modeled as rigid and inflexible, thus imposing the rigid hold on the ends of the beam. The following information and formulas are from Dr. Y.P. Chugh's notes for Rock Mechanics: Principles and Design (2009).

Let γ be the unit weight of distributed load on the beam as shown in Figure 2.8.

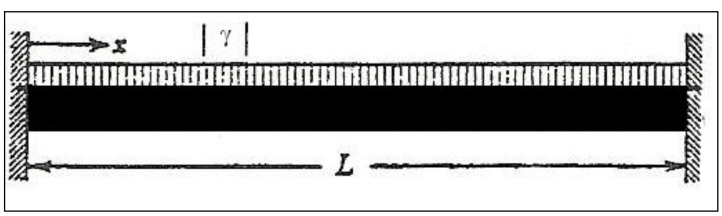

Figure 2.8: Distributed beam loading (Modified from Chugh, 2009)

One then lets L stand for the length or unsupported span, t for the beam thickness, and E the modulus of elasticity. This model has been solved mathematically to show that the maximum normal stress is:

$$\sigma_{xx(\max)} = \frac{\gamma L^2}{2t}$$

One cause of beam failure is tensile stress in the beam, and the beam breaks at the point when the tensile stress on the beam exceeds the tensile strength of the rock. The maximum deflection (η_{max}) at the center of a beam is affected even more by an increase in the span:

$$\eta_{\max} = \frac{\gamma L^4}{32Et^2}$$

One can consider this model further examining shear stresses attempting to slice the beam in two. The shear stress is represented by the equation:

$$\sigma_{xz(\max)} = \frac{3\gamma L}{4}$$

A typical range of tensile strength for coal mine roof rocks is 150 to 500 psi (Chugh, 2009) and a typical value for shear strength is approximately 170 psi (Esterhuizen, 2009). Most coal mine roof rocks are about 10-15 times stronger in compression than in tension. Solving the beam equation one finds the maximum shear stress occurs at the ends of the beam, and the shear stress is much smaller than the tensile stress. This is due to the fact that the tensile stress increases exponentially with length, while shear stress increases at a linear rate. With this considered, one might expect failure to occur at the center of the beam at the point of maximum tensile stress. W.C. Patrick (1980) conducted a study on frequency of roof failure types and found that massive dome failures occur in approximately 66% of intersection falls, with the great majority of falls being longer than the typical intersection width of 20 ft. These results seem to correspond rather poorly to a tensile failure occurring at mid-span and instead point to a shear failure at the pillar edge.

Still another real life complication involves stress fields. The classic beam theory model considers that stress is driven by the downward pull of gravity. In fact, in many areas there is a tectonic stress field that imposes compressive forces from the sides. Depending on the orientation of the rooms and entries relative to the maximum horizontal stress, it is possible for the compressive forces to reduce the tension within the roof beam.

Given these considerations, it appears that the beam model may not correspond well to regular modes of failure seen in the field. Several aspects of the beam model seem inaccurate when one applies it to analysis of intersection failures, because the area in cross section does not extend indefinitely as the 2D model suggests. When the roof length is twice the width, beam theory may be used for entries but when the length is less than twice the width as in intersections, the stress and deflection calculations must be based on the Flat Plate Theory (Chugh, 2009).

2.5.2 The Plate Theory Model

From Dr. Y.P. Chugh's course notes for Rock Mechanics: Principles and Design, flat plate theory considers a rectangular plate that is clamped at all corners and is based on the following conditions:

1) The plate is a straight, flat structural element whose width is at least 4 times the thickness and whose length is equal to or greater than its width.

2) Material is elastic, homogeneous, and isotropic.

3) Maximum deflection is one half the thickness.

4) All loads and reactions are normal to the plate.

5) When the plate deflects, the central plane remains unstressed.

6) Vertical straight lines before flexure remain straight but become inclined to the vertical. The normal stresses in the plane of the plate are proportional to the distance from the central plane.

For such a plate clamped rigidly at four corners, the maximum deflection occurs at the center of the plate and is given by:

$$\eta_{\max} = \frac{\alpha q a^4}{E t^3}$$

Maximum normal stress is found using the following equation:

$$\sigma_{xx(\max)} = \frac{6 \beta q a^2}{t^2}$$

Where q is the uniformly applied load per unit area, a is the cross-sectional area of the plate, α and β are coefficients for a uniformly loaded rectangular plate. A typical intersection has a length to width ratio of 1.0, so the coefficients for α and β are 0.0138 and 0.0513 respectively. These coefficient values were obtained from Dr. Y.P. Chugh's course notes for Rock Mechanics: Principles and Design and are standard inputs for this equation when Poissan's ratio is equal to 0.3. The value for q = γ * t * b, where b is the length of the plate. Table 2.1 shows an example of the changes in stress and deflection that occur from a 16 ft. to a 22 ft. entry span. A mining depth of 400 ft. and an immediate roof thickness of 12 in. were used in the example. As seen below, the 22 ft. span has over three times the deflection and almost double the maximum stress as a 16 ft. entry.

Table 2.1: Plate Theory Analysis of Entry Widths

	16' Plate	18' Plate	20' Plate	22' Plate
Opening length	16	18	20	22
Opening width	16	18	20	22
E	725000	725000	725000	725000
α	0.0138	0.0138	0.0138	0.0138
β	0.0513	0.0513	0.0513	0.0513
q	0.53208	0.53208	0.53208	0.53208
γ	0.04434	0.04434	0.04434	0.04434
Thickness (in.)	12	12	12	12
Area (in.)	192	216	240	264
σ_{xx} (psi)	**41.93**	**53.06**	**65.51**	**79.27**
ηmax (in.)	**0.008**	**0.013**	**0.019**	**0.028**

The beam and plate theory equations show that a minor increase in diagonal span can cause much higher levels of deflection and stresses, and a decrease in stability. The large span in the intersection causes more vertical stress relief, and makes it easier for the roof to yield due to the lower level of vertical confinement. It also causes more shear stress over intersection corners, and increases probability of shear failure (Zhang, 2003). Additionally, the modulus of elasticity (E) has a major impact on roof stability and design of safe room and intersection spans.

Estimates for safe roof spans in U.S. coal mines may be more effectively determined by means of engineering rock mass classifications designed for coal applications. Reliance solely on beam and/or plate theories is not recommended due to uncertainties in the assumptions, as well as in the required input data (Bieniawski, 1983). Geological strata are unlikely to be elastic, homogeneous, and isotropic, and values of Young’s modulus and immediate roof thickness can vary locally throughout a deposit. Additionally, any discontinuities or water present make it more difficult to deal with a rock mass using ideal engineering conditions such as a plate or a beam (Gadde, 2007). The use and application of rock mass classifications will be discussed later in this chapter.

2.6 Previous Studies of Roof Stability

2.6.1 Horizontal Stress Fields

Horizontal in-situ stress is a major issue that affects roof strata behavior, and orienting the entries in a particular direction can increase intersection stability significantly. Numerical 3D modeling has shown that intersections are most stable when the direction of maximum horizontal stress (σ_{hmax}) is square with the intersection and not stressing the roof across the diagonal span. (Gadde, 2004). Entries are most stable only in the direction of σ_{hmax} (and least stable at 90º to σ_{hmax}), therefore the most stable condition for both entries and intersections is to have entries parallel to maximum horizontal stress. This optimum orientation is shown in Figure 2.9.

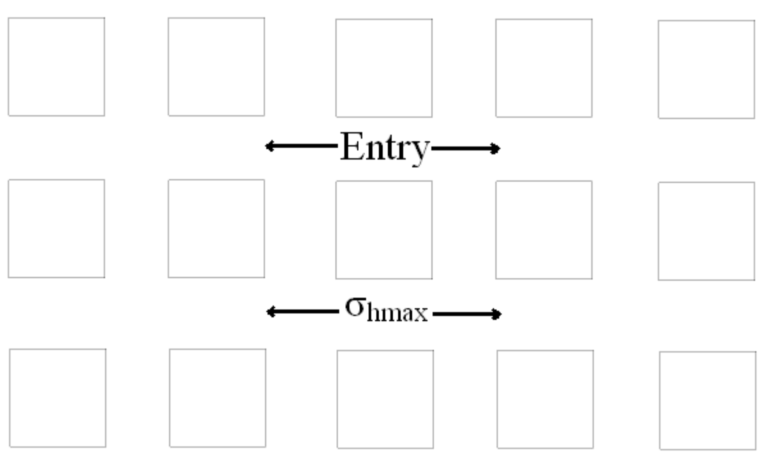

Figure 2.9: Entry Orientation for Maximum Stability

The ratio of horizontal stress to vertical stress (σ_{hmax}/σ_v) is referred to as a k value, and high values can be an indicator of potential roof control problems. Additionally, extremely low k values can cause as much potential instability as high values (Gadde, 2004). The effect of low and high k values on safety factors can be seen in Figure 2.10, which was created by M. Gadde using computer modeling.

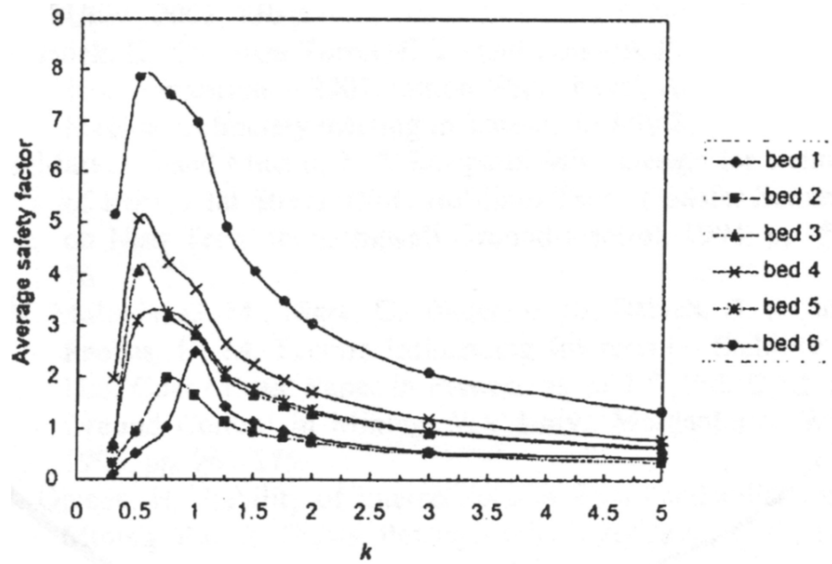

Figure 2.10: Effect of low and high k values on safety factors (Gadde, 2004)

The roof layers (referred to as bed numbers) in Figure 2.10 begin with the weak immediate roof and end with the highest, most stable strata. This graph shows that an optimal k value for highest safety factor is between 0.5 and 1.0, with lower or higher ratios producing lower safety factors. Orienting entries optimally is an excellent way to increase entry and intersection stability, and decrease primary and supplementary support costs. Areas that experience extremely low or high horizontal to vertical stress ratios can potentially benefit from orienting their entries appropriately to optimize their roof stability.

2.6.2 Humidity Impacts

Another factor in the stability of coal mine roof strata can be the amount of humidity in the air. Figure 2.11 shows that the roof fall rate (roof falls per 100 employees) increases in the humid summer quarter in most coal regions of the United States, but the change is most pronounced in the Illinois Basin (Molinda, 2006).

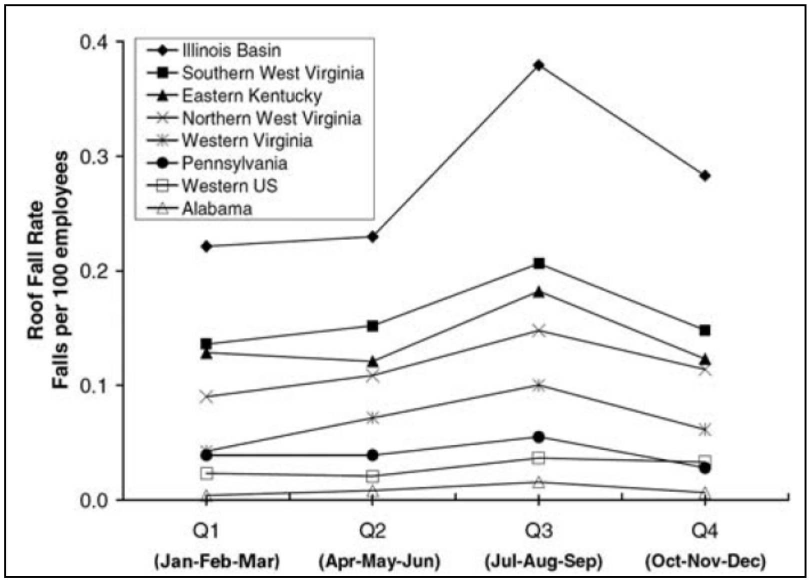

Figure 2.11: Seasonal roof fall rates for U.S. coal basins (Molinda, 2008)

Environmental effects such as atmospheric moisture, barometric pressure and temperature are especially influential on the moisture-sensitive shales that commonly occur above or below an extracted coal seam, as in the Illinois Basin. Dr. Y.P. Chugh suggests there are three ways to deal with moisture effects on weak rocks: control of humidity changes, reducing moisture migration in shales, and rock reinforcement (Chugh, 1982). Controlling humidity is an expensive option, using tempering chambers to condition the surface air to match temperature and moisture equilibrium throughout the mine. Some mines have attempted continuous wetting to reduce varying humidity levels, although this method is not very popular. Reducing moisture migration into shale rocks can be achieved by leaving coal in the roof, using resin bolts, or applying mine sealants (Chugh, 1982). Using sealants to prevent moisture migration gained popularity in the 1970's, although areas of high air velocity can be problematic due to artificial dehydration of the sealant. Steel-reinforced gunite and dry shotcrete was used at the Wabash mine in 1975 for stabilizing entries with immediate shale roofs (Chugh, 1982). A recent study by Peter Zhang also suggests that a thin layer of polymer-based sealing material may be an effective and economical option for preventing weathering in long-term track and belt entries (Zhang, 2009).

2.6.3 Roof Rock Mass Rating Systems

One alternative to plate or beam theory is geological classification systems such as the CMRR (Coal Mine Roof Rating). The CMRR, developed by the U.S. Bureau of Mines in 1994, is an empirically based engineering classification that evaluates roof discontinuities which most contribute to the weakness and failure of the roof mass. The rock sample is assigned a number between 0 and 100 that can be used in engineering calculations to help in pillar design, intersection sizing, and other applications.

As explained by G.M. Molinda, determining the CMRR value is a two-part system. The Unit Rating of each rock strata in the bolted interval is determined by evaluating the discontinuities in the rock with simple field tests such as a hammer and chisel strike. Points are assigned for the spacing and frequency of joint sets, bedding planes, and other discontinuities, and points deducted for moisture sensitivity and multiple discontinuities.

The second part of the CMRR is to determine the Roof Rating. The thickness-weighted average of the individual Unit Ratings is determined, and adjustments made for the presence of a strong bed in the bolted roof. Additionally, the Roof Rating can be adjusted for weak Unit contacts or groundwater inflow. Typically roofs with CMRR<25 fall very soon after mining, so the safer working range is 25-100 (Molinda, 2001). Case studies by G. Molinda confirm that a higher CMRR is related to lower number of roof falls. Even a difference of 10 points on the CMRR scale can affect roof stability significantly. One mine in West Virginia had a weak shale (CMRR=40) fall rate that was

3.4 times the strong shale (CMRR=50) fall rate (Molinda, 1998). In addition to the mine-wide geology, localized geologic anomalies are a major driver in roof stability and the support that may be required. The CMRR system is most applicable to gaining an understanding of the minimum support that will be needed in most parts of the mine, and additional support may be needed in problem areas such as faults and slip zones. Case studies have revealed that roof deflections at slip zones may be seven times greater than deflections measured in intact roof areas, indicating local movement along slip planes (Hanna, 1986).

2.6.4 Ground Reaction Curve Concepts

The goal of any support system is to achieve the equilibrium of the rock mass around the excavation in the most cost effective manner. A concept called the ground reaction curve has been used in the tunneling industry for many years (Brown et al., 1983) and can be utilized to estimate how much support is needed to achieve roof equilibrium. These curves plot the support pressure against the convergence, as shown in Figure 2.12.

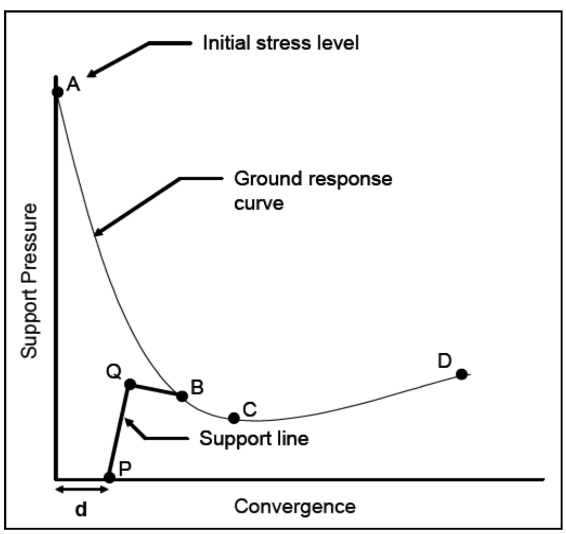

Figure 2.12: Illustration of a ground response curve (Barczak, 2006)

Before excavation, the boundaries have stress equal to the in-situ field stress (Point A in Figure 2.12). Once the excavation is developed, the reactive/support stress that is required to prevent additional convergence reduces as the rock structure begins self-supporting (Point B). Once total rock failure occurs (Point C), and self-supporting capacity is lost, the rock deformation/deterioration accelerates and the required reactive load to create stability increases significantly. Equilibrium for the example shown is at Point B, when the support curve intersects the ground reaction curve. Using numerical modeling, these ground reaction curves and support interactions can be established to find the optimal method of support for a particular roof geology and location (Speers and Spearing, 1996 and Barczak, 2006).

2.6.5 Empirical Observations About Cutter Roof

The specific problem of cutter roof failure (or shear failure directly above pillars) has been investigated and studied intensively by researchers (Hill 1984, Anil Ray and Syd Peng 2009). Cutter roof failure is one of the most common ground control problems affecting the safety and economy of an underground coal mine operation (Ray, 2009). The massive roof falls that are typically associated with this type of failure have more potential for injury or loss of life than a small skin failure, due to the large area that they cover and the larger collapsed mass. The simple and traditional definition of a cutter refers to “fractures that occur at upper corners i.e. the intersection between the roofline and the pillar ribline.” (Peng, 2007.) Cutter failure initially begins as a fracture along one or both riblines, and continues vertically into the roof. When this fracture reaches a height above the anchor horizon or breaks along a weak bedding plane, a massive failure may occur (Hill, 1984). This mechanism can be seen in Figure 2.13 below.

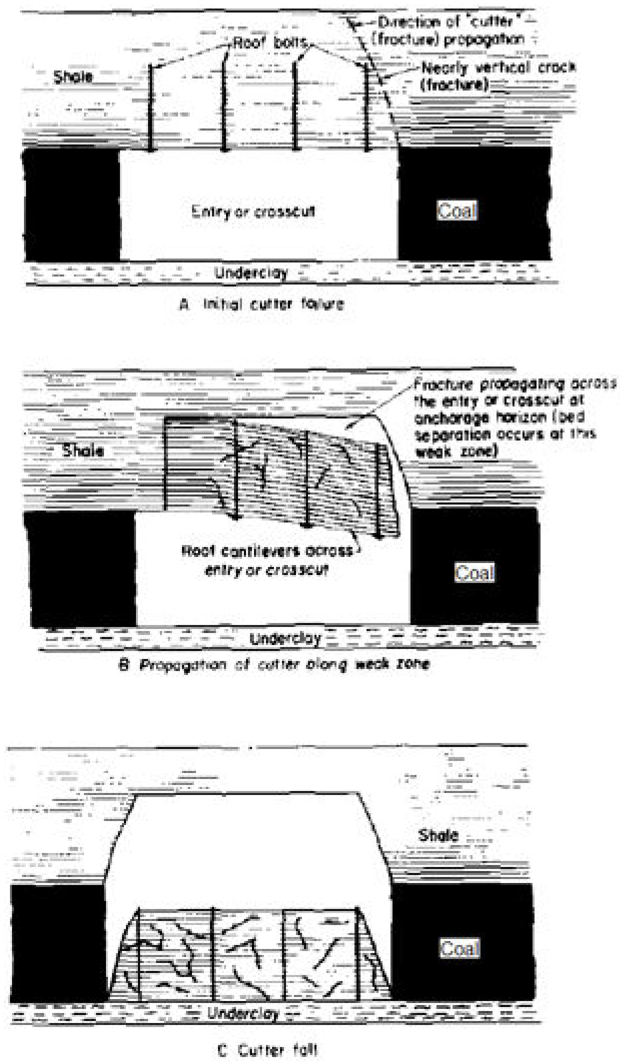

Figure 2.13: Cutter roof failure diagram (modified from Hill, 1984).

Some of the common observations that Peng (2007) has found from the case studies of cutter roof failures are as follows:

• The cutters can form at all working places in entries and crosscuts.

• The duration for the cutter development may vary from 5 minutes to several hours. Thus it can form immediately after the continuous miner's cut or after several feet of face advance.

• The development stages of cutters can be different depending upon the site specific parameters.

• The immediate roof was typically highly laminated and it may be one of the important reasons for the immediate development of the cutter.

• The maximum horizontal stress orientation may influence the cutter formation.

• The cutters develop in sequences and progressively extend upward away from the roof and rib corner.

• The cutters are sometimes very irregularly distributed.

Past research on the topic of cutter roof failure has identified several factors that affect the location and severity of falls such as: magnitude and direction of in situ stresses, stress inducing activities (multiple seam extraction), mechanical properties of roof rocks and coal, geometry (entry width and pillar size, etc.), and geological disturbances (Ray, 2009). Research from the U.S. Bureau of Mines has shown that high horizontal stress fields, as well as the presence of clastic dykes (commonly called clay veins) can have an impact on where cutter failure will occur. Additional research using rock monitoring near clastic dykes has revealed that the roof strata were in fact behaving like a cantilever beam as shown in the previous figure. This beam would then initiate cutter roof failure, developing along an entry or crosscut often across several breaks (Hill 1984).

It is clear from the sources examined for this literature survey that shear (or cutter) failure of the roof above intersections is a serious problem, and a greater understanding of this failure and possible methods of controlling it will be beneficial to the safety and productivity of underground coal mining.

CHAPTER 3

RESEARCH OBJECTIVES AND PROCEDURES

3.1 Statement of the Objective

The objective of this thesis is to identify common characteristics of unplanned roof falls and support methods currently used, and to make recommendations to improve rock fall related safety.

3.2 Work Steps to Achieve the Objective

This study is to have 4 key work components. 1: Compiling a U.S. coal industry wide survey on roof support methods. 2: Analyzing the MSHA 7000 50a forms on roof falls. 3: 2D Finite Element Modeling of failure modes. 4: Statistical analyses of data compilations.

3.2.1 Survey of Roof Support Methods.

The end goal of the roof support survey was to obtain data from a majority of actively producing underground coal mines and examine the methods of roof support that are frequently being used in the industry. Other than sales data provided by roof bolt manufacturers which includes tunneling applications, the author is not aware of any such industry-wide surveys to the mines about their current methods of roof control. Mark Odum, the MSHA Ground Control Supervisor for District 8 maintains a good data set for his District, but it is limited to the Illinois Coal Basin. This survey database provides a current industry-wide snapshot of what mines are currently using.

This study, conducted during the summer of 2008, includes data that was gathered using a survey mailed to the mines that resulted in an 18% response rate. Following the mail survey, mines that did not respond were contacted by telephone for their information; however some were unwilling to provide the details of their ground control. By law every mine needs to submit a Roof Control Plan to MSHA and this is public information, but the mines typically detail a bare minimum of support in their official plan and it may or may not be close to the actual support being used. This potential discrepancy in data is the reason the mines were surveyed directly about their ground control rather than using the publicly available plans. Information from a total of 70 underground mines was obtained that represents approximately 235 million tons of raw coal in 2007, or about 66% of the U.S. underground tonnage. Of these 70 mines, 28 used mainly longwall mining and 42 used the room and pillar method. Surveyed data included: mining method used, extraction height, average room width, maximum primary bolt length and diameter, bolt type (active/passive), and secondary support used. These mining and support conditions are what the mine reported as being used most frequently, and may not represent additional supplemental support deemed necessary by production personnel working in specific and unique strata conditions. Information collected from the surveys was standardized and inputted into Microsoft Excel for further analysis.

3.2.2 Compilation of MSHA 7000 50a Reports

The largest collection of U.S. data on unplanned roof falls is believed to be the MSHA 7000 50a forms. These forms are the most reliable data available on roof falls because they are the basis of any federally enforced fines or court investigations if necessary. Under the new MINER Act of 2006, coal mines are required to report unplanned roof falls to MSHA within 15 minutes of discovery. MSHA then has the option of sending inspectors to investigate the scene when a roof fall is reported. These 7000 50a forms are only written if an inspector chooses to investigate a particular event.

Nine of the 11 MSHA district offices were personally visited over a total of 12 days including travel to collect information from these reports and discuss the falls with MSHA personnel. District 1 (Wilkes-Barre, PA) was not visited because the anthracite mines had too few unplanned falls of ground in the database, and District 9 (Denver, CO) was not visited due to cost constraints. The data collected from 7000 50a reports represents over 600 falls of ground compiled over the summer of 2008. These reports include such details as: dimensions of the fall, primary support used, and the stand-up time before the fall. This aspect of the study is believed by the author and funding agency (NIOSH) to be unique in that no previous work has ever comprehensively examined a full inter-regional data set for roof fall patterns. More limited region specific examinations have been done, for example in the Illinois Basin (Gregory Molinda 2008; W.M. Kester and Y.P. Chugh 1980; W.C. Patrick and N.B. Aughenbaugh 1980). The national scope of work done here exceeds the geographical reach of these previous studies.

Although they are the most reliable fall data available, MSHA 7000 50a reports have potential biases and inconsistencies that could potentially affect results. Not every roof fall triggers a 7000 50a report so the data source begins with a bias as to what type of falls produce data. The law itself only requires operators to report roof falls that occur at or above the anchorage zone in active workings where roof bolts are in use; or, an unplanned roof or rib fall in active workings that impairs ventilation or impedes passage. There may be numerous spalling or crumbling incidents that fall short of the reporting requirement. On the other hand, since the motivation for this study is the large cost, productivity, and safety impacts that unplanned roof falls create, one would probably only wish to focus on roof falls that rise to the level of creating significant impacts in those areas. The data set bias may thus be useful to the purpose of this work. There is another step of bias in that not every reported fall triggers a 7000 50a investigation. One would expect that only the larger falls would warrant this type of attention from MSHA inspectors.

Discussions with MSHA inspectors and individuals in the industry have suggested that a large number of unplanned falls tend to be massive and extend longer than the intersection width and higher than the bolt length. This suggests that increasing bolt length may not be the solution, because the bolts are creating a massive beam that eventually shears above the ribline and falls in a dead weight manner. The bolts create a solid beam and are usually effective at controlling tensile failure and skin failure, but the current support practices may be inadequate to stop a shearing/cantilever fall along the pillar edges. Again, a bias that focuses attention on roof falls large enough to impact productivity, cost and safety is not necessarily undesirable.

There are inconsistencies between districts on the recording of additional fall details such as water presence, cutter presence, and stand-up time before the falls. MSHA districts often function fairly independently of one another in implementing the Mine Health and Safety Act. While this provides for regional needs and flexibility, it can also generate inconsistencies in the way data is recorded that can impact many statistical analysis techniques, since many of them depend on putting data into standard categories. There are also measurements that are easier to write down on paper than to measure in a field setting. Inspectors must estimate fall dimensions without standing directly under the unsupported roof, and they cannot safely detail the roof geology for example. The mine operators are typically present as well, so there is some validity to these estimates.

Data collected from the fall of ground study was organized using Microsoft Excel and plotted on graphs to view the averages and distributions of fall dimensions that were reported.

3.2.3 Finite Element Modeling of Failure Modes

To examine the common mode of failure that was observed in the study of unplanned roof falls, it was decided that computer modeling would be beneficial. The goal of this simulation was to create a model that would replicate a "cutter" type failure by breaking along the riblines to a weak roof layer and falling in a massive beam. Support modifications, such as installing longer bolts or angling bolts over pillars, could then be tested for their stability changes. Rocscience's Phase^2 finite element analysis program was used for these simulations. This 2D program was chosen because it is commonly used by SIU students, NIOSH, and others to analyze simple underground excavation models. Using more complicated 3D software to simulate the type of failure observed is outside the scope of work here and could be considered a PhD dissertation topic itself.

A coal mine intersection profile was set up in Phase^2 7.0, with bolt and rock characteristics that would be seen in a typical coal deposit at a depth of 500ft. At this depth, a vertical stress of 500 psi could be expected, assuming an overburden density of 144 lb/ft^3. Similar to a study by C. Mark (2007), a horizontal stress of twice the amount of vertical stress could be expected, and this value was set at 1,000 psi. The intersection width was set at 20ft., and an extraction height of 6ft. Total model dimensions were

170ft. wide and 100ft. high to minimize any errors from stresses at the outside of the model influencing the center excavation. Boundary conditions were as follows, at the recommendation of Rocscience and G.S. Esteruizen: sides of the model were restrained in the X direction, the top of the model was restrained in the Y direction, and the bottom edge was restrained in both X and Y directions. Figure 3.1 below shows the strata that were used in the model and the thicknesses of each layer.

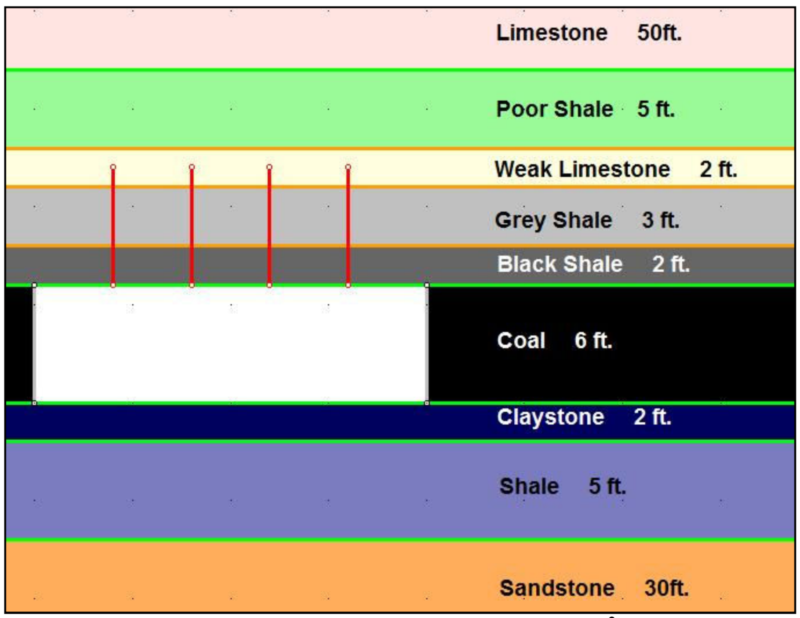

Figure 3.1: Rock strata used in Phase^2

Accurate input parameters such as tensile strength, Young's Modulus and Poisson's Ratio are crucial in obtaining accurate output in computer simulation, so this information was provided by Dr. Y.P. Chugh of Southern Illinois University, and NIOSH. Rock mass properties for each layer can be seen in Table 3.1.

Table 3.1: Input Rock Strata Values

Rock Type	Young's Modulus (psi)	Poisson's Ratio	Tensile Strength (psi)	Friction Angle	Cohesion (psi)
Limestone	750,000	0.2	700	25	2900
Poor Shale	100,000	0.3	150	25	290
Weak Limestone	400,000	0.2	700	25	1740
Grey Shale	350,000	0.25	200	30	653
Black Shale	200,000	0.25	200	30	479
Coal	150,000	0.28	100	26	87
Claystone	45,000	0.32	50	20	290
Shale	200,000	0.3	150	25	290
Sandstone	450,000	0.2	800	25	1740

After the model was created, it was run initially to verify that it was providing stresses and displacements that could be expected in an underground mine. Once it was confirmed the model was behaving realistically, simulations were run with ¾" diameter bolts. Both 4 ft. and 6 ft. lengths were used on 4 ft. spacing, as well as bolts angled over pillars to identify possible stability improvements of this method.

3.2.4 Statistical Analysis of Collected Data

The data from the 7000 50a reports that were collected was analyzed using SPSS 13.0 software from SPSS Inc. Statistical analysis of variance (ANOVA) tests were conducted on the fall of ground data to determine which independent variables affected fall length, width, height, and volume. The independent variables that were analyzed include MSHA District, bolt type (active/passive), bolt length, stand-up time before the fall, immediate roof thickness, and the presence of water or cutters near the fall. It is important to note that geology is regarded as one of the most important factors in roof fall occurrence and severity, and is specific to each site. Therefore, statistical analysis may or may not draw significant conclusions due to the wide variance between mines. Data recording inconsistencies by human beings can also raise the noise level and obscure trends. Finding answers to the problem of mine roof falls can deal with needs for improved data as well as needs for improved practice.

The variables that resulted in the highest ANOVA confidence levels were analyzed further using regression analyses which was used to fit linear or curved models to the plots in an attempt to find more exactly how independent variables affected the dependent variables.

CHAPTER 4

STUDY RESULTS AND DISCUSSION

4.1 Intersection Support Survey

4.1.1 Summary of Results

Complete results of the intersection support survey by state are listed in the Appendices, and the results that follow are averages for all mines that were surveyed.

- The heights of the numerous different coal seams mined tend to vary from 3.5 to 8 ft. in the east, and 6 to 12 ft. in the west.
- Entry widths (rooms) are typically from 18 to 20 ft.
- Primary rock bolt support spacing (on cycle) is commonly 4 ft.
- Primary bolts vary in length from 3.5 to 8 ft.
- Cable bolts are commonly installed as secondary support in intersections, with lengths typically between 8 and 16 ft.
- Only two mines (both in Illinois) regularly installed bolts at a 45° angle over pillars. Neither mine had any 7000 50a forms on record at the time when the MSHA District 8 office was visited.
- The bolts closest to the rib are most commonly installed 3 to 4 ft. from the edge.

4.1.2 Complete Survey Results

The data collected from mines about their maximum reported room width did not include any rounding of pillars that may take place, or smaller rooms that were created locally due to adverse roof conditions. An analysis of the room widths given is in Figure 4.1 and it can be seen that a room width of 20 ft. is the most common, with 54% of the mines surveyed using 20ft. rooms.

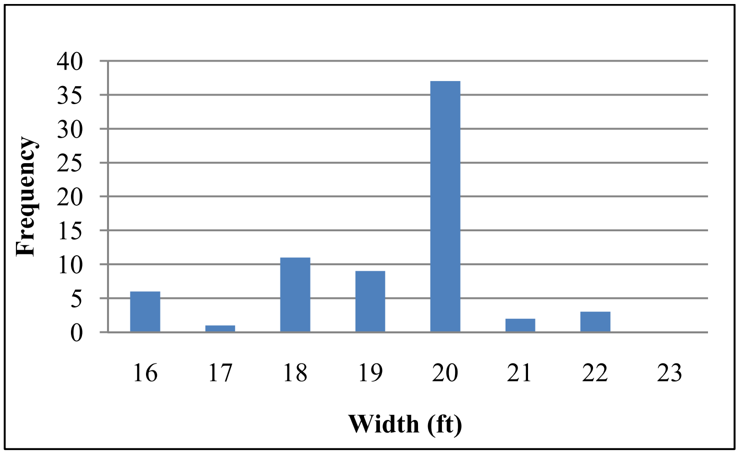

Figure 4.1: Maximum reported room width

There was a wide distribution of mining heights that were reported, varying primarily according to the geographic location of the mine. For example, the western states of Utah, Colorado and New Mexico had higher average extraction heights than Midwestern or Eastern mines. From Figure 4.2, it is observed that the majority of mines have 5 to 7 ft. mining heights. A few mine locations had varying seam thicknesses, so the maximum value that was supplied is used in calculations and graphs.

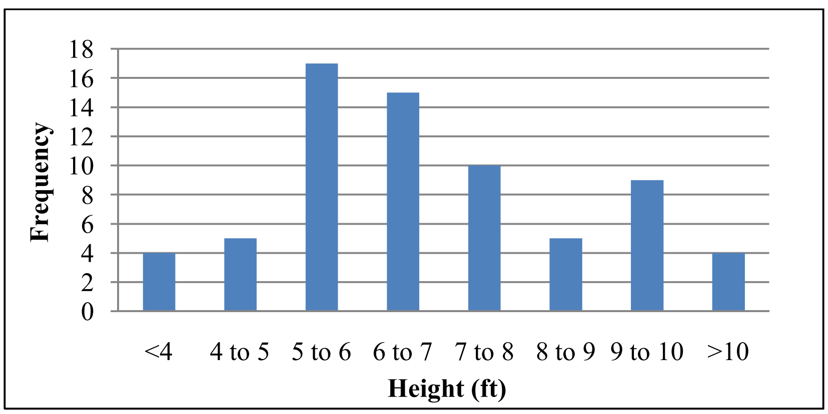

Figure 4.2: Mining height distribution

When examining the roof bolt anchors that mines used, a few stated that they utilized both passive and active systems. The primary bolt type that was used is shown in Figure 4.3. It is important to note that none of the data in this study was normalized to each mine's production; it only reflects the total number of mines that reported using a particular support method. Normalizing data to individual mines' production is a task beyond the scope of this study and would be difficult to accomplish accurately, as some mines used both systems. There were 47 mines that reported they primarily used passive bolt anchorage, and 23 reported active bolts. Of the 23 mines that reported active bolt systems as their main roof support, there were 16 (70%) using partially grouted bolts and the rest were mechanically anchored. There is an ongoing debate as to the preferred system and when they should be used, and it is the subject of a large NIOSH funded project led by Sam Spearing of SIU and Murali Gadde of Peabody Energy. The current consensus seems to be to use active support where the immediate roof is stack rock, although the overall popularity of passive bolt systems has been increasing during the last two decades (Dolinar, 2000). The term "stack rock" refers to thinly laminated rock layers that are usually weak.

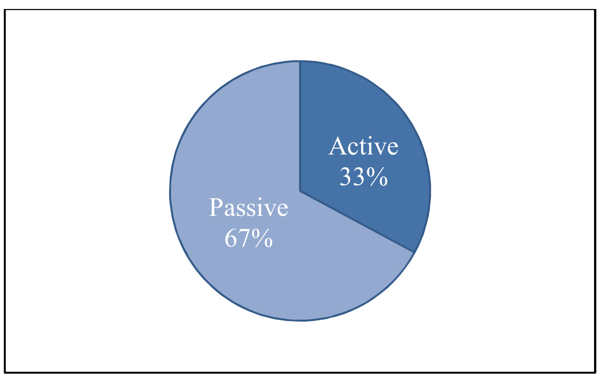

Figure 4.3: Bolt types used

A significant portion of the mines reported that they used different diameter bolts for different applications, so Figure 4.4 was constructed using the largest reported bolt diameter that was regularly used at each mine. The most common bolts were .75" diameter (or #6 bar) with 41% of mines surveyed. This was followed by .625" diameter (#5 bar) bolts that accounted for 31%. As mentioned in the literature review in Chapter 2, Dolinar's research suggests that the optimal size bolt in a 1" hole is #6 bar.

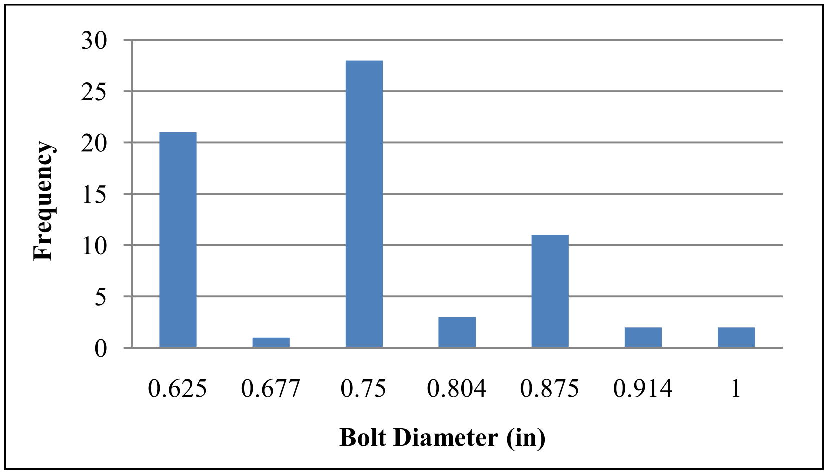

Figure 4.4: Bolt diameter distribution

Bolt length data was also gathered during the surveys. Shown below in Figure 4.5 are the maximum bolt lengths that were reported, and the frequency of each. The most popular were 6 ft. bolts. A major factor in which bolt length is used is the coal seam height; there were only a handful of locations that reported using bolts longer than the mined height, possibly due to the added time and effort of bending bolts. There may also be a level of strength reduction caused by notching bolts to make them bendable. Data from Figures 4.4 and 4.5 were combined to form a chart showing how frequently each bolt length was used, separated by diameter. This is shown in Figure 4.6 and it displays that #6 bar 6 ft. long is by far the most popular bolt used in the mines that were surveyed.

