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DIRECTOR'S REPORT TO THE LEGISLATURE AND GOVERNOR AS REQUIRED BY WEST VIRGINIA CODE §22A-12-1

COAL MINE SAFETY REPORT

PREPARED BY WEST VIRGINIA UNIVERSITY LAW INSTITUTE

Miners Safety Report
December 31, 2013

TABLE OF CONTENTS

APPENDICES

I. INTRODUCTION AND EXECUTIVE SUMMARY

In response to the explosion and the deaths of 29 miners at the Upper Big Branch Mine ("UBB") in 2010, the Legislature in 2012 enacted a major mine safety law to deal with some pressing issues in our mine safety code. H.B. 4351 (2012). The Act also ordered the Director of the Office of Miners' Health, Safety and Training to submit to the Legislature by December 31, 2013, a report on needed revisions in mine health and safety enforcement. That provision, which was codified as West Virginia Code § 22A-12-1, reads:

> The director shall, by December 31, 2013, report to the Legislature and Governor on the need for revisions in the state's underground mine safety enforcement procedures. The director shall initiate the study using appropriate academic resources and mining safety organizations to conduct a program review of state enforcement procedures to evaluate what reforms will assure that mining operations follow state mandated safety protocols. The report shall include recommended legislation, rules and policies, consider various options for improving inspections, accountability and equitable and timely administrative procedures that cause remediation of hazardous working conditions.

This report fulfills the directive made in § 22A-12-1.

West Virginia has repeatedly had the highest coal mine fatality and accident totals in the country.[1] The State must correct that. If West Virginia wants safe mines and healthy miners, it must create a culture of safety. Other states have managed to do so, and individual companies have

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[1] *E.g.*, MSHA, *Coal Mining Fatalities by State by Calendar Year*, available at: http://www.msha.gov/stats/charts/coalbystates.pdf. According to MSHA, between 2002 and 2013, West Virginia had 129 coal mine fatalities; the next highest numbers were Kentucky with 87 and Alabama with 24. *Id.* For thorough data on injuries, *see* MSHA's data at: http://www.msha.gov/ACCINJ/accinj.htm.

accomplished it.[2] What is needed is commitment to the goal, and that commitment must start with legislative commitment of the resources needed to communicate that the State is serious about creating and enforcing a system of mine safety. At present, there are deficiencies in safety enforcement directly traceable to a shortfall of state investment. That must change. Revenues are needed to establish an effective state mine safety regime and to convince all (not just some) coal operators and miners that safety comes first.

The Table of Contents, above, lists the recommendations made in this report, and summaries at the end of Parts II and III also provide condensed lists. The most prominent features of this report can be readily identified. One would be the already-mentioned commitment of resources, especially to the Office of Miners' Health, Safety and Training for enhanced inspectors' pay (*see* Section II-A-1, *infra*), research (§§ II-C-4 and III-C), and training (Part V). Other particularly important recommendations include emphasizing enforcement efforts using impact inspections (§ II-A-4) and focusing on operators with patterns of violations (§ II-B-1), revising rock dusting regulations (§ II-C-2), revamping the composition and procedures of the Board of Coal Mine Health and Safety (§ II-D), adopting all of the suggestions in Part III that address the adverse consequences of the recent increases in miners' lung diseases, and requiring the use of proximity monitors or cameras on equipment and of coal dust explosibility meters (§§ IV-B and -C). As directed by the authorizing statute, § 22A-12-1, the report recommends changes in legislation, rules and policies, considers options for improving inspections and accountability, and addresses improved procedures. Some

[2]Consolidation Coal Company, for example, has been widely cited as maintaining an effective and disciplined commitment to safety. Such was not always the case with Consol. *See, e.g.*, *Rodriguez v. Consolidation Coal Company*, 206 W.Va. 317, 534 S.E.2d 672 (1999); *United Mine Workers, District 31 v. Consolidation Coal Co.*, Monongalia Circuit Court, Civ. Action No. 88-C-391 (enjoining company's "Safety Approach Program," which provided for progressive discipline for work injuries, as being in violation of mine safety and workers' compensation laws); BONNIE E. STEWART, NO. 9: THE 1968 FARMINGTON MINE DISASTER (W.V.U. Press 2011).

of the recommended changes require new legislation while others can be handled administratively. The Office of Coal Miners' Health, Safety and Training has already implemented or is in the process of implementing many of the suggestions.

II. ENFORCEMENT BY THE OFFICE OF MINERS' HEALTH, SAFETY AND TRAINING

A. INSPECTORS AND INSPECTIONS

1. Increase the salaries and number of inspectors

Ensuring coal mine safety in West Virginia requires competent and qualified mine inspectors within the Office of Miners' Health, Safety and Training ("OMHST" or "the Office"). Because of competitive wages being offered by mine operators and the federal Mine Safety and Health Administration ("MSHA"), the low level of salaries currently paid by the State has made it difficult for the Office to find and retain qualified inspectors. Retention has been particularly problematic, as turnover among the inspector corps has been high. Increasing the number and salaries of surface and underground mine inspectors employed by the OMHST will enhance mine safety within West Virginia.

As of the date of this report, the minimum annual salary for surface mine inspectors is $53,904 and for underground mine inspectors the minimum is $54,804. Those compare to West Virginia coal miners' average 2012 income of $84,750[3] and MSHA inspector salaries that approach $75,000.[4] West Virginia Code §§ 22A-1-9, -11, -12, -13, and -24, authorize the Director of the OMHST to set the minimum salaries paid to surface and underground mine inspectors. The

[3]National Mining Association, "Annual Coal Mining Wages v. All Industries, 2012," available at: http://www.nma.org/pdf/c_wages_state_industries.pdf.

[4]U.S. Department of Labor at http://www.doors.dol.gov/jobsearch.

OMHST has the authority to employ as many surface and underground mine inspectors as the Director determines to be "reasonably necessary in fully and effectively carrying out the applicable provisions" of the West Virginia regulations. W. Va. Code §§ 22A-1-12 and -13. While the statutory authority has been provided to the Director to set competitive salaries and hire a sufficient numbers of inspectors to do the work necessary to ensure safe mining, the funding to do so has not been provided. Funding should be allocated to permit the OMHST to increase mine inspectors' salaries to a level that would enable it to be competitive in hiring and retaining qualified inspectors and to permit the agency to increase the number of inspectors to a level believed by the Director to be adequate to meet the need. The agency needs a sufficient number of inspectors not only to perform the statutorily required four inspections per year at each mine, W. Va. Code § 22A-1-14, but also to target particular mines that have troubling safety records. The increase in the number of inspectors is needed to inspect the problem mines more frequently and to subject them to the "impact inspections" that are discussed below.

2. Enhance the training and clarify the duties of mine inspectors

(a) Need for initial and annual training, including specialized training

Unlike certified coal miners, who are required to undergo initial and annual training, mine inspectors are merely required to pass an initial examination and meet experience requirements. W. Va. Code § 22A-1-12. To ensure that mine inspectors are up to date on mine safety regulations and any other information the OMHST deems pertinent to their duties as mine inspectors, initial and continual training should be mandated for all mine inspectors. To be sure, the OMHST has on its own recently implemented an ambitious education program for its inspectors that has included, among other things, ventilation instruction, a first aid/first response course, roof control meetings, an accident investigation course, violations instruction, and, for new inspectors, creation of a

training manual and a mentors program. The educational program, however, needs to be codified to ensure that future administrations are similarly enlightened.

The initial training should include instruction on the duties of mine inspectors, on particular problems that inspectors are likely to encounter, on the pertinent health and safety provisions, and other information that the OMHST deems useful. Providing mine inspectors with initial training will give them some guidance on what is expected of them as inspectors and will result in a more efficient process of conducting inspections and identifying violations. Familiarity with the Code gained through the initial instruction will better facilitate enforcement and reduce inspector errors.

In addition to initial training, mine inspectors should be required to receive continuing education. That training should focus on any changes in safety regulations, new mining technologies, and new safety and health developments (research, techniques, technology, etc.). The training should also address any specific regulatory issues or safety problems that inspectors or other OMHST agents have encountered. Some educational program – on the order of that which the Office has recently initiated – should be mandated. The Director of the OMHST should have broad discretion in fashioning that program.

The Office should tailor the training to each inspector's specific duties. For example, electrical inspectors should receive specialized training on their duties that would not necessarily be pertinent to what is expected of surface and underground mine inspectors.

The training could be supplemented by investing in easily portable computers or hand-held devices loaded with electronic files of the relevant code provisions and regulations. The device could also provide inspectors with the means for storing information gathered during an inspection. (The Office has recently invested in I-Pads for some of its inspectors and has begun training on their use. This process could take a while.)

(b) Need for specialized duties to ensure each mine inspector conducts his or her specific job

Although the West Virginia Code does distinguish the qualifications and duties of electrical inspectors from those of surface and underground mine inspectors, the allocation of responsibilities should be clarified to enable each individual inspector to perform his or her specific job without the concern of surface or underground mine inspectors performing electrical duties that they may not be qualified to perform.

The qualifications of electrical inspectors are set forth in W. Va. Code §§ 22A-1-11 and their duties are stated in 22A-1-16. The latter should be amended to provide more detailed guidance on what is required of electrical inspectors and to clarify for mine inspectors what they are not responsible for. In addition, training for inspectors should include instruction on avoiding risks with electrical equipment and wiring.

3. Provide mine inspectors with the authority to order the abatement of hazards that are not expressly identified in the law

The current West Virginia regulations identify a wide range of potential hazards that mine inspectors may cite operators for violations. Circumstances often arise, however, that are not expressly covered by regulation yet are hazardous to the safety of coal miners. Safety requires that these hazards be identified by mine inspectors and corrected by operators, regardless of the express provisions of the law.

To abate hazards not expressly identified under the law without assigning mine inspectors unbounded discretion in issuing violations, a "catch-all" provision should be created to authorize the OMHST, through its inspectors and upon the approval of its Director or Deputy Director, to issue citations for hazards not expressly covered by statute or regulation and, more importantly, to order abatement of the hazardous condition. The law cannot anticipate every hazard that can arise,

and an inspector in the field needs the authority to order attention to the unanticipated risks. Any citations, of course, would be subject to challenge by the operator and reviewable by the Coal Mine Safety Board of Appeals.

4. Provide for impact or targeted inspections of problem mines and areas

The federal Mine Safety and Health Administration has found considerable success in using "impact inspections." Those inspections employ a team of inspectors and the element of surprise to descend upon a targeted mine at any time of the day and any day of the week. Officials immediately secure the mine's communication lines and devices and proceed to conduct a swift but thorough inspection of the mine. Using impact inspections has enabled MSHA to observe many unsafe practices that otherwise might have gone undetected. Mines are typically selected for impact inspections based upon a data analysis of their past performance, although maintaining the right and threat to do an impact inspection on any mine can also be effective. Between April 2010 and July 2013, MSHA conducted 642 impact inspections, which resulted in 10,789 citations, 996 orders, and 45 safeguards. *News Release: MSHA announces results of July impact inspections,* U.S. Department of Labor, Office of Public Affairs, Aug. 27, 2013, *available at* http://www.msha.gov/media/PRESS/2013/NR130827.pdf.

The OMHST has also used such strategies – which the Office refers to as "blitz inspections" – and found them to be effective. It, however, has not had the resources to do them on the scale that MSHA has done them. As noted above, more resources are needed for this purpose. An express statutory provision authorizing the impact inspections would also be helpful; it would put operators on notice that such inspections are possible and could prove costly to them if they are not safety responsible. In addition, explicit statutory authority to seize a mine's communications would be useful. The OMHST has not yet attempted to control a mine's communications when undertaking

an impact inspection, in part because of concerns about the lack of legislative authorization. These provisions would help to ensure that another disaster like Upper Big Branch does not occur due to an operator's consistent failures to abide by the pertinent laws and regulations.

Those mines that are most in need of impact inspections should be identified by the OMHST based on the history of violations, poor compliance, and accident rates and on particular mine conditions that present hazards (gassy mines, certain geological conditions, historically bad top, etc.). *See* section II-B-1, *infra*, on a "pattern of violations" provision. Sophisticated analyses have been developed to identify high-risk mines. Examples are attached to this report as Appendix A.[5] The OMHST should have the discretion and authority to conduct the impact inspections in mines identified as at-risk mines and to do so in addition to the four inspections per year required by West Virginia Code § 22A-1-14. The Office should also have the discretion to focus particular inspections on problem areas of a mine. Conducting impact inspections that target problem mines and problem areas shifts resources to where they are most needed.

5. Review mine inspection priorities

The OMHST should be required to review regularly its mine inspection priorities and revise them, as appropriate, to ensure that mines that have a history or pattern of violations are inspected more frequently while still conducting the minimum number of inspections of each mine required by West Virginia Code § 22A-1-14. That would codify what OMHST currently does.

6. Randomize the procedures by which regular inspections are conducted

[5]The Appendix reprints Harisha Kinilakodi, Robert Larry Grayson, & Samuel A. Oyewole, *Evaluating Equivalence of the Safe Performance Index (SPI) to a Traditional Risk Analysis*, 2 OPEN J. OF SAFETY SCI. & TECH. 47 (2012), and Harisha Kinilakodi & R. Larry Grayson, *A Methodology for Assessing Underground Coal Mines for High Safety-Related Risk*, 49 SAFETY SCIENCE 906 (2011).

To enhance the effectiveness of inspections, the OMHST should have the express authority to develop strategies to randomize the procedures by which regular inspections are conducted, including conducting inspections at varying hours of the day and days of the week. In addition, inspections should be conducted by randomly proceeding through different areas of the mine, especially in those larger mines that require more than one day to inspect. The Office has already adopted such practices, but an explicit statutory grant would be useful.

The inspection system's effectiveness is enhanced when mine inspectors begin inspections at unpredictable hours of the day and days of the week, including some weekends and holidays. *See* Va. Code § 45.1-161.85 (2011). Implementing a provision similar to Virginia's would help to prevent evasion of the law by unsafe (or even conscientious) operators. Generally, the less predictable the inspection system is, the more effective it is.

7. Revise provisions on removal of inspectors

West Virginia Code § 22A-1-12(e) sets forth the grounds and procedures for removal of mine inspectors. Some of its provisions have constitutional problems. Subsection 5 forfeits the position of any inspector who refuses to answer any question under oath because his testimony might tend to incriminate him or her or who refuses to waive immunity from prosecution. Although circumstances could make a difference, such automatic forfeitures would at a minimum raise questions about their constitutionality under the Fifth Amendment to the United States Constitution and Article III, § 5 of the West Virginia Constitution. *See, e.g.*, *Slochower v. Board of Education*, 350 U.S. 551 (1956). In addition, subsection (e)(6) states that, if the Board removes an inspector, the Board's decision "is final and is not subject to judicial review." It is highly doubtful that the Legislature can insulate any administrative adjudicatory decision from judicial review. *See* W. Va. Constitution, Article VIII, §§ 3 & 6 (conferring constitutional certiorari review on, respectively, the

Supreme Court and the circuit courts). There is, moreover, no reason to insulate the Board's decisions from review.

The subsection 5 forfeiture provisions and the subsection 6 attempted bar to judicial review should be removed.

B. IMPLEMENTATION AND PENALTY PROVISIONS

1. Improve fines and sanctions provisions

(a) Adjust penalties provisions

Two sections of the mine safety code provide for civil penalties. Section 22A-1-21 establishes four categories of sanctions: (1) regular assessments, (2) regular assessments for knowing violations, (3) special assessments, and (4) individual personal assessments. Regular assessments are issued to operators who violate a health or safety provision of Chapter 22A of West Virginia Code or a health or safety rule promulgated pursuant to Chapter 22A of the Code. Regular assessment penalties are not to exceed $5,000. § 22A-1-21(a)(1). If, however, the operator "knowingly" violates a code provision or regulation, then the penalty may be up to $5,000 for the first violation and up to $10,000 for any subsequent knowing violation. § 22A-1-21(b)(1). Special assessment violations are issued when the violation is of a serious nature and involves one or more of the following conditions: (1) violations involving fatalities and serious injuries; (2) failure or refusal to comply with any order issued under § 22A-1-15 of the Code; (3) operation of a mine in the face of a closure order; (4) violations involving an imminent danger; (5) violations involving an extraordinarily high degree of negligence or gravity or other unique aggravating circumstances; or (6) discrimination under §22A-1-22 of the Code. W. Va. Code § 22A-1-21(b)(2). Special assessment violations must be at least $5,000 but may not exceed $10,000. *Id.* An individual personal assessment violation may be issued to any miner who knowingly violates any health or

safety provision of Chapter 22A of the West Virginia Code or a health or safety rule promulgated pursuant to Chapter 22A. W. Va. Code § 22A-1-22(a)(3). Individual personal assessment violations are not to exceed $250. *Id.*

In addition to the 22A-1-21 fines, § 22A-2-66 requires the OMHST Director to impose a $100,000 civil administrative penalty on any operator or general mine foreman who fails to give immediate notice to the state of an incident that caused or threatens to cause death or a serious safety concern. The statute specifically defines such incidents and allows the Director to waive the penalty if the failure to provide notice was caused by circumstances wholly outside the control of the operator.

The provisions of § 22A-1-21 could use some tweaking. The term "knowingly" as used in subsections (a)(3) and (b)(1) should be defined to mean that the violations were intentionally committed and *not* that the person knew that he or she was violating some law. In other words, ignorance of the law should be expressly eliminated as a defense. Subsection (b)(1) should also make clear that an operator "knowingly violates" the law if any agent – any management personnel – knowingly violated the code or regulation. And the ceiling for special assessments should be raised from $10,000 to $20,000.

Unfortunately, many accidents and injuries result from the carelessness or recklessness of coal miners rather than from the operator's actions or inactions. To improve the deterrent effect on unsafe miner behavior, the statutory ceiling for individual personal assessments should be increased. Obviously, individual miners cannot afford to pay the kinds of penalties that operators pay, but the penalty must be sufficient to impose a sanction that will operate as a conscious deterrent on unsafe conduct that is something less than the capital punishment of decertification. The current cap of

$250 is not sufficient to accomplish that purpose. As noted above, "knowingly" should be defined in such a way as to exclude ignorance of the law as a defense.

(b) Enhance pattern of violations provision

A provision authorizing penalties for patterns of violations would allow the OMHST to identify those mines known to continuously violate the health and safety provisions of the West Virginia Code and would provide an additional enforcement tool for protecting the health and safety of coal miners. A provision should be enacted that sets forth criteria to identify those mine operators who have a habit of disregarding the health and safety of the State's coal miners and that establishes what constitutes a pattern of substantial and significant violations. Imposition of stricter penalties should be made available against operators identified as persistent offenders. The penalties should include closure orders until compliance is established.

Procedures and criteria should be created by statute or by the OMHST pursuant to statutorily granted rule-making authority to identify those operators who have established pattern of violations. Consideration should be focused on the operator's compliance history, including: (1) orders issued under W. Va. Code §§22A-1-15(a) and 22A-1-15(b); (2) violations issued; (3) the history of accidents, injuries, and fatalities at the mine while under the operator's control; (4) any other enforcement measures taken against the operator by the OMHST; and (5) any mitigating circumstances. *See* Pattern of Violations, 78 Fed. Reg. 5056 (Jan. 23, 2013) (codified at 30 C.F.R. Part 104). Once a mine operator is identified as having a pattern of violations, notice shall be issued to the mine operator informing him of this characterization. *See* 30 C.F.R. § 104.3 (2013). If notice is issued on a mine operator based on a finding that the mine has been characterized as having a pattern of violations and that mine is issued any substantial and significant ("S&S") violations within three months (90 days) after the issuance of the notice, the OMHST should have the authority

to issue an order, pursuant to § 22A-1-15 of the West Virginia Code, withdrawing all persons from the mine and prohibiting them from reentering the mine until an authorized representative of the OMHST determines that no danger exists and that the mine is in full compliance with all health and safety regulations.

Although the West Virginia Code refers to a pattern of violations, § 21A-1-15(c)(2), that provision applies only as a consideration in issuing a temporary closure order and not as a basis for imposing other penalties. What constitutes a pattern of violations justifying additional penalties and increased oversight needs to be clarified and the criteria must be articulated. The specific pattern criteria and the process for identifying pattern violators should be posted on the OMHST's website. *See* 30 C.F.R. § 104.2.

