

Preliminary Comments on a

**DRAFT CRITERIA for a RECOMMENDED STANDARD:
OCCUPATIONAL EXPOSURE to RESPIRABLE COAL MINE DUST**

July 29, 1993

1. Is the derivation of the recommended exposure limit supported by the scientific data?

When the British dust standard was first published in 1964, a graph summarized the considerable data and quickly conveyed the relationship between exposure to coal mine dust and risk of progression of CWP. The health objective was defined as preventing progression to PMF. It was then a straightforward procedure to select the exposure level that corresponded to the desired level of risk. I had hoped to see something similar to this graph, something that would relate exposure to risk of developing PMF and of COPD.

The 1964 paper had two other virtues: it was short and it was published in a peer reviewed journal (Nature) with very high standards and wide circulation. These are worthy goals for NIOSH to emulate. This document does not have such a graph, it is long, and it has not been submitted for publication in a peer reviewed journal.

But these shortcomings are easily fixed. On the whole, this is an outstanding document that focuses debate on a wide variety and considerable volume of scientific literature.

One important scientific finding recognized in this document is that breathing coal mine dust causes not only CWP and silicosis (if respirable silica is present) but also obstructive lung diseases. This occurs in miners who smoke and in those who do not. While decrements in lung function have been recognized in research over the past four decades, conceptually, it was often treated as secondary to CWP rather than a separate disease process caused by inhalation and deposition of dust. If a miner had impaired lung function and a chest x-ray read as positive for CWP, the impairment was attributed to CWP. If, on the other hand, a miner had impaired lung function but a negative film, the impairment was attributed to something else, usually smoking. But improved use of exposure data and more careful analysis of impaired function made it possible to establish a cause and effect relationship between exposure to dust and impairment, distinguishing it not only from CWP but also from the well known

effects of cigarette smoking. And it also makes it both possible and necessary to use the exposure-response relationship in setting a revised PEL.

This finding also lays the foundation for the use of spirometry in medical monitoring of miners and adds another tool for disease prevention. But since there are other causes of COPD, cigarette smoking being most prominent, it also complicates effective preventive measures. Neither dust control nor smoking control alone are sufficient to prevent COPD; both are necessary.

Another important finding is a change in the conventional wisdom concerning the natural history of CWP. According to the conventional paradigm, PMF was the final stage of disease progression from simple CWP to PMF. This progression was thought to be slow and regular; a miner exposed to excess dust was thought to progress steadily from one stage to another. However, with the recognition that some miners proceed rapidly, perhaps skipping the intermediate stages altogether and develop PMF against a background of normal or nearly normal lungs, the validity of the conventional paradigm was questioned. And along with it, was questioned whether the 2 mg standard was adequate to prevent progression to PMF.

Both of these developments -- the recognition of the relationship between dust and impaired lung function and the change in the conception of the natural history of CWP -- are well described in this document. These two conclusions lay the foundation for estimating risk associated with occurrence of PMF and COPD.

The risk estimations are well founded in the scientific literature. Papers by Attfield (1992), Attfield & Moring (1992), and Hurley and MacLaren (1987) are the essential papers for estimating risk. In addition, the PhD thesis by Seixas (1992) which is the foundation for the five references cited is an important contribution to estimating the risk of impaired lung function associated with dust exposure.

Estimating the effect of coal rank is incomplete. Findings of an increased prevalence of CWP with higher rank coal have not, to my knowledge, adequately assessed exposure. If there is a coal rank effect, then one would find increased occurrence of CWP among workers exposed to higher rank coal when compared to workers exposed to lower rank coal when exposed to the same dust concentration. Is such a comparison in the literature?

2. Are the RELs for respirable coal mine dust and respirable crystalline silica technically feasible?

For surface mines, these RELs are feasible with little additional attention to dust control measures. Achieving the REL for respirable silica will be more difficult than achieving that for mixed mine dust but it is feasible to do so. Dust control methods, especially for high-wall drills, exist and are effective. What is needed is their conscientious application.

For most room and pillar mining sections, the proposed REL's are feasible. Successfully meeting the REL will require conscientious use of effective and feasible engineering control of dust - cutting methods, maintenance of bit sharpness, use of the constant depth linear cutter, ventilation controls, and use of water. Making these effective will also require careful evaluation and oversight of operators' dust control plans. Engineering controls have been described for some continuous mining sections that maintain average concentration of respirable dust to 0.5 mg/m³. (BOM:)

For longwall sections, however, it may be difficult to reduce exposure to the proposed REL's. This is especially true of longwalls with very large panel dimensions: 1000 ft. by 10,000 ft. However, control may be possible with very careful attention to established engineering dust controls for longwall sections, employing the same sorts of generic methods mentioned above in addition to homotropical mining (i.e., having the longwall shear, conveyor, and air across the face all moving in the same direction.) At the least, with careful attention to the mining cycle, most workers on a longwall face can work in relatively clean air but some, e.g., the tail-gate operator and some jack-setters, may be in high concentrations of dust. In some circumstances, personal protective equipment may be necessary.