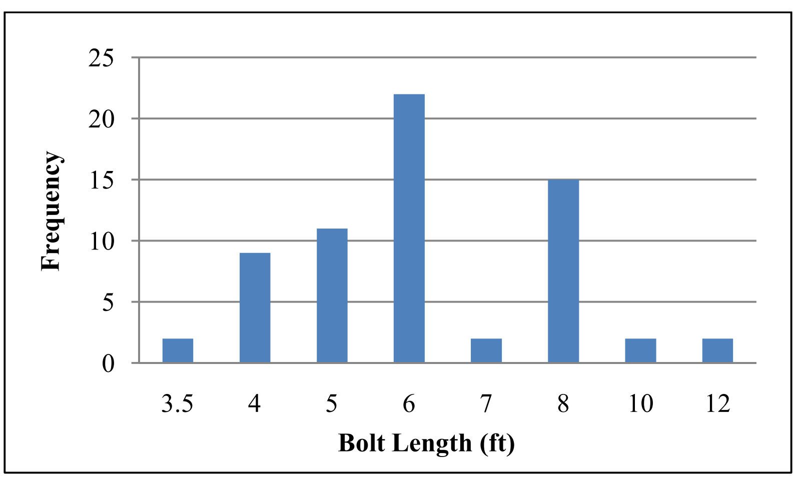

Figure 4.5: Bolt length distribution

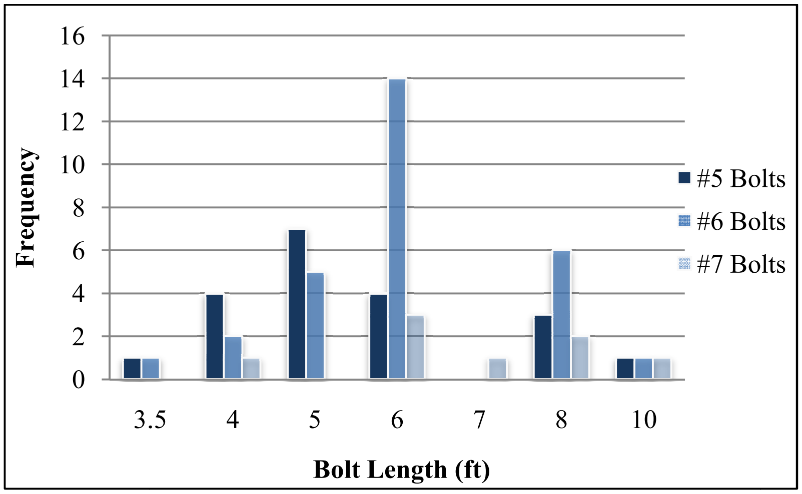

Figure 4.6: Bolt length distribution by diameter

Modern roof bolters are equipped with large mobile canopies to protect the operators, but many of these prevent the rock bolts from being installed closer than about 2 ft. from the pillars. Also, many bolter models cannot drill angled holes. Displayed in Figure 4.7 is the reported distance that primary rock bolts are installed from the pillars at the surveyed mines. It is interesting to note that at this time, Murali Gadde of Peabody Energy is having discussions with mines and manufacturers about solely using roof bolters that have the ability to install the first row of bolts closer to the pillars, and can angle bolts over pillars as well (Spearing, 2009). This may create a more stable environment at the roof-rib intersection where shear stresses are a maximum (also called the pillar knife edge).

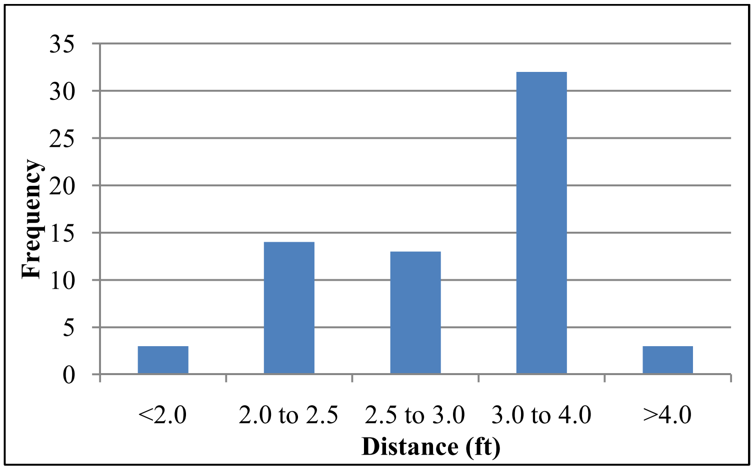

Figure 4.7: Distance of nearest primary rock bolt to pillars

Figure 4.8 below shows the maximum length of cable bolts that the surveyed mines used. Approximately 70% of the mines used cable bolts as regular secondary support, and the rest either used them only in adverse conditions or did not use them at all.

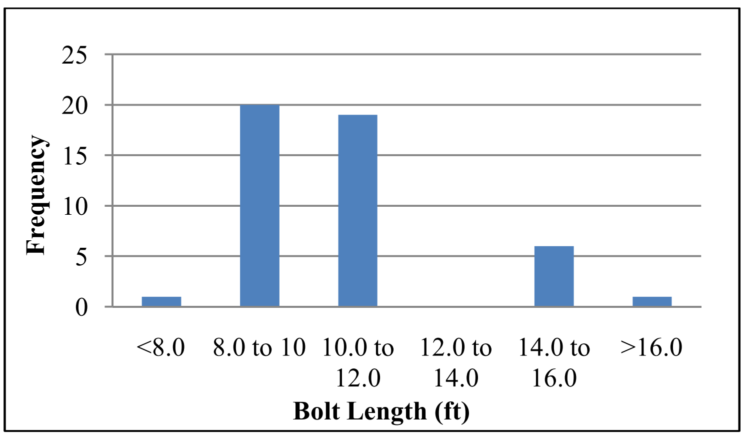

Figure 4.8: Maximum cable bolt length distribution

About 90% of the mines surveyed used some type of supplemental free-standing support; however there did not seem to be a clear pattern relating to room size, bolt size, or other values that were surveyed. The supplemental support is typically installed according to geological conditions at a site which can vary widely at a single mine. Supports that were routinely used included: Timber props, posts, and cribs, pumped concrete posts, cans, and yielding and non-yielding steel props.

4.2 Unplanned Fall of Ground Study

An analysis of the unplanned falls of ground has revealed intriguing results. According to data collected, the average roof fall was 53 ft. long, 20 ft. wide and 8 ft. high. Figure 4.9 shows the distribution of intersection fall thicknesses that were found in the study. Most of the unplanned roof falls extended above the common primary bolt length of 6 ft. that was found in the intersection support survey. Falls reported to MSHA are not always at or above the anchorage height, as smaller falls can still be considered to be unplanned falls of ground if they impede passage or impair ventilation.

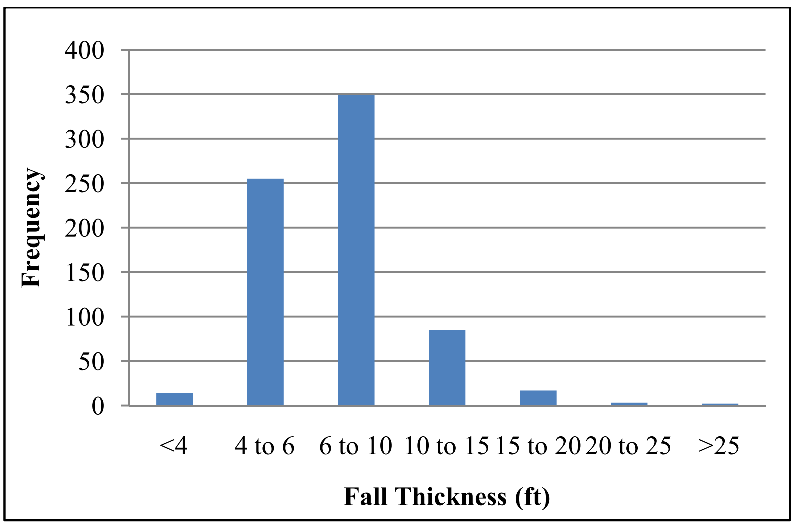

Figure 4.9: Unplanned fall of ground thickness

The relationship between fall thickness and bolt length installed was examined further, and these parameters are compared side by side in Table 4.1. This information was obtained for a total of 607 unplanned intersection falls of ground and confirms that most falls are at least as thick as the primary bolt length, and thus lengthening bolts may not be the solution. Longer bolts simply laminate a thicker beam which tends to fall when cutters reach the higher level. The presence of secondary or supplemental support was not frequently recorded in the MSHA 7000 50a reports and may not be totally accurate if such support was not visible under the falls. For the most part, where cables were reported to be installed the falls were often above the cables. Unfortunately, the data available on presence of cutters in the roof at fall locations was reported too inconsistently to be of significance.

Table 4.1: Relationship of primary bolt length and fall height

Primary bolt length (ft)	Average fall height (ft)	No of data points
< 3	4.5	19
3.01 to 4.0	6.2	163
4.01 to 5.0	7.3	185
5.01 to 6.0	8.4	204
6.01 to 7.0	9.2	8
7.01 to 8.0	9.4	28

Figure 4.10 shows the length distribution of the unplanned intersection falls of ground. As shown in the chart below, a large percentage of unplanned roof falls extended beyond the average intersection width of 20 feet that was found in the mine surveys. Only about 12% of the roof falls were smaller than the intersection width. Informal comments by MSHA employees and mine personnel verified that most falls seem to be massive, extending to, or more frequently past the width of the intersection.

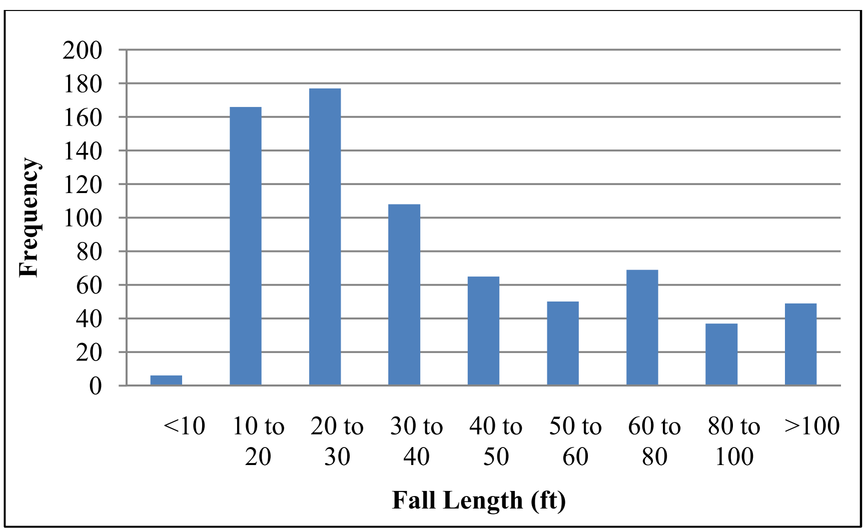

Figure 4.10: Unplanned fall of ground length

The results for fall length and fall thickness mirror a study conducted in 1980 by W.C. Patrick in which dimensions of roof falls were analyzed, mainly in the Illinois Basin. (Aughenbaugh, 2009).

Figure 4.11 below shows the fall length versus fall width, note the two falls that extended to almost 1,000 feet in length. Figure 4.12 shows the clustered results in more detail, and makes it easier to see the small number of falls that would be contained within a typical 20 x 20 ft. entry.

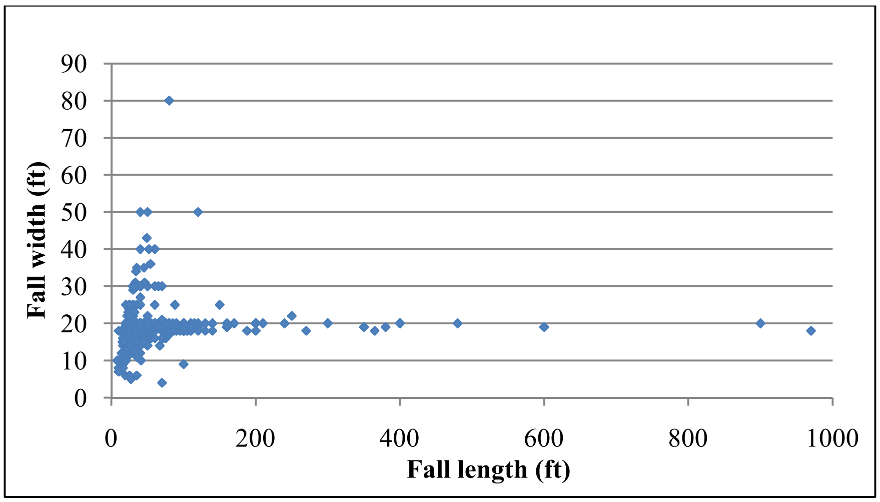

Figure 4.11: Fall length vs. fall width

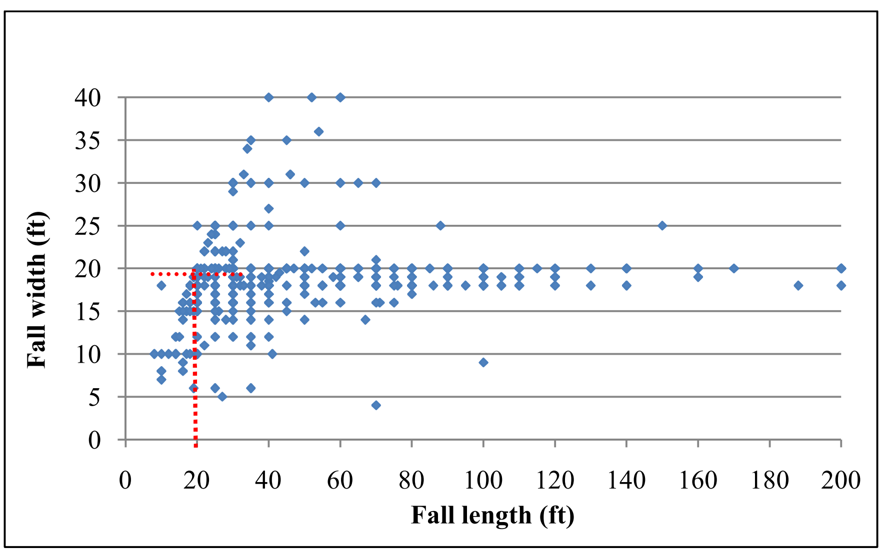

Figure 4.12: Fall length vs. fall width (detail)

Figure 4.13 shows the relationship of stand-up time to the frequency of unplanned falls of ground. The individual graphs from each district are similar to this chart, and have the same bimodal distribution of stand-up times before roof falls.

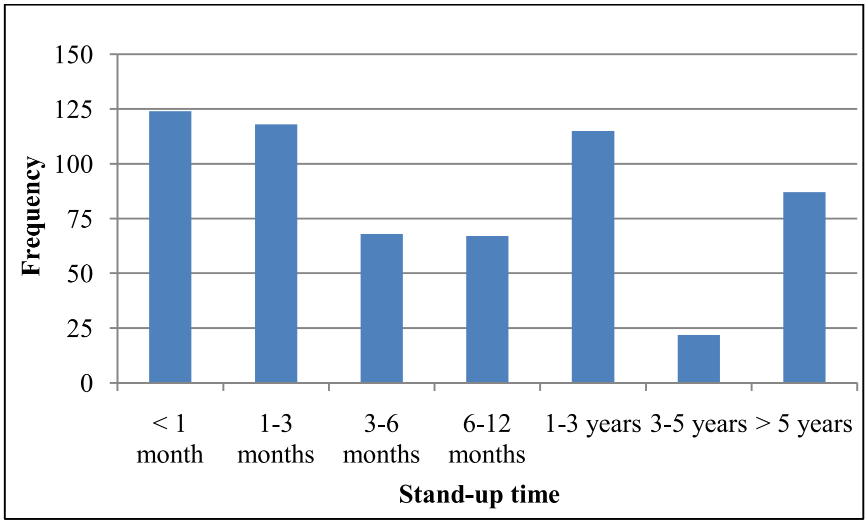

Figure 4.13: Stand-up times for unplanned falls of ground

The amount of falls occurring much later than a month or two suggests that weathering of rock layers and possibly anchor deterioration, particularly by corrosion, may be issues. On the basis of this data, the Illinois Clean Coal Institute (ICCI) agreed to fund a bolt corrosion project led by Dr. A.J.S. (Sam) Spearing in collaboration with Dr. K. Mondal so more information can be gathered about this potential problem.

Discussions with MSHA inspectors while collecting roof fall data have suggested that a majority of unplanned falls tend to be massive and extend longer than the intersection width and higher than the bolt length. This suggests that increasing bolt length may not be the simple solution, because the bolts are creating a thicker massive beam that eventually seems to shear above the ribline and fall in a dead weight manner. The bolts create a solid beam and are usually effective at controlling tensile failure and skin failure, but the current support practices may be inadequate to stop a shearing/cantilever fall along the pillar edges.

4.3 Finite Element Modeling of Failure Modes

To test the validity of input data, the $Phase^2$ model described in Section 3.2.3 was run with a standard support system of 6 ft. bolts on 4 ft. spacing. The weak immediate roof showed deformation, and the floor was buckling upward slightly, which is a realistic response to the applied stresses. This roof and floor displacement is shown in Figure 4.14.

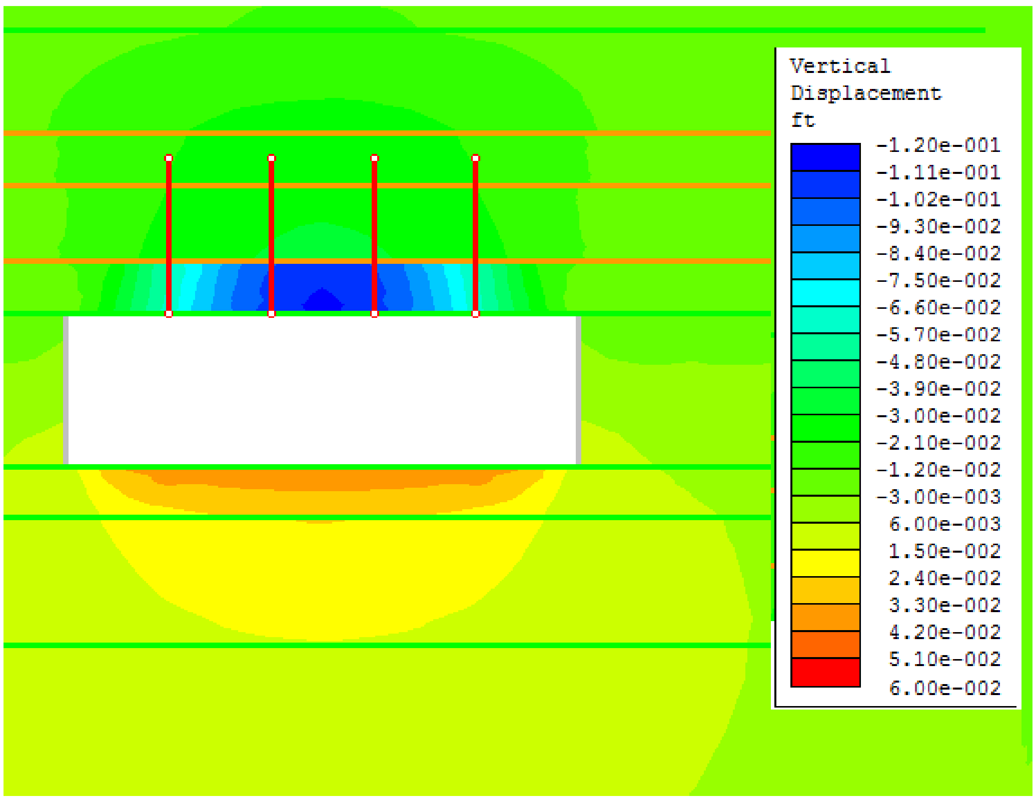

Figure 4.14: Roof and floor displacement

Although this model shows tensile failure in the center of the roof and does not display the massive failure mechanism that has been seen in real-world observations, it does compute the highest shear and normal stresses to be at the pillar edge where cutter failure begins. The actual cause of cutter failure along the pillar edge largely depends on geologic conditions and anomalies at a particular area, which are difficult to recreate in a computer model. The high principal stresses in all three dimensions that concentrate at the pillar edge are displayed in Figure 4.15. As stress increases, the color spectrum on the figure changes from blue→green→yellow→red. Figure 4.16 shows the shear stress acting on the immediate roof, with much higher stress at the corners where massive failure typically occurs.

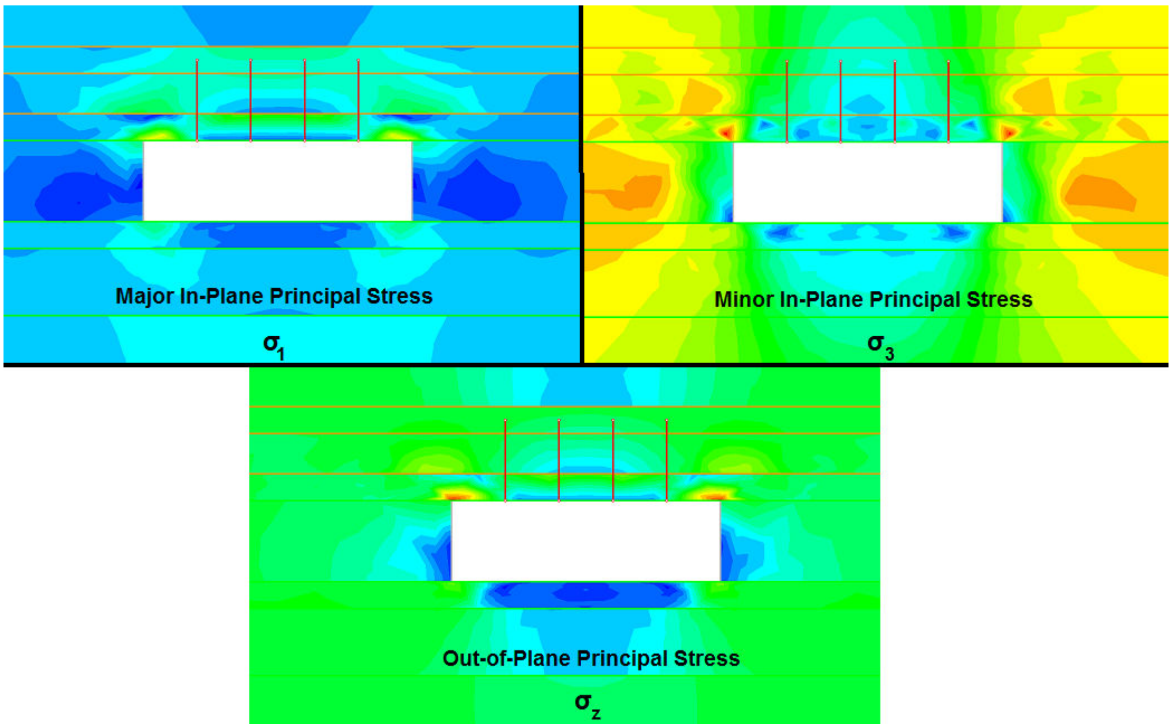

Figure 4.15: Normal intersection stress in three dimensions

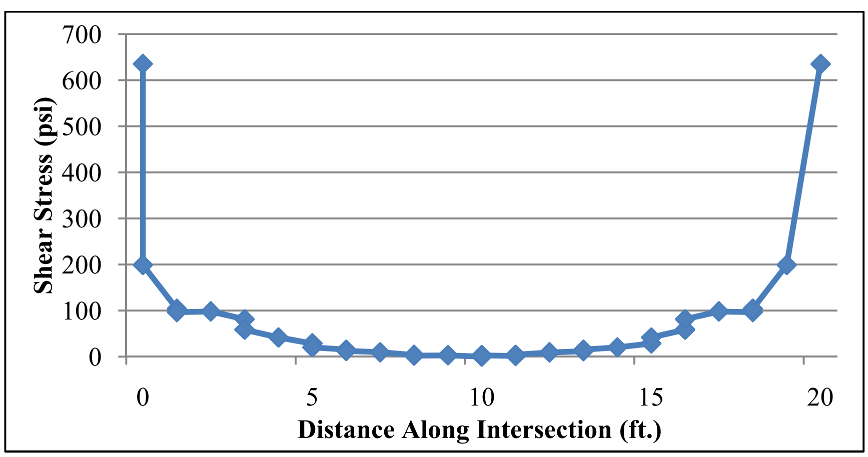

Figure 4.16: Shear stress across intersection width

According to the 2D model, the amount of shear stress applied to the immediate roof above the pillars is a substantial amount, several times larger than the typical shear strength of roof strata which is approximately 170 psi (Esterhuizen, 2009). Any geological discontinuities or cracks would be susceptible to becoming wider and deeper with the shear and normal stresses concentrated at the roof/pillar edge. Although the model did not show massive failure breaking to a greater depth than the roof bolts, trials were run to examine how support changes affected stability. Surprisingly, even adding two additional angled bolts a distance of 2 ft. from the pillars did not result in any reduction in stress or displacement from the standard 4 ft. bolting pattern. The axial load of each bolt was graphed and all bolts were loaded to some degree. A simulation was also run with no bolts, and this showed almost exactly the same stresses and displacements. To simulate the wide diagonal span across an intersection, a model was also run with a 28 ft. intersection and this yielded the same mode of failure and roof characteristics.

When the model was unsuccessful at demonstrating shear (cutter) failure above the pillars or improvements in stability as a result of support changes, numerous factors were adjusted in an attempt to "fix" the model and replicate the massive falls of ground that have been observed. Some of these factors were suggested by Rocscience and G.S. Esterhuizen of NIOSH, and include changing: cohesion, friction angle, strength of pillars and roof, and normal and shear stiffness of the roof joints. These manipulations proved to be unsuccessful and only resulted in minor stability changes according to the output; the failure was still in tension at the center of the roof in a dome fashion and did not represent the failure that is most commonly seen in coal mine intersections.

It is the author's opinion that Phase^2 and 2-D modeling in general may not be powerful or comprehensive enough to capture the true shear behavior of the rock strata in the roof beam because it cannot model failure and dilation. The strength reduction that is a result of combined buckling of layers and extension fracturing processes is beyond the capabilities of 2D elastic modeling software (Esterhuizen, 2008). From the comparisons between no support, 4 bolts, and 6 bolts, and the fact no stability changes occurred, it appears that $Phase^2$ also lacks the capability to compare support systems accurately. Additionally, the two-dimensional model represents a single continuous excavation and does not take into account the development of crosscuts and intersections, and the changes in stresses that occur over time. To demonstrate the massive shear failure that is observed in the mines, a more powerful program such as HcItasca's FLAC3D which can emulate progressive failure may prove to be more successful. Software with 3D capabilities can represent the intersections and crosscuts accurately, and how they affect roof stability.

4.4 Statistical Analysis of Collected Data

Statistical analysis of variance (ANOVA) tests using SPSS 13.0 were conducted on the fall of ground data to determine which independent variables affected fall length, height, and volume. The ANOVA analysis found a correlation between roof type and fall height, which is to be expected. To analyze this data, each roof type reported by the mines was assigned a number between 1 and 14. Dark shale and thinly laminated shale were the immediate roof types that resulted in more falls above 10ft than more competent roof strata such as limestone or sandstone. This ANOVA output table is represented in Table 4.2

Table 4.2: ANOVA test of roof type on fall height

Dependent Variable: Height

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	476.079[a]	14	34.006	1.388	.154
Intercept	3020.586	1	3020.586	123.320	.000
RoofType	476.079	14	34.006	1.388	.154
Error	11732.534	479	24.494		
Total	46320.000	494			
Corrected Total	12208.613	493			

a. R Squared = .039 (Adjusted R Squared = .011)

The most important value considered on Table 4.2 is the p-value shown in the "Sig." column, which indicates the percent chance for error. The p-value of .154 means there is a probability of 84.6% [(1-.154)*100] that fall height is actually dependent on roof type. While statistical analyses typically require at least a 95% confidence level (thus a 5% chance of error), with the assumption of a wide variability in the geology and reporting of data there is a possibility these factors may be significant. Additionally, there was a correlation between fall length and District; this ANOVA table is displayed in Figure 4.3.

Table 4.3: ANOVA test of MSHA District on fall length

Dependent Variable: Length

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	142941.081[a]	9	15882.342	3.280	.001
Intercept	1268219.760	1	1268219.760	261.940	.000
District	142941.081	9	15882.342	3.280	.001
Error	3471460.363	717	4841.646		
Total	5630973.000	727			
Corrected Total	3614401.444	726			

a. R Squared = .040 (Adjusted R Squared = .027)

It appears that due to the very low Sig. value shown in Table 4.3, there is a strong possibility that fall length varies according to MSHA District. The raw data was plotted, and in Figure 4.17 it can be seen that Districts 1, 4, and 10 experienced longer falls than the other Districts' averages.

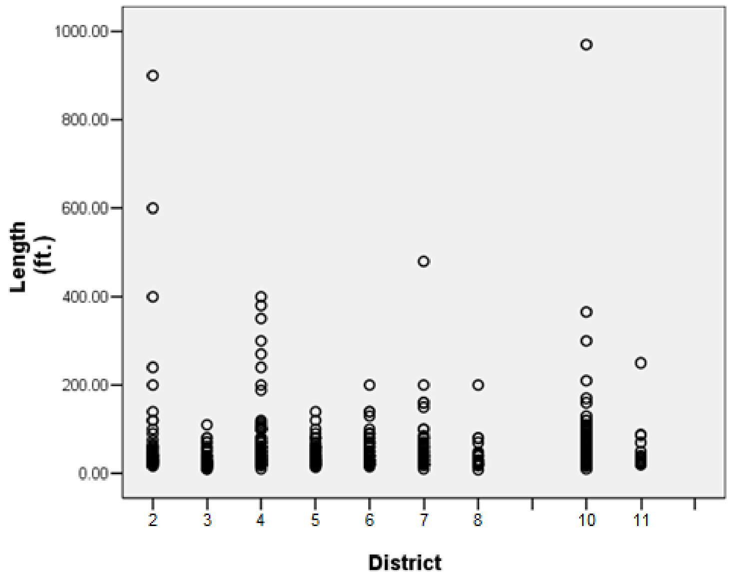

Figure 4.17: Fall length by MSHA district

Stand-up time and the effect on fall length was also found to be a significant relationship. From the ANOVA output in Table 4.4, the Sig. value for this test was .036.

Table 4.4: ANOVA test of stand up time on fall length

Dependent Variable: Length

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	180769.772[a]	58	3116.720	1.497	.036
Intercept	264679.248	1	264679.248	127.126	.000
Standuptime	180769.772	58	3116.720	1.497	.036
Error	222775.987	107	2082.019		
Total	845572.000	166			
Corrected Total	403545.759	165			

a. R Squared = .448 (Adjusted R Squared = .149)

Regression analysis was used to fit linear or curved models to the plots in an attempt to find a correlation between variables. What appears to be a general downward trend in fall length with stand-up time is shown in Figure 4.18, although this may be due to the lack falls occurring after 300 months. If in fact a general reduction in fall length is occurring in these very late falls, a possible explanation may be during that extended timeframe, the areas exhibited cutters or other signs of weakness, and support was added which reduced the size of fall.

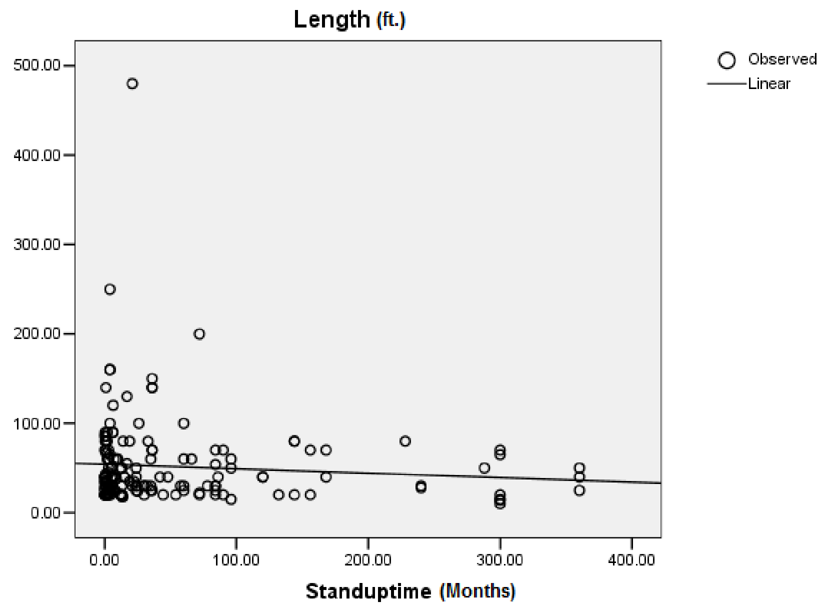

Figure 4.18: Stand-up time vs. fall length

Four-way ANOVA analysis showed that the combined factor of bolt length and water had an interaction effect on fall volume (with a p-value of .294) although it is unclear exactly how or if these two variables affected fall height together. The p-value for that test is very high by statistical standards and it is possible there is no interaction at all. This four-way ANOVA table is shown in Table 4.5.

Table 4.5: Four-way ANOVA test

Dependent Variable: Volume

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.594E+010[a]	33	483080159.7	.709	.870
Intercept	1093326275	1	1093326275	1.606	.208
BoltType	37242837.7	1	37242837.722	.055	.816
BoltLength	1994016099	6	332336016.4	.488	.816
Water	162210987	1	162210987.3	.238	.626
RoofType	798634300	7	114090614.4	.168	.991
BoltType * BoltLength	125464611	2	62732305.725	.092	.912
BoltType * Water	37684509.1	1	37684509.091	.055	.814
BoltLength * Water	1687596168	2	843798083.8	1.239	.294
BoltType * BoltLength * Water	.000	0	.	.	.
BoltType * RoofType	.000	0	.	.	.
BoltLength * RoofType	571067462	3	190355820.5	.280	.840
BoltType * BoltLength * RoofType	.000	0	.	.	.
Water * RoofType	110906969	1	110906969.2	.163	.687
BoltType * Water * RoofType	.000	0	.	.	.
BoltLength * Water * RoofType	707469917	2	353734958.7	.520	.596
BoltType * BoltLength * Water * RoofType	.000	0	.	.	.
Error	7.354E+010	108	680883336.4		
Total	1.020E+011	142			
Corrected Total	8.948E+010	141			

The fact that there are very few (if any) statistical correlations between independent variables and fall dimensions suggests that: 1) Geological differences between sites and localized discontinuities are always a factor and will raise the probability for error in statistical analysis, or 2) Inconsistencies and errors in data reporting cause unreliable statistical results. The presence of cutters or water in the roof at a fall site was inconsistently reported across Districts, and the fact that fall dimensions are visually estimated introduces error as well. The reason for inconclusive statistical results is most likely a combination of widely varying geological conditions and reporting irregularities.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

As mentioned in the previous chapter, this project has confirmed that simply increasing bolt lengths may not be the solution to massive shear failures, which seem to be caused primarily by local geologic conditions and shear stresses acting on the laminated strata beam. These massive failures have been shown to be very common, as only 12% of the falls studied were smaller than the average intersection width of 20 ft.

Figure 5.1 displays the rock bolt compression concept that was introduced in Chapter 2 and incorporates the bolt lengths and fall heights that were listed in Table 4.1. If the intersections are falling as a result of the cohesion/shear failure along the pillars, the height of the fall would then depend on that shear strength and would fail to a horizontal plane in the roof with limited or zero cohesion in a dead weight manner. The data to support this includes:

- The fact that the average fall height increased with increased bolt length.
- The informal observation from several MSHA inspectors that the falls in intersections tend to be massive in nature. These rock masses may be falling in one or several large blocks and breaking up due to impact with the floor.
- Comments from some inspectors indicated that the formation of cutters close to the pillars seemed frequently to be a pre-cursor to the falls.
- Over 75% of the unplanned falls extend to or beyond the total width of the intersection.
- Longer bolts seem not to be effective in resolving the fall problem.

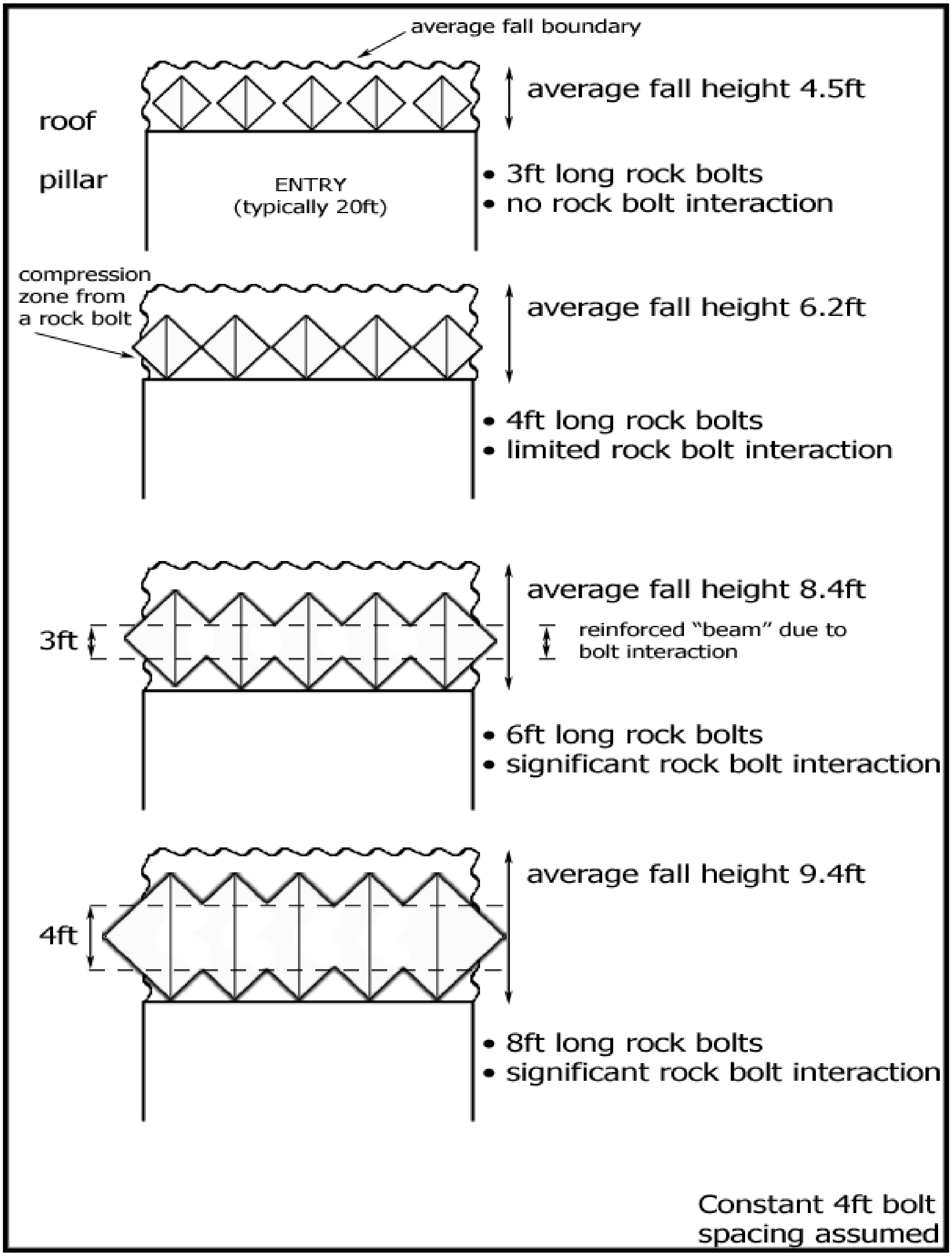

Figure 5.1: Average results for primary bolt length and average fall of ground height (Spearing 2008)

4.2 Recommendations

If the mode of failure described is a correct hypothesis, then the solution would seem to be, in intersections where falls could be expected (based on prior knowledge/experience for example, or presence of rib rashing and cutters):

- Installing bolts closer to the pillars and also possibly angled over the pillars (to effectively increase the shear strength/cohesion against the roof and rib intersection). 3D modeling software that is able to exhibit the failure mechanism more accurately may be able to demonstrate the benefits in stability for this method. Installation of angled roof bolts near the rib has been suggested for mines as early as 1987, when W. H. Su recommended angle bolting at a mine experiencing frequent roof falls. He states, "Results of finite element analyses have shown that little improvement of roof conditions can be expected with the installation of angle bolts. Angle bolting, however, can delay or prevent roof falls at the rib-roof intersections" (Su, 1987). Additionally, the two Illinois mines that reported routinely angling roof bolts over pillars did not have any unplanned fall of ground reports at the District 8 office, although this does not necessarily mean falls did not occur; only that no falls were investigated.
- Designing the bolt length and spacing such that a more effective compression zone is created.
- Immediately installing supplemental support such as timbers or cribs at pillar edges if severe cutters occur.

A detailed study on the stability differences between bolts installed 2 ft. from the pillar edge and 4 ft. from the edge may yield useful data on possible advantages of bolting closer to the rib. Simply comparing mines surveyed in this study may not be reliable due to the differences in geology, so a side-by-side comparison at the same mine and geology would make sense.

Weathering also seems to be a major factor as 60% of the unplanned falls occurred more than 3 months after they were developed, and almost 14% happened more than 5 years after the excavation was first developed. Weathering of the roof strata and/or anchor corrosion may be causing the system to fail in these late stages. Therefore, under roof conditions where weathering is considered possible, some form of effective sealing could be considered for critical long term intersections (such as main entries or belt entries). This sealing could be done using shotcrete or a thin support liner for example. Where cutters form close to the pillars (especially near intersections), the situation should be carefully monitored and free standing supports installed to support the dead weight if the cutters tend to grow. Photo 1 displays the onset of a cutter into the roof. Additionally, previous studies have noted that about 70% of roof falls occurred near areas of substantial rib rashing, indicating another warning sign that a fall may occur (Patrick, 1980).

Photo 1: The onset of a cutter into the roof against the pillar rib

There were wide variations in the reporting of unplanned falls of ground across different MSHA districts, with some districts consistently noting features such as bolt type, stand-up time, immediate roof geology, and if water or cutters were present. Other districts chose not to include this important information in their 7000 50a reports. In order to more effectively avoid a recurrence of a similar fall of ground mechanism, the actual mechanism causing the fall needs to be identified and understood. It would be therefore beneficial if the following was recorded routinely for all unplanned (and other) falls of ground:

- Details of the support associated with the actual fall. This is often difficult to identify but estimation would be useful, even if it is based on the installed support in the nearest stable intersection. A standard format across all districts would be easiest to follow.
- The support spacing and bolt installation angle are also important.
- The stand-up time.

- The presence and nature of any water present.
- The time after development when the primary and any secondary/supplemental support was installed.
- Dimensions of the fall.
- More specific details of the immediate roof strata and local geology in the area.

Additional parameters were suggested by W.C. Patrick in 1980 such as the location of the fall relative to crosscuts, the presence of rib rashing and floor heaving, and the apparent presence of extremely high or low stresses.

It would be helpful if the data gathered was standardized within the coal industry and easily available electronically. This fall data could then be analyzed more accurately using ANOVA and regression statistical analysis to identify and quantify factors that impact the dimensions and stand-up time of unplanned roof falls. More consistent reporting across districts may also show the importance of warning signs of falls such as water presence, rib rashing, and cutters. The main constraint to getting this data reliably is probably a shortage of manpower especially at MSHA, considering their more rigorous duties under the 2006 MINER Act.

