AMERICAN MINING CONGRESS

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December 19, 1990

Richard W. Niemeier, Ph.D.
Director
Division of Standards Development
and Technology Transfer
National Institute for Occupational
Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati, Ohio 45226-1998

Dear Dr. Niemeier:

Re: Draft "Criteria for a Recommended Standard: Prevention of Pneumoconiosis in Surface Coal Miners."

Enclosed for your consideration are the comments of the American Mining Congress (AMC) on the above-referenced draft document prepared by the National Institute for Occupational Safety and Health (NIOSH). We appreciate the opportunity to participate in the peer review process on science policy issues that affect our industry.

For ease of understanding, we have divided our comments into three sections. The first section contains general comments, the second section contains specific comments and the third section contains responses to questions posed in your transmittal letter dated August 15, 1990. Although we have divided our comments into sections, they should not be considered in isolation but as a whole.

The enclosed comments reflect the collective experience and expertise of the safety and health professionals from our member companies. We hope our assessment of the completeness of the information NIOSH has gathered and the soundness of your interpretations of the data prove helpful. Incorporation of our comments in any final policy recommendation <u>will</u> help us attain our mutual goal of protecting the health of the nation's surface coal miners.

Should you have any questions or comments on this matter, please contact AMC Senior Counsel Mark Ellis at 202/861-2860.

Sincerely,

John A. Knebel
President

Enclosure

APPENDIX 1

Comments of the American Mining Congress
on the National Institute for Occupational Safety and Health
Draft Criteria Document Entitled,
"Criteria for a Recommended Standard:
Prevention of Pneumoconiosis in Surface Coal Miners."

Introduction

The American Mining Congress (AMC) appreciates the opportunity to participate in the peer review process of the draft document entitled, "Criteria for a Recommended Standard: Prevention of Pneumoconiosis in Surface Coal Miners," prepared by the National Institute for Occupational Safety and Health (NIOSH). AMC has a continuing interest in the well-being of the Nation's surface coal miners, as is partially evidenced by our comments on this draft and a predecessor document. We are disappointed that NIOSH has not focused its efforts on populations at risk as suggested in our earlier comments on its draft recommendation for an X-ray surveillance program (Attachments 1 and 2). Our basic conclusions remain unchanged:

- NIOSH has not demonstrated an increased risk of pneumoconiosis in the general surface coal mining workforce;

- While there may be a limited number of occupational categories of surface coal miners at slightly increased risk for developing silicosis, NIOSH has not demonstrated that a general medical surveillance program for surface coal miners is warranted; and

- Mandated medical surveillance of all surface coal miners is viewed by industry as a misuse of scarce occupational health resources.

With this historical background in mind, we offer the following comments on the most recent draft recommendations regarding medical surveillance of surface coal miners.

General Comments

Before providing direct comments on the proposed medical surveillance system for surface coal miners, it is instructive to at least briefly review and describe the current medical surveillance system now in force relating to underground coal miners.

The current medical surveillance program is not limited to underground coal miners, but also covers surface workers at underground facilities. The mandatory program covers any miner working in or at any underground coal mine, but specifically does not include any surface worker who does not have direct contact with underground coal mining or with coal processing operations. See 42 CFR § 37.2(g).

Thus, it seems possible that the proposed recommended standard is somewhat redundant and double-covers certain individuals. While this is not a major problem, definitions do need to be specified more tightly.

By way of background, several key provisions of the current regulations might be summarized as follows:

Miners are eligible for chest radiographs, as follows: a) pre-employment or within 6 months of starting coal mining; b) the next one at 3 years; and c) thereafter every 5 years unless pneumoconiosis is detected and then one is eligible on a shorter time interval.

If pneumoconiosis category 1/0 or greater is detected, then the miner can opt to transfer to an area of the mine where less than 1 mg/m^3 of dust exists or to the lowest dust area which can be achieved. A potential problem area exists here as it relates to what constitutes a definitive interpretation of pneumoconiosis. It was realized long ago (by some) that extreme variance in radiographic interpretations can and does exist when the profusion of small lesions are in the area of International Labour Organization (ILO) profusion 0/1 and 1/0. Yet individuals (under the enforced definition of what constituted a definite interpretation of pneumoconiosis) with a sequence of readings of 0/1 and 1/0, or in reverse order 1/0 and 0/1, were still being given a transfer right. In 1987, a regulatory change went into effect. The change demanded that these individuals not be automatically given a transfer right, but that there should be additional interpretations to insure that in fact they had some (at least minimal) degree of pneumoconiosis.

At least two radiographic interpretations are obtained, from an A and B reader or from two B readers. Definitions relating to A and B readers are in the regulations. Issues relating to reader competence, performance and availability are points covered later in these comments as the recommended surface coal mine standards are impacted heavily here.

Miners are also notified of other conditions. Their private physicians are too if so designated. Many physicians have complained that too many ordinary conditions are reported -- which they are well aware of anyway -- and this seems to take up valuable time of the physician, cost excess money to the government and taxpayer, and last but not least create unwarranted anxiety for the miner who was examined. Great care should be taken relating to exactly what is reported to whom.

There has never been follow-up or quality control regarding certification of facilities, X-ray equipment or personnel providing examinations. In reality, one does not know that in fact a particular physician or technician is certified to do the work. Information from facilities regarding individuals who will administer the program, take the X-rays, and give them an initial interpretation (presumably an A reader) is taken at face value without even a routine check. The same goes for the equipment which is listed. It is really unknown if even minimum specifications which are noted in the current regulations are met. In short, there is absolutely no quality control on either of these factors. As an example, it would be an easy chore to borrow equipment belonging to someone else and take 6 ordinary chest films plus a shot of a plastic step wedge (which is required) and submit these to NIOSH so as to become certified. Afterwards, one could then go about the business of taking X-rays in nearly any manner using outdated and even dangerous equipment.

Coupled with the current X-ray surveillance program for underground (and other) miners, NIOSH operates another program in concert with the American College of Radiology (ACR). In part, the program relates to the certification of doctors interpreting radiographs for the pneumoconioses. Two types of certification are involved; the first relating to becoming an A reader. This is accomplished by the doctor attending a course sponsored by the ACR on the subject and then merely making application to become an A reader. This is rather automatic. In addition or otherwise, a doctor may take an examination (from NIOSH) and if a passing grade is made, he/she becomes a so-called B reader. The latter is presumed more proficient than an A reader. Many physicians may become a B reader but be far from proficient because the quantity of chest films reviewed routinely is very small. On the other hand, many well qualified physicians fail the examination as they are not aware of the criteria on which they are being scored, most of which relates to classification versus interpretation of small shadows. In the "real" world, while a radiologist or other physician may in fact be quite competent, interpretations may depart dramatically from reality for economic and other reasons. Extreme variability seems the norm in this program and there is no ongoing method of quality control. It is not the case that the recertification examination given every four years is a suitable form of quality control. In and of itself, the teaching and training of doctors to be proficient in interpreting chest films for the pneumoconioses is worthwhile. The program, however, has grown beyond its intended bounds. The cost (direct and indirect) of administering this program which is connected to the NIOSH X-ray surveillance system for underground miners is indeed not trivial and amongst other items includes an annual contract (or renewal thereof) with the ACR in order to give it credibility. It is common knowledge that while the B reader program is coupled to and came about because of the X-ray surveillance program for underground coal miners, doctors who wish B reader certification may have "other matters" in mind. One might ask whether the government should be involved in such certification at all. Perhaps this type of activity should be the province of a professional society.

The MMWR, Vol. 34, NO. 1SS (pp. 33SS - 37SS), stands as an admission that the current X-ray surveillance program does not work. The Institute should be given credit for this self-criticism. Participation in all rounds of examination is extremely poor. Miners who do participate in a given round of examinations are the ones at least risk, i.e. those who as yet have no underground experience. Most of the X-rays received by NIOSH for evaluation are from workers with 0-4 years in mining and an undetermined number of these are pre-employment examinations involving individuals who in fact were not hired. In a 10 year period, 9800 miners were eligible to transfer to low dust situations but only 1700 exercised this option. At the end of the 10 year period, only 500 (who transferred) were still employed in coal mining; so-called Part 90 miners. Today, there are only 105 coal miners who are active Part 90 miners. Miners (today) who have a transfer option plainly do not exercise it because they become what is known as "letter carriers" and this status is used as super seniority to bid on jobs and for recall from lay-offs. Other reasons for not exercising a transfer option relate to mistrust (of the government, as well as industry). While a denominator is elusive, it is estimated that participation of working miners (excluding the pre-employment examination) has gone from 50% to 44% to 32% over three rounds of examinations. Today, the situation is even worse -- in the past few years, between 3,000 and 5,000 chest radiographs have been processed per year and this includes the pre-employment examinations. Once a miner is examined, the likelihood of repeat examinations so that an individual can be tracked is minimal. NIOSH indicated "that miners tend to participate initially because they are required to as new employees but do not continue participating in the program" -- for whatever reason. Clearly, the primary purpose of the program is to protect the health of the miner and in this regard it fails totally. Such information is indeed questionable for research purposes as it represents a very select group of volunteers and is clearly not representative of the underground coal mining work force. Participation in this program was somewhat successful at its inception, but since has dwindled to near nothing. Without question, and NIOSH itself makes the statement, this particular surveillance program has not met its objectives and it is 20 years old. Here we have a group (mostly underground miners) at potentially greater risk than most surface workers and NIOSH wishes to now include the surface workers in a parallel program which clearly does not work and gives little to no benefit to miners, industry or the taxpayer.

Time and again, the issue of including surface coal miners to the current regulations has come up with NIOSH's Mine Health Research Advisory Committee (MHRAC) (and other groups) and each time the recommendations have been the same -- either NO or the matter was tabled pending further research. Moreover, there have been prior MHRAC and other meetings relating to adding to the underground surveillance program pulmonary function testing and each time the same answer has been heard -- essentially NO -- as one would for the most part be measuring pulmonary performance which would reflect the aging process and the vices of life such as cigarette smoking. NIOSH is now suggesting that the proposed surface miner surveillance program include pulmonary function testing. In addition, NIOSH is requesting that a part of the new surface mining surveillance regulations should include a respiratory disease questionnaire. How is it to be administered -- by the miner himself or by a trained interviewer? These procedures are not even included in the underground surveillance program. What justification exists to include pulmonary function testing and the administration of a respiratory disease questionnaire to a group of individuals who (with the exception of drillers) are at less risk of disease than workers now engaged in a current surveillance program? There seems to be no reasonable justification.

The current underground X-ray surveillance program is plagued with problems and the objectives of the program are largely unmet. The direct and indirect costs associated with the program are indeed staggering. Now, in a time period when the federal budget deficit is a concern, NIOSH wishes to expand the program to surface workers and even add procedures for this group which are not now included in the underground program. Perhaps, a next step would be to include these procedures in the underground X-ray surveillance program too.

It seems that a major concern regarding the health effects of surface coal miners relates to potential silica exposure. Thus, some general words on the subject of the proposed 50 ug/m^3 "standard" are applicable. Added to this recommended exposure limit is the continuing controversy of whether or not silica or the fibrosis produced by the dust is a precursor, a carcinogen, a co-carcinogen or a promoter. By NIOSH's own admission, the early work from the Vermont granite sheds figured most strongly into their decision regarding an REL of 50 ug/m^3. The more recent update of this information by Graham which was published in the American Review of Respiratory Diseases clearly demonstrates that the early Vermont granite shed work is clearly of the wrong caliber to use in setting standards. Also, the World Health Organization (WHO) recommendation of 40 ug/m^3 suffers from the same shortcomings. However, the definitions with which the WHO was dealing were somewhat different than NIOSH's and involved the concept of "health based exposure limits"; i.e. the point below which there would be no disease occurrence. Both NIOSH and WHO reviews involve more than a scientific process and their recommendations are thus based to a large degree on what they consider constitutes a prudent public health stance. Regarding incident cases of silicosis, 100 ug/m^3 is quite protective; i.e. if actual compliance with the 100 ug/m^3 standard is achieved. For example, the experience in the Australian hard rock mining industry involves little to no incident cases of silicosis and this is related to a standard of 200 ug/m^3. Compliance and dust control is the answer rather than routine biological monitoring -- especially with individuals (surface coal miners) who have little to no risk to begin with. Were the silica/silicosis/cancer issue a proven theory, surely there would be those subscribing to the "one grain of sand" point of view -- much like the "one fiber" theory. Such is not the case. The arguments are clearly not scientifically solid and those suggesting silica to be a carcinogen or a likely one are basing their reasoning (again) largely on a conservative public health stance. To name a few, the work of Heppleston, McDonald, and the CMA Chemstar Panel is instructive reading on this subject. Moreover, the marvelous review on occupational lung cancer by Sir Richard Doll is also helpful. He reasoned that there were at least two occupational groups which seemed to be absent the risk of lung cancer; the first being workers with an exposure to diesel and gasoline fumes and the second being workers exposed to silica and thus with a risk of silicosis.

The concept in the proposal of pulmonary function testing (spirometry) for surface workers is indeed questionable. The same reasons can be advanced as why not to do it as have been put forth regarding the underground miner surveillance program. The literature is replete with information showing that the mechanics of breathing are not associated with stages of simple coal workers' pneumoconiosis; and of course the pneumoconiosis can be taken as a biological marker of dust exposure. Some would argue that pneumoconiosis is a response to the dust (and indeed it is) and argue further that one must review spirometric results versus actual dust exposure irrespective of pneumoconiosis. In this regard, a review of the work of Rogan et al. and Morgan et al. is appropriate. Both showed that indeed dust irrespective of stage of pneumoconiosis had an effect on spirometric results but the exceedingly small decrements shown were overshadowed by the dramatic effects of aging and cigarette smoking. Moreover, Morgan et al. and others have shown in numerous articles that such small changes were insignificant and rarely if ever would they lead to meaningful impairment, let alone disability. Some rely on the results of the early Vermont granite shed studies, but the more recent update of Graham showed the original pulmonary function studies to be in error and that rather than the workers experiencing decrements (as predicted from the original work), their pulmonary performance actually increased -- and this occurred in the face of them getting several years older. The only critical work relating to surface coal miners which considered the mechanics of breathing was by Fairman et al., Cornwell and Hanke, and Amandus et al. In the first two studies, no effects were noted other than relating to cigarette smoking. The work by Amandus et al. is more complete but shows mixed results. Only for drillers was there a decrement in the forced expiratory volume in one second and this amounted to around 18/1000 ths of a liter/year of drilling. This translates to a loss of one liter in around 56 years of work. On the other hand, Amandus et al. showed no changes whatsoever relating to work in coal cleaning plants or other surface coal mine jobs. Pulmonary function testing for surface coal miners as a whole is thus without justification.

To suggest the administration of an MRC-type respiratory symptom questionnaire for surface coal miners is likewise questionable. For the types of exposures one is dealing with for these types of workers, the cough, phlegm and dyspnea will be related to non-occupational factors. It is unclear for what the responses would (or even should) be used. The research value of such data would be quite limited if one considers that the participation in such a program would parallel the voluntary surveillance program for underground coal miners (with all of its biases). While the proposed surveillance is inappropriate, there is a conspicuous absence of an expanded work history, an informed consent section, and the collection of information on tobacco usage.

Specific Comments

Page iii of Foreword -- "This document recommends an environmental and medical surveillance program for surface coal miners, including workers at surface sites of underground coal mines." First, as noted earlier in these comments, there seems to be some redundancy here. The current program for "underground" coal miners includes some surface workers. From this page of the forward section of the proposal, one gets the idea that surface miners in a general context are to be covered. However, the periodic medical examination criteria for eligibility noted on page 8 appear different. While the criteria on page 8 seem specific, they in fact can be interpreted broadly to include the entire work force.

Most surface mining operations are small. NIOSH's past experience with small underground operations is worse than their general performance -- e.g. participation at these types of operations has essentially been nil.

It is instructive to review notes from prior deliberations of the MHRAC subcommittee on X-ray surveillance. They note that participation rates have been steadily declining, quality control is lacking, they have voiced continued concerns regarding an effective program of health education which needs expansion, and have indicated that pulmonary function evaluations might perhaps be the province of the miners' personal physicians. One particular recommendation made by the subcommittee is enlightening; i.e. "in view of the problems surrounding the (current) surveillance program for underground miners, it would appear the energies should be first directed to this program (rather than towards surface coal miners)."

Pages 1 - 2 -- NIOSH claims that their document demonstrates that silicosis is a health threat to surface coal miners. This is plainly not the case at all. The relevant literature suggests that a particular occupational job class (drillers and driller helpers) at surface coal mines jobs may have an increased risk of developing silicosis. This does not seem to be the case with other surface coal mining jobs or jobs in or at coal preparation plants. Drillers and driller helpers may indeed have an increased risk of silicosis, but medical surveillance will not solve or prevent this problem. However, keeping silica dust levels within the currently existing standard will.

"In 1988, NIOSH recommended that crystalline silica be regarded as a potential occupational carcinogen...." While NIOSH apparently has already determined that silica is a carcinogen, a re-evaluation of the scientific literature (as noted earlier) would be instructive. This proclamation is clearly not scientifically based.

In addition, this draft document (in several instances) utilizes the potential carcinogenicity of silica dust as the basis of regulating surface coal mine exposures. The references to IARC, NTP and others are quoted to support these conclusions. Yet recently, this same agency proposed a study, "A Study of Mortality of U.S. Metal Miners, 1959-1990" (which incidentally was a misnomer), to prove the hypothesis that fibrosis was a precursor to lung cancer. We suggest that it is premature for this draft criteria document to address the cancer issue.

Page 5 -- Workplace Environment

(a) An REL of 0.05 mg/m3 for respirable crystalline silica was previously suggested by NIOSH in 1974 and during testimony at a hearing on a proposed rule of OSHA on air contaminants NIOSH recommended that crystalline silica be regarded as a potential carcinogen. The data necessary to support this concept was not, and is still not, available. Supporting a change of the quartz standard to the lowest concentration achievable is certainly premature without the supporting evidence. The first, and last, NIOSH recommendation directly related to quartz in coal mines was in 1972.

(b) Neither recommended sampling or analytical method is presently used in enforcing 30 CFR 71. The differences in opinion as to the most appropriate flow rate, 2.0 or 1.7 liters per minute (l/m) that results in respirable coal mine dust meeting the ACGIH size selection criteria have never been decided. Researchers such as Lippman have stated that 1.7 l/m through the 10 mm nylon cyclone best approximates the ACGIH size selection curve. However, his evidence also shows that the 50% inflection point of the penetration curve, 3.5 um, is best met when 2.0 l/m is used. Actually, the difference in flowrate is insignificant as reported by Treaftis.

A major problem with sampling the respirable mine dust with personal samplers operated at 1.7 l/m is that there is no correlation with MRE sampling and therefore equivalent concentrations cannot be reported to the mine operators and the miners as well as enforcement as required by law.

The use of NIOSH methods 7500 and 7602 or their equivalents for quartz is unnecessary. The MSHA has been using their method P-7 which has a detection limit of 0.01 mg quartz with a range of 0.025 to 0.250 mg. The analysis can be performed on a single sample having a weight gain of 0.50 mg or more (0.50 mg dust having 5% quartz contains 0.025 mg quartz).

Pages 5 - 7 -- <u>Exposure Monitoring</u>

(a)&(b) In accordance with 30 CFR 71.101 and 71.201, a miner's exposure to respirable coal mine dust containing quartz is sampled by the mine operator. Additional sampling is conducted by MSHA.

Is NIOSH recommending that each miner be sampled or that the exposures of all miners be determined using the NIOSH recommended strategy in addition to 30 CFR 71.101 and 201?

(c) Reduction of sampling frequency to every six months when consecutive samples contain below 0.014 mg/m^3 quartz is an admirable recommendation. This means that a change in sampling frequency would be implemented when the quartz content of a respirable dust sample contained less than 2.5 percent quartz. This is half the mandated level of action taken when the quartz content exceeds 5.0 percent. Furthermore, most laboratories could not conform to this degree of accuracy.

(d) Miners should be notified when their validated exposure to dust and quartz exceeds allowable levels. In fact, they should be kept aware of their cumulative dust exposure at least on an annual basis.

In order to achieve this, each miner's exposure as measured by initial and periodic sampling must have a personal identifying number or its equivalent marked on each sample. This system would be similar to the 30 CFR 70 sampling conducted prior to the deletion of the individual miner's identifier (SSN) from the sample card. Without an identifying mark on each sample, there is no valid way to relate exposure of the individual miner without also requiring the mine operator to log location and time each miner spent at the sites relative to those sampled.

(f) If the individual identifier concept outlined in (d) is implemented, the mine operator can provide miner exposure results to the medical facility. Dust exposure levels then can be correlated with the miner's medical records. The exposure of each miner or groups of miners working at the noted site would then be available for evaluating cumulative dust exposures.

The increase in paperwork for the mine operator, MSHA and for NIOSH to accomplish the goals of the recommendation may require clearance from OMB for the sample card as well as for other documentation. Once the dust exposure data becomes part of the miner's medical record it is covered by the confidentiality criteria.

Pages 7 - 12 -- Medical Surveillance -- For the most part, this has been covered earlier. Reading the activities in which NIOSH wishes to become involved, it appears that they wish to turn this surveillance activity into a "research" project. The procedures and tools recommended are precisely what one would use in a general research project relating to respiratory disease. These procedures are just not applicable to a surveillance activity conducted to determine occupational exposures. Moreover, the absence of risk for surface coal miners does not justify the initiation of the program. Furthermore, as noted earlier, if the results coming from the initiation of such a new program even closely parallel the results from the underground miner surveillance program, the data would be of minimal use for research purposes. NIOSH seems to consider pulmonary function results which fall below some pre-determined level (LLN from Knudson's equation) as being "abnormal" (page 11). A certain percentage of the so-called normals evaluated by Knudson himself had values as low or lower than the specified cut-off. Is one to likewise believe that individuals with values as high or higher than the upper limit specified by Knudson should be considered super-healthy? Few would disagree that a low value might be justification for referral to a physician for further evaluation but that, in and of itself, does not indicate that the person is abnormal.

Active tuberculosis is uncommon to nonexistent in the coal mining population of the U.S. While the silicosis-tuberculosis connection has been demonstrated, the small number of (reported) incident cases of silicosis in the mining industry coupled with the virtual non-existence of tuberculosis in the coal mining industry does not set the stage for routine tuberculin skin testing.

Page 13 -- Engineering Controls and Work Practices -- This section notes that the mine operator shall apply engineering controls and work practices to maintain miners' exposures below the exposure limit. Which limit? NIOSH needs to specify the appropriate limit (0.05 mg/m^3, 0.014 mg/m^3, their MRE equivalents, some future new instrumentation detection limit, etc.).

Pages 13 - 15 -- Respiratory Protection -- This section flies in the face of MSHA's currently proposed regulations on "Air Quality, Respiratory Protection and Hazardous Chemicals." MSHA is currently in rulemaking on this issue. Due process is in progress and should be completed (not duplicated) as this draft proposes.

Pages 16 - 17 -- Informing Miners of Hazards -- This recommendation is totally unnecessary and purports to revise 30 CFR Part 48. One does not need to keep duplicating what is already mandated. Mine operators are required to train (and periodically re-train) individuals regarding workplace hazards. If anything should be added to a continuing education program for miners, it should relate to lifestyle habits which can have deleterious effects on health. Those additions, however, should be instituted through the now-in-force MSHA regulations regarding miner training and not be tied to this NIOSH proposal.

Pages 17 - 18 -- Sanitation -- These provisions currently exist in 30 CFR and do not need to be rewritten.

Pages 18 - 19 -- Recordkeeping -- This section is a duplicate of the current MSHA proposed Air Quality regulation with two notable exceptions: (1) NIOSH will maintain all medical records (mine operators are specifically prohibited from direct access, which may prevent them from taking remedial action at the earliest time); and (2) the marked absence of employee's "Duly Authorized Representative" and subsequent definition leave too many opportunities for mischief. There is no need to retain exposure monitoring records for the duration of employment.

Pages 20 - 21 -- NIOSH notes that this recommended standard for surface coal miners is appropriate for several reasons: (a) It should be considered separately from underground coal miners. Why? Aren't the presumed adverse biological effects of silica the same regardless of your place (or the nature) of your employment? (b) The CWXSP Program did not include (all) surface coal miners. Why? Congress did not see the need for such a program. (c) Medical studies have documented radiographic evidence of pneumonoconiosis in surface coal miners. This matter is discussed more fully below. (d) MSHA exposure data indicates potential exposure to high concentrations of respirable silica in certain surface coal mine occupations. Again, there is serious question as to the representative nature of MSHA data in that it was often developed during periodic "problem situations" and may therefore be considered technically biased.

Page 37 -- NIOSH notes that in order to obtain the required relatively high filter weight "gain," MSHA "composited" different samples from a mine to achieve the weight required for the analysis. The reason "composite" samples had to be employed during the 1970's and earlier 1980's was due to a lack of technology for analyzing minute samples collected with the mandated 30 CFR devices. While "average" quartz content for respirable coal mine dust samples collected at the given mine might be assumed to be relatively constant from highwall to highwall, NIOSH must reliably identify specific occupations at risk based upon validated exposure samples, etc. Respirable dust samples collected for other surface coal mine occupations typically would be at such low levels that the quartz content would be minute.

Page 54 -- One might ask, what is the nature and mechanism behind the decreasing respirable quartz concentrations and the percent exceeding comparative standards, based primarily on MSHA samples? Perhaps existing regulation in the form of engineering and administrative controls is working.

Pages 58 - 59 -- NIOSH suggests that MSHA samples provide an estimate of long-term exposure. This simply is not true. Six years hardly constitutes a long-term view of any occupational exposure issue. Page 59 notes that less than one quartz sample (inspector) per mine has been taken each year since *1983*. This sampling frequency is simply not adequate to suggest that respirable quartz exposure is a problem at all surface coal mines, for all occupations, at all times. It is certainly not consistent with NIOSH's own sampling proposal in this draft document. This inherent "weakness" in the NIOSH argument surfaces on page 59: "This extremely low frequency (of inspector samples per operating mine) adds uncertainty to the representativeness of the quartz data." Why propose a standard based solely on "possibilities?"

Pages 68 - 84 -- Relevant studies relating to surface coal miners are noted in the listing below. For the most part, NIOSH bases their case for a broad-based surveillance program for surface coal miners on a sampling from this listing:

(1) Respiratory Status of Surface Coal Miners in the United States, Fairman et al., Arch Env. Hlth, Vol. 32, 1977.

(2) NIOSH HHE MTA 80-117, Banks et al., (No Date, early 1980s).

(3) Silicosis in Surface Coalmine Drillers, Banks et al., Thorax, Vol. 38, 1983.

(4) NIOSH HHE HETA 82-112/113/114, Cornwell and Hanke, 1983.

(5) A Re-evaluation of Radiological Evidence from a Study of U.S. Strip Coal Miners, Amandus et al., Arch Env Hlth, Vol. 39, 1984.