2. Clarify decertification for coal miners, foremen, and others and coordinate decertification with other states

(a) Clarify decertification

Suspension or revocation of a miner's certification imposes a greater sanction than a mere monetary fine. Currently, West Virginia Code § 22A-1-31 sets forth the procedures for withdrawal of a miner's certification, but the practice is rarely used and the provision does not specify which offenses warrant suspension or revocation of one's certification. Currently in West Virginia, the only specified ground for miner decertification is a violation of the substance abuse drug screening provisions that were implemented in January, 2013. *See* W. Va. C.S.R. § 56-19-5.4 (2013).

To strengthen penalties for coal miners, foremen, and other certified personnel within the mines, the OMHST and Coal Mine Safety Board of Appeals should be authorized to suspend or revoke a miner's certification for specified serious offenses or for a pattern of individual personal assessments. What constitutes a serious offense warranting suspension or revocation of certification

must be clearly defined. *See* 805 Ky. Admin. Regs. 8:010 (2002) (defines first offense as an individual's or entity's intentional violation of, or order to violate, a mine safety law that places a miner in imminent danger of serious injury or death). Provision should be made, however, to authorize the OMHST to seek decertification for unspecified conduct that involves a serious breach of safety and to decline to seek decertification for specified conduct that, in the particular circumstances, was rational and justified. The procedure used to decertify those miners charged with committing a serious offense or pattern of violations can be the same procedure as is used to decertify those miners who have violated the substance abuse drug screening policy. Once it is determined that the specified offense(s) warrant(s) suspension, the Board of Appeals, in its discretion, shall determine the appropriate period of time for suspension. *See* 805 Ky. Admin. Regs. 8:030 (2002). After the suspension period ends, the miner may apply to the Board of Appeals for reinstatement of his certification. *See id.* The Board should also have the authority to revoke certification permanently or for an unspecified period.

(b) Coordinate decertification with other states

The law should direct the OMHST, upon the suspension or revocation of a miner's certification, to share that information with surrounding states. The Office should also be required to post on its website a list of the names of decertified miners and the periods of their suspensions. The distribution to other states' mine safety agencies and the website postings should include those miners whose certification has been suspended or revoked due to a violation of the substance abuse drug screening provision.

3. Strengthen subpoena power

Currently under West Virginia Code § 22A-1-4(b)(9), the Director of the OMHST has the power to call or subpoena witnesses for the purpose of conducting hearings into any mine accidents,

fires, or explosions. The section should be amended to empower the Director to delegate his subpoena authority to OMHST legal counsel and to inspectors to question any individual, without the presence or knowledge of a mine operator, regarding a mine accident. The provision should expressly recognize an individual's right to retain legal representation during any questioning and state the duty of OMHST to inform the interviewee of that right. Amendment should also be made to provide that, if the interviewee is being questioned on the record as the spokesperson for the operator, then the operator has a right to have its counsel attend as well.

Finally, the mileage rate allowed by § 22A-1-4(b)(9) to witnesses should be increased from the current $.15 to that amount that the State pays its employees for their official travel.

4. Modify Accident investigation procedures

To achieve more efficient and thorough investigations following serious or fatal mine accidents, a mine accident investigation team should be created. The mine accident investigation team should consist of a number of mine inspectors that the Director deems sufficient to conduct a thorough investigation and preserve evidence collected during the investigation.

The need for a mine accident investigation team has been created by the delays that occur before the Coal Mine Safety Board of Appeals. Because of a backlog in the Board's docket, a hearing on the events of a serious accident is often held years after the investigation and issuance of any citation. Under the current practice, once the operator gives notice to the OMHST of the accident, an inspector investigates the conditions of the mine and the causes of the accident. W. Va. Code §22A-1-14. A report is then issued to the Director of the OMHST setting forth the results of the investigation, including the conditions of the mine and the perceived causes of the violations. *Id.* When a violation is alleged and is challenged, a hearing ensues before the Coal Mine Safety Board of Appeals. By the time the case gets to hearing, it is often difficult for an inspector to recall

accurately the exact events and why violations were issued. This problem can be alleviated by the creation of a mine accident investigation team that has received special training in investigation and hearing procedures.

The duties and compensation of the mine accident investigation team should be specifically set forth by law. The team should consist of a panel of mine inspectors, both underground and surface. The number of inspectors that shall be employed on a particular mine accident investigation should be decided by the Director of the OMHST, based on the proximity of the mine inspectors to the accident scene and the need for a smaller or greater number of mine inspectors to serve. Because of practical limitations, a mine accident investigation team would only be engaged in fatalities or those cases that, in the Director's opinion, involve a serious injury. The duties of the mine accident investigation team shall include:

- Conduct a thorough investigation of the mine accident, including (a) identifying all factors that caused the accident, (b) identifying any contributing actions or inactions of any party;
- Prepare a thorough report of the accident, identifying (a) the causes of the accident, (b) any citations issued and the basis for them, © witnesses relied on in identifying the causes of the accident, (d) a list of persons within or around the mine at the time of the accident, (e) copies of all pertinent records pertaining to the accident at the time it occurred and to the perceived causes of the accident, and (f) any actions taken by the mine accident investigation team or operator to remedy the violations and any future actions that must be taken by the operator (or other person) to comply with the relevant provisions of the law and prevent a reoccurrence; and
- Upon completion of the investigation and the report, compile inventory, and preserve all evidence relating to the investigation, including any notes taken during or after the investigation, all records collected, and all witness statements.

Regulations should also specify the compensation for the members of the mine investigation team. The provisions relating to OMHST mine rescue teams provide an appropriate analogy for determining an appropriate compensation for mine accident investigation team members. *See* W. Va. C.S.R. § 36-44-4. Currently, the minimum compensation to be paid to mine rescue team members is $250 per month in addition to the required salary earned as a mine inspector employed by the OMHST. Minimum compensation for mine accident investigation team members should be established and reviewed annually by the Director of the OMHST. See Appendix B for a proposed statute on mine investigation teams.

5. Create Corporate Director, Officer, and Agent Liability

West Virginia does not currently impose comprehensive liability on individual members of corporate boards or corporate officers and agents. The federal Mine Safety and Health Act does. 30 U.S.C. § 820© provides:

> Whenever a corporate operator violates a mandatory health or safety standard or knowingly violates or fails or refuses to comply with any order issued under this chapter or any order incorporated in a final decision issued under this chapter, except an order incorporated in a decision issued under subsection (a) of this section or section 815© of this title, any director, officer, or agent of such corporation who knowingly authorized, ordered, or carried out such violation, failure, or refusal shall be subject to the same civil penalties, fines, and imprisonment that may be imposed upon a person under subsections (a) and (d) of this section.

West Virginia should consider adopting this provision or follow a recommendation made by the Governor's Independent Investigation Panel on the UBB disaster on the same subject:

3. Adopt provisions similar to those contained in the Sarbanes-Oxley Act to make a Board of Directors accountable for mine safety compliance. Boards of Directors should utilize existing health and safety committees or form a committee to oversee health and safety aspects of the mines under the company's control. The committee would be responsible for ensuring compliance with all federal and state regulations and would be required to certify that the mines are in compliance each quarter. A criminal penalty should be assessed on these board members who certify, negligently or willfully, that the mine is in compliance when it is not.[6]

6. Strengthen the Anti-Retaliation Provision

West Virginia Code § 22A-1-22 provides a remedy for miners and their authorized representatives who have been discriminated against because they have invoked the protections of the mine safety laws or have participated in any proceeding resulting from the administration or enforcement of those laws. An aggrieved miner may apply to the Board of Appeals which is directed to investigate the matter. In reality, there is no investigation. Rather, the matter proceeds to a hearing at which each side presents its evidence, and the Board renders its decision. The provision could use improvements.

First, the miner is given only thirty days in which to file his application with the Board of Appeals. That is an extremely short limitations period for what can often be a fairly complicated matter. Six months would be a more reasonable limitation. Second, in light of the Board's practice of not investigating the cases, the parties could be given some limited rights of informal discovery.

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[6]J. Davitt McAteer, *et al.*, Governor's Independent Investigation Panel, UPPER BIG BRANCH: REPORT TO THE GOVERNOR 109 (May 2011), available from: http://www.nttc.edu/ubb/.

Third, the provision could provide an alternative remedy to the miner of filing a court claim that could seek not only back pay but also noneconomic damages or, perhaps, liquidated damages equal to the amount of back pay or other economic loss. Technically, that alternative already exists in discharge cases due to the State Supreme Court's decisions in *Collins v. Elkay Mining Company*, 179 W. Va. 549, 371 S.E.2d 46 (1988), and *Wiggins v. Eastern Associated Coal Company*, 178 W. Va. 63, 357 W. Va. 745 (1987), which held that employment discharges of miners who have invoked the mine safety laws violate a substantial public policy of the State and are therefore actionable in tort. *See also Stanley v. Sewell Coal Company*, 169 W. Va. 72, 285 S.E.2d 679 (1981). A statutory provision would, however, solidify that a tort claim is an alternative, could make the administrative and judicial alternatives mutually exclusive (which is not currently the case), could also provide for attorneys' fees for prevailing plaintiffs in the circuit court cases (something that the public policy cases do not authorize), and could expand the alternative remedy beyond the discharge cases. As a practical matter, the judicial alternative would only make sense to claimants when there is a potential for substantial damages.

C. PERFORMANCE STANDARDS

1. Review the drug and alcohol testing and enforcement provisions

In January, 2013, and pursuant to the authority created in the 2012 Act, W. Va. Code §§ 21A-1A-1, *et seq.*, the OMHST rule took effect requiring operators to administer random substance abuse drug screening of certified personnel at least four times per year testing at least twenty-five percent of a mine's employees. W.Va. C.S.R. § 56-19-3.13 and -5. The Rule has been amended to include mandatory alcohol breath tests. W.Va. C.S.R. § 56-19-5.4. The statute could use some tweaking.

Subsection 1 of Article 1A should authorize covered employers to use testing procedures that are as reliable as the currently required urine tests. (Notably, that would currently be use of hair and blood samples.) Subsection 2 should make clear that, at the Board of Appeals hearing, the burden of persuasion rests on the person who has tested positive for a prohibited substance. The Act should also give the Director the discretion and authority to modify the program's scope and procedures.

In addition, the first year of the testing program has yielded a very large number of appeals to the Board of Appeals, a number that threatens to displace the Board's other important work. Consideration should be given to providing for some alternative mechanism for satisfying the employees' due process rights and relieving the Board of that onus.

Finally, § 22A-1A-3, regarding the confidential nature of substance abuse screening tests, should be amended to make clear that the OMHST can disclose to other state mine safety agencies, and can publicly post, the names of miners who have been decertified because they have failed a substance abuse test. The section raises an additional problem with regards to the conduct of appeals by miners who have tested positive. Section 3 precludes release of the test results except in limited circumstances. It is critical, however, for the OMHST in the appeal cases to adduce the results as evidence and to have medical personnel testify about the results. At the same time, the Board of Appeals has insisted that the hearings shall be public. Section 22A-1A-3 must therefore be amended to either authorize disclosure of the test results in hearings before the Board of Appeals or to mandate closure of the hearings.

2. Revise rock dusting requirements

Section 22A-2-24 of the West Virginia Code currently requires and regulates rock dusting, but enforcement to ensure adequate rock dusting has proven difficult. Inadequate rock dusting

contributed in a significant way to the UBB explosion.[7] Several changes must be made to address the problem. First, § 22A-2-24 should be revisited. The 2012 Act amended it to raise the required level of incombustible content of mine dust from 65% to 80%. The State should also consider increasing the required incombustible content when methane is present and adopt something similar to the federal standard. It provides: "Where methane is present in any ventilating current, the percent of incombustible content of such combined dust shall be increased 0.4 percent [above 80%] for each 0.1 percent of methane." 30 C.F.R. § 75.403. Second, the incombustibility standard should be enforced by inspector use of a Coal Dust Explosibility Meter, which provides real time readings of the combustibility of particles in the mine air. *See* Part IV-C, *infra*, on Technology. Third, operators should be required to purchase and use the meters. Finally, the State should develop and insert in § 22A-2-24 a standard for the quality of rock dust that is used, and inspectors should be trained on how to test rock dust for quality.

As suggested elsewhere in this report, varying the times of the day when inspections occur could contribute to better enforcement of rock dusting and air quality control.

3. Eliminate remaining references to "flame safety lamps"

Section 22A-2-14 makes reference to and authorizes use of a "flame safety lamp." That equipment is no longer in use or considered safe. The 2012 Act removed references to the flame safety lamp in other provisions of the Act and replaced it with "approved methane detecting device," but overlooked § 22A-2-14. That oversight should be corrected.

4. Study Extended Cut Mining

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[7]*See* J. Davitt McAteer, *et al.*, Governor's Independent Investigation Panel, UPPER BIG BRANCH: REPORT TO THE GOVERNOR (May 2011), available from: http://www.nttc.edu/ubb/.

The OMHST has plans to study the effects of deep or extended cut mining. This needs to be supported. By using such techniques, operators may be able to reduce the number of equipment moves (which are high-risk measures), enhance efficiency, and possibly reduce dust levels (because of the way the scrubbers on the machines work). Nevertheless, the federal government has been limiting the ability of operators to use deep or extended cuts. Study is needed to more precisely assess upsides and down sides of the technique and to work with federal officials to reach an appropriate balance.

D. BOARD OF COAL MINE HEALTH AND SAFETY

Revise the composition and procedures of the Board of Coal Mine Health and Safety

The powers and composition of the Board of Coal Mine Health and Safety ("Board") are set forth in Chapter 22A, Article 6 of the West Virginia Code. Currently, the Board is made up of six voting members, three members selected by the Governor from nominations submitted by the operators' association and three selected from union-submitted names. W. Va. Code § 22A-6-3. The OMHST Director serves as an ex officio, non-voting member. W. Va. Code § 22A-6-3(a) (4). The duties of the Board include proposing and promulgating rules to enhance coal mine safety, reviewing all reports and recommended rules submitted by the Director of the OMHST, and reviewing coal mine fatalities. W. Va. Code § 22A-6-4.

The Board's ability to function has been hampered by the lack of a voting member to serve as a tiebreaker in the event that the six industry- and union-nominated voting members cannot agree on a proposed rule. Prior practice provided the Director of the OMHST with voting rights, but there are good reasons not to put the Director in that position again. There are several alternatives. One would be to require the six members to provide the Governor with three nominations of persons knowledgeable in coal mine health and safety from which he or she can select the seventh member.

Or the Governor could be given full authority to name the tiebreaker without confining the selection to a particular list. Yet another possibility would be to assign the selection or nomination in the first instance to the industry- and union-nominated members and, if they fail to agree on a person or set of nominees within a stated time period, to then allow the governor full authority to select a person of his or her choice. In any event, the nominee should be subject to Senate confirmation. Obviously, with an odd-numbered Board, the possibility of gridlock can be avoided.

Section 22A-6-3(f) should also be amended by deleting its clause that prohibits the Board from voting unless all of its members are present. For a Board with an even number of members, the provision promotes gridlock. For a Board of any size, it gives each Board member a veto power by simply not attending a meeting.

E. SUMMARY

To improve the current West Virginia mine safety laws and regulations and enhance the health and safety of the State's coal miners, the following recommendations are made:

- Increase the salaries and number of surface and underground mine inspectors employed by the OMHST, as deemed appropriate by the Director of the OMHST;
- Implement initial, annual, and specialized training programs for inspectors;
- Authorize mine inspectors to order the abatement of hazards that are not expressly identified within the law;
- Create criteria and procedures for targeted and impact inspections of those mines that have an identifiable history of noncompliance, a high accident rate, or geological or other features that create unusual safety risks;
- Review regularly mine inspection priorities;

- Increase fines on operators cited for special assessments and include a pattern of violations provision;
- Clarify decertification grounds and procedures for mine personnel and coordinate decertification with surrounding states;
- Strengthen the OMHST's subpoena power to allow the OMHST attorneys and inspectors to question those witnesses deemed pertinent to a mine accident investigation;
- Creation of a mine accident investigation team to be used for fatal mine accidents and those determined to be serious;
- Create liability for corporate directors, officers, and agents;
- Strengthen the anti-retaliation provision;
- Revise the drug testing provisions and monitor other states' substance abuse drug screening regulations to ensure the best practices in monitoring miners and sanctioning those found to be in violation;
- Revise and enforce rock dusting requirements.
- Eliminate remaining references to "flame safety lamps"; and
- Create a seventh position on the Board of Coal Mine Health and Safety and establish a procedure for the selection of that member.

III. COAL MINERS' LUNG DISEASES AND AIR QUALITY CONTROL

A. INTRODUCTION

Coal miners risk a spectrum of lung diseases from their inhalation of coal dust. These include not only the interstitial lung diseases of pneumoconiosis (or black lung) and silicosis but also dust-related diffuse fibrosis and chronic obstructive pulmonary disease, such as chronic bronchitis

and emphysema.[8] Following the imposition in the Coal Mine Health and Safety Act of 1969[9] of federal air standards and monitoring, there was a steady decline in the rates of pneumoconiosis and other detected lung diseases among coal miners. This trend reversed itself in (about) 2000.[10] A study completed in 2010 of the files of West Virginia coal miners during a nine-year period showed, among other things, rapid disease progression, with as little as five years and a mean of twelve years between the miner's last normal chest radiograph and a diagnosis of progressive massive fibrosis.[11] Moreover, the *post mortems* that were able to be done on 24 of the 29 UBB victims revealed that 17 of them had pathologic findings of pneumoconiosis. The diseased miners ranged in age from 25 to 61 years and included five who had less than ten years of experience.[12] Smaller mines and the mines of Central Appalachia have been "hot spots" for black lung incidence.[13]

The explanation for this surprising and disturbing turn-around is likely multifaceted. A likely contributing cause is that, with thick-seamed coal being depleted, mining has shifted to harder-to-access and thinner seams of coal, which requires cutting into more rock, which in turn

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[8]Edward L. Petsonk, Cecile Rose, & Robert Cohen, *Coal Mine Dust Lung Disease: New Lessons from an Old Exposure*, 187 AM. J. RESPIR. CRIT. CARE MED. 1178 (2013).

[9]30 U.S.C. §§ 801, *et seq.*

[10]DHHS (NIOSH), *Work Related Lung Disease Surveillance System*, Table

[11]W.A. Wade, Edward L. Petsonk, B. Young, & I. Mogri, *Severe Occupational Pneumoconiosis among West Virginian Coal Miners: One Hundred Thirty-Eight Cases of Progressive Massive Fibrosis Compensated between 2000 and 2009*, 139 CHEST 1458 (2010).

[12]J. Davitt McAteer, *et al.*, Governor's Independent Investigation Panel, UPPER BIG BRANCH: REPORT TO THE GOVERNOR (May 2011).

[13]Grayson & H. Kinilakodi, *Analysis of U.S. Small-Mine Compliance with Proposed New Respirable Dust Standards and Implications for Better Dust Control Methods*, 332 TRANSACTIONS (Society for Mining, Metallurgy, and Exploration) (2012).

increases the miners' exposure to silica.[14] In addition, miners are generally working longer shifts, and longer shifts increase the miners' exposure, especially since dust levels tend to build up as a shift progresses. (The longer the production goes, the more dust.) Changes in mining practices and enforcement may have rendered the 1969 standards no longer adequate to protect miners' health.[15] Finally, there is evidence that some operators have learned how to game the monitoring system and exceed dust limits without detection.[16]

Whatever the causes, it is clear that lung disease among coal miners and its prevention continue to present huge challenges.

There are several issues that need to be addressed relating to the occurrence of black lung and silicosis among miners. Miners suffering from black lung or silicosis have full access to workers' compensation, as provided in Chapter 23 of the West Virginia Code. Unfortunately, while workers' compensation may provide miners with benefits once they have been diagnosed with black lung and/or permanently disabled, it does nothing to protect those individuals from being discriminated against because of their disease or to prevent instances of black lung or silicosis

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[14]A.S. Laney, Edward L. Petsonk, & M.D. Attfield, *Pneumoconiosis among Underground Bituminous Coal Miners in the United States: Is Silicosis Becoming More Frequent?* 67 OCCUP. ENVIRON. MED. 652 (2009); R.L. Grayson & H. Kinilakodi, *Analysis of U.S. Small-Mine Compliance with Proposed New Respirable Dust Standards and Implications for Better Dust Control Methods*, 332 TRANSACTIONS (Society for Mining, Metallurgy, and Exploration) (2012).