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APPENDICES

APPENDIX A1: Current intersection support practices by state

Mine ID	Mine	Coal seam	Method	2007 production	Room width (ft)	Room height (ft)	Bolt type	Bolt length (ft)	Resin length (ft)	Bolt spacing (ft)	Active/ Passive	Bolt angle
Alabama												
	Coke Mine #1 - Shelby Mining	Coke Seam	Room&Pillar	150,000	21	3.75	3/4"	6	Full	4	Passive	Vert
	201 Tucker Rd. Suite 101						Fully Grouted					
	Helena, AL 35080											
	Tel: 205-6644704											
	Greg Franklin - Safety Coordinator											
	JWR No 4 Mine	Blue Creek	Longwall	7,000,000	22	7	7/8"	4	Full	5	Passive	Vert
	14730 Lock 17 Rd						Fully Grouted					
	Brookwood, AL 35444											
	Tel: 205-5546450											
	Bill Marston - MNGE											
	JWR No 7 Mine	Blue Creek	Longwall	6,000,000	21	7	.804"	6	Full	5	Passive	Vert
	18069 Hannah Creek Rd						Fully Grouted					
	Brookwood, AL 35444											
	Tel: 205-5546750											
	Johnny Humphreys - MNGE											
	North River #1 - Chevron Mining	Pratt	Longwall	5,000,000	18	6.67	.677"	6	1.5	4.5	Active	Vert
	12398 New Lexington Rd						Combination					
	Barry, AL 35546											
	Tel: 205-3335041											
	Jeff Gregs - MNGE											
	Oak Grove Mine	Blue Creek	Longwall	2,250,000	20	8	3/4"	4-8ft	Full	4	Passive	Vert
	8800 Oak Grove Mine Road						Fully Grouted					
	Adger, AL 35006											
	Tel: 205-497-3651											
	Tim Thompson - Manager of Safety											
	Shoal Creek Complex	May Lee	Longwall	4,000,000	20-22	7-11 ft	3/4" and 5/8"	4 to 8	2	5	Active	Vert
	PO Box 1549	Blue Creek					Combination					
	Jaspar, AL 35501											
	Tel: 205-4916200											
	Jay Vilsek - MNGE											

Colorado												
	Bowie Resouces Ltd.	B Seam	Longwall	5,200,000	19	9.5	3/4"	6 or 8	Full	4.5	Passive	Vert
	PO Box 1488,						Fully Grouted					
	Paonia, CO 81428											
	Tel: 970-5274135											
	Jim Abshire - MNGE											
O503505	**Desarado Mine**	?	Longwall	1,424,000	16 to 19	8 to 14	#7	7	5	4.5	Passive	Vertical
	3607 County Rd 65											Ribs 30-45 deg
	Rangely, CO 81648											
	Tel: 970-6754345											
	King Coal	Menefee	Room&Pillar	550,000	17	6	#6	5 or 6	Full	5	Passive	Vert
	4424 CR 120						Fully Grouted					
	Espress, CO 81326											
	970-385-4528 ext. 15											
	Dan Meadors - Mine Manager											
503836	**Twenty Mile Coal Co.**	Wadge	Longwall	8,290,117	18-20	8.5-10	0.804	8	Full	5	Passive	Vert
	29515 Routt County Rd 27						Fully Grouted					
	Oak Creek, CO 80467											
	Tel: 970-8793800/8702782											
	Bob Johnson - Tech Safety Coordinator											
O503672	**West Elk Mine**	B Seam	Longwall	6,500,000	18	10	0.804"	6	Full	5.0	Passive	All vertical
	PO Box 591											
	Somerset, CO 81434											
	Tel: 970-9295015											
Illinois												
	Crown III Mine	#6 Herrin	Room&Pillar	1,511,109	18	7	1" Tension	6, 8	3	4	Active	Vert
	4440 Ash Grove, Suite A,						Rebar					
	Springfield, IL 62711											
	Tel: 217-6272161											
	Andy Ditch - MNGE											
1102752	**Galatia Mine**	#5	Longwall	7,009,000	18 (#5)	6	#6 & #7	2.5 to 8ft (#6)	3	4.0	Active	All vertical
	PO Box 727	#6			20 (#6)			8ft (#5)				
	Harrisburg, IL 62946											
	Tel: 618-2686444											

1120408	**Gateway Mine**	Herrin #6	Room & pillar	4,200,000	20	7	?	4	?	5.0	Active	All vertical
	13101 Zeigler 11 Road											
	Coulterville, IL 62237											
	Tel: 618-7582395											
1103147	**Prairie Eagle Underground Mine**	Herrin #6	Room & pillar	597,000	19 to 20	6.5 to 7	#5 Gr75	30, 36, 48, 60"	N/A	4.5	Active	All vertical
	7290 County Line Road						#6 double lok	6 ft	2 ft	4.5	Active	All vertical
	Cutler, Illinois 62238											
	Tel: 618-4972768											
	Riola Mine - Vermillion Grove	Herrin	Room&Pillar	2,300,000	18-19 ft	6-7 ft	Combo or	8' or	Combo - ?	4.5	Active	Vert
	4500 N 1500E						Fully Grouted	6'	Grouted - full		Passive	
	Ridgeform, IL 61870											
	Tel: 217-2472145											
	Dick Reisinger - MNGE											
1103162	**Royal Falcon Mine**	Herrin #6	Room & pillar	0	18	8 to 10	#6	6 to 8	Full	4.0	Active	All vertical
	2220 Royal Falcon drive											
	Elkville, Illinois 62932											
	Tel: 618-9842483											
	Viper Mine	Springfield #5	Room&Pillar	2,100,000	20	5.5	#5	4,6,8 ft	Full	4	Passive	Vert
	8100 E. Main						Fully Grouted					
	Williamsville, IL 62693											
	Tel: 217-5663000											
	Joe Olson - MNGE											
1103058	**White County Coal - Pattiki**	Herrin #6	Room & pillar	4,297,463	18 to 20	5 to 9	0.75" Gr75	3 to 10	2	4.5	Active	All vertical
	1525 County Rd 1300E											
	Carmi, IL 62821											
	Tel: 618-3824651											
1103156	**Wildcat Hills**	Herrin #6	Room & pillar	1,713,00	18 to 20	5 to 6.5	0.875" SRD	6	Full	4.5	Active	All vertical
	115 Grayson Lane											
	El Dorado, IL 62930											
	Tel: 818-2738606											
1103054	**Willow Lake Portal**	Springfield #5	Room & pillar	6,469,000	18.5 to 20	5.25 to 6.25	#5 Gr60	4 to 6	Full	4.5	Passive	All vertical
	420 Long Lane Road						#6 Gr40					

	Equality, Illinois 62934										
	Tel: 618-2731320										
Indiana											
	Air Quality Mine	#7	Room&Pillar	5,000,000	19	6	5/8"	4 ft	Full	4-5 ft	Passive	Vert
	PO Box 409						Fully Grouted					
	Monroe City,IN47557											
	Tel: 812-7439292											
	Steve Mesker - MNGE											
	Carlisle Mine	Indiana #5	Room&Pillar	1,000,000	18	4.5-8	5/8"	4.5-6	Full	4.5	Passive	Vert
	6641 SR 46						Fully Grouted					
	Terre Haute, IN 47802											
	Tel: 812-3982200 ext 107											
	Sam Elder - MNGE											
	Gibson County Coal	Springfield #5	Room & pillar	4,900,000	18	4.5-9	Resin, mech	10	3	4	Passive	Vert
	PO Box 1269, 2579 West Gibson Rd					Avg 7	shell, 5/8-7/8					
	Princeton, IN 47670											
	Tel: 812-3851816											
	Chris Hopple - Chief Engineer											
	Prosperity Mine (5 Star Mining Inc.)	Indiana #5	Room&Pillar	3,500,000	18	6	5/8"	5	Full	4	Passive	Vert
	6594 W State Rd 56						Fully Grouted					
	Petersburg, IN 47567											
	Tel: 812-3546883											
	Triad Underground	#5	Room & pillar	1,068,000	18 to 20	4 to 6	#5	4 to 6	Full	4.5 to 5.0	Passive	All vertical
	14521 E State Road 58											
	Edwardsport, Indiana 47528											
	Tel: 812-3282491											
Kentucky												
	Bledsoe Coal Corp.	Hammond #4	Room&Pillar	2,000,000	20	4.16-13 ft	5/8"	4-5 ft	Full	4	Passive	Vert
	Rt 2008 Box 3514						Fully Grouted					
	Big Laurel, KY 40808											
	Tel: 606-5385506											
	Adam Smith - MNGE											

	C3 Mine - Rex Coal	Creek Seam	Room&Pillar	77,000	20	2.8	5/8"	4	Full	4	Passive	Vert
	Box 269						Fully Grouted					
	Gray's Knob, KY 40829											
	Tel: 276-5237137											
	Mike Palmer - MNGE											
	Dodge Hill Mine #1	West Kentucky #6	Room & pillar	2,326,834	20	4.8	#6 Gr40	5	5	4	Passive	All vertical
	PO Box 165							6	3	4	Active	
	Sturgis, KY 42459											
	Tel: 270-9526761											
1518826	**Elk Creek Mine**	KY #9	Room & pillar	3,770,000	18 to 20	4.5 to 5.3	#6	5 and 6	Full	4.0	Passive	All vertical
	35 Frank Cox Rd	KY #11			18 to 20	5 to 6	#6	6	Full	4.0	Passive	All vertical
	Madisonville, KY 42431											
	Tel: 270-3264007											
	Flint Ridge Mine	#8 Haddix	Room&Pillar	800,000	20	6	5/8"	4	Full	4	Passive	Vert
	Breathitt County, KY						Fully Grouted					
	Tel: 606-6666802											
	Everett Kelly - Safety director											
1502709	**Highland Mine**	Kentucky #9	Room & pillar	6,572,000	20	5.5	#6	6	Full	4.0	Passive	All vertical
	530 French Road											
	Waverly, Kentucky 42462											
	Tel:											
	Jones Fork Complex	Elk 1-3	Room&Pillar	1,422,398	20	4-6ft	#5	5	5	4	Passive	Vert
	550 184 Fourmile Branch						Fully Grouted					
	Mousie, KY 41839											
	Tel: 606-9463100											
	John Hell - MNGE											
	Manalapan Mining Co. RB-P1 Mine	Path Fork	Room&Pillar	200,000	20	3.5	3/4"	4	Full	4	Passive	Vert
	8174 E Highway 72						Fully Grouted					
	Pathfork, KY 40863											
	Tel: 606-5732020 ext 31											
	Dennis Wilson - Engr tech											
	Martin County Coal Corp	Coalburg	Room&Pillar	0	20	5.5-6	not sure	4-5 ft	Full	4	Passive	Vert
	PO Box 5002,						Fully grouted					

	Inez, KY 41224											
	Tel: 606-3956881											
	Philip Meade - MNGE											
	McCoy Elkhorn Complex	Fireclay	Room&Pillar	5,000,000	19-22	4.5	3/4"	5	Full	4	Passive	Vert
	1148 Long Fork Rd.,						Fully Grouted					
	Kimper, KY 41539											
	Tel: 616-835-2233 ext 21											
	Robert Maynard - MNGE											
	Mine 77 Blue Diamond	Elk Horn #3	Room&Pillar	600,000	19	5-6 ft	3/4"	6	Full	4	Passive	Vert
	P.O. Box 47						Fully Grouted					
	Slemp, KY											
	Tel: 606-6753311											
	Craig Travis - MNGE											
	Pontiki/Excel	Pond Creek	Room & pillar	2,000,000	19	6	Mostly 3/4"	6	Full	4	Passive	All Vertical
	HC 67, Box 615						Also use 5/8, 7/8					
	Pilgrim, KY 41250											
	Tel: 606-395-5348											
	David Arington - MNGE											
	Premier Elkhorn P-1	Elk Horn 3	Room&Pillar	240,000	20	4.3	Torque	4	not sure	4	Active	Vert
	PO Box 130						Tension					
	Myra, KY 41549											
	Tel: 606-6399623											
	Sid Stanley - Chief Engineer											
	Sidney Coal Co. Inc. - Freedom mine	Pond Creek	Room&Pillar	3,000,000	20	5-8 ft	5/8"	5	Full	4	Passive	Vert
	PO Box 299						Fully Grouted					
	Sidney, KY 41564											
	Tel: 606-3535509											
	John Cline - Chief Engineer											
1502132	**Webster County Coal - Dotiki**	Kentucky #9	Room & pillar	6,400,000	20	5.17	#6 Gr40	5	Full	5' width	Passive	All vertical
	1586 Balls Hill Rd									4' advance		
	Nebo, KY 42441											
	Tel: 270-249-2205											
	Eric Blanford - Engr Manager											

New Mexico												
	San Juan Mine	Fruitland #8	Longwall	7,000,000	18	9-9.5	1"	7	Full	4	Passive	Vert
	PO Box 561						Fully Grouted					
	Waterflow, NM 87421											
	Tel: 505-5982000											
	Steve Jones - MNGE											
Ohio												
	Powhatan #6	Pittsburgh #8	Longwall	5,000,000	18	6	5/8"	8	2	4	Active	Vert
	56864 Pleasant Ridge Road						Combination					
	Alledonia, OH 43902											
	Tel: 740-9261351											
	Dick Homco - Safety Coordinator											
Pennsylvania												
	Bailey Mine	Pittsburgh #8	Longwalll	9,827,946	15.5	7.75	Genmar	12	2	4	Active	Vert
	192 Crabapple Rd						"Install 2"					
	Wind Ridge, PA 15377						Resin assist combo					
	Tel: 724-4281200											
	Rob Robinson - MNGE											
	Clementine Mine	Lower Kittanning	Room & pillar	1,200,000	17 to 20	3.5 to 4.5	#6	3.5	Full	3.5	Passive	All vertical
	151 Clinton Road											
	Freeport, PA 16229											
	Tel:											
	Enlow Fork	Pittsburgh #8	Longwall	11,200,000	15.6	8	Genmar	8	2	4	Active	Vert
	Rte 231						Point Anchor					
	East Finley (Washington Co), PA											
	Tel: 724-6633102											
	Paul Kelly - MNGE											
3600958	**Mine No. 84**	Pittsburgh	Longwall	3,606,000	16	6.5 to 8	#7 mech shell	8	2	3.0 to 4.0	Active	All vertical
	PO Box 284											
	Eighty Four, PA 15330											
	Tel: 724-2501500/1577											
Utah												
	Bear Canyon #4	Tank Seam	Longwall	2,000,000	18-19 ft	6-7 ft	3/4"	5-6 ft	Full	5	Passive	Vert

PO Box 300						Fully Grouted					
Huntington, UT 84528											
Tel: 435-6875777											
Miles Stevens - MNGE											
Deer Creek Mine	Hiawatha	Longwall	3,500,000	20	8.5	.914" gr 75	5	Full	5	Passive	Vert
PO Box 310	Blind Canyon					Fully Grouted					
Huntington, UT 84528											
Tel: 435-6876626											
Larry Lafrent - MNGE											
Dugout Canyon	Gilson	Longwall	3,800,000	20	8.5	#7	6	Full	5	Passive	Vert
PO Box 1029						Fully Grouted					
Wellington, UT 84542											
Tel: 435-6376360											
David Spillman - Tech. Services Manager											
Emery Mine	I Seam	Room&Pillar	1,200,000	20	7	5/8"	5	Full	5	Passive	Vert
PO Box 527						Fully Grouted					
Emery, UT 84522											
Tel: 435-2862301											
Russel Hardy - MNGE											
Skyline Complex	Lower O'Connor A	Longwall	2,560,000	20	9	0.875" SRD	8	Full	5.0	Passive	All vertical
North Lease Mine											
PO Box 380											
Helper, UT 84526											
Tel: 435-6377925											
Sufco Mine	Hiawatha	Longwall	7,000,000	18-20	9.5	3/4"	5	Full	5	Passive	Vert
397 South 800 West						Fully Grouted					
Salina, UT 84654											
Tel: 435-2864880											
John Byers - MNGE											
Westridge Mine	Lower Sunny Side	Longwall	2,500,000	18	7	3/4"	5	Full	5	Passive	45deg at rib
PO Box 910						Fully Grouted					
East Carbon, Utah 84520											
Tel: 435-8884000											

Jay Marshall - MNGE											
Virginia											
Cumberland River	F Seam, D Seam	Room&Pillar	7,264,244	20	5-10 ft	5/8"	4	Full	4	Passive	Vert
Pardee Complex	Parson Seam					Fully Grouted					
PO Box 109											
Appalachia, VA 24216											
Tel: 606-6339474											
Willie Adams - MNGE											
Knox Creek Coal Corp (Tiller 1)	Tiller	Room&Pillar	270,000	19.5	3.33	3/4"	5	4	4	Active	Vert
PO Box 519						Combination					
Raven, VA 24639											
Tel: 276-9644333											
Eric - MNGE											
Lone Mountain Processing Inc.	Kellioka	Room&Pillar	1,186,166	19	6	3/4"	8	not sure	4	Active	Vert
Drawer C	Darby					Combination bolt					
St. Charles, VA 24282	Owl										
Tel: 606-8372299 ext 21											
James Sumner - MNGE											
West Virginia											
Bridger Coal Co.	D-41	Longwall	2,700,000	17.5	10	.972"	8, 12	3	5	Active	Vert
PO Box 68,						Combination					
Point of Rocks, WY 82942											
Tel: 307-3829741 (603)											
Tom Hurst - MNGE											
Coal-Mac Inc, Mountaineer Mine	Alma A	Room & pillar	900,000	19.5	5.5	Fully Grouted	4	Full	4	Passive	Vert
Ragland Complex						3/4"					
PO Box 1050											
Holden, WV 25625											
Tel: 304-6644000											
Brian Damron - MNGE											
Independence (Justice Mine)	Powellton	Longwall	2,000,000	19	7	3/4"	4-6 ft	Full	4-5 ft	Passive	Vert
PO Box 1800						Fully grouted					
Madison, WV 25130						sometimes Torque Tension					

Tel: 304-3697103											
Andy Ashurst - MNGE											
Kingston No 1	Glen Alum	Room & pillar	2,700,000	19.5	4.5	#5	3.5	Full	4.0	Passive	All vertical
PO Box 76-C											
Scarbro, WV 25917											
Tel: ???????											
Loveridge Mine	Pittsburgh #8	Longwall	8,250,000	15.5	8	Combination	8	1.5	5	Passive	Vert
County Road M, 2 miles N of Fairview											
Fairview, WV 26570											
Tel: 304-6621229											
Mark Cramer - MNGE											
McElroy Mine	Pittsburgh #8	Longwall	9,667,258	15.8	7.5	Fully grouted	6	Full	4	Active	Vert
Rd 1 (Marshall Co),						Mech. Anchor					
Glen Easton, WV 26039											
Tel: 304-8433700											
Eric Shereda - MNGE											
Miller Creek Complex	Coalberg	Room&Pillar	700,000	20	7	3/4"	6	Full	4	Passive	Vert
1 Stella Deskins Drive						Fully Grouted					
Williamson, WV 25661											
Tel: 304-2351850 ext 11											
Duffy Farrell - MNGE											
Mountaineer 2 Mine	Thalma	Longwall	4,100,000	19-19.5 ft	5-14 ft	5/8"	5	Full	4	Active	Vert
Box 100, State Route 17,						Combination					
Sharples, WV 25183											
Tel: 304-3697518											
Rob Brawner - MNGE											
Performance (Upper Big Branch)	Eagle	Room&Pillar	650,000	19.9	5.5-10ft	5/8"	6	not sure	5 ft	Active	Vert
PO Box 457,						Combination					
Whitesville, WV 25209											
Tel: 304-8541761											
George Leao - MNGE											
Pinnacle Mine	Pocahontas #3	Longwall	2,000,000	20	6.5	3/4"	5 or 6	not sure	4	Active	Vert
Pinnacle Creek Road						Combination					
PO Box 338						Genmar					

Pineville, WV 24874						Install 2					
Tel:304-7325337											
David Trade - MNGE											
Rockspring Mine	Winterford	Room&Pillar	7,000,000	20	8	3/4"	6	2	4	Active	Vert
PO Box 390						Combination					
East Lynn, WV 25512											
Tel: 304-720-2531											
George Smith - Senior Engineer											
Shoemaker Mine	Pittsburgh #8	Longwall	100,000	16	7.67	7/8"	6	Full	4	Passive	Vert
PO Box 62A (Ohio Co)						Fully Grouted					
Dallas, WV 26036											
Tel: 304-2381500											
Barry Miller - MNGE											
TOTAL PRODUCTION:			**234,605,535**								

APPENDIX A2: Current intersection support practices by state

Mine ID	Mine	Plate	Plate	First bolt	Wire	Channel			Cables			Trusses	
		detail	type	from rib	Mesh	Type	Size	Thickness	Length (ft)	Diameter (in)	Resin lgth (ft)	L/Dia	Angle
Alabama													
	Coke Mine #1 - Shelby Mining 201 Tucker Rd. Suite 101 Helena, AL 35080 Tel: 205-6644704 Greg Franklin - Safety Coordinator	6x16"	Flat	3	Not used	Rarely Used	N/A	N/A	Nil			Nil	
	JWR No 4 Mine 14730 Lock 17 Rd Brookwood, AL 35444 Tel: 205-5546450 Bill Marston - MNGE	6x6"	Flat	4	If needed	Nil	N/A	N/A	8	1"	not sure	Nil	
	JWR No 7 Mine 18069 Hannah Creek Rd Brookwood, AL 35444 Tel: 205-5546750 Johnny Humphreys - MNGE	6x6"	Volcano	3-4 ft	no	Thin flat metal strips			8	0.6	6	Nil	
	North River #1 - Chevron Mining 12398 New Lexington Rd Barry, AL 35546 Tel: 205-3335041 Jeff Gregs - MNGE	8x8?	Flat	3	Not used	Nil	N/A	N/A	12	0.7	5	Nil	
	Oak Grove Mine 8800 Oak Grove Mine Road Adger, AL 35006 Tel: 205-497-3651 Tim Thompson - Manager of Safety	6x6"	Donut	<5 ft	Nil	Not used often			Used very rarely			Nil	
	Shoal Creek Complex PO Box 1549 Jaspar, AL 35501 Tel: 205-4916200 Jay Vilsek - MNGE	6x6"	Donut	5	Not used	Nil	N/A	N/A	Nil			Nil	

Colorado													
	Bowie Resouces Ltd.	6x6"	Domed	2	4x4" Mesh	Monster	not sure	not sure	8-12 ft	0.75	not sure	Nil	
	PO Box 1488,					Mat							
	Paonia, CO 81428												
	Tel: 970-5274135												
	Jim Abshire - MNGE												
O503505	**Desarado Mine**	6x6" Gr3	Domed	2 ft	Mesh/screen	Nil	N/A	N/A	10	0.6	7.0	Nil	
	3607 County Rd 65				14 gauge				12 per intersection				
	Rangely, CO 81648												
	Tel: 970-6754345												
	King Coal	6x6"	Flat	1.5	Used everywhere	Nil	N/A	N/A	Nil			Nil	
	4424 CR 120												
	Espress, CO 81326												
	970-385-4528 ext. 15												
	Dan Meadors - Mine Manager												
503836	**Twenty Mile Coal Co.**	6x6" 3/8"	Volcano	2	Everywhere	Bacon	12x18"	not sure	8-12 ft	.6-.7	4 ft	Nil	
	29515 Routt County Rd 27					strip							
	Oak Creek, CO 80467												
	Tel: 970-8793800/8702782												
	Bob Johnson - Tech Safety Coordinator												
O503672	**West Elk Mine**	4x4"	Domed	2 ft	Mesh/screen	Nil	N/A	N/A	12		3.0	8ft #8	45 deg
	PO Box 591				9 gauge							**?**	
	Somerset, CO 81434												
	Tel: 970-9295015												
Illinois													
	Crown III Mine	6x16"	Dome	<4 ft	Not used	Nil	N/A	N/A	Nil			Nil	
	4440 Ash Grove, Suite A,												
	Springfield, IL 62711												
	Tel: 217-6272161												
	Andy Ditch - MNGE												
1102752	**Galatia Mine**	8x8" Gr40	Flat	3 ft	Nil	Nil	N/A	N/A	12	0.6	3.0	8ft #7	45 deg
	PO Box 727											0.6" cable	
	Harrisburg, IL 62946												
	Tel: 618-2686444												

1120408	**Gateway Mine**	8x8"	Domed	2.5 ft	Nil	Nil	N/A	N/A	Nil	N/A	N/A	Nil	
	13101 Zeigler 11 Road	6x16"	Flat										
	Coulterville, IL 62237	6x20"wood	Flat										
	Tel: 618-7582395												
1103147	**Prairie Eagle Underground Mine**	8x8" Gr2	Dimple	4 ft	Mesh/screen	Nil			Nil			Nil	
	7290 County Line Road	8x8" Gr2	Flat	4ft	8 gauge								
	Cutler, Illinois 62238												
	Tel: 618-4972768												
	Riola Mine - Vermillion Grove	8x8"	Flat or	<3.5	In about 25%	Metal	10"x16'		12-15 ft	Not sure	Not sure	Nil	
	4500 N 1500E		Donut		Area								
	Ridgeform, IL 61870												
	Tel: 217-2472145												
	Dick Reisinger - MNGE												
1103162	**Royal Falcon Mine**	8x8" Gr2	Dimple	3 ft	Nil	Roof matt		14 gauge	Nil			8ft #7	45 deg
	2220 Royal Falcon drive												
	Elkville, Illinois 62932												
	Tel: 618-9842483												
	Viper Mine	6x6" 16ga	Flat	2	Mains, Beltway	Nil	N/A	N/A	12	0.6	12	Varied L	45
	8100 E. Main											.6"	
	Williamsville, IL 62693												
	Tel: 217-5663000												
	Joe Olson - MNGE												
1103058	**White County Coal - Pattiki**	6x6" Gr 2&3	Domed	2 to 4 ft	2x6x12" boards	Nil	N/A	N/A	Nil	N/A	N/A	Nil	
	1525 County Rd 1300E												
	Carmi, IL 62821												
	Tel: 618-3824651												
1103156	**Wildcat Hills**	8x8" Gr2	Donut	2.5 ft	Mesh/screen	Nil	N/A	N/A	10	0.6	50"	Nil	
	115 Grayson Lane				8 gauge				4 per insection				
	El Dorado, IL 62930												
	Tel: 818-2738606												

1103054	**Willow Lake Portal** 420 Long Lane Road Equality, Illinois 62934 Tel: 618-2731320	8x8" Gr2	Domed	2 to 2.5 ft	Nil	Nil	N/A	N/A	12 & 16	0.6	4 ft	Nil
Indiana												
	Air Quality Mine PO Box 409 Monroe City,IN47557 Tel: 812-7439292 Steve Mesker - MNGE	6x16"	not sure	2.5 ft	In entries	Nil	N/A	N/A	Nil			Nil
	Carlisle Mine 6641 SR 46 Terre Haute, IN 47802 Tel: 812-3982200 ext 107 Sam Elder - MNGE	6x6"	not sure	4	in entries	Nil	N/A	N/A	Nil			Nil
	Gibson County Coal PO Box 1269, 2579 West Gibson Rd Princeton, IN 47670 Tel: 812-3851816 Chris Hopple - Chief Engineer	8x8"	Flat	<3ft	Welded wire in some areas	Nil	N/A	N/A	8	0.6	4	Nil
	Prosperity Mine (5 Star Mining Inc.) 6594 W State Rd 56 Petersburg, IN 47567 Tel: 812-3546883	6x16"	Donut	3.5 ft	No, pizza pan	Nil	N/A	N/A	12	0.8	not sure	Nil
	Triad Underground 14521 E State Road 58 Edwardsport, Indiana 47528 Tel: 812-3282491	6x6" Gr2	Donut	2 to 4ft	Nil	Nil			Nil			Nil
Kentucky												
	Bledsoe Coal Corp. Rt 2008 Box 3514 Big Laurel, KY 40808 Tel: 606-5385506 Adam Smith - MNGE	6x6"	Donut	4	Track, Belt line	Bacon strips			10 and 12	5/8" and 3/4"	4	Nil

	C3 Mine - Rex Coal	6x6"	Flat	4	Not used	Nil	N/A	N/A	Not used			Nil
	Box 269											
	Gray's Knob, KY 40829											
	Tel: 276-5237137											
	Mike Palmer - MNGE											
	Dodge Hill Mine #1	6x6" Gr2	Domed	2 ft	1x6x16"	Nil	N/A	N/A	10	0.6	4.0	Nil
	PO Box 165				pinboards				8 per intersection			
	Sturgis, KY 42459											
	Tel: 270-9526761											
1518826	**Elk Creek Mine**	6x6" Gr2	Domed	3.0 to 3.5	Nil	Nil	N/A	N/A	8	0.6	6.0	Nil
	35 Frank Cox Rd	6x6 Gr2	Domed	3.0 to 3.5	Nil	Nil	N/A	N/A	8	0.6	6.0	Nil
	Madisonville, KY 42431								around slips			
	Tel: 270-3264007											
	Flint Ridge Mine	6x6" or	Flat	4	Not used	Used rarely			8 or 10 ft	5/8"	4 or 5 ft	Nil
	Breathitt County, KY	6x16"										
	Tel: 606-6666802											
	Everett Kelly - Safety director											
1502709	**Highland Mine**	5x5" Gr?	Domed	2.5	Nil	Nil	N/A	N/A	10	0.6	3.0	Nil
	530 French Road											
	Waverly, Kentucky 42462											
	Tel:											
	Jones Fork Complex	4x4"	Bearing	4	In mains	Nil	N/A	N/A	10	not sure	not sure	Nil
	550 184 Fourmile Branch		Plate									
	Mousie, KY 41839											
	Tel: 606-9463100											
	John Hell - MNGE											
	Manalapan Mining Co. RB-P1 Mine	6x6"	Donut	3	Not used	Channel	6"		Not used			Nil
	8174 E Highway 72					Straps						
	Pathfork, KY 40863											
	Tel: 606-5732020 ext 31											
	Dennis Wilson - Engr tech											
	Martin County Coal Corp	6x6"	not sure	2 ft	Not used	Nil	N/A	N/A	Used very rarely as supplemental			Nil
	PO Box 5002,											

	Inez, KY 41224											
	Tel: 606-3956881											
	Philip Meade - MNGE											
	McCoy Elkhorn Complex	6x6" or	Not sure	4	No	Nil	N/A	N/A	10	0.75	not sure	Nil
	1148 Long Fork Rd.,	8x8"										
	Kimper, KY 41539											
	Tel: 616-835-2233 ext 21											
	Robert Maynard - MNGE											
	Mine 77 Blue Diamond	6x6"	Flat	4	Not used	Nil	N/A	N/A	10	3/4"	Not sure	Nil
	P.O. Box 47											
	Slemp, KY											
	Tel: 606-6753311											
	Craig Travis - MNGE											
	Pontiki/Excel	8x8"	Donut	4 ft	Nil	Nil	N/A	N/A	10	0.75	N/A	Nil
	HC 67, Box 615											
	Pilgrim, KY 41250											
	Tel: 606-395-5348											
	David Arington - MNGE											
	Premier Elkhorn P-1	8x8"	Flat	3	Not used	Nil	N/A	N/A	4	3/4"	not sure	Nil
	PO Box 130											
	Myra, KY 41549											
	Tel: 606-6399623											
	Sid Stanley - Chief Engineer											
	Sidney Coal Co. Inc. - Freedom mine	8x8"	Donut	<2 ft	Not used	Bacon Strip	occasionally		6-10 ft	5/8"	not sure	Nil
	PO Box 299											
	Sidney, KY 41564											
	Tel: 606-3535509											
	John Cline - Chief Engineer											
1502132	**Webster County Coal - Dotiki**	8x8"	Donut	3-4 ft	Nil	Nil	N/A	N/A	10 & 12	0.6	5 ft	5-6'
	1586 Balls Hill Rd											1.5"
	Nebo, KY 42441											
	Tel: 270-249-2205											
	Eric Blanford - Engr Manager											

New Mexico												
	San Juan Mine	8x8"	Flat	2	Everywhere	Nil	N/A	N/A	Nil			10ft 3/4"
	PO Box 561											
	Waterflow, NM 87421											
	Tel: 505-5982000											
	Steve Jones - MNGE											
Ohio												
	Powhatan #6	6x6"	Flat	4	Occasional	Metal		14ga	12	not sure	not sure	Nil
	56864 Pleasant Ridge Road											
	Alledonia, OH 43902											
	Tel: 740-9261351											
	Dick Homco - Safety Coordinator											
Pennsylvania												
	Bailey Mine	6x6"	Waffle plate	<4 ft	Nil	T5	14'	T5	12-16ft	0.7	4	Nil
	192 Crabapple Rd											
	Wind Ridge, PA 15377											
	Tel: 724-4281200											
	Rob Robinson - MNGE											
	Clementine Mine	6x6" Gr4	Donut	2.5 to 4.0	Nil	J Channel		0.25"	8 to 12	?	4.0	Nil
	151 Clinton Road					T-5 channel						
	Freeport, PA 16229											
	Tel:											
	Enlow Fork	5x7 3/8"	Channel	3.3 ft	Nil	Genmar T5	Not sure	T5	16	0.7	4.5	Nil
	Rte 231											
	East Finley (Washington Co), PA											
	Tel: 724-6633102											
	Paul Kelly - MNGE											
3600958	**Mine No. 84**	4x4"	Embossed	3.5 ft	Nil	T5 or T3	14ftx6"	?	8 to 20	0.6 and 0.7	4.0	Nil
	PO Box 284	6x6"	Flat						8 per intersection			
	Eighty Four, PA 15330											
	Tel: 724-2501500/1577											
Utah												
	Bear Canyon #4	6x6"	Donut	3	on Gate roads	Nil	N/A	N/A	8	3/4"	2	Nil

PO Box 300											
Huntington, UT 84528											
Tel: 435-6875777											
Miles Stevens - MNGE											
Deer Creek Mine	6x6"	Flat gr4	<5 ft	Everywhere	Mats	10x16ft	14ga	7-16 ft	0.6	5' or 7'	Nil
PO Box 310				6 ga 4x4"							
Huntington, UT 84528											
Tel: 435-6876626											
Larry Lafrent - MNGE											
Dugout Canyon	6x6"	Not sure	<2.5 ft	Wire mesh	Nil	N/A	N/A	10	no sure	6	Nil
PO Box 1029				in all development							
Wellington, UT 84542											
Tel: 435-6376360											
David Spillman - Tech. Services Manager											
Emery Mine	6x6"	Domed	3	No	Nil	N/A	N/A	10	5/8"	not sure	Nil
PO Box 527											
Emery, UT 84522											
Tel: 435-2862301											
Russel Hardy - MNGE											
Skyline Complex	6x6" Gr5/16	Domed	2.5 ft	Mesh/screen	W	16'x12"	3/16"	10	0.6	5.0	Nil
North Lease Mine				10 gauge							
PO Box 380											
Helper, UT 84526											
Tel: 435-6377925											
Sufco Mine	not sure	not sure	<1 ft	As needed	Nil	N/A	N/A	10-12ft	Varied	Not sure	Nil
397 South 800 West											
Salina, UT 84654											
Tel: 435-2864880											
John Byers - MNGE											
Westridge Mine	6x6"	Flat	Angled in	Rarely used	Nil	N/A	N/A	Nil			Nil
PO Box 910			ribline								
East Carbon, Utah 84520											
Tel: 435-8884000											
Jay Marshall - MNGE											

Virginia												
Cumberland River	6x6"	Flat	3.3	Not used	Nil	N/A	N/A	Nil			Nil	
Pardee Complex												
PO Box 109												
Appalachia, VA 24216												
Tel: 606-6339474												
Willie Adams - MNGE												
Knox Creek Coal Corp (Tiller 1)	3x3" and	Pizza Pans	3	Not used	Nil	N/A	N/A	6	3/4"	4	Nil	
PO Box 519	4.5 x 4.5"											
Raven, VA 24639												
Tel: 276-9644333												
Eric - MNGE												
Lone Mountain Processing Inc.	6x6"	Flat	3 ft	Not often	Nil	N/A	N/A	8, 12 ft	0.75	not sure	Nil	
Drawer C												
St. Charles, VA 24282												
Tel: 606-8372299 ext 21												
James Sumner - MNGE												
West Virginia												
Bridger Coal Co.	6x6"	Volcano	2.5	Everywhere	Pans			Nil			8'	45 deg
PO Box 68,												
Point of Rocks, WY 82942												
Tel: 307-3829741 (603)												
Tom Hurst - MNGE												
Coal-Mac Inc, Mountaineer Mine	6x6"	Flat	4 ft	Nil	Used if in bad top			Used where needed, not sure on dimensions				
Ragland Complex					no specifics available							
PO Box 1050												
Holden, WV 25625												
Tel: 304-6644000												
Brian Damron - MNGE												
Independence (Justice Mine)	8x8"	Tension - flat	4	Very rarely	Nil	N/A	N/A	8-12 ft	.6 or .7	not sure	Nil	
PO Box 1800		Resin - Donut										
Madison, WV 25130												
Tel: 304-3697103												

Andy Ashurst - MNGE											
Kingston No 1	6x6" Gr ?	Donot	3.5 ft	Nil	Nil	N/A	N/A	Nil	N/A	N/A	Nil
PO Box 76-C											
Scarbro, WV 25917											
Tel: ???????											
Loveridge Mine	6x6"	Flat	3.5	Belt line and track	not sure	12'	not sure	12	not sure	not sure	Nil
County Road M, 2 miles N of Fairview											
Fairview, WV 26570											
Tel: 304-6621229											
Mark Cramer - MNGE											
McElroy Mine	6x4"	Channel	4	In mains	T4	Not sure	T4	12	0.7	4	Nil
Rd 1 (Marshall Co),											
Glen Easton, WV 26039											
Tel: 304-8433700											
Eric Shereda - MNGE											
Miller Creek Complex	6x6"	Flat	<4 ft	Not used	Pizza Pans			10	3/4"	not sure	Nil
1 Stella Deskins Drive											
Williamson, WV 25661											
Tel: 304-2351850 ext 11											
Duffy Farrell - MNGE											
Mountaineer 2 Mine	6x6"	not sure	4	Not used	Thin Metal			8, 12	1"	4	Nil
Box 100, State Route 17,											
Sharples, WV 25183											
Tel: 304-3697518											
Rob Brawner - MNGE											
Performance (Upper Big Branch)	8x8"	Donut	<4 ft	No	8 ga	4'	not sure	10-12ft	0.6	not sure	Nil
PO Box 457,											
Whitesville, WV 25209											
Tel: 304-8541761											
George Leao - MNGE											
Pinnacle Mine	6x6"	Donut	3	Very rarely	T5	16'	T5	9	3/4"	3	Nil
Pinnacle Creek Road											

PO Box 338 Pineville, WV 24874 Tel:304-7325337 David Trade - MNGE											
Rockspring Mine PO Box 390 East Lynn, WV 25512 Tel: 304-720-2531 George Smith - Senior Engineer	8x8"	Donut	3.5	Not used	Nil	N/A	N/A	12	.9"	not sure	Nil
Shoemaker Mine PO Box 62A (Ohio Co) Dallas, WV 26036 Tel: 304-2381500	6x6"	Not sure	3.5	Belt line entry	Nil	N/A	N/A	12 and 16'	0.7	4	Nil

APPENDIX A3: Current intersection support practices by state

Mine ID	Mine	Free standing support			Immediate roof geology			Typical time
		Type	Spacing (ft)	Comments	From roof			to install secondary
Alabama								
	Coke Mine #1 - Shelby Mining	Timbers, Cribs,	5	As needed	4-8 ft	Massive Sandstone		As needed
	201 Tucker Rd. Suite 101	Steel Jacks			Shale			
	Helena, AL 35080							
	Tel: 205-6644704							
	Greg Franklin - Safety Coordinator							
	JWR No 4 Mine	Cribs, Timbers, Pumpable	5		200 ft			Soon after mining
	14730 Lock 17 Rd	6,8,10" Props			Massive sandstone			
	Brookwood, AL 35444							
	Tel: 205-5546450							
	Bill Marston - MNGE							
	JWR No 7 Mine	4, 9 point cribs	5' edge to edge	As needed	3-5 ft	1.5 ft	Sandstone	As needed
	18069 Hannah Creek Rd	Propsetters, 6x6 timbers			Sandy shale	Coal		
	Brookwood, AL 35444							
	Tel: 205-5546750							
	Johnny Humphreys - MNGE							
	North River #1 - Chevron Mining	Heinzman Props	5		20 ft	Sandstone		Varies
	12398 New Lexington Rd				Shale			
	Barry, AL 35546							
	Tel: 205-3335041							
	Jeff Gregs - MNGE							
	Oak Grove Mine	8" Posts or 4' cribs	5	As needed	1 ft	2-8 ft	3-4 ft	Varies
	8800 Oak Grove Mine Road				Shale	Sandy Shale	Coal	
	Adger, AL 35006							
	Tel: 205-497-3651							
	Tim Thompson - Manager of Safety							
	Shoal Creek Complex	Pumpable Cribs	10-20 ft	Always in tailgate	10 ft	20 ft		Varies
	PO Box 1549				Sandy Shale	Sandstone		
	Jaspar, AL 35501							
	Tel: 205-4916200							

	Jay Vilsek - MNGE							
Colorado								
	Bowie Resouces Ltd.	Can crib	13' center	Always installed	3-4 ft	1-6 ft		Soon after mining
	PO Box 1488,				Siltstone	Sandstone		
	Paonia, CO 81428							
	Tel: 970-5274135							
	Jim Abshire - MNGE							
O503505	**Desarado Mine**	Nil			10ft			**?**
	3607 County Rd 65				mudstone/shale			
	Rangely, CO 81648							
	Tel: 970-6754345							
	King Coal	Timbers, Cribs,	As needed	As needed	0-3 ft	20 ft		Varies
	4424 CR 120	Heinzman Jacks			Shale	Sandstone		
	Espress, CO 81326							
	970-385-4528 ext. 15							
	Dan Meadors - Mine Manager							
503836	**Twenty Mile Coal Co.**	Timbers, Cribs	Varies	Always in some areas	3 ft	2-5 ft		Soon after mining
	29515 Routt County Rd 27	Propsetters, Cans		also supplemental	Laminated Shale	Sandstone	Shale	
	Oak Creek, CO 80467							
	Tel: 970-8793800/8702782							
	Bob Johnson - Tech Safety Coordinator							
O503672	**West Elk Mine**	Cans	7		1 to 3 ft	3 to 10 ft		45 days
	PO Box 591				mudstone	laminated sandstone		
	Somerset, CO 81434							
	Tel: 970-9295015							
Illinois								
	Crown III Mine	Props, Cribs	As needed	As needed	Varied	Sandstone		As needed
	4440 Ash Grove, Suite A,				Shale			
	Springfield, IL 62711							
	Tel: 217-6272161							
	Andy Ditch - MNGE							
1102752	**Galatia Mine**	Cribs	6	FSS during longwall retreat	40 to 50 ft			?