(6) Dust Exposures at U.S. Surface Coal Mines in 1982-1983, Amandus and Piacitelli, Arch Env. Hlth, Vol. 42, 1987.

(7) NIOSH HHE MHETA 87-173, Cornwell, 1987.

(8) Health Status of Anthracite Surface Coal Miners, Amandus et al., Arch Env. Hlth, Vol. 44, 1989.

(9) Respirable Dust Exposures in U.S. Surface Coal Mines (1982-1986), Piacitelli et al., Arch Env. Hlth, Vol. 45, 1990.

A summarization of results from these studies follows (item numbers are keyed to the above references).

(1) Four percent of surface miners had pneumoconiosis. Most had worked previously for prolonged periods in underground operations. Pulmonary function decrements occurred only amongst smokers. The association between chronic bronchitis and cigarette smoking was obvious and dramatic, but there nonetheless seemed to be a modest increase in the prevalence of chronic bronchitis with years of exposure within age groups and smoking status. This relationship did not hold up however for the long-tenured miners. Marked airways obstruction was obvious amongst the miners who smoked cigarettes and was not so common amongst the non-smokers.

This study argues against X-ray surveillance of surface miners. As for the mechanics of breathing and symptoms, this study clearly indicts cigarette smoking as the primary factor to consider.

(2) Ten workers with drilling experience and 60 other surface workers were examined. No pneumoconiosis was found

amongst the 60 non drillers. Pulmonary function results were not reported for the non drillers but it can be assumed that they were normal; otherwise it would have been noted. Three of the 10 drillers had evidence of silicosis. One case was acute silicosis, rapidly progressing to PMF, which developed with less than 5 years exposure and resulted in death 26 months after diagnosis. As would be expected with acute silicosis and its complications, severe pulmonary impairment was also involved. The onset of acute silicosis is believed related to massive exposures over a short time period. The other 2 cases were simple silicosis with no pulmonary function limitations noted. Both of these cases also reported relatively short exposure times (4 and 6 years). Regardless of environmental measures taken, clearly these cases would have had high level silica exposures.

This study argues that workers with drilling experience may (and do) have a risk of developing silicosis. Compliance with existing standards, however, and not overall medical surveillance of an industry can provide the necessary remedy. The expected severe pulmonary impairment for the one case with acute silicosis is not justification for performing across-the-board spirometric evaluations of an entire industry. This work argues against there being a risk of silicosis amongst surface workers other than drillers.

(3) This study is basically a peer reviewed publication of #2 above. In addition, it is noted that the earlier Fairman et al. work overlooked the fact that a major proportion of the pneumoconiosis occurring amongst surface workers involved drillers who comprised only a fraction of the workforce.

This study argues that there is an increased risk of occupational lung disease amongst surface coal mine drillers.

(4) Examinations were performed at 5 surface coal mines to evaluate the respiratory status of highwall drillers. A total of 88 drillers and 85 non-drillers were involved in the analysis. A sizeable group of both drillers and non-drillers were not included in the analysis because of past work histories involving underground work, welding, etc. No differences in spirometry was observed between the drillers and non-drillers. Overall, 6 cases of pneumoconiosis was found; 2 of the cases were in the group analyzed, one a former driller and the other a mechanic with long tenure. The other four cases were in the group excluded from the analysis owing to past exposures; 3 of these 4 had relatively long prior underground mining experience.

In this study, no marked excess disease was found which related to currently employed surface coal mine highwall drillers. Thus, these results do not support NIOSH's proposal for a broad-based surveillance activity for surface miners.

(5) A re-evaluation of the Fairman et al. work was performed with a view towards determining risk of category 2 or greater pneumoconiosis: a) overall; b) amongst miners with no previous underground exposure; c) between bituminous and anthracite workers; and d) amongst drillers. Five of the 8 cases of category 2 or greater pneumoconiosis had significant prior underground work experience -- presumably at a point in time when exposures were excessive. Amongst workers with no underground experience, category 2 or greater pneumoconiosis was more prevalent in anthracite than bituminous strip mines. The prevalence of any category of pneumoconiosis amongst drillers with more than 10 years drilling experience was 12.8% and amongst drillers with less than 10 years drilling experience the prevalence was 1.6%. The prevalence of pneumoconiosis for non-drillers was 0.8%.

Clearly, this study points to a potential problem with surface drillers. Other workers, especially those with prior underground experience who were classed as having pneumoconiosis, were exposed (in the past) to excessive levels -- before appropriate standards were in place and enforced. It is inappropriate to extrapolate these data as showing an overall problem in the anthracite region. First, only one mine was involved. Second, one of the workers with category 2 pneumoconiosis was a driller. This study argues for concern regarding highwall drillers and little more. Data involving symptoms and pulmonary mechanics are not involved in this report, thus it does not support (nor refute) their use for surveillance activities -- for surface coal mine workers or others. There is no justification on the basis of this work to perform overall surveillance of an entire industry -- the vast majority of which is not at risk of pneumoconiosis.

(6) MSHA and operator samples for respirable dust and quartz for surface coal mines for 1982 and 1983 were analyzed. Average respirable dust was below the 2 mg/m^3 standard and most surface coal mine jobs showed the average quartz concentrations to be less than 100 ug/m^3. On the other hand, quartz exposures for drilling jobs were excessive and this was marginally the case for bulldozer operators. While there seems to be marginal elevations in quartz exposures for the bulldozer operators, no documentation exists elsewhere regarding elevation of silicosis rates amongst this job classification. Thus, on the basis of these data, it would be premature to classify bulldozer operators at significant risk. On the other hand, these data are consistent with other reports showing an elevated risk of silicosis amongst workers with jobs in highwall drilling.

This study supports the contention that drillers and driller helpers are at risk of developing silicosis. A review of the concentrations measured (340 ug/m^3 to 490 ug/m^3) is an indication of the problem. Clearly, control of quartz exposures and enforcement of the existing standard should remedy this problem.

(7) An environmental survey concentrating on drilling operations was performed at an anthracite strip mine. During the survey dry drilling was performed and all samples exceeded the adjusted MSHA standard. Thus, it was properly determined that a health hazard did exist for the drilling crews. The company then reinstituted wet drilling techniques and reduced quartz exposures. MSHA confirmed that dust samples collected after wet drilling was reinstated were within compliance standards.

This study demonstrates that control measures (in the absence of overall industry surveillance techniques) can and do reduce if not eliminate the risk of silicosis and respiratory disease amongst drillers.

(8) A study of anthracite strip miners was performed which involved a full battery of testing: X-rays, pulmonary function testing, symptom questionnaires, and work and smoking histories. Over 4% of workers who had no prior dusty exposure had evidence of pneumoconiosis. All category 2 and 3 cases were drillers. Moreover, the vast proportion of all other

cases were individuals with drilling experience. Tenure of drilling was associated with an increased prevalence of pneumoconiosis. Tenure in drilling was related to changes in pulmonary function amongst workers with normal chest films, supporting the hypothesis that silica may be associated with pulmonary function changes in the absence of radiographic evidence of silicosis. As noted previously, Rogan _et al_. and Morgan _et al_. have both shown this effect amongst underground coal workers, but the associated changes are indeed minimal compared to those produced by aging and cigarette smoking. The pulmonary function results from this study are not conclusive as tenure drilling was not related to decrements in workers who had also held other dusty jobs. Thus, these data do not support the use of pulmonary function testing for the surveillance of drillers, let alone for an overall industry-wide surveillance plan.

This study clearly argues that a risk of silicosis exists amongst drillers in the anthracite strip mining industry and that there appears to be a dose-response relationship between tenure drilling and the prevalence of silicosis.

(9) This evaluation of environmental data is an update of #6 above. These are the data which are "expanded" in the NIOSH proposal. Nonetheless, on balance these data indicate nothing much different from reference 6 above which shows that

excessive quartz exposures exist for drilling crews. Concentrations of respirable dust and quartz for other types of operations were generally within bounds. Minor elevations for specific jobs are not documented as being associated with increases in either the incidence or prevalence of pneumoconiosis.

This study argues for the control and enforcement of the silica standard -- especially for drilling operations.

The above studies (individually or together) do not support NIOSH's arguments for an expanded surveillance activity which would include all surface coal miners. They do, on the other hand, support the notion that MSHA should perhaps be more diligent in enforcing the existing standard and that operators should be using existing control technology to control exposures. A silicosis hazard does exist amongst drillers and driller helpers and a remedy for this subgroup of surface coal mine workers should be put in force. In this case, an industry-wide environmental and medical surveillance plan would be wasteful and moreover, would not cure the problem. Compliance with standards will.

A final word seems in order regarding silica exposure, silicosis, and lung cancer. Mortality studies of coal miners reflect a deficit of deaths for lung cancer. Many of the coal miners in the various cohort studies have had appreciable exposure to silica and also, many of these coal miners have been surface workers. This issue was covered fully in Heppleston's review.

Page 93 -- The collection of breathing zone samples of each miner during the sampling schemes is admirable. Assuming 75,000 miners working in the surface mines and in the surface work areas of underground mines, then about 500,000 additional samples would be required each year at a cost of $2 million. This would be in addition to noncompliance sampling and respirable coal mine dust sampling per 30 CFR 71. There is no way that this number of samples can be analyzed for quartz content unless NIOSH volunteers the service of their analytical laboratory, free of charge.

MSHA analytical method, P-7, IR spectrometric method, along with the sampling procedure has been ruggedized through the work at Stanford University. This method is as sensitive and accurate for detecting silica as NIOSH method 7602. As there has been no reported tridymite and/or cristobalite in coal mine dusts, the use of X-ray analytical methods such as NIOSH 7500 is not required. Both types of analysis are equally sensitive and precise.

Kaolin is the primary mineral that interferes with the IR analysis. Therefore, its contribution is subtracted from the total absorbance.

Pages 96 - 97 -- "Uneven depositions of the ash have been observed in the filtration step ... can adversely affect the quantification of quartz .... Method 7602 is the preferred method because of the 1.7 l/m sample collection flowrate and the avoidance of uneven ash depositions." The rationale contained in this statement is without merit. To infer that sampling dust at 1.7 l/m through the personal sampler instead of at 2.0 l/m could have any effect on the uniformity of deposition of ashen material from a liquid slurry lacks scientific backing.

The NIOSH database is grossly inadequate from a technical and a statistical standpoint. NIOSH proposes to place the entire burden (based on their previously noted erroneous assumptions) of exposure characterization on the mine operator through a series of open-ended assumptions: "... silica should be presumed in any surface mining operation..."; "... only through intensive long-term sampling...."

NIOSH also clearly defines the responsibility for accountability in operations. Sampling for "at least 5 consecutive workshifts or days..." will be no small task, again in the absence of demonstrated need and certainly without precedent.

The recommended and periodic sampling is an ideal strategy for a government-sponsored research program. In fact, it almost duplicates the original respirable dust sampling program implemented in 1972 under 30 CFR 71. There have been millions of samples collected in surface mines and surface work areas of underground mines. Unfortunately, the quartz contents of these samples could not be determined to the level of accuracy and precision needed prior to the development of new analytical procedures by MSHA.

The sampling strategy mandated by 30 CFR 71.208 provides the information needed for compliance determinations related to the existing 2.0 mg/m^3 respirable coal mine dust standard and the 10 divided by percent quartz mg/m^3 standard.

A dust sampling program conducted by the mine operators is to insure that the miners are not exposed to excessive levels of dust as specified in 30 CFR 71. Additional data for developing dose-response relationships and other physiological responses should be collected by NIOSH or other interested parties capable of funding the research projects.

Pages 100 - 101 -- Apparently, the changes cited, such as production, process controls, work practices, machinery, geology or weather conditions that may result in increased exposures can also significantly cause erroneous low levels. The recommended strategy will not delineate these effects. The use of an "approved dust control plan" as specified in 30 CFR 71 will incorporate the effects of the physical surroundings, work practices, machinery and weather.

There is no question about instituting corrective action to reduce exposure or in notifying the miner of his excessive exposure. However, these actions are related to potential noncompliance situations which may require citations with civil penalties in addition to notification and correction.

In most of the smaller surface mines there are no industrial hygienists or engineering personnel available to conduct the recommended sampling program. Apparently, little thought has been given to the existing sampling general requirements, 30 CFR 71.201, and to certified persons, 71.202 and 71.203.

Adoption of the statistical system for the number of samples required to provide a 90% confidence will result in an excessive number of samples being taken by the mine operator. If there were no information relative to this environment it might be justified, but after almost 20 years of dust exposure evaluation, this is an exercise in nitpicking. The cost of this sampling program, if instituted, will far exceed the current costs to comply with the requirements of 30 CFR 71.

The proposed sampling strategy has taken a new approach. NIOSH is suggesting that sampling and immediate actions based upon analytical results will eliminate overexposure to quartz in the mining environment. The morass of paperwork and computer decisions required would require a workforce far exceeding that available.

Pages 101 - 110 -- Comments in the literature confirm that simple chronic silicosis is a slowly progressive disease in which the physical examination is relatively unhelpful and in which chest X-ray changes precede any pulmonary function changes:

In "chronic silicosis," the duration of exposure until silicosis is first diagnosed is usually more than 20 years.[1]

"Chest X-ray changes do not develop before 20 years of exposure."[2,3]

Classical silicosis is, in most industrial processes where the hazard has been long recognized, a chronic and slowly progressive disease. In classical nodular silicosis in most cases, no abnormalities on physical examination can be found. Physical signs are practically absent in the initial stages of silicosis.[4]

Significant decremental changes in lung function probably do not occur in simple silicosis, but some observers claim that the forced vital capacity and forced expiratory volume decrease with increasing exposure to dust and as the radiographic changes become more prominent. Most patients do not become short of breath until the advanced stage of PMF appears.[5]

Simple silicosis - that is, silicosis in the radiographic stage of isolated rounded small opacities - usually does not produce significant impairment of lung function. This is true even in silicotic sandblasters, in whom serious functional impairments were associated with progression to the radiographic stage of complicated pneumoconiosis, usually PMF.[6]

The worker with simple silicosis usually is asymptomatic, and even the early stages of massive fibrosis are not associated with signs or symptoms. Pulmonary function tests usually are normal until the onset of dyspnea.[7]

[1]Criteria for a Recommended Standard: Prevention of Pneumoconiosis in Surface Coal Miners (Draft); NIOSH, August 1990, p. 65.

[2]Lloyd et al.; BJIM 30:227-31, 1973.

[3]Theriault et al., Arch. Env. Health, 28:22-30, 1974.

[4]Public Health and preventive Medicine; Lasted; Appleton - Century - Crofts/Norwalle, CN; Chap. 14 -- Occupational Respiratory Diseases; 1986.

[5]Disease associated with exposure to silica and non-fibrous silicate minerals; Silicosis and Silica Disease Committee; Arch. Pathol Lab Med; 112:673-720; July, 1988.

[6]Environmental and Occupational Medicine; Rom ed; Little Brown and Co., Boston; Chap 16 - Silicosis, 1983.

[7]Occupational Medicine; Zenz ed; Year Book Medical Publishers,
Inc., Chicago; Chap 10 - Occupational Pulmonary Disease; 1982.

(End of footnote.)

Therefore, it makes no scientific sense to require chest X-rays every five years and then require pulmonary function tests every year.

The following listing outlines the recommendations of various organizations regarding frequency of monitoring:

Organization	Tests - Frequency in Years	
	PFT	CXR
American Thoracic Society[1]	None given	2-5
OSHA directive on silica[2] (not a standard)	Yearly	Yearly
NIOSH Silica Criteria Document[3]	3	3
NIOSH Draft Criteria Document on Surface Coal Miners[4]	Yearly	5
Canadian Thoracic Society Task Force[5]	Baseline Only	2

NIOSH *ad hoc* committee on medical screening and monitoring[6]	None	5

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[1]Surveillance for Respiratory Hazards in the Occupational Setting. This official ATS statement was adopted by the ATS Board of Directors, June, 1982.

A. CXR: Routine PA screening films at 2 to 5 year intervals in asymptomatic individuals depending on specific hazard.

B. PFT: No specific frequency recommended.

[2]Occupational Safety and Health Administration directives pertaining to 29 CFR sections 1910.94 - 1910.116 OSHA instruction CPL 2 - 2.7.

[3]Criteria for a recommended standard -- Occupational Exposure to Crystalline Silica. NIOSH 1974.

[4]Draft document: Criteria for a Recommended Standard Prevention of Pneumoconiosis in Surface Coal Miners. NIOSH, Aug. 8, 1990.

The annual spirometry recommendation is made because: "Certain other chronic respiratory diseases (e.g., reversible or fixed airways obstruction) are better screened by pulmonary function testing and/or medical questionnaire. Although they may not be the direct results of respirable dust exposure, chronic respiratory diseases could be complicated by pneumoconiosis or aggravated by continued dust exposure. In the context of a comprehensive medical screening program for surface coal miners, NIOSH believes that the inclusion of pulmonary function testing and a medical questionnaire is justified. Pulmonary function tests and a questionnaire should be administered annually in order to screen for fixed airways obstruction."

[5]Ostiguy GL, Summary of Task Force Report on Occupational Respiratory Disease (Pneumoconiosis) Can Med Assoc J. 121: 414-421, 1979.

[6]Personal Communication with John Parker, M.D., Pulmonologist, NIOSH, Pulmonary Division of Safety Research. (End of footnote.)

The recommendation for the most frequent monitoring in terms of silica exposure occurs in an OSHA directive on silica. This is not a standard. It is an old directive and it is not based on science.

The NIOSH silica criteria document that was issued in 1974 recommends monitoring of pulmonary function and chest X-rays be done at least every three years.

More recent recommendations from the American Thoracic Society, the Canadian Thoracic Society Task Force, and the NIOSH ad hoc committee on medical screening and monitoring have a sounder scientific basis and are based on the actual epidemiology and pathogenesis of the disease. The recommendations of these organizations do not even include routine pulmonary function tests other than a baseline.

The NIOSH draft document in its recommendations for a pulmonary function testing on page 105 states:

> "Certain other chronic respiratory diseases (e.g., reversible or fixed airways obstruction) are better screened by pulmonary function testing and/or medical questionnaire. Although they may not be the direct results of respirable dust exposure, chronic respiratory diseases could be complicated by pneumoconiosis or aggravated by continued dust exposure."

In essence, NIOSH is asking the industry to monitor for disease processes that are not caused by the exposure that is being addressed in the criteria document. This is not reasonable.

On page 109, there is a reference to the NIOSH medical committee on guidelines and protocols for medical screening and monitoring. This committee's initial recommendation for pneumoconiosis is a chest radiographs at five year intervals and no pulmonary function test. It is surprising that NIOSH references its own preliminary ad hoc committee findings and then recommends testing at variance with those recommendations.

Nowhere in the draft criteria document has NIOSH attempted to justify the recommended medical screening procedures. Clearly, there are accepted principles for deciding if a screening test is justified and some of these are noted below:

(1) The condition being sought should be an important health problem for the individual and the community.

(2) There should be an acceptable form of treatment for patients with recognizable disease.

(3) The natural history of the condition, including its development from latent to declared disease, should be adequately

understood.

(4) There should be a recognizable latent or early symptomatic stage.

(5) There should be a suitable screening test or examination for detecting the disease at the latent or early symptomatic stage, and this test should be acceptable to the population.

(6) The facilities required for diagnosis and treatment of patients revealed by the screening program should be available.

(7) There should be an agreed policy on whom to treat as patients.

(8) Treatment at the presymptomatic, borderline stage of a disease should favorably influence its course and prognosis.

(9) The cost of case-finding (which would include the cost of diagnosis and treatment) needs to be economically balanced in relation to possible expenditure on medical care as a whole.

(10) Case-finding should be a continuing process, not a "once and for all" project.

(11) The benefits accruing to the true-positive should outweigh the harm done as a result of false-positive diagnosis.

In addition, various criteria for screening procedures need to be specified. Some accepted criteria are noted below:

(1) Acceptance by subjects: Test should not cause discomfort.

(2) Simplicity: Equipment and procedure should be simple.

(3) Objectivity: Results should not be influenced by whether subject cooperates fully or not.

(4) Precision (reproducibility): Repetition yields the same value.

(5) Accuracy: The test quantifies accurately what one needs to know.

(6) Validity: Sensitivity, specificity and predictive value.

Questions

1. The respirable crystalline silica dust sampling strategy recommended on pages 5-7 and 97-101 are definitely not appropriate. This strategy would impose unjustified sampling and compliance on top of that currently required by 30 CFR Part 71. <u>See</u> General and Specific Comments.

2. <u>See</u> General and Specific Comments.

3. The concept of an action level for respirable quartz would result in increased sampling or changes in work practices and controls. It also infers that potential enforcement actions would be implemented at exposure levels well below the permissible exposure limit.

Requiring a mine operator to increase sampling or other similar actions must be triggered by noncompliance with a scientifically justified standard. In our opinion, the recommended 0.05 mg/m^3 and the LOD (determined by sampling with a personal sampler operated at 1.7 l/m with no relation to equivalent MRE values) assume a risk without the necessary dose-response evidence.

4. The transfer option for surface miners is comparable to the option presently available to miners working at surface work

areas of underground coal mines, 30 CFR Part 90.

There have been no reported dose-response data for U.S. coal miners since the initiation of the sampling and medical surveillance programs mandated by the Federal Coal Mine Health and Safety Act (FCMHSA) of 1969. How can the industry be in a position to comment upon transfer to jobs at lower concentrations preventing progression of CWP or the decrement of lung functions? If NIOSH, having all the miner exposure data and the medical surveillance data, has been incapable of reporting any conclusive results other than those developed by the English and the Germans, the U.S. coal mining industry is at the mercy of flawed recommendations such as those advanced in the draft criteria document.

Basically, the U.S. research results do not clearly provide a defensible quartz or respirable dust standard different from those currently in effect. During the past 20 years, exposure levels in underground coal mines were measured. Surface miners were only evaluated during the past 17 years. Little or no dose-response data comparable to that reported by the UK National Coal Board has been made available. The English started their 25 pit scheme about 1950 and presented their findings with the rationale for the relationships by 1969. The coal mining industry has been the most studied of any in the country. Also, miners in U.S. coal mines have been sampled to determine their exposure to respirable dust more than any place in the world, including the UK and Germany. Where are applicable dust and quartz standards supported by creditable evidence and a status report on pneumoconiosis in employed miners, disabled and the retired miners?

5. Under no circumstances should mandatory operation-specific work practices and controls be implemented. Through a dust control plan, mine operators could provide the engineering and/or work practice protection needed to prevent overexposure. Mandatory engineering controls and work practices limit, and even prevent, mine operators from applying new technology or revising ineffective methods.

Dust control equipment provided as part of original equipment or as a retrofit will normally accomplish its job when used and maintained as directed. However, the mine operator must retain the ability to modify his equipment and to decide what is adequate for his operation. Keep in mind that maintaining the dust concentration below the standard is mandatory.

6. See General and Specific Comments

7. In accordance with the law, a pre-placement medical examination is mandated. All follow-up examinations must be made available to the miner, but only the miner has the right to

accept. If the mine operator has been meeting his obligations to control the dust at or below the exposure standard, why should the miners be obligated to have physical examinations at the expense of the industry?

8. All mine operators must meet the training and dust sampling requirements of 30 CFR Part 48 and 30 CFR Part 71.

9. Little information has been provided linking results of pulmonary function tests with X-ray categorization. See General and Specific Comments.

10. The recommendations for clean change rooms and for storage lockers are already included in 30 CFR 71.400 and 71.500.

11. NIOSH should have the entire responsibility for the recordkeeping and confidentiality of medical records. They are supposed to make the determination of the status of the miner's health and are supposed to monitor the progression of pneumoconiosis in all underground and surface coal miners. This would make all medical data, and data provided by MSHA, available for evaluating dose-response and for the development of a realistic, defensible respirable coal mine dust and quartz standard based upon U.S. mining industry experience.

12. Individual miner responsibility for tobacco lifestyle

habits may be the best line of defense in preventing disease.

13. NIOSH should consult with the U.S. Geological Survey and obtain topographical and geological maps pertinent to those areas of the U.S. where surface coal mines are located. State geologists might also prove helpful.

14. Throughout these comments, reference has been made on the need for research to determine realistic dust and quartz standards for surface coal mines, as well as the need to establish dose-response relationships in order to protect miners from getting CWP. Management, labor and MSHA have been requesting this research since before the passage of the FCMHSA of 1969.

MSHA repeatedly has requested NIOSH for research related to a quartz standard and for the status of the health of coal miners. The requests have been made each year since 1979 through the mechanism of the NIOSH Planning Group, a joint Department of Labor and Health and Human Services umbrella task group.

Further research for control of dust, sampling, analysis and medical procedures should assist efforts to prevent disease, not replace effective systems simply because they do not fit the statistical model being recommended at the time.

15. No Comment.

Attachment 1

AMERICAN MINING CONGRESS

FOUNDED 1897

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Copy

January 15, 1987

Mr. Richard A. Lemen
Director
Division of Standards Development
and Technology Transfer
National Institute for Occupational
Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226

Dear Mr. Lemen:

Re: Draft Criteria for a Recommended Standard ... Chest Radiographic Surveillance of Surface Coal Mine Workers

In response to your request for comments on the above-referenced draft document, AMC's preliminary view is that the scientific and technical information proferred does not support a conclusion that justifies wholesale x-ray surveillance of surface coal miners for evidence of coal workers' pneumoconiosis. Accordingly, as presented, the draft document does not constitute a sufficient basis for a recommended standard as provided for in Section 101 of the 1977 Federal Mine Safety and Health Act.

You will recall that at the time you released the draft document for comment, I indicated that a January 15, 1987, response date was entirely too short a deadline for thorough and reasoned comment and that late-February was a more reasonable deadline. That has proven to be the case.

AMC's Occupational Health Committee will be meeting February 3, 1987, to consider this draft among other issues. Accordingly, I expect that this preliminary conclusion will be supplemented with additional comments once the Committee has met.