[15]D.E. Pollock, J.D. Potts, & G.J. Joy, *Investigation into Dust Exposures and Mining Practices in Mines in the Southern Appalachian Region*, 2010 MIN. ENG. 44 (Feb. 2010); J.L. Weeks, *The Mine Safety and Health Administration's Criterion Threshold Value Policy Increases Miners' Risk of Pneumoconiosis*, 49 AM. J. IND. MED. 492 (2006); *Criteria for a Recommended Standard: Occupational Exposure to Respiratory Coal Mine Dust*, DHHS (NIOSH) Publication 95-106 (1995), available at: http://www.cdc.gov/niosh/docs/95-106/. Based on the latter research, MSHA has twice proposed revised standards. A 1999 proposal was not adopted. A currently pending proposal was published for comment, revised, and then submitted. It is currently pending before the Office of Management and Budget.

[16]U.S. Department of Labor, MSHA, REPORT OF INVESTIGATION OF FATAL UNDERGROUND MINE EXPLOSION OF APRIL 5, 2010 (available at: http://www.msha.gov/Fatals/2010/UBB/FTL10c0331noappx.pdf).

among miners. Several strategies are needed. First, coal miners with black lung or silicosis must be protected from discrimination by mine operators in the hiring and firing process. Second, resources should be provided the OMHST to study the need for additional State regulation of air quality in coal mines, what standards if any should be imposed by the State, and what would be the most effective means to implement and enforce any standards that are imposed. Third, there needs to be improved monitoring of the miners. This includes preliminary and periodic testing and other prevention strategies that seek to identify black lung and other occupational diseases before they become permanently disabling. Fourth, educational efforts must be initiated to teach miners about the ravages of miners' lung diseases and about how the risks of contracting them can be reduced. Lastly, data collection must be improved to include data regarding dust conditions and the incidences of lung disease by mine location and job.

B. PROTECT MINERS WITH LUNG DISEASE FROM DISCRIMINATION

West Virginia must implement regulations to protect miners with black lung or silicosis from discrimination in the workplace.

One of the main problems discouraging miners from getting tested and treated for black lung is the negative stigma attached to having the disease. Not only is it a fatal and abhorrent disease, but it also often makes those miners who have been diagnosed less appealing to employers. Because of the effects that black lung has on a miner's health and the potential liability that attaches to an employer if that employee becomes permanently disabled or dies during the course of his employment, an employer will often choose to hire a miner who has not been diagnosed with black lung over a miner who has. For these reasons, miners choose not to get tested for fear that a diagnosis will result in loss of their job or inability to get another job.

Currently, state regulations protect miners from being discriminated against for a variety of reasons. For example, West Virginia Code § 22A-1-22 is a whistleblower protection law that prevents an employer from discharging an employee for notifying the Office of Miners' Health, Safety and Training of an alleged violation occurring within the mine, for instituting a proceeding under that law, or for testifying in a proceeding resulting from the enforcement of the provisions of that law. W. Va. Code § 22A-1-22(a) (West 2011). In addition, West Virginia Code § 23-5A-1 et seq. prohibits employers from discriminating against an employee because he or she sought or is receiving workers' compensation benefits. Like all employees, miners are protected by the State's Human Rights Act from discrimination on the basis of race, sex, disability, age, and similarly invidious class-based grounds. W. Va. Code 5-11-1, *et seq*. Additional protection is needed, however. The State should prohibit an employer from discriminating against an employee who is capable of performing the job in question because he or she has been diagnosed with black lung or other occupational disease.[17] Such measures would not only protect those miners who have been diagnosed with a lung disease from the potential loss of a job but also would reduce the stigma that is attached to a black lung diagnosis. If miners are not afraid of losing their jobs or being assigned to a less desirable job within a coal mine, they are much more likely to get tested and treated.

C. ADDRESS MONITORING OF THE WORKPLACE

Successfully monitoring the workplace and attempting to reduce or eliminate those hazards that are linked to black lung and other occupational diseases are important efforts that must be undertaken to reduce diagnoses among miners. Respirable coal dust causes lung diseases yet it is

[17]This provision would not create that dramatic of a change; following the enactment of the Americans with Disabilities Act Amendments Act of 2008, it is likely that most employer discrimination against qualified persons because they have black lung would be considered to be a violation of the Americans with Disabilities Act, 42 U.S.C. §§ 12101, *et seq*. To date, however, that possibility has not been the subject of a reported decision known to the reporter.

not currently regulated in a meaningful way by West Virginia. West Virginia Code § 22A-2-74 authorizes the Board of Coal Mine Health and Safety to "promulgate rules governing respirable dust," but the Board has not used that authority and lacks the resources to do so.

Regulation of the concentration of respirable dust in a mine's atmosphere is currently the domain of MSHA. Federal regulation now requires that the average concentration of respirable dust during each active shift not exceed 2.0 milligrams per cubic meter of air ("mgs./cm"). 30 C.F.R. § 70.100. MSHA has proposed new regulations that, if adopted, would reduce the respirable dust standard to 1 mg./cm and create a 0.1 mg./cm standard for quartz. These standards were based on a major NIOSH study done in the nineties and had been proposed but not adopted during the Clinton Administration. The current proposal has been through the comment period, been revised, and is presently pending before the Office of Management and Budget.

To ensure that the State does what it can to reduce the occurrence of black lung and other occupational diseases among miners, resources should be committed to the OMHST to study the need for state regulation and monitoring of respirable dust in coal mines and, if the need exists, to develop the standards to be imposed and the means for enforcing those standards. The resources needed would include not only those to support additional personnel but also additional expertise.

D. IMPROVE MONITORING OF MINERS

Reducing the instances of total disability among miners caused by black lung and other occupational diseases would be facilitated by periodic testing and check-ups for miners. While mandatory testing for black lung is impractical, there are other alternatives that should be considered. One alternative is to incentivize testing. Providing operators with discounts on their workers' compensation or insurance premiums if they choose to implement a testing program for their employees will give operators an incentive to do so. An example of a testing program is the

Coal Workers' X-ray Surveillance Program, used by the National Institute for Occupational Safety and Health ("NIOSH") as a medical monitoring and surveillance program to detect and prevent black lung. The program requires up to three chest x-rays performed on coal miners within a specified time frame after their employment begins. After those are performed, the initial testing is followed by voluntary periodic chest x-rays performed approximately every five years. This and similar programs would obviously keep a participating miner informed about his health, but it would also provide valuable data for both operators and regulators.

E. EDUCATE MINERS ABOUT LUNG DISEASE ISSUES

Education of miners about lung diseases is needed on several fronts. First, they need to know what they risk when they breathe coal dust. That is, they need to learn about the debilitating effects of black lung, silicosis, and other diseases, and they need to learn it when they are starting their careers. Second, miners need to learn what they can do to lessen the risks of getting black lung. How a miner does his job can affect the amount of dust that he breathes, so he must know the techniques for limiting that amount. Third, miners must learn how to detect, monitor, and seek help regarding lung diseases. Finally, miners must be taught about their rights and remedies regarding the diseases – their protection from discrimination and the benefits available to them if they do get black lung and how to go about seeking those benefits.

The United Mine Workers' of America provides training to its members on prevention strategies and on how to detect symptoms of the disease. Operators must be required to develop instructional programs of the same order so that all miners are as informed as those in the union. Providing such training would not impose a burden on the operators, who are already required to provide continual training.

F. IMPROVE DATA COLLECTION

To improve the monitoring of the workplace and of miners, and to eventually reduce the prevalence of black lung, there needs to be better data collection. The Office of Mine Safety and Health Research ("OMSHR"), a subdivision of the Center for Disease Control ("CDC"), has focused its research efforts on establishing enhanced methods of measuring the amount of dust and finding ways to reduce miners' exposure to that dust. While the OMSHR has paved the way, additional research and data collection need to be undertaken on a smaller level, beginning on a company-wide basis.

Black lung-related deaths have been clustered in the Central Appalachian region, including West Virginia, Kentucky, and Virginia. Because of this, more advanced research is necessary in this region than in other parts of the country. To begin, coal mine operators should be required to periodically use the five sample method.[18] That requires the operator to test the dust exposure levels and levels of black lung in five separate parts of the mine and averaging their numbers. The average of those numbers is the average for that specific coal mine and is that number that MSHA uses to determine compliance with the 2.0/cm standard. These numbers should then be added to a statewide database. Doing the five samples will not only provide useful data for monitoring coal dust levels throughout West Virginia, but each coal mine operator will know where in the mine the dust levels are most problematic and can explore corrective and preventive measures.

G. SUMMARY

The new and surprising increase in black lung among coal miners makes it necessary for the state of West Virginia, as well as coal mine operators, to adopt policies that seek to provide better

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[18] *See* 30 C.F.R. §§ 70.207 - 70.210.

monitoring of the workplace and of miners to reduce the occurrence of black lung. To do so, it is recommended that:

- Protection be provided to qualified miners who have black lung or other occupational disease from discrimination in employment;
- Legislation be enacted protecting miners from discrimination because of a black lung diagnosis;
- Resources should be invested in the OMHST to study the need for and desirable scope of State regulation of respirable dust concentrations in coal mines;
- The use of more efficient, accurate, but practical technology for monitoring the workplace be encouraged;
- An incentive be provided to operators for initial and periodic testing of coal miners for black lung;
- Training be provided to miners on the severity of black lung and other occupational diseases and what the miners can do to reduce the risk of contracting black lung;
- Coal mine operators be required to periodically collect five air dust samples at different locations within the mine and submit the results to the States for the creation of a statewide database.

IV. TECHNOLOGY

A. EDUCATE ABOUT AND ENCOURAGE USE OF NEW TECHNOLOGIES

The Mine Safety Technology Task Force is responsible for providing technical and other assistance to the OMHST relating to the implementation of new technological requirements. W. Va. Code §22A-11-3. In addition, the Task Force is charged with conducting a study each year on the opportunities for new and emerging technological advances. *Id.* Once the study is complete, the

Task Force must submit a report to the Governor and the Board of Coal Mine Health and Safety that includes a comprehensive overview of any issues regarding the implementation of technological advances and recommendations as to the enactment, repeal, or amendment of any statute to take advantage of technological advancements. *Id.*

In addition to continuing the current procedures used by the Mine Safety Technology Task Force, methods should be established to make the information contained in the task force study and other work more readily available to operators, miners, and organizations representing miners in a user-friendly format to inform them of emerging and available technologies. The Task Force has recently created a website to begin that process,[19] but it needs to be developed.

To encourage the use of the safest and most advanced technologies, incentives such as tax credits or decreased insurance premiums should be provided to mine operators to use those technologies. The Code currently includes the West Virginia Innovative Mine Safety Technology Tax Credit Act, W. Va. Code §§ 11-3BB-5, et seq. The Act could use liberalization by increasing the allowable credits, allowing for carry-overs and carry-backs, and shortening the length for qualifying lease terms in subsection 3(b)(10)(A). In addition, § 14 presently calls for the Act to terminate on December 31, 2014. That needs to be amended to continue the Act. Finally, provision must be made to publicize the Act's potential to coal operators and to make it more user-friendly. To date, the Act has been under-used.

There are three technological advances whose safety benefits would justify the costs of their adoption. They are discussed in the following three sections.

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[19]Go to: http://wvcoalboards.com/company/task-force.html.

B. REQUIRE PROXIMITY MONITORS AND/OR CAMERAS

One of the most important things that could be done to increase day to day safety in coal mines would be to require use of either proximity monitors or cameras on moving equipment.[20] Using both would be most effective. Many, and perhaps most, serious mining accidents occur when equipment is being moved.[21] Proximity monitors or cameras would significantly reduce the risks in equipment moves, and using both could render equipment moves no more dangerous than other deep mining activity. If only one device is required, it should be the proximity monitor.

The proximity monitor automatically shuts off heavy equipment if it gets too close to miners working around it or to other objects. It would thus prevent the equipment from crushing or injuring nearby miners and would protect the equipment operator, as well. There is concern that a monitor could create a false sense of security if, unbeknownst to the operator, it has been overridden. Adding a camera to the equipment would fill this gap in safety and enable the equipment operator to see other miners if they have gotten in his blind spots. A provision that would make overriding a proximity monitor grounds for decertification would also increase the effectiveness of a monitor requirement.

Coal mining can be highly repetitive, which increases the risk that a miner might not be as attentive as he should be. Proximity monitors guard against such circumstances. The use of both proximity monitors and cameras would be the ideal. The cameras could increase efficiency by

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[20]The West Virginia Coal Mine Technology Task Force has recommended to the Board on Coal Mine Health and Safety that it adopt a rule requiring use of proximity detection devices in all of the State's underground coal mines. Ken Ward, Jr., *Task Force Recommends "Proximity Systems" in Mines*, CHARLESTON GAZETTE, Sept. 19, 2013. The same recommendation had been made in 2008 by a team of inspectors from the OMHST. *Id.* The Board recently created a subcommittee to study the proposal.

[21]For example, "between 1984 and 2010, 30 miners died and 220 were injured nationwide when they became crushed, pinned or struck by continuous mining machines underground." *Id.*

allowing machinery operators to see miners before forcing a shutdown, and in the event a monitor was not working, the cameras would provide a back-up mechanism.

C. REQUIRE USE OF COAL DUST EXPLOSIBILITY MONITORS

Another piece of technology that should be required is the hand-held rock dust monitor, referred to as the Coal Dust Explosibility Meter, or CDEM. This device gives real time measurements of the percentage of noncombustible dust and the explosibility of the coal dust present in the mine. They are not now required, however, and have not achieved widespread use. Unfortunately, the industry still judges rock dusting mostly by a visual test, trusting that the responsible miner or inspector can just tell. While it may be the case that some individuals do have that ability, coal dust explosibility is not something that should be left to eyeball inspection. The massive explosions at Farmington in 1968 and UBB in 2010 attest to the disasters that inadequate rock dusting can wreak.[22]

Reluctance to use the device should have been dispelled by an extensive 2009-10 cooperative study between NIOSH and MSHA. The study found that, in close to 300 samples, laboratory retestings agreed with CDEM field readings in 97% of the cases in which the sample was found to be combustible. (That is, the noncombustible content was less than 80%. *See* 30 C.F.R. § 75.403.) The 3% difference was attributed to the samples' variability, that is, the retained moisture in the

[22]J. Davitt McAteer, *et al.*, Governor's Independent Investigation Panel, UPPER BIG BRANCH: REPORT TO THE GOVERNOR (May 2011); U.S. Department of Labor, MSHA, REPORT OF INVESTIGATION OF FATAL UNDERGROUND MINE EXPLOSION OF APRIL 5, 2010 (available at: http://www.msha.gov/Fatals/2010/UBB/FTL10c0331noappx.pdf).

samples, and the inherent ash in the coal.[23] In the wake of the Upper Big Branch explosion, there is no reason why mine operators and inspectors should not be required to use CDEMs.

D. ENCOURAGE USE OF VIRTUAL AND INTERACTIVE TRAINING

Additional technological advancements that the industry should move toward are virtual training and interactive training. Virtual training has developed over the last few years and has true potential. It is an encompassing term used to describe computer simulated training of varying degrees. The OMHST has developed two virtual training videos that it makes available to schools for the eighty hour training, and some schools have used them. Several mining academies as well as a number of operators use this type of training for equipment operators. Functioning similarly to flight simulators, the programs simulate operation of coal mining equipment. The simulators are interactive and real time and give miners hands-on experience before they ever step foot on the real equipment in the mine. The simulators could be incorporated into state-offered training, and coal operators and mining schools could be given incentives to induce their use of the technique. The training offers a safer and more effective means for giving inexperienced miners the foundation to perform safely.

One of the most often heard complaints about miner training is that it is repetitive and boring. Interactive training could alleviate this problem by allowing miners or prospective miners to become much more engaged in the process. Some trainers have used computer programs to turn training into a game, and others have created simulated environments of roof falls, fires, etc. The

[23]The study is reported in M.L. Harris, M.J. Sapko, & F.D. Varley, *Coal Dust Explosibility Meter Evaluation and Recommendations for Application*, DHHS (NIOSH) Publication No. 2012-172 (Aug. 2012). As reported to the OMHST, Consolidation Coal Company has conducted its own tests of the CDEM and found its accuracy to be exceptional.

simulated environments show miners the true importance of (for example) their rescue equipment and force them to understand its proper use.

V. TRAINING AND CERTIFICATION

A. IMPROVE PREEMPLOYMENT TRAINING

The training required for miner certification needs major attention. Currently, many operators depend upon independent businesses to provide the training for the 40 (surface mining) and 80 hour (deep mining) cards. W. Va. Code § 22A-8-3 and -4. There are no standards for qualifying these businesses; the OMHST maintains an approval process and requires some proof of mining experience, but the process is not rigorous and is not pursuant to statutory or regulatory standards.[24] There are no standards for suspending approval. There is some monitoring of the instructional programs, but it is not structured and depends upon inspectors and mine safety instructors who have many other duties to perform. The situation needs attention. The State has several alternatives. If the current regime is to continue, the OMHST should be authorized and directed to issue regulations that establish criteria that businesses must meet to qualify to become mine training facilities, that create a licensing system, that provide for periodic review of the substance of the training, and that specify standards and procedures for license revocation. Alternatively, resources could be given to the OMHST to develop high quality training programs to be offered in various regions of the state on a regular basis. Ideally, the programs would take advantage of the latest training technology and would have facilities similar to those built in Boone County by Alpha Coal Company as part of the UBB settlement. Coal operators could continue to

[24]One interviewee reported seeing a Southern West Virginia business that was a combination hair salon and miner training school. Another school shared a building with an illegal drug operation.

offer their own training, but it should be subject to approval and oversight by the OMHST. *See* W. Va. Code § 22A-8-3.

B. REVISE APPRENTICESHIPS

West Virginia Code §§ 22A-8-4 to -6 require an apprenticeship following the initial training of at least six months during which time the trainee, referred to as a "redhat" because of the color of the hard hat that he is required to wear, must always be working with and under the supervision of a certified miner. There is currently, however, no structure to the apprenticeships, and redhats are frequently assigned tasks without regard to whether they are actually learning how to become knowledgeable, competent and safe coal miners. Operators should be required to develop training programs for their apprentices to ensure they receive a well-rounded training. The programs should be submitted to the Director for approval. The Director should be authorized to issue regulations setting forth what the training programs should contain. Finally, serious consideration should be given to extending the apprenticeship period for an additional two or three months.

C. ENHANCE CONTINUING TRAINING

A repeated refrain heard from miners is that the routine safety/training sessions are repetitive and ineffective. Because many – or most – operators do not have the capacity to develop meaningful educational programs, resources should be allocated to the OMHST to do it for them. The programs could be developed and then distributed to operators to be delivered to the miners and could include interactive training that engages the miner in computerized or nontechnological simulations. Operators would continue to be free to develop their own training or to contract with outside firms to provide it, subject to OMHST oversight. Furthermore, the Office should be given authority to develop regulations establishing a minimum number of continuing training hours that a miner must complete within a twelve month cycle in order to retain his certification. (This system

would be similar to what many professions require for continuing education.) A separate set of regulations should be authorized for training and certification of foremen. The training hours should be supplemented by post-incident (accidents and near-accidents) briefings delivered by the operator and monitored by inspectors.

D. ENHANCE EQUIPMENT TRAINING

Whether it is new equipment or equipment that is new to the miner, equipment training for miners has been inadequate. The OMHST needs the authority to issue regulations requiring adequate training on equipment before a miner can be assigned to operate it and should be given the resources to develop training programs (including simulated training) to be made available to operators and administered by inspectors or safety instructors. The OMHST currently provides instruction to inspectors on new technology, but that should be statutorily required. Furthermore, assignment by an operator of a miner to operate equipment on which he has not been trained should be made a serious safety violation.