	PO Box 727	Props	6		shale (#5)				
	Harrisburg, IL 62946	Timbers	6		0 to 4 ft	0 to 7 ft	2 to 5 ft	30 to 40 ft	
	Tel: 618-2686444				shale (#6)	limestone	shale	sandstone	
1120408	**Gateway Mine**	8" Timber	5		1 to 2 ft	4 to 8 ft	6 ft	12 ft	?
	13101 Zeigler 11 Road				shale	limestone	shale	shale	
	Coulterville, IL 62237								
	Tel: 618-7582395								
1103147	**Prairie Eagle Underground Mine**	Nil			2 to 4 ft	5 to 9 ft	> 50 ft		?
	7290 County Line Road				black shale	brereton lime	shaley limestone		
	Cutler, Illinois 62238								
	Tel: 618-4972768								
	Riola Mine - Vermillion Grove	8x8" Timbers,	4.5	As needed	Varied	Varied			As needed
	4500 N 1500E	Propesetters			Shale	Sandstone			
	Ridgeform, IL 61870								
	Tel: 217-2472145								
	Dick Reisinger - MNGE								
1103162	**Royal Falcon Mine**	Nil			1 ft	4 to 6 ft	>60 ft		0 to 5 days
	2220 Royal Falcon drive				coal	gray black shale	sandstone		
	Elkville, Illinois 62932								
	Tel: 618-9842483								
	Viper Mine	Wood props	5	As needed	0-5 ft	2-4 ft			As needed
	8100 E. Main				Shale	Limestone			
	Williamsville, IL 62693								
	Tel: 217-5663000								
	Joe Olson - MNGE								
1103058	**White County Coal - Pattiki**	Cribs	1 in each center	Cross cuts only	1 to 3 ft	2 to 5 ft	10 to 60 ft		7 to 14 days
	1525 County Rd 1300E				shale	limestone	sandstone		
	Carmi, IL 62821								
	Tel: 618-3824651								
1103156	**Wildcat Hills**	Cribs	6	As needed	2 to 10 ft	2 to 6 ft	3 to 6 ft	18 to 20 ft	In cycle
	115 Grayson Lane	Timbers		Where limestone absent	shale	sandy shale	laminated shale	sandstone	
	El Dorado, IL 62930			in mains					

	Tel: 818-2738606							
1103054	**Willow Lake Portal**	Cribs/timbers/propsetters	4.5 ft		2 ft	3 to 6 ft	10 to 50 ft	about 7 days
	420 Long Lane Road				Dykersburg gray shale	Turner black shale	sandy shale	
	Equality, Illinois 62934							
	Tel: 618-2731320							
Indiana								
	Air Quality Mine	Cribs, Timbers	Varies, 5' max	As needed	0-15 ft	Varied		As needed
	PO Box 409				Shale	Sandstone		
	Monroe City,IN47557							
	Tel: 812-7439292							
	Steve Mesker - MNGE							
	Carlisle Mine	Timbers, cribs	As needed	As needed	2-3 ft	1-3 ft	Shale	As needed
	6641 SR 46				Shale	Limestone		
	Terre Haute, IN 47802							
	Tel: 812-3982200 ext 107							
	Sam Elder - MNGE							
	Gibson County Coal	Propsetters, timbers	As needed	As needed	5-20 ft	Sandstone		Varies, as needed
	PO Box 1269, 2579 West Gibson Rd	strata props	Usually 6-10		Shale			
	Princeton, IN 47670							
	Tel: 812-3851816							
	Chris Hopple - Chief Engineer							
	Prosperity Mine (5 Star Mining Inc.)	Timbers, cribs, props	Varies	Always in main travelway	6-10 ft	Sandstone or		1 month
	6594 W State Rd 56		usually 12' center	as needed elsewhere	Shale	Limestone		
	Petersburg, IN 47567							
	Tel: 812-3546883							
	Triad Underground	Cribs	4		12ft	3ft	3 to 6 ft	As needed
	14521 E State Road 58	Timbers	4		gray shale	limestone	black shale	
	Edwardsport, Indiana 47528							
	Tel: 812-3282491							
Kentucky								
	Bledsoe Coal Corp.	Timbers, Cribs	4	As needed	0-10 ft	Sandstone		As needed
	Rt 2008 Box 3514				Sandy Shale			

	Big Laurel, KY 40808							
	Tel: 606-5385506							
	Adam Smith - MNGE							
	C3 Mine - Rex Coal	Timbers and Cribs	As needed	As needed	2 ft	20-40 ft		As needed
	Box 269				Shale	Sandstone		
	Gray's Knob, KY 40829							
	Tel: 276-5237137							
	Mike Palmer - MNGE							
	Dodge Hill Mine #1	Nil			1.5 ft	10 to 40ft	50ft	About 7 days
	PO Box 165				black shale	sandy shale	sandstone	
	Sturgis, KY 42459				slickensided on sandy shale			
	Tel: 270-9526761							
1518826	**Elk Creek Mine**	Timbers	5	Intakes and returns	2ft	6 to 30 ft	5 to 30 ft	Cables in cycle
	35 Frank Cox Rd	Cribs			0.5 to 2 ft	0 to 8 ft	4 to 10 ft	Timber 3-4 days
	Madisonville, KY 42431	as needed			gray shale	limestone	gray shale	
	Tel: 270-3264007							
	Flint Ridge Mine	Cribs, Heinzman Jacks	As needed	As needed	0-15 ft	Sandstone		As needed
	Breathitt County, KY				Shale			
	Tel: 606-6666802							
	Everett Kelly - Safety director							
1502709	**Highland Mine**	Nil			2 ft	>20 ft		?
	530 French Road				Turner shale	sandy shale		
	Waverly, Kentucky 42462							
	Tel:							
	Jones Fork Complex	Timbers, Cribs	As needed	As needed	10-15 ft	20 ft		As needed
	550 184 Fourmile Branch				Shale	Sandstone		
	Mousie, KY 41839							
	Tel: 606-9463100							
	John Hell - MNGE							
	Manalapan Mining Co. RB-P1 Mine	Cribs, Timbers,	4 or 8	As needed	1 ft	30 ft		As needed
	8174 E Highway 72	Heinzman Jacks			Shale	Sandstone		
	Pathfork, KY 40863							
	Tel: 606-5732020 ext 31							
	Dennis Wilson - Engr tech							

	Martin County Coal Corp	Cribs, timbers, blocks	As needed	As needed	6-20 ft	Sandstone			As needed
	PO Box 5002,				Shale				
	Inez, KY 41224								
	Tel: 606-3956881								
	Philip Meade - MNGE								
	McCoy Elkhorn Complex	Timbers, Cribs	4 in belt	As needed	40-50 ft				As needed
	1148 Long Fork Rd.,			elsewhere	Sandstone	Shale			
	Kimper, KY 41539								
	Tel: 616-835-2233 ext 21								
	Robert Maynard - MNGE								
	Mine 77 Blue Diamond	Heinzman Jacks	As needed	As needed	1-10 ft	5-20 ft			Varies
	P.O. Box 47	Cribs			Shale	Sandstone			
	Slemp, KY								
	Tel: 606-6753311								
	Craig Travis - MNGE								
	Pontiki/Excel	Timbers/Props	Varies	As Needed	Shale or Sandstone				Sooner if needed
	HC 67, Box 615								
	Pilgrim, KY 41250								
	Tel: 606-395-5348								
	David Arington - MNGE								
	Premier Elkhorn P-1	Cribs, Timbers	As needed	As needed	2-3 ft	20-30 ft			7 days
	PO Box 130				Sandy Shale	Sandstone			
	Myra, KY 41549								
	Tel: 606-6399623								
	Sid Stanley - Chief Engineer								
	Sidney Coal Co. Inc. - Freedom mine	Timbers, Cribs	6 or 8'	As needed	5-80 ft	Sandstone or coal			As needed
	PO Box 299	Heinzman Jacks			Shale				
	Sidney, KY 41564								
	Tel: 606-3535509								
	John Cline - Chief Engineer								
1502132	**Webster County Coal - Dotiki**	Square Timbers	5 ft	Always on belt line	1-2 ft	10-30 ft	40 ft	Limestone	3-7 days
	1586 Balls Hill Rd			also one intake, one return	Black Shale	Grey Shale	Sandstone		
	Nebo, KY 42441								
	Tel: 270-249-2205								

	Eric Blanford - Engr Manager							
New Mexico								
	San Juan Mine	Rock Props	5' center	As needed	2-3 ft	2-3 ft	Sandstone	As needed
	PO Box 561				Coal	Shale		
	Waterflow, NM 87421							
	Tel: 505-5982000							
	Steve Jones - MNGE							
Ohio								
	Powhatan #6	Cribs/Timbers	As needed	As needed	1 ft	4 ft	4 ft	As needed
	56864 Pleasant Ridge Road	Rarely			Coal	Shale	Limestone	
	Alledonia, OH 43902							
	Tel: 740-9261351							
	Dick Homco - Safety Coordinator							
Pennsylvania								
	Bailey Mine	Cribs, Cans, Timbers,	Won't say		Varies	Varies		Won't say
	192 Crabapple Rd	Pumpable support			Laminated Shale	Sandstone		
	Wind Ridge, PA 15377							
	Tel: 724-4281200							
	Rob Robinson - MNGE							
	Clementine Mine	Cribs			2ft	12ft		less than 1 day
	151 Clinton Road				dark gray shale	dark gray sandy shale		
	Freeport, PA 16229							
	Tel:							
	Enlow Fork	24" Cans, wood cribs	6 or 8	Always in tailgate	0-10 ft	Sandstone		6-10 months
	Rte 231		edge to edge		Shale			
	East Finley (Washington Co), PA							
	Tel: 724-6633102							
	Paul Kelly - MNGE							
3600958	**Mine No. 84**	Nil			1 ft	1 ft		?
	PO Box 284				shale	coal/shale	sandstone	
	Eighty Four, PA 15330							
	Tel: 724-2501500/1577							

Utah

Bear Canyon #4	Cans, Posts	10 ft	Always in tailgate	1 ft	60-100 ft		Varies
PO Box 300				Shale	Sandstone		
Huntington, UT 84528							
Tel: 435-6875777							
Miles Stevens - MNGE							
Deer Creek Mine	3' Cans	8' Centers	Always installed	over 2000 feet			Less than a week
PO Box 310				Varied competent rock			
Huntington, UT 84528							
Tel: 435-6876626							
Larry Lafrent - MNGE							
Dugout Canyon	Rock props, ball busters	5	As needed	Varies			3-7 days
PO Box 1029	timbers, cans			Sandstone/Siltstone			
Wellington, UT 84542							
Tel: 435-6376360							
David Spillman - Tech. Services Manager							
Emery Mine	Timbers in retreat	4		0-12 ft	60 ft		Immediate
PO Box 527	Cribs rarely			Shale	Sandstone		
Emery, UT 84522							
Tel: 435-2862301							
Russel Hardy - MNGE							
Skyline Complex	Cans	5	Tailgates and bleeders	10 ft	12 ft	10 ft	?
North Lease Mine	24 & 30" diameter	skin to skin		sandstone	siltstone	sandstone	
PO Box 380							
Helper, UT 84526							
Tel: 435-6377925							
Sufco Mine	Cans (floor heave) timbers	As needed	As needed	Varies			Varies, as needed
397 South 800 West	rock props			Sandy Shale			
Salina, UT 84654							
Tel: 435-2864880							
John Byers - MNGE							
Westridge Mine	Cans	Varies	Always in tailgate	10-15 ft	Sandstone		Varies
PO Box 910				Shale			
East Carbon, Utah 84520							

Tel: 435-8884000						
Jay Marshall - MNGE						
Virginia						
Cumberland River	Cribs, Timbers	6	As needed	40-80 ft		As needed
Pardee Complex	Heinzman Jacks			Sandstone		
PO Box 109						
Appalachia, VA 24216						
Tel: 606-6339474						
Willie Adams - MNGE						
Knox Creek Coal Corp (Tiller 1)	Cribs, Timbers	As needed	As needed	5 ft	Competent rock	As needed
PO Box 519				Sandstone		
Raven, VA 24639						
Tel: 276-9644333						
Eric - MNGE						
Lone Mountain Processing Inc.	6x6 Timbers, cribs,	As needed	As needed	1-20 ft	1-20 ft	As needed
Drawer C	heinzman jacks			Shale	Sandstone	
St. Charles, VA 24282						
Tel: 606-8372299 ext 21						
James Sumner - MNGE						
West Virginia						
Bridger Coal Co.	Rock prop, timbers	As needed	As needed	1 ft	19 ft	As needed
PO Box 68,	cribs			Claystone	Siltstone	
Point of Rocks, WY 82942						
Tel: 307-3829741 (603)						
Tom Hurst - MNGE						
Coal-Mac Inc, Mountaineer Mine	Timbers, Cribs	As needed	As needed	20-30 ft	10-20 ft	Varies, as needed
Ragland Complex				Sandstone	Shale	
PO Box 1050						
Holden, WV 25625						
Tel: 304-6644000						
Brian Damron - MNGE						
Independence (Justice Mine)	Propsetters or cribs	8	As needed	5-20 ft	20-30 ft	1-6 months

PO Box 1800				Shale	Sandstone		
Madison, WV 25130							
Tel: 304-3697103							
Andy Ashurst - MNGE							
Kingston No 1	Nil			1 ft	50 ft		
PO Box 76-C				sandy shale	sandstone		
Scarbro, WV 25917							
Tel: ???????							
Loveridge Mine	Cribs, cans	5	Always installed on retreat	Shale	Sandrock	Limestone	A few months
County Road M, 2 miles N of Fairview							
Fairview, WV 26570							
Tel: 304-6621229							
Mark Cramer - MNGE							
McElroy Mine	24" Cans, cribs,	6' edge to edge	Always installed	10	Very thick		1 mo - 1 yr
Rd 1 (Marshall Co),	Rock props			Poorly laminated shale	Massive Limestone		
Glen Easton, WV 26039							
Tel: 304-8433700							
Eric Shereda - MNGE							
Miller Creek Complex	Cribs, Timbers	As needed	As needed	Shale or Sandstone	10 ft		As needed
1 Stella Deskins Drive					Sandstone		
Williamson, WV 25661							
Tel: 304-2351850 ext 11							
Duffy Farrell - MNGE							
Mountaineer 2 Mine	Cribs, Posts	6' edge to edge	Always installed	4-8 ft	Sandstone		Varies
Box 100, State Route 17,				Shale			
Sharples, WV 25183							
Tel: 304-3697518							
Rob Brawner - MNGE							
Performance (Upper Big Branch)	Cribs	As needed	As needed	0-2 ft	60 ft		As needed
PO Box 457,				Shale	Sandstone		
Whitesville, WV 25209							
Tel: 304-8541761							

George Leao - MNGE							
Pinnacle Mine	Propsetter	4-5 ft or	As needed	2-3 ft	20-50 ft		As needed
Pinnacle Creek Road	4 Point Crib	as needed		Shale	Sandstone		
PO Box 338							
Pineville, WV 24874							
Tel:304-7325337							
David Trade - MNGE							
Rockspring Mine	Cribs, Timbers	As needed	As needed	80 ft	Sandstone		As needed
PO Box 390				Shale			
East Lynn, WV 25512							
Tel: 304-720-2531							
George Smith - Senior Engineer							
Shoemaker Mine	Water Rock props	As needed	As needed	10-14 ft	20-30 ft		As needed
PO Box 62A (Ohio Co)				Laminated Shale	Limestone		
Dallas, WV 26036							
Tel: 304-2381500							

APPENDIX B

THE UNPLANNED FALL RESULTS FROM MSHA

The results for each of the 11 MSHA Coal Districts are given, and it should be noted that all District Offices visited were very helpful.

The MSHA Districts are responsible for the following geographical areas:

District 1	Anthracite coal mining regions in Pennsylvania
District 2	Bituminous coal mining regions in Pennsylvania
District 3	Maryland, Ohio, and Northern West Virginia
District 4	Southern West Virginia
District 5	Virginia
District 6	Eastern Kentucky
District 7	Central Kentucky, North Carolina, South Carolina, and Tennessee
District 8	Illinois, Indiana, Iowa, Michigan, Minnesota, Northern Missouri, Wisconsin
District 9	All States west of the Mississippi River, except for Minnesota, Iowa, and Northern Missouri
District 10	Western Kentucky
District 11	Alabama, Georgia, Florida, Mississippi, Puerto Rico, Virgin Islands

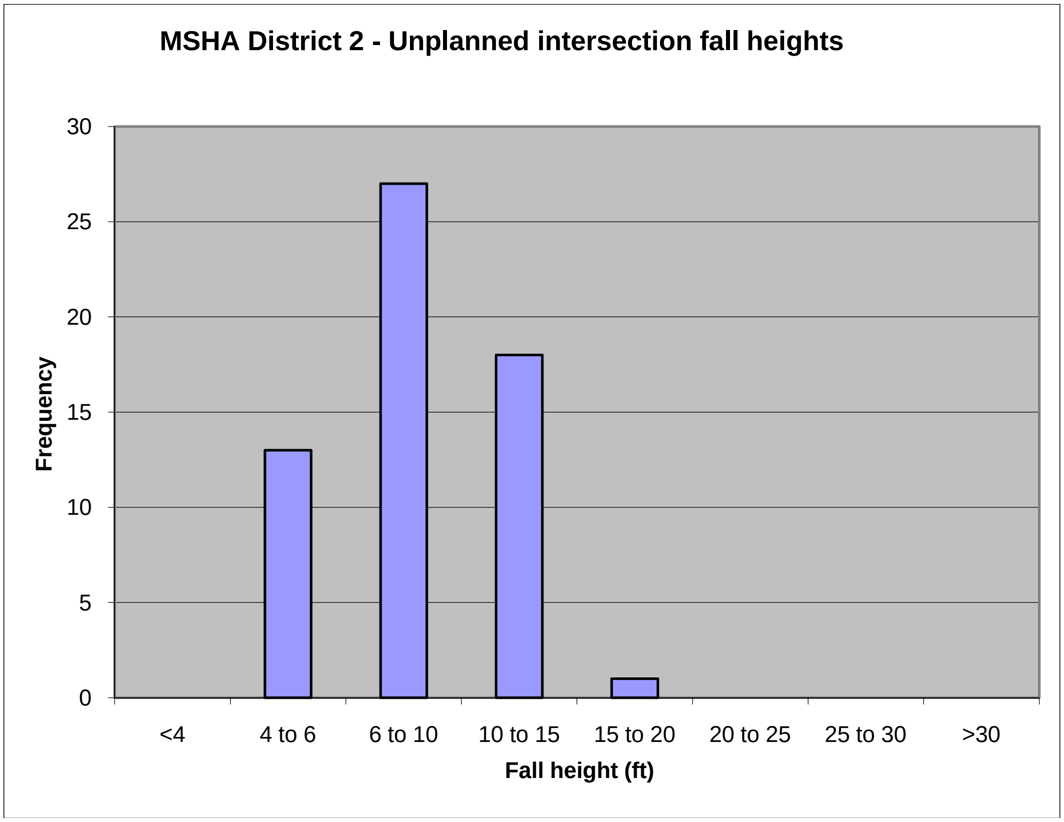
RESULTS FOR MSHA DISTRICT 1

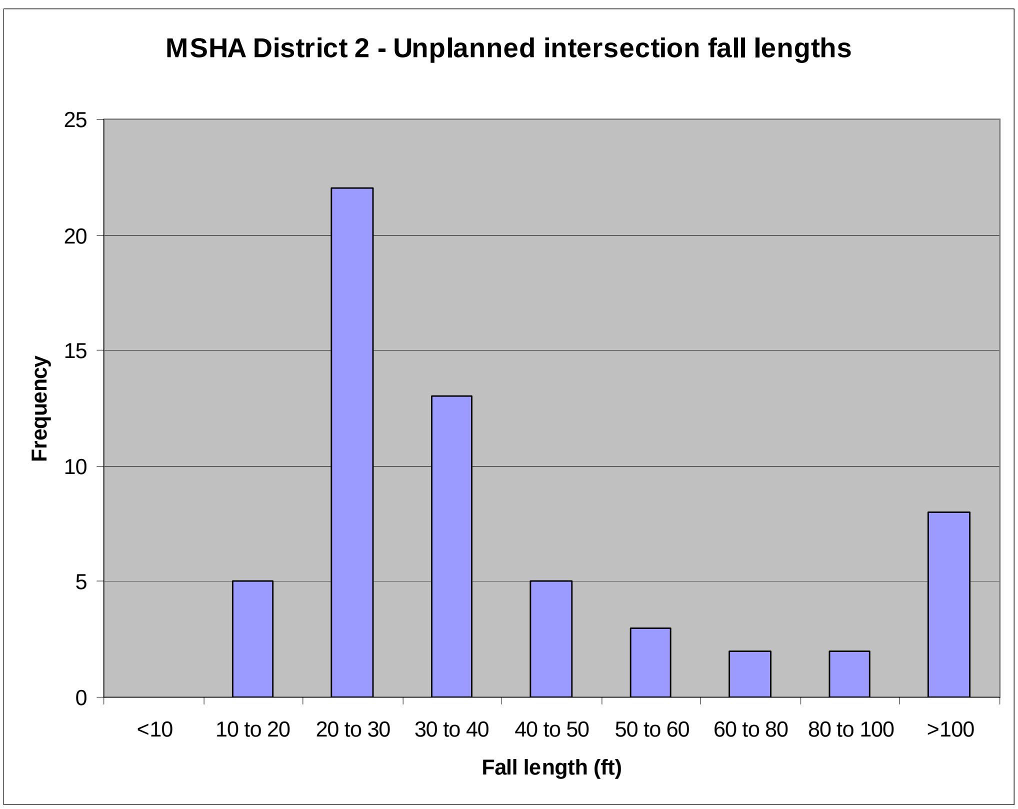
The following are the underground mines in District 1. Of these, 3 are listed as currently “not active”.

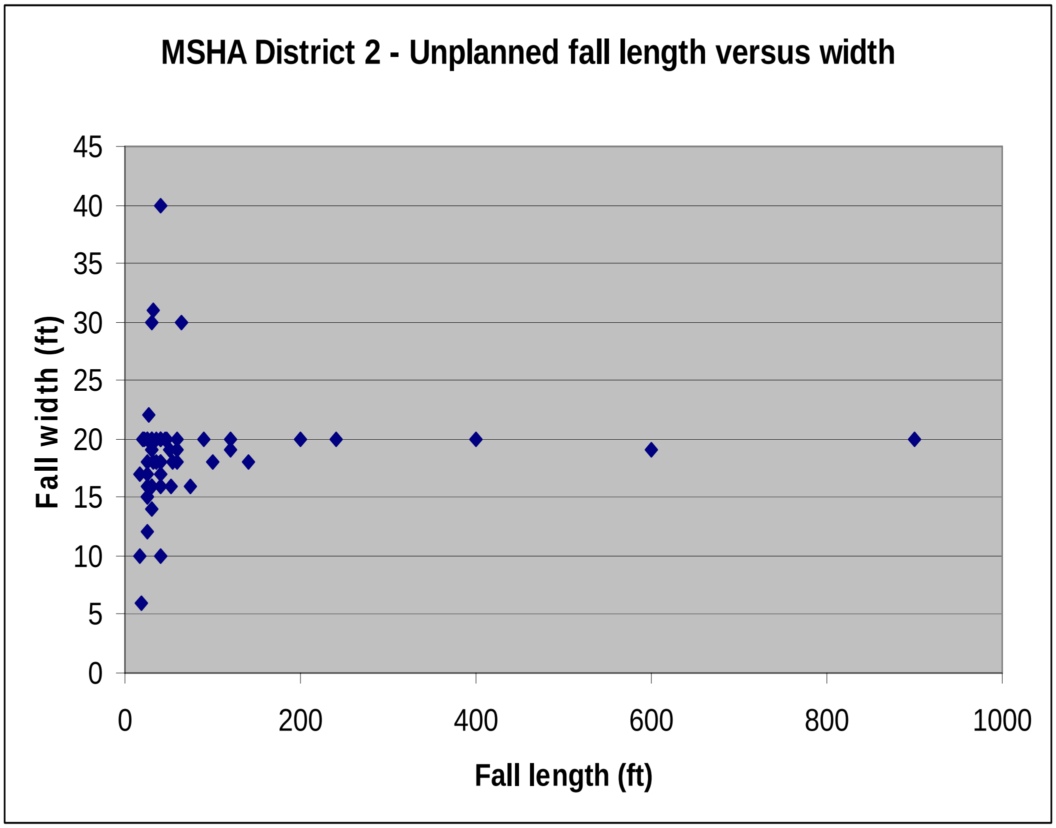
The MSHA Data Retrieval System indicated that between 2005 and June 2008, there had been no unplanned rock falls reported.

*Mine ID	Operator Name	Mine Name
3601818	R S & W Coal Company Inc	R S & W Drift
3602022	S & M Coal Company	Buck Mountain Slope
3602203	Bear Gap Coal	N & L Slope
3606815	Tito Coal	Whites Vein Slope
3607741	B & B Coal Company	Rock Ridge No 1 Slope
3607838	Uae Coalcorp Associates	Harmony Mine
3608299	Little Buck Coal Company	No 2 Slope
3608341	R & K Coal Company Inc	Primrose Slope
3608346	Orchard Coal Company	Primrose Slope
3608637	F K Z Coal Inc	No 1 Slope
3608702	Joliett Coal Company	#3 Vein Slope
3608893	Alfred Brown Coal Company	7 Ft Slope
3609435	Kimmel's Mining, Inc	Williamstown Mine #1
3609475	Chestnut Coal Co	No 13 Slope
3609491	Little Buck Coal Company	Bottom Split Slope
3609493	Chestnut Coal Co	No 12 Slope

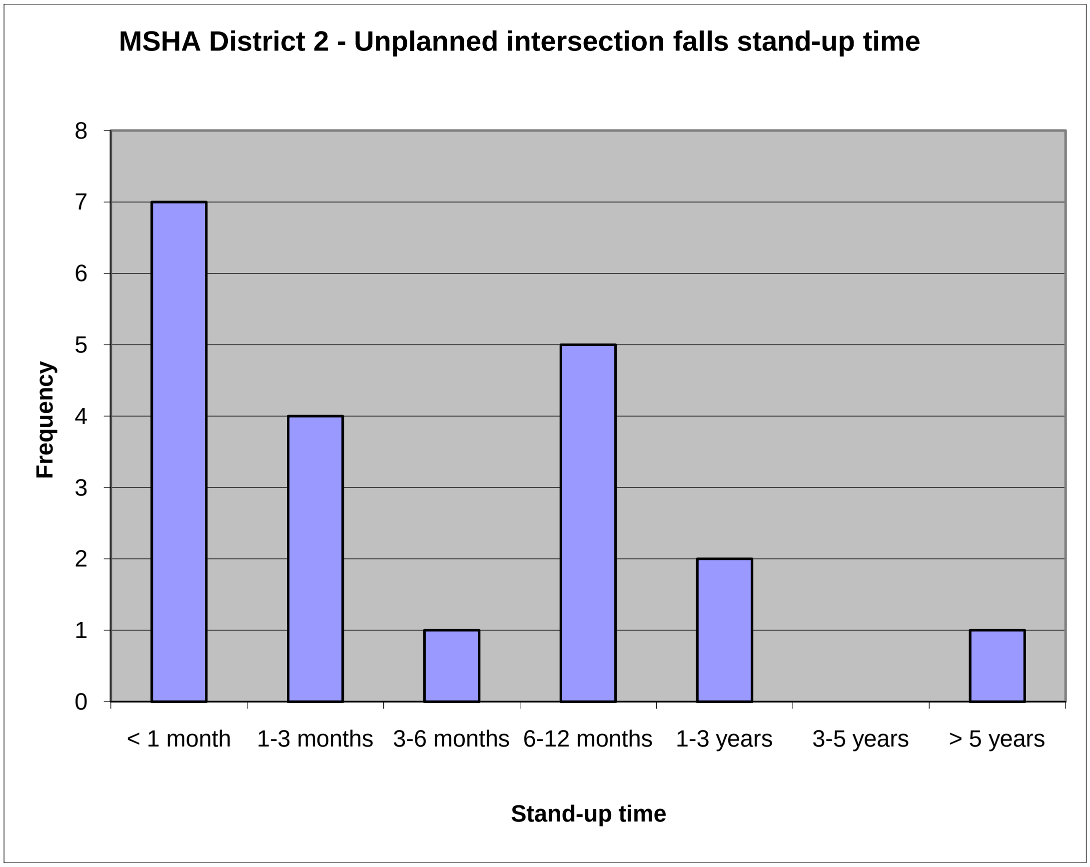
RESULTS FOR MSHA DISTRICT 2





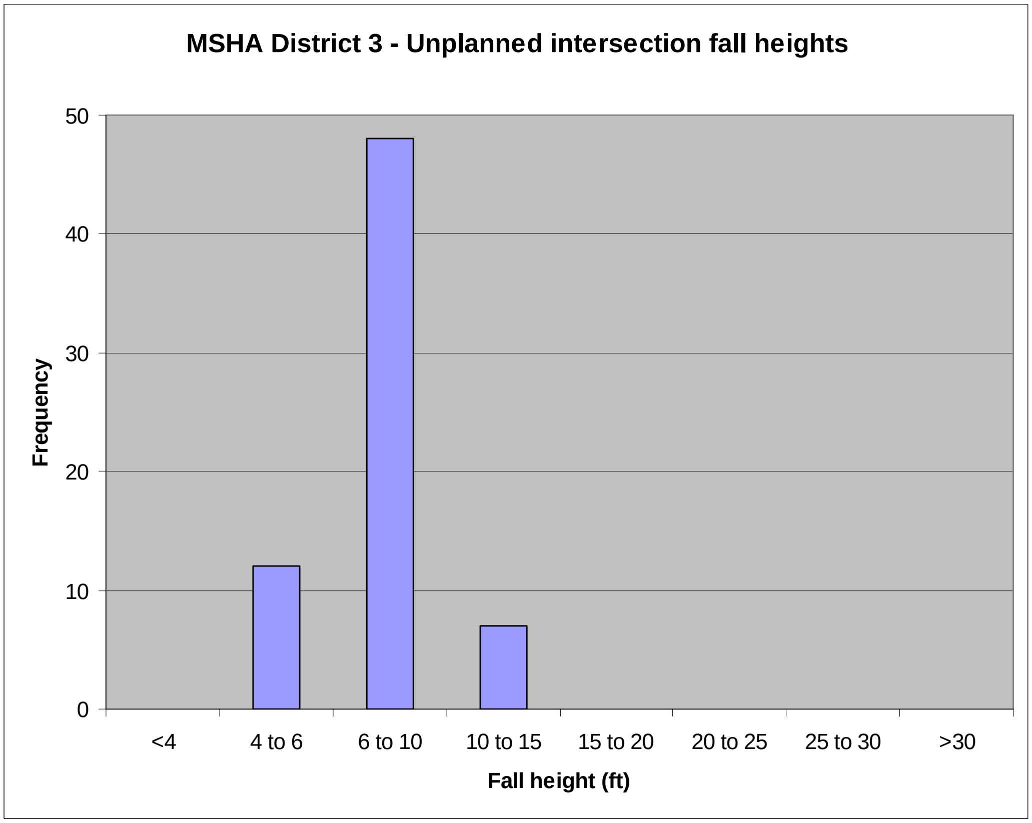


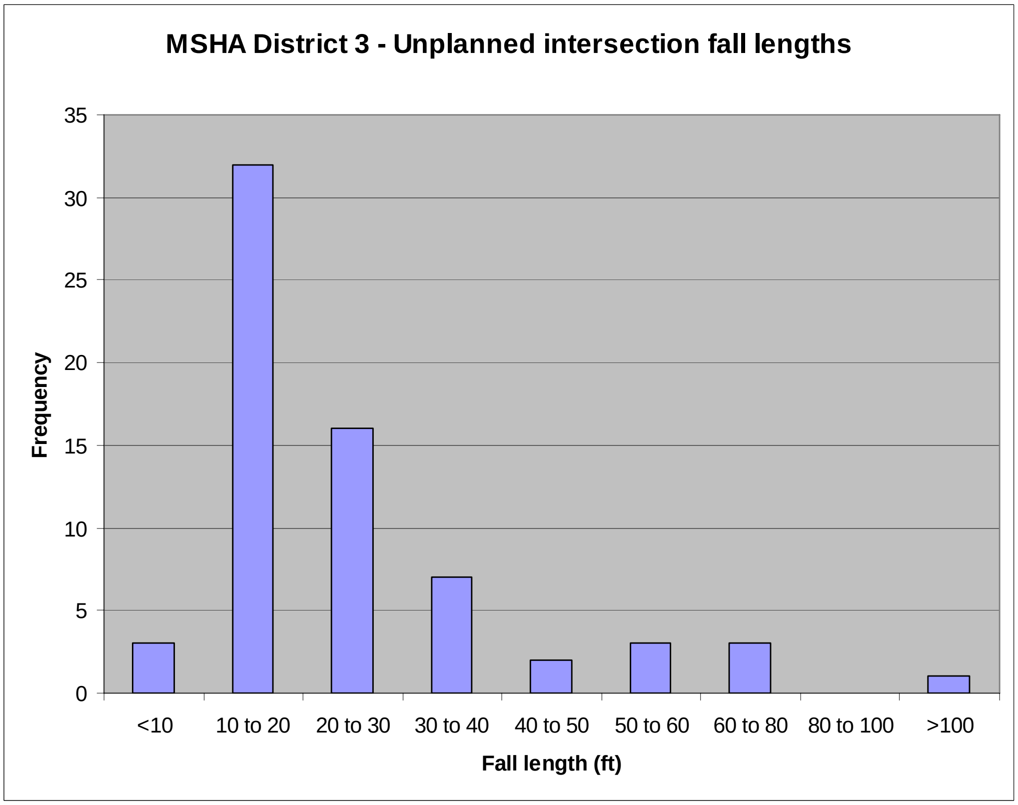
MSHA District 2 - Unplanned fall length versus width
Fall width (ft)
45
40
35
30
25
20
15
10
5
0
0
200
400
600
800
1000
Fall length (ft)

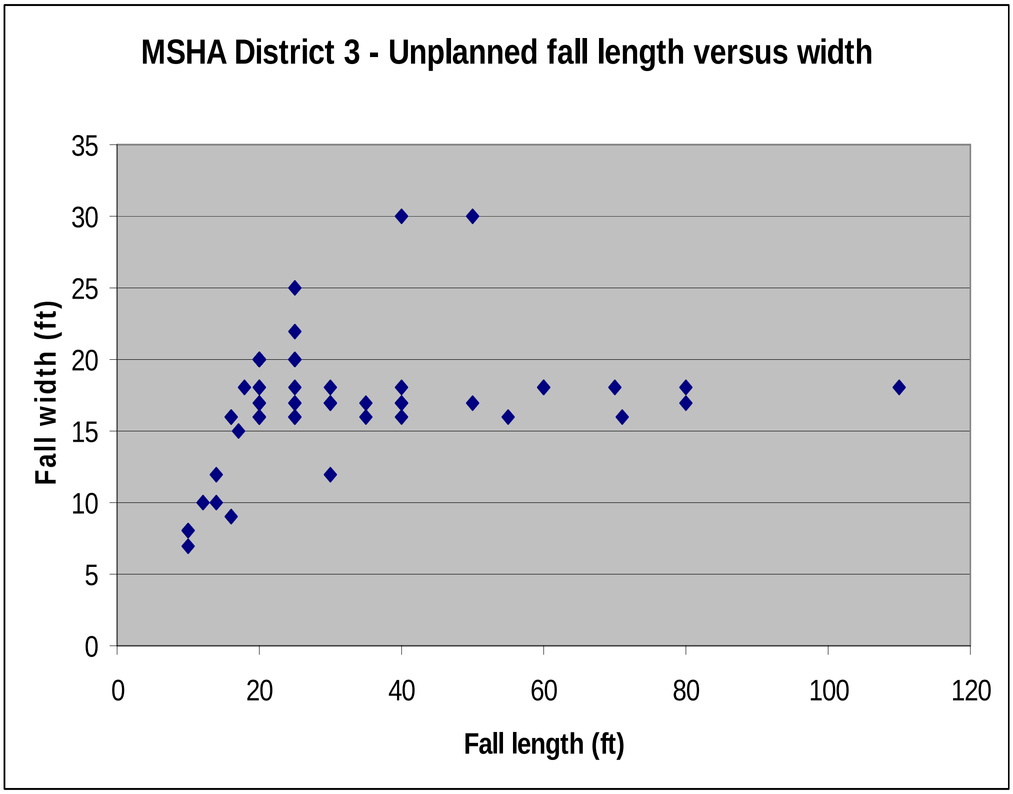


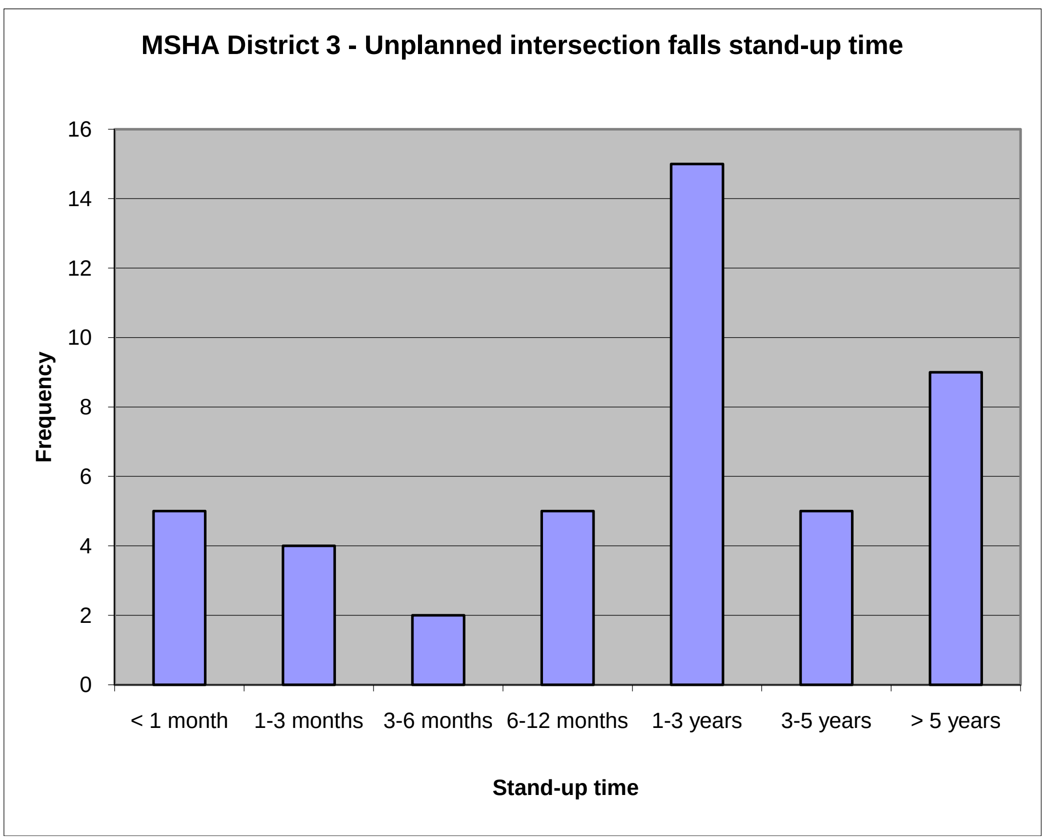
MSHA District 2 - Unplanned intersection falls stand-up time
Frequency
8
7
6
5
4
3
2
1
0
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years
Stand-up time

RESULTS FOR MSHA DISTRICT 3

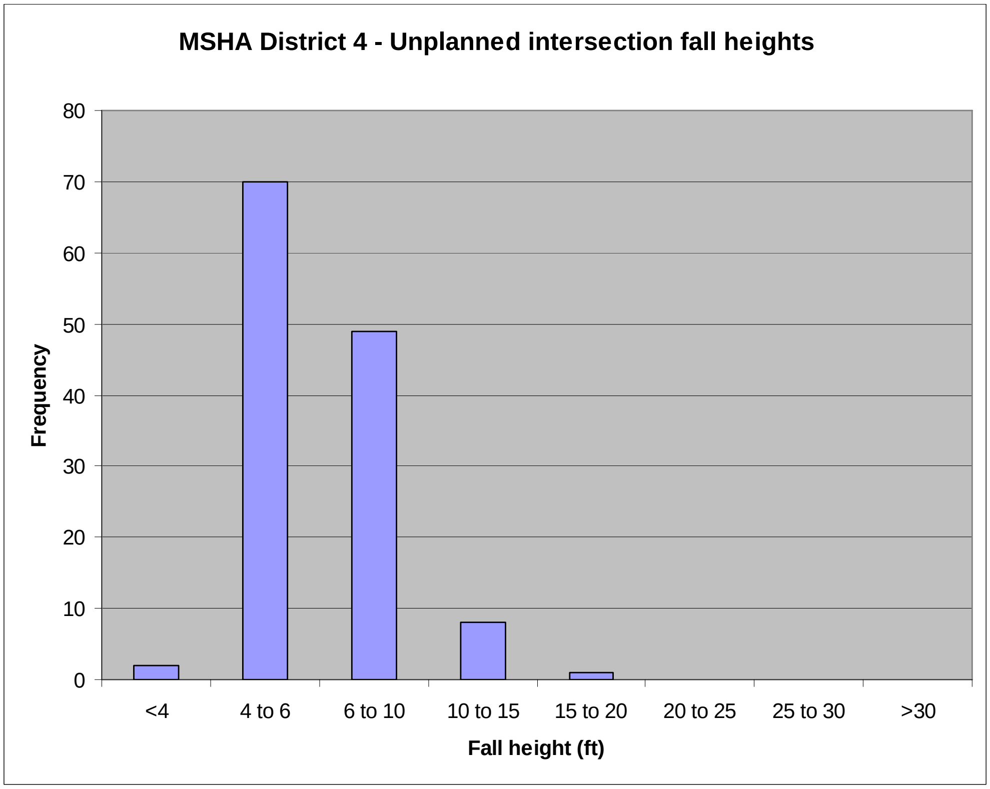


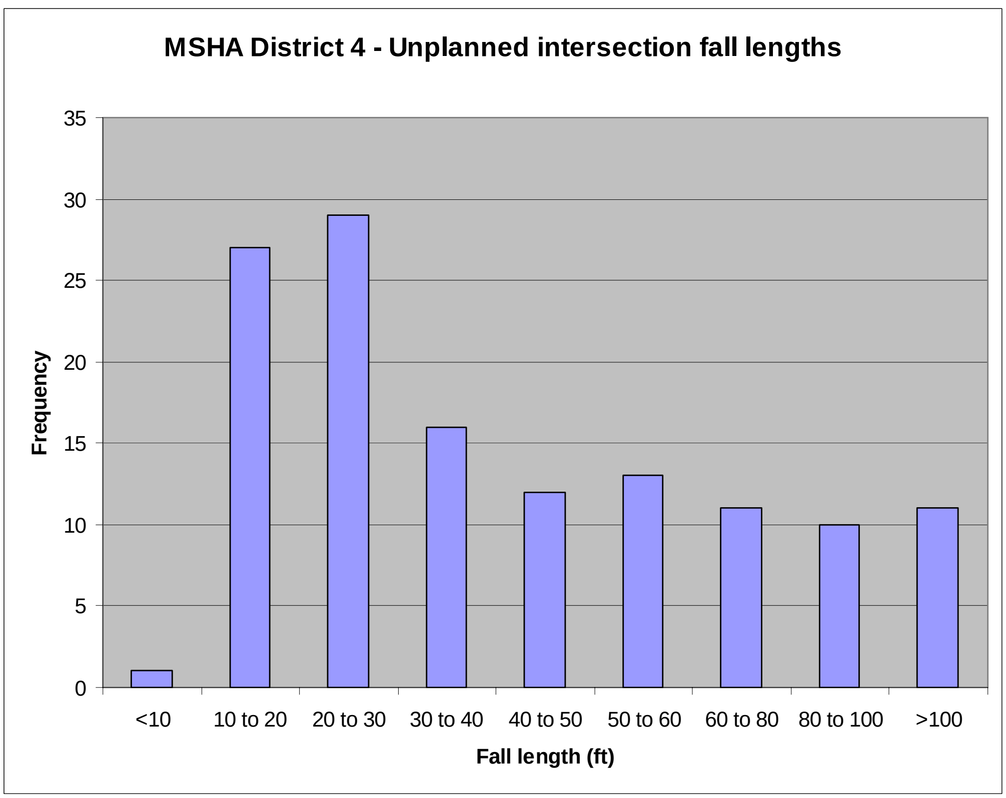


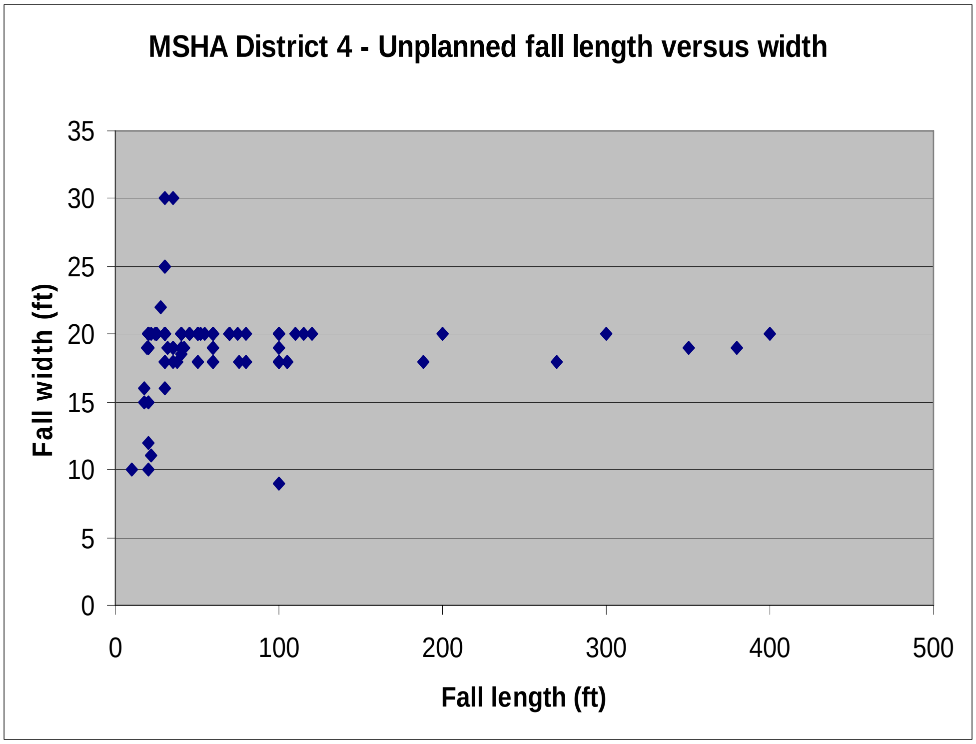

MSHA District 3 - Unplanned fall length versus width
Fall width (ft)
Fall length (ft)
0
5
10
15
20
25
30
35
0
20
40
60
80
100
120