Sincerely,

Michael F. Duffy
Senior Counsel

PRODUCT-ID: MSA009

TYPE PRODUCT: FINAL
ORGANIZATION CODE: 20020
ORGANIZATION TITLE: NATIONAL
LOCATION: OFFC OF THE ADMIN

U. S. DEPARTMENT OF LABOR

COAL MINE SAFETY AND HEALTH

SUMMARY OF OPERATOR/INSPECTOR SAMPLES

RUN DATE: OCT 22, 1985
PERIOD OF REPORT:
10/01/84 - 09/30/85

PART II - SURFACE OCCUPATIONS

OCCUPATION NUMBER	OCCUPATION TITLE	OPERATOR SAMPLES	AVERAGE CONCENTRATION	INSPECTOR SAMPLES	AVERAGE CONCENTRATION
423	SURVEYOR	0	0.0	2	0.2
449	MINE FOREMAN/MINE MANAGER	14	0.4	36	0.2
464	INSPECTOR	6	0.0	1	0.4
481	SUPERINTENDENT	0	0.0	5	0.1
489	OUTSIDE FOREMAN	48	0.6	16	0.3
494	PREPARATION PLANT FOREMAN	71	0.5	12	0.6
495	SAFETY DIRECTOR	6	0.0	2	0.3
496	UNION REPRESENTATIVE	0	0.0	1	0.4
497	CLERK/TIMEKEEPER	6	0.1	1	0.1
SUBTOTAL		12060	0.8	8894	0.6

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10/01/84 - 09/30/85

PART III - DESIGNATED AREAS

AREA NUMBER	AREA TITLE	OPERATOR SAMPLES	AVERAGE CONCENTRATION	INSPECTOR SAMPLES	AVERAGE CONCENTRATION
100-0 THRU 199-0	TRACK HAULAGE	378	0.7	42	0.7
200-0 THRU 299-0	BELT AREA	13688	0.8	848	0.8
300-0 THRU 399-0	TRACKLESS HAULAGE	338	0.7	35	0.8
400-0 THRU 499-0	SHOPS	49	0.3	1	0.5
500-0 THRU 599-0	SECTION DUMPING POINTS	836	0.7	75	0.8
600-0 THRU 699-0	ROTARY DUMPS AND CRUSHERS	92	0.9	10	0.8
700-0 THRU 799-0	MISCELLANEOUS	582	1.0	50	1.7
800-0 THRU 899-0		0	0.0	19	0.8
SUBTOTAL		15959	0.8	1085	0.7

PRODUCT-ID: MSA00D

TYPE PRODUCT: FINAL
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PART II - SURFACE OCCUPATIONS

OCCUPATION NUMBER	OCCUPATION TITLE	OPERATOR SAMPLES	AVERAGE CONCENTRATION	INSPECTOR SAMPLES	AVERAGE CONCENTRATION
301	CONVEYOR OPERATOR	33	0.7	42	0.4
302	ELECTRICIAN	192	0.6	96	0.4
303	ELECTRICIAN HELPER	17	0.2	3	0.4
304	MECHANIC	876	0.7	394	0.5
305	MECHANIC HELPER	16	0.3	11	1.0
306	WELDER (NON-SHOP)	61	0.6	22	0.4
307	BLASTER/SHOOTER/SHOTFIRER	70	0.8	35	0.5
308	MASON	0	0.0	3	0.1
309	SUPPLY MAN	75	0.3	19	0.1
310	SCRAPPER OPERATOR	133	0.6	238	0.3
311	WIREMAN	0	0.0	2	0.3
312	BELT VULCANIZER	5	0.2	1	0.1
313	CLEANUP MAN	466	0.7	144	0.8
314	COAL SAMPLER	150	0.7	63	0.6
316	LABORER/BLACKSMITH	1204	0.7	816	0.8
317	RODMAN	0	0.0	3	0.6
318	OILER/GREASER	160	0.5	132	0.3
319	WELDER (SHOP)	29	0.5	98	0.9
320	CAGE ATTENDANT/CAGER	0	0.0	2	0.3
321	HOIST ENGINEER/OPERATOR	18	0.3	16	0.2
322	COAL STRIP OPERATOR	0	0.0	2	0.2
323	TRANSIT MAN	0	0.0	1	0.1
324	BACKHOE OPERATOR	0	0.0	22	0.2
325	DIESTER TABLE OPERATOR	0	0.0	3	0.5
326	FORKLIFT OPERATOR	0	0.0	11	0.2
327	PUMPER	0	0.0	7	0.3
328	UTILITY MAN	7	1.4	21	1.2
329	VACUUM FILTER OPERATOR	0	0.0	1	0.7
331	CLAW OPERATOR	0	0.0	2	0.1
333	COAL DRILL HELPER	5	0.2	4	0.3
334	COAL DRILL OPERATOR	94	0.5	13	0.5
340	BOOM OPERATOR	1	0.3	11	0.3
341	BELT MAN/CONVEYOR MAN	22	0.3	24	0.4
342	BIT SHARPENER	19	0.4	7	0.3
343	CAR TRIMMER CAR LOADER	25	0.3	40	0.3
344	CAR SHAKE-OUT OPERATOR	0	0.0	4	0.5
345	CRUSHER ATTENDANT	63	0.8	46	0.8
347	FROTH CELL OPERATOR	11	0.7	8	0.5
348	MACHINIST	5	0.4	26	0.4
349	ROTARY DUMP OPERATOR	8	0.2	8	0.4
350	SHUTTLE CAR OPERATOR	0	0.0	1	0.8

PRODUCT-ID: MSA089
TYPE PRODUCT: FINAL
ORGANIZATION CODE: 20020
ORGANIZATION TITLE: NATIONAL
LOCATION: OFFC OF THE ADMIN

U. S. DEPARTMENT OF LABOR
COAL MINE SAFETY AND HEALTH
SUMMARY OF OPERATOR/INSPECTOR SAMPLES

RUN DATE: OCT 23, 1985
PERIOD OF REPORT:
10/01/84 - 09/30/85

PART II - SURFACE OCCUPATIONS

OCCUPATION NUMBER	OCCUPATION TITLE	OPERATOR SAMPLES	AVERAGE CONCENTRATION	INSPECTOR SAMPLES	AVERAGE CONCENTRATION
351	SCOOP OPERATOR	0	0.0	1	0.4
352	STEEL WORKER	0	0.0	0	0.2
354	SWEEPER OPERATOR	0	0.0	7	0.0
356	ROCK DRILLER	96	0.0	30	1.0
357	WASHER OPERATOR	57	1.1	44	0.9
360	SHOPMAN REPAIR CARS	12	0.3	2	0.1
362	BRAKEMAN	0	0.0	2	0.1
365	DISPATCHER	32	0.2	6	0.2
366	WATERBOY	0	0.0	2	0.5
367	COAL SHOVEL OPERATOR	40	0.4	77	0.3
368	BULLDOZER OPERATOR	1607	0.5	1551	0.5
369	MOTORMAN/LOCOMOTIVE OPERATOR	0	0.0	2	0.5
370	AUGER OPERATOR	3	0.1	40	0.3
371	AUGER HELPER	4	0.9	39	0.2
372	BARGE ATTENDANT	12	0.4	24	0.3
373	CAR DROPPER	171	0.4	104	0.4
374	CLEANING PLANT OPERATOR	449	0.7	237	0.0
375	ROAD GRADER OPERATOR	30	0.4	92	0.2
376	COAL TRUCK DRIVER	183	0.4	156	0.3
378	CRANE OPER DRAGLINE OPERATOR	41	0.4	170	0.5
379	DRYER OPERATOR	87	0.8	35	0.0
380	FINE COAL PLANT OPERATOR	821	1.2	100	1.4
381	HOIST OPERATOR HELPER	0	0.0	1	0.0
382	HIGHLIFT OPERATOR,FRONT END LOADER	570	0.4	1405	0.4
383	HIGHWALL DRILL HELPER	225	0.8	63	0.7
384	HIGHWALL DRILL OPERATOR	2125	0.8	713	1.2
385	LAMPMAN	105	0.3	27	0.2
386	REFUSE TRUCK DRIVER/BACKFILL TRUCK DRIVE	645	0.5	633	0.7
387	ROTARY BUCKET EXCAVATOR OPERATOR	0	0.0	9	0.5
388	SCALPER-SCREEN OPERATOR	269	0.7	110	1.0
390	SILO OPERATOR	20	0.4	2	0.3
391	STRIPPING SHOVEL OPERATOR	14	0.3	57	0.2
392	TIPPLE OPERATOR	814	0.6	400	0.6
393	WEIGHMAN	2	0.2	44	0.2
394	CARPENTER	0	0.1	0	0.5
395	WATER TRUCK OPERATOR	12	0.3	13	0.2
397	YARD ENGINE OPERATOR	0	0.0	0	0.1
398	GROUNDMAN	13	0.2	10	0.2
404	MASTER MECHANIC	0	0.0	1	0.1
414	DUST SAMPLER	0	0.7	0	0.0
418	MAINTENANCE FOREMAN	7	0.5	5	0.2

Attachment 2

AMERICAN MINING CONGRESS

FOUNDED 1897

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April 28, 1987

Mr. Richard A. Lemen
Director, Division of Standards
Development and Technology Transfer
NIOSH
4676 Columbia Parkway
Cincinnati, Ohio 45226

Dear Mr. Lemen:

Re: Draft Criteria for Recommended Standard ... Chest Radiographic Surveillance of Surface Coal Mine Workers

On February 3, 1987, AMC's Occupational Health Committee met to consider the above-referenced draft document. Comments were solicited from committee members and compiled for submission to NIOSH. This letter serves to supplement AMC's preliminary conclusions contained in our letter of January 15, 1987.

As we stated then, AMC believes that the scientific and technical information proffered in the draft criteria document does not support a wholesale X-ray surveillance program for surface coal miners. It is essential that NIOSH criteria documents demonstrate an increased risk prior to recommending regulatory action. As in this case, where no increased risk exists, the program cannot be adopted due to the Supreme Court's decision in the benzene case. AFL-CIO v. American Petroleum Institute, 448 U.S. 607 (1980).

The intent of the X-ray surveillance program is to monitor the incidence of coal worker's pneumoconiosis (CWP) in miners, primarily to prevent the occurrence of progressive massive fibrosis (PMF). In this regard, the draft contains no documentation of any progression in the accepted radiographic classifications to a higher category while an individual was working at a surface coal mine. Similarly, no incidence of PMF has been detected in surface coal miners who were not employed as drillers or who previously had not worked in underground coal mines. Also, those cases of pneumoconiosis identified in surface coal miners employed as drillers were ascribed to silicosis, not CWP. It should be noted that silicosis differs in causation, pathology, and strategies of prevention from coal worker's pneumoconiosis.

Fundamental differences exist in the mining environments encountered by surface coal miners as opposed to underground coal miners. Highlighting some of these distinctions demonstrates the inappropriateness of mandating wholesale X-ray surveillance of surface coal miners. For instance, the respirable dust levels encountered in surface coal mining operations are relatively low. The enclosed survey of occupational dust samples reported to the U.S. Department of Labor, reflecting the results of both operator and inspector-generated sampling, indicates extremely low average concentrations of respirable dust in surface coal mines. Although not specifically analyzed, the dust sampled probably was composed mostly of soil and surface minerals, not coal. It follows that the likelihood of a surface coal miner developing a pneumoconiosis due to excessive exposure to coal dust is exceedingly small. Furthermore, as a practical matter, the right to transfer to a less dusty environment would have virtually no meaning in a surface coal mining setting.

In summary, the draft criteria document has not demonstrated an increased risk of coal worker's pneumoconiosis, or its complications, in surface coal miners. However, a few occupational categories of surface coal miners may be at slightly increased risk for silicosis. Whether this risk is significant enough to warrant an X-ray program for specific occupational categories should be the focus of the NIOSH criteria document. In contrast, mandated surveillance of all surface coal miners is viewed by industry as a misuse of resources, one that will result in unnecessary X-ray exposure of our employees without commensurate health benefits.

It is recommended that the scientific basis for the draft criteria document be reviewed by the Mine Health Research Advisory Council.

Sincerely,

Mark G. Ellis
Counsel

Enclosure

FEDERAL MINE SAFETY AND HEALTH REVIEW COMMISSION

OFFICE OF ADMINISTRATIVE LAW JUDGES
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5203 LEESBURG PIKE
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JUL 20 1993

IN RE:	CONTESTS OF RESPIRABLE DUST SAMPLE ALTERATION CITATIONS	Master Docket No. 91-1

DECISION ON COMMON ISSUES TRIAL

Appearances: For the Secretary of Labor: Douglas N. White, Esq., Carl C. Charneski, Esq., James B. Crawford, Esq., L. Denise Galambos, Esq., Richard L. Gilman, Esq., Page H. Jackson, Esq., Mark R. Malecki, Esq., and Patrick M. Zohn, Esq., Arlington, Virginia;

For the Lead Defense Counsel Committee: Laura E. Beverage, Esq., Henry Chajet, Esq., and L. Anthony George, Esq., Charleston, West Virginia; Timothy M. Biddle, Esq., and R. Timothy McCrum, Esq., Washington, D.C.; Michael T. Heenan, Esq., and William I. Althen, Esq., Washington, D.C.; R. Henry Moore, Esq., Pittsburgh, Pennsylvania; John C. Palmer IV, Esq., and Edward L. Kropp, Esq., Charleston, West Virginia; and H. Thomas Wells, Esq., and J. Alan Truitt, Jr., Esq., Birmingham, Alabama;

For the United Mine Workers of America: Mary Lu Jordan, Esq., Washington, D.C.

Before: Judge Broderick

STATEMENT OF THE CASE

Each of the cases consolidated in the master docket involves an allegation that the mine operator altered the weight of the filter cassette used to sample the concentration of respirable dust to which its miners were exposed. Following extensive discovery, a common issues trial was commenced on December 1, 1992, and concluded on February 22, 1993. The Secretary of Labor (Secretary) and the Lead Defense Counsel Committee (LDCC) each filed a posthearing brief on April 30, 1993, and a reply brief on May 28, 1993. I have considered the entire record and the contentions of the parties, including the proposed findings of fact, in reaching this decision. To the extent that the proposed findings and conclusions are not incorporated in this decision, they are rejected. (The Secretary proposed 701 findings and

APPENDIX 2

conclusions, and 13 ultimate findings and conclusions; LDCC proposed 79 findings of fact, and two ultimate and nine subordinate conclusions of law.)

I. FACTUAL AND PROCEDURAL BACKGROUND

A. RESPIRABLE DUST SAMPLING PROGRAM

Section 202 of the Federal Mine Safety and Health Act of 1977 (Mine Act), 30 U.S.C. § 801, 842, requires coal mine operators to take accurate samples in a manner prescribed by the Secretary of the respirable dust to which miners are exposed in the mine atmosphere. Title 30 C.F.R. §§ 70.201-220 (for underground mines), 71.201-220 (for surface mines), and 90.201-220 (for Part 90 miners) set forth the sampling requirements and procedures to which the mine operators must conform. Dust samples are taken by the use of an MSA sampling train unit containing a pump, a hose, a cyclone assembly, and a filter cassette. If properly calibrated, the pump draws 2 liters of air per minute into the cyclone assembly which is designed to separate out the larger particles of dust which fall into what is called the "grit pot." The air with the smaller (respirable) dust particles is directed into the filter cassette. Inside the cassette is a capsule consisting of an aluminum cone, a filter, and a backing pad. The particles enter the capsule and are deposited on the filter face and the air goes through the filter and the backing pad into the hose and back to the pump. At the conclusion of each sampling shift, the filter cassettes are sent to the Mine Safety and Health Administration (MSHA) (usually by mail) for weighing. The cassettes with their dust data cards attached are sent in cardboard mailing boxes. At MSHA's Pittsburgh Health Technology Center (PHTC), lab technicians remove the filter cassettes and dust data cards from the boxes and place them on carrying trays. Using forceps, the lab technicians open the cassettes, remove the filter capsules, and place the capsules on processing trays for weighing. The filter capsules are desiccated to remove any moisture that may be present and then stored before weighing to ensure stability of weight. PHTC weighs about 90 percent of its samples using a robotic weighing system. The remainder are weighed manually.

Section 209(b) of 30 C.F.R. Parts 70, 71, and 90 provides in identical language: "The operator shall not open or tamper with the seal of any filter cassette or alter the weight of any filter cassette before or after it is used to fulfill the requirements of this part."

B. CHRONOLOGY OF THE AWC LITIGATION

Robert A. Thaxton, currently a supervisory industrial hygienist for MSHA, worked as an industrial hygienist in MSHA District 4 at Mt. Hope, West Virginia, in 1983. At the direction of his supervisor, Thaxton examined the dust sampling equipment to determine the potential for removal of dust by tampering. After some preliminary consideration of the alteration of the internal workings of the pump and misalignment of the filter cassette in the assembly, Thaxton concluded that removal of dust from the filter itself could be accomplished without being readily detected, especially since of the approximately 100,000 samples submitted annually, less than 1 percent were opened to be examined for oversize particles. He subjected 25 to 50 filters to reverse air flow tests, using the pump, blowing by mouth into the cassette outlet, and directing a jet of air into the outlet. Thaxton noted the results: white, circular areas in the center of the filters in direct alignment with the cassette inlets, and varying amounts of weight loss.

In February 1989, a laboratory technician in the MSHA Mt. Hope office, when weighing an abatement sample, discovered the filter protruding into the opening of the aluminum foil capsule. When the foil was removed, a raised, white area in the center of the filter was observed. The filter was submitted to Thaxton who determined that it resembled the reverse air experimental filters he had created in 1983. When similar filters were observed from the same mine operator (Peabody Coal Company), PHTC, which receives bi-monthly respirable dust compliance samples, was instructed to examine other filters from the same mine for similar appearances. The matter was referred to the U.S. Attorney's Office for criminal investigation. PHTC was instructed to examine all Peabody filters from southern West Virginia, and later all Peabody filters nationwide. In August 1989, PHTC was directed to examine all filters submitted by all coal mine operators in the United States for abnormalities which might indicate tampering.

Thaxton performed additional tests attempting to replicate the abnormal patterns on the examined filters. He subjected dust laden filters to reverse air flow by various means, including altering the pumps and using compressed air, methane, and vacuum sources; he inserted cotton swabs, pipe cleaners, and liquids into the filter cassettes; and he dropped cassettes from varying heights and threw them against a wall. Two formal studies were conducted, one by PHTC, one by the Department of Industrial Engineering at West Virginia University, which are said to have confirmed Thaxton's conclusion that normal sample collection procedures would not cause the filter appearances.

In April or May 1989, PHTC began referring filters suspected of having an abnormal white center (AWC) to Thaxton. At PHTC, after the filter capsules are weighed, the capsules are collected, opened, and examined for abnormal appearances. Except for 1 week in late August 1989 when he was assisted by an analytical branch employee and until October 1989, the only person who performed the examination and referred suspected AWC filters to Thaxton was Lewis D. Raymond, head of the weighing laboratory. In October 1989, Raymond trained two weighing lab technicians to prescreen suspected AWC filters for his review. No written instructions were provided, but Raymond showed them filters he considered normal and those he considered suspected AWCs. In November 1990, Raymond trained another weighing lab technician to replace a retiring technician. The training for the new technician included showing her photographs of filters. Raymond in turn referred the filters he considered abnormal to Thaxton. Prior to March 19, 1990, whenever Raymond had doubts as to whether a filter should be selected as an AWC he "sent it along and let Mr. Thaxton decide." Tr. 1477. After that date Raymond did not forward such filters to Thaxton even though he felt they were abnormal in some way. This change did not affect "95 percent or so of . . . the samples that got voided for AWC." Tr. 1475. Those deemed by Raymond to be normal, later termed "non-voids," were discarded until some time in the summer of 1991 when, at the mine operators' request, PHTC began retaining them. Over time, cassette halves, compartment trays, and petri dishes have been used to transport suspected AWC filters to Thaxton. However, none of the cited filters submitted to PHTC were transported to Thaxton inside cassette halves. Tr. 348-49. Thaxton also used cassette halves and petri dishes for storage of the AWC filters.

On many occasions between February or March of 1989 and September 1992, Thaxton reviewed the PHTC referrals of suspected AWC filters and was satisfied that they were properly referring suspected filters to him. Between February 1989 and October 1990 Thaxton examined 6600 Peabody filters, 6100 of which PHTC concluded exhibited normal appearances. In June 1991, he reviewed 1200 to 1600 filters at PHTC to compare the filters he would expect to be referred to him with those actually selected. In September 1992, he reviewed 5100 filters at PHTC for the same purpose. Thaxton concluded that only two filters of the 5100 should have been referred to him and that he would have issued a citation for one of them. Thaxton met with Raymond on numerous occasions during this period and compared suspected AWC filters. During the entire time Thaxton found only 10 or 12 filters that were not referred to him which he believed should have been.

When cross-examined at trial concerning compliance filters he had previously seen at PHTC, Raymond was able to identify the ultimate status of only nine of 16 filters. Three others which at trial he considered void were determined to be no-calls by Thaxton, and one which he stated he would send to Thaxton to decide was ultimately cited.

The Secretary argues that "Thaxton's consistency in identifying tampered filters has been nothing short of remarkable" and that "[a]s a result of their numerous communications regarding filters with AWC characteristics, Thaxton and Raymond developed an extraordinary consistency in the criteria which they both used to identify AWC's." Secty. Br. 5, 34. The LDCC states that "Thaxton's AWC determinations are incomprehensible" and it points to "Inconsistencies Between Thaxton's and [PHTC's] AWC Criteria." LDCC Br. 12, 16 (underline omitted). As will appear in this decision, I find the facts to be somewhere between these hyperbolic claims.

On March 19, 1990, MSHA began voiding all samples exhibiting AWCs. The AWC void code takes precedence over all other void codes, such as those for oversize particles, low tonnage, etc. After the initiation of the AWC void code, field laboratories began examining filters for AWCs and forwarding suspected filters to PHTC, where they were reviewed and referred to Thaxton if PHTC considered them suspected AWCs.

On April 4, 1991, MSHA issued nearly 5000 citations to approximately 800 mines followed by proposed civil penalty assessments totalling about $6.5 million. Each citation charges the mine operator with violating the provisions of Section 209(b) of 30 C.F.R. Part 70, 71, or 90, and alleges that "the weight of the respirable dust cassette . . . has been altered while the cassette was being submitted to fulfill the sampling requirements . . . ." Although the citations were issued by MSHA Inspectors James H. Wills and William D. McKinney, the determination whether the filters should be cited for AWCs was made solely by Thaxton.

The filters referred to Thaxton which he decided should not be cited are termed "no-calls." Those he decided should be cited were classified in one of 10 "tamper codes." The bases for his determinations were the physical appearances of the filters and what he believed caused those appearances. Generally, cited AWC filters exhibit a lighter (in color), circular area in the center of the filter, approximately 6 millimeters in diameter in direct alignment with the cassette inlet. Tamper codes 1 through 4 were conceived during the Peabody investigation and prior to August 1989, when the examination of all coal mine operators' filters began. Tamper codes 5 through 9 originated within 30 to 60 days after August 1989, and tamper code 10, which applies only to filters from one geographic area, was initiated after the void code was instituted on March 19, 1990. Thaxton assigned a tamper code to each of the filters prior to the issuance of the citations. However, physical damage in the central portion of a filter could preclude it from being cited. Thaxton also considered any pertinent information on the dust data cards submitted by the mine operators, and the number of AWC filters submitted by the same mine or the same contractor within a short period of time. Thaxton did not prepare or follow a written protocol describing his criteria for determining which filters were to be cited. He described the filter appearances under each of the tamper codes at the trial, showing examples of the cited filters.

Filters classified under tamper code 1, termed "light cleaned," contain a white ring in the center of the filter approximately 6 millimeters in diameter in direct alignment with the cassette inlet where the degree of dust removal in the center portion is not significantly different than that immediately outside. Thaxton testified that tamper code 1 appearances result from reverse air flow.

Filters classified under tamper code 2, "cleaned," exhibit a circular area approximately 6 millimeters in diameter in direct alignment with the cassette inlet with a markedly lighter dust deposition within the circular area. Thaxton testified that tamper code 2 appearances result from reverse air flow.

Filters classified under tamper code 3, "cleaned and coned," are similar to those classified under tamper code 2, with the addition of a slight rise or cone in the center of the 6-millimeter, circular area. Thaxton testified that tamper code 3 appearances result from reverse air flow.

Filters classified under tamper code 4, "torn (ruptured)," show a tear in the 6-millimeter, central portion of the filter in alignment with the cassette inlet. "There does not have to be a drastic change in the dust deposition [in the center of the filter], . . . but there typically is a lighter area of some type that goes along with the tear." Tr. 216. Thaxton testified that tamper code 4 appearances result from an object being inserted through the cassette inlet to contact the filter or from reverse air flow.

Filters classified under tamper code 5, "wiped (clean wiped)," exhibit in the center portion of the filter "rough marks that look like scratch marks . . . [giving] the appearance of physically something coming in contact with the filter face and wiping across the dust to remove it." Tr. 224. The center area is greater than 6 millimeters in diameter. Thaxton testified that tamper code 5 appearances result from inserting a brush or cotton swab into the cassette inlet and twisting it to wipe dust from the filter. A few of the tamper code 5 cited filters exhibit characteristics similar to those resulting from dropped experimental filters.

None of the filters involved in this proceeding were classified under tamper code 6.

Filters classified under tamper code 7, "clean tool," exhibit a 6-millimeter area with a very light ring and rectangular area attached to the ring on one side and jutting into the interior of the ring, with a darker area filling the balance of the ring. Thaxton was unable to replicate this appearance in his laboratory. Later, "[t]hrough varying degrees of reverse air flow it has been found that you can create this type of appearance." Tr. 256.

Filters classified under tamper code 8, "clean face," show a wide area of dust disturbance encompassing the greater part of the filter with a slightly darker, circular center in direct alignment with the cassette inlet. Thaxton testified that tamper code 8 appearances result from an object being inserted through the cassette inlet and being twisted to wipe dust from the filter.

Filters classified under tamper code 9, "clean touch," show a disturbance area in the center of the filter in direct alignment with the cassette inlet, which is much lighter than the surrounding area. There is a darker deposition immediately outside the lighter central area. The central area is smaller than 6 millimeters in diameter. Thaxton testified that tamper code 9 appearances result from an object being inserted through the cassette inlet and touching the filter.

Filters classified under tamper code 10, "clean ring," show a slightly darker, circular center less than 6 millimeters in diameter surrounded by a broad, lighter ring larger than 6 millimeters, shaped like a donut. Thaxton was not able to replicate this appearance in his laboratory.

Of the approximately 5000 filters cited, more than 4800 or 97 percent were originally classified under tamper codes 1, 2, and 3. In March 1992, Thaxton reexamined the cited filters with the filter media and backing pad being separated, and changed the tamper codes for 464 of the cited filters. The greatest change involved tamper code 3, which increased from 36 filters to 440 filters. More than 95 percent of the cited filters remain in the first three tamper codes.

Concurrent with the operator sample investigation, a large number of respirable dust samples taken in mines by MSHA inspectors were found to exhibit AWC characteristics. Thaxton characterized them under his tamper codes as he did the mine operators' samples. Most, but not all, of the inspector samples were classified under one of the reverse air flow tamper codes. The Office of Inspector General (OIG) of the Labor Department conducted an investigation to determine whether the inspectors who submitted these filter samples were guilty of misconduct. The investigation was closed, and misconduct was not found, based apparently on the finding that AWC appearances can result from snapping together the two parts of a dust laden filter cassette. This finding resulted from a chance discovery by MSHA Inspector Wills at the Mt. Hope laboratory in approximately November 1991. Thaxton testified that MSHA inspector samples are processed differently than operator compliance or abatement samples. In the former case, the MSHA field laboratory separates the cassette to examine it for oversize particles. If the oversize particle criteria are not met, the capsule is not removed, and the cassette halves are replaced and the entire cassette is mailed to PHTC. In the latter case, operator samples are stripped of the aluminum foil in the field labs and examined for AWC characteristics. Filters suspected of having characteristics like AWCs are forwarded to PHTC. MSHA and apparently the OIG concluded that the snapping together of the cassette halves was a reasonable technical explanation for the MSHA inspector AWCs. And all of the experts agree that snapping together the cassette halves on a dust laden filter can cause a reverse air dust dislodgment. Thaxton testified that the inspector AWCs classified under tamper codes other than those thought to result from reverse air are explained by the fact that the inspector is not present at the sample site during the entire sampling period, and operator tampering could occur during his absence.