E. REQUIRE CERTIFICATION OF MINE SUPERINTENDENTS

The OMHST should be authorized and directed to develop a certification program for mine superintendents that includes basic experiential requirements, an examination of the applicant's knowledge and ability to carry out the State's mine health and safety laws, and in-mine demonstration of superintendent skills.

ACKNOWLEDGMENTS

The West Virginia Law Institute acknowledges and extends appreciation to the many people who contributed their time to this report. The project leaned heavily, as it should, on officials, staff, and inspectors of the West Virginia Office of Miners' Health, Safety and Training. Mine safety

experts with the United Mine Workers of America, the West Virginia Coal Association, the State's mine safety boards, the Upper Big Branch investigative team, Consolidation Coal Company, and researchers in the field all gave freely of their time. The bulk of the information gathering and research fell upon Marissa Zielinsky and Joshua Elliot, law students at the West Virginia University College of Law, who did yeomen and accomplished work on the report for over eighteen months. Two other W.V.U. law students, Kenneth Bannon and Katrina Harper, also provided valuable assistance. To all of these contributors, the Law Institute says "thank you."

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GLOSSARY OF ABBREVIATIONS

Abbreviation	*The Reference*
CDC	Center for Disease Control (U.S. research agency)
CDEM	Coal Dust Explosibility Monitors
C.F.R.	Code of Federal Regulations
DHHS	Department of Health and Human Services (U.S. Cabinet Department)
MSHA	Mine Safety and Health Administration (U.S. enforcement agency)
NIOSH	National Institute of Occupational Safety & Health (U.S. research agency)
OMHST	Office of Miners' Health, Safety and Training (W. Va. enforcement agency)
OMSHR	Office of Mine Safety and Health Research (U.S. research agency)
UBB	Upper Big Branch (W. Va. 2010 mine disaster)
W. Va. C.S.R.	West Virginia Code of State Regulations

APPENDICES

Appendix A – Harisha Kinilakodi, Robert Larry Grayson, & Samuel A. Oyewole, *Evaluating Equivalence of the Safe Performance Index (SPI) to a Traditional Risk Analysis*, 2 OPEN J. OF SAFETY SCI. & TECH. 47 (2012).

Harisha Kinilakodi & R. Larry Grayson, *A Methodology for Assessing Underground Coal Mines for High Safety-Related Risk*, 49 SAFETY SCIENCE 906 (2011).

Appendix B – Proposed Statute to Create Mine Accident Investigation Teams

Appendix C – Rock Dusting: A Jurisdictional Survey

Appendix D – *Recommendations and Findings* of the Governor's Independent Investigation Panel on the Upper Big Branch Explosion (May, 2011).

APPENDIX A

Harisha Kinilakodi, Robert Larry Grayson, & Samuel A. Oyewole, *Evaluating Equivalence of the Safe Performance Index (SPI) to a Traditional Risk Analysis*, 2 OPEN J. OF SAFETY SCI. & TECH. 47 (2012).

Harisha Kinilakodi & R. Larry Grayson, *A Methodology for Assessing Underground Coal Mines for High Safety-Related Risk*, 49 SAFETY SCIENCE 906 (2011).

Open Journal of Safety Science and Technology, 2012, 2, 47-54
doi:10.4236/ojsst.2012.22007 Published Online June 2012 (http://www.SciRP.org/journal/ojsst)

Evaluating Equivalence of the Safe Performance Index (SPI) to a Traditional Risk Analysis

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Received January 11, 2012; revised February 10, 2012; accepted February 17, 2012

ABSTRACT

Following up on a recommendation by the Mine Safety Technology and Training Commission relative to the modification of the Australian risk assessment approach for application to U.S. mines, the authors had previously developed the Safe Performance Index (SPI) as a risk-based methodology. It was designed to assess the relative safety-related risk of underground coal mines regarding injuries and citations for violations of regulations. To determine whether it is equivalent to a traditional risk analysis, a Risk Index is developed in this paper using a traditional risk analysis that embraces the frequency and severity of accidents and violations of mine regulations in a final equation. This methodology is used to analyze the relative risk for all underground coal mines for the years 2007-2010, and the results are compared to the results obtained using the SPI. The comparison revealed that the SPI does emulate a traditional approach to risk analysis. A correlation coefficient of –0.89 or more was observed between the results of these two methodologies, and either can be used to assist companies, the Mine Safety and Health Administration (MSHA), or state agencies in targeting mines with high risk for serious injuries and elevated citations for remediation of their injury and/or violation experience. The SPI, however, provides a more understandable approach for mine operators to apply using measures compatible with MSHA's enforcement tools. The SPI is also a transparent and reproducible approach for mine operators and federal and state enforcement agencies to apply.

Keywords: Risk Analysis; Risk Index; Mine Safety; Performance Index; Safety Violation; Safety-Related Risk

1. Introduction

The U.S. underground coal mining industry has made significant progress in safety over the years, but the recent major disasters have set back the progress. Historically, major disasters have led to a major legislative and regulatory reform that is stricter and highly specified regarding compliance. Last decade was no different following the 2006 underground coal mine multiple-fatality events, the U.S. Congress passed the Mine Improvement and New Emergency Response Act [1], and the disaster of 2010 (the worst mining disaster in 40 years) initiated a bill, the Robert C. Byrd Miner Safety and Health Act, which was voted down by the Congress; however, another version is pending further action. These events indicate that the industry has likely been following a reactive approach to managing safety, rather than a proactive approach in managing major-hazard risks.

In 2006, the National Mining Association established an independent, tripartite commission [2] to study the status of safety in underground coal mines and to determine what may be done to elevate the industry to a global leadership position in mine safety. As described in their report [3], the commission "specified 75 recommendations that, if implemented, would set safe performance standards for achieving a culture of prevention at mines, including risk assessment, and noted that mines which could not meet the level of safety requirements specified in the report should not be allowed to mine coal." The report was "aimed at preventing underground coal mine disasters in the future and targeting the goal of zero fatalities and lost-time accidents." The commission also recommended that some form of risk assessment needs to be adopted in every mine to mitigate the major-hazard risk and improve the safety performance; however, the Australian risk assessment approach should be modified for application in U.S. mines.

In 2007, the Mine Safety and Health Administration (MSHA) implemented an enforcement risk-targeting tool called Pattern of Violations (POV) to target mines with a poor safety performance, specifically to force improvement of their safety. By 2010, the POV process was called broken because of its failure to place any mine on POV status [4-5], its legal complexities, and its ineffectiveness in targeting the poor-performing mines [6]. On

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the commissions' recommendation, the National Institute for Occupational Safety and Health (NIOSH) pursued a project on Major Hazard Risk Assessment (MHRA), a pilot study [7], to demonstrate risk assessment methodologies in the U.S. mining industry. However, it has not largely been adopted by the industry. Some of the possible reasons for industry's reluctance to adopt a formal risk assessment methodology include: 1) too busy with compliance, 2) complicated or sophisticated methodologies, 3) lack of on-site expertise (particularly at small mines), 4) lack of safety infrastructure to support its use, and 5) learning curve associated with the implementation of formal risk assessment.

Previously, the Safe Performance Index (SPI) was developed as a transparent and reproducible risk-based methodology to assess the relative overall safety performance of a mine [3]. Until late 2010, the POV screening criteria were not transparent and reproducible by the mine operators. The Safe Performance Index (SPI) was offered as an alternative to the POV process in assessing a mine's overall safety performance, and it could help in overcoming the industry's reluctance in adopting formal risk-based methodologies [8]. In this paper, a traditional risk-analysis method is developed using MSHA data on accidents and citations for violations of regulations during 2007-2010. The results will be compared to the SPI results to assess how well the SPI emulates a more traditional risk analysis.

2. Literature Review

According to Joy and Griffiths [9], there are many different ways of doing risk analysis, both qualitatively and quantitatively. Generally, experienced people are necessary to make good judgments in a qualitative risk analysis. Unfortunately, in the U.S., 60% of the underground coal mines are small-size mines (less than 50 employees) [8], and they are generally not equipped with on-site safety expertise capable of performing a complex or sophisticated risk analysis. Quantitative risk analysis has the advantage of using historical safety performance data to evaluate the frequency and severity in a more objecttive way. Historically, small underground coal mines have experienced higher fatality rates than larger mines [10-11], and a similar trend was found in a recent study which "indicates a heavy occurrence of very severe injuries in a number of very small (<20 employees) and small mines" [8]. Mine size is highly correlated with coal seam height in the U.S., and smaller mines tend to operate in significantly thinner coal seams than large mines. Miners are at higher risk of having a nonfatal injury as mining height decreases [12].

Often, fatality and injury rates are used to evaluate the safety performance of mines and their ability to manage risk. However, in the U.S. mining industry, elevated citations for certain violations of regulations (such as those designated as Significant and Substantial (S&S) and withdrawal or imminent danger orders) may reflect failures of mine personnel to manage risks and may result in "poor" mine safety performance. Risk analysis is not mandatory in the U.S. as it is in Australia, where risk analysis is considered as a part of the daily work routine. The South African mining industry "has established a Hazard Identification and Risk Assessment Program (HIRA-2003) to identify and record significant risks" [13].

Quantitative performance measurement has been proven valuable in the fields such as economics, health care management, and education, where policies are driven by indicators such as the unemployment rate, infant mortality, and standardized test scores [14]. The policymakers in the U.S. mining industry have recognized the importance of data and analytically accurate details for decision-making. During congressional hearings on mine safety reform (H.R. 5663), the current paper's co-author presented the SPI as an alternative methodology to the POV process [15].

3. Methodology

In this paper, a risk analysis method is developed and compared with the SPI methodology which was previously developed by the authors [3]. The description of the data, detailed description of the risk analysis method, and a brief description about the SPI methodology is given next. Comparison is made to evaluate the equivalence of the SPI in assessing the risk of accident and citation data of differing severity in a combined measure (the SPI) to a risk analysis approach.

3.1. Data Description

The accident/injury data and citation data for the years 2007 to 2010 were downloaded from the MSHA Open Government Data Sets website [16]. Mines with no production and zero inspection hours were excluded from the analysis. There were 563 underground coal mines in 2007, 583 in 2008, 539 in 2009, and 496 in 2010. The non-finalized or under-contest citations, significant and substantial (S&S)-designated citations, and unwarrantable failure, withdrawal and imminent danger orders [104(b), 104(d), 104(g), and 107(a)] were included in the citation data. Higher risk is associated with more severe accident measures and with more elevated citation measures.

3.2. Risk Analysis

Generally, risk is defined as the product of the probability of occurrence (frequency) of an event and its severity of impact. In this study, the probability of occur-

rence is the normalized safety measure and severity is determined from the relative level of associated loss. For example, a general citation has low severity, an S&S citation has medium severity, and an order has high severity; a similar scheme is applied to the accident/injury measures. Accordingly, a risk analysis approach is developed by assigning five risk levels (very low, low, medium, high, and very high) to the six normalized safety measures, which are calculated using downloaded calendar-year data on injuries, employee-hours worked, citations, and inspection hours.

The six safety measures are the no days-lost incidence rate (NDL IR, number of no lost-time accident/injuries per 200,000 employee hours), the non-fatal days-lost incidence rate (NFDL IR, number of lost-time injuries per 200,000 employee hours), the severity measure (SM/100, number of statutory, restricted, and lost work days per 200,000 employee hours, divided by 100), the number of citations per 100 inspector hours (C/100 IH), the number of significant and substantial citations per 100 inspector hours (SS/100 IH), and the number of withdrawal orders and unwarrantable failures per 100 inspector hours (O/100 IH).

Each measure's range of values is divided into five equal intervals in ascending order, and risk values of 1 (very low), 2 (low), 3 (medium), 4 (high), and 5 (very high) are assigned accordingly. In the majority of the cases, there will be few extreme values that influence the determination of the ranges of values for a normalized safety measure, and in this case, it was no different. In order to negate the influence of extreme values, the boxplot method, available in the Minitab statistical software [17], is used to determine the lower quartile, upper quartile, and interquartile range values. In examining the data, the boxplot, a non-parametric statistical method, is used to identify outliers and extreme outliers without making any assumptions about the population distribution. For each normalized safety measure, the interquartile range (IQR: the absolute difference between the upper and lower quartile) is calculated using the values from the boxplot as shown in **Figures 1-4**. The outliers and extreme outliers are calculated as follows [18]:

$$\text{IQR} = \text{upper quartile (Q3)} - \text{lower quartile (Q1)} \quad (1)$$

$$\text{Outlier} > \text{upper quartile (Q3)} + 1.5\ (\text{IQR}) \quad (2)$$

$$\text{Extreme Outlier} > \text{upper quartile (Q3)} + 3.0\ (\text{IQR}) \quad (3)$$

In this paper, extreme outliers are identified and excluded from the process of determining the five equal intervals of values for each safety measure. However, the extreme values are included when assigning the risk value, and they were assigned a very high risk value (5). For each mine's safety measures, based on the interval values for each safety measure, a corresponding risk value is assigned to convert it to a risk measure. The new risk measure has values ranging from 1 (very low risk) to 5 (very high risk). To form the risk index for a mine, the weights 0.05, 0.15, 0.30, 0.05, 0.15, and 0.30 are used as pre-multipliers for RNDL, RNFDL, RSM, RC, RSS, and RO, respectively, which are symbols for the no days lost risk, the non-fatal days-lost risk, the severity measure risk, the citation risk, the S&S-designated citation risk, and the types of orders risk, respectively, and the products are summed. The weighting factors vary according to the severity of the various measures; for example, orders are the most severe citations that can be issued by inspectors, thus they get the highest weighting factor. Note that the

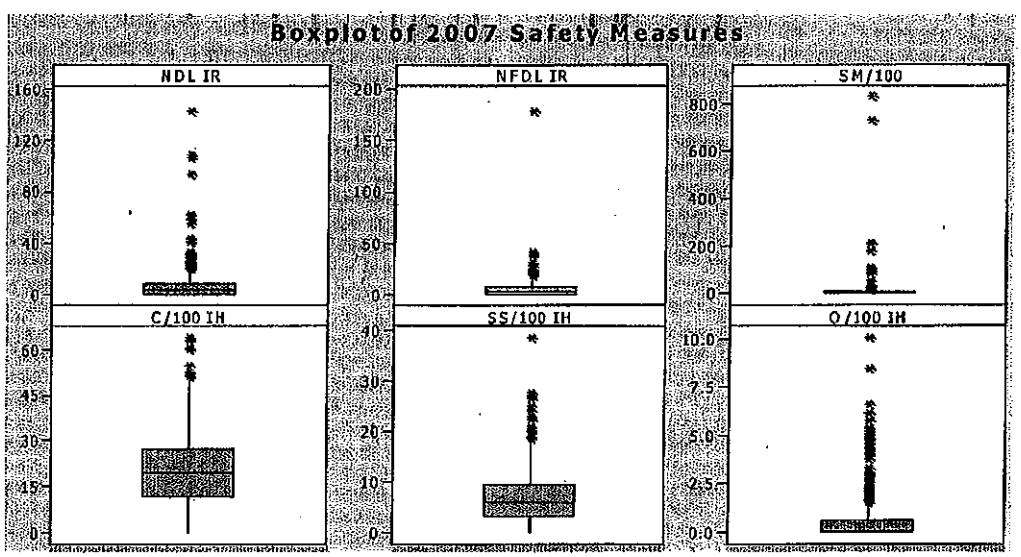

Figure 1. Boxplot of 2007 safety measures.

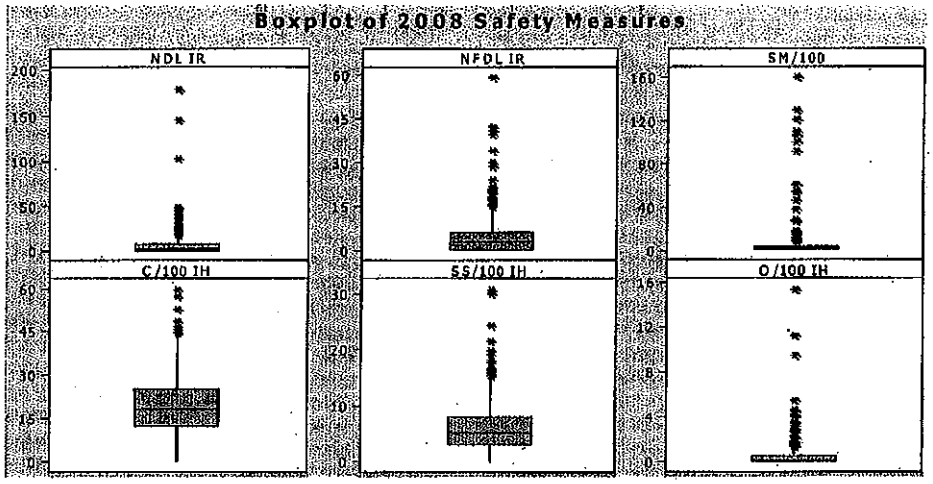

Figure 2. Boxplot of 2008 safety measures.

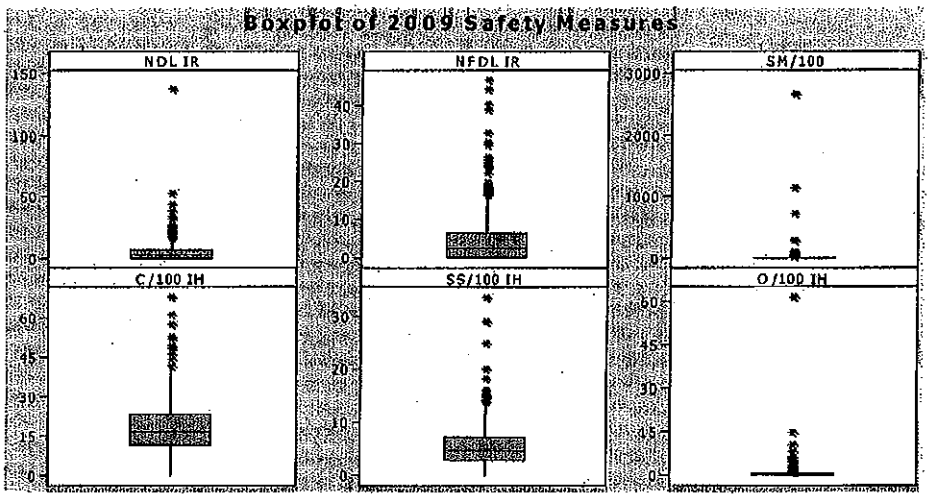

Figure 3. Boxplot of 2009 safety measures.

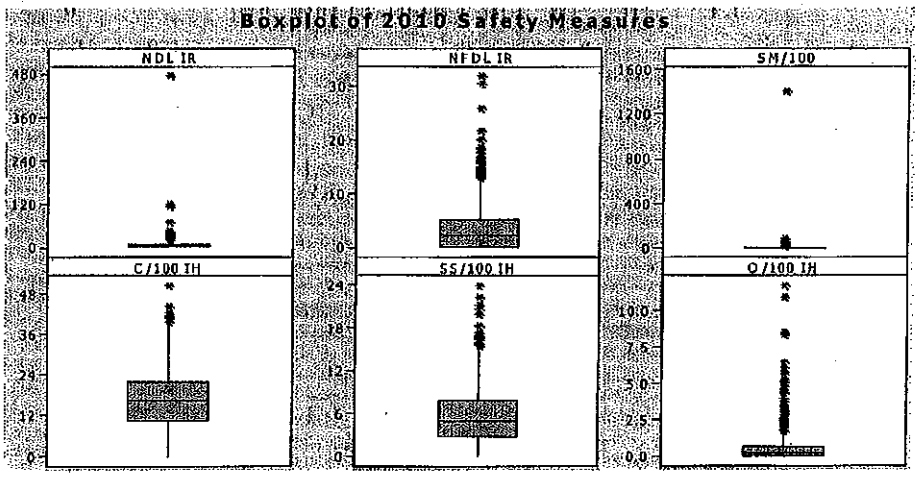

Figure 4. Boxplot of 2010 safety measures.

sum of the weighting factors equals 1, appropriately, and the sum of weights for the injury experience (three measures) and the citation experience (three measures) are each 0.5. The authors believe that the injury experience and the citation experience should have equal weights for a mine safety performance index to be well-balanced. This method represents a traditional risk-analysis approach using a new risk measure that embraces frequency and severity in the final equation.