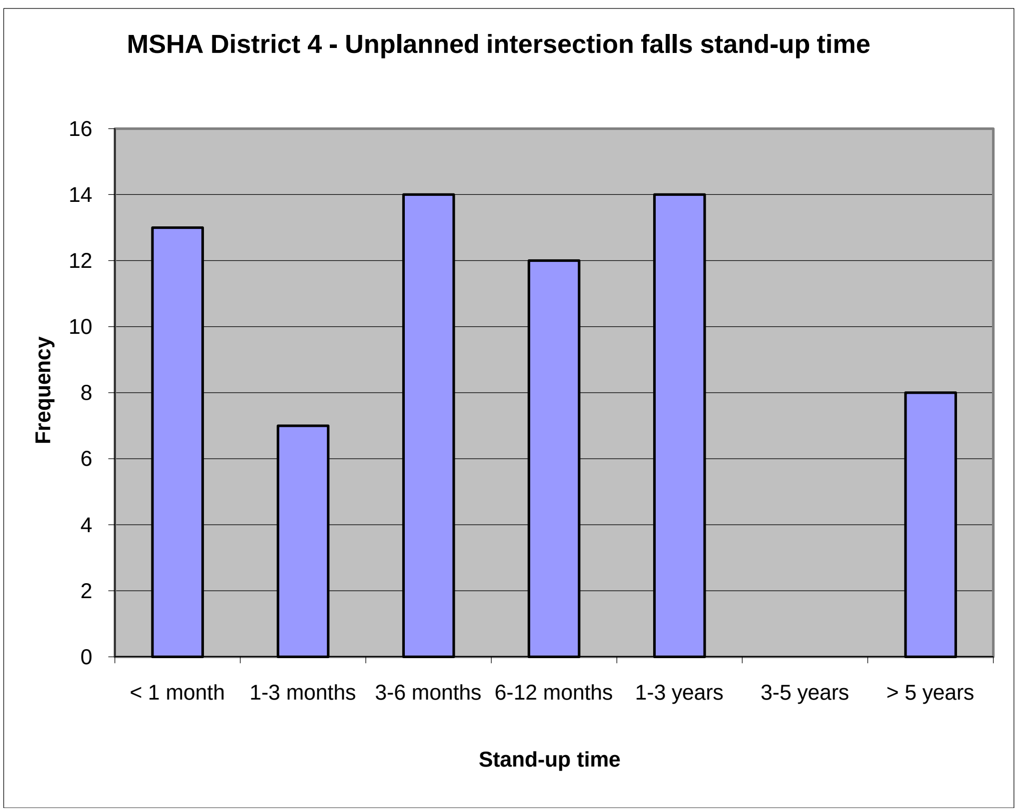

MSHA District 3 - Unplanned intersection falls stand-up time
Frequency
Stand-up time
0
2
4
6
8
10
12
14
16
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years

RESULTS FOR MSHA DISTRICT 4

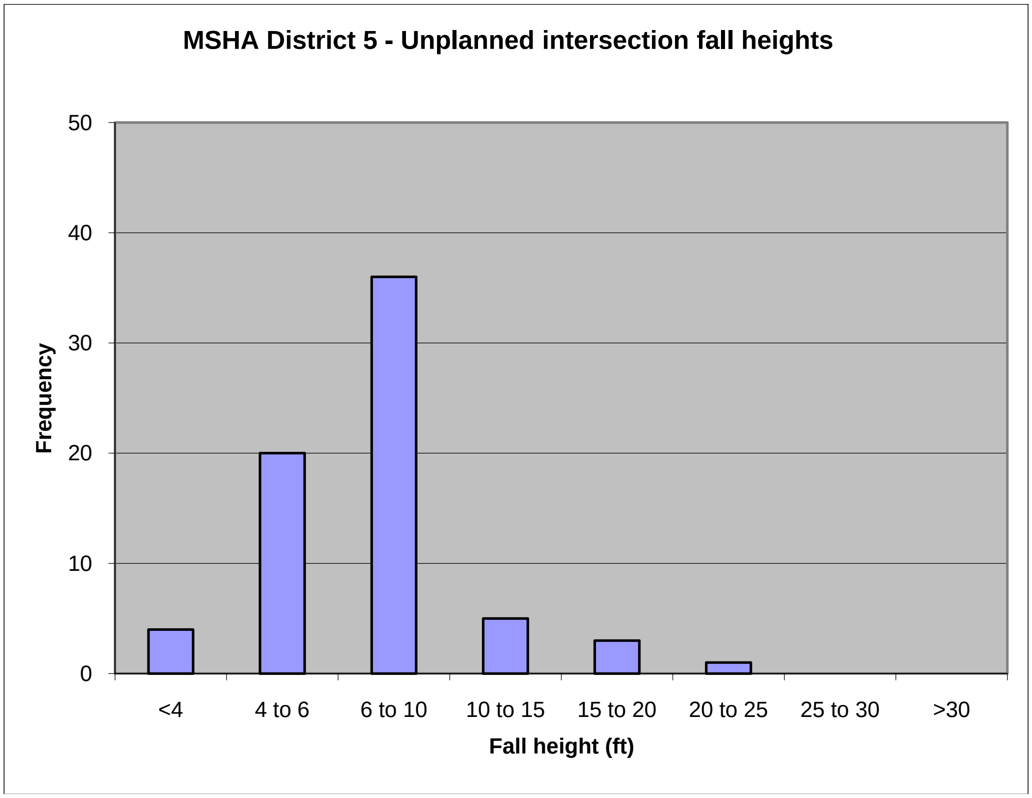


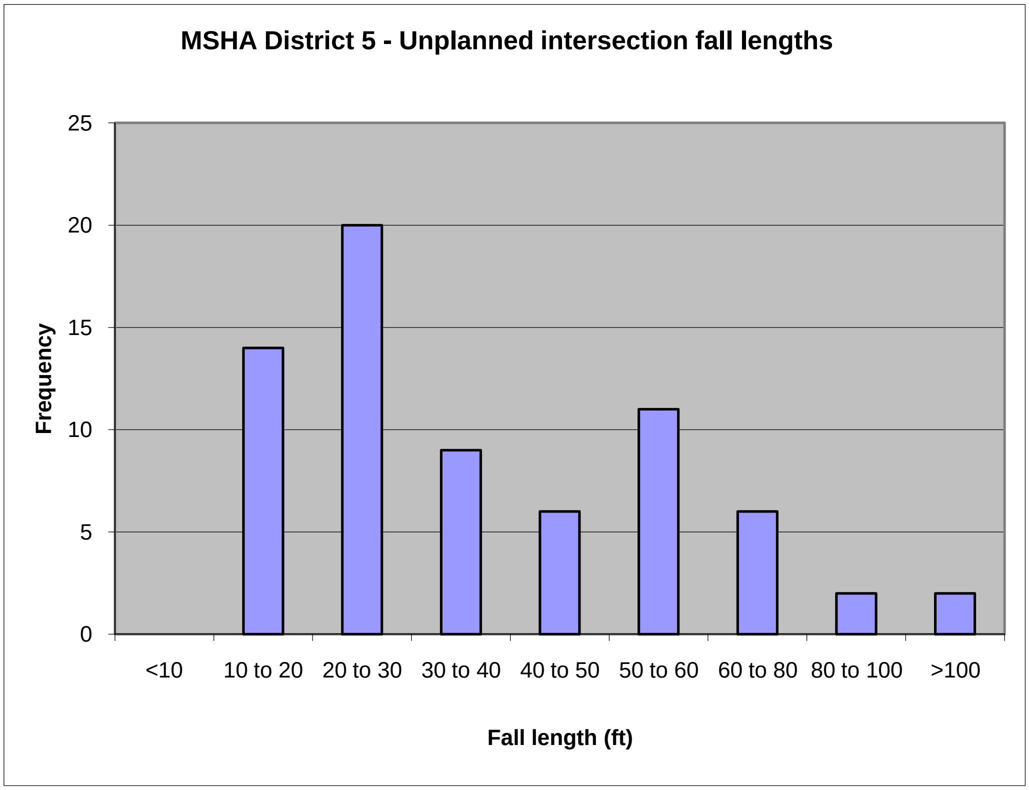


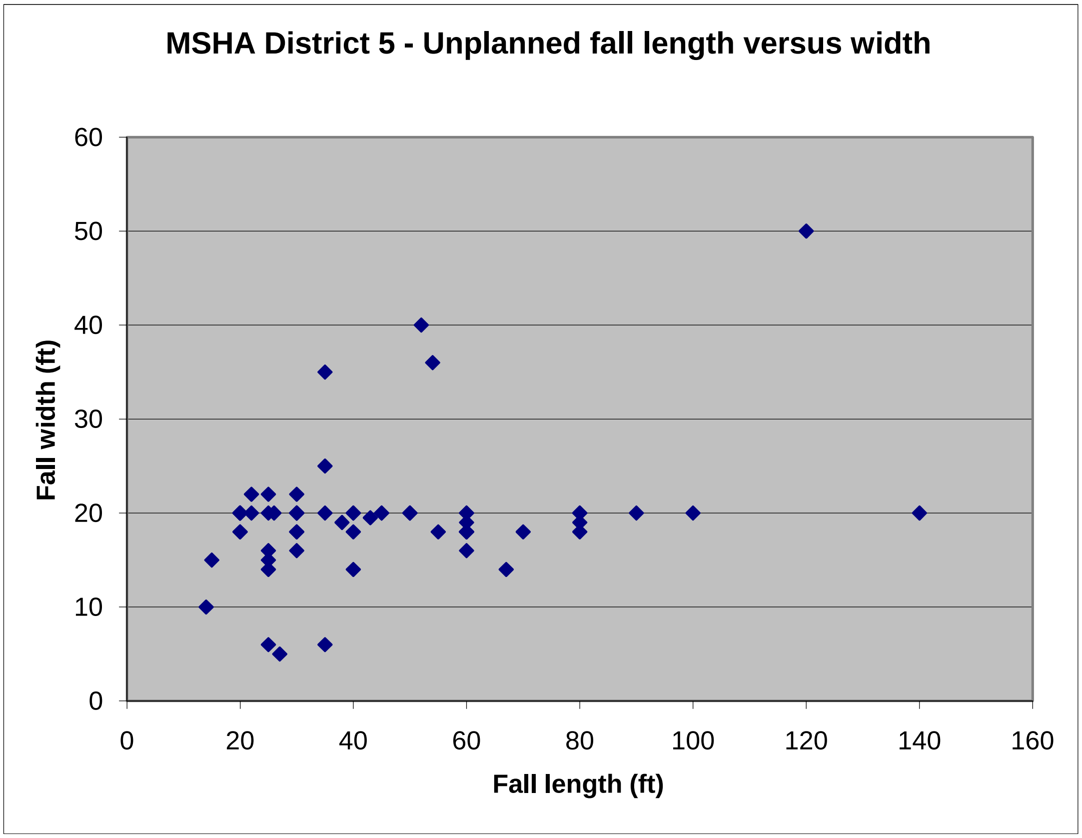

MSHA District 4 - Unplanned fall length versus width
Fall width (ft)
35
30
25
20
15
10
5
0
0
100
200
300
400
500
Fall length (ft)

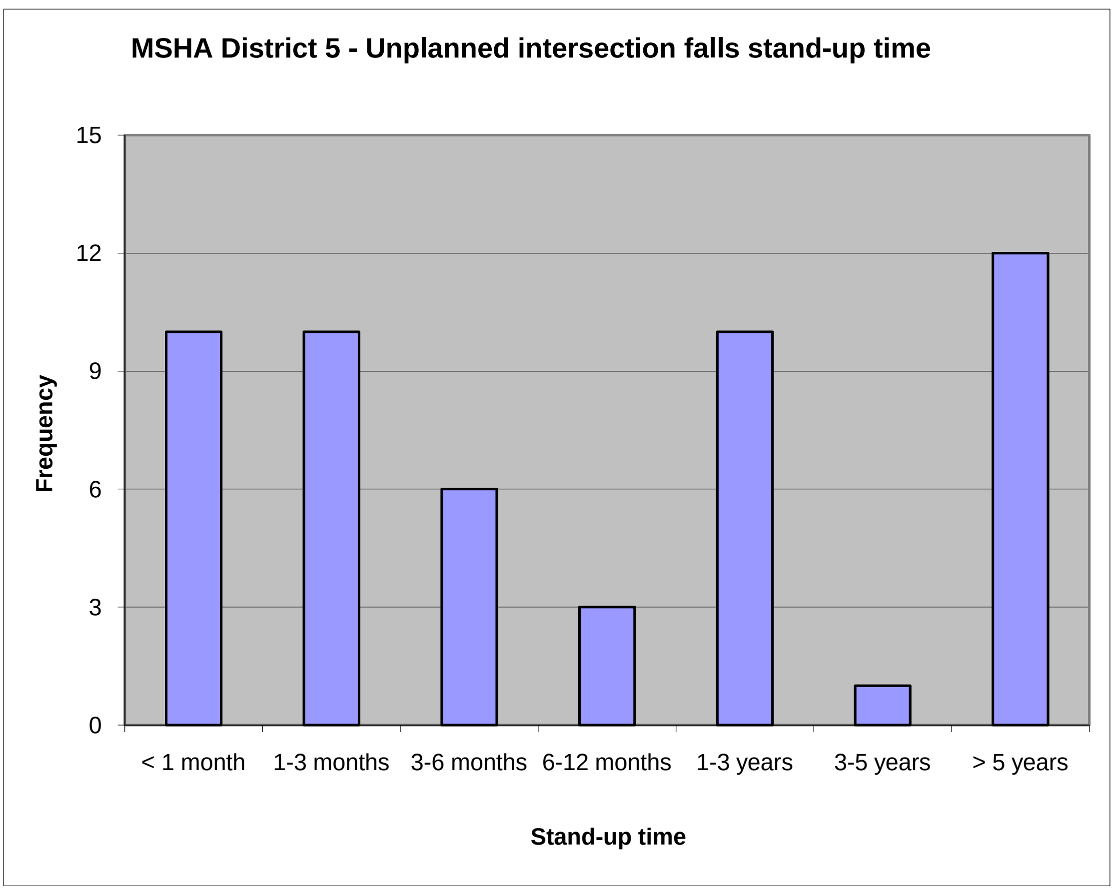

MSHA District 4 - Unplanned intersection falls stand-up time
Frequency
16
14
12
10
8
6
4
2
0
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years
Stand-up time

RESULTS FOR MSHA DISTRICT 5

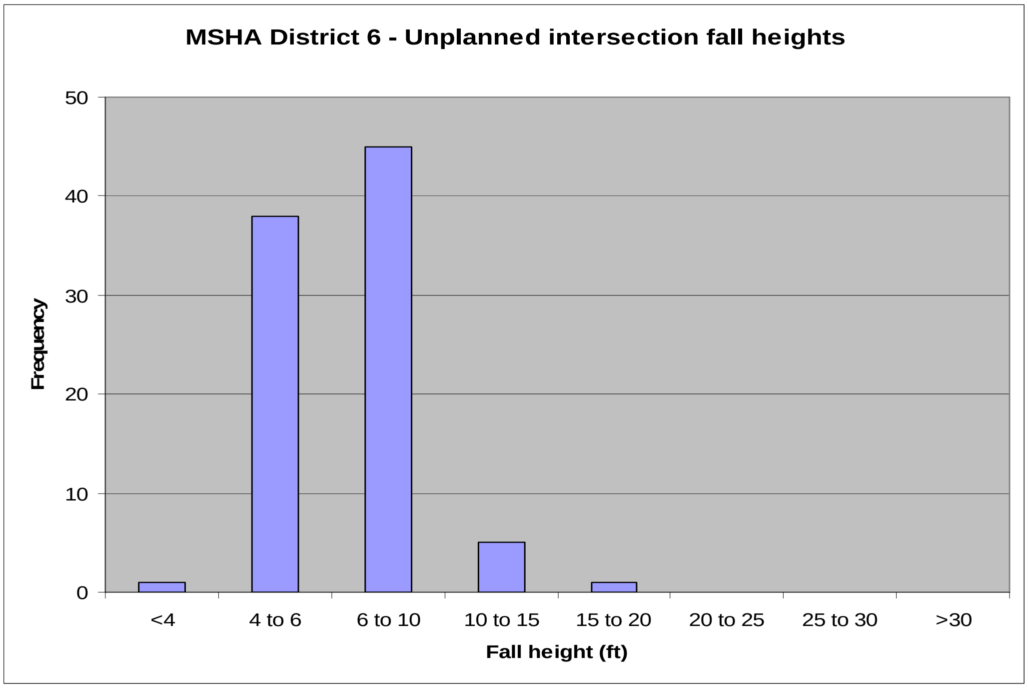


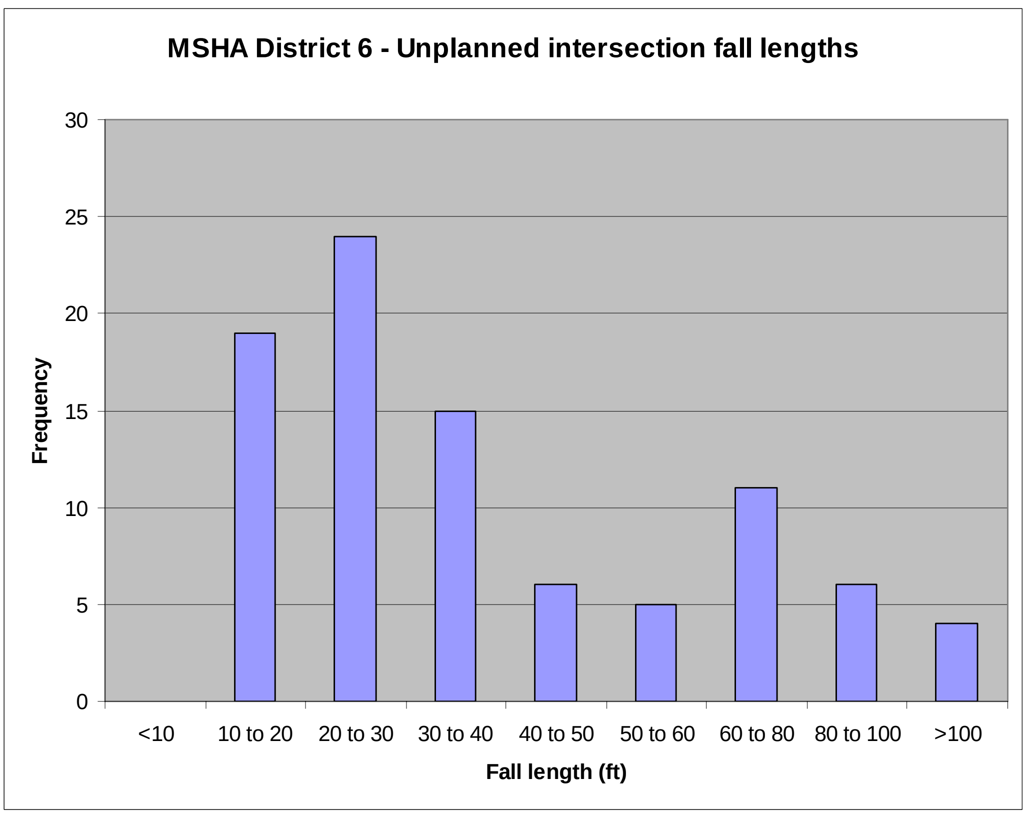


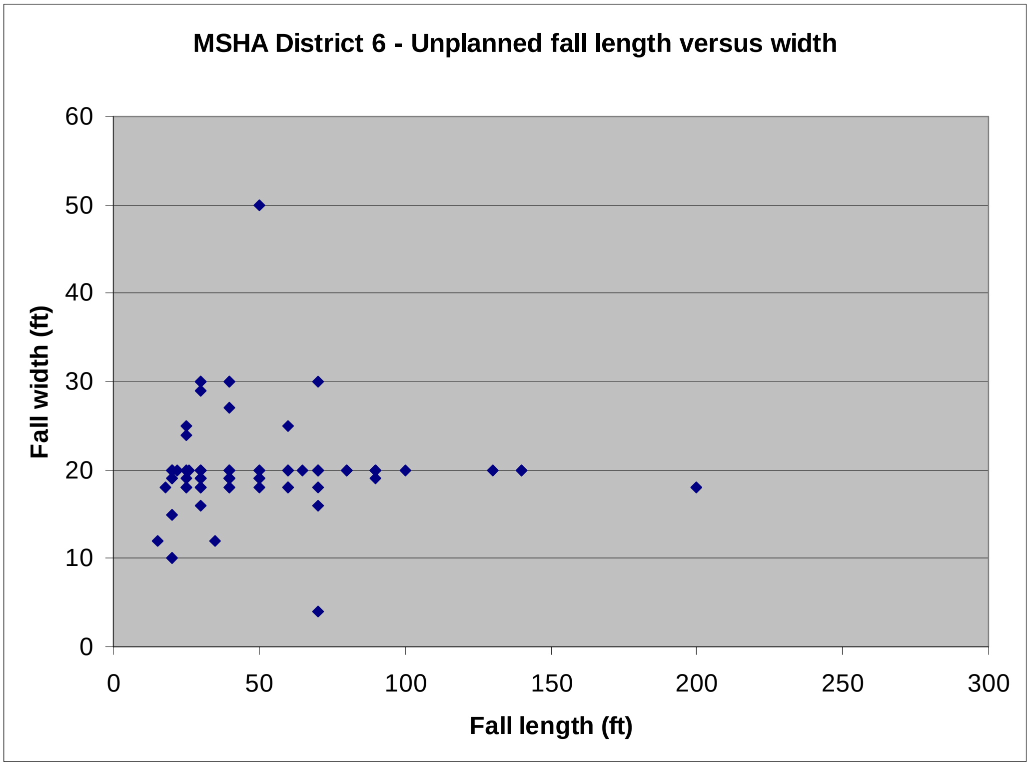

MSHA District 5 - Unplanned fall length versus width
Fall width (ft)
Fall length (ft)
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160

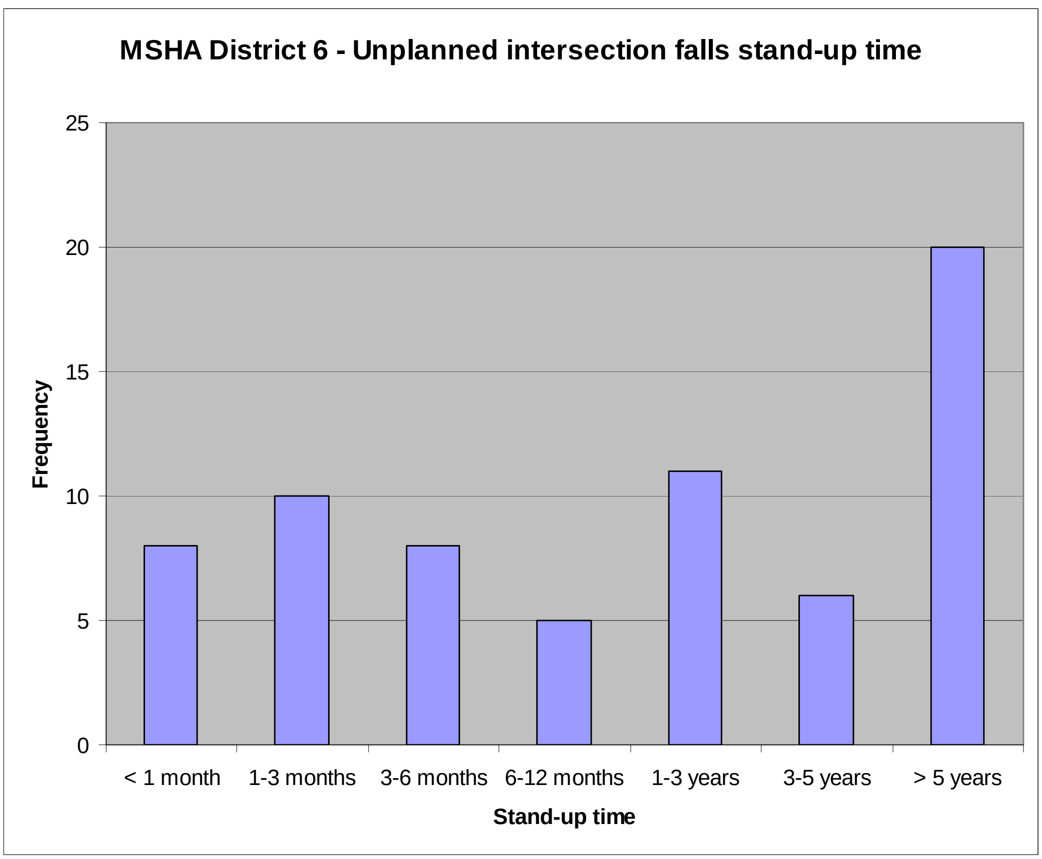

MSHA District 5 - Unplanned intersection falls stand-up time
Frequency
0
3
6
9
12
15
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years
Stand-up time

RESULTS FOR MSHA DISTRICT 6

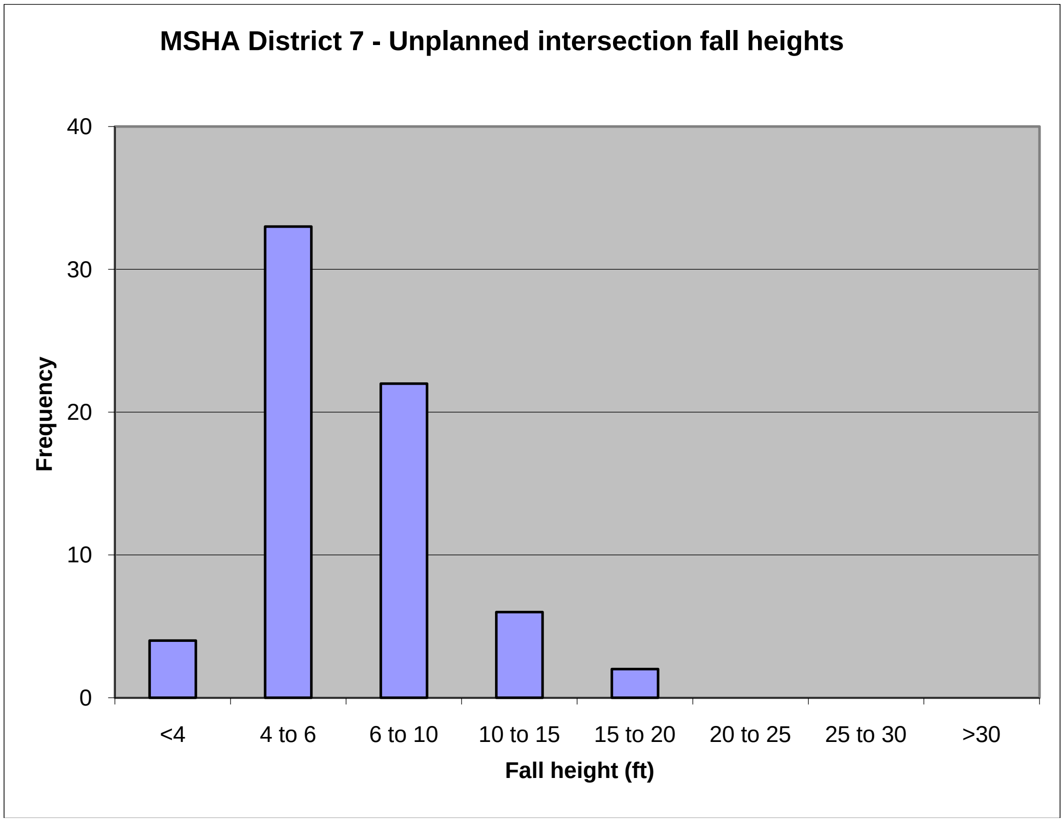


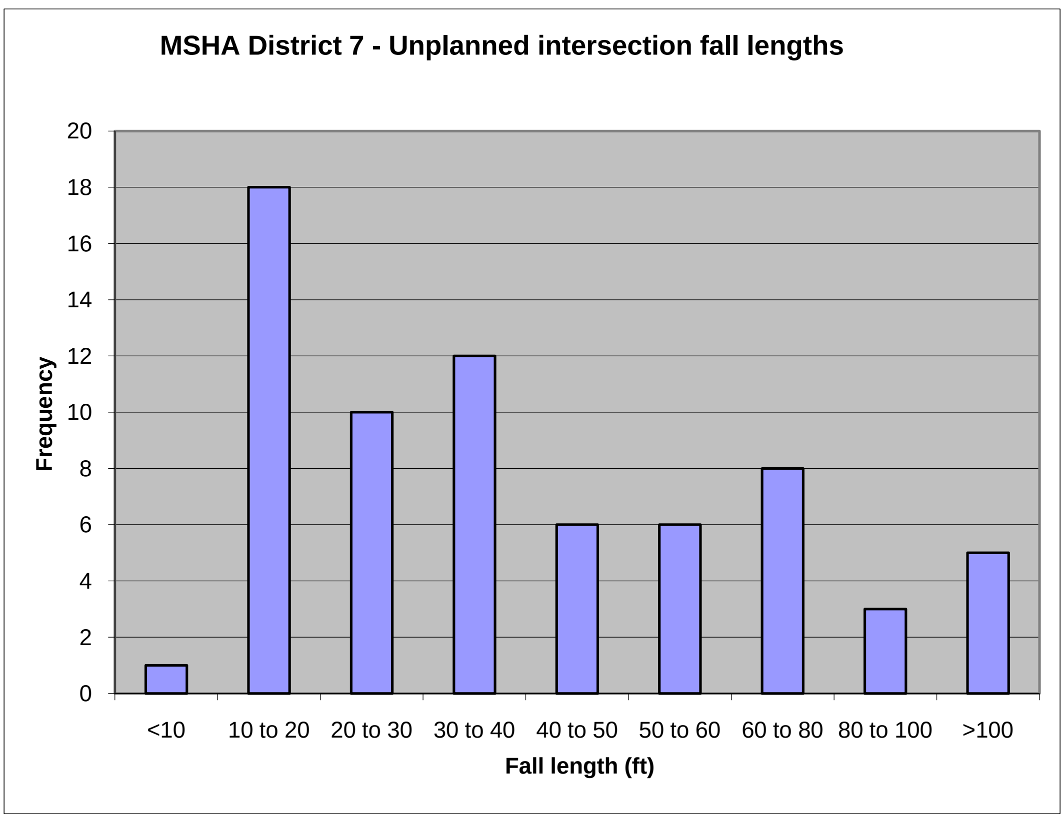


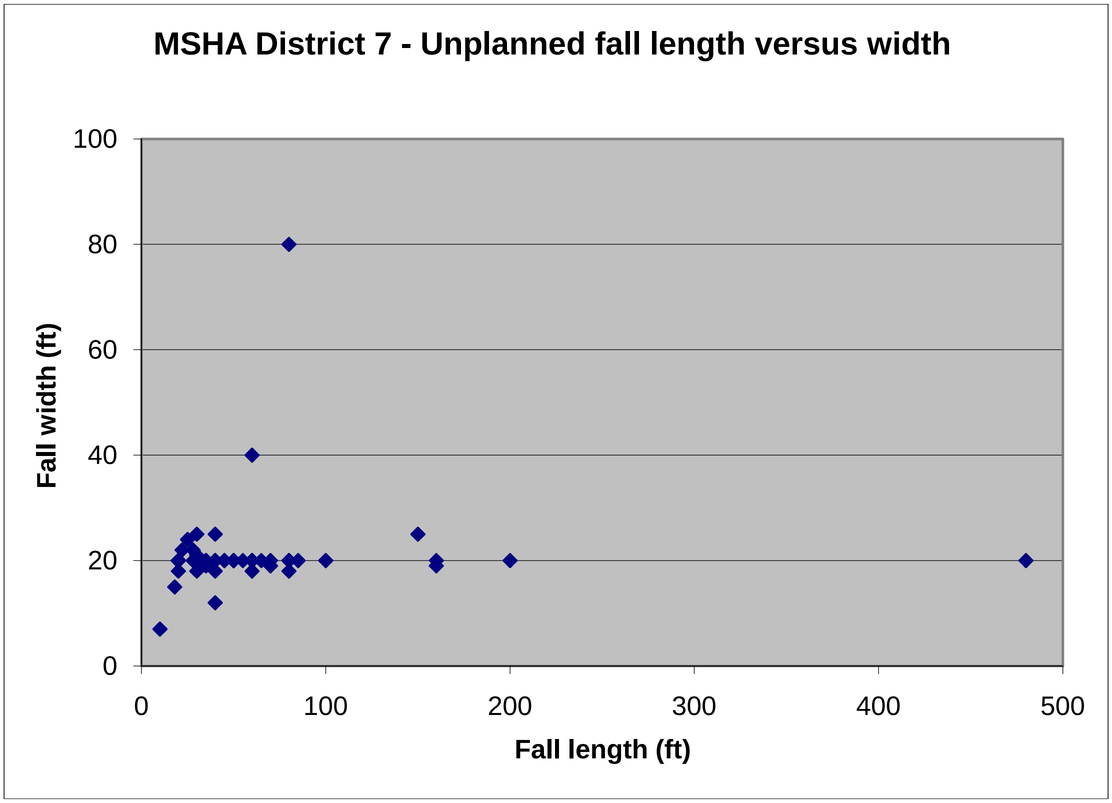

MSHA District 6 - Unplanned fall length versus width
Fall width (ft)
60
50
40
30
20
10
0
0
50
100
150
200
250
300
Fall length (ft)

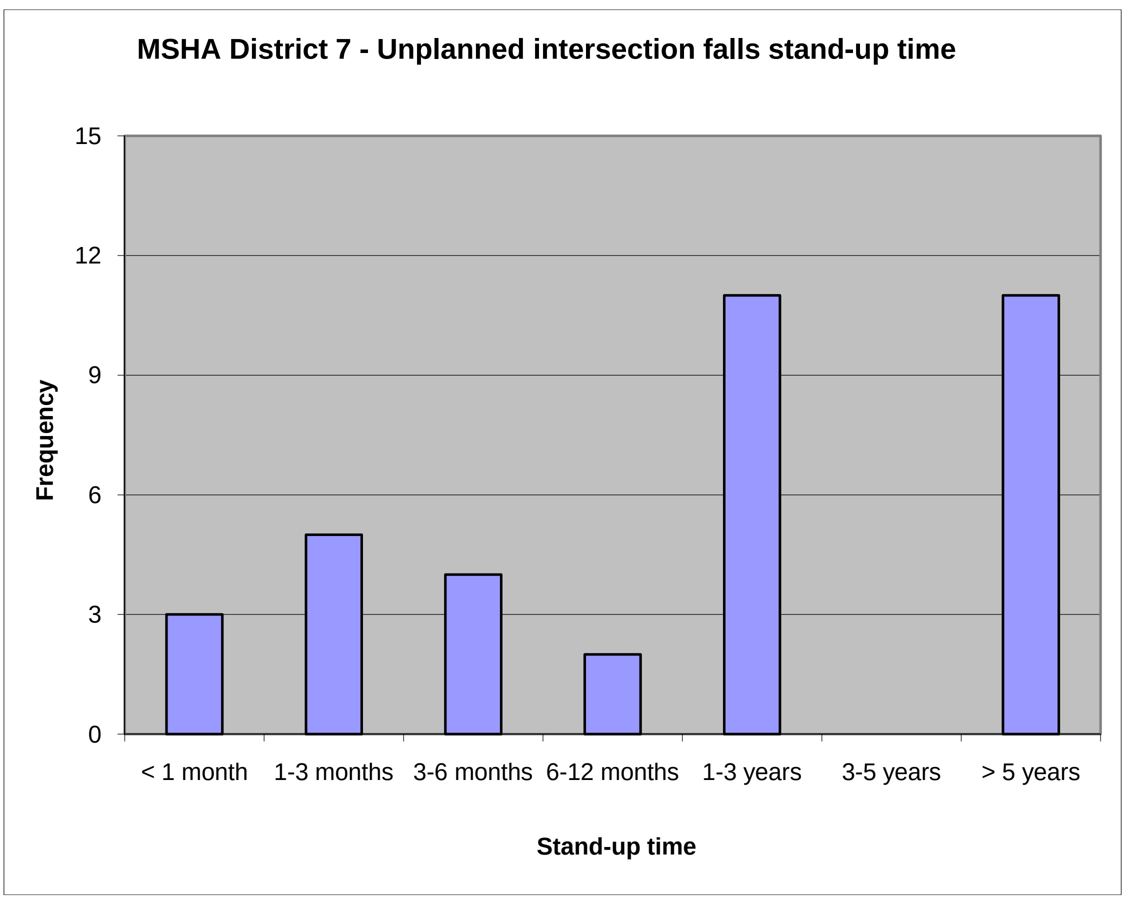

MSHA District 6 - Unplanned intersection falls stand-up time
Frequency
25
20
15
10
5
0
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years
Stand-up time