The citations were contested, and the contest and penalty cases were assigned to me. On June 28, 1991, I adopted a Plan and Schedule of Discovery which distinguished joint discovery under the generic caption and master docket number from case-specific discovery under individual docket numbers. The discovery plan was amended on five different occasions and the time was extended for completing various stages of discovery. Throughout the joint discovery period, many issues involving evidentiary privileges and other procedural matters were decided. On May 22, 1992, I denied motions of certain contestants to vacate the contested citations on the grounds that the Secretary failed to issue the citations with the "reasonable promptness" required by Section 104(a) of the Mine Act.

On August 13, 1992, I ordered consolidation of all pending cases for trial of the common issues to commence on December 1, 1992. I appointed the LDCC and directed the completion of expert witness discovery and filing of witness and exhibit lists. Case-specific discovery was stayed.

II. ISSUES

1. What is an AWC?[1]

2. Does an AWC on a cited filter establish that the mine operator intentionally altered the weight of the filter?

The Secretary has the burden of proof on these issues. The burden requires that the Secretary show by a preponderance of

[1] Appendix A is a conceptual diagram of an AWC on a filter prepared by Dr. Andrew R. McFarland. R-1032.

evidence that (1) the term "AWC" has a coherent meaning and was consistently applied; (2) the cited AWCs can only have resulted from intentional acts; and (3) the AWCs resulted in weight losses in the cited filters.

There is no direct evidence of tampering in the record. I have excluded from this proceeding evidence concerning mine-specific handling practices or other mine-specific circumstances which may be relevant to the ultimate disposition of these proceedings. I am not considering any such evidence which may have been admitted into the record.

III. ARE THAXTON'S CLASSIFICATIONS OF CITABLE AWCs COHERENT AND CONSISTENT?

Although these cases have been consolidated for purposes of discovery and the common issues trial, it is important to keep in mind that they involve approximately 5000 individual citations to more than 800 mines, each alleging that the mine operator tampered with a dust sample by altering the weight of the filter cassette. This is not a conspiracy trial. It is not analogous to an employment discrimination case where the Government may introduce statistical evidence to establish or support allegations of racial, gender, or age discrimination. See, e.g., International Brotherhood of Teamsters v. United States, 431 U.S. 324 (1977); Walther v. Lone Star Gas Co., 952 F.2d 119 (5th Cir. 1992); Palmer v. Schultz, 815 F.2d 84 (D.C. Cir. 1987); Capaci v. Katz and Besthoff. Inc., 711 F.2d 647 (5th Cir. 1983). Nor is it analogous to a mass tort proceeding where a large number of plaintiffs were injured in a common accident, or allege exposure to a toxic substance. See, e.g., Schneider v. Lockheed Aircraft Corp., 658 F.2d 835 (D.C. Cir. 1981), cert. denied, 455 U.S. 994 (1982); In re Bendectin Litigation, 857 F.2d 290 (6th Cir. 1988), cert. denied, 488 U.S. 1006 (1989). The cases before me involve charges of individual violations by a number of different mine operators. The purpose of this common issues trial is to decide questions on which essentially the same evidence probably would be presented. At this stage of the cases, I reject the LDCC's contention that "[t]he Secretary must satisfy [his] burden of proof on each and every citation individually." LDCC Reply Br. 3.

The basic issue to be determined in the common issues trial is whether an AWC on a cited filter establishes per se that the mine operator intentionally altered the weight of the filter. Before I resolve that issue, I have first to determine what an AWC is, and whether the criteria for an AWC were coherently and consistently applied.

The term "AWC" purports to describe an appearance on the filter face. Thaxton defined it as "a filter that exhibits an based on Thaxton's review of the filters at some time between 1989 and the date of the citations and his assigning a tamper code to each. Therefore, whether a filter exhibited evidence of tampering must be judged as of the time Thaxton made his original determination. Thaxton's reclassification following his second review in March 1992 cannot be used in deciding whether his AWC criteria were intelligible and consistent. The citations were issued based on Thaxton's observation and judgment at or prior to the time of their issuance. Further, except for the reclassification of filters from tamper codes 1 and 2 to tamper code 3, the record does not explain the rationale for the changes.

During his testimony, Thaxton displayed[2] and described cited filters represented as typical under each of the relevant tamper codes. Photographs of the cited filters have been admitted into evidence as exhibits with the designation "G" followed by the filter number.

I viewed the filters described by Thaxton at the hearing, and have reviewed the photographs of the cited filters which were introduced as exhibits. The filters cited within each of the tamper codes, while similar in many respects, exhibit a wide spectrum of appearances. This fact as well as the problems related to the reclassification referred to above creates some doubt as to the coherence of Thaxton's tamper code classification. Nevertheless, considering the filter appearances and Thaxton's explanation of the tamper codes, I find that the classification of citable AWCs under the tamper codes is, for the purposes of the common issues trial, intelligible and coherent.

The LDCC challenges the consistency of Thaxton's calls based in part on a comparison of some of the filters cited under one of the tamper codes with filters deemed to be "no-calls" (tamper code 11). It also compares Thaxton's judgments on the experimental filters of Dr. Lee with the cited filters. A consideration of Dr. Lee's experimental filters will appear later in this decision.

Exhibit R-1643 contains photographs of a number of filters -- including cited, no-call, and experimental. Filters 462514 and 323857 are displayed next to one another on page 10 of the exhibit. Both have a sharply defined, central ring approximately 6 millimeters in diameter with what Lee calls a "keyhole." The dust within the ring appears to be similar to

[2] Many of the filters and other exhibits discussed during the trial were displayed using the Elmo Visual Presenter which projected images of the objects on television screens in the courtroom. The instrument was commonly and affectionately referred to in the transcript as "Elmo." See Commission Ex. 1.

that outside the ring. Filter 462514 was cited under tamper code 2; filter 323857 was a no-call. In reviewing the filters at the trial, Thaxton concurred with his previous determination that filter 462514 was citable under tamper code 2. With respect to filter 323857 he testified:

> if there was any other information available with the dust data card that was submitted that would also be looked at . . . at this time . . . I would say that it is a code 11 . . . . The image . . . on . . . [the] TV screen is sort of washed out compared to the actual filter. If you look at the actual filter, it's much plainer to see but the light area that's in the center with the ring . . . has basically the same deposition as that immediately outside. And in that case on this type of filters [sic], I did not believe that was definitive enough to give the benefit of any doubt to the operator.

Tr. 773-74. I viewed the actual filters as well as the photographs and find no significant differences in the appearance of the filters considering the criteria in Thaxton's tamper codes.

Photographs of filters 285344 and 510557 are displayed on page 9 of R-1643. Both have a very faint ring approximately 6 millimeters in diameter in the center of the filter. The area within the ring is slightly lighter than the area outside. Filter 285344 was cited under tamper code 2, filter 510557 was a no-call. Thaxton reviewed the filters at the hearing and testified:

> The filter on the right [285344] does exhibit what I would class as a code 2 type appearance . . . . The filter on the left, 510557, to be able to tell you . . . why it's a code 11 there is insufficient information being given to me with just the filter to tell me why that was coded as an 11.

Tr. 770. The dust data card for no-call filter 323857, R-1461A, was shown to Thaxton who found "nothing [on] here that indicates anything other than a normal dust sample that I can tell at this time." Tr. 784. I viewed the filters and the photographs and find no significant differences in the appearance of the filters considering the criteria in Thaxton's tamper codes.

Photographs of filters 462514 and 406735 are displayed on pages 10 and 11 of R-1643. Both were cited under tamper code 2. Filters 323857, 305291, and 268680, also photographed in R-1643, were no-calls. In my judgment, there are no significant differences in terms of Thaxton's tamper code criteria in these filters.

Filter 325301 was cited under tamper code 7; filter 324931 was a no-call. See photographs on page 12 of R-1643. The appearances are not significantly different in terms of Thaxton's tamper code criteria. Filter 305727 was cited under tamper code 2; filter 327749 was a no-call. See photographs on pages 12 and 13 of R-1643. Again the appearances are not significantly different in terms of Thaxton's tamper code criteria.

Thaxton reviewed thousands of filters. He determined that approximately 5000 should be cited and that thousands more should not be cited. I have reviewed photographs of the cited filters, the no-calls, and the normal compliance filters. I have considered his testimony concerning the filters cited under the different tamper codes. The above discussion shows that Thaxton was not 100 percent consistent in the application of his tamper code criteria. However, for the purposes of a decision on the common issues trial, perfect consistency is not required or expected. I find that Thaxton's determinations as to whether a filter should be cited under his tamper code criteria were sufficiently consistent so that I must consider whether an AWC establishes a violation.

IV. THAXTON TAMPER CODES vs. SCIENTIFIC EXPERT CLASSIFICATIONS

A. THAXTON TAMPER CODES vs. MARPLE DUST DISLODGMENT PATTERNS

Dr. Virgil A. Marple, working with Dr. Kenneth L. Rubow, both of the University of Minnesota, subjected dust laden filters to various experiments and classified them into various types according to their dust dislodgment patterns. Dr. Marple was not aware of Thaxton's tamper codes at the time he classified his experimental filters.

Marple's types A-1, A-2, and A-3 resulted from air flow through the filter in the reverse direction (through the outlet). Marple's type A-1 is described as having a sharply defined ring 6 millimeters in diameter with a center lighter than the outer portion of the filter and a white "dagger" extending from the perimeter of the 6-millimeter ring to the center of the filter. Types A-2 and A-3 are variations of type A-1. The descriptions and the experimental filters so classified resemble Thaxton's tamper codes 1, 2, and 7 (and 3 if a cone is shown). Marple did not address tearing in the central part of the filter and has no type analogous to Thaxton's tamper code 4.

Marple's types B-1 and B-2 were created by directing air into the inlet of the cassette. Type B-1 is described as a white, circular spot in the center of the filter of irregular diameter and often an area within the white spot containing a darker deposit. Type B-2 shows a circular, white spot of a more uniform diameter with no darker deposit within the spot. Type

B-1 resembles Thaxton's tamper code 8; type B-2 looks most like Thaxton's tamper code 5.

Marple's type C was created by a vacuum applied to the cassette inlet. The resultant pattern resembles type A-2 but has a more uniform gray value in the light center. Type C resembles tamper codes 1 and 2 (and 3 if a cone is present).

Marple's type D was created by inserting a cotton swab into the cassette inlet and touching the filter face. The pattern is described as showing particles removed from the center of the filter in an area generally smaller than the inlet. In some cases swirl marks are seen on the filter. Type D resembles Thaxton's tamper code 9.

Marple's types E-1, E-2, and F were created by randomly dropping the cassettes. Type E-1 is described as larger in diameter and less sharply defined than type A patterns. Type E-2 is described as smaller in diameter with a less diffuse boundary than type E-1, and has a diffuse dagger in the center. Type F exhibits a thin, white ring 6 millimeters in diameter. Type E-1 may resemble tamper code 10. Type E-2 may resemble tamper code 7 and type F may resemble tamper code 1, but these resemblances are tenuous.

B. THAXTON TAMPER CODES vs. LEE TYPES AND FEATURE CODES

Dr. Richard J. Lee, President of the R. J. Lee Group, examined more than 1450 cited filters and videotapes of more than 1240 additional cited filters. Lee stated that he grouped the cited AWCs into five major types based on three variables: (1) a 6-millimeter ring resulting from contact between the filter and the 6-millimeter inlet ring on the aluminum foil; (2) a "keyhole" -- a wedge-shaped or circular-shaped, lighter area within the 6 millimeter, circular zone in the center of the filter; and (3) a diffuse zone -- a generally circular zone with dust dislodgment which can be within or extend beyond the 6-millimeter ring. Each feature appears with various degrees of intensity. Thus, AWCs could be considered, according to Lee, to represent a continuum.

Lee's type 1 exhibits a white ring with a nominal 6-millimeter diameter in the center of the filter. The remnant deposit of dust within the ring has a color and density similar to the dust outside the ring. The center deposit has a white, wedge-shaped or circular-shaped, lighter area termed a keyhole. Type 1 resembles Thaxton's tamper code 1.

Lee's type 2 shows a white ring with a 6-millimeter diameter in the center of the filter. The dust deposit enclosed by the ring has the same color but is significantly lighter in density than the dust outside the ring. The keyhole is often less distinct and sometimes appears irregular. Type 2 resembles Thaxton's tamper code 2.

Lee's type 3 has a circular, white center with a diameter of about 6 millimeters. Any remaining dust in the center is so light that characteristics, such as a keyhole, are difficult to discern. Type 3 is most like Thaxton's tamper code 2.

Lee's type 4 has a circular, light center about 6 millimeters in diameter, but the transition between the dust outside the center and that within is generally more irregular than types 1, 2, and 3. The particulate in the center is evenly distributed but usually shows a stippled or mottled texture. Type 3 most resembles Thaxton's tamper code 2.

Lee's type 5 shows some features of types 1 through 4, but is unique in some way -- water spots, white centers greater than 6 millimeters or some other irregularity. Type 5 is a catch-all category with a variety of appearances which cannot be characterized. The filter shown in R-1001 as a Lee type 5 was cited by Thaxton under tamper code 8.

Lee also characterized filters according to "feature codes" which he described as follows:

1. 6 = a distinct 6-millimeter ring
2. 9 = a distinct 9-millimeter segmented ring
3. K = keyhole (a wedge-shaped, lighter area) inside the 6-millimeter ring
4. R = a ring or series of resonance rings beyond the 9-millimeter area in the center of the filter
5. F = a partial, faint, or fuzzy feature combined with any of the above
6. B = spots, smears, or undefined dislodgment of large amounts of dust (a blotch)
7. O = other features
8. X = no discernible dust dislodgment

C. THAXTON TAMPER CODES vs. CORN CENTRAL DISCOLORATION

Dr. Morton Corn, Professor of Environmental Health Engineering at Johns Hopkins University, viewed about 100 cited filters of some 300 such filters selected by Thaxton at the Mt. Hope MSHA laboratory. Thaxton told Corn that the 300 filters represented the spectrum of AWCs. A consultant hygienist accompanied Corn and looked at a number of the filters. Photographs were taken of these filters.

Corn testified that he saw a wide range of features on the cited filters -- dark centers, partial dark centers, light centers, patterns in centers, patterns elsewhere, billowing patterns outside the center, artifacts of the handling process, etc. Corn concluded that the array defied confident classification by visual means. He considered categories and combinations of pattern, linear dimension, and depth of coloration, but concluded that it was not possible to visually classify AWCs.

D. THAXTON TAMPER CODES vs. McFARLAND CDC PATTERNS

Dr. Andrew R. McFarland, Professor of Mechanical Engineering at Texas A&M University, viewed the U.S. Steel Mining Co. cited filters -- 43 in all, in Arlington. Forty-two were cited under tamper codes 1 and 2, and one was cited under tamper code 9. They had four basic characteristics, though not all had all four, and on some the characteristics are not as fully defined as on others:

1. A 6-millimeter ring lighter than the average color on the rest of the filter.

2. The region in the 6-millimeter center is lighter than the average on the rest of the filter.

3. A dagger pattern within the 6-millimeter ring, lighter in color than any other portion of the filter.

4. Many filters had indentations or cuts or embossed areas in the ring where the filter had contacted the aluminum shroud. The cuts often can only be seen under a microscope.

After Thaxton's March 1992 reclassification McFarland studied the coning phenomenon. His report refers to patterns which have cones, dimples, or cuts as "CDC" patterns. McFarland examined the U.S. Steel filters which had been reclassified -- five were reclassified to tamper code 3, "cleaned and coned." McFarland concluded that three exhibited cones, one did not have a cone but had a cut, and one had a faint cone. One filter which was not reclassified had a cone and many others had cuts.

E. THAXTON TAMPER CODES vs. GRAYSON "Y" AND "N" CATEGORIES

Dr. R. Larry Grayson, Dean of the College of Mineral and Energy Resources at West Virginia University, examined more than 400 cited AWC filters of mine operator clients of Crowell & Moring. He also attended Thaxton's deposition. Grayson performed experiments on more than 740 compliance samples from 34 different mines operated by Crowell & Moring clients and classified the results as "Y" - probably a citable AWC, "Y?" - possibly a citable AWC, and "N" - not a citable AWC. He testified that his "Y" and "Y?" categories reflect the full range of AWCs that he observed in the cited filters.

Grayson subjected the experimental filters to sampling assembly impact tests and hose impact tests. He described the resulting "Y" and "Y?" filters as having a nominal, 6-millimeter diameter ring with a dust dislodgment pattern inside the ring, and dust loading outside the ring. He compared his experimental filters with cited filters and testified he did not see a substantial difference between the general features of his "Y" and "Y?" filters and the cited filters. The cited filters to which he compared his experimental filters were cited under tamper codes 1, 2, 3, and 9. Certain of the experimental and cited filters were compared at the hearing, and the filters in fact were not substantially different.

V. DOES AN AWC ESTABLISH TAMPERING?

A. THE SECRETARY'S EVIDENCE

1. THAXTON

Robert Thaxton, an MSHA Industrial Hygienist, has a bachelor's degree in analytical chemistry and a master of science degree in occupational health and safety engineering. He has been employed as an industrial hygienist for about 16 years. Thaxton was accepted as an expert witness in respirable dust sampling and in determining normal and abnormal dust patterns on respirable dust filters. However, since the accuracy of his determination of citable tampering is the precise issue in this proceeding, his expert opinion is not disinterested, and must be evaluated with that fact in mind.

Thaxton's judgments that certain dust dislodgment patterns establish tampering are based in part on the reverse air experiments he performed in 1983 when 25 to 50 filters were subjected to different kinds of reverse air flow tests, and on various tests he performed beginning in February 1989 and continuing until the fall of 1990. During this period, he subjected dust laden filters to various experiments described previously herein. The tests were non-systematic and not conducted with any scientific rigor. Consequently, Thaxton's expert opinions are of diminished weight. The two formal studies, one conducted by the PHTC and the other at West Virginia University at MSHA's request, though reported, were not offered in evidence. A further problem with Thaxton's determinations is his failure to note in his classification of cited AWC filters the phenomenon described by other witnesses as a "dagger" or "keyhole" -- a white area within the central 6-millimeter area enclosed by a white ring. Thaxton noted such a condition only in the filters classified under tamper code 7 (63 filters were so classified). A review of the cited filters classified under tamper codes 1, 2, and 3 (4849 in all) shows that the vast majority display such a condition.

2. MARPLE/RUBOW

Dr. Virgil A. Marple is a Professor of Mechanical Engineering at the University of Minnesota and a participant in the Generic Mineral Technology Center for Respirable Dust, a consortium composed of Pennsylvania State University, West Virginia University, University of Minnesota, Massachusetts Institute of Technology, and Michigan Technological University, and funded in part by the United States Bureau of Mines. He has a Ph.D. in mechanical engineering from the University of Minnesota, specializing in aerosol particle technology. He was accepted as an expert witness in the fields of mechanical engineering, aerosol physics, particle technology, and coal dust research. Dr. Kenneth L. Rubow is a Research Associate and Manager of the Particle Technology Laboratory and Associate Director of the Center for Filtration Research at the University of Minnesota Department of Mechanical Engineering. He has a Ph.D. in mechanical engineering from the University of Minnesota, specializing in aerosol science and particle technology. Dr. Rubow was accepted as an expert witness in the fields of mechanical engineering, aerosol physics, particle technology, coal dust research, and filtration research. The work and reports of Drs. Marple and Rubow were reviewed and critiqued (orally) by Dr. James Vincent of the University of Minnesota and Dr. Dale Lundgren of the University of Florida. Because neither Dr. Vincent nor Dr. Lundgren participated in the experiments of Drs. Marple and Rubow, because they did not submit any written reports, and because they did not testify at the trial, the hearsay evidence as to their opinions is of very limited value.

a. Preliminary Studies

Initially, Drs. Marple and Rubow examined the relative "pressure drops" (the difference in pressure between two points in an air flow) through the various elements of the personal dust sampler with an air flow rate of 2 liters per minute. They concluded after testing randomly selected samplers that the highest pressure drop element in the sampling system is the filter. This was confirmed by monodisperse particle deposition studies and polydisperse particle deposition studies. From these studies they concluded that dust is normally deposited uniformly on the filter with a slight tendency for larger particles to concentrate near the center. Therefore, normal dust sampling in a coal mine using the MSA sampler will not result in a white center on the filter.

In their particle dislodgment studies Marple and Rubow determined that a jet of air directed through the filter cassette from the outlet ("reverse air") causes the filter to move toward the inlet because the pressure drop through the filter causes the air to flow uniformly. Just before the filter contacts the lip of the foil near the inlet, the air flows radially inward over the filter and out through the inlet. This causes removal of dust particles and a white ring in the center. The ring is the same dimension as the inlet diameter, approximately 6 millimeters. Where the filter is pressed tightly against the foil lip, an opening must be formed for the air to escape. This in turn produces a high velocity jet of air which dislodges particles in a white dagger shape inside the white ring. The amount of air movement required to remove particles from the center of the filter is quite small if the movement is in the form of a pulse. The same effect can result from introducing a vacuum source into the cassette inlet. Air directed into the inlet also causes dislodgment but the white center is much larger and may include the entire center area of the filter.

Marple and Rubow impacted filter cassettes by hand on a table top, with the plugs removed; this resulted in the removal of a thin, round ring of dust particles where the filter had touched the foil. Ordinarily the ring was more diffuse and wider than that caused by reverse air flow.

Marple and Rubow were of the opinion that the "threshold velocity" (the velocity required to remove particles from the filter) is the overriding parameter in determining dust dislodgment. The threshold velocity is a property of the dust particles on the filter and varies from filter to filter. When the tangential air flow through the cassette becomes larger than the threshold velocity, dust dislodgment occurs. Threshold velocity can vary from mine to mine and from location to location within the same mine.

Marple and Rubow attempted to characterize the patterns of dust dislodgment in an objective way. They took video images of the filters with a camera attached to a TV screen and a computer. Each filter was digitized into 153,000 pixels[3] and a grayness value of between 1 and 256 was assigned to each pixel. The computer printed out a graph and a digital image which they called a fingerprint. Dr. Marple testified that the fingerprint combined with a visual inspection of the filter provided a powerful and accurate tool in identifying the pattern of particle dislodgment. Subsequent witnesses who used digital analysis

[3] A pixel is defined as a picture element. The video camera creates a digitized image consisting of a number of small elements of equal area. Each of these areas is a pixel.

criticized Marple's fingerprint because it had only two values and because he used inferior equipment. I find that for Dr. Marple's purposes it was adequate, and it provided intelligible data to the court.

b. Systematic Dust Dislodgment Studies

Drs. Marple and Rubow conducted a series of systematic studies of particle dislodgment (Pitt-1 and Pitt-2) at the PHTC in approximately September and December 1991. Seven hundred and forty filters taken from MSHA's compliance program from 10 MSHA districts throughout the United States were subjected to various tests. The tests were performed in two sets, approximately 3 months apart, with 435 filters in the first set and 305 in the second. The filters used in the tests were visually examined for particle dislodgment and those exhibiting such dislodgment were not tested. The capsules had been weighed by MSHA and were again weighed by Marple before testing. After testing they were again weighed, photographed, and transported to Marple's laboratory for digitizing and classification by Marple. Twenty filters from the first set and 60 from the second set were selected as control filters and not subjected to testing.

Sixty-four filter cassettes were subjected to reverse air flow tests -- air was blown by mouth through a tube inserted into the cassette outlet; air was introduced by pressure through a valve and into the outlet; and a vacuum was introduced into the inlet. In all cases the pressure drop and flow rate were measured, the cassette was opened, the capsule weighed, the filter examined, placed in a petri dish, and photographed. Marple types A-1, A-2, and A-3 were found on 45, five, and six respectively. There were five type F patterns and three showed no effect.

Ten filter cassettes were subjected to air flow through the cassette inlet, either through a tube inserted into the inlet or from 1 inch away. Type B was found in four of five when the tube was inserted into the inlet; type B-2 was found in five of five when the tube was 1 inch away. Twenty filters were subjected to a rapid decrease in air pressure, 10 in containers and 10 without containers. The pressure was equivalent to the pressure decrease at 49,000 feet. No dust dislodgment patterns resulted.

Seventy filters were subjected to tests involving disconnecting the air line at the pump or from the cassette outlet with the pump on, and a finger on the cyclone inlet. The finger was withdrawn to let the air rush back in. No reverse air flow patterns resulted. Only two type E-1 patterns were found.

Two hundred and ten filter cassettes were subjected to random drop tests from 3 feet and 6 feet to an asphalt tile covered concrete floor. They were dropped in various configurations: with all plugs in; with all plugs out; with inlet plugged and outlet open; with outlet plugged and inlet open; with inlet down; with outlet down; and with side down. A type E pattern resulted in 35 cassettes; type E-2 in two cassettes, type F in three cassettes. The dislodgment pattern was quite different than the reverse air flow patterns in that it was larger in diameter and less sharply defined. In a second set of drop tests, 70 cassettes were dropped with the inlet down from a height of 5 feet. Dust dislodgment patterns resulted in 55 cassettes: 43 were type E1, one was type E-2, 11 were classified as other.

Twenty tests were performed dropping the entire sampling assembly from heights ranging from 3 to 6 feet. A type E-1 pattern was found in 11 of them.

Ten filter cassettes were tested by touching the filter with a cotton swab inserted into the cassette inlet and moving the swab over the filter surface. A type D pattern resulted in each of the filters.

Twenty filters were tested with a combination reverse air flow and impact test. The cassette was impacted on a table top or with a screwdriver handle while air was flowing in the reverse direction through the cassette. Fifteen had particle dislodgment patterns; seven were type A-1, one type A-2, three type E-1, two type F, and two other.

Twenty filters were tested by removing the pump inlet and outlet valves and the dampener and attaching the cassette to the tampered-with pump and allowing it to run for 30 seconds. No dislodgment patterns resulted.