3.3. Safe Performance Index (SPI)

The SPI methodology was previously developed by the authors [3] to monitor mine safety performances using the appropriate accident/injury and citation safety measures. An in-depth explanation on criteria for choosing the six safety measures and the corresponding weighting factors to form the SPI is given in [3]. In this paper, the same methodology is used to calculate the SPI of each mine for the years 2007 to 2010 which are then compared to the results of the risk-index analysis. It is noted that the West Virginia Coal Association (WVCA) and Arch Coal Company have given statements at regulatory hearings on the POV process in support of using the SPI. Arch Coal's Tony Bumbico "noted that MSHA should consider SPI, a holistic measure that more equitably blends injury and enforcement data" [19]. The SPI methodology was also explicitly proposed in the U.S. House of Representatives' bill H.R. 5788 to target "poor" mine safety performances.

4. Equivalence of the Safe Performance Index Results to the Risk Analysis Results

The SPI results were evaluated to determine how well the SPI methodology emulates a traditional risk analysis approach, as represented by the risk-index methodology. The values of the upper quartile, interquartile range, and extreme outliers for all the six safety measures for the years 2007-2010 are shown in **Table 1**. The C/100 IH measure did not have any extreme outliers, except in 2009. In 2007, there were 12 extreme outliers in NDL IR, 4 in NFDL IR, 22 in SM/100, 2 in SS/100 IH, and 35 in O/100 IH. The extreme outliers of each risk measure for the years 2008, 2009, and 2010 are shown in **Table 1**. The constructed risk ranges for each normalized safety measure for the years 2007-2010 are given in **Tables 2-5**, respectively.

4.1. Risk Index Results

The final risk index values for mines range from one to five. A risk index value of one implies a very low-risk mine, >1 but ≤2 is a low-risk mine, >2 but ≤3 is a medium-risk mine, >3 but ≤4 is a high-risk mine, and >4 is a very high-risk mine. The numbers of very high-risk and high-risk mines for the years 2007-2010, as per the risk-index are shown in **Table 6**. In 2007, there were 8 mines with very high risk (>4) and 27 mines with high risk (>3), whereas in 2008, there were 4 mines with very high risk (>4) and 28 mines with high risk (>3). In 2009, there were 7 mines with very high risk (>4) and 29 mines with high risk (>3), and in 2010, there were 3 mines with very high risk (>4) and 25 mines with high risk (>3). The average risk index for all the mines was 1.65, 1.67, 1.69, and 1.66 in 2007, 2008, 2009, and 2010, respectively. The average risk index for all mines for the four years was at the low-risk level and 6% of the mines were at the high/very high risk levels.

4.2. Safe Performance Index Results

The final SPIs of the mines range from 100 to 0 (zero). An SPI of 100 implies a very good safety performance mine, an SPI less than 40 implies "below average" or "poor" safety performance, and an SPI of zero indicates the worst safety-performance mines. The average SPI for all mines was 66.66 each year due to the intrinsic design of the methodology, which is a valuable and consistent marker for average performance. As shown in **Table 6**,

Table 1. Safety measures' interquartile range, upper quartile, and extreme measures: 2007-2010.

Measures	Boxplot											
	2007			2008			2009			2010		
	Inter Quartile Range	Upper Quartile (Q_3)	Extreme Outliers (nos.)	Inter Quartile Range	Upper Quartile (Q_3)	Extreme Outliers (nos.)	Inter Quartile Range	Upper Quartile (Q_3)	Extreme Outliers (nos.)	Inter Quartile Range	Upper Quartile (Q_3)	Extreme Outliers (nos.)
NDL IR	7.77	7.77	31.08 (12)	6.82	6.82	27.28 (15)	6.54	6.54	26.16 (12)	7.70	7.70	30.80 (13)
NFDL IR	7.57	7.57	30.28 (4)	5.91	5.91	23.64 (8)	6.47	6.47	25.88 (8)	5.12	5.12	20.48 (4)
SM/100	4.32	4.32	17.28 (22)	3.20	3.20	12.80 (25)	4.11	4.11	16.44 (29)	1.88	1.88	7.52 (29)
C/100 IH	15.34	27.33	73.35 (0)	12.76	25.33	63.61 (0)	11.89	23.32	58.99 (2)	11.37	21.96	56.07 (0)
SS/100 IH	6.06	9.43	27.61 (2)	4.87	8.08	22.69 (3)	4.43	7.32	20.61 (3)	5.09	7.88	23.15 (1)
O/100 IH	0.60	0.60	2.40 (35)	1.15	1.15	2.00 (31)	0.42	0.42	1.68 (38)	0.65	0.65	2.60 (28)

Table 2. Safety measures' risk level scheme: 2007.

Measures	Risk Level				
	Very Low	Low	Medium	High	Very High
	1	2	3	4	5
NDL IR	0.00 - 6.21	6.22 - 12.43	12.44 - 18.64	18.65 - 24.86	24.87 - 31.07
NFDL IR	0.00 - 6.05	6.06 - 12.11	12.12 - 18.16	18.17 - 24.22	24.23 - 31.27
SM/100	0.00 - 3.45	3.46 - 6.91	6.92 - 10.36	10.37 - 13.82	13.83 - 17.27
C/100 IH	0.00 - 12.81	12.82 - 25.62	25.63 - 38.43	38.44 - 51.24	51.25 - 64.05
SS/100 IH	0.00 - 5.52	5.53 - 11.04	11.05 - 16.56	16.57 - 22.08	22.09 - 27.60
O/100 IH	0.00 - 0.48	0.49 - 0.96	0.97 - 1.43	1.44 - 1.91	1.92 - 2.39

Severity ↓

Note: ↓ Indicates increasing severity of accident/injury measures and citation measures.

Table 3. Safety measures' risk level scheme: 2008.

Measures	Risk Level				
	Very Low	Low	Medium	High	Very High
	1	2	3	4	5
NDL IR	0.00 - 5.45	5.46 - 10.91	10.92 - 16.36	16.37 - 21.82	21.83 - 27.27
NFDL IR	0.00 - 4.73	4.74 - 9.45	9.46 - 14.18	14.19 - 18.90	18.91 - 23.63
SM/100	0.00 - 2.56	2.57 - 5.12	5.13 - 7.67	7.68 - 10.23	10.24 - 12.79
C/100 IH	0.00 - 11.97	11.98 - 23.94	23.95 - 35.91	35.92 - 47.88	47.89 - 59.85
SS/100 IH	0.00 - 4.54	4.55 - 9.07	9.08 - 13.61	13.62 - 18.14	18.15 - 22.68
O/100 IH	0.00 - 0.40	0.41 - 0.80	0.81 - 1.19	1.20 - 1.59	1.60 - 1.99

Severity ↓

Note: ↓ Indicates increasing severity of accident/injury measures and citation measures.

Table 4. Safety measures' risk level scheme: 2009.

Measures	Risk Level				
	Very Low	Low	Medium	High	Very High
	1	2	3	4	5
NDL IR	0.00 - 5.23	5.24 - 10.46	10.47 - 15.69	15.70 - 20.92	20.93 - 26.15
NFDL IR	0.00 - 5.17	5.18 - 10.35	10.36 - 15.52	15.53 - 20.70	20.71 - 25.87
SM/100	0.00 - 3.29	3.30 - 6.57	6.58 - 9.86	9.87 - 13.14	13.15 - 16.43
C/100 IH	0.00 - 11.80	11.81 - 23.59	23.60 - 35.39	35.40 - 47.18	47.19 - 58.98
SS/100 IH	0.00 - 4.12	4.13 - 8.24	8.25 - 12.36	12.37 - 16.48	16.49 - 20.60
O/100 IH	0.00 - 0.33	0.34 - 0.67	0.68 - 1.00	1.01 - 1.34	1.35 - 1.67

Severity ↓

Note: ↓ Indicates increasing severity of accident/injury measures and citation measures.

Table 5. Safety measures' risk level scheme: 2010.

Measures	Risk Level				
	Very Low	Low	Medium	High	Very High
	1	2	3	4	5
NDL IR	0.00 - 6.16	6.17 - 12.32	12.33 - 18.47	18.48 - 24.63	24.64 - 30.79
NFDL IR	0.00 - 4.09	4.10 - 8.19	8.20 - 12.28	12.29 - 16.38	16.39 - 20.47
SM/100	0.00 - 1.50	1.51 - 3.00	3.01 - 4.51	4.52 - 6.01	6.02 - 7.51
C/100 IH	0.00 - 10.06	10.07 - 20.12	20.13 - 30.18	30.19 - 40.24	40.25 - 50.03
SS/100 IH	0.00 - 4.63	4.64 - 9.26	9.27 - 13.88	13.89 - 18.51	18.52 - 23.14
O/100 IH	0.00 - 0.52	0.53 - 1.04	1.05 - 1.55	1.56 - 2.07	2.08 - 2.59

Severity ↓

Note: ↓ Indicates increasing severity of accident/injury measures and citation measures.

Table 6. Very high- and high-risk mines as per risk analysis and SPI: 2007-2010.

Years	Risk Index (RI)			SPI		
	>4	>3	Avg.	0.00's	<40	Avg.
2007	8	27	1.65	30	59	66.65
2008	4	28	1.67	27	64	66.66
2009	7	29	1.69	15	40	66.66
2010	3	25	1.66	24	52	66.66

there were 30 mines with zero SPI and 59 mines with an SPI less than 40 in 2007. Similarly in 2008, there were 27 mines with zero SPI and 64 mines with an SPI less than 40, whereas in 2009, there were 15 mines with zero SPI and 40 mines with an SPI less than 40. In 2010, there were 24 mines with zero SPI and 52 mines with an SPI less than 40.

4.3. Correlation of the SPI to the Risk Index Results

Based on the analysis of results, in the authors' opinion the mines with a very high risk level should be targeted for improvement and immediate action should be taken to reduce the risk. Likewise, the mines with zero SPI should be targeted and immediate interventions should be taken to improve the safety performance. Mines with high risk or with an SPI less than 40 should take action to remediate their poor safety performance.

The risk index results and the SPI results were tested for correlation using the Minitab statistical software with a level of significance (α) of 0.05. The risk index and SPI correlations are shown in the **Table 7** for the years 2007-2010. The negative correlations of the risk index with the SPI were expected, as a high risk index indicates a high-risk mine, whereas, the SPI was constructed as a positive safe performance indicator. The correlations of the risk index with the SPI were –0.913, –0.922, –0.905, and –0.898 for the years 2007, 2008, 2009, and 2010, respectively. The correlations between the risk index and the SPI for each year were excellent as well as significant (based on the p-value). This indicates that the SPI methodology effectively emulates the risk index developed using the traditional risk approach.

Using the SPI approach does have the advantage over the use of the risk index, because in the risk index approach, the range of values for each risk measure is generally unknown in deciding what intervals to create. Analysis of the data is required to construct an appropriate risk interval for each measure. Also, because of the normalized measures incorporated, the SPI is an understandable approach (no learning curve) for mine operators as well as federal and state enforcement agencies, and it would likely be more compatible with MSHA's enforcement tools.

Table 7. Correlation of risk index and SPI results: 2007-2010.

Years	Correlation (RI-SPI)	p-value ($\alpha = 0.05$)
2007	–0.913	0.000
2008	–0.922	0.000
2009	–0.905	0.000
2010	–0.898	0.000

5. Conclusion

In this paper, a traditional risk approach was used to develop a risk index that embraces frequency and severity in the final equation for assessing the safety performances of U.S. underground coal mines based on six prominent normalized safety measures. The risk index ranks the mines' relative safety performances on a risk scale that ranges from very low risk to very high risk. In order to explore the equivalence of a traditional risk analysis approach with the SPI, the mines' safety performances were also calculated using the previously developed Safe Performance Index methodology. The risk index and SPI results for each mine for the years 2007-2010 showed a correlation coefficient of –0.89 or more between the results of these two methodologies. Thus the application of the SPI methodology effectively emulates a traditional risk analysis. Either can be used to assist companies, the U.S. Mine Safety and Health Administration, or state enforcement agencies in targeting mines with high risk for serious injuries and elevated citations for remediation of their injury and/or violation experience. The SPI is, however, a transparent, understandable, and reproducible approach for mine operators and federal and state agencies, with a quick learning curve, and it is likely more compatible with MSHA's enforcement tools than a formal risk analysis.

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Safety Science 49 (2011) 906–911

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

A methodology for assessing underground coal mines for high safety-related risk

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ARTICLE INFO

Article history:
Received 27 July 2010
Received in revised form 4 February 2011
Accepted 12 February 2011
Available online 10 March 2011

Keywords:
Mine safety
Performance Index
Safety violation
Safety-related risk

ABSTRACT

In 2008 the authors developed a methodology for assessing underground coal mines for high risk for major-hazard events. It focused on major hazard-related violations of safety standards associated with high-risk conditions. Later using the same stratified pilot sample of 31 mines, injury measures and MSHA citation data were combined into a Safe Performance Index (SPI). Using 2009 data, the database was expanded to 107 mines, which is a 30% sampling of all underground coal mines. The SPI was used to assess the relative safety-related risk of mines, including by mine-size category. The methodology can be used to assist companies, the Mine Safety and Health Administration, or state agencies in targeting mines with high risk for serious injuries and elevated citations for remediation of their violation and/or injury experience.

1. Introduction

Following the underground coal mine disasters of 2006, the U.S. Congress passed the Mine Improvement and New Emergency Response Act (MINER Act, P.L. 109-236). It was enacted primarily to address several shortcomings in emergency preparedness and response, aiding miners in escaping and surviving emergency situations, and to increase the enforcement of safety in mines. An independent, tripartite commission (Mine Safety Technology and Training Commission, 2006) was established by the National Mining Association, which published a consensus report aimed at preventing underground coal mine disasters in the future and targeting the goal of zero fatalities and lost-time accidents. The report specified 75 recommendations that, if implemented, would set safe performance standards for achieving a culture of prevention at mines, including risk assessment, and noted that mines which could not meet the level of safety requirements specified in the report should not be allowed to mine coal.

Post-MINER Act, the Mine Safety and Health Administration (MSHA) increased enforcement of mines in all sectors, and the level of fines was about 3.5 times higher than pre-2006. The provisions of the MINER Act were largely implemented by 2009, with few exceptions, thereby increasing the protection of miners during emergencies and better preparing mines for effective emergency response. Mine safety professionals hoped that major hazard-related disasters would be avoided in the future. However, in spite of many efforts by the Federal government and a number of state governments, the worst underground coal mine disaster in 40 years occurred at the Upper Big Branch-South Mine on April 5, 2010.

Following publication of the Mine Safety Technology and Training Commission (MSTTC) report, the National Institute for Occupational Safety and Health (NIOSH) followed up on the MSTTC recommendation that NIOSH "develop a series of case studies that mines could use as templates (for risk assessment), and that it conduct workshops and seminars to diffuse this approach to safety throughout the industry." NIOSH completed its study, but there was little response by industry to attend workshops to diffuse the major-hazard risk assessment methodology. Thus, a key component of the MSTTC report remained largely unaddressed, and it was critical for establishing a safety culture of prevention founded on systematic risk assessment and follow-up remediation of identified major hazard-related risks.

Beyond ventilation and roof control plans, MSHA has pursued risk management over the years. Stop Look Analyze and Manage (SLAM), the Pattern of Violations (POV) provision, and Rules to Live By are the most recent examples. The two-step POV process was initiated in earnest in June 2007. Today problems persist with the POV process, which depends on final citations, including elevated ones. The process is also not transparent to the mine safety community, is complex with 10 components comprising the calculation, and is cumbersome to enforce, particularly because a significant percentage of significant and substantial (S&S) citations and orders are challenged through the due process that operators exercise via the Mine Safety and Health Review Commission.

In the summer of 2007, the authors initiated a pilot study of 31 underground coal mines, stratified by mine size and state, to analyze the comparative risk among them. One of the tools developed was the Safe Performance Index (SPI), which combines statistics on a mine's injury experience with its citation experience in

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doi:10.1016/j.ssci.2011.02.007

determining its relative level of safety, or risk (Kinilakodi, 2009). Emulating the Environmental Performance Index (Emerson et al., 2010), the SPI was designed to provide a more straight-forward, transparent, and understandable method for determining the relative risk of mines than the POV process. In the calculation, it gives greater weight to the injuries and citations that are more serious. It can be used to benchmark superior safety performance, including by mine size or type of mining, or for screening mines for improvement efforts. The details on the development of the SPI as well as the results of analyses using it will be given next.

2. Pilot-sample study

The 31 pilot-sample mines shown in Table 1 were created for the risk assessment exploratory study by Grayson et al. (2009). The pilot-sample mines were created to study the MSHA citation database and it was the first attempt to use the MSHA citation database for a risk assessment study, other than MSHA using it in POV calculations. The 31 mines in the pilot study were randomly selected and stratified based on mine size and the state in which they are physically located. In 2006, there were 421 active underground coal mines with production greater than or equal to 10,000 tons. Out of 421 mines, 112 were very small mine-size, 143 were small mine-size, 78 were medium mine-size, 49 were large mine-size, and 39 very large mine-size. In the pilot sample there were 8 very small mines, 10 small mines, 6 medium-size mines, 4 large mines, and 3 very large mines which were proportionately representing the various mine-size categories and the nine different states (Alabama, Colorado, Illinois, Indiana, Kentucky, Pennsylvania, Utah, Virginia, West Virginia). Hence, the 31 mines sampled satisfy the size-wise and state-wise representation/distribution. In general, the 31 pilot-sample mines represent the overall industry situation. Final MSHA 2006 injury, employment and citation data were captured on the 31 mines. Three tools were developed for monitoring mine safety performance, as follows:

- Risk assessment for major-hazard conditions using major hazard-related citation data – the calculation made for each mine was the product of the frequency of occurrence of citations and the penalties (in dollars) assessed on them (Grayson et al., 2009).
- The reliability of not getting an MSHA citation on an inspector visit (Kinilakodi and Grayson, 2011).
- The Safe Performance Index.

The remainder of this paper focuses on the details of the development of the Safe Performance Index and the results from using it.

3. Safe Performance Index calculations from pilot study

MSHA data for 2006 on the 31 mines in the stratified, random sample was used in this pilot study. When the project was begun, 2007 data was not yet available. The basic safety data on the sample mines is given in Table 1. The 'inspector hours' field contains total inspector hours, primarily because the Pattern of Violation process (Smith, 2010) was not yet implemented. In the pilot study data there were no fatalities, which indicate the low probability for an underground coal mine to have a fatality in a given year (approximately 4% chance).

The measures used in calculating the Performance Index (PI), and later the SPI, for 2006 data included standard injury measures, i.e. the No Days Lost Incidence Rate (NDL IR), the Non-Fatal Days Lost Incidence Rate (NFDL IR), and the Severity Measure (SM), and citation-related measures, i.e. Citations per 100 Inspector Hours (C/100 IH), Significant and Substantial Citations per 100 Inspector Hours (SS/100 IH), and withdrawal Orders and unwarrantable failures per 100 Inspector Hours (O/100 IH). They are shown in Table 2 for the 31-mine sample.

As the first step in calculating the SPI, the PI is calculated as the summation of the safety measures. The PI thus gives a combined

Table 1
MSHA safety data on pilot study mines.