RESULTS FOR MSHA DISTRICT 7

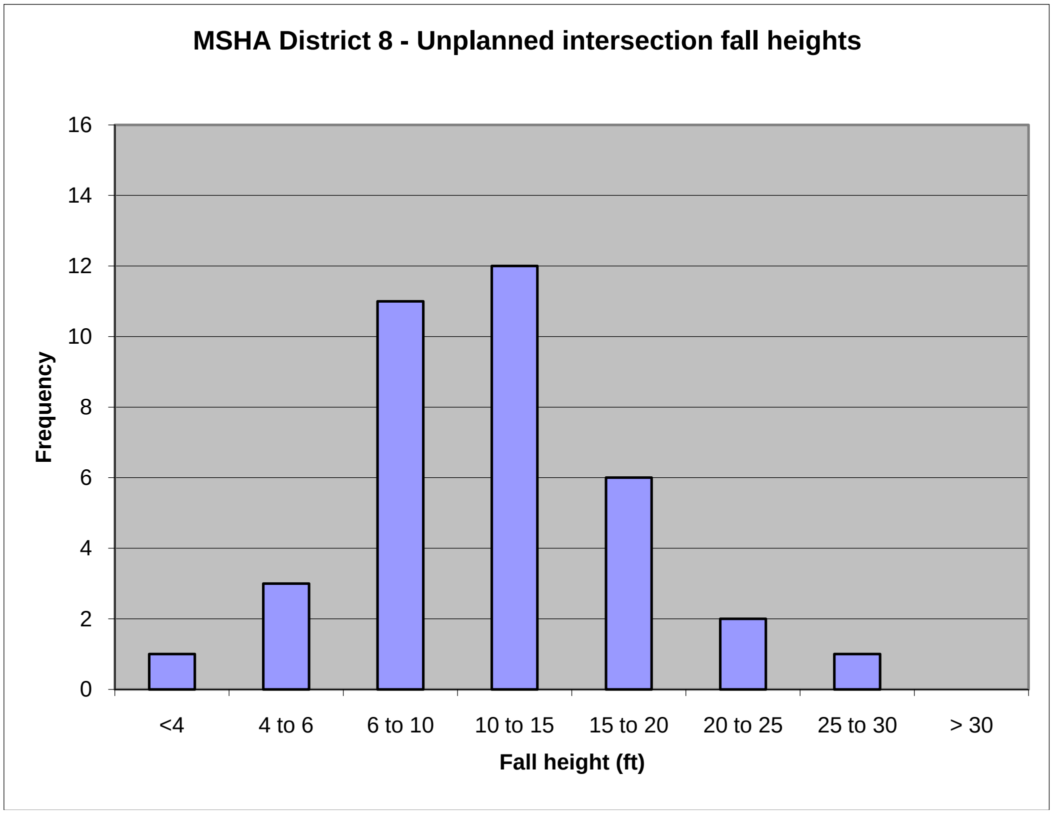


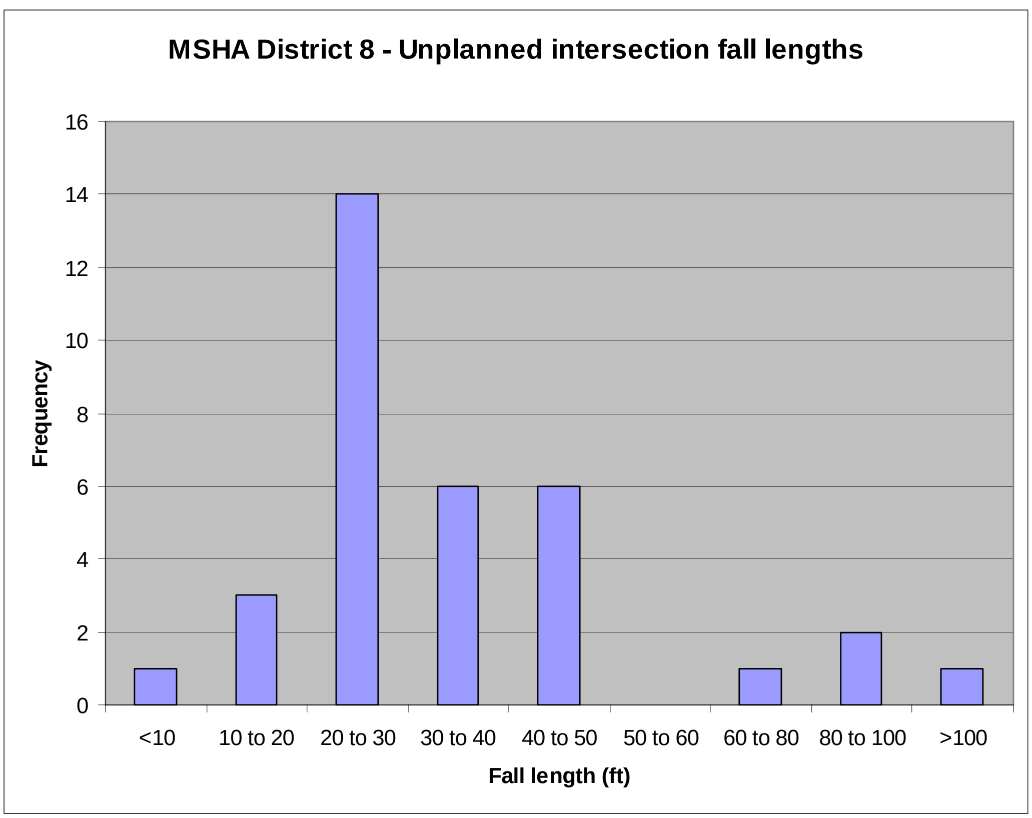


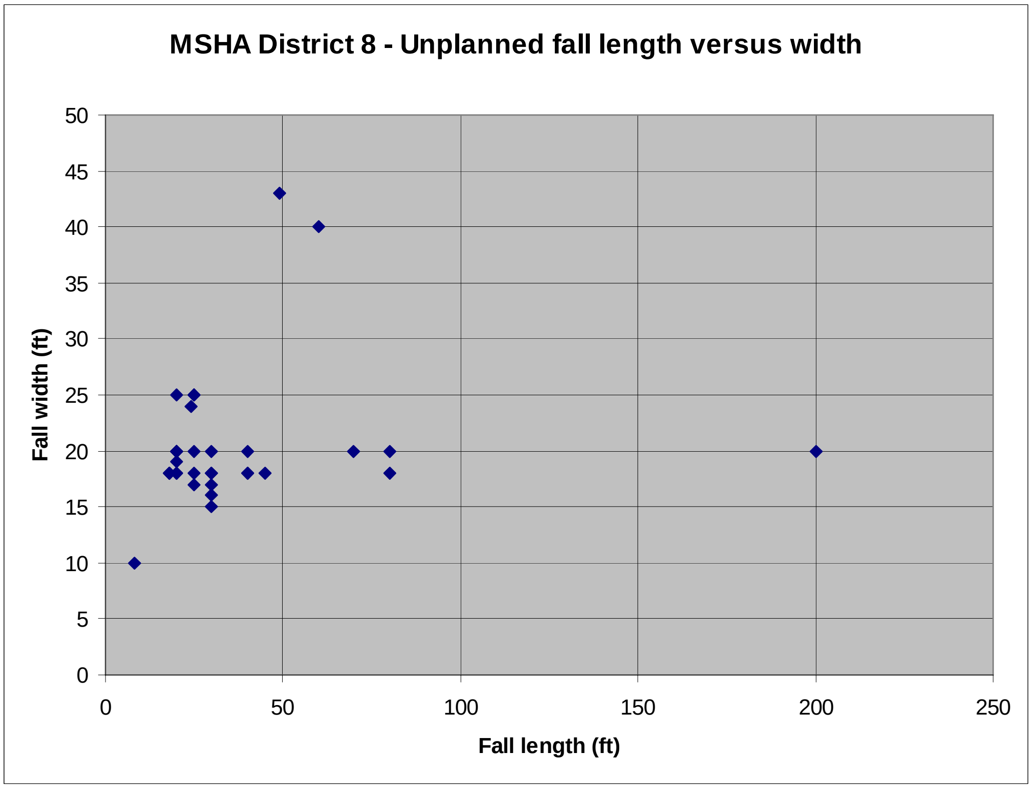

MSHA District 7 - Unplanned fall length versus width
Fall width (ft)
100
80
60
40
20
0
0
100
200
300
400
500
Fall length (ft)

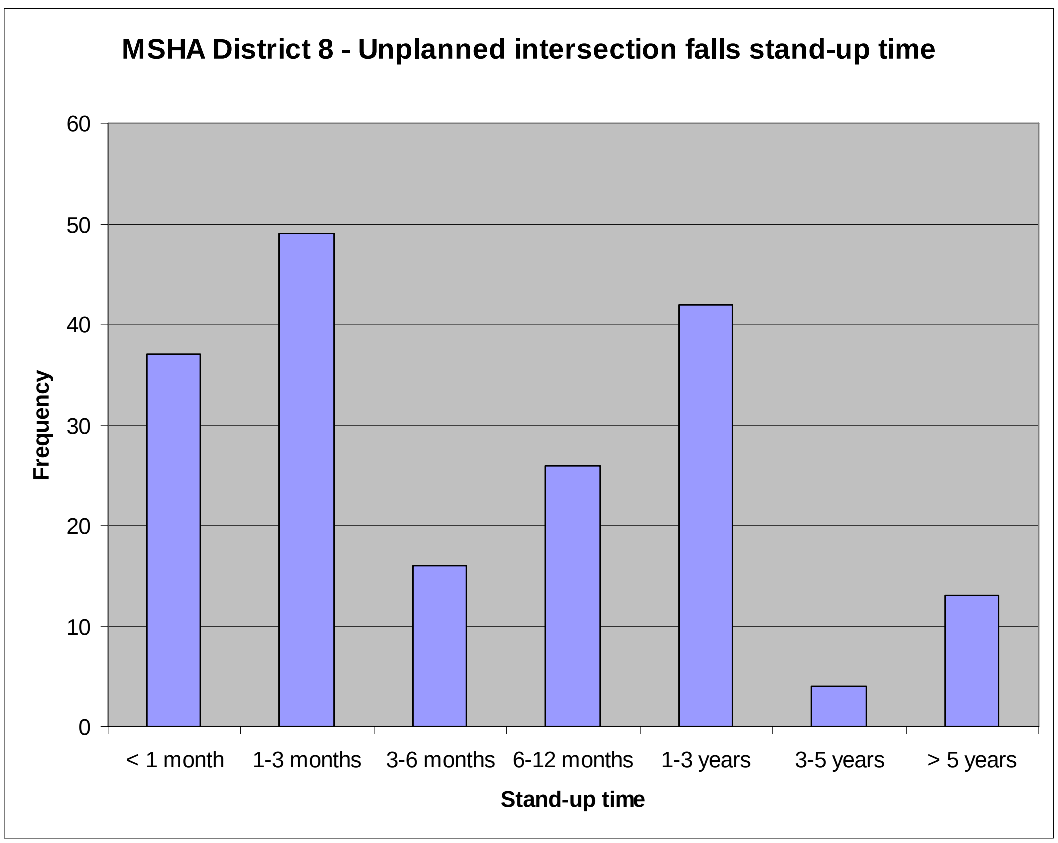

MSHA District 7 - Unplanned intersection falls stand-up time
Frequency
15
12
9
6
3
0
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years
Stand-up time

RESULTS FOR MSHA DISTRICT 8

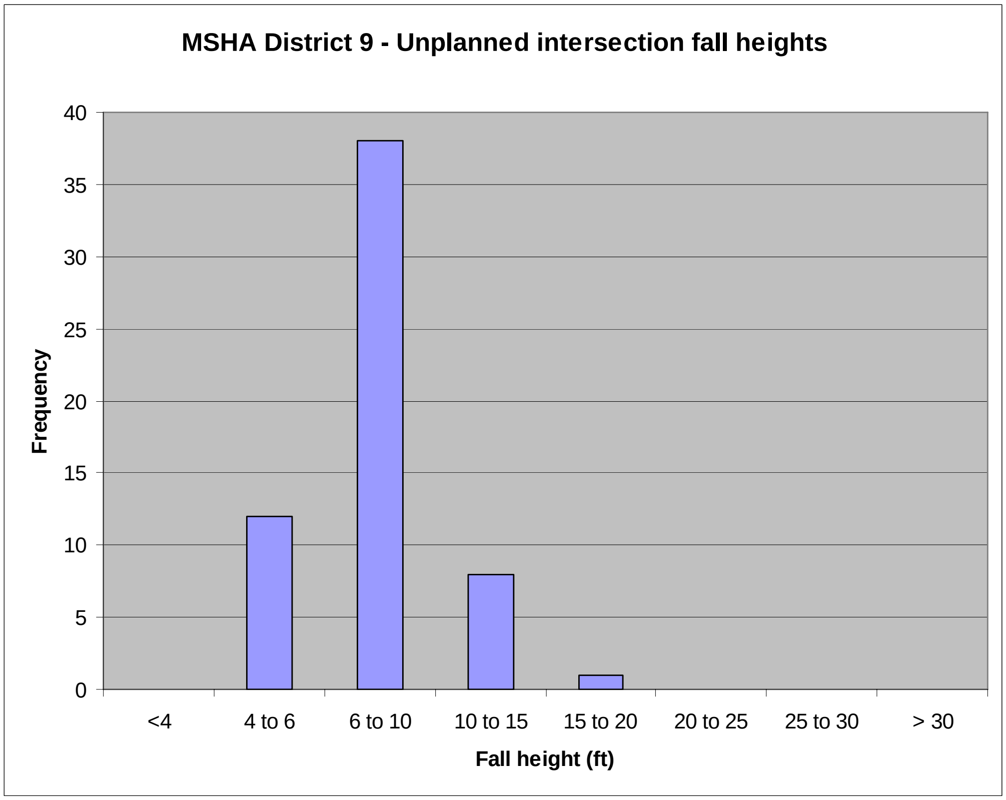


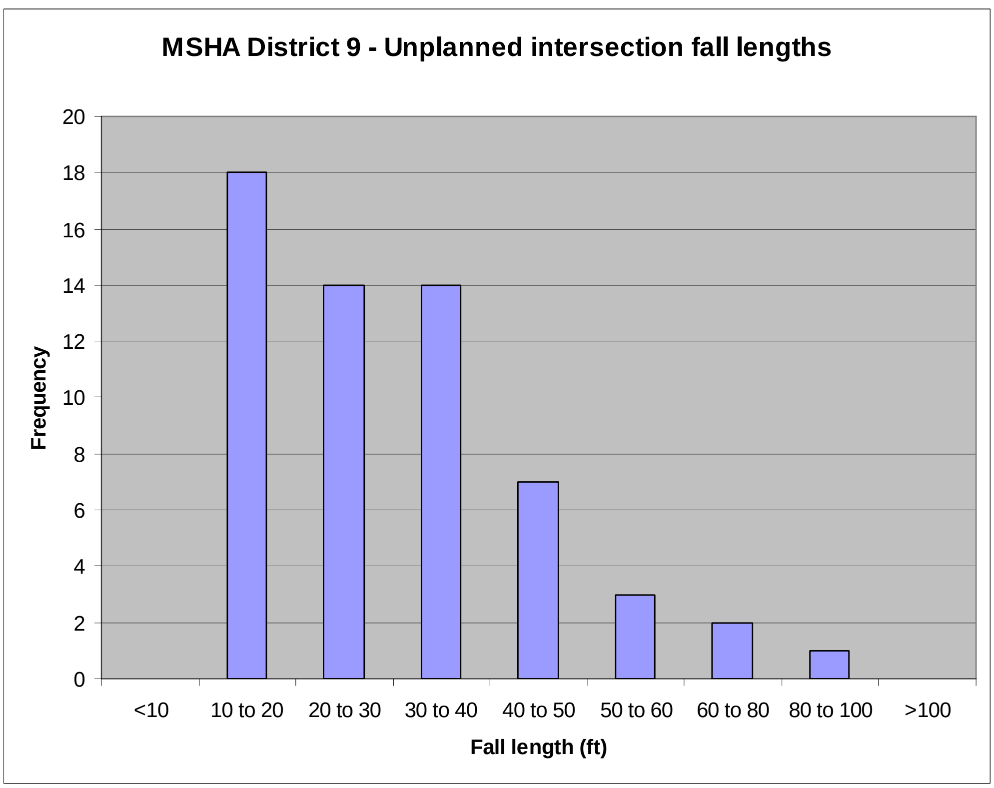


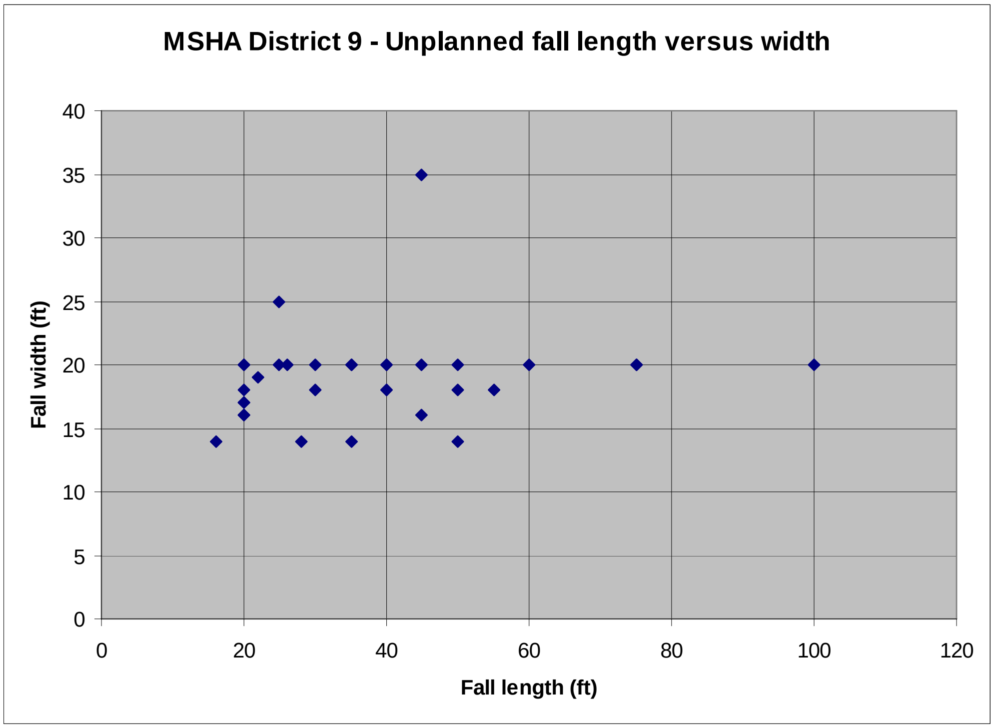

MSHA District 8 - Unplanned fall length versus width
Fall width (ft)
Fall length (ft)
0
5
10
15
20
25
30
35
40
45
50
0
50
100
150
200
250


MSHA District 8 - Unplanned intersection falls stand-up time
Frequency
Stand-up time
0
10
20
30
40
50
60
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years

RESULTS FOR MSHA DISTRICT 9

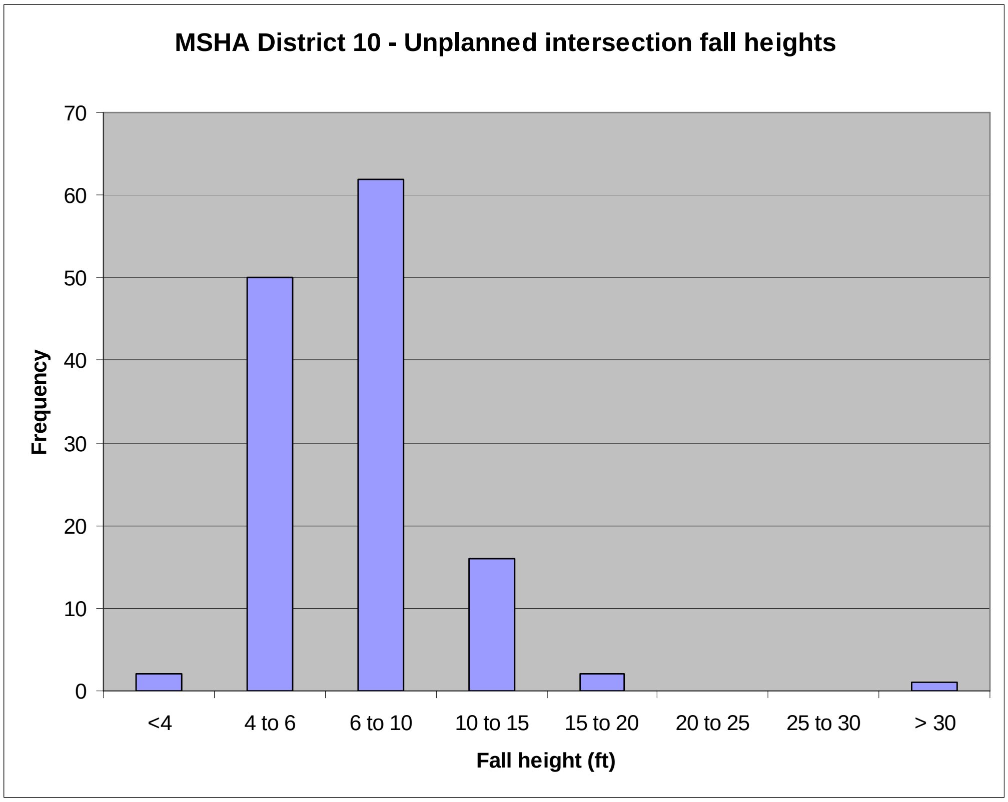


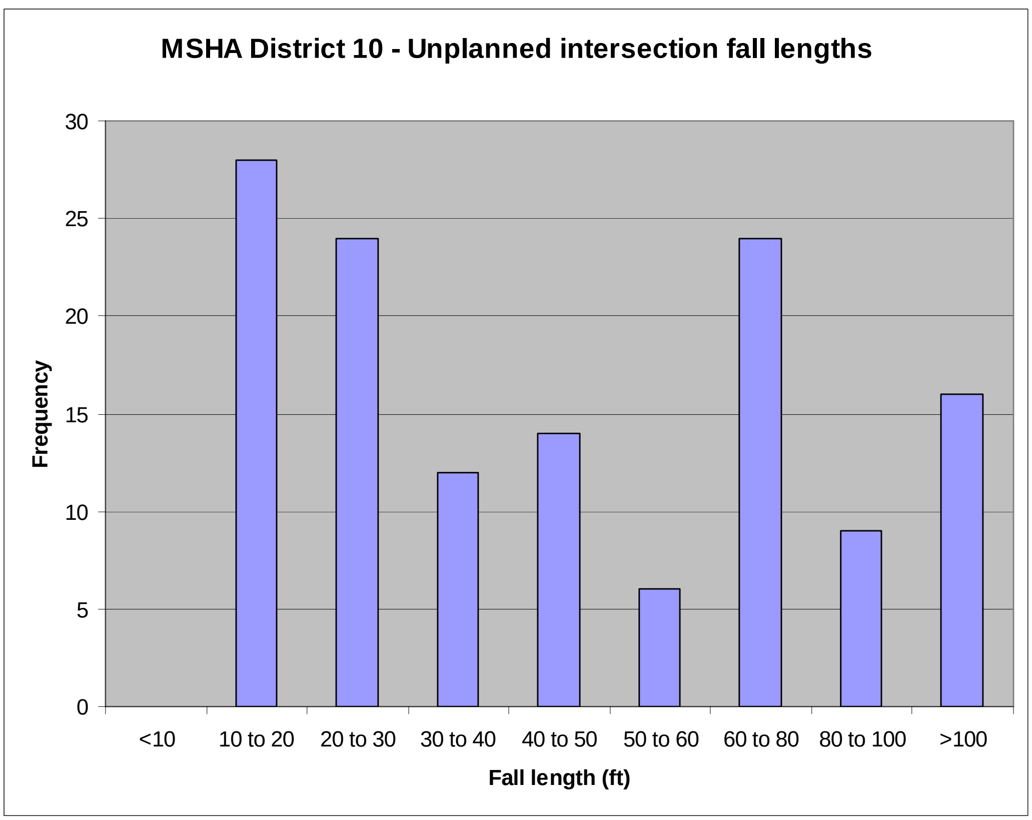


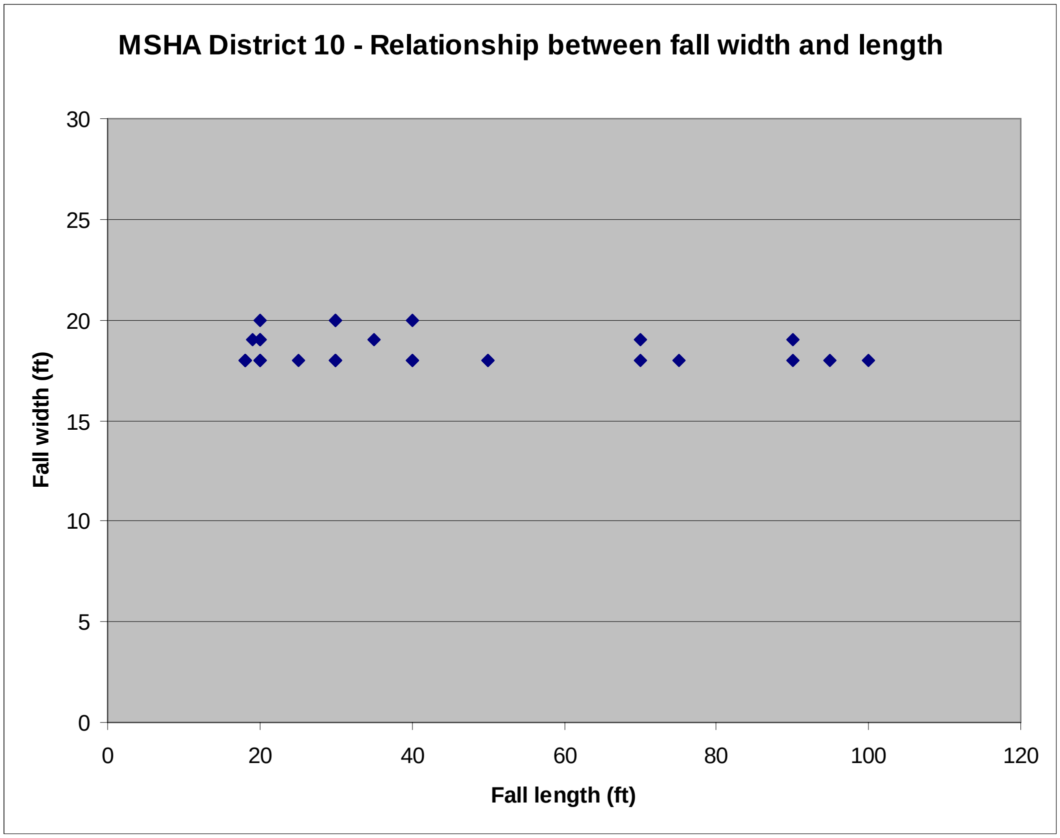


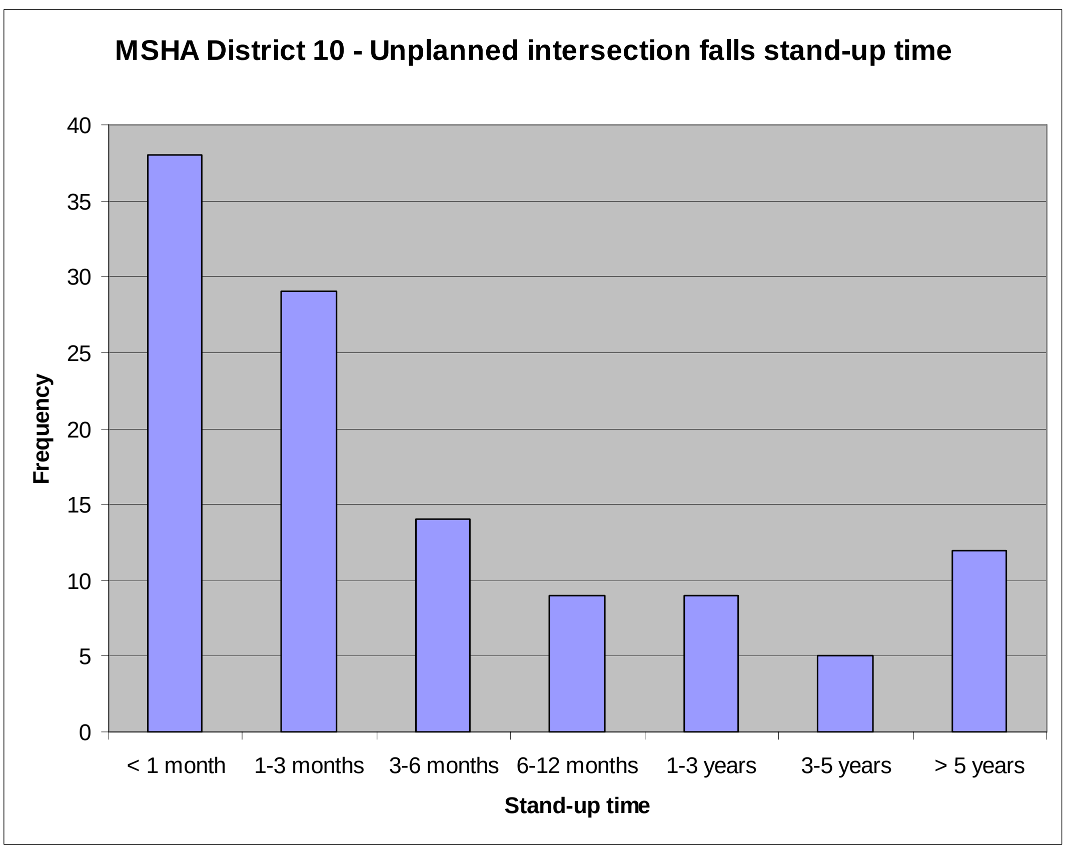
Note: There was no data available for stand-up times, as a visit was not personally made to District 9 in Denver, CO.

RESULTS FOR MSHA DISTRICT 10

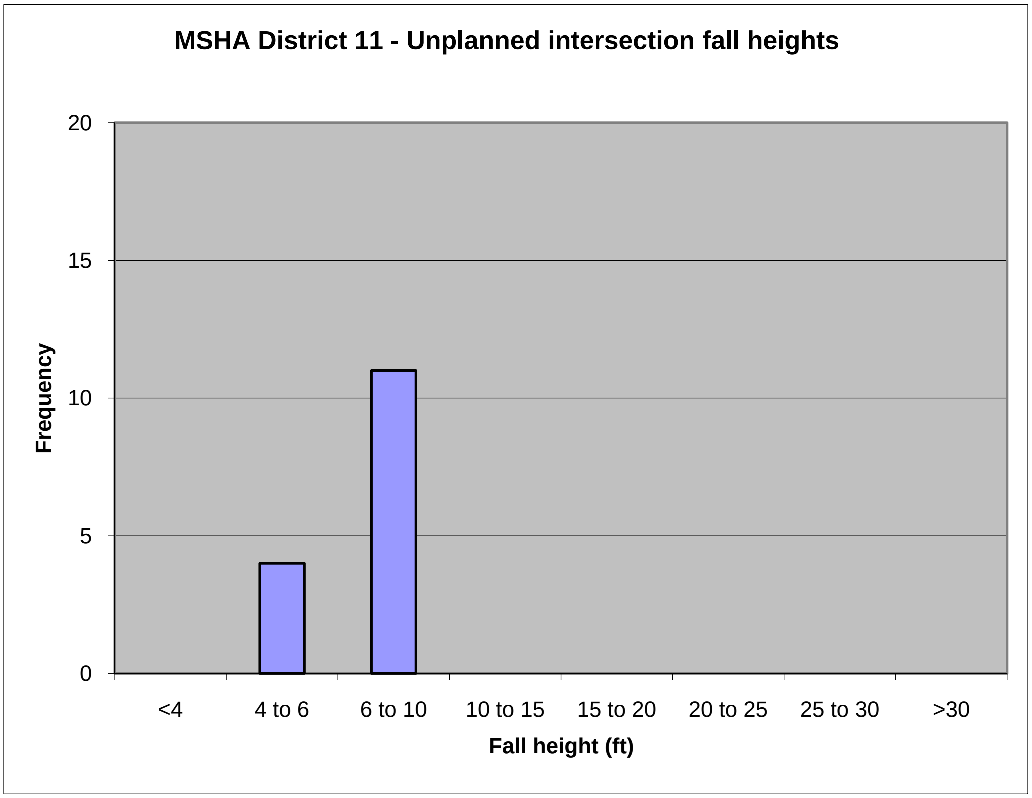


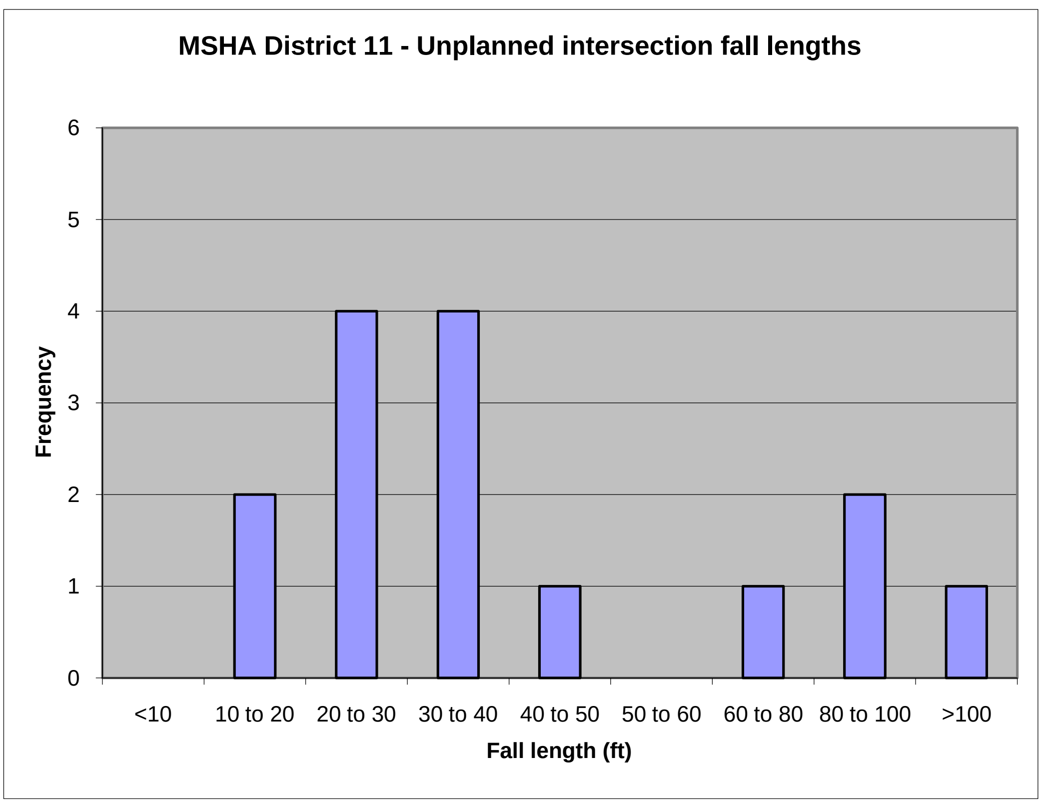


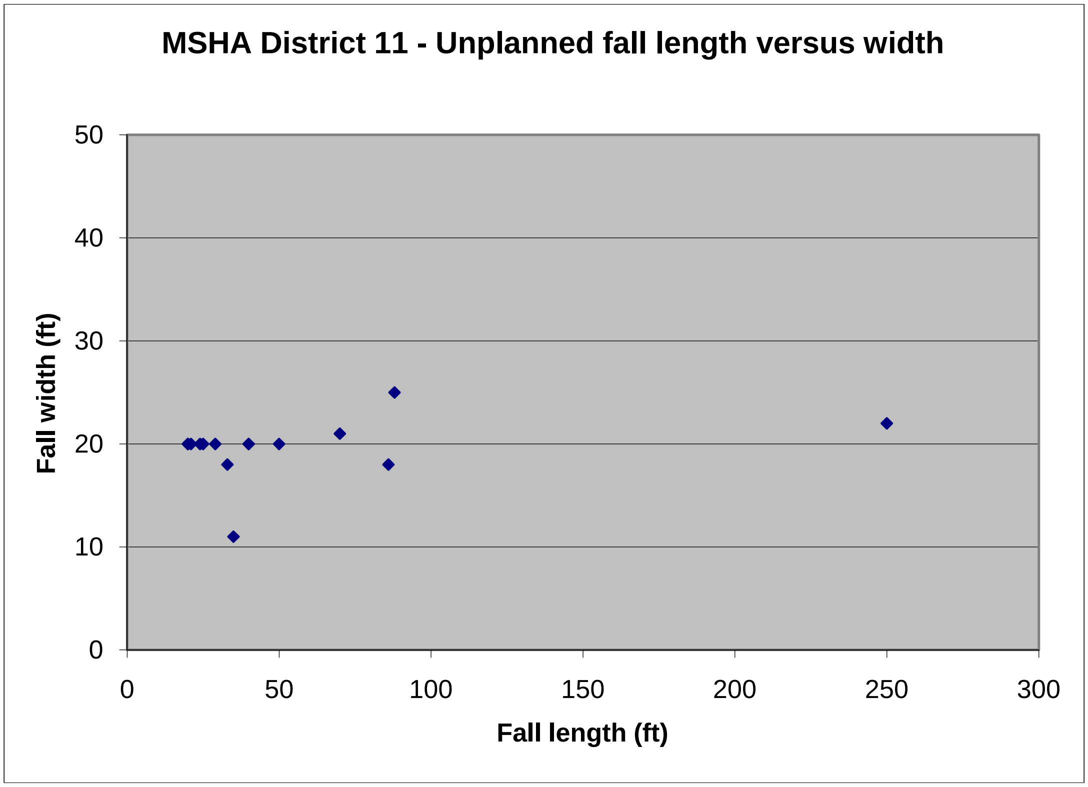

MSHA District 10 - Relationship between fall width and length
Fall width (ft)
Fall length (ft)
0
5
10
15
20
25
30
0
20
40
60
80
100
120

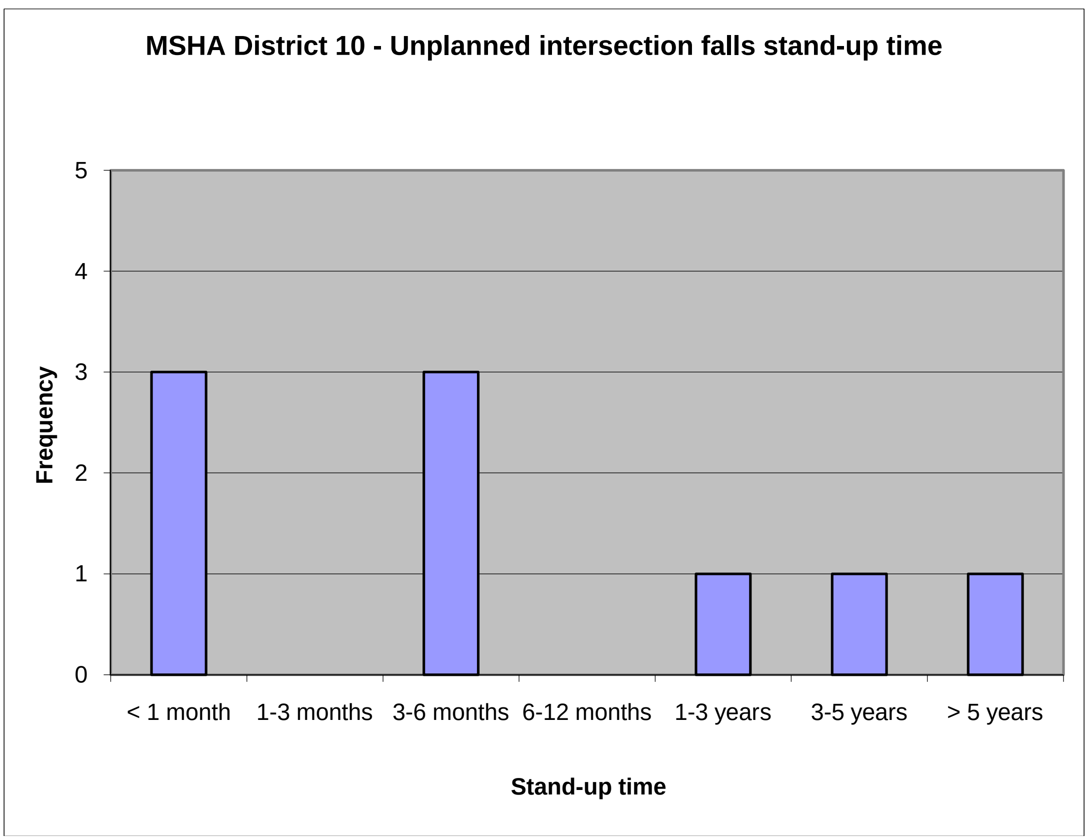

MSHA District 10 - Unplanned intersection falls stand-up time
Frequency
Stand-up time
0
5
10
15
20
25
30
35
40
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years

RESULTS FOR MSHA DISTRICT 11






MSHA District 11 - Unplanned fall length versus width
Fall width (ft)
50
40
30
20
10
0
0
50
100
150
200
250
300
Fall length (ft)


MSHA District 10 - Unplanned intersection falls stand-up time
Frequency
5
4
3
2
1
0
< 1 month
1-3 months
3-6 months
6-12 months
1-3 years
3-5 years
> 5 years
Stand-up time

APPENDIX C – Detailed fall results by MSHA District

Contents:

- Unplanned intersection fall of ground data by mine in each MSHA District (note there were no falls reported in District 1 from 2005 to the present).
- Frequency distribution by District of the fall heights, lengths and stand-up time.