Twenty cassette filters were subjected to a snap cassette closed test which had been suggested by MSHA. Reverse air dislodgment patterns were found on seven filters.

c. Coal Mine Dust vs. Laboratory Dust

As I stated earlier, Marple and Rubow believe that the threshold velocity of the dust was of overriding importance in their testing. They have worked with wind tunnels and dust chambers and believed that they could not duplicate in a tunnel or chamber the kind of dust found in coal mines. For this reason they used filters from the compliance program -- from a number of different mines from all 10 MSHA districts. Marple and Rubow measured and compared the threshold velocity of particles on filter surfaces containing coal mine generated dust and laboratory generated dust. The coal mine generated dust was collected on filters by MSHA field offices -- 388 such filters were returned to PHTC and were called special test filters. Thirty were used in the threshold velocity tests. They were compared with 18 laboratory loaded filters from Drs. Lee, McFarland, and Yao (Shell). The velocities required to create particle dislodgment from the mine-generated samples varied from 30 to 140 centimeters per second. The velocity required to create particle dislodgment with the lab-generated samples was consistently about 30 centimeters per second. Dr. Marple concluded on the basis of these tests that in general dislodgments were easier to create on laboratory prepared dust samples than on mine prepared dust samples. Lab-generated dust samples do not provide the mix of threshold velocities required to simulate mine samples.

d. Marple Classification of Dust Dislodgment Patterns

Following his threshold velocity studies, his digitized fingerprints of filters, and his Pitt-1 and Pitt-2 experiments, Dr. Marple classified dust dislodgment patterns into six major types, some of which had subordinate categories.

Type A patterns resulted predominately from reverse air flow tests. In type A, type A-1 was the most common. Marple classified as type A-1 patterns those with a 6-millimeter, white ring in the center of the filter, some type of dagger formation within the ring, with the dust inside the ring of a lighter color than that outside the ring. He classified as type A-2 patterns those exhibiting a 6-millimeter, central dislodgment with a fairly uniform coloring across the center. Neither the white ring nor the dagger formation were "predominate," but the ring was very sharp and there appeared to be a "V" through the central portion of the dislodgment. He classified as type A-3 patterns those exhibiting a very light but sharp, 6-millimeter, narrow ring around the outside, and a dagger formation inside the ring. The color inside and outside the ring was the same.

Type B patterns resulted from blowing air into the inlet of the cassette. The type B-1 pattern exhibited a rather large, diffuse area in the center, "not extremely circular," where the particles have been removed. The type B-2 pattern also had a very diffuse, white center somewhat smaller than B-1, and was fairly uniform in color.

The type C pattern resulted from introducing a vacuum source by way of a tube inserted into the inlet. The pattern was quite circular with sharp, crisp edges and a uniform gray value across the bottom not unlike the type A-2 pattern.

The type D pattern resulted from inserting a cotton swab into the cassette inlet and twisting it. Spiral lines were caused if the swab was twirled. The dislodgment was generally less than 6 millimeters in diameter.

The type E pattern resulted from the dropping experiments, both random and controlled. The type E-1 pattern was rather diffuse, and donut-shaped with diffuse outer and inner surfaces. There was a wide variety of E-1 patterns. The type E-2 pattern showed a dagger in the center going across the internal section of the dislodgment. It was more diffuse than the type A patterns.

The type F pattern, also resulting from the drop tests, exhibited a very thin, white ring with a little dip in the fingerprint.

e. Dust Dislodgment and Weight Loss

The filters exhibiting dust dislodgment patterns as a result of the Marple/Rubow experiments (sets 1 and 2) generally showed a weight loss. See G-280, tables 5.1 and 5.2. The average percentage loss varied from 0.7 percent, for the test involving disconnecting the air line from the cassette outlet with the pump on and a finger over the cyclone inlet, to 23.6 percent, for the test involving air blown into the inlet through a tube. The control filters used in set 1 showed a 1.3 percent weight loss and those used in set 2 showed a 0.9 percent weight gain. Filters used in the test involving removal of the pump inlet valve and flow dampener using the Model G pump showed a 1.5 percent weight gain. Filters used in the test involving a rapid decrease in air pressure surrounding the cassette in a container, in the test involving a 3-foot control drop with all plugs out, and in the test involving the air line disconnect with the pump on and a finger on the cyclone inlet, all showed no loss or gain in weight. Of the 700 test filters used by Marple and Rubow in their experiments, about 250 showed a dust dislodgment pattern. Of this number approximately 220 showed a weight loss, 20 a weight gain, and 10 no change. Of the approximately 75 type A dislodgment patterns, about 70 had a weight loss, two a weight gain, and three no change. Of the approximately 110 to 115 type E patterns, 100 had a weight loss, about 10 to 12 a weight gain, and one no change. Dr. Marple explained the weight gain on the filters with dislodgment patterns as due to "uncertainty in the measurements of the weight." Tr. 3070. The A-1 patterns showed an average weight loss of 13.4 percent; A-2, 16.3 percent; A-3, 0.6 percent; E-1, 10 percent; E-2, 6.3 percent; F, 0.2 percent gain; others, 13.2 percent loss.

f. Filter-to-Foil Distance and Filter Floppiness

Drs. Marple and Rubow directly measured the filter-to-foil distance of about 1040 unused filters from MSHA field offices. The filters were manufactured in 1988, 1990, 1991, and 1992. None were available from 1989. They were measured with a laser measuring device and measurements were taken (1) "out of the box;" (2) when 2 liters of air was pulled through the filter;

(3) with a small amount of pressure on the back side; and (4) when the pressure was released. The filter-to-foil distance for 31 1988 filters averaged 1.57 millimeters; for 280 1990 filters, 1.13 millimeters; for 439 1991 filters, 1.29 millimeters; and for 274 1992 filters, 0.87 millimeters. The 31 1988 filters were largely manufactured on the same day, June 9, 1988. Marple and Rubow conclude that the filter-to-foil distance has not increased with time for the examined filters having manufacturing dates in 1988, 1990, 1991, and 1992. But see exhibits G-253A, 255A, 257A, 259A, 260A, 261A, 262A, 263A, 265A, 266A, and R-1068, 1069, 1070, and 1071 which indicate a tendency for larger filter-to-foil distances over time between April 1988 and May 1992.

The floppiness of the filters was determined by measuring the difference in filter distances between when the filter was pressurized in reverse direction by 1 inch water and when 2 liters per minute was pulled in the correct direction through the cassette. The floppiness has not decreased over time and there is some indication that it has increased.

Of the 1040 filters which were measured, 400 were sent to have dust collected from mines; 388 were returned. These are referred to as special test filters. In one group the filter-to-foil distance before and after loading are in good correlation. In the other group, filters have a larger filter-to-foil distance after sampling than before. This indicates to Marple that large filter-to-foil distances after loading do not indicate the extent of the filter-to-foil distance before loading.

The special test filters were subjected to certain systematic studies (Pitt-3 experiments). In the hose step tests, a 230-pound individual wearing size 10-1/2D mining boots walked in a normal walking pattern on a hose. No dislodgment resulted. When the same individual stepped on the hose with maximum stomping force with the toes pointed toward the filter, dislodgments resulted as they did when he stepped on a hose in a heavy manner with his toes directed toward the filter. When a 30-pound tool box was dropped on a hose from a height of 6 inches, only one dislodgment occurred on 20 cassettes tested. When an individual sat on a hose as hard as he could, seven of 25 cassettes tested showed A-3 patterns; 17 showed no dislodgment. No effect resulted from the same individual leaning back against a wall with the hose wrapped around him. Marple also performed two desiccator tests, using 40 capsules in each. Only two filters showed any dislodgment patterns and they were unlike any in Marple's classification. Wrapping the hose around the pump and throwing the pump on a table from 6 feet caused dislodgment patterns in only two of 60 cassettes tested.

Marple and Rubow performed additional threshold velocity tests, using the special test filters, lab filters from Lee, McFarland, and Yao, and filters from the compliance program. The

100 lab dust filters had a threshold velocity of from 0 to 40. Thirty of the mine dust filters had threshold velocities of from 0 to 40; 24 of from 40 to 80; 33 of from 80 to 120; and 12 of over 120.

g. MSA Documents

Dr. Rubow reviewed certain documents from MSA, particularly R-1100 to 1191, in which manufacturing defects and problems were disclosed and discussed. In Dr. Rubow's opinion, changes in the filter and backing pad pressure drops would not render the filter susceptible to the formation of dust dislodgment patterns in the center of the filter under reverse air flow or reverse air pulse situations. Dr. Rubow conceded that a sustained reverse air flow on a filter with higher resistance would tend to cause the filter to flex, but this is not the case, in his opinion, with a reverse pulse.

h. Marple/Rubow Conclusions

1. **Dust dislodgment patterns on filters cannot occur naturally in the operation of a personal dust sampler in a coal mine environment.**

2. **The primary mechanism for removing dust from a filter is the tangential air flow being larger than the threshold velocity of the dust on the filter.**

3. **The most probable cause of type A patterns of dust dislodgment on filters is reverse air flow.**

4. **The easiest method for producing reverse air flow to create an type A pattern is blowing through the filter outlet.**

5. **Type A patterns most probably result from deliberate mishandling.**

6. **The most probable cause of type E patterns of dust dislodgment on filters is impact.**

7. **Type E patterns most probably result from accidental mishandling of sampling equipment.**

8. **The operation of the desiccator at PHTC is not a source of dust dislodgment patterns.**

9. **The shipment of compliance samples by airplane is not a probable cause of dust dislodgment patterns on filters.**

10. **Cone formations on filters are probably caused by reverse air flow.**

11. Impacts to the hose on MSA sampling units most probably do not create dust dislodgment patterns. However, Marple's Pitt-3 tests showed that 28 out of 119 filters subjected to hose impact tests resulted in dust dislodgment patterns. See G-282, table 1.

12. Snapping a cassette shut is not a probable cause of dust dislodgment patterns on filters. However, Marple's Pitt-2 study reported that snapping the cassette closed can create a dislodgment pattern on the filter. Twenty cassettes were tested in this manner and reverse air flow dislodgment patterns were found in seven filters.

13. A dust dislodgment pattern on a filter indicates that there has been a weight loss on the filter. But see page 24, <u>supra</u>, on which it is indicated that in some instances no weight loss occurs; in fact some filters show a weight gain after a dust dislodgment.

14. Mine dust is preferable to lab dust in studying the problem of dust dislodgment patterns on filters.

15. Manufacturing variables such as filter-to-foil distance and floppiness are not probably contributing factors to dust dislodgment patterns. But see Marple's testimony at Tr. 2803-04.

> Q. . . . [Y]ou found a wide range in response among the filters in how they flexed in response to the reverse airflow; is that right?
>
> A. I would say not probably on how they flexed, but when they touched the inlet, how high they got up, yes.
>
> Q. And you believe that it's the variation between different filters which produces these differences, isn't that right . . . ?
>
> A. I would say this is related back to the floppiness of the filter . . . .
>
> Q. . . . You believe that its variations between different filters . . . in how they respond to the reverse airflow?
>
> A. I think it would be variations in the floppiness.

Dr. Marple also testified that floppiness, and the distance between the filter and foil could be influential in the formation of cones on a filter. Tr. 2821-42.

> A. So I still believe that that would be a factor, that floppiness should be a factor.
>
> Q. And then I asked should be a factor in influencing dust dislodgement?
>
> A. Correct.
>
> Q. And then I asked "and that a more floppy filter would be more prone to forming a dust dislodgement pattern" and you answered --
>
> A. That's right.

3. <u>McCAWLEY</u>

Dr. Michael A. McCawley, employed as Team Leader, Research Team, Environmental Investigations Branch, National Institute of Occupational Safety and Health (NIOSH), testified as a rebuttal witness for the Secretary. Dr. McCawley has a master's degree in air pollution engineering from West Virginia University, and a Ph.D. in environmental health from New York University. He teaches courses in air pollution and aerosol science at West Virginia University as an adjunct professor. His work includes taking and processing samples of particulate matter including coal dust. He was accepted as an expert witness in the fields of aerosol sampling and respirable coal dust sampling and processing for NIOSH.

Dr. McCawley was involved in the preparation of a report, including tables and a chart, responding to a request from Senator Arlen Specter. Senator Specter requested, <u>inter alia</u>, that NIOSH determine the amount of dust that could be removed from a filter sample by tampering, and whether others had performed tests on tampered samples to determine the amount of dust that could be removed.

Dr. McCawley and others at NIOSH performed two tests involving 20 filters which had been loaded with coal dust in a dust chamber. The dust had been collected as an airborne sample from a coal mine in the Pittsburgh coal seam some years previously. The PHTC study and the West Virginia University study of Dr. Myers were referenced in NIOSH's report to Senator Specter, but were not relied upon. Eight filter cassettes were used in the first test. Each loaded cassette was tapped two or three times on the side of a table. Then with both caps off McCawley (and his co-worker Frank J. Hearl) "blew about as hard as you would blow to blow up a balloon" into the cassette outlet. Tr. 8933. This produced a puff of dust out of the inlet. The cassettes were weighed before and after sampling and again after the "tampering" (testing). Some of the test filters were lightly loaded (sampled for 6 hours); some were heavily loaded (sampled for 12 hours). Eight additional cassettes were used in the second test. They were tapped two or three times on a desk and then an MSA sampling pump was attached to the inlet to suction off dust. The person conducting the test placed his thumb over the outlet "and pulsed the air through two to three times . . . ." Tr. 8933. On cross-examination, Dr. McCawley changed his estimate to four times. The loading and weighing processes were the same as in the first test. There were also four filter cassettes used as controls.

The dust removed as a result of the two tests varied from 0.08 milligrams (over 5 percent) to 1.12 milligrams (34.25 percent). The control filters showed essentially no change in weight. In Dr. McCawley's opinion, the weight loss due to the tests is statistically significant. The average weight loss for the filters subjected to the first test was 10.27 percent, and for the filters in the second test, 16 percent. According to the series numbers the filters used appear to have been manufactured in 1988.

4. MILLER

Dr. John J. Miller is an Associate Professor in the Department of Applied and Engineering Statistics at George Mason University. He has a Ph.D. in statistics from Stanford University. He was accepted as an expert witness in the field of statistics.[4]

Miller used as his database, MSHA's Denver database including a record of all dust samples processed between August 8, 1989, and March 31, 1992, Thaxton's database including

[4] The LDCC argues that statistical evidence has no probative value in this case. I answered this contention in part in my order denying Contestants' motion to exclude the testimony of Dr. Miller. Statistical evidence alone obviously cannot prove causal relationships. "Even when the correlation is very strong and predictions are firm, we cannot use that fact to prove that one variable causes the other . . . ." Derek Rowntree, Statistics Without Tears 188 (1981). Nevertheless, statistical evidence can be helpful in explaining probable relationships between variables, and it has long been accepted as probative in the federal courts. Hazelwood School District v. United States, 433 U.S. 299 (1977).

all filter samples submitted to Thaxton with the tamper code assigned to each by Thaxton, all mines in the Denver database from the MSHA Norton subdistrict, all Peabody mine IDs, all mine IDs of companies (or officers of companies) which pled guilty to criminal charges of submitting fraudulent samples, all abatement samples, and records from MSA Corporation showing the date of manufacture of the filter cassettes. With this database, Miller performed certain statistical tests. He created three variables for his subsequent analyses, each of which had three possible values: "before," "after," or "missing." Before-A version was "before" if the sample date or the processing date was on or before March 19, 1990. If the dates were known and were not on or before March 19, 1990, before-A was "after." If both dates were missing, before-A was "missing." Before-B version was defined in the same way except the cutoff date was March 31, 1990. Before-C version was used to delete the observation of sample dates between March 19, 1990, and March 31, 1990.

a. Whether the Rate of Cited AWCs was Random

First, Dr. Miller performed a chi-square (χ^2) analysis of cited rates to determine whether the rate of cited AWCs was random as between mines. For purposes of the analysis, the null hypothesis[5] is that the rate of AWCs is the same at each mine. The test shows a P-value of 1×10^{-72} which is overwhelming evidence against the null hypothesis.[6] The conclusion is that the phenomena generating cited cassettes are not random or the likelihood of cited cassette generation is very heterogenous, with some mines much more prone to generate cited cassettes than others. Similar tests involving only cassettes whose sample date is before March 20, 1990, and before April 1, 1990, and tests excluding mines in the Norton subdistrict and excluding abatement samples all result in overwhelming rejection of the null hypothesis.

In Dr. Miller's opinion, the results of these tests exclude mailing as a cause of the cited AWCs, assuming that the Post Office handles the cassettes mailed to MSHA in essentially the

[5] "The hypothesis being tested is called the null hypothesis . . . . If the condition specified under the null hypothesis is rejected by the test, the condition is assumed to be false." Wayne C. Curtis, Statistical Concepts For Attorneys 119 (1983).

[6] The "P" stands for probability. The P-value is the statistical measure of the consistency between the null hypothesis and the observed data: P-values are always numbers between 0 and 1. P-values close to zero are not consistent with the null hypothesis.

same manner. The results also rule out handling in the PHTC as the cause of AWCs assuming it does not handle cassettes from different mines in a different manner.

b. Tests for Sample Date vs. Cited Rate

Miller then performed a number of analyses of sample date vs. cited rate. The purpose of these analyses was to determine whether there was any inhomogeneity through time in the rate of cited cassettes, and, more particularly, whether there was any change in the cited rate occurring on or about March 19, 1990, when the AWC void code was instituted. The results show a Z-score[7] of over 80. This is overwhelming evidence that the null hypothesis (no difference in the before and after cited rates) is not correct.

Dr. Miller concluded that (1) there seems to be a trend to decreasing cited rates over time; and (2) there seems to be a marked decrease in the cited rate on or about March 19, 1990. This could be due to a behavior modification at the mines leading to a decrease in the cited rate or to a systematic change in the cassettes over time. The data are not consistent with a hypothesis of randomness with homogeneous rate over time.

c. Cassette Manufacture Date

Dr. Miller then did an analysis of sample date vs. cited rate adjusting for cassette manufacture date. The adjustment assumed that cassettes manufactured on the same date or on temporally close days would exhibit similar properties. He used a statistical test called the sign test, and used both the analysis data set and the reduced analysis data set in versions A, B, and C. In all cases the results were extremely small P-values and, thus, an overwhelming rejection of the null hypothesis. Dr. Miller thus concluded that there is overwhelming evidence of a definitive change in the cited rate between "before" and "after" even after adjustment for manufacture date. Because of potential bias resulting from the fact that there is a difference in the number of samples in the before and after period for any individual date of manufacture, Dr. Miller did a bootstrap analysis.[8] The analysis did disclose such a bias, but it is a small one. The null hypothesis (that date of manufacture

[7] A Z-score of more than 2 or 5 translates into an extremely small P-value. The P-value corresponding to a Z-score of 80 is less than 1.0×10^{-72}.

[8] A test using hypothetical data enforcing the null hypothesis to be true. The test is designed to determine the effect of potential bias resulting from unequal variables.

makes a difference) is still not consistent with the data. Therefore, adjustment for manufacture date does not explain the large differences in cited rates before and after March 19, 1990, or March 31, 1990.

Dr. Miller did a test to determine whether the difference in cited rates is explained by whether the cassettes were manufactured before or after January 1, 1990. The null hypothesis is that the hypothetical rate of citations for cassettes manufactured before January 1, 1990, is the same as the hypothetical rate for cassettes manufactured January 1, 1990, and after. Following a bootstrap analysis to enforce the null hypothesis, he concluded that there is little or no evidence that holding the sample date constant, there is no difference in before and after January 1, 1990, in terms of manufacture date and cited rate. Therefore, the date of manufacture does not explain the observed difference when analyzing sample date before and after March 19, 1990, or March 31, 1990. The observed difference in cited rate for cassettes manufactured before and those manufactured after January 1, 1990, is explained by an adjustment for sample date.

d. Filter-to-Foil Distance and Floppiness

For Dr. Marple's Pitt-3 experiments, Dr. Miller allocated 400 filters by (1) year of manufacture (there were none from 1989); (2) filter-to-foil distance, as measured by Marple; and (3) floppiness as measured by Marple; to be sent to the MSHA district offices for dust loading. After the Pitt-3 experiments, Miller did a logistic regression to determine whether the possibility of citable dislodgment (using Thaxton's calls) could be predicted using the type of experiment and either the filter-to-foil distance or floppiness, or both. The results failed to show any statistically or marginally statistically significant relationship between filter-to-foil distance or floppiness and citable AWC formation. However, the piston test data did show a significant effect of both filter-to-foil distance and floppiness on dust dislodgment: larger filter-to-foil distance was associated with larger probability of dislodgment, and larger floppiness was associated with larger probability of dislodgment. The strength of the floppiness relation was much greater than that of the filter-to-foil distance. (This conclusion of Miller refers to Marple's calls on dislodgment, not Thaxton's calls on citable AWCs).

e. AWCs and Weight Loss

Miller did a formal statistical analysis to determine whether a weight loss was associated with reverse air AWC formation. He studied compliance filters (including operator filters and inspector filters), and special filters separately. The statistical null hypothesis is that the average weight change in the control group is the same as in the experimental group. The statistical analysis is an analysis of variance. Because the four groups had unequal numbers of filters, Dr. Miller did a least squares means analysis: an estimate of the mean that the group would have had if the sample sizes in all the groups were the same. Least squares means are the statistically appropriate things to compare if averages are being compared as here. The analysis took into consideration the fact that the filter weights differed: some were lightly loaded; some heavily loaded. The conclusion is a rejection of the null hypothesis: there is a greater weight loss for the experimental group. Some filters do not show a weight loss with an AWC, but the likelihood that an AWC filter will have a weight loss is greater than the likelihood that it won't.

f. Miller Conclusions

1. The cited AWC phenomenon is not a random occurrence.

2. A mechanism or event which is equally likely to occur at all mines is not responsible for the observed pattern of cited AWCs.

3. There was a decrease in the rate of cited AWCs at about the time of the initiation of the void code in March 1990.

4. The observed drop-off in the rate of the cited AWCs is not due to a change in the quality of the cassettes over time.

5. Any potential mine-specific explanation for the occurrence of AWCs is not constant over time.

6. When filter cassettes have air blown through them in the reverse direction there is the likelihood of a weight loss.

B. THE MINE OPERATORS' EVIDENCE

1. LEE

Dr. Richard J. Lee is President of the R. J. Lee Group, an independent testing and research laboratory which, inter alia, engages in materials characterization. Dr. Lee has a Ph.D. in solid state physics from Colorado State University. He was accepted as an expert witness in physics, materials characterization and analyses, and environmental monitoring. I previously stated that Dr. Lee examined and evaluated more than 1450 cited filters and examined videotapes of more than 1240 additional cited filters. He classified them into five types previously identified in this decision. Approximately 34 percent were type 1, 46 percent were type 2, 6 percent were type 3, 7 percent were type 4, and 6 percent were type 5.

When Lee was cross-examined at trial with respect to filters he had previously classified, his trial classification agreed with his prior classification in only 10 of 35 filters, not an impressive batting average.

a. Svstematic Dust Dislodqment Studies

For use in his experiments, Lee generated over 3100 dust samples in the R. J. Lee Group dust tunnel. The coal used was from various coal seams and included high-vol, medium-vol, and low-vol coal. Samples included particle sizes within the same range as those from coal mines, and were of similar shape and aerodynamic diameter. Samples were collected under controlled temperature and humidity. In addition to the laboratory samples, Lee obtained over 650 dust samples from coal mines across the country. For each sample tested, Lee measured the filter-to-foil distance with a stereo optical microscope. For laboratory samples, these measurements were taken prior to testing both before and after dust loading. The tests were designed to simulate sample collection, handling, and processing.

Lee first conducted a series of cassette and cyclone impact tests. Cassettes were dropped from heights ranging from 3 inches to 4 feet; with caps in and with caps out; with secondary impact and without secondary impact. When cassettes were dropped from 4 feet with caps in and with secondary impact, AWC appearances indistinguishable from cited AWCs occurred in 33 percent of the samples with a filter-to-foil separation of less than 1 millimeter. When the filter-to-foil separation was greater than 3 millimeters, AWC appearances resulted in only 4 percent of the samples. Sampling heads (including cyclone and filter cassette) were dropped from heights ranging from 3 inches to 3 feet, some with secondary impact. When dropped from 2 feet with secondary impact, AWC appearances indistinguishable from cited AWCs occurred in 40 percent of the samples with a filter-to-foil distance of less than 1 millimeter. They occurred in only 8 percent of the samples when the filter-to-foil separation was greater than 3 millimeters.

Hose impact tests were performed using hoses that were soft, medium, and hard. AWC appearances occurred more frequently with soft hoses during the initial tests. Weights ranging from 1/2 pound to 10 pounds were dropped from heights ranging from 1 inch to 8 inches onto a sampler hose. When hoses were impacted by a 1-pound weight dropped from 3 inches to 1 foot onto a 1-inch length of hose, AWC appearances occurred in 67 percent of samples with a filter-to-foil separation of less than 1 millimeter. AWC appearances resulted in only 10 percent of the samples when the separation was greater than 3 millimeters. Filter-to-foil distance was the dominant factor affecting AWC formation. Capsules with a filter-to-foil distance of 1 millimeter or less were extremely susceptible to AWC formation. Potentially citable AWCs occurred both with the pump on and off. However, with the pump on and running at 2 liters per minute, impacts were less likely to produce AWCs. An important factor in the hose impact tests was the abruptness of the impact. Heavy tread on a hose with the foot perpendicular to the hose caused AWCs. Lighter treads were not capable of doing so. When the hose was wrapped around the pump and the pump placed down firmly on a countertop, it resulted in potentially citable AWCs when the pump was off and the filter-to-foil distance was small.

b. PHTC Handling and AWC Formation

Lee viewed an MSHA videotape, G-170, on PHTC procedures, and he inspected and videotaped procedures in the PHTC laboratory. He then designed tests to simulate the MSHA laboratory handling practices. Lee measured the rates of evacuation and recompression in MSHA's desiccator. He then performed a series of tests in his own desiccator using the same evacuation and recompression rates. In Lee's opinion, AWCs occurred when the capsule was close to the recompression port and at recompression rates possible in the MSHA desiccator. Subsequently, eight dust laden filter capsules were placed on a carrying tray from which they were picked up, stacked, and chucked into a cardboard box. This resulted in some cases in the formation of AWCs. Lee also conducted tests to simulate the rapid disassembly of the filter capsules at the PHTC lab. AWCs were formed as a result of these tests and considerable damage was done to the aluminum foils. Dr. Lee evaluated about 700 cited filters to determine the percentage that resulted from MSHA handling. It was his opinion that 5 to 15 percent were caused and 20 to 50 percent were contributed to by MSHA handling.

c. AWCs and Weight Loss

Forty-seven filters used in the hose impact tests which resulted in AWC formation were weighed before and after testing. Lee followed the MSHA weighing and calculation protocol. Twenty-eight of the filters showed no weight loss; 10 showed a weight loss, and nine showed weight gains. On the average no weight loss was recorded. Lee concluded that the formation of an AWC does not necessarily result in a reduction in filter weight.

d. Filter-to-Foil Distance

Lee measured the filter-to-foil distance on over 3000 filters newly purchased from MSA. The distances varied from about 0.1 millimeter to almost 5 millimeters. The measurements were made using a microscope with a computerized 3 axis state. The measurement is accurate to within 0.1 millimeter. After dust was deposited on the filters, the filter-to-foil distance was again measured. Two populations were found: one had a generally large filter-to-foil distance (about 3.7 millimeters), while the other measured about 1 millimeter. In some groups of filters, the measurement before loading was similar to that after loading; in another group, the measurement before was much smaller than the measurement after -- the latter were floppy filters.