Mine ID	No. Empl.	No. NLT accidents	No. LT accidents	Restricted and lost work days	Empl. hrs	No. citations	No. S&S	No. orders	Insp. hrs
1	15	0	0	0	36,004	16	3	0	237.50
2	13	0	0	0	8429	11	6	0	101.50
3	7	0	0	0	12,285	11	4	0	307.75
4	20	7	3	8	54,692	51	15	0	740.50
5	20	0	1	354	38,214	150	84	0	518.00
6	15	2	2	162	36,060	65	27	2	435.00
7	14	0	0	0	27,067	7	1	0	212.25
8	15	0	1	120	14,608	13	1	0	156.50
9	49	8	2	146	135,414	512	228	76	2740.50
10	35	2	2	51	79,853	54	23	1	434.00
11	21	0	2	60	36,708	46	18	0	301.75
12	25	2	2	6	40,880	47	20	0	356.75
13	21	0	0	0	38,274	73	39	1	408.25
14	30	2	0	0	67,958	55	11	2	1092.80
15	36	2	4	326	69,822	9	5	0	181.50
16	42	0	1	9	106,095	48	27	2	445.75
17	22	0	0	0	29,166	84	32	3	416.00
18	37	2	5	384	93,419	72	28	0	681.75
19	67	1	0	0	178,226	107	53	0	825.75
20	72	4	2	16	71,977	48	9	0	492.00
21	56	5	2	229	122,416	65	20	0	364.00
22	72	15	11	1435	170,692	96	41	4	619.75
23	63	6	23	1188	152,847	141	45	1	1162.30
24	58	7	1	62	169,469	86	57	10	588.00
25	142	10	5	47	278,557	133	31	8	1556.50
26	107	13	3	165	257,958	154	53	2	858.75
27	103	19	10	176	309,759	167	92	2	845.00
28	231	10	4	428	499,328	196	69	12	2088.00
29	390	30	8	658	894,791	370	100	5	2861.50
30	303	13	12	392	655,104	103	33	1	1706.50
31	383	29	16	1541	794,802	517	128	5	2969.00

Table 2
Normalized safety measures used in calculating the SPI.

Mine ID	NDL IR	NFDL IR	SM	C/100 IH	SS/100 IH	O/100 IH
1	0.00	0.00	0.00	6.74	1.26	0.00
2	0.00	0.00	0.00	10.84	5.91	0.00
3	0.00	0.00	0.00	3.57	1.30	0.00
4	25.60	10.97	29.25	6.89	2.03	0.00
5	0.00	5.23	1852.72	28.96	16.22	0.00
6	11.09	11.09	898.50	14.94	6.21	0.46
7	0.00	0.00	0.00	3.30	0.47	0.00
8	0.00	13.69	1642.94	8.31	0.64	0.00
9	11.82	2.95	215.64	18.68	8.32	2.77
10	5.01	5.01	127.73	12.44	5.30	0.23
11	0.00	10.90	326.90	15.24	5.97	0.00
12	9.78	9.78	29.35	13.17	5.61	0.00
13	0.00	0.00	0.00	17.88	9.55	0.24
14	5.89	0.00	0.00	5.03	1.01	0.18
15	5.73	11.46	933.80	4.96	2.75	0.00
16	0.00	1.89	16.97	10.77	6.06	0.45
17	0.00	0.00	0.00	20.19	7.69	0.72
18	4.28	10.70	822.10	10.56	4.11	0.00
19	1.12	0.00	0.00	12.96	6.42	0.00
20	11.11	5.56	44.46	9.76	1.83	0.00
21	8.17	3.27	374.13	17.86	5.49	0.00
22	17.58	12.89	1681.39	15.49	6.62	0.65
23	7.85	30.10	1554.50	12.13	3.87	0.09
24	8.26	1.18	73.17	14.63	9.69	1.70
25	7.18	3.59	33.75	8.54	1.99	0.51
26	10.08	2.33	127.93	17.93	6.17	0.23
27	12.27	6.46	113.64	19.76	10.89	0.24
28	4.01	1.60	171.43	9.39	3.30	0.57
29	6.71	1.79	147.07	12.93	3.49	0.17
30	3.97	3.66	119.68	6.04	1.93	0.06
31	7.30	4.03	387.77	17.41	4.31	0.17

Table 3
Calculated PI, normalized PI and SPI.

Mine ID	PI	Norm PI	SPI
1	8.00	0.00	100
2	16.75	0.01	99
3	4.87	0.00	100
4	74.74	0.04	96
5	1903.13	1.00	0
6	942.29	0.50	50
7	3.77	0.00	100
8	1665.58	0.88	12
9	260.18	0.14	86
10	155.72	0.08	92
11	359.01	0.19	81
12	67.69	0.04	96
13	27.67	0.01	99
14	12.11	0.01	99
15	958.70	0.50	50
16	36.14	0.02	98
17	28.60	0.02	98
18	851.75	0.45	55
19	20.50	0.01	99
20	72.72	0.04	96
21	408.92	0.21	79
22	1734.62	0.91	9
23	1608.54	0.85	15
24	108.63	0.06	94
25	55.56	0.03	97
26	164.67	0.09	91
27	163.26	0.09	91
28	190.30	0.10	90
29	172.16	0.09	91
30	135.34	0.07	93
31	420.99	0.22	78

measure where the highest value is the 'worst' performer in the group of mines and the lowest value gives the 'best' performer. Since the PI had a wide range of values, it was considered useful to index the PI to give a range of values from 0 (best-performing mine) to 1 (the worst-performing mine). Thus the normalized PI was calculated as a mine's PI divided by the highest PI among all mines.

The SPI was then calculated as the normalized PI times 100, with the result subtracted from 100. This gives the best-performing mine with zero injuries and zero citations, theoretically, having a value of 100, with the worst-performing mine having a value of zero. The results of the calculations are presented in Table 3.

4. Modified Safe Performance Index using 2009 data

Following completion of the pilot study, MSHA 2009 data was captured to examine primarily the fluctuations in the SPI for the 31 mines. As this process unfolded in early 2010, the Upper Big Branch-South Mine disaster occurred and issues related to the ineffectiveness of the Pattern of Violations process were emphasized in the mainstream press and media, and to the U.S. Congress (Smith, 2010). This sparked an examination by the authors of all underground longwall coal mines as compared to the pilot-sample mines. Added to the list of mines to examine were the underground coal mines given to Congressman Miller (Chair, of the US House Education and Labor Committee) by MSHA as 'dangerous' mines and mines that were targeted for special inspections by MSHA following the disaster. Ultimately, MSHA 2009 accident, injury and citation data were captured to form a database comprised of 107 mines. This provided a robust database (30% of all mines) for examining the overall value of the Safe Performance Index in specifying the relative risk of the mines and in identifying the high-risk underground coal mines. The 2009 MSHA data for the upper 5%, middle 5%, and lower 5%, representing the best-performing, average-performing, and worst-performing mines, respectively, of the 107 mines is given in Table 4.

For this more recent database, responsive to the need to better reflect the impact of fatalities and full and partial disabilities, the Severity Measure was modified to include statutorily charged days for these more serious injuries. Scrutiny of the previous model for calculating the SPI showed, for the larger sample, that the modified Severity Measure and to a lesser extent a couple of other measures would heavily influence the combination of the component measures. In order to address this situation, first each component measure was scaled to have the same mean (5.00); essentially the data dispersion remained the same. Once equality of means was achieved, then weighting factors were used to place proper weight on the most serious safety-compromising components, e.g., Severity Measure/100 and Orders/100 IH.

Following are the criteria used for assigning proper weights on safety measures. Every underground coal mine in the U.S. is inspected by an MSHA inspector on a quarterly basis to check whether a mine is complying with the mandatory health and safety standards. During an inspection, the MSHA inspector(s) issue citation(s) for mandatory health and safety standards that are violated and determine the degree of seriousness based on tabled criteria and their judgment. According to case law (MSHA, 2010a), "significant and substantial violations, which are more serious, must have four elements proved:

1. The underlying violation of a mandatory standard.
2. The existence of a discrete safety hazard contributed to by the violation.
3. A reasonable likelihood that the hazard contributed to will result in an injury.
4. A reasonable likelihood that the injury in question will be of a reasonably serious nature."

If a violation is caused by an unwarrantable failure, where MSHA has determined that the "mine operator has engaged in aggravated conduct constituting more than ordinary negligence", then a

Table 4
MSHA 2009 safety data on top six best-performing, average performing, and worst-performing mines of 107 underground coal mines.

Mine ID	# NLT	# LT	Days lost	# Fatals	Empl. hrs	# Citations	# S&S	# Orders	Insp. hrs
Pilot mine 3	0	0	0	0	15,925	13	0	0	306.25
LW-19	17	0	0	0	370,524	47	16	0	2225.50
LW-26	1	1	148	0	482,319	80	12	0	1064.50
LW-25	2	1	27	0	772,482	178	38	1	1807.00
LW-14	15	4	60	0	893,530	160	37	0	1522.00
Pilot mine 14	2	0	0	0	26,612	24	9	0	485.75
LW-11	26	9	418	0	414,021	355	71	10	1635.75
MB-13	6	4	97	0	166,376	229	66	5	850.50
ML-15	13	13	471	0	451,091	360	147	5	1584.25
LW-7	7	14	801	0	343,844	250	28	0	965.00
ML-8	3	0	0	0	266,533	715	205	36	2384.00
MB-28	16	5	152	0	204,501	582	241	3	1890.75
LW-31	15	9	286	0	482,132	517	202	56	1848.00
MB-22	6	6	179	0	169,676	125	64	12	481.00
MB-16	8	4	3064	0	254,779	437	85	4	2110.75
ML-2	15	11	6062	0	541,880	619	198	14	2001.75
MB-12	13	12	6616	0	470,964	322	134	2	2148.75
MB-9	6	13	6658	1	476,391	362	138	3	2087.75

LW = Longwall mine; MB = MSHA blitz mine; ML – MSHA List to Congressman Miller.

Table 5
Scaled values for SPI components for top six best-performing, average performing, and worst-performing mines of 107-mine MSHA 2009 data sample.

Mine ID	NDL IR	NFDL IR	SM/100	C/100 IH	SS/100 IH	O/100 IH
Pilot mine 3	0.00	0.00	0.00	1.00	0.00	0.00
LW-19	7.14	0.00	0.00	0.50	0.51	0.00
LW-26	0.32	0.62	0.60	1.76	0.81	0.00
LW-25	0.40	0.38	0.07	2.31	1.50	0.32
LW-14	2.61	1.33	0.13	2.47	1.74	0.00
Pilot mine 14	11.70	0.00	0.00	1.16	1.32	0.00
LW-11	9.77	6.45	1.98	5.09	3.10	3.59
MB-13	5.61	7.13	1.15	6.32	5.54	3.45
ML-15	4.49	8.55	2.05	5.33	6.63	1.85
LW-7	3.17	12.08	4.58	6.08	2.07	0.00
ML-8	1.75	0.00	0.00	7.04	6.14	8.86
MB-28	12.18	7.26	1.46	7.23	9.10	0.93
LW-31	4.84	5.54	1.17	6.57	7.81	17.77
MB-22	5.50	10.49	2.07	6.10	9.50	14.63
MB-16	4.89	4.66	23.63	4.86	2.88	1.11
ML-2	4.31	6.02	21.98	7.26	7.07	4.10
MB-12	4.30	7.56	27.60	3.52	4.45	0.55
MB-9	1.96	8.10	27.46	4.07	4.72	0.84

Note: The means for each measure were scaled to 5.

withdrawal order is generally issued, and "a reasonable amount of punitive charges" are assessed (MSHA, 2010b). Thus, a weight of 0.05 was given to Citations/100 IH, 0.15 was given to SS/100 IH, and 0.30 was given to Orders/100 IH. In order to balance the consideration of accident and citation in determining a mine's safety performance an equal weighting of the accident measures and citation measures are used. The case for accident/injury safety measures (NDL IR, NFDL IR, and Severity Measure/100) are similarly assigned analogous weighting factors based on the seriousness of the accidents. To achieve proper weighting factors, their sum was forced to 1. The SPI was then calculated as the sum of the weighting factors times the component measures. Table 5 shows the results of the scaled measures for mines given in Table 4.

In examining the calculations of the SPI using the original approach, it was found that dividing each mine's PI by an extremely high PI for the worst-performing mine would excessively inflate SPI values. Because of this inflation, very few mines would have an SPI that fell below 50, even though some of the mines had one or more relatively poor safety measures. Thus to achieve a reasonable SPI that would be practically applicable in targeting poor-performing mines, a value of 15 was selected to normalize the PI for all mines. In the SPI calculation, poor-performing mines with PI values greater than 15 would then get negative SPI values; these would be assigned the lowest SPI value of zero.

Using fixed values of 5 for the scaled means of the safety measures and 15 for normalizing the PI, a straight-forward and transparent methodology was thus developed for the screening of poor-performing mines. In this way, each stakeholder group would use the same methodology when making SPI calculations. The results of the SPI calculations are given in Table 6 for the mines listed in Tables 4 and 5.

5. Discussion of results

In analyzing the SPI results for the 107-mine sample, comparisons of various metrics were made among the top 10% (best-performing), middle 10% (average-performing), and bottom 10% (worst-performing) mines. The best-forming 10% SPI mines, shown in Table 7, are characterized as follows:

- All of them had an NFDL IR and SM/100 much less than the averages for all mines.
- Ten of 11 of them had a SS/100 IH and all of them had an O/100 IH much less than the averages for all mines.

Table 6
PI, normalized PI and SPI values for mines listed in Tables 4 and 5.

Mine ID	Norm		
	PI	PI	SPI
Pilot mine 3	0.05	0.00	99.7
LW-19	0.46	0.03	96.9
LW-26	0.50	0.03	96.7
LW-25	0.54	0.04	96.4
LW-14	0.75	0.05	95.0
Pilot mine 14	0.84	0.06	94.4
LW-11	3.85	0.26	74.4
MB-13	3.88	0.26	74.2
ML-15	3.94	0.26	73.7
LW-7	3.96	0.26	73.6
ML-8	4.02	0.27	73.2
MB-28	4.14	0.28	72.4
LW-31	8.25	0.55	45.0
MB-22	8.59	0.57	42.7
MB-16	9.04	0.60	39.7
ML-2	10.37	0.69	30.9
MB-12	10.64	0.71	29.1
MB-9	10.71	0.71	28.6

- Ten of the 11 mines had no withdrawal orders or unwarrantable failure citations.
- Five pilot mines and six longwall mines were in the list.
- Significantly, only one mine on the MSHA list of targeted mines for special inspection made the list.

The average-performing 10% SPI mines, shown in Table 8, have expected characteristics. They are characterized as follows:

- Three mines (LW-7, MB-25, and MB-28) had a single measure that was more than two times the scaled mean of a metric, but in each case two or more metrics were significantly lower than the other metrics, including some with higher weighting factors.
- In one case (MB-1), the mine had four metrics that were 15–36% higher than their means, but one metric with the highest weighting factor was very low, thereby keeping the mine near average.
- Three mines (LW-6, LW-9, and ML-22) had four or five metrics below their respective means, including one in a highly weighted metric that offset another highly weighted metric that was significantly above its respective mean.
- In one case (ML-8), the mine's injury metrics were all excellent, and offset the citation metrics that were somewhat higher than their respective means.
- In the final three mines (LW-11, MB-13, and ML-15), somewhat elevated but lower-weighted metrics were offset by the highest-weighted metrics that were significantly lower than their respective means.
- Intuitively, these are the types of performances expected in the middle 10% group. Trade-offs among metrics occurs, but there are no highly weighted metrics that have values much higher than their means.

The worst-performing 10% SPI mines, shown in Table 9, are characterized as follows:

- For six of the mines (LW-22, LW-31, MB-2, MB-14, and MB-20), a very high rate for SS/100 IH and/or O/100 IH got them on the list.
- For five of the mines, a very high rate for SM/100 got them on the list.
- Four mines had five elevated metrics versus the means for the metrics, while three mines had four elevated metrics versus their means.

Thus, poor performances on either the injury experience or the citation experience can lead to targeting for interventions, or several worse-than-average performances can earn greater scrutiny.

Table 7
Top 10% SPI best-performing mines.

Mine ID	SPI	NDL IR	NFDL IR	SM/100	C/100 IH	SS/100 IH	O/100 IH
Pilot mine 3	99.7	0.00	0.00	0.00	1.00	0.00	0.00
LW-19	96.9	7.14	0.00	0.00	0.50	0.51	0.00
LW-26	96.7	0.32	0.62	0.60	1.76	0.81	0.00
LW-25	96.4	0.40	0.38	0.07	2.31	1.50	0.32
LW-14	95.0	2.61	1.33	0.13	2.47	1.74	0.00
Pilot mine 14	94.4	11.70	0.00	0.00	1.16	1.32	0.00
Pilot mine 12	94.0	3.97	0.00	0.00	4.21	3.25	0.00
LW/Pilot Mine 28	92.3	2.52	1.44	1.82	2.51	0.91	0.00
LW-18	92.3	3.71	3.20	0.63	1.44	1.51	0.00
MB-17	91.9	3.42	0.00	0.00	6.07	4.92	0.00
Pilot mine 27	91.1	5.00	1.91	0.09	4.20	3.70	0.00
Scaled averages	73.2	5.00	5.00	5.00	5.00	5.00	5.00

Table 8
Middle 10% SPI average-performing mines.

Mine ID	SPI	NDL IR	NFDL IR	SM/100	C/100 IH	SS/100 IH	O/100 IH
LW-6	74.9	2.51	3.83	0.86	3.44	2.71	7.43
LW-11	74.4	9.77	6.45	1.98	5.09	3.10	3.59
MB-13	74.2	5.61	7.13	1.15	6.32	5.54	3.45
ML-15	73.7	4.49	8.55	2.05	5.33	6.63	1.85
LW-7	73.6	3.17	12.08	4.58	6.08	2.07	0.00
ML-8	73.2	1.75	0.00	0.00	7.04	6.14	8.86
MB-28	72.4	12.18	7.26	1.46	7.23	9.10	0.93
ML-22	72.2	4.43	0.00	0.00	5.81	4.88	9.75
LW-9	72.2	2.96	4.70	0.96	5.54	2.70	7.83
MB-1	70.9	5.74	3.52	0.91	6.21	6.82	6.50
MB-25	70.5	0.93	0.00	0.00	6.07	6.34	10.42
Scaled averages	73.2	5.00	5.00	5.00	5.00	5.00	5.00

Table 9
Bottom 10% SPI poorest-performing mines.

Mine ID	SPI	NDL IR	NFDL IR	SM/100	C/100 IH	SS/100 IH	O/100 IH
LW-22	51.4	4.65	8.87	3.04	5.99	3.51	13.30
LW-31	45.0	4.84	5.54	1.17	6.57	7.81	17.77
MB-22	42.7	5.50	10.49	2.07	6.10	9.50	14.63
MB-16	39.7	4.89	4.66	23.63	4.86	2.88	1.11
ML-2	30.9	4.31	6.02	21.98	7.26	7.07	4.10
MB-12	29.1	4.30	7.56	27.60	3.52	4.45	0.55
MB-9	28.6	1.96	8.10	27.46	4.07	4.72	0.84
MB-14	2.6	3.85	14.69	1.02	8.37	12.45	32.09
MB-2	0.0	18.92	18.04	0.36	16.52	24.45	61.35
MB-8	0.0	7.41	0.00	280.48	7.03	6.84	15.80
MB-20	0.0	8.27	5.26	0.07	14.17	21.48	88.86
Scaled averages	73.2	5.00	5.00	5.00	5.00	5.00	5.00

Following discussions with representatives from Congressman Miller's office and jointly with several vice presidents in charge of underground coal mine safety, the findings of the application of the Safe Performance Index and its ability to target poor-performing mines were given in testimony before the US House Education and Labor Committee on July 13. A new screening method, designed to replace the existing POV process was included in the Robert C. Byrd Miner Safety and Health Act of 2010, which uses similar metrics, with weighting factors to be determined through interim rulemaking whenever the bill passes through the Congressional processes. At present, the bill has not been passed by the US House of Representatives, and in early 2011 it was introduced in the US Senate. The methodology to target truly poor-performing mines for heightened enforcement action would then be implemented and its effectiveness as a screening tool could be determined.

6. Conclusions

During 2007–2009, the authors used a random, stratified pilot sample of 31 underground coal mines to develop the Safe Performance Index, which uses Mine Safety and Health Administration injury data and citation data to assess the relative safety-related risk of mines. Using 2009 data, the database was expanded to 107 mines, which is a 30% sampling of all underground coal mines producing 10,000 tons or more. Analyses demonstrated that the methodology can be used to assist companies, MSHA, or state agencies in targeting mines with high risk for serious injuries and elevated citations for remediation of their violation and/or injury experience. The results of analyses were presented at a hearing conducted by the US. House Education and Labor Committee, and a similar methodology is now planned to be used for targeting poor-performing mines for elevated enforcement action. Implementation will not occur until the Robert C. Byrd Miner Safety and Health Act of 2010 is enacted.