MSHA DISTRICT 2 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

						Fall size						
Mine	**Owner**	**ID number**	**Date**	**Event #**	**Seam**	**Length**	**Width**	**Height**	**Support**	**Supplemental**	**Water**	**Geology**
TJS #5	TJS Mining		3/16/2008	4020982	Upper Freeport	120ft	19ft	8ft	6ft tens	5X8ft cables	No	Brown gray sandstone & gray sandstone 40-60ft
			5/31/2007	4051987	Upper Freeport	35ft	18ft	7ft	4ft tens	6ft tens	No	Gray sandyshale & gray sandstone
			5/18/2007	4051986	Upper Freeport	45ft	20ft	12ft	5ft full	10ft cables		Gray sandyshale & gray sandstone
Rossmoyne #1	TJS Mining		11/16/2007	4020969	Upper Freeport	40ft	17ft	7ft	4ft & 6ft full		No	9ft dark shale, 6ft gray sandy shale
Titus Mine	Dana Mining		6/13/2005	4025048	Sewickley	25ft	17ft	6.5ft	6ft full	9ft tens	No	5ft gray shale, 20ft sandstone
			9/8/2004	4025006	Sewickley	25ft	12ft	4ft	4ft full		No	15ft gray shale, 20ft sandstone
			9/8/2004	4025008	Sewickley	30ft	16ft	5ft	4ft full		No	15ft gray shale, 20ft sandstone
West Mine	Dana Mining		6/14/2007	4025952	Sewickley	17ft	17ft	10ft	6ft full		No	5ft shale, 12ft sandstone
			2/26/2007	4013111	Sewickley	30ft	20ft	12ft	5ft & 6ft full		No	5ft shale, 15ft sandstone/sandy siltstone
			2/16/2007	4051269	Sewickley	17ft	10ft	10ft	6ft full	12ft cables	No	4.5ft shale, 12ft sandstone
			1/27/2007	4013020	Sewickley	75ft	16ft	12ft	4ft full	12ft cables	No	Shale, Sandstone
			10/10/2007	4011694	Sewickley	41ft	10ft	8ft	5ft full T-bar		No	5ft shale, 15ft sandstone/sandy siltstone
			9/20/2006	4013105	Sewickley	32ft	18ft	13ft	6ft full T-bar		No	5ft shale, 15ft shale or sandstone
Josephine #3	Rosebud Mining	36-08719	11/1/2004	4019197	Lower Kittanning	33ft	31ft	9ft	4ft full		No	5ft slickensided shale, 20ft sandstone & shale
			9/13/2004	4050876	Lower Kittanning	30ft	20ft	9ft	4 & 6ft full		Yes	24ft gray shale, 28ft gray sandstone
			4/8/2004	4050848	Lower Kittanning	40ft	18ft	12ft	4ft full		Yes	24ft gray shale, 28ft gray shale/sandstone
Tracy Lynne Deep	Rosebud Mining		6/10/2005	4032379	Lower Kittanning	26ft	15ft	5ft	3ft full		No	20ft slickensided shale, 43 ft sandy shale
			6/10/2005	4032379	Lower Kittanning	26ft	15ft	5ft	3ft full & 6ft		No	20ft gray shale, 43ft sandy shale
Logansport	Rosebud Mining		12/16/2007	4051949	Lower Kittanning	60ft	19ft	4.5ft	3.5ft full	Spot cables & longer bolts	No	4ft dark laminated shale/ 16ft gray sandy shale
			6/25/2007	4032420	Lower Kittanning	40ft	18ft	4ft	3.5ft full & posts		No	4ft laminated dark shale/ 16ft gray sandy shale
			12/12/2005	4032389	Lower Kittanning	25ft	16ft	4ft	3 & 3.5ft full		No	27ft dark shale, 16ft gray sandy shale
Twin Rocks	Rosebud Mining	36-08836	12/16/2007	4020973	Lower Freeport	30ft	19ft	6ft	3.5ft full		No	12ft gray shale, 10-32ft grayshale/sandy shale
			4/22/2006	4051510	Lower Freeport	100ft	18ft	10ft	6ft supertwists	6X10ft cable	No	12ft gray shale, 10ft gray sandy shale
			1/4/2006	4033505	Lower Freeport	19ft	6ft	8ft	6ft full & 5ft tens T-bar	8-12ft cables	No	12ft gray shale, 32ft gray & sandy shale
			7/15/2005	4031280	Lower Freeport	200ft	20ft	8ft	3.5ft full		No	12ft gray shale with sandstone streaks, 15ft gray shale
			4/5/2005	4050895	Lower Freeport	25ft	20ft	7ft	6ft full	spot 12ft cables	No	12ft gray shale, 20ft sandy shale
			3/10/2004	4031205	Lower Freeport	900ft	20ft	14ft	4 & 6ft full	12 & 14ft cables	No	12ft gray shale, 20ft sandy shale
			2/9/2004	4031202	Lower Freeport	120ft	20ft	10ft	4 & 6ft full		No	12ft gray shale, 20ft sandy shale
Little Toby Mine	Rosebud Mining		5/23/2007	4039672	Lower Kittanning	40ft	20ft	7ft	3.5ft & 6ft full		Yes	Dark gray shale, 10-40ft grayshale
Dora 8	AMFIRE Mining	36-08704	7/27/2004	4050870	Lower Kittanning	25ft	20ft	6ft	4ft full		Yes	47ft hard shale, 25ft hardshale & sandstone

			2/13/2004	4050834	Lower Kittanning	25ft	15ft	6ft	3ft full		No	47ft hard shale, 250ft silty hard shale
Ondo Extension	AMFIRE Mining		8/7/2007	4039737	Lower Kittanning	25ft	18ft	15ft	6ft full	12ft cables	No	1.5ft shale, 15ft shale/sandstone
Ridge Deep	AMFIRE Mining		3/3/2006	4020926	Pittsburgh	20ft	20ft	15ft	6ft tens		No	20ft dark shale/ 15ft sandstone
Madison Mine	AMFIRE Mining	36-09127	8/14/2006	4051517	Upper Freeport	90ft	20ft	6ft	4ft full		No	2ft dark shale/ 10ft shale or sandstone
			10/18/2004	4031241	Upper Freeport	27ft	22ft	14ft	4ft & 5ft full	beams and props	No	4ft shale, 20ft mud shale
			10/11/2004	4031240	Upper Freeport	22ft	20ft	12ft	4ft full	beams and props	No	20ft shale, 20ft shale
Nolo Mine	AMFIRE Mining	36-08850	4/11/2007	4020959	Lower Kittanning	600ft	19ft	11ft	6.5ft combo T5 ch	10-12ft cables	No	19ft shale, 22ft sandy shale/sandstone
			2/8/2007	4020952	Lower Kittanning	65ft	30ft	11ft	6.5ft combo	10ft cables, 8ft spacing	No	19ft shale, 22ft sandy shale/sandstone
			3/18/2006	4020930	Lower Kittanning	60ft	18ft	7ft	7ft double tens T-bar	10ft cables, 8ft spacing		
			10/21/2005	4050579	Lower Kittanning	55ft	18ft	8ft	5ft point anchor		No	30ft dark shale, 22ft sandy shale & sandstone
			8/5/2005	4020545	Lower Kittanning	20ft	20ft	10ft	6ft full	5X12ft cables	No	30ft dark shale, 22ft sandy shale
			7/9/2005	4020544	Lower Kittanning	60ft	20ft	80ft	6ft point tens	12ft cables	No	30ft dark shale, 22ft sandy shale
			4/8/2005	4020540	Lower Kittanning	30ft	20ft	8ft	6ft tens		No	30ft dark shale, 22ft shale with sandstone
			4/8/2005	4020540	Lower Kittanning	40ft	20ft	8ft	6ft tens		No	30ft dark shale, 22ft shale with sandstone
			3/7/2005	4020388	Lower Kittanning	30ft	14ft	5ft	4ft tens		No	30ft dark shale, 22ft shale with sandstone
			6/25/2004	4050859	Lower Kittanning	40ft	20ft	8ft	4ft tens		Yes	19ft laminated shale, 22ft sandy shale
			6/28/2004	4050861	Lower Kittanning	35ft	20ft	7ft	5ft tens		No	19ft laminated shale, 22ft sandy shale
			2/20/2004	4050835	Lower Kittanning	140ft	18ft	14ft	4ft active		No	19ft laminated shale, 22ft sandy shale
			2/2/2004	4050832	Lower Kittanning	50ft	19ft	12ft	4 & 6ft active	12ft cables	No	30ft dark soft shale, 22ft shale with sandstone
Dooley Run Mine	Cobra Mining		1/26/2007	4013019	Sewickley	40ft	40ft	20ft	4ft full		No	Drawslate, shale/sandstone
Bailey Mine	CONSOL	36-07230	9/27/2007	4015817	Pittsburgh #8	53ft	16ft	13ft	8ft full & channels		No	6.5ft gray shale, 23ft sandy shale
			7/12/2005	4022594	Pittsburgh	40ft	16ft	12ft	8-12ft tens		No	8ft laminated shale, 22ft sandstone
			5/16/2005	4024570	Pittsburgh	30ft	16ft	7ft	8ft tens		No	6ft shale/coal, 22ft shale & limestone
			5/16/2005	4024570	Pittsburgh	30ft	16ft	7ft	8ft tens T5 ch		No	6.5ft shale/coal, 22ft shale & gray limestone
Cherry Tree Mine	Parkwood Resources		12/18/2006	4020947	Upper Freeport	30ft	19ft	10ft	6ft full	12ft cables	No	5ft sandy shale/ 15ft shale or sandy shale
Quecreek #1	Black Wolf Coal		10/9/2005	4031285	Upper Kittanning	400ft	20ft	15ft	4ft & 6ft full	10ft cables	No	10ft shale, 20ft sandstone
			8/7/2005	4031281	Upper Kittanning	240ft	20ft	15ft	4-6ft full	10ft cables	No	10ft shale, 20ft sandstone
Genesis #17		36-08980	9/27/2004	4031238	Upper Kittanning	40ft	20ft	7ft	5ft tens		No	5ft laminated shale, 15ft sandstone
Miller Mine	Rox Coal	36-08622	4/19/2004	4031209	Upper Freeport	30ft	30ft	10ft	4 & 5ft full	8ft cables	No	8ft shale, 10ft sandstone
			3/9/2004	4031203	Upper Freeport	47ft	20ft	6ft	4ft full		No	6ft shale and sandstone, 10ft sandstone

MSHA DISTRICT 3 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

						Fall size						
Mine	Owner	ID number	Date	Event #	Seam	Length	Width	Height	Support	Supplemental	Water	Geology
Whitetail	Alpha Natural Res.	46-08751	4/13/2008		Lower Kittanning	25ft	18ft	8ft	6ft full straps	Screen & trusses	No	10-15ft sandy shale to claystone then sandstone
			4/9/2008		Lower Kittanning	20ft	18ft	8ft	6ft full straps	Screen & 12ft cables	No	10-15ft sandy shale to claystone then sandstone
			4/8/2008		Lower Kittanning	20ft	17ft	7ft	6ft full straps	Screen & 12ft cables	No	10-15ft sandy shale to claystone then sandstone
			4/7/2008		Lower Kittanning	80ft	17ft	7ft	6ft full straps	Screen	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/11/2008		Lower Kittanning	20ft	20ft	8ft	6ft full pans	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/13/2008		Lower Kittanning	60ft	18ft	8ft	6ft full straps		No	10-15ft sandy shale to claystone then sandstone
			3/10/2008		Lower Kittanning	20ft	20ft	8ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/5/2008		Lower Kittanning	20ft	20ft	8ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/4/2008		Lower Kittanning	60ft	18ft	8ft	6ft full straps		No	10-15ft sandy shale to claystone then sandstone
			3/3/2008		Lower Kittanning	20ft	20ft	8ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			3/3/2008		Lower Kittanning	20ft	20ft	8ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			2/25/2008		Lower Kittanning	30ft	18ft	8ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			2/20/2008		Lower Kittanning	25ft	22ft	7ft	6ft full straps	12ft cables & trusses	No	10-15ft sandy shale to claystone then sandstone
			2/9/2008		Lower Kittanning	25ft	17ft	7ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			2/7/2008		Lower Kittanning	20ft	20ft	7ft	6ft full straps	Trusses	No	10-15ft sandy shale to claystone then sandstone
			2/5/2008		Lower Kittanning	20ft	17ft	8ft	6ft full straps	Trusses	No	10-15ft sandy shale to claystone then sandstone
			1/28/2008		Lower Kittanning	20ft	17ft	7ft	6ft full straps	Trusses	No	10-15ft sandy shale to claystone then sandstone
			1/27/2008		Lower Kittanning	10ft	8ft	4ft	6ft full straps	Trusses	No	10-15ft sandy shale to claystone then sandstone
			12/6/2007		Lower Kittanning	40ft	17ft	7ft	6ft full straps		No	10-15ft sandy shale to claystone then sandstone
			11/28/2007		Lower Kittanning	25ft	25ft	8ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			11/9/2007		Lower Kittanning	18ft	18ft	7ft	6ft full straps	12ft cables & cribs	No	10-15ft sandy shale to claystone then sandstone
			11/3/2007		Lower Kittanning	30ft	17ft	7ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			10/27/2007		Lower Kittanning	35ft	17ft	12ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
			10/22/2007		Lower Kittanning	50ft	17ft	8ft	6ft full straps	Trusses	No	10-15ft sandy shale to claystone then sandstone

			10/11/2007		Lower Kittanning	10ft	8ft	8ft	6ft full straps	Cables & screens	No	10-15ft sandy shale to claystone then sandstone
			10/11/2007		Lower Kittanning	40ft	18ft	8ft	6ft full straps	Cables	No	10-15ft sandy shale to claystone then sandstone
			10/10/2007		Lower Kittanning	25ft	17ft	8ft	6ft full	Screens, 12ft cables & jacks	No	10-15ft sandy shale to claystone then sandstone
			9/29/2007		Lower Kittanning	30ft	17ft	7ft	6ft full straps	12ft cables	No	10-15ft sandy shale to claystone then sandstone
Tusky	Rosebud	33-04509	9/25/2007		Middle Kittanning	80ft	18ft	15ft	4ft full	Timber	No	15-20ft gray shale, 35-60ft gray sandstone
			8/12/2007		Middle Kittanning	20ft	20ft	6ft	4ft full	Cables	No	15-20ft gray shale, 35-60ft gray sandstone
			7/23/2007		Middle Kittanning	25ft	20ft	5ft			No	15-20ft gray shale, 35-60ft gray sandstone
			9/15/2007		Middle Kittanning	50ft	30ft	15ft			No	15-20ft gray shale, 35-60ft gray sandstone
			8/27/2007		Middle Kittanning	40ft	30ft	6ft	4ft full		No	15-20ft gray shale, 35-60ft gray sandstone
			7/16/2007		Middle Kittanning	70ft	18ft	4ft	4ft full	12ft cables	No	15-20ft gray shale, 35-60ft gray sandstone
			7/23/2007		Middle Kittanning	40ft	17ft	5ft	4ft full		No	15-20ft gray shale, 35-60ft gray sandstone
			5/22/2007		Middle Kittanning	30ft	17ft	4ft	5ft full	Cables	No	15-20ft gray shale, 35-60ft gray sandstone
Mountain View	Mettiki Coal	49-09028	11/3/2007		Upper Freeport	16ft	16ft	10ft	6ft tens	Roof mats	No	±10ft shale and siltstone then sandstone
			11/5/2007		Upper Freeport	25ft	20ft	9ft	6ft tens	Screen	No	±10ft shale and siltstone then sandstone
			10/18/2007		Upper Freeport	55ft	16ft	15ft	6ft tens	Screen	No	±10ft shale and siltstone then sandstone
			11/3/2007		Upper Freeport	16ft	16ft	10ft	6ft tens	Screen	No	±10ft shale and siltstone then sandstone
			1/18/2006		Upper Freeport	25ft	16ft	6ft	6ft tens	Screen	No	±10ft shale and siltstone then sandstone
			5/9/2007		Upper Freeport	25ft	20ft	9ft	6ft tens	12ft cables & trusses	No	±10ft shale and siltstone then sandstone
			8/25/2006		Upper Freeport	14ft	12ft	6ft	6ft tens	Screen	No	±10ft shale and siltstone then sandstone
			8/1/2006		Upper Freeport	20ft	16ft	6ft	6ft tens		No	±10ft shale and siltstone then sandstone
			2/14/2006		Upper Freeport	20ft	16ft	13ft	6ft tens	12ft spot bolts	No	±10ft shale and siltstone then sandstone
			2/1/2006		Upper Freeport	20ft	18ft	12ft	6ft tens T5 ch	12ft cables	No	±10ft shale and siltstone then sandstone
			8/25/2006	4358669	Upper Freeport	20ft	16ft	6ft	6ft tens T5 ch	Screen	No	±10ft shale and siltstone then sandstone
			1/18/2006	4077670	Upper Freeport	25ft	16ft	6ft	6ft tens T5 ch	Screen	No	±10ft shale and siltstone then sandstone
Imperial	Wolf Run	46-09115	1/19/2008		Middle Kittanning	17ft	15ft	6.5ft	6ft full		No	19ft shale, 20ft sandy shale
			4/28/2008		Middle Kittanning	110ft	18ft	8ft	6ft full		No	19ft shale, 20ft sandy shale
Blacksville No.2	Consol	46-01968	2/13/2008		Pittsburgh 8	40ft	16ft	8ft	8ft tens straps		No	8-20ft shale then 5-30ft redstone/limestone
			11/22/2007		Pittsburgh 8	12ft	10ft	8ft			No	8-20ft shale then 5-30ft redstone/limestone
			8/23/2007	4359483	Pittsburgh 8	30ft	12ft	10ft	8ft tens T3 ch	16ft cables	No	8-20ft shale then 5-30ft redstone/limestone
			2/13/2007	4358884	Pittsburgh 8	10ft	7ft	12ft	8ft tens T3 ch	12ft cables	No	8-20ft shale then 5-30ft redstone/limestone
			10/27/2005	4077664	Pittsburgh 8	20ft	16ft	9ft	8ft tens T3 ch		No	8-20ft shale then 5-30ft redstone/limestone
			12/11/2005		Pittsburgh 8	35ft	16ft	10ft	8ft tens T3 ch		No	8-20ft shale then 5-30ft redstone/limestone
			8/29/2007		Pittsburgh 8	14ft	10ft	8ft	8ft tens		No	8-20ft shale then 5-30ft redstone/limestone
			9/18/2007		Pittsburgh 8	25ft	16ft	8ft	8ft tens	12ft cables	No	8-20ft shale then 5-30ft redstone/limestone
			8/13/2007		Pittsburgh 8	16ft	9ft	8ft	8ft tens		No	8-20ft shale then 5-30ft redstone/limestone

8/4/2007	Pittsburgh 8	71ft	16ft	8ft	8ft tens		No	8-20ft shale then 5-30ft redstone/limestone

MSHA DISTRICT 4 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

						Fall size					
Mine	**Owner**	**ID number**	**Date**	**Event #**	**Seam**	**Length**	**Width**	**Height**	**Support**	**Supplemental**	**Water**
Round Bottom Powellton	Elk Run	46-09163	4/23/2008		Powellton	70	20	8ft			No
			4/13/2008			60	20	7ft			No
Justice #1	Independence Coal	46-07273	5/11/2008			45	20	10ft			No
Laurel Coalburg Tunnel Mine	Mammoth Coal Co.	46-09148	5/9/2008			20	20	6ft			No
No. 2 Gas	Mammoth Coal Co.	46-09108	5/10/2008			42	19	13ft			No
			5/5/2008			80	18	12ft			No
			4/23/2008			50	18	16ft			No
No. 130	Mammoth Coal Co.	46-06051	5/6/2008			60	18	12ft			No
Candice No. 2	Long Branch Energy	46-08429	5/2/2008			30	20	8ft			No
			4/8/2008			30	20	5ft			No
			4/8/2008			30	20	5ft			No
Laurel Creek 5	Laurel Creek Mining	46-09132	5/2/2008			20	19	5ft			No
Fork Creek Mine #1	Coal River Mining	46-08763	4/29/2008			20	20	6ft			No
Aracoma Alma	Aracoma Coal Co	46-08801	4/26/2008			300	20	12ft			No
Ruby Energy	Spartan Mining	46-08808	4/25/2008		#2 Gas	100	19	7ft			No
			3/20/2008			100	18	7ft			No
			1/14/2008			100	9	6ft			No
			1/28/2008			60	19	8ft			No
			1/14/2008		2 Gas	30	25	8ft	5ft full		No
Cedar Grove Mine	Marfork Coal Co.	46-09048	4/24/2008			70	20	6ft	4ft full		No
Mountaineer II	Mingo Logon	46-09029	4/7/2008		Alma & Cedar Grove	20	19	9ft			No
			3/4/2008			25	20	4.5ft	4ft full		No
			2/21/2008			60	20	6.5ft			No
			10/1/2007			30	18	4.5ft	4ft full		No
No. 23 Mine	Long Branch Energy	46-08637	4/18/2008			30	20	6ft			No
Lick Branch No. 2	Little Eagle Coal Co.	46-08676	4/15/2008			30	30	4ft			No
			9/25/2007			50	20	6ft	4ft full		No
Pocahontas Mine # 3	ICG	46-05252	4/14/2008			70	20	8ft			No
Midland Trail Mine #1	West Virginia Mine Power	46-08522	3/27/2008		Beckley	40	20	6ft			No
			1/17/2008		Beckley	20	20	5ft	4ft full		No
			11/25/2007		Beckley	20	12	6ft	6ft tens		No

			11/14/2007	Beckley	40	20	5ft	4ft full		No
			10/23/2007	Beckley	20	20	5ft	5ft full		No
			10/3/2007	Beckley	20	20	6ft	4-5ft tens		No
			9/11/2007	Beckley	18	16	7ft	6ft tens		No
			8/30/2007	Beckley	40	20	5ft	4-5ft tens		No
			8/30/2007	Beckley	70	20	5ft	4-5ft tens		No
			9/7/2007	Beckley	20	20	8ft	6ft tens		No
			8/30/2007	Beckley	40	20	5ft	4-5ft tens		No
Copperhead #1	Glow Worm Coal Co.	46-08897	4/2/2008		35	18	3.5ft			No
No. 1	Laurel Creek Co.	46-08019	3/17/2008	Coalburg	30	20	10ft	Bolts	Cribs	No
			3/25/2008	Coalburg	20	10	3ft	4ft full	Cribs	No
No. 5	Laurel Creek Co.	46-09132	3/19/2008		350	19	4ft	4ft full	Cribs	No
Camp Springs	Rocksprings Development	46-05121	3/23/2008	Winifred	60	20	6ft	5ft tens		No
Josephine # 2	Pocahontas Coal	46-07191	2/22/2008	Pocahontas 2	20	15	5ft	4ft full		No
			1/2/2008	Pocahontas 2	80	20	5ft			No
			10/16/2007	Pocahontas 2	110	20	5ft	4ft full		No
			10/16/2007	Pocahontas 2	200	20	5ft	4ft full		No
Poplar Ridge # 1	Brooks Run Mining Co.	46-08885	3/24/2008	Lower Kittanning	30	18	7ft	5ft tens		No
Pinnacle Mine		46-01816	3/21/2008	Pocahontas 3	30	18	12ft	5ft tens		No
			12/3/2007	Pocahontas 3	188	18	6ft	5ft full		No
Rivers Edge		46-08890	3/10/2008	Powellton	20	19	8ft	5ft full		No
			11/28/2007	Powellton	20	20	8ft	5ft full		No
Upper Big Branch	Performance Coal Co.	46-08436	3/12/2008	Eagle	20	20	5ft	4ft tens		No
			12/31/2007	Eagle	20	20	4.5ft	4ft tens		No
			12/31/2007	Eagle	20	20	4.5ft	4ft tens		No
			11/9/2007	Eagle	100	18	4ft	4ft full		No
			9/27/2007	Eagle	60	18	5ft	4ft full		No
			9/11/2007	Eagle	30	20	4.5ft	4ft tens		No
Rama 1A	Rama Development	46-09173	2/22/2008		50	20	6ft			No
Camp Creek	Rockspring Deer	46-05121	2/29/2008		240	?	8ft	5ft tens		No
			10/23/2007		100	20	7ft	5ft tens		No
Eagle # 1	Appalachian Fuels	46-09164	2/26/2008	Eagle	380	19	5ft	4ft full		No
Grassy Creek No. 1	White Buck Coal	46-08365	2/8/2008		25	20	6.5ft	4ft full		No
			1/4/2008		40	20	5ft	4ft full		No
			11/19/2007		20	20	7ft	6ft tens		No

		46-08345	9/24/2007		40	20	6.5ft	6ft tens		No
Mountaineer Pocahontas	West Virginia Mine Power	46-09154	1/29/2008		20	20	5ft	5ft tens		No
			1/14/2008		19	19	5ft	5ft full		No
Castle Logans Fork	Elk Run Coal	46-07009	1/5/2008	Peerless	50	20	5ft	4ft full		No
Tunnel Mine	Shelby Coal	46-09209	1/31/2008		76	18	7ft	5ft full straps		No
No. 65 Mine	Double Bonus Coal	46-09020	1/31/2008	Fire Creek	20	20	6ft			No
Tiny Creek # 2	Coal River Mining	46-08835	1/17/2008		30	20	10ft	6ft tens & 8ft points		No
Castle East Portal	Elk Run Coal	46-08923	1/2/2008		105	18	8ft	5ft full	Cables	No
			1/2/2008		105	18	8ft	5ft full	Cables	No
			11/7/2007		22	20	6ft	4ft full		No
		46-07009	11/1/2007		50	20	6ft	6ft full		No
			10/10/2007		70	20	5ft	4ft full		No
Allen Powellton	Marfolk Coal Co.	46-09092	1/8/2008	Powellton	20	20	15ft	4ft full & 6ft spot		No
			1/8/2008	Powellton	20	20	15ft	4ft full & 6ft spot		No
Poplar Ridge No. 1		46-08885	12/6/2007		60	18	6ft	5ft tens		No
White Buck Coal		46-07042	10/26/2007	Sewell	50	18	4ft	4ft full		No
Big Mountain # 16	Pine Ridge Coal	46-07908	11/26/2007	Coalburg	100	20	10ft	5ft full		No
			10/24/2007	Coalburg	100	20	7ft	5ft full		No
Rocklick Coalburg Deep Mine	Little Eagle Coal	46-09171	10/31/2007		30	20	4ft	4ft full		No
			10/2/2007		28	22	4.5ft	4ft full		No
			9/23/2007		35	19	5ft	4ft full		No
White Queen	Marfolk Coal Co.	46-08297	10/31/2007	Upper Powellton	70	20	6ft	4ft full		No
Pinnacle			11/5/2007		40	20	9ft	5ft full		No
			9/3/2007		30	20	8ft	5ft tens		No
War Branch # 1	Brooks Run Mining Co.	46-09055	11/6/2007	Douglas Red Ash	30	20	4ft	3.5ft full		No
Mountaineer # 2			10/23/2007	Alma	100	18	12ft	5ft point		No
Brody Mine # 1	Brody Mining	46-09086	10/15/2007		30	20	6ft	5ft tens		No
			9/11/2007		115	20	8ft	6ft tens		No
Aracoma Alma No. 1			10/19/2007	Alma	400	20	10ft	6ft tens	8ft cables	No
Horse Creek Eagle Mine	Marfolk Coal Co.		10/4/2007		100	18	6ft	4ft ?		No
			8/31/2007		60	20	6ft	4ft full	Cribs	No
Tiny Creek # 2	Coal Mining River	46-08835	10/1/2007		60	19	7ft	6ft tens		No
Slip Ridge Cedar Grove	Marfolk Coal Co.	46-09048	10/3/2007	Cedar Grove	10	10	8ft	4ft full		No
Mountaineer Pocahontas # 2			9/21/2007		20	20	10ft	4ft full		No
Rocklick # 3	Little Eagle Coal	46-09171	8/30/2007		38	18	4ft	4ft full		No

			8/28/2007			35	30	5ft	4ft full		No
Midland Trail # 2		46-08909	9/11/2007			40	18.5	7ft	6ft tens		No
Black King	Elk Run Coal	46-08553	9/18/2007			45	20	6ft	5ft tens		No
Beckley Crystal	Brylon Mining Inc.	46-08829	9/3/2007			20	20	8ft	6ft tens		No
Eagle Mine	Newtown Energy	46-08759	9/6/2007			35	19	5ft	4-6ft full		No
			9/6/2007			25	20	8ft	5-8ft tens		No
Mammoth #2	Mammoth Coal Co.	46-09108	9/3/2007			30	20	8ft	6ft tens T5 straps	8ft cables	No
Mine #1	Selah Corp	46-08999	9/7/2007			25	20	4ft	4ft full		No
Big Mine No. 16	Pine Ridge Coal	46-07908	1/22/2008	4118666		30	25	4ft	5ft full		No
Tiny Creek # 2	Coal River Mining	46-08835	1/29/2008	4120165		30	16	6ft			No
Mine No. 1A	Mare Development	46-09173	2/22/2008	4119879		50	20	7ft	5ft full		No
Diamond Energy	Spartan Mining	46-08738	2/27/2008	4190717	Williamson	24	20	10ft	5ft full		No
Jerry Fork Eagle	Alex Energy	46-08787	3/3/2008	4116826		100	20	6ft	4-6ft full		No
Beckley Pocahontas	ICG Beckley	46-05252	4/14/2008	4119552	Pocahontas No. 3	60	20	6ft	5ft tens		No
Ruby Energy	Spartan Mining	46-08808	4/20/2008	4120811	#2 Gas	50	20	8ft	6ft tens	12ft cables	No
Cucumber Mine	Brooks Run Mining Co.				Pocahontas No. 3						No
Grassy Creek No. 1	White Buck Coal	46-08365	3/7/2007	4112549	Sewell	52	20	5.5ft	4ft full		No
Brody Mine # 1	Brody Mining	46-09086	3/19/2007	4116438	Eagle	270	18	14ft	5ft full		No
Ruby Energy	Spartan Mining	46-08808	3/27/2007	4114280	#2 Gas	40	19	7ft	5ft full		No
Harris No. 1	Eastern Assoc. Coal	46-01271	4/21/2007	4113397	Eagle	30	20	6ft			No
8-C Mine	Hanover Resources	46-06500	6/15/2007	4115971	#2 Gas	80	18	8ft	4-6ft full		No
Camp Creek	Rockspring Deer	46-05121	7/13/2007	4116134	Coalburg	120	20	7ft			No
Rocklick Coalburg Deep Mine	Little Eagle Coal Co.	46-09171	7/17/2007	4117307	Coalburg	55	20	7ft	4ft full & 6ft tens		No
Dorothy No.3	Mountain Edge Mining	46-09150	7/18/2007	4118653	Dorothy	20	20	9ft			No
Big Mountain # 6	Pine Ridge Coal	46-07908	7/19/2007	4115840	Coalburg	60	20	6ft			No
Horse Creek Eagle Mine	Marfolk Coal Co.	46-09091	9/19/2007	4114687	Eagle	18	15	5ft			No
Deep Mine No.7	Argus Energy	46-08772	7/26/2007	4115976	Five Black	35	19	6ft	6ft full & 6ft tens		No
Mine No.7	Rock n' Roll Coal	46-09093	8/8/2007	4117859	Red Ash	45	20	6ft	2.5ft full		No
Justice #1	Independence Coal	46-07273	8/18/2007	4118366	Powellton	32	19	7ft			No
Mountaineer II	Mingo Logon	46-09029	8/19/2007	4117100	Alma	30	20	8ft			No
No. 6	Laurel Creek Co.	46-08224	9/4/2007	4112070	Cedar Grove	22	11	7ft			No
Harris No. 1	Eastern Assoc. Coal	46-01271	10/8/2007	4118382	Eagle	75	20	5ft			No

MSHA DISTRICT 5 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

Mine	Owner	ID number	Date	Event #	Seam	Fall size Length	Width	Height	Support	Supplemental	Water	Geology
Cherokee Mine	Dickenson Russell Coal	44-06864	3/20/2008	4402635	Splashdam	25	14	4	4' full			10' shale then 20' sandstone
Cherokee Mine			4/13/2007	4160316	Splashdam	52	40	3	4' full	Timber		5' laminated shale then 10 sandstone
Roaring Fork No 4	Dickenson Russell Coal	44-07146	11/18/2007	4156746	Lower Banner	20	20	8	5' full	8' cables		
Roaring Fork No 4			10/17/2007	4128985	Lower Banner	45	20	10	5' full	6 by 8' cables		10' gray shale then 20' sandstone
Roaring Fork No 4			8/16/2005	4128952	Lower Banner	30	16	6.5	6' tens			10' slickensided shale then 10' sandstone
Roaring Fork No 4			5/13/2005	4128936	Lower Banner	67	14	17	6' tens	8 & 12' cables		17' slickensided and laminated shale then sandy shale
Mine No 3	Guest Mountain	44-07069	1/17/2008	4127540	Lower Parson	80	20	25	5' full, 8' superbolts			10' shale then 10' sandstone
Mine No 4	Guest Mountain	44-05815	1/7/2008	4157529	Upper Parson	60	20	5	5' full, 8' superbolts			10' shale then 10' sandstone
Mine No 1	Bluff Spur Coal	44-05559	12/17/2007	4127532	Mareker	20	18	5	5' pt anchor	10' cables		10' laminated shale then 10' shale
Mine No 1			9/11/2006	4141100	Taggart	120	50	15	4' full	8' cables		gray shale
Tiller No 1	Knox Creek Coal	44-06804	11/20/2007	4127521	Jawbone	25	16	6.5	5' tens			3.5' shale then 10' sandstone
Tiller No 1			9/20/2006	4153873	Tiller	30	18	8	6' tens	10' cables		3.5' shale then 10' sandstone
Tiller No 1			9/6/2005	4153403	Tiller	30	20	10	6' tens	10' cables		10' laminated shale then sandstone
Premium Mine	The Banner Co	44-07181	11/3/2007	4141170	Hagy	20	20	6	5' full			10' shale then 10' sandstone
Deep Mine No 26	Paramount Coal Co	44-06929	10/9/2007	4127515	Lower Banner	30	18	6	5' full	12' cables		shale
Deep Mine No 26			11/27/2006	4129279	Lower Banner	60	18	8	5' full	10' cables		shale
Deep Mine No 26			8/26/2006	4155491	Lower Banner	25	6	5	5' full	10' cables		shale
Deep Mine No 26			11/27/2006	4129279	Lower Banner	60	18	8	5' full	10' cables		shale
Deep Mine No 26			2/16/2005	4128001	Lower Banner	90	20	10	5' full	8' cables		10' laminated shale then 43' shale
No 2	Black Dog Coal	44-04946	9/14/2007	4127510	Jawbone	26	20	12	5' full	8' cables		10' shale then 10' sandstone
No 2			7/18/2006	4158440	Jawbone	20	20	18	5' full & 6' pt anchor	8' cables		10' slickensided shale then 20' sandstone
Dominion No 34	Dominion Coal Co	44-06839	8/28/2007	4402621	Kennedy	35	25	12	3.5 full			shale
Deep Mine No 35	Paramount Coal Co	44-07123	7/16/2007	4129245	Tiller	30	20	10	4' full	12' cables		6' laminated shale then 70' sandstone
No 5	Da Coal Mining	44-07154	5/8/2007	4128979	Hagy	27	5	5	4' full			shale
Mine No 4	Dorchester Enterprises	44-07052	6/29/2007	4129242	Imboden	22	22	8	6' pt anchor, 8' superbolts	12' cables		10' laminated shale then 10' sandstone
Mine No 4			8/9/2006	4129031	Dorchester	20	20	10	5' full	8' cables		10' laminated shale then 10' sandstone
Mine No 4			5/8/2005	4128935	Imboden	55	18	6	5' tens			10' shale then 10' sandstone
Miles Branch	Consolidation Coal	44-03932	4/19/2007	4402523	Pocahontas #5	60	20	8	4' full, 6' full	Timber		4' soft shale then 10' laminated sandstone
Miles Branch			8/18/2006		Pocahontas #5	22	20	8	4' & 6' full	Timber		?

Miles Branch			5/2/2006	4153709	Pocahontas #5	40	18	7	4', 5' & 6' full			10' laminated shale the 10' sandstone
Miles Branch			4/11/2006	4160285	Pocahontas #5	60	18	6	4' full			6' laminated shale then 10' sandstone
Miles Branch			2/7/2006	4153418	Pocahontas #5	40	14	4	4' full			10' laminated shale then 10' sandstone
Miles Branch			12/13/2005	4153412	Pocahontas #5	80	18	4	3.5' full			10' laminated shale then 10' sandstone
No 1 Mine	Keokee Mining	44-06947	2/26/2007	4129213	Wilson	50	20	10	4' full			shale
No 4 Mine	L&J Equipment Co	44-00280	10/9/2006	4129048	Lower Banner	14	10	5.5	5' full			8' slickensided shale then shale
Honey Branch	JJJ Coal Corp	44-06599	10/2/2006	4158409	Jawbone	70	18	7	5' full			3' shale then 10' sandstone
Honey Branch			6/15/2005	4128748	Jawbone	20	18	7	4' full & 6' tens		Yes	3' sandy shale then 10' sandstone
Mine No 3	Cat Bird Mining	44-06812	6/27/2006	4129020	Splashdam	30	20	4	3' full			10' laminated shale then 15' sandstone
Mine No 1	SANW Inc	44-06836	4/17/2006	4153707	Jawbone	15	15	2	3' & 4' full	Cribs		10' laminated shale then 10' sandstone
Mine No 3	Paramount Coal Co	44-06853	8/11/2006	4157083	Jawbone	60	19	20	6' tens	10' cables		6' shale then 20' shale and sandstone
Mine No 1	Snapco Inc	44-06866	2/18/2006	4153419	Splashdam	140	20	8	4' full	8' cables		10' laminated shale then 10' sandy shale
Low Splint No 1	Meadow Branch Mining	44-06883	6/29/2006	4155484	Low Splint	40	20	8	4' full			10' sandy shale then 10' sandstone
Low Splint No 1			11/13/2005	4128113	Low Splint	30	20	10	4' full	8' cables		6' shale with coal streaks then 10' sandstone
Low Splint No 1			11/16/2005	4128954	Low Splint	54	36	7	4' full			6' shale with coal streaks then 10' sandstone
No 7 Mine	Sigmon Coal Co	44-06947	10/11/2006	4155500	Wilson	25	15	7	6' pt anchor	8' cables		shale
No 7 Mine			8/9/2006	4129029	Wilson	20	20	12	6' tens	8' cables		10' laminated shale then 10' shale
NME	Estep Coal Co	44-06979	3/21/2006	4153701	Lower Banner	20	20	6	4' & 6' full			10' sandy shale then 10' sandstone
Mine No 4	Hubble Mining Co	44-07048	9/8/2006	4129037	Low Splint	40	20	6.5	5' full	8' cables		10' laminated shale then 10' shale
Mine No 4			4/13/2005	4155856	Low Splint	20	20	10	5' full	10' cables		10' shale then sandstone
Deep Mine No 10	Paramount Coal Co	44-07055	5/29/2006	4125750	Jawbone	35	35	15	6' pt anchor	10' cables		15' shale then 15' sandstone/shale
Pardee/Wax	Powell Mountain Coal	44-07060	5/17/2006	4157014	Wax	60	18	10	4' full			10' shale then 10' sandstone
No 8	Bristol Coal Corp	44-07075	1/2/2006	4128778	Lower Banner	30	22	10	5' full	8' cables		10' laminated shale then 10' sandy shale
No 8			1/17/2006	4128780	Lower Banner	35	20	8	5' full	8' cables		10' laminated shale then 10' sandy shale
No 1 Mine	Exeter Coal Corp	44-07106	8/28/2006	4129035	Low Splint	20	20	5.5	5' full	8' cables		10' laminated shale then 10' sandy shale
Buchanon No 1	Consolidation Coal	44-04856	7/14/2005	4153398	Pocahontas #3	25	20	6	6' full			10' laminated and sandy shale then 10' sandstone
VP 8	Island Crek Coal	44-03795	6/10/2005	4153394	Pocahontas #11	100	20	9	6' full	Truss bolts		10' laminated and sandy shale then 10' sandstone
Mine No 1	Appalachia Coal Co	44-05815	7/28/2005	4128104	Parsons	30	20	8	?' full	Cribs		6' soft shale then 10' shale
Laurel Mountain	Dickenson Russell Coal	44-06444	7/8/2005	4128943	Jawbone	80	20	10	6' tens	8' cables		12' sandy shale then 20' sandstone
Laurel Mountain			1/5/2005	4128091	Jawbone	50	20	10	5' full	8' cables		5' gray shale with slips then gray to black shale
Dominion No 22	Dominion Coal Co	44-06645	6/3/2005	4153391	Tiller	60	16	2	4' full			5' sandy shale then 10' sandstone
Dominion No 22			11/8/2005	6184249	Tiller	45	20	5	3' full	Cribs		5' sandy shale then 10' sandstone

Deep Mine No 3	Paramount Coal Co	44-06853	4/20/2005	4128933	Jawbone	38	19	5.5	5' pt anchor		20' slickensided shale then 20' shale
Mine No 1	Tech Leasing & Rebuild	44-06859	5/28/2005	4128693	Pocahontas #11	43	19.5	3.5	3.4' full		10' laminated shale then 10' sandstone
No 1 Mine	American Energy	44-06973	4/6/2005	4128929	Norton	20	20	10	4' full		10' stack rock then 10' shale
Roaring Fork No 3	Dickenson Russell Coal	44-06975	10/24/2005	4128950	Lower Banner	25	22	10	6' tens	12' cables	shale
Mine No 9	CS&S Coal Corp	44-07025	8/1/2005	4128947	Lower Banner	50	20	7	4' full		10' laminated sandy shale then 10' sandstone
No 7 Mine	Capital Coal Corp	44-07049	6/27/2005	4128938	Imboden	80	19	8	4' full		14' shale then 14' sandstone
Deep Mine No 10	Paramount Coal Co	44-07055	8/13/2005	4128951	Jawbone	35	6	6	6' tens		6' thinly laminated shale then 20' shale
Mine No 3	Harvest Time Coal	44-07104	10/27/2005	4128112	Widow Kennedy	30	20	4.5	4' mechanicals		4.5' slickensided shale then 10' shale

MSHA DISTRICT 6 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

						Fall size						
Mine	**Owner**	**ID number**	**Date**	**Event #**	**Seam**	**Length**	**Width**	**Height**	**Support**	**Supplemental**	**Water**	**Geology**
Meathouse Energy	Sidney Coal Co	15-17287	9/23/2007	4193650	Pond Creek	60	18	5	5' tens			10' shale then 50' sandstone and shale
Meathouse Energy			9/12/2007	4194510	Pond Creek	15	12	5	4' full			5' sandstone and shale then 200' mainly sandstone
Advantage No 1	Sapphire Coal Co	15-02057	7/20/2007	4193639	Elkhorn #2	40	30	10	5' full	2 by 8' cables	Yes	Shale
Advantage No 1			12/7/2007	4194463	Elkhorn #3	30	18	6	5' tens	8' cables		Shale
Advantage No 1			7/20/2007	4193639	Elkhorn #2	40	30	10	5' full	2 by 8' cables		Shale
Eagle	Jet Coal Co	15-19029	11/12/2007	4194648	Elkhorn #3	20	20	8	4' full			15' shale then 20' sandstone
Simpson Branch	Mitac Mining Co	15-18814	8/9/2007	4193640	Elkhorn #3	25	18	8	4' full	2 by 8' cables every 8'	Yes	Shale
Simpson Branch			3/20/2008	4191203	Elkhorn #3	100	20	6	6' full			Blue shale
Simpson Branch			1/13/2008	4190548	Elkhorn #3	40	20	6	6' full			Blue shale
Simpson Branch			3/14/2008	4190549	Elkhorn #3	18	18	4.5	4' full			Blue shale
Simpson Branch			8/9/2007	4193640	Elkhorn #3	25	18	8	4' full	2 by 8' cables every 8'		Shale
No 1	Midgard Mining	15-18827	11/7/2007	4194461	Lower Elkhorn	30	20	4	4' full			Sandstone
No 1	Freedom Energy Mining	15-07082	5/5/2008	4195179	Pond Creek	80	20	8	5' full			10' sandstone and shale then 60' sandstone
No 1			9/27/2007	4194451	Pond Creek	90	20	6	6' full	10' cables		10' sandstone and shale then 60' sandstone
No 1			12/23/2007	4194907	Pond Creek	20	20	10	6' full	10' cables		10' sandstone and shale then 60' sandstone
No 1			5/5/2008	4195179	Pond Creek	80	20	8	5' full			10' sandstone and shale then 60' sandstone
No 1			5/6/2008	4193545	Pond Creek	70	20	7	6' full			10' sandstone and shale then 60' sandstone
No 1			2/6/2008	4194524	Pond Creek	20	20	10	5' full			10' laminated sandstone then 50' sandstone
No 1			11/23/2007	4194907	Pond Creek	20	20	12	6' full	10' cables		10' laminated sandstone then 50' sandstone
No 1			10/27/2007	4194458	Pond Creek	40	20	8	6' full			10' sandstone and shale then 60' sandstone
No 1			10/15/2007	4194518	Pond Creek	22	20	7.5	6' tens	8' cables		8' sandstone and shale then 60' sandstone
No 1			9/27/2007	4194451	Pond Creek	90	20	6	6' tens	10' cables		10' sandstone and shale then 60' sandstone
Mine No 15	McCoy Elkhorn Coal	15-18775	6/22/2007	4193633	Glamorgan	20	10	8	5' full	10' cables		10' sandstone and shale then 60' sandstone
Mine No 15			5/7/2008	4173531	Miller	30	30	5	5' full	8' cables		16' sandstone and gray shale then 10' gray shale
Mine No 15			11/24/2007	4173488	?	70	20	12	5' full	6 by 10' cables		16' shale and sandstone then 10' shale
Mine No 15			6/22/2007	4193633	Glamorgan	20	10	8	5' full			10' laminated sandstone then 50' sandstone
Mine No 16	South Akers Mining	15-19127	12/31/2007	4194911	Elkhorn #3	20	19	8	4' full	8' cables		6' laminated shale then 20' sandstone
Mine No 16			11/17/2007	4190709	Elkhorn #3	60	20	8	4' full	8' cables		6' shale and coal rider then 20' sandstone
Mine No 16			12/31/2007	4194911	Elkhorn #3	20	19	8	4' full	8' cables		6' laminated shale then 20' sandstone
Love Branch Mine	Road Fork Development	15-09830	11/26/2007	4195151	Williamson	50	19	5	4' full			Shale