Exhibits R-1068, 1069, 1070, and 1071 show the filter-to-foil distances in the experimental filters of Lee, Grayson, and Marple manufactured from April 3, 1988, to February 13, 1990, from February 20, 1988, to April 3, 1989, from February 13, 1990, to October 25, 1990, and from February 15, 1992, to May 28, 1992. See the reference to these exhibits in the Marple discussion, supra. There is a significant difference in the filter-to-foil distance after the 300,000 series (those manufactured from April 3, 1989, to February 13, 1990). Lee testified that the cited filters (from the 200,000 and 300,000 series) had shorter filter-to-foil distances than those he used in his experiments.

e. Filter-to-Foil Distance and Dust Dislodgment

In the 4-foot cassette drop test with secondary impact and caps in, 33 percent of 30 filters with a filter-to-foil distance of 0 to 1 millimeter were found to have potentially citable AWCs (Lee's type and feature 1 6K); 27 percent of 129 filters with a filter-to-foil distance of 1 to 2 millimeters were found to have potentially citable AWCs; none of 43 filters with a distance of 2 to 3 millimeters, 4 percent of 52 filters with a distance of 3 to 4 millimeters, and none of 5 with a distance of 4 to 5 millimeters were found to have potentially citable AWCs.

In the hose impact test using a 1-pound weight, with 1 inch of hose impacted and the pump off, 66 percent of 30 filters with a filter-to-foil distance of 0 to 1 millimeter, 12 percent of 8 filters with a distance of 1 to 2 millimeters; none of three filters with a distance of 2 to 3 millimeters, 12 percent of 30 filters with a distance of 3 to 4 millimeters; and none of nine filters with a distance of 4 to 5 millimeters were found to have potentially citable AWCs.

Lee concluded that cassettes with a short filter-to-foil distance have a higher degree of susceptibility to formation of AWCs either by reverse air pulses or mechanical impacts. In Lee's opinion, the filter-to-foil distance is the strongest factor in increasing susceptibility to AWC formation. Filters with short filter-to-foil distances before or after loading are more susceptible to AWC formation with small impacts or air pulses than filters with large filter-to-foil distances before and after loading. Filters with variable filter-to-foil distances, in that pre-loading and post-loading distances differ, are less susceptible to reverse air pulse AWCs than those with small distances. Lee is uncertain of the situation involving mechanical impacts. Filters with a larger filter-to-foil distance have a greater incidence of 9-millimeter standoff rings. Twenty to 24 percent of the filters tested by Lee (field and dust tunnel samples) had 9-millimeter standoff rings. One percent or less of the cited filters, and about 1 percent of the Peabody filters had such rings.

Lee examined the no-call filter population, some of the non-void filters, and some of the 5109 normal filters and concluded that some of the filters in each category were physically indistinguishable from the cited filters.

f. Lee Second Set of Experiments

One hundred and thirteen samples from various underground coal mines and 82 samples previously collected in the R. J. Lee dust tunnel were subjected to three different types of experiments. A weight of 1 or 2 pounds was dropped from heights ranging from 3 inches to 2 feet onto a known length of hose attached to a pump and cyclone. Of 31 filters tested, 18 exhibited AWCs. Pumps were dropped from heights of 4 inches to 1.5 feet onto a hose. The pumps weighed about 1.71 pounds. All the hoses were soft. Of the 20 filters tested, 14 exhibited AWCs. A hose was left hanging out of a cabinet door or drawer and the door or drawer was closed on the hose. Of the six filters tested, five exhibited AWCs. A person sat on a hose which was attached to the pump and cyclone. Of the 13 filters tested, 4 exhibited AWCs. The hose was wrapped around the pump and then impacted on a table. Of the five filters tested, five exhibited AWCs.

Hoses of soft, medium, and hard pliability were tested using filters with similar filter-to-foil distances. Of 17 filters tested, four used a soft hose, six a medium hose, and seven a hard hose. AWCs occurred on all of the filters using the soft hose, two using the medium hose, and none using the hard hose. All the samples were taken from the dust tunnel and used mid-vol coal from the Pocahontas No. 4 coal seam.

Lee concluded that hose softness or toughness is a significant factor in susceptibility to AWC formation on hose impacts.

Lee performed cassette snap tests: the cassette was snapped closed while the outlet was plugged or covered with a thumb. Thirty-four of the filters were still in the capsule. Twenty-five of them exhibited AWCs. Forty-five filters were removed from the capsule and put in the cassette before it was snapped closed. Thirty-two exhibited AWCs.

In another test, the hose was impacted to create a reverse air pulse with a thin, plastic sheet inserted between the capsule and the cassette outlet to prevent the flow of air through the filter. Of 24 filters tested, 17 exhibited AWCs.

g. Lee Coning Report

After Thaxton reclassified many of the cited filters in his tamper codes including 425 said to have evidence of cones, Lee examined 266 of the filters for coning. In some there was no discernible evidence of coning, including some with a dust disturbance in the 6-millimeter, central region. When dust has been partially removed from the front surface of the filter and the filter is wrinkled through the center, there may be an optical illusion of a cone. Manufacturing variabilities or mishandling during disassembly may contribute to coning. Cones were found on some of the inspector samples examined by Dr. Lee.

h. Lee Analysis of Marple Filter-to-Foil Study

Dr. Lee examined and analyzed photographs of the filters used in Dr. Marple's piston studies, groups 1 and 2, using the filter-to-foil measurements supplied by MSHA. Sixty-one filters were included, but Lee's analysis was limited to 57 because the others had no information regarding filter-to-foil distance after dust loading. With respect to group 1, including Marple's piston tests 1, 2, and 3, filters with a short (less than 1.6 millimeters) filter-to-foil distance pre-dust loading and post-dust loading (14 in all) exhibited AWCs in 50 percent of the cases. Filters with a shorter initial filter-to-foil distance and longer filter-to-foil distance after loading (10 filters) exhibited AWC characteristics in 10 percent of the cases. Filters with a long filter-to-foil distance before and after loading (three filters) did not exhibit any AWCs. Lee used his type codes to determine which filters exhibited AWC characteristics. With respect to group 2, Marple's test 4, filters with a short filter-to-foil distance before and after loading (13 filters) exhibited AWCs 50 percent of the time. Those with a short pre-loading distance and a long post-loading distance (14) exhibited AWCs 46.7 percent of the time. Those with a long distance before and after loading (three) exhibited AWCs 33.3 percent of the time. Combining the two groups: where the filter-to-foil distance was small before and after dust loading, AWCs resulted 50 percent of the time. Where it was small pre-loading and large after loading, AWCs resulted 32 percent of the time. Where it was large before and after loading, they resulted 16.7 percent of the time.

i. The 5109 Filters

Lee examined several thousand of the 5109 normal filters identified by MSHA. There were complete, identifiable, 6-millimeter rings on about 20 percent of those examined, and about 50 percent had indications of a partial ring. This would indicate that the filters come in contact with the foil on a regular basis and thus are "halfways on the way to being AWCs." Tr. 6276.

j. AWC and Weight Loss

Lee took apart a series of filters after dust had been deposited on them, weighed them, reassembled them, subjected them to tests, and reweighed them. He followed the formula prescribed by MSHA, which means the second decimal is truncated, e.g., a weight of 19.23 milligrams is recorded as 19.2 milligrams. Lee found that some filters showed a weight gain, some a weight loss, and some no change. Of the 47 filters measured, Lee found no weight loss on average.

Lee did an analysis of the dust weights reported for the 4900 cited filters recorded in MSHA document 405. The existence of gaps in the number of samples for each frequency interval results from MSHA's truncation process. Thus, in the 1 to 2 milligram range there will be about a "5 percent or greater intrinsic uncertainty in the dust concentration determination." Tr. 6306. Therefore, unless there is a weight change of more than 5 percent, one can't be certain that in fact there was a weight change.

k. Lee Conclusions

1. The primary mechanism for causing AWCs is not air flow through a filter, but a tympanic or mechanical wave. The impact of the filter at the foil causes a pulse through the filter resulting in "different effects and different amounts of dust dislodgement and different patterns." Tr. 6285-86. Tangential air flow may be a competing factor depending on the nature of the dust, the humidity, etc.

2. There are cited filters which can be directly attributed to MSHA's handling in the PHTC or other facilities where filters are disassembled.

3. Manufacturing variables, especially filter-to-foil distance, increase the susceptibility of filters to the AWC formation seen on the cited filters. A shorter filter-to-foil distance was seen on the cited filters than on those manufactured more recently.

4. Manufacturing variability continues to change. In the cassettes recently purchased and used for tests, there appear to be more filters with a filter-to-foil distance that varies substantially before and after

loading. There is also a higher incidence of 9-millimeter rings after loading.

5. Hose pliability is an important factor affecting the occurrence of AWCs.

6. MSHA's definition of what constitutes a citable AWC is subjective and inconsistent. (Tr. 6536 "consistent" should read "inconsistent.")

7. The appearance of a lighter area in the central region of the filter does not necessarily imply that there has been a reduction in the weight or the concentration pursuant to MSHA's method of calculation.

8. The presence of a 9-millimeter, segmented ring generally indicates a larger filter-to-foil distance and vice-versa.

9. AWCs can occur by dropping the pump on the hose from a height of 6 inches, closing a door or a drawer on the hose, sitting on the hose, or wrapping the hose around the pump and impacting the assembly on a table.

10. AWCs can be caused by snapping the cassette halves shut with or without the aluminum foil cone.

1. Miscellaneous

Graphs created from R. J. Lee data (G-217, 219; See also G-221, 223) indicating the percentage of potentially citable AWCs (Lee's 1 6K) vs. filter-to-foil distances show:

1. The 4-foot cassette drop test with secondary impact, caps out, where the filter-to-foil distance was 0 to 1 millimeter, 12-1/2 percent of 32 filters exhibited AWCs; where the distance was 1 to 2 millimeters (118 filters), 30 percent; where the distance was 2 to 3 millimeters (61 filters), 16 percent; where the distance was 4 to 5 millimeters (12 filters), 25 percent.

2. The 4-foot cassette drop test with no secondary impact, caps in, where the filter-to-foil distance was 0 to 1 millimeter (36 filters), 14 percent showed AWCs; where the distance was 1 to 2 millimeters (77 filters), 26 percent; where the distance was 2 to 3 millimeters (56 filters), 2 percent; where it was 3 to 4 millimeters (49 filters), 2 percent; where it was 4 to 5 millimeters (7 filters), 0 percent.

3. The 4-foot cassette drop test, no secondary impact, caps out, where the filter-to-foil distance was 0 to 1 millimeter (36 filters), 27 percent showed AWCs; where the distance was 1 to 2 millimeters (78 filters), 22 percent; where it was 2 to 3 millimeters (35 filters), 15 percent; where it was 3 to 4 millimeters (48 filters), 12.5 percent; where it was 4 to 5 millimeters, 16 percent.

4. The 2-foot cyclone drop with no secondary impact, where the filter-to-foil distance was 0 to 1 millimeter, 36 percent of 10 filters showed AWCs; where the distance was 1 to 2 millimeters (96 filters), 47 percent; where the distance was 2 to 3 millimeters (52 filters), 35 percent; where the distance was 3 to 4 millimeters (49 filters), 10 percent; where the distance was 4 to 5 millimeters (11 filters), 0 percent.

The data in the Lee report shows that 60 percent of the field samples (5 filters) vs. 37.5 percent of the dust tunnel samples (48 filters) with 0 to 1 millimeter filter-to-foil distance had 6K features; where the distance was 1 to 2 millimeters, 27.9 percent of the field samples (43 filters) and 39 percent of the dust tunnel samples had 6K features; where the distance was 2 to 3 millimeters, 0 percent of the 21 field samples and 39.4 percent of the dust tunnel samples had 6K features; in the 3 to 4 millimeter range, 0 percent of the 21 field samples and 10.2 percent of the 33 dust tunnel samples had 6K features; in the 4 to 5 millimeter range, 0 percent of the two field samples and 10.5 percent of the 19 dust tunnel samples showed 6K features.

The Lee experimental filters reviewed by Thaxton included about 40 filters classified by Thaxton as citable which resulted from cassette drops, cyclone drops, hose impacts, hose wrap and impact, and vacuum desiccator. About twice as many of these filters had short filter-to-foil distances.

2. <u>CORN</u>

Dr. Morton Corn is Professor and Division Director, Department of Environmental Health Sciences, School of Hygiene and Public Health, the Johns Hopkins University. He has a Ph.D. in industrial hygiene and sanitary engineering from Harvard University. He was a Professor in the Department of Industrial Environmental Health Sciences at the University of Pittsburgh, and was Assistant Secretary of Labor for Occupational Safety and Health from December 1975 to January 1977. Corn was accepted as an expert witness in the fields of industrial hygiene and exposure assessment; aerosol and particle physics; coal mine dust sampling technology; design and management of research and investigation of projects that involve exposure assessment, aerosol and particle physics, and sampling technology; and federal occupational safety and health regulation and enforcement systems.

Corn cooperated with the R. J. Lee Group in the experiments on dust samples simulating events expected from MSHA compliance sampling, handling, and analysis. He reviewed and photographed 300 filters from MSHA's Mt. Hope office, visited the PHTC, and visually inspected and videotaped 1248 cited filters in Arlington. He also examined AWCs identified as MSHA inspector samples and more than 200 no-call filters. He then performed an image analysis of the central discolorations of the cited filters. The image analysis will be discussed later in this decision.

Corn visually examined the Lee experimental filters produced in Lee's supplemental study. Based on his subjective visual observation, Corn concluded that the Lee tests caused central discolorations indistinguishable to the human eye from cited AWCs. It is Corn's opinion that image analysis of the experimental filters would produce a significant number of filters with characterizing parameters matching those of cited AWCs. Corn's conclusion is that commonplace events associated with collection, handling, and analysis, in compliance with MSHA regulations and procedures, are a more plausible explanation for central discolorations than the tampering alleged by MSHA.

3. GRAYSON

Dr. R. Larry Grayson is Dean of the College of Mineral and Energy Resources, West Virginia University. He has a Ph.D. in mining engineering from West Virginia University and was accepted as an expert witness in the fields of respirable coal dust research and mining engineering.

a. Sampler Assembly Drop Tests

At Dr. Grayson's request, nine operator clients of Crowell & Moring submitted approximately 20 samples each, taken in a normal compliance manner, for a total of more than 740 samples from 34 different mines across the country. The cassettes were opened and weighed to the nearest 0.01 milligram and divided into five groups according to their weight. They varied from 0.35 milligram to more than 2 milligrams. Before testing they were examined and none was found to have AWC appearances.

It was originally planned to drop the sampler assembly including the dust laden cassette from heights of 1.5, 2.5, and 3.5 feet onto a corrugated cardboard on the floor. Because many cassettes cracked during the 3.5 foot drop, the test was modified and the assemblies were dropped from 1.5, 2, and 2.5 feet. After the assembly was dropped from the designated height, the filter was inspected. If the dust was disturbed or the cassette cracked, testing was stopped. If not, the procedure was repeated. A maximum of three drops were performed. The capsules were removed and reweighed, and the filters were examined for AWCs. Grayson's determination that a dust disturbance was equivalent to an AWC was based on Thaxton's deposition testimony and on Grayson's examination of more than 400 cited AWC filters. Of the 744 filters tested, 11 were found to have distinct, 6-millimeter AWCs (1.5 percent); 159 were found to have probably citable or possibly citable AWCs (21.4 percent). Later, Dr. Grayson went to a Utah mine and performed assembly drop tests on 36 filters. Eight were found to have AWCs (six had distinct, 6- millimeter AWCs; two had probable or possible AWCs). The assemblies were each dropped once on a concrete floor. Grayson believes that the greater number of AWCs from the Utah mine is related to differences in coal seam properties, humidity, mineralology, etc.

b. Filter-to-Foil Distance

Of the samples received from the mines, 178 were measured for filter-to-foil distance. Two had distances of 0 millimeter; seven of 0.5 millimeter; 23 of 1 millimeter; 20 of 1.5 millimeters; 26 of 2 millimeters; 30 of 2.5 millimeters; 30 of 3 millimeters; 31 of 3.5 millimeters; and nine of 4 millimeters. Thus, 29.2 percent had a 1.5 millimeter or smaller filter-to-foil distance. The measurements were taken by inserting a millimeter scale into the cassette inlet and barely touching the filter. No microscope was used. Ninety-four were drop tested and 84 were not tested but examined for AWCs. No AWCs were found. The two cassettes with a filter-to-foil distance of 0 millimeter when tested were found to have probable or possible AWCs; 50 percent of those with a distance of 0.5 millimeter, 66.7 percent of those with a distance of 1, 40 percent of those with 1.5, 21.4 percent of those with 2, 18.8 percent of those with 2.5, 20 percent of those with 3, and none of those with 3.5 or 4 were found to have probable or possible AWCs.

c. Grayson Conclusions

1. Mailing the filter cassettes is not a factor in causing AWCs.

2. The fact that the samples mailed to Grayson did not show AWCs indicated that no accidental dropping had occurred. This was "probably for good reason. The sensitivities in the industry were such that they would take special handling at this point in time . . . ." Tr. 5744.

3. AWCs result from the striking of the shroud on the surface which imparts a vibration to the filter causing varying degrees of dislodgment.

4. AWCs can result from sampler assembly drops and impacts, and from hose impacts.

5. Filter cassettes with a lower range of filter-to-foil distances (below 2 millimeters) have a greater likelihood of developing AWCs.

d. Further Tests

In November 1992, Grayson examined 13 filters which were reclassified by Thaxton to tamper code 3. In Grayson's opinion seven of the filters did not show evidence of a three-dimensional effect but were the result of optical illusions. Four filters had a very slight three-dimensional effect and only two had a clear three-dimensional character. The filters were examined with an unlighted magnifying glass.

Grayson also participated with the R. J. Lee Group involving the dropping of weights from a specified height onto a hose connected to a pump and cyclone. A 10-pound weight was dropped impacting a 6-inch length of hose. Three-dimensional effects were found "in many of the post-test filters." R-1014A at 2. A 2-pound weight was dropped from 2 feet impacting a 6-inch length of hose. Many of the resulting filters exhibited three-dimensional effects substantially identical to, and often more pronounced than, those observed in the reclassified filters.

4. <u>McFARLAND</u>

Dr. Andrew R. McFarland is a Professor of Mechanical Engineering at Texas A&M University. He has a Ph.D. in mechanical engineering from the University of Minnesota. His thesis was on the grinding of fine particles. He was accepted as an expert witness in the fields of aerosol mechanics, fluid mechanics, thermodynamics, aerosol filtration, and engineering statistics.

a. McFarland Experiments

For all his experiments, Dr. McFarland used coal dust obtained from U.S. Steel Mining Company (USSMC) mines. He crushed and ground the coal and size-classified it by a process described as fluidized bed/flow duct, and loaded it onto the filters. Most of the experiments were conducted with dust weights of about 1.5 milligrams which is the equivalent of 1.8 milligrams per meter squared -- the average concentration on the cited AWCs. However, some of the experiments were conducted with weights of 0.05 to 0.8 milligram of dust on the filter. A steady back flow of air was directed through the dust laden filter cassettes. When the flow was greater than about 4 liters per minute, light areas in the center of the filters were noted. This resulted from the filter touching the inlet part of the aluminum shroud. Thereupon, the air predominately flowed through the small region of the port opening rather than through the entire filter. As a consequence the velocity is higher at the port region and there is a greater tendency for dust to be removed from the filter in that area.

When a back pulse is introduced from the hose to the filter, the filter is pushed up toward the aperture and a jet of air is directed across to the center of the filter causing a dagger formation. The air flows radially to the center of the filter. Dr. Marple called it tangential air flow. The velocity of the air flow is on the order of tens of meters per second, considerably higher than the normal velocity of air passing through the filter, which would be a fraction of a meter per second. The keyhole and the white ring are formed by the air as it is escaping through the filter before the filter contacts the foil. It is possible to produce AWCs with radial flow alone but not with normal flow alone. However, it is easier to create AWCs when both normal flow and radial flow are present.

A vacuum pump was connected to the inlet side of dust laden cassettes. In some cases, the vacuum was applied gradually and in some cases as a pulse. Typically, a light, gray center was produced with a gradually applied vacuum. For the pulsed vacuum, a sharp, white ring was also noted.

A student assistant stepped on the hose connecting the cassette to the pump and created a pressure pulse sufficient to generate an AWC pattern. A pulse, as distinguished from an air flow, is of short duration, less than 0.1 second, but the patterns produced on the filters by reverse air flow and reverse air pulse are virtually indistinguishable.

McFarland set up an apparatus (a piezoelectric crystal transducer) to measure the pressure associated with an air pulse and to record the pressure on a computer. It was used extensively by Dr. McFarland for producing AWC-type patterns in his laboratory. A smaller version of the apparatus was set up in the courtroom on January 13, 1993. A bottle of nitrogen gas under pressure was used to inject 3 cubic centimeters of air into the piston cylinder and the air in front of the cylinder was displaced and travelled through the MSA hose to the back side of the filter. The filter showed a very distinct, 6-millimeter ring with a dagger formation in the center. An AWC pattern was apparent. About 30 inches water pressure was generated. A second courtroom demonstration was presented in which a pulse was applied with a pressure reading of 23 inches water at its peak. An AWC pattern resulted. The 6-millimeter ring was somewhat thicker on one side with a dagger-type pattern and a difference in coloration between the outer region of the filter and the 6-millimeter center. McFarland performed more than 100 experiments, using reverse air flow, pressure pulses, stepping on the hose, dropping the pump, wrapping the hose, snapping the cassettes, tool box drop, hose in cabinet, using different coal types, varying filter-to-foil gaps, and flexible and non flexible filters. On all tests, he recorded what he considered to be AWC formations. He recorded the results in computer generated graphs. See R-1035.

Stepping on a hose with the pump running and the foot oriented in the lengthwise direction caused AWC patterns with pressure on the order of 20 to 30 inches water. Higher pressures are required to create AWCs when the pump is running than with the pump off. Stepping on the hose with the pump off created AWC formations at pressures of 11, 22.5, and 34 inches water. Pump drops of 8 inches on a hose and drops of a pump with a hose wrapped around it produced AWCs on both mine-run and laboratory samples at pressures of from 9.2 to 17.5 inches water. Shutting a door or drawer on a hose can cause pressure pulses as high as 22 inches water. The average pressure pulse needed to create an AWC is about 10 inches water. AWCs were created on seven filters by shutting a cabinet door or drawer on a hose. AWCs were formed by snapping the cassette halves together using both mine-run and lab samples. Snapping the cassette can cause pressure pulses of 3.75 to 11 inches water.

McFarland presented a videotape attempt to capture on film the actual formation of an AWC. See R-1029. The time required for the formation of an AWC is very small, on the order of 0.01 second. No AWC resulted from a pressure of 3 inches water, but an AWC patten was seen after 9.6 inches water was applied. He demonstrated, by squeezing a hose which was attached to a cassette from which the inlet nipple was machined off, that the filter rises and falls, moving in the direction of the foil when squeezed and dropping back when relaxed.

b. McFarland Review of Cited Filters

McFarland examined the 43 USSMC cited filters in the MSHA Arlington offices. They were cited under tamper codes 1 and 2, with one filter cited under tamper code 9. The filters had four basic characteristics, though not all filters had all four and on some the characteristics were not as fully defined as on others. The characteristics were:

1. A dagger pattern within the confines of the 6-millimeter ring, lighter in color than any other portion of the filter;

2. A 6-millimeter ring also lighter than the average color of the rest of the filter;

3. The region within the 6-millimeter ring is lighter than the average on the rest of the filter;

4. Many filters had indentations or cuts or embossed areas in the ring where the filter had contacted the aluminum shroud. The cuts can often only be seen under a microscope.

c. Filter-to-Foil Distance

McFarland set up an apparatus to measure the distance between the filter surface and the aluminum shroud of the filter cassette. A microscope was focussed on the filter and then on the cassette inlet and a deal micrometer was used to measure the distance between the two points. The MSA patent application drawing indicates the distance at 0.125 inch. McFarland measured several hundred cassettes. The filter-to-foil distance varied from 0.002 to 0.142 inch. Filters with gaps larger than 0.07 inch were loaded with dust and a pulse volume of 1.5 cubic centimeters was applied. Of six filters tested, only three showed AWC patterns. Increasing the pressure volume to 3 cubic centimeters caused AWC patterns on the three filters. Eleven filters were dust loaded in a USSMC mine. Seven were rigid filters and four had large gaps. One and one-half cubic centimeters air volume was applied using the piston cylinder apparatus. No AWCs resulted on two of the seven rigid filters. One AWC was produced on the four large gap filters. AWCs were produced on all the six close gap mine-run filters. The initial gaps of 110 filters were measured and recorded. The mean gap was 0.061 inch. The range was from 0.014 to 0.147 inch. One-fourth of the filters had a gap of less than 0.05 inch. The average pressure which caused contact of the filter with the aperture was 5 inches water with a standard deviation of 1.3 inches water. Twelve percent of the filters strike the aperture with an applied pressure of less than 4 inches water. In Dr. McFarland's opinion the initial gap is an important factor in susceptibility to AWCs. The floppiness of the filter is also of consequence. However, some filters were found to be too floppy to form AWCs. Only one of 30 had a gap of 0.125 inch or larger. Some had a zero gap. The vast majority lie in the range of about 0.06 inch.

d. Other Tests

An individual sat on a hose placed on a bench. The hose was laid straight and then in a coiled arrangement. The pump was not running. The uncoiled hose was sat on 25 times and created a mean pressure of 11.4 inches water with a maximum pressure of 19.5 inches water. No AWCs resulted. An individual sat on a coiled hose 11 times and created a mean pressure of 25.8 inches water and a maximum pressure of 56 inches water. An AWC with cuts but no dimple or cone resulted.

A tool box weighing 40 pounds loaded was dropped on a straight hose and on a coiled hose. In some tests the pump was operating and some not. Pressure pulses of 25 to 128 inches water were generated. Only one filter was used. After the second test (involving a pressure pulse of 119 inches water), a cone could be clearly viewed through the opening of the aluminum shroud.