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APPENDIX B

PROPOSED STATUTE

TO CREATE MINE ACCIDENT INVESTIGATION TEAMS

H. B. _____

[By Delegates _____]

Introduced _____; referred to the Committee on the Judiciary

A BILL to amend the Code of West Virginia, 1931, as amended by adding thereto one new section, designated §22A-1-41, all relating to the investigation of serious or fatal mine accidents conducted by the Office of Miners' Health, Safety and Training.

Be it enacted by the Legislature of West Virginia:

That the Code of West Virginia, 1931, as amended be amended by adding thereto one new section, designated §22A-1-41 all to read as follows:

CHAPTER 22A. MINERS' HEALTH, SAFETY AND TRAINING.

ARTICLE 1. OFFICE OF MINERS' HEALTH, SAFETY AND TRAINING; ADMINISTRATION; ENFORCEMENT.

§22A-1-41. CREATION OF A MINE ACCIDENT INVESTIGATION TEAM; ASSIGNING DUTIES AS SET FORTH IN OTHER PROVISIONS OF THIS CHAPTER AND CREATED WITHIN THIS

1 **SECTION; REQUIRING TRAINING AND COMPENSATION;**

2 **EFFECTIVE UPON PASSAGE.**

3 (a) Whenever a serious mine accident involving a serious or
4 fatal injury takes place within any underground or surface
5 coal mine, a team of mine inspectors, including the mine
6 inspector assigned to the mine where the accident occurred
7 (hereinafter "mine accident investigation team"), shall be
8 appointed by the Director of the Office of Miners'
9 Health, Safety and Training, and shall be responsible for
10 investigating such serious mine accidents.

11 (b) Subsection (a) applies to-

12 (1) A serious accident at a coalmine resulting in a
13 person receiving-

14 (A) A serious injury that has the reasonable
15 potential to cause death; or

16 (B) An injury causing the death of an individual
17 at a coal mine.

18 (c) The purposes of the mine accident investigation team are
19 to-

20 (1) Investigate all serious and fatal mine accidents
21 within the State of West Virginia;

22 (2) Determine the causes of all serious and fatal
23 mine accidents;

24 (3) Properly and thoroughly document all relevant records,
25 violations issued, and any other evidence deemed

1 necessary by the Office of Miners' Health, Safety
2 and Training; and
3 (4) Provide recommendations to the operator to remedy any
4 issued violations or orders.
5 (d) Once notice of a serious mine accident is received by the
6 OMHST, members of the mine accident investigation
7 team, appointed by the Director of the Office of Miners'
8 Health, Safety and Training, must-
9 (1) Inspect the site of the serious mine accident;
10 (2) Determine the causes of the serious mine accident,
11 identifying-
12 (i) Any and all factors that caused the accident;
13 (ii) Any and all contributing actions or inactions of
14 any party, including operators, contractors, or
15 other mine personnel;
16 (3) Gather, document, and preserve all relevant evidence
17 for at least five years following the investigation,
18 unless necessary for any current or impending
19 litigation. This evidence includes photographs,
20 notes taken during the investigation,
21 witness statements, and all other evidence
22 deemed necessary by the Office of Miners'
23 Health, Safety and Training;
24 (4) Prepare a detailed written report in compliance with
25 §22A-2-67 of the West Virginia Code, which then shall

be presented to the Director of the Office of Miners' Health, Safety and Training. The report shall include-

(i) The causes of the serious mine accident;

(ii) All violations issued and the basis for such violations;

(iii) Witnesses relied on in the investigation and sufficient contact information for each witness;

(iv) A list of all persons within or around the mine at the time of the accident; and

(v) Copies of all pertinent records pertaining to activities occurring at the mine for a period of six months prior to the serious mine accident, unless otherwise unavailable; and

(5) If necessary, testify at any hearing before the Coal Mine Safety Board of Appeals regarding the conditions of the accident site, any violations issued and the bases for those violations, and all other pertinent evidence obtained during the mine accident investigation, which shall occur within a reasonable time following the accident investigation.

(e) Each member appointed to the mine accident investigation team shall undergo initial training, as well as annual refresher training. The structure and content of the training shall be determined by the Director of the Office of Miners' Health, Safety and Training.

(f) Members of the mine accident investigation team shall receive reasonable compensation for their services, in addition to regular salaries received under W. Va. Code §§22A-1-12 and 22A-1-13. The amount of compensation shall be determined by the Director of the Office of Miners' Health, Safety and Training.

(g) In addition to the duties and responsibilities set forth in this section, the mine accident investigation team shall have all duties and responsibilities set forth in other provisions of this chapter relating to mine accident investigations.

(h) The provisions of this section shall take effect upon passage. The Director of the Office of Miners' Health, Safety and Training may propose such rules and regulations, pursuant to article three, chapter twenty-nine-a of this Code, as he shall deem necessary to fully effectuate the provisions of this section.

NOTE: The purpose of this bill is to authorize and direct the Director of the Office of Miners' Health, Safety and Training to create a mine accident investigation team to investigate serious and fatal coal mine accidents with the goal of ensuring that more efficient practices are undertaken when investigating and documenting serious and fatal mine accidents. The bill creates the mine accident investigation team, giving the Director of the Office of Miners' Health, Safety and Training the discretion in setting forth the structure. It also sets forth the duties, training requirements, and reasonable compensation to be provided to each member of the mine accident investigation team. This bill contains a new section; therefore, strikethroughs and underscoring have been omitted.

APPENDIX C

ROCK DUSTING: A JURISDICTIONAL SURVEY

Rock Dusting
A Jurisdictional Survey

I. Federal Practice

A. § 864. Combustible materials and rock dusting

1. §864(a)- Accumulations; Maintenance- Coal dust and other combustible materials shall not accumulate in active workings or on electric equipment.
2. §864(b)- Water shall be used in working places, particularly less than 40 feet from ribs, roof, and floor, to minimize coal dust.
3. §864(c)- Rock Dusting of All Areas of Underground Mine; Exceptions- All areas of the mine shall be rock dusted to within 40 feet of all working faces, unless the dust is too wet or too high in incombustible content or it would be unsafe.
4. §864(d)- Distribution of Rock Dust; Places, Quantities- Rock dust goes on to the top, floor, and sides of underground mines. The incombustible content shall be not less than 65 per centum, but it shall be no less than 80 per centum in return aircourses. If methane is present in any ventilating current, the incombustible content is increased.

II. Practice of States

A. Pennsylvania

- 52 Pa. Stat. Ann. § 690-239
  - Title 52 P.S. Mines and Mining, Chapter 12. Bituminous Coal Mine Safety Act of 2008, Chapter 2. General Requirements for Underground Bituminous Mines
  - (a) Method of removal.—
    - (1) Dangerous accumulations of fine, dry coal dust shall be removed from a mine or neutralized by the application of rock dust, and all dry and dusty operating sections and haulageways and the back entries for at least 1,000 feet outby the first active working place in each operating section shall be kept watered down, rock dusted or dust allayed by such other methods as may be approved by the department.
    - (2) A mine or location in a mine that is too wet or too high in incombustible content to initiate or propagate a coal dust ignition need not be rock dusted during the time any of those conditions prevail.

        - (3) Coal dust and other dust in suspension in unusual quantities shall be allayed by sprinkling or other dust allaying or collecting devices.
    - (b) Specifications.—
        - (1) In a dry and dusty mine or section thereof, rock dust shall be applied and maintained upon the roof, floor and sides of all operating sections, haulage ways and parallel entries connected thereto by open crosscuts. Back entries shall be rock dusted for at least 1,000 feet out by the junction with the first active working place.
        - (2) Rock dust shall be so applied to include the last open crosscut of rooms and entries and to within 40 feet of the faces. In mines where mining is done by continuous-type mining machinery, the distances from the face to which rock dust shall be applied shall be the mining distance for one shift if:
            - (i) The active working place shall be kept from damp to wet.
            - (ii) After coal production on any shifts has ceased, an application of rock dust shall be made in the exposed area to within 40 feet of the face before additional mining is performed in the area.
        - (3) Rock dust shall be maintained in such quantity that the incombustible content of the mine dust shall not be less than 65%.
    - (c) Composition of rock dust. -- Rock dust shall not contain more than 5% by volume of quartz or free silica particles and shall be pulverized so that 100% will pass through a 20-mesh screen and 70% or more will pass through a 200-mesh screen.

B. Ohio

1. § 1563.26- Rock Dusting; Testing of Dust Samples
    - All mines, except those that are too wet or too high in incombustible content to propagate an explosion, shall be rock dusted.
        - The rock dusting shall be done with such regularity so that incombustible content of the adhering and lodging dust is not less than 65%.
        - When methane is present in any ventilating current, such incombustible content shall be not less than 65% plus one and four-tenths per cent for each one tenth of one per cent of methane so present.

- The rock dust to be used shall be pulverized limestone or any other material containing less than 5% combustible material. All dust shall be so pulverized that it will all go through a sieve that has 20 openings to the linear inch and at least 50% of such dust shall pass through a sieve with two hundred openings to the linear inch. The rock dust shall not contain more than 4% free silicon and silicon dioxide.
- The rock dust shall be distributed on top, bottom, and sides of all haulageways, traveling ways, developing entries, and rooms to within 40 feet of face. Back entries shall be rock dusted for at least 1,000 feet out by the junction with the first active entry.
- In mine where rock dusting is required, the superintendent shall see that a dust sample is gathered at each sampling point from the roof, sides, and floor of all entries by a competent person once each 60 days and tested to determine if any part of the mine requires redusting.
    - A record shall be kept in a book furnished by the division of mineral resources management for that purpose.
        - Such books shall be kept in the mine office and show the location at which samples have been taken and the results of the tests.
- The distance between sampling points on haulageways and traveling ways shall not exceed 2,000 feet, but in developing entries and in entries producing coal from rooms or pillars and their parallel entries the distance between sampling points shall not exceed 500 feet.
- No operator of a mine shall refuse or neglect to comply with this section.

C. Oklahoma

- §417 establishes mandatory water sprinkler systems.
- There is no other mention of rock dusting .

D. Illinois

- CH 225 § 705-24.03- All underground mines, except those mines or areas of mines in which the dust is too wet or too high in incombustible content to propagate an explosion, shall be rock-dusted to within 40 feet of all faces
- CH 705-§ 24.04. (Chapter 225, Article 24) In mines partially rock-dusted or in mines that are required to start rock-dusting, haulage ways and parallel entries connected thereto by open crosscuts, shall be rock-dusted. Back entries shall be rock-dusted for at least 1,000 feet outby the junction with the first active entry. Inby this junction, the rooms, entries, and crosscuts, shall be rock-dusted. Rock-dusting shall be started at once and completed as herein

provided, and the mine shall be rock-dusted as it develops and rock-dusting shall be maintained to the shaft bottom or entrance.

E. Indiana

- Nothing in Code on rock dusting.

F. Utah

- Nothing in Code on rock dusting

G. Kentucky

- § 352.060 (Title XXVIII, Chapter 352)-
- The following rules shall govern in the rock-dusting of mines:
    - (1) All mines shall be rock-dusted if conditions are found to be dusty or hazardous, after proper inspection. If such conditions are found to exist, then the commissioner shall require the necessary rock-dusting to make the mine, part of the mine, or section safe.
    - (2) Accumulations of excessive loose coal and fine dry coal dust shall be removed from the mine, and all operating sections kept thoroughly rock-dusted, and the dust on the mine floor allayed by methods approved by the commissioner, but in every mine, or in any part or section thereof, rock-dusting shall be applied to maintain at all times a minimum percentage of 65% of noncombustible matter to within 40 feet of the faces, including last open crosscuts, and under certain special conditions the department may require that places be rock-dusted to the faces, and that additional rock-dust be added.

H. Wyoming

- Title 30, Chapter 3, Article 1- § 30-3-113- The inspector shall establish by rule for underground coal mines, areas in which rock dusting is required, required levels of incombustible content and other content and size requirements for rock dusting. The inspector or his deputies may require that sufficient samples of the mine dusts are taken in order to enforce this section.

I. Montana

- There is nothing in the Code on this. This is perhaps because there are only four active underground coal mines in the state.[1]

J. New Mexico

[1] This figure is as of the last government report in 2011. *See* http://www.eia.gov/coal/annual/pdf/table1.pdf

- Chapter 69: Mines, Article 22: Rock Dust in Coal Mines, 69-22-1 through 69-22-6 repealed by Laws 1987, ch. 234, § 84.
- The lack of information in the Code may be because there is only one underground coal operation in New Mexico.[2]

K. West Virginia

1. §22A-2-24
    - §22A-2-24(a)- Dusty operating sections, haulage-ways, back-entries, and conveyors shall be rock dusted.
    - §22A-2-24(b)- All mines that are too wet or high in incombustible content do not have to be rock dusted.
    - §22A-2-24(c)- in dry mines, rock dust shall be applied to the roof, floor and sides of all operating sections, haulage-ways and parallel entries connected thereto by crosscuts. Back-entries shall be dusted too. Rock dust shall also be applied to include the last open crosscut of rooms and entries, and to within 40 feet of faces.

L. Maryland

- § 15-402(d)(2) - (Title 5, Subtitle 4)-
    - The mine foreman, personally or by an assistant shall: See that any loose coal or other dangerous material is taken down or secured, especially upon traveling ways and airways, standing water is drained from passageways and working places, explosive and noxious gases and dangerous accumulations of dust are removed, and rock dusting is properly done so that in general the ventilation, stoppings, doors, timbering, drainage, equipment, electrical installations, traveling and airways, trackage, and other mine works and ways are in good working order and reasonably safe condition;

M. Tennessee

- There is nothing in Code.

N. Alabama

- § 25-9-110 (Title 25, Chapter 9, Article 5)
    - (a) Coal dust shall not be allowed to accumulate excessively along conveyor lines, roadways, at loading points or at underground tipples, but shall be loaded and sent out of the mines. Coal dust in dangerous

[2] http://arrowheadcenter.nmsu.edu/sites/default/files/uploadecd/coal-mining-impact-report.pdf

quantities in abandoned areas shall, where practicable be rendered inert.

  - (b) Where mining operations raise an excessive amount of dust into the air currents, water or water with a wetting agent added to it or other effective methods shall be used to allay such dust at its source.
- § 25-9-111
  - (a) Rock shall come within the following specifications:
    - Combustible matter not more than 5% by volume, quartz or free silica particles not more than 5% by volume, & not unduly absorbent of moisture & preferably light in color. Rock dust shall be pulverized so that 100 % will pass through a 20 mesh screen & 70% or more will pass through a 200 mesh screen.
  - (b) Rock dust shall be applied/maintained upon the top, floor, and sides of all open places, passages, and haulageways in such quantities that the incombustible contents of mine dust that could initiate or propagate an explosion will not be less than 65%, but the incombustible content in the return air courses shall be no less than 80%. Rock dust shall be so applied and maintained to include the last open breakthrough of rooms and entries and to within 40 feet of the faces or closer if necessary.
  - (c) In back entries and air courses, rock dust barrier protection in lieu of generalized rock dusting may be authorized by the chief of the division upon request by the operator.
  - (d) Where methane is present in any ventilating current, the percentage of incombustible content shall be increased one percent and four-tenths percent for each one-tenth percent of methane where 65 and 80 percent, respectively, of incombustibles are required.
  - (e) Mines or locations in mines that are too wet or too high in incombustible content for a coal dust explosion to initiate or propagate are not required to be rock dusted during the time such conditions prevail.

O. Arkansas

- There is nothing in the state's code.

P. Colorado

- There is nothing in the state's code.

Q. Virginia

- Va. Code Ann. § 45.1-161.235
  - Chapter 14.3. Requirements Applicable to Underground Coal Mines, Article 14. Ventilation, Mine Gases and Other Hazardous Conditions
    - (A) All underground areas of a mine, except those areas where the coal dust is too wet or too high in incombustible content to propagate an explosion, shall be rock dusted to within forty feet of all working faces, unless such areas are inaccessible or unsafe to enter or unless the Chief, or his authorized representative, permits an exception upon his finding that such exception will not pose a hazard to the miners. All crosscuts that are less than forty feet from working faces shall also be rock dusted.
    - (B) All other areas of a mine shall be rock dusted if conditions are found to be so dusty as to constitute a hazard after proper inspection. Should such conditions be found to exist, the Chief, or his authorized representative, shall require the necessary rock dusting to make the areas of the mine safe.
    - (C) Coal dust, including float coal dust deposited on rock-dusted surfaces, loose coal, and other combustible materials shall be cleaned up and not be permitted to accumulate excessively in active workings, or on electric equipment therein.
- Va. Code Ann. § 45.1-161.278 (West)
  - Title 45.1. Mines and Mining, Chapter 14.4. Requirements Applicable to Surface Coal Mines
    - (A) Where mining operations raise an excessive amount of dust into the air, water or water with wetting agent added to it or other effective methods shall be used to allay such dust at its sources.
    - (B) Drilling in rock shall be done wet, or other means of dust control shall be used.
    - (C) Loose coal, coal dust, oil, grease, and other combustible materials shall not be permitted to accumulate excessively on equipment or surface structures.

III. Additional Alternatives that are Feasible

A. Dust Explosibility Meter

B. Active machine mounted (continuous miner/road header) coal dust/methane explosion suppression System.[3] These systems are mounted on board continuous mining machines and detect the presence of a methane ignition by means of light sensors.

- The electronic signal from the sensors is used to trigger the suppression system, creating a barrier of flame-suppressing material, thus containing the flame in the immediate vicinity of the ignition and so preventing further development and the propagation of a coal dust and/or methane explosion.
- These commercial systems are widely applied in Europe.

C. Passive 'bag based' Stone Dust Barriers Systems[4]

- The new stone dust bag system in various configurations makes use of a previous concept of containing stone dust in a bag but incorporates a new method of rupturing the bag based on materials properties, relative volumes and a patented suspension device.

D. Active Explosion Barriers

- The barrier's sensors detect the presence of an explosion and deploy to drench it with water or inert dust.

E. More Rigorous Cutter Drum Maintenance[5]

- Be replacing bits and requiring the use of more water sprays on continuous miners aimed at cooling the pick path, the risk of a spark is reduced.

IV. Practices of Other Countries[6].

This section outlines the methods used by the top ten coal-producing countries to prevent coal dust explosions. [7]

- Stone Dust; [8]
- Passive and Active Explosion Barriers; [9]

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[3] G.L. Smith. and J.J. do Plessist. *Control Strategies for Coal Dust and Methane Explosions in Underground Coal Mines: current South African research and development.* Initiatives."http://www.salmm.co.za/Journal/v099n03p117.pdf

[4] *Id.*

[5] Cain, Peter. *The Use of Stone Dust to Control Rock Dust Explosions: A Review of International Practices.* http://www.msha.gov/S&HINFO/RockDusting/RokDok.pdf

[6] NIOSH had an article entitled *A Study Of Dust-Control Methods For Continuous Mining Of Coal;* however, I was unable to access the article because I was not a member of the group.