Love Branch Mine			11/12/2007	4173385	Williamson	40	19	7	2.5' & 4' full			Shale
Love Branch Mine			11/26/2007	4195151	Williamson	50	19	5	4' full			Shale
Love Branch Mine			11/20/2007	4173429	Williamson	25	25	8	4' full			Shale
Love Branch Mine			11/5/2007	4173427	Williamson	140	20	6	4' full			Shale
Love Branch Mine			6/13/2007	4194609	Williamson	70	4	4.5	4' full			Shale
Mine No 1	Clean Energy Mining	15-10753	5/12/2008	4173442	Pond Creek	70	20	7	5' tens			10' shale and sandstone then 5' sandstone
Mine No 1			2/27/2008	4173396	Pond Creek	25	19	8	5' full	8' cables		8' soapstone and shale then 10' sandsone
Mine No 1			3/13/2008	4173399	Pond Creek	20	20	9	5' tens			9' shale and sandstone then 10' sandstone
Mine No 1			12/4/2007	4195152	Pond Creek	20	20	7	5' tens			10' shale and sandstone then 60' sandstone
Mine No 1			10/28/2007	4173381	Pond Creek	30	19	8	5' full	4 by 10' cables		10' shale then 60' sandstone
Mine No 1			10/22/2007	4173380	Pond Creek	70	16	6	5' full			10' shale and sandstone then 60' sandstone
Mine No 1			12/21/2007	4173608	Pond Creek	40	19	7	5' tens			7' shale and chalkstone then 20' sandstone
Mine No 1			11/14/2007	4173387	Pond Creek	30	18	7	6' tens	4 by 10' cables		Shale
Mine No 1			9/6/2007	4173477	Pond Creek	40	20	8	5' full			10' shale and sandstone then 60' sandstone
Mine No 1			9/19/2007	4173478	Pond Creek	25	20	10	5' tens	4 by 8' cables		10' shale and sandstone then 60' sandstone
Mine No 1			9/3/2007	4173476	Pond Creek	50	20	9	5' tens	4 by 8' cables		10' shale and sandstone then 60' sandstone
Mine No 1			8/17/2007	4173475	Pond Creek	40	19	5	5' tens			10' shale and sandstone then 60' sandstone
Mine No 1			8/7/2007	4173504	Pond Creek	30	20	8	5' tens	4 by 8' cables		10' shale and sandstone then 60' sandstone
Mine No 1			5/1/2007	4193627	Pond Creek	30	20	8	5' full	4 by 10' cables		10' shale and sandstone then 60' sandstone
No 1	B&C Coal	15-19159	4/25/2008	4201748	Elkhorn #3	30	18	5	4' full			10' shale then 30' shale and sandstone
Sandlick II	Sapphire Coal Co	15-18782	4/21/2008	4182373	Elkhorn #3	20	20	4.5	5' full	8' cables		25' shale then 25' sandstone
No 2	TRC Mining Co	15-17720	4/16/2008	4182604	?	65	20	6.5	4' full			10' dark gray shale then 15' gray shale
No 12	North Star Mining	15-18581	4/9/2008	4195176	Hazard #4	30	16	4	3.6' full			Sandstone
No 12			7/24/2007	4190282	Hazard #4	25	20	4.5	3.5' full			Laminated sandstone
No 12			10/2/2007	4190651	Elkhorn #3	20	19	4	3.5' full		Yes	10' sandstone and shale then sandstone
No 6	Murriel Don Coal Co	15-19129	2/12/2008	4190290	Elkhorn #3	26	20	8	4' full			Shale
Clean Energy Mine	ICG Knott County	15-18393	2/1/2008	4182239	Hazard #4	40	27	5	4' full with straps			20' shale then 20' sandstone
E3-5B	Premier Elkhorn Coal	15-18370	1/10/2008	4182504	Elkhorn #3	20	15	5	4' full			22' shale then 6' sandstone
E3-5B			9/19/2007	4194512	Elkhorn #3	30	29	5	4' full			5' slate then 300' slate and shale
E3-5B			12/26/2007	4184166	Elkhorn ##	60	25	5.5	4' full			22' shale then 60' sandstone
Mine No 2	Excel Mining LLC	15-09571	4/7/2008	4195175	Pond Creek	40	18	6	5' full			10' shale then 30' shale and sandstone
No 10	Fools Gold Energy Corp	15-18927	2/11/2008	4190716	Fireclay	70	18	8	4' full	Cribs		Sandstone
No 10			4/15/2007	4190430	Fireclay	40	19	7	4' full with straps			15' shale then sandstone

Mine No 25	McCoy Elkhorn Coal	15-15138	3/13/2008	4193726	Elkhorn #2	90	20	8	4' full		Shale
Mine No 25			5/21/2007	4193629	Elkhorn #2	30	19	8	4' full		Shale
Mine No 3	Excel Mining LLC	15-08079	3/12/2008	4193841	Hazard #4	50	20	10	6' full		10' laminated sandstone then 50' sandstone
Mine No 3			1/21/2008	4194126	Pond Creek	30	19	10	6' full	10' cables	10' weak shale then 10' firm shale and sandstone
Mine No 3			11/16/2007	4193715	Pond Creek	20	15	4	3' chuck bolts		10' shale then 50' sandstone and shale
Mine No 3			7/12/2007	4194614	Lower Elkhorn	50	50	9	6' full		10' shale then 50' sandstone and shale
No 20	Eagle Coal Co	15-18929	1/17/2008	4190664	Coalburg	30	30	6	4' full		?
No 20			1/17/2008	4190664	Coalburg	90	20	6	4' full		?
No 20			7/16/2007	4194615	Coalburg	35	12	20	4' full		3' slate then 30' sandstone
Jones Fork	Consol	15-18589	1/6/2008	4438220	Elkhorn #3	130	20	12	4' full		6' laminated gray shale then 10' sandy shale
Mine No 1	Rockhouse Energy Mining	15-17651	1/4/2008	4195053	Elkhorn #3	70	30	3.5	4' full		10' shale then 100' sandstone
Mine No1			12/12/2007	4192899	Elkhorn #3	20	20	5	4' full		10' shale then 80' sandstone
Mine No 1			11/4/2007	4194460	Elkhorn #3	20	20	5	4' full		10' shale then 80' sandstone
Mine No 1			1/23/2007	4193028	Elkhorn #3	80	20	5	4' full		Slate
Mine No 16	McCoy Elkhorn Coal	15-18250	11/18/2007	4194650	Elkhorn #3	90	19	6.5	4' full		10' sandy shale then 50' shale and sandstone
Mine No 16			11/30/2007	4173518	Cedar Grove	40	20	5	4' full		7' shale then 50' shale and sandstone
Mine No 28	CAM Mining	15-18911	12/19/2007	4177614	Glamorgan	30	19	4.5	4' full		4.5' slate then 54' sandstone
Mine No 28			7/29/2007	4194616	Glamorgan	50	18	4.5	4' full		11' sandy shale then sandstone
Mine No 28			6/21/2007	4199853	Glamorgan	30	20	6.5	4' full	8' cables	11' shale then 54' sandstone
Mine No 1	Solid Energy Mining	15-07475	12/10/2007	4195201	Pond Creek	60	20	5	4' full		10' shale and sandstone then 60' sandstone
Mine No 8	Woodman Three Mine	15-17979	10/26/2007	4177612	Clintwood	40	18	8	4' full		Shale
Raven Mine No 1	ICG Knott County	15-18949	10/26/2007	4201734	Elkhorn #2	20	20	6.5	6' full	10 by 14' cables	10' laminated shale then 10' sandstone
Raven Mine No 1		15-18949	8/30/2007	4194621	Elkhorn #2	40	19	6	5' tens		20' shale then 50' shale and sandstone
Van Lear Mine	Excel Mining LLC	15-18839	9/24/2007	4192893	Van Lear	25	24	13	6' full		10' sandy shale then 10' sandstone
?	Damco LLC	15-16855	8/29/2007	4178747	Elkhorn #3	140	20	4	3.5' full		8' sandstone and shale then 60' shale
No 7	Marshall Mining Inc	15-18709	6/13/2007	4190570	Elkhorn #1	200	18	15	5' tens		5' sandstone then 15' sandy shale
No 10	Ember Contracting	15-17894	12/20/2006	4177674	Elkhorn #3	60	18	10	4' full		Sandy shale

MSHA DISTRICT 7 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

Mine	Owner	ID number	Date	Event #	Seam	Fall size Length	Width	Height	Support	Supplemental	Water	Geology
Darby Fork No 1	Lone Mountain Processing	15-02263	8/25/2006		Darby	20	20	5	5' hy-tech (tens)			
Darby Fork No 1			9/20/2006		Darby	35	19	6	?			
Darby Fork No 1			11/20/2006		Darby	20	20	12	?			
Darby Fork No 1			12/14/2006		Darby	20	20	7	5' hy-tech (tens)			
Darby Fork No 1			8/9/2007		Darby	20	20	8	5' hy-tech (tens)			
No 77	Blue Diamond Coal	15-09636	2/15/2006		Alma	60	20	8	?			
No 4	Bledsoe Coal Corp	15-11065	1/22/2007		Hazard #4	20	20	6	?			
RB #4	Manalapan Mining Co	15-17077	8/1/2007		Hazard #4	40	12	4	?			
Huff Creek No 1	Lone Mountain Processing	15-17234	3/1/2006		Kelioka	20	20	6	5' hy-tech (tens)	8' super bolts		
Huff Creek No 1			4/11/2006		Kelioka	20	20	12	5' hy-tech (tens)	8' super bolts		
Huff Creek No 1			6/12/2006		Kelioka	20	18	8	5' hy-tech (tens)			
Huff Creek No 1			7/19/2006		Kelioka	50	20	8	5' hy-tech (tens)	8' super bolts		
Huff Creek No 1			7/30/2006		Kelioka	20	20	8	5' hy-tech (tens)			
No 75	Blue Diamond Coal	15-17478	3/20/2006		Hazard #4	30	25	10	?			
No 75			5/19/2006		Hazard #4	45	20	10	?			
No 74	Blue Diamond Coal	15-18022	2/17/2006		Hazard #4	100	20	10	?			
Clover Fork No 1	Lone Mountain Processing	15-18647	2/21/2007		Darby	40	18	6	5' hy-tech (tens)			
No 4	Century Operations	15-18422	2/17/2006		Hazard #8	30	20	3				
S&H No 10	S&H Mining	40-03143	11/2/2006	4219996	Walnut Mountain	160	20	6	4' & 6' full	Cribs		Sandstone
S&H No 10			1/2/2007	4242337	Walnut Mountain	70	20	6	4' full			Sandstone
Beech Fork No 30	Bledsoe Coal Corp	15-18939	8/2/2006	4239081	Hazard #4	50	20	7	5' full	10' cables		7.5' slate and sandstone then 7' sandstone
Moseley Spur	Bell County Coal	15-18939	10/27/2007	4443801	Poplarlick	20	20	14	5' full	10' cables		laminated
No 4	Bledsoe Coal Corp	15-11065	10/8/2007	4443411	Hazard #4	80	20	4	4' full			4' slate 20' sandstone
No 4			7/26/2007	?	Hazard #4	50	20	6	4' full			10' laminated sandstone
Beechfork	Bledsoe Coal Corp	15-18376	12/4/2007	4443027	Hazard #4	60	20	7	5' full			22' laminated shale then dark shale
Beechfork			11/30/2006	4239351	Hazard #4	80	80	5	5' full			5' shale then 50' shale & sandstone
Beechfork			2/27/2008	4443328	Hazard #4	40	20	7	5' full			20' grayshale
Beechfork			5/9/2008	4444213	Hazard #4	150	25	6	5' full			
Coal Creek	Bell County Coal	15-18058	11/26/2006	4239086	Buckeye Springs	60	18	5	4' full			5' shale then 10' sandy shale

Coal Creek			3/10/2008	?	Buckeye Springs	30	21	4.5	4' full			5' shale then 10' sandy shale
Coal Creek			3/10/2008	?	Buckeye Springs	30	21	4.5	4' full			5' shale then 10' sandy shale
Huff Creek No 1	Lone Mountain Processing	15-17234	5/7/2007	4240307	Kelioka	35	20	6	5' hy-tech/tens	8' super bolts		7' laminated shale then 10' sandstone
No 1	Three Bells LLC	15-17074	1/22/2007	4238891	Jellico	20	20	3	3' full			2.5' shale then 10' sandstone
No 4	Century Operations	15-18422	2/16/2006	4239069	Hazard #8	35	20	3	2.5' full			?
No 1	Altec Energy	15-09636	2/15/2006	4222540	Alma	45	20	10	5' full			10' shale then 40' laminated shale
No 1			3/16/1998	6130903	Alma	30	20	6	4' full plus straps			10' gray shale then 10' sandstone
Butcher Branch	Century Operations	15-18924	5/12/2006	4238977	Hazard #4	40	20	5	4' full			Sandstone
Butcher Branch			1/22/2008	4443711	Hazard #4	40	20	4.5	?			?
F-M No 4	F-M Coal Corp	15-18466	8/19/2006	4239080	Blue Gem	28	22	5	2.5' full			Shale
Straight Creek No 1	Left Fork Mining	15-12564	2/4/2008	4239399	Rim	10	7	4	5' full			4' slate then 50' sandstone
Big Laurel	Bledsoe Coal Corp	15-11065	3/28/2008	4443528	Hazard #4	65	20	8	5' full			Gray shale with sandstone streaks
No 3	Arjay Mining	15-16695	1/3/1998	6076576	Poplarlick	200	20	20	4' full	Timbers		Dark shale
BRD #1	BRD Inc	15-17907	1/12/1998	6093809	Hazard #8	80	18	5	5' full		Yes	18' shaley sandstone then 10' sandstone
No 1	Straight Creek Mining	40-02353	1/12/1998	6077229	Coal Creek	80	20	5	4' full			30' shale then 10' sandstone
No 1			3/23/1998	6078555	Mason	40	25	8	4' full plus straps			20' firm shale then 10' sandstone
No 37	Arch	15-04670	1/1/1998	6129481	Harlan	28	20	7	5' full			10' siltstone then 10' sandstone
No 2	T&T Mining	15-16576	1/6/1998	6129482	Kelioka	60	20	10	5' full			?
Maces Creek Mine	Leeco Inc	15-17911	2/2/1998	6082925	Hazard # 4	160	19	5	4' full			5' sandy shale then 30' sandstone
Maces Creek Mine			5/29/1998	6082963	Hazard # 4	18	15	4	5' full			4' sandy shale, coal and sandstone mix then shale
Maces Creek Mine			6/2/1998	6082401	Hazard # 4	480	20	12	5' full			4' sandy shale with coal then 15' sandy shale
Maces Creek Mine			6/17/1998	4213015	Hazard #4	100	20	10	5' full			5.5' ironstone then 7' sandy shale
Maces Creek Mine			6/21/1998	6082498	Hazard #4	30	18	5	4' full		Yes	5' laminated shale with coal then 15' gray shale
Mine No 1	Good Coal Co	15-15455	3/29/1998	6079228	Hazard # 4	20	20	4	3' full			Sandstone
Darby Fork No 1	Lone Mountain Processing	15-02263	3/31/1998	5858980	Darby	22	22	12	5' full plus straps			10' shale then 10' sandstone
Darby Fork No 1			6/28/1998	4205010	Darby	25	24	5.5	4' full	5' full		5.5' sandstone and laminated shale then sandstone
Mine No 6	US Coal Inc	40-03092	3/16/1998	6078581	Red Ash	20	20	5	4' full plus straps			16' gray shale then 36' sandstone & shale
Mine No 6			4/27/1998	4211201	Red Ash	40	20	7	3' full plus straps			16' gray shale then 36' sandstone & shale
Mine No 1	Blue Gate Energy	15-12482	3/28/1998	6129493	Kelioka	70	19	14	5' full			4' gray shale then 10' cross bedded shale
No 68	Leeco Inc	15-17497	3/3/1998	4082993	Amburgy	55	20	6	3' & 4' full			4' laminated sandstone then 15' shale & sandstone
Eas No 1	Perry County Mining	15-02085	4/20/1998	6082979	Hazard No 4	40	20	8	4' full			8' shale with coal rider then 30' shale & sandstone
Eas No 1			5/27/1998	4213104	Hazard No 4	20	20	6	4' full			4' shale, coal and sandstone then shale and sandstone
Eas No 1			6/1/1998	4213105	Hazard No 4	80	20	18	8' full with straps		Yes	6' laminated shale, slate, coal and sandstone
Stoney Fork No 2	G&P Contractors	15-17909	5/21/1998	4210001	Blue Gem	50	20	2.5	? Full with straps			20' laminated shale then 20' shale

Little Leaterwood Mine No 1	ANR Coal Co	15-17870	5/8/1998	6082976	Hazard #4	20	20	7	4' full		2' sandy shale then gray shale & sandstone
Little Leaterwood Mine No 1			6/4/1998	6082964	Hazard #4	20	20	5	4' full		2.5' sandy shale with coal then 15' gray shale
No 5	Ember Contracting Group	15-16727	6/1/1998	4214506	#3 Elkhorn	20	20	3	3' full		10' laminated shale then 40' shale
C-2	Harlan Cumberland Coal	15-07201	6/11/1998	5858984	Creech	60	40	8	4' full	7' combo	10' dark shale then 30' sandstone
No 74	Leeco Inc	15-18022	6/24/1998	6130924	Hazard #4	85	20	5	4' full		10' slate and sandstone then 10' sandstone

MSHA DISTRICT 8 - UNPLANNED INTERSECTION
FALLS OF GROUND INVESTIGATIONS

							Fall size					
Mine	**Owner**	**ID number**	**Date**	**Event #**	**Seam**	**Length**	**Width**	**Height**	**Support**	**Supplemental**	**Water**	**Geology**
Gibson		12-02215	2/3/2008	4245639		70	20	30	6' pt anchor	10' cables	Yes	laminated shale and clay
			1/7/2008	4245635		25	17	20	6' pt anchor	10' cables		thinly laminated shale
			1/9/2008	4245636		30	18	15	6' double lok	4 cribs		thinly laminated shale
			12/7/2007	4245331		?	?		?			stack rock shale
			5/1/2006	4244903		18	18	12	6' pt anchor			shale and stack rock
			7/20/2006	4244802		24	24	15		10' cables		stack rock
			2/23/2006	4244009		?	?	10		10' double lok		gray shale
			3/3/2006	6139499		80	18	20	6' double lok			gray shale
			11/6/2006	4244630		20	18	15		10' cables		stack rock
				4244630		20	18	15		10' cables		stack rock
			10/27/2005	6049703		20	20	19		10' cables		unconsolidated shale
Prosperity		12-02249	2/18/2008	4245458		18	18	12	5' full gr	10' cables		laminated sandy shale
			2/22/2008	4286589		20	20	12	6' full gr			slip, stack rock
			2/26/2008	4244861		20	25	10	5' full gr	10' cables	Yes	slickenside
			12/18/2007	4245246		8	10	3	5' full gr			stack rock
			2/27/2007	4244423		?	?		?			slip
			9/6/2006	4244228		20	20	12	5' full gr	10' cables		cutters
			8/8/2006	4244804		30	20	8	4' full gr			slickenside
Mach #1		11-03141	2/3/2008	6156326				9	8' tens full gr		Yes	horizontal stress
Pattiki		11-02662	12/5/2007	6156542		25	25	7	?		Yes	shale, limestone then sandstone
			8/27/2007	6155937		45	18	9	6' tens full gr		Yes	?
			11/15/2006	6155763		200	20	10	4' tens full gr			weak shale
			1/24/2006	6155710		40	18	9	7' tens full gr	4 cribs	Yes	?
Willow Lake		11-03054	10/5/2007	6155987		20	19	5	3.5' full gr			?
Riola		11-02971	8/10/2007	4244848		30	15	8	8' full gr			slips, gray shale
			5/30/2007	4244837		20	20	10	6' full gr			cutter, laminated shale
			11/28/2006	6136694		40	20	15	8' pt anchor			cutter, laminated roof
Crown II		11-02236	2/2/2007	4256416		30	18	8	6/8' tens full			gray shale
Viper		11-02664	2/7/2007	4256308		60	40	10	6/8' tens full			?
Freelandville		12-02316	8/13/2006	4244619		25	20	8	4/6/8' full gr			laminated rock and limestone

			4244619	80	20	12	4/6/8' full gr			laminated rock and limestone
Howesville	12-02354	1/29/2006	4244602	40	18	12	6' full gr		Yes	shale and limestone
		11/11/2005	6138044	18	18	8	5' full gr	12' cables	Yes	laminated slickenside
		11/21/2005	6139474	25	18	12	5' full gr	12' cables	Yes	laminated shale
Gateway	11-02408	1/5/2006	6157064	30	16	6	4/6/7' full gr			?
		9/6/2005	6156275	30	17	5	5' full gr			?
Air Quality	12-02010	9/13/2006	4244529	25	25	5	5' full gr			laminated shale
Liberty	11-02636	11/20/2005	6156017	49	43	7	4' double lk		Yes	slips and shale

MSHA DISTRICT 9 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

						Fall size					
Mine	**Owner**	**ID number**	**Date**	**Seam**	**Length**	**Width**	**Height**	**Support**	**Supplemental**	**Water**	**Geology**
Bowie #2	Bowie Resources	05-04591	4/22/2007	B Upper	100	20	7				
Bowie #2			2/12/2004		20	18	12				
Bridger	Pacific Minerals	48-01646	7/24/2007	D 41	20	16	7			Yes	
Bridger			2/17/2007		30	20	15				
Bridger			12/24/2006		20	16	7				
Bridger			10/24/2006		50	14	9				
Bridger			6/14/2006		55	18	10				
Bridger			5/14/2006		35	14	10				
Bridger			3/16/2006		22	19	9				
Deer Creek	Energy West	42-00121	1/6/2008	Blind Canyon	35	20	8				
Deer Creek			11/3/2007	Hiamwatha	75	20	5.5	6ft full			
Deer Creek			6/25/2007		25	20	8	6ft full			
Deer Creek			5/23/2007		20	20	4	7ft full	10ft cables		
Deer Creek			8/11/2006		75	20	4				Laminated mudstone and caprock
Deer Creek			1/11/2006		45	20	7			Yes	Laminated mudstone and caprock
Deer Creek			7/28/2004		20	20	6				Laminated mudstone and caprock
Deer Creek			6/29/2004		45	35	6			Yes	Laminated mudstone and caprock
Deserado	Blue Mountain Energy	05-03505	8/18/2007	B seam	50	20	9				
Deserado			11/11/2006		20	17	20				
Deserado			7/28/2006		20	17	8	7ft full			
Deserado			7/18/2006		16	14	8				
Deserado			10/12/2005		26	20	9	7ft full			
Deserado			7/21/2005		28	14	9				
Dugout Canyon	Canyon Fuel	42-01890	No unplanned falls recorded								
Elk Creek	Oxbow Mining	05-04674	5/30/2008	D2 seam	35	20	9				
Elk Creek			2/25/2007		40	18	7				
Elk Creek			1/9/2007		30	18	8				
Elk Creek			12/20/2006		45	16	8			Yes	
Elk Creek			12/14/2006		50	18	8				
Elk Creek			12/15/2005		40	18	7				
Elk Creek			8/13/2005		40	20	6.5				

Elk Creek			8/7/2005		60	20	12	
Elk Creek			6/23/2005		40	20	8	
Elk Creek			4/7/2005		25	25	6.5	
Elk Creek			11/4/2004		24	20	7	
Elk Creek			6/6/2004		25	14	12	
Elk Creek			4/21/2004		46	31	12	
San Juan	BHP	29-02170	1/23/2007	Fruitland #8	20	20	15	
San Juan			12/7/2005		20	20	10	
San Juan			5/8/2004		23	23	14	?
SUFCO	Arch Coal	42-00089	1/23/2008	Hiawatha	40	18	6	5ft full & mesh
SUFCO			1/15/2006		30	20	5	
West Elk	Arch Coal	05-03672	5/15/2008	B seam	25	22	6	
West Elk			5/7/2008	E seam	17	15	8	
West Elk			1/22/2008		40	30	7	
West Elk			11/29/2007		40	20	10	
West Elk			5/24/2007		19	15	8	
West Elk			3/26/2007		30	25	10	
West Elk			3/14/2007		16	8	5.5	
West Elk			1/24/2007		20	18	9	
West Elk			11/19/2006		60	20	6	
West Elk			10/19/2006		34	34	7	
West Elk			7/24/2006		16	15	6	
West Elk			4/18/2006		20	16	9	
West Elk			2/6/2006		30	20	12	
West Elk			1/1/2006		35	15	7	
West Elk			9/18/2005		18	18	9	
West Elk			8/17/2005		30	20	7	
West Elk			4/14/2005		18	18	8	
West Elk			4/13/2005		32	23	6	

MSHA DISTRICT 10 - UNPLANNED INTERSECTION
FALLS OF GROUND INVESTIGATIONS

Mine	Owner	ID number	Date	Event #	Fall size Length	Width	Height	Support	Supplemental	Water	Geology
Elk Creek			4/28/2006	4286819	90	19	10	4ft full	Cribs		1ft gray shale, 3ft limestone
#9 seam			4/27/2007		100	18	10	4ft full	No		?
			4/26/2007		25	18	6	6ft full	No		?
			8/2/2007		70	19	6	5ft full	Cablebolts/Cribs	Yes	gray shale, dark gray shale
			6/6/2007		35	19	6	5ft full	Cribs/Propsetters	Yes	gray shale, dark gray shale
			6/26/2007		19	19	12	6ft full	ACS/Propsetters	Yes	gray shale, dark gray shale
			7/6/2007		20	20	10	6ft full	Props/Cribs	Yes	gray shale, dark gray shale
			7/6/2007		30	20	10	6ft full	Props/Cribs	Yes	gray shale, dark gray shale
			7/6/2007		50	18	10	6ft full	Props/Cribs	Yes	gray shale, dark gray shale
			7/6/2007		20	19	10	6ft full	Props/Cribs	Yes	gray shale, dark gray shale
			6/21/2007		20	18	6	6ft full	Cables/Propsetters	Yes	gray shale, dark gray shale
			5/24/2007		40	18	6	6ft full	Timber	Yes	gray shale, dark gray shale
			5/24/2007		75	18	6	6ft full	Timber/Propsetters	Yes	gray shale, dark gray shale
			5/24/2007		30	18	6	6ft full	Timber	Yes	gray shale, dark gray shale
			5/22/2007		18	18	12	6ft full	8ft Cables		gray shale, dark gray shale
			5/22/2007		20	18	7	6ft full	Timber		gray shale, dark gray shale
			5/21/2007		40	18	10	6ft full	Propsetter		gray shale, dark gray shale
			5/16/2007		40	20	6	6ft full	Timber/Cribs	Yes	gray shale, dark gray shale
			5/11/2007		70	18	8	6ft full	Cables	Yes	gray shale, dark gray shale
			5/10/2007		95	18	6	6ft full	Cables	Yes	gray shale, dark gray shale
			4/25/2007		30	18	8	6ft full	Timbers	Yes	gray shale, dark gray shale
			4/27/2007		20	19	8	6ft full	Cables/Cribs	Yes	gray shale, dark gray shale
			5/3/2007		18	18	12	6ft full	Nil		gray shale, dark gray shale
			5/2/2007		90	18	12	6ft full	Timbers		gray shale, dark gray shale
			5/2/2007		18	18	12	6ft full	Timbers		gray shale, dark shale
			4/18/2007		30	20	12	6ft full	Timbers		gray shale, dark shale
			4/19/2007		50	18	6	6ft full	Timbers		gray shale, dark shale
			4/11/2007		18	18	10	6ft full	Timbers		gray shale, dark shale
			3/29/2007		18	18	8	6ft full	Cables/Propsetters		gray shale, dark shale
			1/30/2007		20	18	7	5ft full	Cribs/Propsetters/Timber		gray shale, dark shale
			3/14/2007		30	18	8	6ft full	Timbers/Cribs		gray shale, dark shale
			3/7/2007		30	18	8	6ft full	Timbers/Cribs		gray shale, dark shale
			3/5/2007		22	18	10	6ft full	Timbers/Cribs		gray shale, dark shale

	2/22/2007	70	18	8	5ft full	Timbers/Cribs	gray shale, dark shale
	2/5/2007	30	18	8	5ft full	Propsetters	gray shale, dark shale
	2/2/2007	50	18	8	5ft full	Trusses/Cribs	gray shale, dark shale
Cardinal Mine	7/3/2006	40	18	12	6ft tens	7/8 Trusses/Beams	gray shale, gray sandstone
#9 seam	12/6/2003	20	20	8	6ft tens	Timbers	gray shale, black shale
	12/4/2003	45	15	6	6ft tens	No	gray shale, black shale
	4/28/2003	19	19	7	6ft tens	Timbers/Props/Trusses	gray shale, dark shale
	4/19/2003	18	18	8	6ft tens	Cribs	gray shale, dark shale
	2/23/2003	20	20	8	6ft tens	Timbers/Trusses	gray shale, dark shale
	12/6/2002	30	30	6	6ft tens	Timbers/Trusses	gray shale, dark shale
	11/18/2002	50	18	12	4ft full	Timbers	gray shale, dark shale
	8/2/2002	40	18	10	8ft tens	Trusses	gray shale, dark shale
	7/11/2002	20	20	6	6ft full	Timbers	gray shale, dark shale
#11 seam	10/15/2007	105	19	9	4ft full	Cribs/Timbers	limestone
	11/5/2007	80	18	6	4ft full	Timbers/Cribs	GOB(very weak shale/mud), limestone
	8/4/2007	18	18	6	6ft full	Timbers	GOB, limestone
	5/27/2007	100	20	10	4ft full	Timbers	GOB, limestone
	5/24/2007	20	19	8	6ft full	Timbers	GOB, limestone
	11/18/2006	80	19	10	3&6ft full	Cribs,Steel Sets	GOB, limestone
	10/31/2006	50	20	8	4ft full	Timbers/Cribs	GOB, limestone
	9/27/2005	45	20	5	4ft full	Timbers	GOB (15 in.), 8ft limestone
	12/22/2005	80	19	8	4ft full	Timbers	GOB (15 in.), limestone
	1/12/2006	30	20	7	6ft full	Timbers	GOB (15 in.), limestone
	6/15/2006	50	22	5	3ft full	Timbers	GOB (6 in.), limestone
	8/9/2006	100	19	4	4ft full	Timbers	GOB, limestone
	7/25/2006	20	20	6	5ft full	Timbers/Cribs	GOB, limestone
	6/18/2004	70	19	8	4ft full	Timbers	GOB, limestone
	7/9/2004	75	19	7	3ft full	Cribs	GOB (15 in.), limestone
	10/19/2003	25	18	3	3ft full	Timbers	GOB (3 in.), limestone
	7/2/2003	300	20	5	4ft full	Timbers	GOB, limestone
Dodge Hill	2/4/2008	110	18	6	5ft full	10 ft Cables/Cribs	2ft gray shale, 5-16ft sandy shale
#6 seam	12/27/2007	75	20	8	6ft tens	10 ft Cables	gray shale, sandy shale
	8/9/2007	30	20	8	6ft tens	Timber	gray shale, sandy shale
	3/30/2007	18	18	6	5ft tens	Nil	gray shale, sandy shale
	8/18/2006	210	20	10	6ft tens	10 ft Cables/Cribs/Timbers	gray shale, sandy shale
	8/20/2006	20	20	10	6ft tens	Cables/Cribs/Timbers	gray shale, sandy shale
	7/21/2004	40	20	20	6ft tens	12 ft Cables	gray shale, sandy shale

		8/12/2004	40	50	10	6ft tens	12 ft Cables	gray shale, sandy shale
		7/16/2004	28	20	9	5ft tens	10 ft Cables/Cribs/Timbers	gray shale, sandy shale
	3 way	12/15/2003	10	18	5	5ft tens	Timbers	gray shale, sandy shale
	3 way	12/4/2003	25	18	15	6ft tens	Timbers	gray shale, sandy shale
	3 way	11/30/2003	22	20	8	6ft tens	Cribs	gray shale, sandy shale
	3 way	10/22/2003	25	17	15	6ft tens	Cribs	gray shale, sandy shale
		11/1/2006	60	30	15	6ft tens	No	gray shale, sandy shale
Freedom Mine		2/16/2004	40	20	7	6ft tens	9 ft Mega Bolts	black shale, gray shale
		3/24/2004	80	19	5	3 1/2 ft full	Timbers	black shale, gray shale
		3/25/2004	110	19	4	3 1/2 ft full	Timbers/6ft Tens	gray shale, dark shale
		9/21/2004	70	19	5 1/2	5ft full	Timbers/Cribs	black shale, gray shale
		10/19/2004	35	19	5 1/2	5ft full	No	black shale, gray shale
		8/22/2005	40	19	12	5ft full	Timbers/12 ft Cables	black shale, gray shale
		11/1/2005	160	19	6	5ft full	Timbers	black shale, gray shale
		3/23/2006	120	19	6	6ft tens	No	black shale, gray shale
		12/19/2006	80	20	45	4ft full	Timbers/Cribs	black shale, gray shale
		12/20/2006	110	20	3 1/2	4ft full	Timbers/Cribs	black shale, gray shale
		2/13/2007	100	19	7	4ft full	Timbers/Cribs	18 in. black shale, gray shale
Paradise Mine		2/19/2008	80	18	6	5ft full	Timbers/9ft mega Bolts	2 ft black shale, gray shale
#9 seam		2/19/2008	90	18	6	5ft full	Timbers/9ft mega Bolts	2 ft black shale, gray shale
		2/15/2008	19	19	6	5ft full	Nil	2 ft black shale, gray shale
		1/29/2008	31	19	9	5ft full	9ft Mega Bolts	2 ft black shale, gray shale
		12/21/2007	60	18	10	5ft full	Nil	2 ft black shale, gray shale
		10/27/2007	50	19	7	5ft full	Cribs	2 ft black shale, gray shale
		12/3/2007	30	18	6	?	Timbers	2 ft black shale, gray shale
		12/4/2007	20	18	6	5ft full	9ft Mega Bolts	2 ft black shale, gray shale
		10/28/2007	18	10	6	6ft tens	12ft Cables	2 ft black shale, gray shale
		10/23/2007	58	19	7	5ft full	Timbers/Cribs	2 ft black shale, gray shale
		10/22/2007	70	19	7	5ft full	?	2 ft black shale, gray shale
		9/26/2007	970	18	5	5ft full	9ft Mega Bolts	2 ft black shale, gray shale
		9/26/2007	365	18	5	5ft full	9ft Mega Bolts	?
#11 seam		12/10/2007	50	18	5	2 1/2ft full	Cribs	limestone
		10/18/2007	25	18	5	3 1/2ft full	Cribs	GOB, limestone
		11/1/2007	50	18	5	2 1/2ft full	NIL	6ft GOB, limestone
		9/25/2007	18	18	4	2 1/2ft full	Timbers/Cribs	limestone
Dotiki Mine		7/2/2007	60	20	5	5ft full	?	gray shale, black shale
#9 seam		6/5/2007	120	18	6	5ft full	12ft Cables	2 ft dark shale, laminated shale

4/7/2007	80	20	18	5ft full	Timbers/Cables	2 ft dark shale, laminated shale
4/2/2007	80	20	8	5ft full	10ft Cables	2 ft dark shale, laminated shale
3/8/2007	25	20	6	5ft full	12ft Cables	2 ft dark shale, laminated shale
2/2/2007	80	18	10	5ft full	10ft Cables/Trusses/Timbers	dark shale, laminated shale
1/28/2007	60	19	10	5ft full	?	dark shale, laminated shale
8/8/2006	19	19	6	5ft full	Timber	2 ft dark shale, laminated shale
8/9/2006	105	19	12	5ft full	Timber	2 ft dark shale, laminated shale
1/22/2002	130	18	6	5ft full	Timbers/Cribs	2ft dark shale, sandy shale
12/11/2001	50	18	5	5ft full	12ft Cables/Timbers/Cribs	2ft dark shale, sandy shale
12/8/2001	170	20	7	5ft full	12ft Cables/Timbers/Cribs	2ft dark shale, sandy shale
11/13/2001	105	19	7	5ft full	Timbers/Cribs	2 ft dark shale, laminated shale
10/24/2001	110	19	10	5ft full	12ft Cables/Timbers/Cribs	2 ft dark shale, laminated shale
1/25/2008	100	19	7	5ft full	Truss Bolts	2 ft dark shale, laminated shale
1/2/2008	50	19	10	5ft full	10ft Cables	2 ft dark shale, laminated shale
12/24/2007	65	19	15	5ft full	10ft Cables	2 ft dark shale, laminated shale
1/2/2008	23	19	10	5ft full	Cables/Trusses	2ft gray shale, dark shale
10/27/2007	75	20	5	5ft full	?	?
1/8/2008	18	15	4 1/2	3 1/2ft full	Trusses	2 ft dark shale, laminated shale
2/14/2008	30	19	7	5ft full	Truss Bolts/Props	dark shale, sandstone
10/26/2007	65	19	8	5ft full	Trusses/Timbers	2 ft dark shale, laminated shale
11/4/2007	70	18	8	5ft full	Timbers/Cribs	gray shale, laminated shale
9/14/2007	70	19	13	5ft full	12ft Cables/Trusses	?
12/10/2007	60	20	6	5ft full	Timbers/Cribs	2ft gray shale, laminated shale
12/24/2007	65	19	15	5ft full	10ft Cables	2ft gray shale, laminated shale
12/17/2007	50	20	8	5ft full	Timbered	2 ft dark shale, laminated shale
12/17/2007	25	25	8	5ft full	?	2 ft dark shale, laminated shale

MSHA DISTRICT 11 - UNPLANNED INTERSECTION FALLS OF GROUND INVESTIGATIONS

						Fall size						
Mine	**Owner**	**ID number**	**Date**	**Event #**	**Seam**	**Length**	**Width**	**Height**	**Support**	**Supplemental**	**Water**	**Geology**
Oak Grove	Oak Grove Resources	01-00851	9/22/2007	4298385	Blue Creek	70	21	6	4' full			6' imbedded shale and coal then 100' sandstone/shale
Corinth Mine	Warrior Investment	01-03002	4/4/2007	4297831	America	25	20	9	3' full			4' shale then 14' sandy shale
Coke Mine No1	Shelby Mining Co	01-03217	4/6/2007	4299127	?	50	20	6.6	6' full			Sandy shale
Coke Mine No1			7/25/2007	4299060	Coke	33	18	9	6' full		Yes	30' gray shale then 100' sandstone
Coke Mine No1			8/10/2007	4298961	Coke	250	22	9	6' full		Yes	30' gray shale then 100' sandstone
Coke Mine No1			9/1/2006	4291262	Coke	40	20	5	6' full ?			4' laminated sandstone then 7' sandstone
Coke Mine No1			8/28/2006	?	Coke	88	25	7	4' full			20' gray shale then 100' sandstone
Shoal Creek Mine	Drummond Co	01-02901	7/23/2005	4297536	Blue Creek	35	11	4	6' full			Sandstone
Shoal Creek Mine			2/8/2005	4295491	Blue Creek	40	20	6	6' tens			20' laminated sandstone & shale then sandstone
Shoal Creek Mine			6/27/2004	4294069	Blue Creek	20	20	10	4' & 8' pt anchor	Trusses		14' sandstone & shale then 230' sandy shale
North River No 1	Pittsburg & Midway Coal	01-00759	5/5/2005	4297411	Pratt	29	20	9	6' pt anchor			Laminated shale and sandstone
North River No 1			7/7/2004	4295450	Pratt	86	18	7	6' tens			Shale with laminated sandstone streaks
North River No 1			9/24/2004	4293984	Pratt	21	20	8	6' tens			Laminated shale and sandstone
North River No 1			9/5/2004	4293979	Pratt	20	20	8	6' tens			Laminated shale and sandstone
North River No 1			9/11/2004	4295465	Pratt	24	20	8	6' tens			Shale with laminated sandstone streaks
No 4 Mine	Jim Walter Resources	01-01247	11/15/2006									

Data averaged per District

Average fall height (ft) distribution by District

Height	Frequency All	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
<4	14	0	0	0	2	4	1	4	1	0	2	0
4 to 6	255	0	13	12	70	20	38	33	3	12	50	4
6 to 10	349	0	27	48	49	36	45	22	11	38	62	11
10 to 15	85	0	18	7	8	5	5	6	12	8	16	0
15 to 20	17	0	1	0	1	3	1	2	6	1	2	0
20 to 25	3	0	0	0	0	1	0	0	2	0	0	0
25 to 30	1	0	0	0	0	0	0	0	1	0	0	0
>30	1	0	0	0	0	0	0	0	0	0	1	0
TOTAL	**725**											

Average fall length (ft) distribution by District

Length	Frequency All	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
<10	6	0	0	3	1	0	0	1	1	0	0	0
10 to 20	166	0	5	32	27	14	19	18	3	18	28	2
20 to 30	177	0	22	16	29	20	24	10	14	14	24	4
30 to 40	108	0	13	7	16	9	15	12	6	14	12	4
40 to 50	65	0	5	2	12	6	6	6	6	7	14	1
50 to 60	50	0	3	3	13	11	5	6	0	3	6	0
60 to 80	69	0	2	3	11	6	11	8	1	2	24	1
80 to 100	37	0	2	0	10	2	6	3	2	1	9	2
>100	49	0	8	1	11	2	4	5	1	0	16	1

Average stand-up time distribution by District

Age	Totals	District 1	2	3	4	5	6	7	8	9	10
< 1 month	124	0	7	5	13	10	8	3	37		38
1-3 months	118	0	4	4	7	10	10	5	49		29
3-6 months	68	0	1	2	14	6	8	4	16		14
6-12 months	67	0	5	5	12	3	5	2	26		9
1-3 years	115	0	2	15	14	10	11	11	42		9
3-5 years	22	0	0	5	0	1	6	0	4		5
> 5 years	87	0	1	9	8	12	20	11	13		12
										NO DATA	

Note: There is no data for District 9 as a visit was not made to the MSHA Office in Denver, CO to review the 7000 50a reports.

VITA

Graduate School

Southern Illinois University

Allen R. Mueller Date of Birth: January 14, 1985

4022 N. Central Park, Apt. 3W, Chicago, Illinois 60618

407 Pine Ridge Drive, Washington, Illinois 61571

AllenRMueller@gmail.com

Southern Illinois University, Carbondale

Bachelor of Science, Mining Engineering, December 2008

Thesis Title:

An Analysis of Current Intersection Support and Falls in United States Coal Mines and Recommendations to Improve Safety

Major Professor: Dr. A.J.S. (Sam) Spearing

Publications:

Spearing, A.J.S., and A. Mueller (2008), "State-of-the-Art Intersection Support in Coal Mines in the USA", *SHIRMS Proceedings – Vol. 1*, pp. 641-652.

Spearing, A.J.S., and A. Mueller (2009), "A Review of Rock Support and Falls in U.S. Coal Mine Intersections", *SME Annual Meeting*, Feb. 22-25, 2009