On January 14, 1993, McFarland conducted a tool box drop demonstration in the courtroom. The tool box was 6 inches by 19.5 inches and weighed 31 pounds. It was dropped from a height of 6 inches onto a towel-covered table. The pressure pulse was 72 inches. An AWC pattern resulted with a 6-millimeter ring and a dagger in the center, with a difference in coloration between the region inside the ring and that outside. The filter had been loaded with laboratory dust. A second demonstration was conducted with a filter loaded with 2.32 milligrams of mine-run dust. The filter-to-foil distance was 0.055 inch. The tool box was dropped from 6 inches and a pressure peak of 42 inches water was recorded. An AWC pattern resulted with a 6-millimeter ring, diffuse rather than clear cut, a resemblance of a dagger pattern, and a difference in coloration between the area inside and that outside the 6-millimeter zone.

e. Mine Dust vs. Laboratory Dust

McFarland did tests with laboratory samples and mine-run samples from three mines in three different States. Back pulses were delivered to filter cassettes. Fifteen cubic centimeters of air created AWCs. The mean pressure at which AWCs were formed using mine-run coal was 9.72 inches water. The mean pressure for laboratory loaded samples was 9.82 inches water. Statistically there was no difference in the ease of AWC formation using mine-run or laboratory loaded samples. By using laboratory dust, Dr. McFarland was better able to control variables such as dust weight, dust type, particle size, humidity, etc. McFarland had CCI Technologies make a determination of the size distribution of dust collected on filters. There is little difference in the median particle sizes of the lab dust and the mine dust, though the lab dust is slightly smaller. The similarity of the median sizes results from the cyclones stripping the largest particles from the dust prior to its being deposited on the filter. The dust concentration on the USSMC cited filters averaged about 1.9 mg/m^3. The average concentration on non-cited filters of USSMC was about 0.5 mg/m^3. Cited filters have higher dust loadings because (1) it is easier to recognize an AWC on a filter with a higher dust loading in that the optical contrast is better; and (2) it is more difficult to form AWCs on lightly loaded filters.

f. McFarland Cone Studies

McFarland refers to patterns which have cones, dimples, or cuts as CDC patterns. Dr. McFarland's studies show that CDC patterns can be produced at pressures considerably lower than those reported by MSHA expert Dr. Marple. Thaxton reviewed 67 filters used by Dr. McFarland in his experiments and concluded that 44 of them exhibited AWC characteristics that would be citable and eight were coned or dimpled. The maximum pressures recorded for three of the eight were 7.5 inches water, 8.4 inches water, and 16 inches water. McFarland did not find cones or dimples on two of the eight. He believes that Thaxton, who did not use a microscope, confounded the cuts with dimples or cones. McFarland examined the USSMC cited filters which were reclassified by Thaxton. Three had cones, one a faint cone, and one a cut. He found one not reclassified which had a cone and many with cuts. All the filters reclassified to tamper code 3 were floppy. Floppiness not only enhances AWC formation but also could enhance CDC formation. McFarland measured floppiness by a pressure to touch method. A wide range of pressure to touch values was found, ranging from 3 inches water to about 10 inches water. In his lab tests, Dr. McFarland produced CDC patterns with pressures of 34 inches water or more. Tests established that filters do not fatigue and cause a CDC at abnormally low pressure levels when subjected to repeated pulses provided the pulses do not cause the filter to exceed its elastic limit.

g. McFarland Conclusions re CDCs

1. A CDC pattern can be produced by removal of the sampling hose from the pump.

2. CDCs can be created at pressures as low as 7.5 inches water.

3. A pressure of 47 inches water can result when air is squeezed from as little as 2.5 inches of hose.

4. Pressures as high as 40 inches water were created when an individual duck-walked on a hose.

5. A CDC can be produced by stepping heavily on a coiled hose and generating pressures no larger than 44 inches water.

6. A pressure of 56 inches water can be created by sitting on a coiled hose placed on an 8-inch high bench with an inoperative pump.

7. CDC patterns can be produced on dust loaded filters subjected to pressure pulses of about 20 inches water.

8. There are great variations in the susceptibility of filters to forming AWCs and CDCs. A pressure of about 20 inches water caused an AWC and CDC on a floppy filter.

h. McFarland Conclusions

1. At least a portion of the filters cited under tamper codes 1, 2, and 3 have the same characteristics as the AWCs McFarland obtained by reverse air flows or pulses.

2. The AWC patterns obtained by reverse air flow and those obtained by reverse air pulse have the same characteristics.

3. When reverse air comes into a cassette it pushes the filter toward the aperture of the aluminum shroud. This causes air that is trapped between the upper surface of the filter and the inner surface of the shroud to be squeezed through the annular region at the 6-millimeter ring and sweep away the dust from the surface and produce an AWC pattern.

4. The filter-to-foil distance is a factor in the production of an AWC pattern. If the distance is less than 0.125 inch, an AWC is more likely to result.

5. Filter-to-foil distance varies from filter to filter in all those examined by McFarland. The majority have a gap of less than 0.125 inch.

6. Floppiness of the filter is an important factor in susceptibility to AWC formation.

7. The minimum volume of air needed to form an AWC pattern is 0.5 to 1 cubic centimeter. The minimum pressure is about 4 inches water in the form of a back pulse. But a pressure of 10 inches water will not always produce an AWC. "There are no absolutes." E.g., Tr. 5026, 5057.

8. It is possible to apply pressure pulses sufficient to create AWC patterns by squeezing the hose attached to the sampling unit.

9. Any of the following can cause sufficient pressures and sufficient volumes of air to cause an AWC pattern on a filter:

a. Dropping an object such as a pump on the hose from a distance of 8 inches.

b. Shutting a drawer or door on a hose while the sampling head assembly is attached.

c. Dropping an object 6-inches wide and 30 pounds in weight on a sampling hose.

d. Sitting on a hose to which the sampling assembly is attached.

e. Stepping on a hose to which the sampling assembly is attached.

f. Removing the hose from the pump at the completion of the sampling period in accordance with the instructions contained in the MSA instruction manual.

10. There is no difference between mine-run samples and laboratory samples with respect to AWC formation, or with respect to threshold velocity, or dislodgment patterns associated with threshold velocity experiments.

11. Variables such as water during or after the sampling process, the presence of diesel equipment, and other factors can influence the manner in which dust is deposited on a filter.

12. The most influential factors in the AWC formation process with respect to tamper codes 1, 2, and 3 are the filter-to-foil distance and filter floppiness.

13. The next most influential factor is the condition of the hose.

14. The presence of an AWC-type pattern on a filter does not indicate that the weight of the filter was intentionally altered.

5. <u>ROTH</u>

Dr. H. Daniel Roth is President and founder of Roth Associates, Inc., a statistical consulting firm. He has a Ph.D. in mathematics (probability theory) from the State University of New York at Stony Brook. He was accepted as an expert witness in the field of statistics.

a. Analysis of AWC Citation Rate Over Time

Using the same data as Dr. Miller, Dr. Roth plotted the weekly rates of AWC citations from August 1989 to March 1992. The plot shows a strong trend of declining AWC rates over virtually the entire period. After a brief initial period of apparently increasing AWC rates in August and September 1989, the rate of cited AWCs continuously decreased through the rest of the period.

The rate of decline was significantly steeper before the March 1990 void code notification than after that event. Roth did a regression analysis which showed that the slope of weekly AWC rates before March 19, 1990, was -0.11 (P-value 0.0001). The difference is highly significant and is inconsistent with the claim that the March 19, 1990, void code notification caused a decline in the AWC rate. In fact, the decline in the cited rate is monotonical throughout the entire period.

b. Analysis of Sample Date vs. Cited Rate

Dr. Miller's conclusion that there is a marked decrease in the cited rate on or about March 19, 1990, has a fundamental flaw: he fails to recognize that the rate of AWCs is statistically significantly higher before virtually any cutoff date in the study period than it is after that date. Roth prepared a chart comparing the cited rates before and after the 15th of each month from August 1989 to April 1991. In every case the cited rate after was statistically significantly lower than the cited rate before. Roth was provided with data on the MSHA inspector sample AWCs from July 1989 to October 1991. From January 1990 the number of inspector AWC samples (not the rate) is declining.

c. Analysis of AWC Rates Between Mines

Dr. Roth did a chi-square analysis comparing AWC rates between all mines, replicating Dr. Miller's chi-square analysis. Roth states that Miller didn't go far enough in that he did not do an analysis to see if there was a variation in rates between mines after March 19, 1990. Roth did such an analysis testing the homogeneity of AWC rates after March 19, 1990, and March 31, 1990, using the same data set as Miller with 2377 different mine IDs. The result showed a non-randomness in AWC rates after these periods. In fact there was a wide disparity in the AWC rates between the mines.

Further, Miller's data set did not include data in the before period for 762 mines because there was no information, but they were considered in the after period. Three hundred additional mine IDs were only considered in the before period, not in the after. Therefore, more than 1000 mines out of a total of 2677 weren't used in both analyses. So the entire difference in cited rates could be explained by differences between mines having nothing to do with cutoff dates.

d. Analysis of Date of Manufacture

Of the cassettes manufactured before 1990, 4337 filters were cited, 95,246 were not cited. Thus, the cited rate was 4.36 percent. Of the cassettes manufactured in 1990 and after, 482 were cited, 122,590 were not cited. The cited rate was 0.392 percent. Roth performed a sign test of cited rates after January 19, 1990, March 19, 1990, and May 19, 1990, using Miller's adjustment for manufacture date. They show that the rates were declining throughout the period, and using different cutoff dates the result was the same: the rates were higher before. "[T]here is nothing magic about the March 19th, 1990 date." Tr. 3994. Roth prepared a plot of a trend analysis of the monthly AWC rates by date of manufacture. He concluded that the decline in cited rates seems to be nicely correlated with manufacturing date. In Roth's opinion, Miller's analysis of the differences in cited rates for cassettes manufactured before January 1, 1990, and after December 31, 1989, was "totally contaminated." The sign test was inappropriate because Miller eliminated 44,000 cassettes manufactured in 1989 or before. Miller also strung out the analysis to 1992 by which time all the cassettes manufactured before 1990 would have been used up. The sign test does not have any power and the bootstrap doesn't correct it.

e. Weight Loss Analysis

Dr. Roth did a weight loss analysis using four variables: type, condition, MSHA load (the weight of the compliance filter over the initial manufacturer's weight), and the Marple load (the load on the filter before the experiment), and the interaction between these variables. Miller used only the type and condition variables. Using the four variables, Roth did not find the experimental condition (reverse air flow AWC) to be a statistically significant explainer of weight loss. Roth agrees that for the compliance filters in the Miller/Marple analyses of weight loss/gain, the reverse air AWCs had a mean weight loss, and the control filters had a mean weight gain. In Roth's opinion this is not explained by whether the filter was a reverse air AWC or not, but by the MSHA load and the compliance weight, mainly by the compliance weight. The Marple load is not a statistically significant explainer of weight loss.

f. Roth Conclusions

1. If beginning in October 1989, the PHTC lab technicians began for the first time to make initial screening of filters prior to Raymond's seeing them to determine

which ones would be sent to Thaxton, this could have an effect on the rate of AWCs thereafter.

2. If beginning in March 1990, Raymond first began looking at filters under magnification, this could affect the rate of AWCs thereafter.

3. If between March and June 1990, photographs of examples of AWCs were posted for PHTC technicians to use in prescreening, and if Raymond developed a written protocol for the technicians to follow, and filters not meeting the criteria in the protocol were not further reviewed, this could affect the AWC rate thereafter.

4. If the dust collected on filters differs from mine to mine, some being more difficult to dislodge, this could affect the differences in AWC rates in different mines and could explain the chi-square distribution among mines.

5. If the dust collected on filters differs from mine to mine, some being more difficult to dislodge, the Post Office or PHTC handling of the filters could result in different AWC distributions.

6. If the dust collected on filters differs from mine to mine, some being more difficult to dislodge, and handling practices at all mines are identical, the difference in susceptibility to dust dislodgment could explain the chi-square results.

C. IMAGE ANALYSIS EVIDENCE

The testimony of three expert witnesses was largely devoted to image analysis evidence: Dr. Morton Corn, Dr. John C. Russ, and John C. Holm.

Dr. Corn, whose expertise is set out earlier in this decision (he is not an expert in image analysis), viewed about 100 cited AWC filters through a stereo microscope at the Mt. Hope MSHA facility. The array of filters which he examined defied confident classification by visual means. Because he believed it impossible to visually classify the cited AWCs which showed such a spectrum of features, Corn concluded that a more objective method of classification was required.

Corn chose the Ponca City laboratory of Conoco to do image analysis of the cited filter central discolorations and a comparison with other filters discussed hereafter. (Corn uses the term "central discoloration" or "CD" rather than the MSHA term "AWC.") The image analyst, Page Johnson, a graduate chemist who had worked at Conoco for 2 years, with a specialization in optical imaging, performed the analysis under Corn's general direction. Corn had 1248 cited filters videotaped and a Zeiss image analysis system was used to measure 884 for diameter, area, perimeter, circularity, and similar morphological parameters of the central discoloration. He found that the CDs varied in roundness, diameter, image clarity, and internal shape. Corn's "gold standard" was determined by the cited AWC filters. No-calls, R. J. Lee experimental filters, and MSHA inspector AWC filters were measured and compared with the gold standard in six linear parameters of shape: average diameter, maximum diameter, minimum diameter, aspect ratio (ratio of minimum diameter to maximum diameter), internal shapes (P1/P2: ratio of perimeters of exterior edge and any keyholes to exterior edge only), and circularity (comparison with the area of a circle). Corn considered CDs indistinguishable if the CD parameters fell within the following ranges of Corn's six parameters:

$5\text{ mm} < \text{average diameter} < 10\text{ mm}$
$5.5\text{ mm} < \text{maximum diameter} < 11.8\text{ mm}$
$4\text{ mm} < \text{minimum diameter} < 10\text{ mm}$
perimeter ratio P1/P2 (internal shapes) < 2.25
circularity > 0.2
aspect ratio > 0.65

These parameters obviously do not take into account all the features of cited AWCs, including changes in grayness levels inside or outside the 6-millimeter ring, three-dimensional changes (e.g., cones), tears in the filter, scratch marks, and the position of the CD on the filter face (i.e., in alignment with the cassette inlet).

Using the optical imaging system, Corn had 65 of 265 no-call filters measured. Forty-seven were found to be indistinguishable from cited AWC filters. Two hundred and fifty-five of 438 R. J. Lee experimental filters with CDs were measured and 213 were found to be indistinguishable from cited AWCs. One hundred and eleven of 193 MSHA inspector AWC filters were measured and 99 were found to be indistinguishable from cited AWCs. Corn concluded that MSHA's allegations of tampering based on visual examination of the AWC filters are subjective and inconsistent. In Corn's opinion, characterizing parameters of cited AWCs are variable when measured objectively by image analysis techniques. Corn concluded that MSHA's tamper codes indicating causes of AWCs are not supported by image analysis techniques.

Corn did a supplemental analysis involving a reproducibility study of Dr. Lee's February 6 report. Sixty-five Lee experimental filters were randomly selected and measured using the Zeiss imaging system. Thereafter, 60 filters were remeasured once and five were remeasured seven times. Corn concluded that the reproducibility study indicated that the Lee experimental filters, the no-call filters, and the MSHA inspector filters match the "AWC acceptability criteria," i.e., are consistent with Lee's February 6 report findings, although "a small number of filters might be affected in their match to cited AWCs" -- filters "at the fringes of the acceptability criteria." R-1037 at 4. In Corn's opinion his image analysis used high quality data, he obtained good reproducibility, and his conclusions are accurate. He conceded that his database had transmission, typographical, and reanalysis errors. He did not check Page Johnson's decisions that some filters could not be analyzed (because she saw no CD or the image required enhancement). Johnson was not offered as a witness at trial. Prior to this case, Corn had never worked with computer-assisted image analysis.

Dr. John C. Russ, a Research Associate and Visiting Associate Professor in the Materials Science and Engineering Department, North Carolina State University received his Ph.D. in engineering from California Coast University. He was accepted as an expert witness in image analysis and statistical analysis of image analysis results.

Dr. Russ reviewed Dr. Corn's report and concluded that it was consistent with standard practice for applying computer-based image analysis methods. In Russ' opinion, Corn's conclusions that the cited AWC filters are not distinguishable from inspector filters, no-call filters, and R. J. Lee experimental filters are logical and supported by the data. Russ concluded that Corn's supplemental analysis on reproducibility shows that there was no operator bias and that the measurement parameters are reproducible with sufficient accuracy. Russ did a statistical analysis of Corn's study which showed that it was not possible to distinguish cited AWC filters from non-cited filters. Russ concluded that there is no characteristic or combination of characteristics which would permit distinguishing such filters with confidence. Dr. Russ criticized John Holm's critique of Corn's report as flawed, irrelevant, inconsequential, or misinformed. Russ' opinion is based on viewing Corn's images of cited AWC filters only, not experimental, inspector, or no-call filters.

John C. Holm is employed as Network Manager, Department of Radiology at the University of Minnesota. He previously was employed by Kontron Elektronik in the areas of development, sales, and support. He has a B.S. in medical technology from Michigan Technological University and is pursuing a master's degree in biophysical sciences at the University of Minnesota. His research topic involves image analysis using a Kontron system. He was accepted as an expert witness in the field of image analysis.

Holm reviewed Corn's initial analysis and concluded that it had significant defects which call into question the results claimed. He is of the opinion that Corn's use of a color CCD video camera was inappropriate because the object of interest is in shades of gray. In Holm's opinion, Corn's choice of video lens and magnification factor was inappropriate as was his use of videotape rather than direct video camera input. Holm asserts that Corn's database is compiled from an unknown source and is unreliable and undermines Corn's digital analyses and conclusions. In Holm's opinion, Corn's definition of what constitutes an AWC is too broad to compare filter populations because the ranges include almost all of the measurements -- the boundary points are not based on any statistical or percentile test. Holm testified that almost all of the experimental filters fall within Corn's ranges. Holm criticized Corn for selecting only experimental filters that resembled cited AWCs (i.e., the least distinguishable) for comparison to cited AWCs.

Holm performed measurements and analysis using a Kontron system and concluded that many of the R. J. Lee experimental filters (drop filters) which Corn found indistinguishable from the cited AWC filters are distinguishable on the basis of area alone. Holm found that the filters subjected to desiccator experiments are distinguishable from the cited filters on the basis of area or on observable differences in the off-center position of the CD. In Holm's opinion, choosing appropriate image acquisition techniques, feature measures, and classification scheme would have enabled classification of a greater number of filters and distinguished between cited AWC filters and the non-cited and R. J. Lee experimental filters. Holm performed a courtroom demonstration in which, inter alia, he measured and analyzed cited and experimental filters that were considered not analyzable or unmeasurable by Johnson, and excluded from Corn's study. Holm found that there were differences between the experimental and cited filter populations in area size, perimeter, maximum diameter, and minimum diameter. Circularity, shape factor, P1/P2 ratio, and roughness were similar in the two populations.

Although the measurements are processed objectively by the computer, the decision of which digitized shape to measure is made subjectively by the operator. Johnson apparently measured CDs approximately 6 millimeters in diameter, but there is no record of the measurements (threshold values) with which she defined the CDs, making verification of the precision of her measurements difficult. Holm's measurements included much larger shapes where the dust dislodgment continued outside the 6 millimeter, central area. Clearly, the image analysts defined the shapes they measured differently.

The reports and testimony on image analysis of the filters are complex, confusing, and contradictory. The image analysis experts are attempting to objectify and quantify what is basically a subjective and qualitative judgment of an experienced government technical expert. If such a task is possible, it has not in my judgment been accomplished in this case. I have carefully considered the reports and testimony of Dr. Corn, Dr. Russ, and Mr. Holm concerning image analysis, but I am not relying on their conclusions in this decision.

FINDINGS OF FACT

I. AWCs IN GENERAL

A. The term "AWC" has a coherent, intelligible meaning. It refers to an abnormal filter appearance in a dust sample consisting of dust dislodgment from the central portion of the filter.

B. The classification of AWCs by Thaxton under his tamper codes was consistently applied to the cited filters.

II. REVERSE AIR AWCs

A. More than 95 percent of the cited filters were classified by Thaxton under tamper codes 1 (light cleaned), 2 (cleaned), and 3 (cleaned and coned). Thaxton concluded that the dust dislodgment patterns on these filters resulted from reverse air flow through the filter cassette. He later came to believe that filters cited under tamper code 7 (clean tool) also resulted from reverse air flow.

B. The dust dislodgment patterns on the cited filters classified under tamper codes 1, 2, 3, and 7 can have resulted from intentional acts: blowing by mouth through the cassette outlet, otherwise directing a jet or pulse of air into the cassette outlet, or introducing a vacuum source into the cassette inlet. This finding is supported by all the expert testimony.

C. The dust dislodgment patterns on the cited filters classified under tamper codes 1, 2, 3, and 7 can have resulted from:

1. impacts to the cassette from dropping or striking it;

2. impacts to the hose from stepping on it, dropping an object on it, striking it against a wall while the hose was wrapped around the sampling assembly, closing a door or drawer on it, or sitting on it;

3. snapping together the two halves of the filter cassette.

Although the expert witnesses for the Secretary and the mine operators differ as to the likelihood that a dust dislodgment pattern similar to the cited AWCs would result from incidents described in numbers 1 and 2 above, the experiments all show that at least sometimes they do occur. Many of the filters subjected to tests such as those described exhibit dust dislodgment patterns indistinguishable from cited AWCs. All the expert witnesses agree that snapping together the two halves of the filter cassette can cause an AWC pattern on a dust loaded filter.

D. The dust dislodgment patterns on the cited filters classified under tamper codes 1, 2, 3, and 7 cannot have resulted from:

1. a rapid decrease in air pressure such as might occur when the cassettes were transferred by airplane, or the handling of the cassettes by the Post Office. The results of Dr. Marple's rapid decrease in air pressure experiment and the experience of Dr. Grayson who received a number of dust laden filters by air and postal delivery establish that air transport and Post Office handling do not cause AWC patterns on filters.

2. desiccation of the filter capsules in the PHTC weighing laboratory. Dr. Lee's desiccator tests which produced what he termed AWCs are of limited evidentiary value because of the differences in the desiccator used by MSHA and that used by Lee. Moreover, most of the photographs of the filters which underwent the test do not show dust dislodgment patterns similar to cited AWCs. Dr. Marple's experiment using the MSHA desiccator establishes that proper operation of the desiccator (and there is no evidence that it was not used properly by MSHA) does not cause dust particle dislodgment.

3. handling of the cassettes and capsules in the PHTC. Dr. Lee was of the opinion based on his observation of the handling practices in the PHTC and on the results of his stack and chuck tests and rapid disassembly tests that 5 to 15 percent of the cited AWCs resulted from PHTC handling and 30 to 50 percent were contributed to by PHTC handling. He did not provide the rationale for these percentage estimates. The photographs of the filters after the stack and chuck and rapid disassembly tests for the most part do not resemble the cited filters. Based upon my consideration of G-170 showing the operation of the PHTC and of the various tests and experiments which produced AWC-like dust dislodgment patterns, I conclude that the PHTC handling, including the stack and chuck procedures and the rapid disassembly procedures, did not cause the cited AWCs.

E. I am not considering in this decision the effect, if any, on the cited cassettes of the handling of the sampling assemblies, including the cassettes, at the mines, nor any factors peculiar to any specific mine or mines. I have excluded evidence of such mine-specific matters from this proceeding.

F. Sampling assembly variables

1. Filter-to-foil distance in the MSA cassettes used for dust sampling in the time period pertinent to this proceeding, and in the experiments performed by the expert witnesses varied from filter to filter.

2. Floppiness or tautness of the filters used for dust sampling in the time period pertinent to this proceeding, and in the experiments performed by the expert witnesses varied from filter to filter.

3. A filter cassette with a smaller filter-to-foil distance is more prone to an AWC dust dislodgment pattern than one with a larger filter-to-foil distance. With respect to this issue I am accepting the opinions and conclusions of Drs. Lee, Corn, Grayson, and McFarland over the contrary opinions and conclusions of Drs. Marple and Rubow (and the statistical conclusion of Dr. Miller). If a reverse air flow or reverse air pulse creates an AWC by causing the filter to move toward the inlet, resulting in the removal of particles close to the foil lip (Dr. Marple), it is reasonable to conclude that the closer the filter is to the foil, the easier it is to cause the movement and resulting dislodgment.

4. A floppy filter is more prone to an AWC dust dislodgment pattern than a more taut filter. Although there is some ambiguity in the opinions of Drs. Marple and Rubow, I conclude that all of the expert witnesses ultimately agree to this finding.

5. The cited filters had a shorter filter-to-foil distance than those manufactured subsequently and specifically than those used in the experiments performed by the expert witnesses. Dr. Lee testified that 1400 to 1500 of the cited filters were from the MSA 200,000 series, which were manufactured between April 20, 1988, and April 3, 1989. He further testified that about 2800 of the cited filters were from the 300,000 series which were manufactured between April 3, 1989, and February 13, 1990. The Secretary did not controvert this evidence. Thus between 4200 and 4300, or more than 80 percent, of the approximately 5000 cited filters were manufactured between April 20, 1988, and

February 13, 1990. The filter-to-foil distance on the cited filters was not measured before the citations were issued, and is, of course, not recoverable now since the cassettes were disassembled and the foils discarded. Exhibits G-253A, 255A, 257A, 259A, 260A, 261A, 262A, 263A, 265A, 266A, and R-1068, 1069, 1070, and 1071 referred to supra at page 25, consist of graphs prepared by the Government which show the filter-to-foil distances on experimental filters manufactured from April 20, 1988, until after May 28, 1992. The pre-loading measurements show a slight tendency toward an increase over time in the percentage of filters with filter-to-foil distances of more than 2 millimeters. Ninety-five percent of those in the 200,000 series and 100 percent of those in the 300,000 series had filter-to-foil measurements of 2 millimeters or less; 97 percent of those in the 400,000 series (manufactured from February 13, 1990, to October 25, 1990), and 72 percent of those in the 500,000 series (manufactured from October 25, 1990, to August 5, 1991) had such measurements. The post-loading measurements show a somewhat greater increase over time in the percentage of filters with larger filter-to-foil distances. Eighty percent of those in the 200,000 series and 95 percent of those in the 300,000 series had filter-to-foil measurements of 2 millimeters or less; 45 percent of the 400,000 series and 50 percent of the 500,000 series had such measurements. Dr. Rubow injected two cautionary notes with respect to these graphs: the number of filters measured from each series varied considerably. In the pre-loading measurements, 32 filters were from the 200,000 series, 24 from the 300,000 series, 259 from the 400,000 series, and 1684 from the 500,000 series. In the post-loading measurements, 69 filters were from the 200,000 series, 24 from the 300,000 series, 156 from the 400,000 series, and 1591 from the 500,000 series. With respect to some of the series, only Marple's measurements are included; with respect to others the measurements of Marple and McFarland; Lee, Marple, Yao, and McFarland; Lee, Grayson, and Marple; and Lee, Grayson, Marple, and McFarland are included. Furthermore, Lee, Grayson, Marple, and McFarland all followed different methods in measuring the filter-to-foil distance. Nevertheless, keeping these cautions in mind, the graphs provide the best evidence on an important issue, and they indicate and I find, that the cited filters had a shorter filter-to-foil distance than those manufactured subsequently.

6. The firmness or softness of the sampling assembly hose may be related to the formation of an AWC. A softer

hose is more prone to an AWC dust dislodgment. Dr. Lee was of the opinion that AWCs occurred more frequently in his experiments when he used soft hoses than when he used medium or hard ones. He concluded that hose softness or toughness is a significant factor in susceptibility to AWC formation on hose impact. Dr. McFarland concurred and demonstrated that it is possible to apply pressure pulses sufficient to create AWC patterns by squeezing the hose. Both Dr. Marple and Dr. Rubow stated that a softer hose is more susceptible to a reverse air pulse.