[7] http://www.worldcoal.org/resources/coal-statistics/

[8] *Guideline for coal dust explosion prevention and suppression*"http://www.resources.nsw.gov.au/__data/assets/pdf_file/0003/420267/MDG-3006-MTR-5.pdf

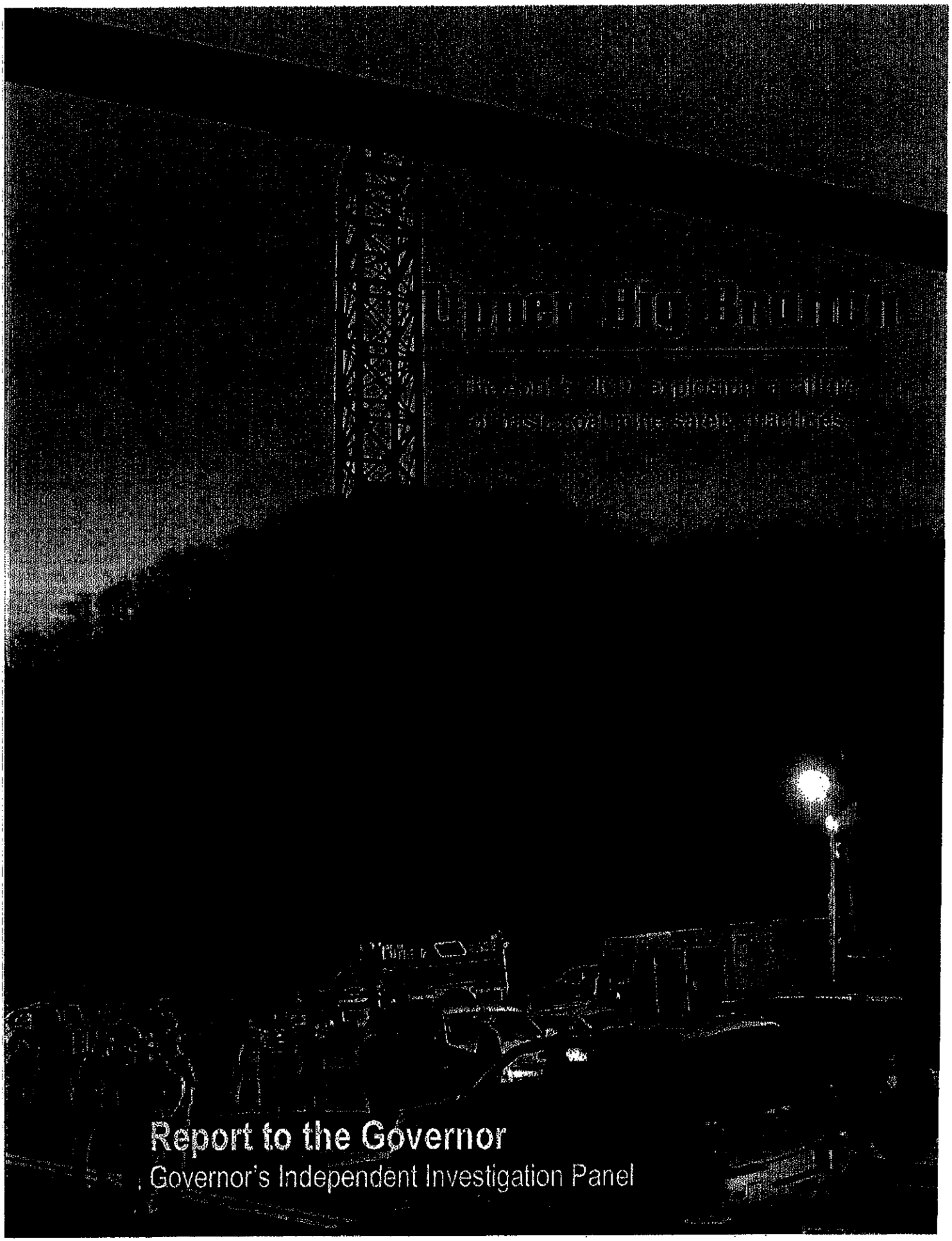
[9] *Guideline for coal dust explosion prevention and suppression*

- Active Machine Mounted (continuous miner/road header) coal dust suppression systems; [10]
- SkillPro-CSIR Bag Barrier;[11]

[10] http://www.qrc.org.au/conference/_dbase_upl/1997_spk015_Smith.pdf
[11] http://www.skillpro.com.au/index.php?option=com_content&view=category&layout=blog&id=5&Itemid=8

APPENDIX D

RECOMMENDATIONS AND FINDINGS OF THE
GOVERNOR'S INDEPENDENT INVESTIGATION
PANEL ON THE UPPER BIG BRANCH EXPLOSION
(May, 2011).



Report to the Governor

Governor's Independent Investigation Panel

Upper Big Branch

The April 5, 2010, explosion: a failure of basic coal mine safety practices

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Report to the Governor

Governor's Independent Investigation Panel

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and associates

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Deborah C. Roberts

Beth Spence

Suzanne Weise

May 2011

This preliminary report sets out the findings of our investigation and recommendations to date. The report is available electronically at http://www.nttc.edu/ubb. We will update this site with additional information should it become available. The report also is available at http://www.wju.edu

FINDINGS and RECOMMENDATIONS

Finding #1: The disaster at Upper Big Branch was man-made and could have been prevented had Massey Energy followed basic, well-tested and historically proven safety procedures.

Recommendations:

1. Require that every mine superintendent be certified by the state agency in underground mining and in carrying out the mine health and safety laws with regard to individual mines. The state agency should develop and administer an examination, including an in-mine demonstration of the superintendent's skills, as part of the certification process.
2. Require a quarterly report certifying that all safety standards are being complied with. Sanction for knowingly or negligently falsifying the report would be the revocation of the mine superintendent's certification.
3. Adopt provisions similar to those contained in the Sarbanes-Oxley Act to make a Board of Directors accountable for mine safety compliance. Boards of Directors should utilize existing health and safety committees or form a committee to oversee health and safety aspects of the mines under the company's control. The committee would be responsible for ensuring compliance with all federal and state regulations and would be required to certify that the mines are in compliance each quarter. A criminal penalty should be assessed on these board members who certify, negligently or willfully, that the mine is in compliance when it is not.

Finding #2: The Upper Big Branch mine explosion occurred because of failures of three basic safety practices: a properly functioning ventilation system; adherence to federal and state rock dusting standards; and proper maintenance of safety features on mine machinery. Although many standards have been adopted to safeguard the lives of miners, these basic systems should be the primary concern of operators and enforcement officials.

Recommendations:

4. Specifically use a "pattern of violation" and/or "flagrant violation" authority for violations of key standards designed to prevent explosions,[1] and apply meaningful sanctions, such as revoking the operator's ventilation plan. If an operator's plan is revoked for reckless or repeated behavior, he should be offered a brief period of time (e.g., five days) to make the safety case to MSHA as to why the mine's ventilation plan should not be revoked. [See "Making the Safety Case"]
5. A procedure should be adopted that would require mine operators repeatedly cited for failing to follow their own approved ventilation plan to notify MSHA and WVMHST when subsequent ventilation changes are completed and before miners are allowed back underground. Affected miners would be entitled to full compensation by the operator at their regular rates of pay and work schedule for the entire period they are idled.
6. Each mine should be required to maintain and continuously update records of the amount of rock dust purchased and the amount used daily. Failure to maintain adequate records would result in a citation with a monetary fine.
7. WVMHST and MSHA should undertake reorganization on their ventilation approval system to ensure that plans and requirements are known and understood by both the ventilation specialists as well as the inspectors.

Finding #3: 21st century coal mine safety practices have failed to keep pace with 21st century coal mine production practices. Improved technology is required to ensure that the lives of miners are safeguarded.

Recommendations:

8. "Black box" technology must be instituted for mining equipment, including shearers, continuous miners, roof bolters, shuttle cars, motors,

1 For example, 30 CFR 75.370, the requirements to develop and follow a ventilation plan approved by MSHA, that is designed to control methane and respirable dust and suitable to the conditions and mining systems in the mine; 30 CFR 75.400: the prohibition of accumulated coal dust, including float coal dust deposited on rock-dusted surfaces, loose coal, and other combustible materials, in active workings including on equipment therein; 30 CFR 75.402: the requirements for rock dusting; 30 CFR 75.403: the requirement to maintain incombustible content of rock dust.

conveyors and shields. The black boxes should provide information regarding methane, oxygen, carbon monoxide and coal dust levels.

9. Immediate implementation of a computerized, real-time electronic personnel-recording system to formally identify and locate all personnel who are underground at a given time, including supervisory personnel. Redefine the state and federal regulations to ensure that no one, including management, goes underground without a tagging device.

10. Each mine must be required to institute a "Communication and Information Recording Center" outside the underground portions of underground mines and away from the working areas of surface mines. These communications centers would provide instantaneous communication to MSHA, to state agencies, to company officials and state and county emergency management officials regarding safety and health.

11. Mine operators should be required to adopt computer-based monitoring of air quality, quantity and direction of flow throughout a mine. A suitable system would alert not only the mine operator and miners to impending danger, but it would also alert the state and federal regulatory agencies. Regulatory agencies would have the authority to shut down an operation based on data provided by the system.

12. Current monitors for methane, carbon monoxide and coal dust must be upgraded to include memory chips, as well as instant communication to the communications center.

13. Operators must be required to use real-time continuous monitoring for explosive methane gas and respirable dust in coal mines.

14. Mechanized rock dusting must be conducted in all portions of underground mines, as well as the installation of "passive barriers" to help stop ignitions from turning into large explosions, such as occurred at Upper Big Branch.

15. Operators must assess the adequacy of rock dust through direct readout explosibility meters and submit these results electronically to regulatory agencies.

16. The state inspector system for writing violations must be converted from paper and pencil to a computerized system. This system must be capable of generating reports for individual mines.

17. Electronic records should be maintained regarding methane, intake and return air levels on all coal producing sections for no less than seven years. Had this information been available, investigators would have had data related to the previous methane inundation at UBB.

18. The regulatory agencies should use ventilation simulation models as part of their plan approval and modification process. The simulation model results for each mine would be part of the mine file and available to inspectors for review before commencing an inspection.

19. Mine operators should be required to install equipment, such as seismographs, to monitor geologic activity at or near their mining operations.

20. MSHA and NIOSH should develop an approved rescue vehicle for removing injured miners safely from the mines. State and federal agencies should have a vehicle for removing injured miners and victims from a mine in a safe and efficient manner. Rescue workers should not have to carry miners great distances underground.

Finding #4: The pre-shift/on-shift examination system, established in the early 1900s to identify hazards and take corrective actions, has in many instances, become a meaningless exercise. Examiners are overly dependent on paper, and their examinations are characterized by a monotonous routine and the reliance on "dittos" and abbreviations. Moreover, evidence shows that certified foremen, mine foremen and examiners at UBB were not adequately trained to understand and perform their safety inspections and how their recognition of hazards provides essential information to assure miners' safety.

Recommendations

21. Pre-shift and on-shift examinations must be computerized with the information transmitted to regulatory agencies, much like coal truck weights are transmitted to the Department of Transportation on a daily basis.

22. The West Virginia Office of Miner's Health Safety and Training should re-double its efforts to ensure that all examiners are trained, and tested as many times as necessary, including in-mine demonstrations of their skills, to ensure the examiners understand their duties and perform them as they should be performed.

23. The West Virginia Office of Miners' Health, Safety and Training should focus training efforts on those mines in which mine operators are found to be lax on safety training. MSHA and

the state should have the authority to revoke the licenses of habitual offenders, for those who falsify records and for flagrant violations.

24. MSHA and the State agency should provide annual training to miners on their statutory rights under the Mine Act and applicable state mine safety laws. This curriculum should outline the benefits of designating a miners' representative.

25. Digital photographs from recent inspections and other appropriate visual aids should be used to demonstrate to miners, managers and inspectors acceptable and non-acceptable mining equipment and conditions.

26. Federal and state agencies should undertake an aggressive campaign to undermine the "safety myths" or inaccuracies that emerged during the UBB investigation. Agencies should dispel these inaccuracies on federal and state agency websites and incorporate "myth busters" into miners' training. A few examples of the inaccuracies that emerged during interviews with miners and bosses include:

    a) a proper air velocity reading can be taken instantaneously;

    b) a CH4 monitor on a mining machine can be disconnected if it is defective or keeps alarming, and the operator is allowed to run coal for up to 24 hours while waiting for a new monitor to be installed;

    c) a miner should not don an SCSR until he knows it's really an emergency or when a boss tells him to don it;

    d) a miner can make a run by himself, without a CH4 detector, because only a boss can be certified to carry a spotter;

    e) red hat miners can be left by themselves while a boss goes ahead of them to check for hazardous conditions.

Finding #5: MSHA and WVMHST inspectors and their supervisors are the watchdogs for mine workers. When faced with a mine operator that repeatedly ignores, evades or disregards fundamental safety regulations, federal and state inspectors and supervisors must craft enforcement strategies which match the compliance approach of the mine company. This means using all the administrative and legal authority at the agencies' disposal, and promptly elevating to supervisors any regulatory, resource or political constraints that prevent action needed to protect miners' lives.

Recommendations:

27. Existing laws and regulations must be stringently and effectively enforced. Supervisors and managers are responsible for ensuring that front-line inspectors are provided equipment, tools, training and management support to succeed at their jobs.

28. Inspectors are responsible for elevating to their supervisors problems or concerns that the inspectors believe impede their ability to enforce the law. Likewise, supervisors and district managers are responsible for elevating issues to senior officials in the agency.

29. When either state enforcement agencies or MSHA recognize a significant or persistent problem at a mine, the agencies should coordinate their responses. State and MSHA district offices should meet periodically to review problematic mines and formulate strategies to best protect miners. Cooperative efforts would maximize the effectiveness of the agencies against recalcitrant violators.

30. MSHA should use its resources, and experienced and talented personnel to bolster its ability to notice the warning signs and see the big picture at mining operations with persistent health and safety problems.

31. WVMHST should modify inspectors' work assignments to ensure that mines covering a large geographic area have an appropriate number of inspectors assigned to them, and that all mandatory inspections are completed.

32. Management and labor in the agencies must discuss and negotiate terms to provide more flexibility for the days and hours in which mine inspections are conducted. If inspectors' work shifts are extended because of travel distance to the mine or demands at the mine, it is not unusual for the employee to complete 40 hours of work by Thursday. Currently, inspections on Fridays, Saturdays and Sundays are somewhat infrequent, but should be encouraged. An effective mine safety enforcement system should be flexible enough to facilitate inspections any day of the week, at any hour of the day.

33. The current law, which states that no mine operator or anyone else should provide advance notice for federal mine safety and health inspectors, should be strengthened. Such a violation should constitute a felony.

Finding #6: Federal and state mine safety laws allow mine operators to use administrative or judicial review to avoid or delay paying citations and penalties. Mine operators know they can contest violations and tie them up in litigation for years. They also recognize that by litigating citations, the company stands a good chance of getting the fines reduced to a fraction of the original amount.

Recommendations:

34. Government officials must ensure that adjudicating bodies have the personnel and resources necessary for speedy resolution of contested citations and penalties.

35. Government officials must implement alternative dispute resolution mechanisms with appropriate means for worker involvement.

Finding #7: Miners' rights to a safe workplace are compromised when the operator's commitment to production comes at the cost of safety. Workers should not be penalized if operators fail to follow safety requirements so that miners' interests can be separated from the operator's interest.

Recommendations:

36. State and federal officials must ensure that miners are aware of the protections afforded under state and federal law. An ongoing effort should be made to re-educate miners about the existence of the MSHA hotline and the state hotline and about the protections afforded them if they report unsafe conditions.

37. When a mine is closed by a state or federal inspector's order, all affected miners would be entitled to full compensation by the operator at their regular rates of pay and work schedule for the entire period they are idled.

Finding #8: The emergency response to the Upper Big Branch disaster raised concerns about how decision-making was conducted in the Command Center and the manner in which mine rescue teams were deployed underground. Standard protocols were not followed, effective records were not kept and rescuers' lives were placed in jeopardy.

Recommendations:

38. The mining industry, MSHA, and West Virginia should adopt the National Incident Management System (NIMS) Incident Command Model, a nationally recognized emergency incident management system, to improve coordination, cooperation and communication between public and private entities.

39. Protocols should be established and followed with regard to mine rescue and recovery, using lessons learned and best practices identified from other emergency response events.

40. The one-to-one backup system for mine rescue personnel, which is already established protocol, is absolutely critical for the safety of these volunteers.

41. The mine rescue community should convene a summit of mine rescue team members, in particular, individuals who responded to the mine emergency incidents from 2006 to the present, to discuss the state of the U.S. mine rescue system. Advisory guidelines should be written for mine rescue teams.

42. MSHA and West Virginia should require a digital recording of the activities and communications in a mine emergency command center. Briefings and debriefings of mine rescue team personnel also should be recorded. The current paper and pencil method fails to produce a thorough record of key data and decision points. Such a record is necessary to conduct a thorough investigation, assess the effectiveness of existing mine rescue operations and contribute to training curriculum for advanced mine rescue personnel.

43. Mine operators' emergency response plans (ERPs) must be treated more than just more paperwork. ERPs should be developed collaboratively with miners, their families, local responders, and mine rescue team members, and revised based on mine-specific drills and table-top exercises.

Finding #9: Investigations of major mining disasters must be conducted in an open, independent and transparent manner that inspires public trust in the fact-finding process and the conclusions that are reached.

Recommendations:

44. The U. S. Department of Labor should adopt a public investigation process for major mine disasters. Procedures should be established to provide for public hearings, including interviews of witnesses.

45. If the investigations continue to be under the MSHA's direction, the agency should have subpoena power to compel witnesses to appear to testify under oath and for companies and individuals to produce evidence, including documents, data, correspondence and physical evidence.

46. Explicit rights should be provided to any individual who is willing to speak with or provide a statement to MSHA, the state agency or the independent panel during an accident investigation, to do so without the presence, involvement or knowledge of the operator or the operator's agents or attorneys.

47. Rights should be granted to a deceased miner's immediate next-of-kin to name an individual to serve as a miners' representative in such investigations.

48. A coordinated, formal debriefing of all mine rescue team members who respond to a major mine emergency should be conducted within a month of the event. The objectives of the assembly would include offering counsel on post-traumatic stress, discussing what worked well and what didn't in their mine emergency response, and identifying team members whose testimony would be helpful to accident investigators.

Finding #10: Testimony from UBB miners indicated that the SCSR training they received was not effective in educating them about the practicalities of donning the device in a potential emergency situation. Miners at other operations also may not be receiving effective training.

Recommendations:

49. SCSR training should be realistic and conducted in actual mining situations, such as riding in a mantrip and working on a longwall. It should incorporate a variety of actual in-mine scenarios for which the SCSR must be donned and activated. The training should emphasize the importance of activating the SCSR at the very first warning of an emergency.

50. SCRS training should be conducted quarterly, instead of annually.

51. MSHA, WVMHST and NIOSH should develop a program to measure and evaluate the effectiveness of training provided by certified trainers.

Finding #11: The prevalence of coal workers' pneumoconiosis among the deceased Upper Big Branch miners is both surprising and troubling.

Recommendations:

52. WVMHST, NIOSH, MSHA and the mining industry should adopt before the end of 2011 rules to: reduce the permissible exposure limit (PEL) for coal mine dust to 0.09 mg/m^3; reduce the PEL for crystalline silica to 0.05 mg/m^3; and mandate continuous dust monitoring, verification of mine operators' dust control plans at normal production (e.g., at least equal to the average production recorded for the most recent 30 production shifts), and single-shift sampling.

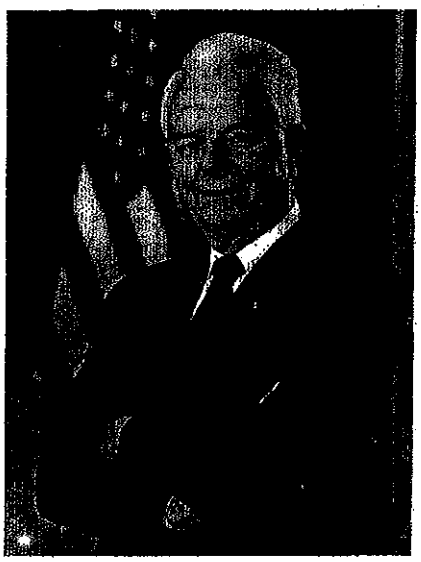
United States Senator Robert C. Byrd
November 20, 1917 – June 28, 2010

Senator Robert C. Byrd served West Virginia in the United States Senate from 1959 until his death in 2010. He was the longest-serving senator in the history of the United States Congress.

In one of his last commentaries, Senator Byrd lamented the loss of the 29 miners in the Upper Big Branch disaster.

"Reflecting on President John F. Kennedy's death, Robert F. Kennedy once said, 'Tragedy is a tool for the living to gain wisdom,'" he wrote.

Senator Byrd also said, "As West Virginians, our birthright is



coal... Coal brings much-needed jobs and revenue to our economy. But the industry has a larger footprint, including inherent responsibilities that must be acknowledged by the industry.

"First and foremost, the coal industry must respect the miner and his family. A single miner's life is certainly worth the expense and effort required to enhance safety.

"The old chestnut that 'coal is West Virginia's greatest natural resource' deserves revision. I believe that our people are West Virginia's most valuable resource. We must demand to be treated as such."