G. Dust variables

1. Susceptibility to AWC dust dislodgment patterns varies with:

   a. type of coal; Dr. Marple and Dr. Grayson both indicated that the type of coal may be influential in the formation of dust dislodgment patterns.

   b. humidity in the mine environment; humidity, of course, affects the weight and adhesion of the dust on the filter. It was believed to be a factor in dust dislodgment by Dr. Marple, Dr. Grayson, and Dr. McFarland.

   c. weight of dust on the filter; the weight of dust on the filter was stated to be an important factor by Dr. Lee and Dr. Grayson. Dr. Grayson testified that a lightly loaded filter is less susceptible to dust dislodgment than a heavier one.

   d. size and shape of the dust particles; Dr. Corn stated that the size and shape of the dust particles could be a factor in dust dislodgment patterns.

   e. amount of rock dust or diesel dust, if any, on the filter; these factors were believed to be important by Dr. Marple and Dr. McFarland.

H. Weight Loss

1. Not all cited AWC dust dislodgment patterns result in a weight loss. Some show a weight gain.

2. However, reverse air AWC filters with dust dislodgment patterns show on the average a weight loss.

III. AWCs CITED UNDER OTHER TAMPER CODES

A. Thaxton speculated that with respect to tamper code 4 (torn, ruptured) the tear resulted from something contacting the filter face, tearing it, and pulling it toward the inlet when it was removed. Dust dislodgment patterns on the cited filters classified under tamper code 4 can have resulted from someone intentionally inserting an object into the cassette inlet and contacting and tearing the filter media. They also can have resulted from reverse air flow or reverse air pulses.

B. Thaxton testified that filters classified under tamper code 5 (wiped, clean wiped) give the appearance of something contacting the filter face and being rubbed or twisted to try to remove dust from the filter.

1. Dust dislodgment patterns on the cited filters classified under tamper code 5 can have resulted from someone inserting a cotton swab into the cassette inlet and rubbing or twisting it on the filter.

2. Dust dislodgment patterns on the cited filters classified under tamper code 5 can have resulted from dropping the filter cassettes.

C. Thaxton concluded that tamper code 8 (clean face) resulted from inserting an object through the cassette inlet, possibly wetted with some liquid such as water, alcohol, etc. A review of the four filters originally cited under this tamper code, 206368, 262147, 264160, and 326966, discloses rather marked differences in appearances. The first two listed do not appear to have a lighter deposition encompassing the greater part of the filter. In fact they closely resemble many filters cited under tamper codes 1 and 2.

D. Thaxton testified that tamper code 9 (clean touch) filters were caused by inserting an object into the inlet. The dust dislodgment patterns on the cited filters classified under tamper code 9 can have resulted from someone intentionally inserting something in the cassette inlet.

E. There is no evidence in the record from which I could find or infer that the dust dislodgment patterns on the cited filters classified under tamper code 10 (clean ring) can have resulted from intentional acts; Thaxton was unable to reproduce this pattern in his laboratory.

IV. STATISTICAL EVIDENCE

A. RANDOMNESS OF CITED AWCs

Dr. Miller stated that his chi-square analysis resulted in overwhelming evidence that the rate of AWCs was not random as between mines either when he used the entire data set or when he used only cassettes whose sample date was before March 20, 1990, and before April 1, 1990, or when he eliminated the mines in the MSHA Norton subdistrict and the compliance samples. The results of these tests provide cogent evidence that Post Office handling and PHTC handling were not causes of the cited AWC patterns. However, because there are many other variables between mines, I do not find that it is persuasive evidence of intentional tampering of the dust samples. Dr. Roth's chi-square analysis using the same data set as Dr. Miller shows a wide disparity in AWC rates between mines after March 19, 1990, and after March 31, 1990, which tends to show that there was no change in randomness of cited AWCs after the void code was instituted.

B. SAMPLE DATE vs. CITED RATE

Whether the data show a significant change in the rate of cited AWCs on or about March 19, 1990, when the AWC void code was instituted, is sharply disputed by Dr. Miller and Dr. Roth. They agree that there was a general decline in cited rates during the period from August 1, 1989, to March 31, 1992. Dr. Miller did a chi-square analysis of the data and concluded that the evidence pointed to a significant change in the cited rate on or about March 19, 1990. Dr. Roth, using the same data as Dr. Miller, concluded that after a brief initial period of apparently increasing AWC rates in August and September 1989, the rate of AWCs continuously decreased through the rest of the period. He states that the rate of decline was significantly steeper before the March 1990 void code notification than after that event. Dr. Roth also noted that the number of MSHA inspector filters with AWCs declined at about the same rate during the relevant periods. I am including as Appendix B to this decision a copy of a graph prepared by Dr. Miller (attachment 4, G-454) showing the cited AWC rate by week from August 1, 1989, to March 31, 1992. The graph clearly shows a steep decline in cited rates beginning about March 19, 1990, followed by ups and downs, mostly downs, through the remainder of the period. However, it also shows other sharp declines, although not so steep, beginning about October 1989, about November 1989, about January 1990, and about February 1990. The Secretary argues that the steep decline beginning about March 19, 1990, can only be construed as showing intentional misconduct which ceased when the operators became aware of the void code. I am unable to make the suggested leap from the fact of a declining rate to a conclusion that it shows intentional tampering followed by a cessation of intentional tampering. The fact that AWC citations continued, albeit in reduced numbers, long after the initiation of the void code, after the publicity concerning the criminal investigation including guilty pleas and jail sentences, and after the issuance of the citations which are the subject of these proceedings would argue to the contrary. I find that the statistical evidence does not establish that AWCs resulted from intentional tampering which ceased when the void code was instituted.

C. CASSETTE MANUFACTURE DATE

Dr. Miller did a sign analysis of sample date vs. cited rate adjusted for cassette manufacture date, using G-342 listing the cassette numbers of cassettes manufactured on certain dates between June 22, 1987, and February 26, 1990 (cassettes made after the latter date obviously were not used in sampling by March 19, 1990). He found that there is a definite change in cited rate occurring on or about March 19, 1990, even after adjusting for date of manufacture. The marked decrease in cited rate cannot be explained by a time trend in the quality of the cassettes. Dr. Roth disagreed with Miller's analysis and concluded that the date of manufacture of the cassettes is a plausible explanation of the decline in rates of cited AWCs. The evidence shows that cassettes manufactured before January 1, 1990, had a much higher rate of AWC citation than those manufactured later. This does not establish that the decline resulted from changes in the cassettes over time, but may point to variables in the cassettes uncovered by the scientists.

D. STATISTICAL RELATIONSHIP BETWEEN FILTER-TO-FOIL DISTANCE OR FLOPPINESS AND AWC CITED RATES

Dr. Miller did a logistic regression test[9] using 400 special filters to determine the relationship between citable dust dislodgment and filter-to-foil distance or floppiness. He found no statistically significant relationship for the special filters measured by Dr. Marple and deemed citable by Thaxton. This statistical conclusion does not overcome the weight of the scientific evidence that shows that filters with a shorter filter-to-foil distance or which are floppy are more susceptible to reverse air AWC formation.

E. WEIGHT LOSS

Miller and Roth agree that of the 200 reverse air AWC compliance filters drawn at random from Thaxton's database for the Miller/Marple analyses, the AWC filters had a mean weight loss and the control filters a mean weight gain. They disagree on whether the weight loss is explained by whether the filter was

[9] Regression is a technique for estimating the mathematical relationship between factors on the basis of numerical data.

a reverse air AWC or not. I previously found that reverse air AWC filters with dust dislodgment patterns show on the average a weight loss. The statistical evidence does not affect that finding.

CONCLUSIONS OF LAW

Based on the above findings of fact and the entire record in the common issues trial, I conclude:

1. The Secretary has failed to carry his burden of proving by a preponderance of the evidence that an AWC on a cited filter establishes that the mine operator intentionally altered the weight of the filter.

2. The Secretary has failed to carry his burden of proving by a preponderance of the evidence that deliberate conduct on the part of the cited mine operators is the only reasonable explanation for the cited AWCs.

I noted earlier that there is no direct evidence in the record that the mine operators intentionally altered the weight of the cited filters. To prove his case, the Secretary relies on circumstantial evidence: the appearances of the cited filters, expert opinion as to the causes of these appearances, and statistical conclusions related to the time period during which the filter appearances occurred, and the time when the appearances "declined dramatically." Tr. 33. Findings of Fact II.C.1, 2, and 3 indicate that the appearances of the filters cited under tamper codes 1, 2, 3, and 7 can have resulted from many different incidents or accidents unrelated to intentional tampering. Drs. Marple and Rubow are of the opinion that type A patterns of dust dislodgment (similar to cited AWC patterns) most probably result from deliberate mishandling. The opinions of Drs. Lee, Grayson, McFarland, and Corn are to the contrary. Weighing the conflicting opinions and considering all the evidence of record especially the systematic studies of the experts, I conclude that the evidence does not establish that the AWCs resulted from deliberate mishandling.

The susceptibility of a filter to a dust dislodgment pattern similar to those on the cited filters depends in large part on filter variables (filter-to-foil distance and floppiness), on the firmness or softness of the sampling assembly hose, and on the dust variables listed in Findings of Fact II.G.1.a, b, c, d, and e. These conditions vary from filter to filter, from sampling assembly to sampling assembly, from mine to mine, from section to section within each mine, and even from day to day. Dr. Miller's statistical analyses did not adequately take all these variables into account. His conclusions do not establish that the cited AWCs are not the result of accidental occurrences or manufacturing variables. The record contains relatively little expert evidence concerning the filters cited under the other tamper codes, and I conclude that it does not establish that they resulted from intentional weight alteration. In summary, the record shows too many other potential causes for the dust dislodgment patterns on the cited AWCs for me to accept the Secretary's circumstantial evidence as sufficient to carry his burden of proof that the mine operators intentionally altered the weight on the cited filters.

FURTHER PROCEEDINGS

I excluded from the common issues trial evidence proffered by the Secretary and LDCC concerning the dust sampling practices in individual coal mines. Therefore, the record in the consolidated cases is not complete, and it is not appropriate for me to consider the proposal in the LDCC's reply brief that the citations be vacated. Nor does it seem to me to be conducive to "as prompt and economical a resolution as possible" of these cases to refer them back to the Chief Judge for general assignment to Commission Administrative Law Judges as the LDCC's original posthearing brief proposes. The Secretary suggests a case-specific trial covering all the citations issued to either Consolidation Coal Company (20 mines, 396 violations) or Rochester & Pittsburgh Coal Company (15 mines, 646 violations). In my judgment such a case-specific trial would be unwieldy. As an alternative, I am selecting a single mine, Urling No. 1 Mine of the Keystone Coal Mining Corp. for a mine-specific trial. The mine is located in Indiana County, Pennsylvania, and has a total of 75 violations cited under four different tamper codes.

The trial will be limited to evidence of dust sampling and handling practices at the Urling No. 1 Mine, and evidence concerning the specific filters covered by the citations issued to the mine. I will not receive or consider any further evidence on the matters covered in the common issues trial, including scientific or experimental evidence concerning the causes of AWCs, nor will I consider further evidence concerning the effect of mailing of cassettes from the mines to MSHA facilities or the handling of the cassettes in the MSHA offices. The findings and conclusions in this decision will be incorporated in any decision following the mine-specific trial. Following the mine-specific trial I will render a final decision with respect to the citations issued to the Urling No. 1 Mine.

The issue in the mine-specific trial is whether the weight of the filters cited as AWCs from the Urling No. 1 Mine was intentionally altered by the mine operator, considering the findings made as a result of the common issues trial, and the evidence which may be introduced concerning the dust sampling and handling practices at the mine. The burden of proof remains with the Secretary.

Therefore, IT IS ORDERED

1. Proceedings in all the pending cases except with respect to the citations issued to Keystone Coal Mining Corp. for the Urling No. 1 Mine are STAYED.

2. Counsel for the Secretary and for Keystone Coal Mining Corp. shall appear at a prehearing conference in the Commission Hearing Room, 5203 Leesburg Pike, Suite 1000, Falls Church, Virginia, on Tuesday, August 10, 1993, at 10:00 a.m., for the purposes of discussing discovery proceedings and a trial date for the case-specific trial referred to above.

James A. Broderick
James A. Broderick
Administrative Law Judge

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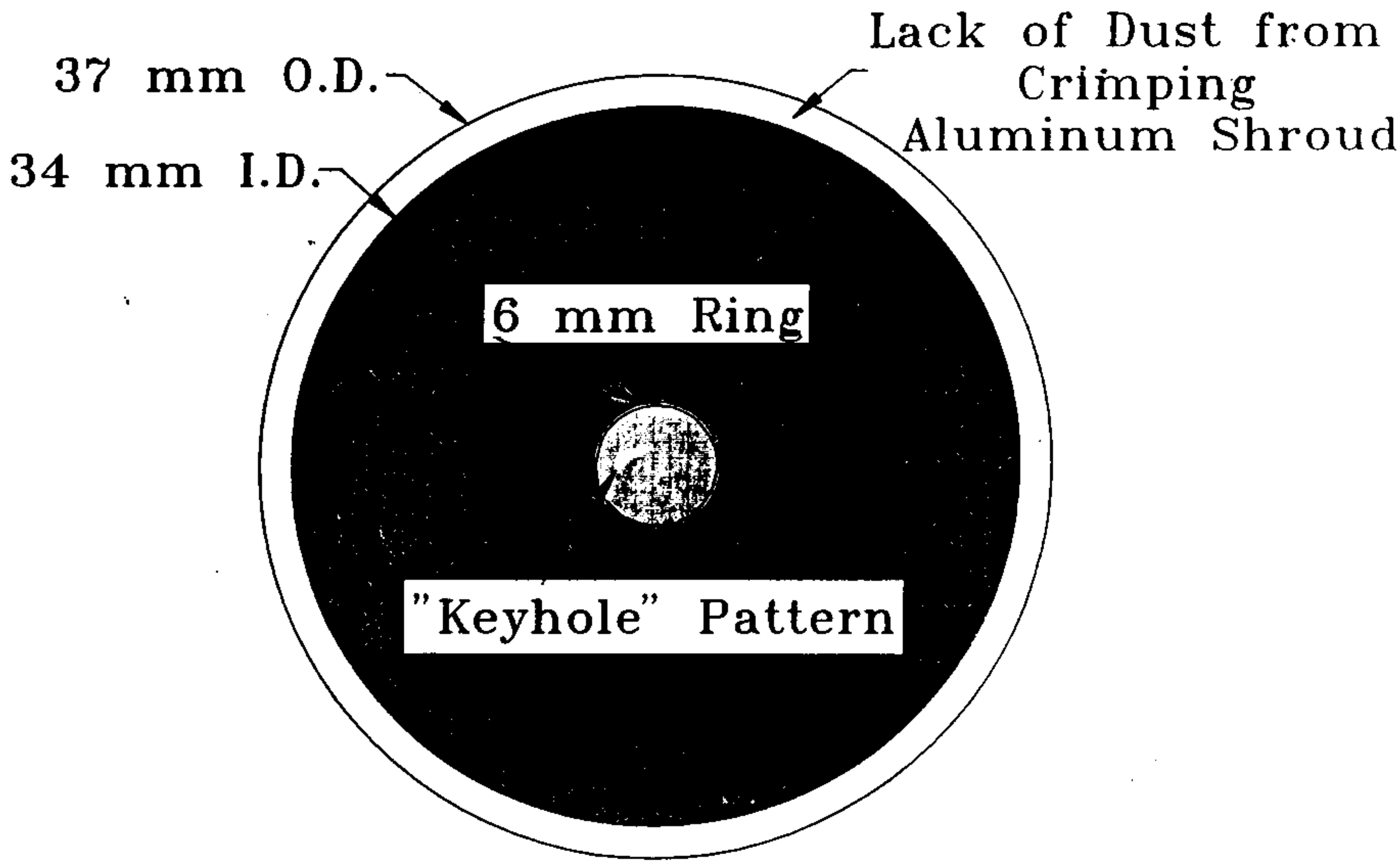
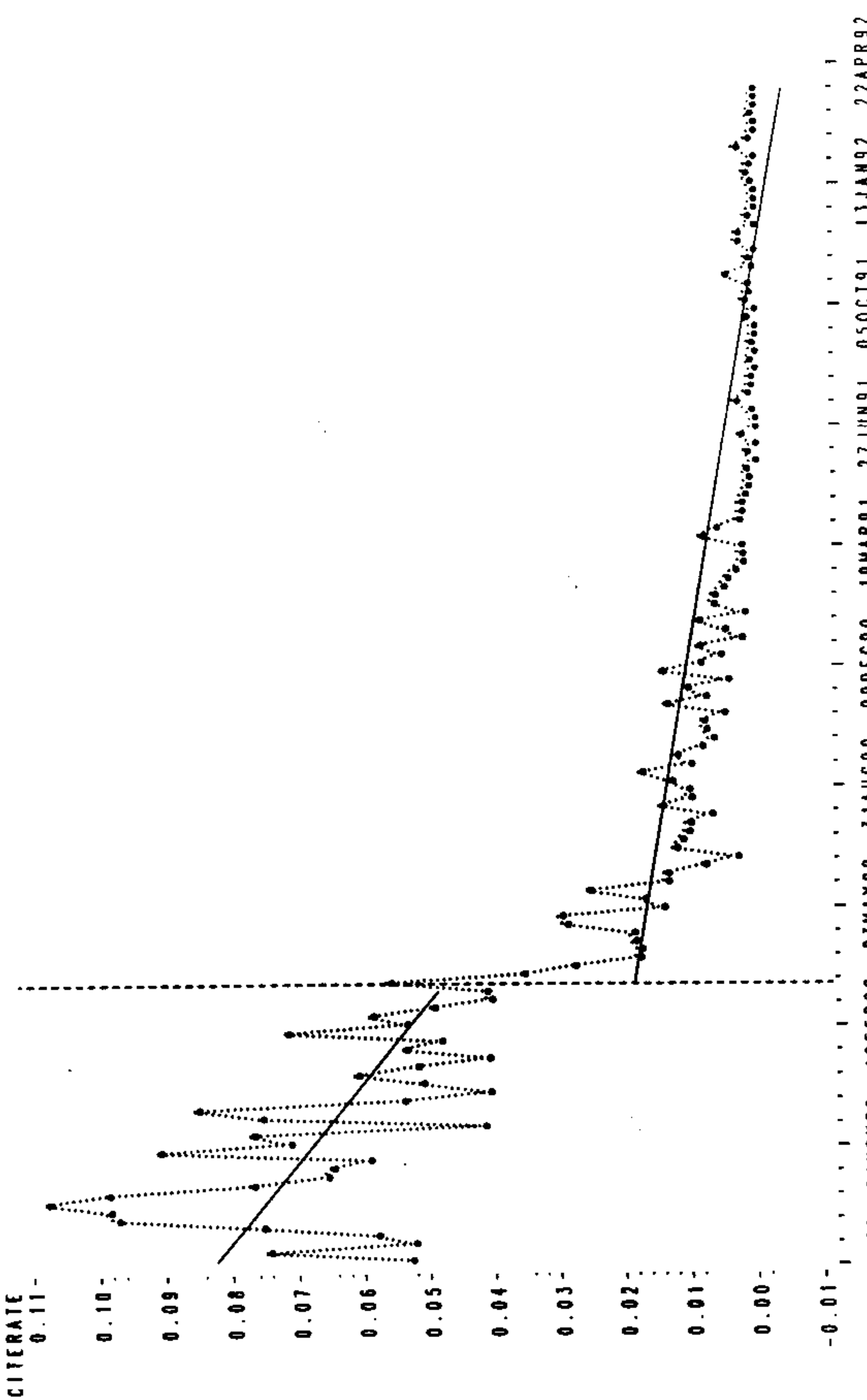
Appendices A and B


37 mm O.D.
34 mm I.D.
Lack of Dust from Crimping Aluminum Shroud
6 mm Ring
"Keyhole" Pattern

Cited Rate by Week from 8/1/89 to 3/31/92 (Linear Fit in Solid)
(Analysis Data Set)
(Vertical Line at 3/19/90--Pre and Post Smoothed Separately)



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Correlation Coefficient or "Goodness of Fit" of Five BLS Average Coal Employment Data Points Equals 0.93

No.	Year	BLS Average Coal Employment	Projected Employment from Linear Regression	Years from Today (1993)
1	1987	162,900	160,200	
2	1988	150,800	154,400	
3	1989	145,900	148,500	
4	1990	147,700	142,600	
5	1991	135,100	136,700	
6	1992		130,900	
7	1993		125,000	0
8	1994		119,100	1
9	1995		113,300	2
10	1996		107,400	3
11	1997		101,500	4
12	1998		95,700	5
13	1999		89,800	6
14	2000		83,900	7
15	2001		78,000	8
16	2002		72,200	9
17	2003		66,300	10
18	2004		60,400	11
19	2005		54,600	12
20	2006		48,700	13
21	2007		42,800	14
22	2008		37,000	15
23	2009		31,100	16
24	2010		25,200	17
25	2011		19,300	18
26	2012		13,500	19
27	2013		7,600	20
28	2014		1,700	21

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PULMONARY FUNCTION OF U.S. COAL MINERS RELATED TO DUST EXPOSURE

To the Editor:

The paper entitled "Pulmonary Function of U.S. Coal Miners Related to Dust Exposure Estimates" by Attfield and Hodous (March, 1992) contains erroneous inferences and data. We agree that accurate measurements of dust exposure are vital, but question the pneumoconiosis field research (PFR) as the ne plus ultra. It is interesting to read two statements that appear in separate papers with a common author concerning the accuracy of the PFR dust measurements. One states that "This has made it possible to quantify cumulative exposure in individual miners etc.," (1) while the second reads "The conversion of these historical records into exposure units is based on an unverifiable assumption about the approximate equivalents of mean dust concentration in the first ten years of follow-up, etc." (2).

It is noted that Attfield and Hodous included the anthracite miners whom we studied (3) in their analysis. Their inclusion is unjustified because: (*1*) the methods of mining anthracite were radically different from those used in bituminous mines, (*2*) no dust data were available for the two now defunct anthracite mines, (*3*) The Bureau of Mines sampled only bituminous mines and while it was maintained that the anthracite mines were more dusty, there were no data to confirm this, and (*4*) the prevalence of CWP and airways obstruction were higher in anthracite than in bituminous miners (3).

Reference is made to two papers in press that describe how the cumulative exposure estimates for U.S. miners included in the Attfield/Hodous study were derived from data collected by coal-mine operators (4, 5). Nowhere do they mention the dust data collected between 1970 and 1972 were invalid (6, 7). The GAO, in 1975, found it virtually impossible to determine how many sections were in compliance with the then regulations (7). While these reports did not appear in the scientific literature, government scientific staff might be expected to be aware of them.

Despite the inclusion of anthracite miners, there is a remarkable resemblance of the lung function measurements to those of Kibelstis and colleagues (8). We have observed that the effects of dust were overwhelmed by those of smoking (8). Attfield and Hodous claim there is an association between dust exposure and the FEV_1; however, a casual glance at figure 3 of their paper shows that in the smokers in those age groups where high, medium, and low dust levels could be compared, the decline in FEV_1 was almost identical, and the regression lines virtually inseparable. In the nonsmokers (figure 1), a small effect on the FEV_1 is evident in some dust exposure groups but not in all. In miners aged 45 to 54 years, the FEV_1 of the medium exposed group is better than that of the low exposure group. The differences in FEV_1 of the medium and high dust groups in the older subjects was only 0.1 L.

The purported relationship between dust exposure and the $FEV_1/FVC\%$ is tenuous and depends on the inappropriate inclusion of anthracite miners for whom no dust data were available.

References 18 and 20 appear to relate to predicted values; however, there is no call out in the text. In short, we believe the data upon which they relied are inaccurate and the conclusions not valid.

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From the Author:

Drs. Lapp and Morgan question our results on dust exposure and coal miners' lung function. We feel that their criticisms have no basis for the following reasons.

Anthracite workers. In our study, anthracite workers made up less than 5% of the total, and were therefore unlikely to severely impinge on the overall findings, even if anthracite dust did have a different effect compared to bituminous dust, which we feel is unlikely. Our results, in any case, included a correction for systematic differences associated with the anthracite region. However, to be sure that anthracite workers had not unduly affected the results, we repeated the analysis reported in table 2 of our paper, omitting anthracite workers. The resulting coefficient of dust exposure on FEV_1 for the 6,792 bituminous miners was −0.63 ml per gh/m³, close to the published value of −0.69 ml per gh/m³ for all miners, and well within the standard error of the coefficient of 0.13 ml per gh/m³. The coefficients for FVC and the $FEV_1/FVC\%$ ratio were similarly little changed, and retained the quoted statistical significance. Given this result, we feel that the inclusion of anthracite workers had essentially no effect on the overall conclusions.

Dust exposures. Because we were well aware of the difficulties and pitfalls involved in exposure estimation, we made certain to look at a number of methodologic variations to determine what effect the various assumptions would have on the estimated exposure-response relationships. We found that the main conclu-

[redacted]

APPENDIX 4

sions were little affected. For example, use of an exposure index generated from the Bureau of Mines data and MSHA data from 1973–78 (i.e., ignoring the initial period of MSHA sampling from 1970–72 which Drs. Lapp and Morgan criticize) gave a dust exposure coefficient on FEV_1 of −0.64 ml per gh/m^3, again close to the published figure.

Other aspects. Perusal of observed data is no substitute for rigorous examination of effects adjusted for confounders and covariates. For this reason we believe that the core of our findings are available from table 2, and not in the figures. In any case, an obvious dust exposure effect is evident among the never smokers in figure 1 of our report. We should note that two factors we did not take into account in our analysis may have led us to underestimate the effect of dust exposure on ventilatory function. The first factor concerns the omission of those miners for whom three acceptable blows were not available. Several studies have demonstrated that this practice tends to exclude the more impaired individuals, thus reducing the measured effect of interest (1, 2). We have reanalyzed the data including all miners with at least one blow. The magnitude of the dust exposure coefficient for FEV_1 increased from −0.69 to −0.83 ml per gh/m^3. In contrast, the size of the pack-years coefficient barely changed (new value = −4.9 ml). The second factor concerns attenuation of exposure-response coefficients due to unreliability in the estimated exposures (3). Lacking the necessary information, we have been unable to quantify this factor, but point out that it may have biased the dust coefficient towards zero (no effect).

Conclusion. We believe that our study and conclusions are not only valid, but reflect a careful and conservative approach to the study questions. We would remind Drs. Lapp and Morgan that a large number of studies, undertaken on various groups and in various countries, have now demonstrated convincingly consistent findings with regard to dust exposure (or its surrogates) and decline in ventilatory function in underground coal miners (4–13). Accordingly, we believe that the hypothesis that coal mine dust exposure leads to ventilatory function changes, and that in certain instances these changes may be of medical significance, should now be generally accepted.

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