3. Should the proposed international definition of respirable dust be recommended as the criteria for sampling respirable coal mine dust and respirable crystalline silica?

Yes. The use of international standards has an obvious appeal for facilitating comparison and use of data and information from other coal mining countries. There is an international standard for outcome (the ILO standard for CWP and silicosis); there should also be an international standard for exposure.

4. Should improvements in the coal mine dust personal sampling unit, including all metal construction to minimize charge effects be recommended. Should performance criteria be developed for the approval of more than one type of sampling device?

Yes, to both questions. The current sampling unit is burdened with two problems. First, it operates at 2 lpm which is inconsistent with physically identical samplers used elsewhere in the U.S., most of which operate at 1.7 lpm. Second, it employs conversion factor to obtain an MRE equivalent concentration and use no conversion factor, and is enmeshed in cumbersome adjustments that should no longer be necessary and that introduce their own sources of error. The lack of precision in the current sampling unit is also no longer tolerable, given our ability to develop better performing sampling devices.

NIOSH should develop generic performance criteria in order to facilitate development and use of alternative units. For example, direct-reading instruments could be very useful to either operators or MSHA for conducting surveys to identify sources of dust or for conducting compliance sampling. Direct reading instruments include light scattering devices such as the RAM, the TEOM (tapered element oscillating monitor), or older instruments such as the "beta-gage." Some of these instruments also use a cyclone to separate the non-respirable portion and in these instances, use of the metal rather than the nylon cyclone to reduce charge effects would be a positive development. The obvious advantage of a direct-reading instrument is that it provides information at the time and place where it is needed rather than two weeks later, thus facilitating identification of sources of dust and therefore more effective controls.

Change in the flow rate (from 2 to 1.7 lpm) and elimination of the 1.38 MRE correction factor seem to be changes in the right direction. A change in the flow rate would bring coal mine dust sampling in line with sampling for industrial aerosols used throughout the U.S. Elimination of the correction factor would simplify the interpretation and analysis of data.

However, additional experimentation is needed to insure comparability of measurements over time. We need not duplicate the problem the British had when they converted from particle counts to gravimetric measures. When they did so, they lost the utility of valuable historical data. If we change from the current sampling method, calibrated to the MRE data and do not insure continuity, we could similarly render much data useless. Therefore, I suggest experimental analysis of four samplers running side by side in the same environment in a lab and in a mine. The four instruments would be the current pump run at 2 lpm, the MRE instrument, a third and a fourth running at 1.7 lpm

one with a metal, the other with a nylon cyclone.

5. Is the recommended sampling strategy reasonable on the basis of both statistical validity and practical considerations for measuring airborne concentrations of respirable dust in the coal mine environment?

The strategy is reasonable on the basis of statistical validity. The steps taken to increase the precision of sample analysis -- changing the flow rate, use of the metal cyclone, reducing errors introduced with robotic weighing, and rounding off values rather than truncating -- all validate (1) determination of compliance for operator samples and (2) the use of single MSHA samples for issuing citations if exposure exceeds the lower confidence limit of the PEL.

Current practices of issuing citations based on truncated averages of operator samples or if a single MSHA sample exceeds 2.5 mg/m³ are insufficiently protective of miners and are not, to my knowledge, sufficiently validated statistically, as the Mine Act requires that they be.

The sampling strategy is a partial solution to a practical problem not described in the document. While NIOSH referred to the MSHA task force on dust sampling, the situation that prompted this task force was not mentioned. That situation was the documentation of wide-spread fraud and tampering of dust samples by mine operators and their agents.

Fraud is invited by the structure of the current sampling strategy. This invitation is built on two pillars. The first is that mine operators are given wide and unsupervised discretion to manage sampling. The second is that the very samples that operators take are the principal means for determining compliance with the PEL.

The proposal in NIOSH's report -- to have mine operator take "compliance samples" for the purpose of controlling exposure -- removes one important pillar. By relieving mine operators of the responsibility for taking samples that would be used to make compliance decisions, there is less of an incentive to perpetrate fraud.

Having MSHA determine whether a standard had been violated seems sensible also. With improved precision and accuracy of the sampling device (due to technical changes in the sampling unit and due to a generally higher level of expertise among MSHA inspectors when compared to a mine operator's certified person) the confidence limits are smaller and consequently, MSHA could more easily issue a citation based on exceeding the exposure limit determined by a single sample. Current practice is for MSHA to issue citations based on a single sample only when

exposure is documented at 2.5 mg/m³, 0.5 mg/m³ above the current exposure limit.

6. Is the inclusion of spirometry tests in the medical surveillance program justifiable for the prevention of chronic obstructive lung disease in underground surface miners?

Yes. COPD is, in part, caused by exposure to mine dust. Spirometry is the best measure of COPD suited for medical monitoring and screening. It is inexpensive and informative. Some aspects of COPD -- notably bronchitis -- are reversible with cessation of exposure. These two features satisfy some important requirements of a useful screening test. Therefore, inclusion of spirometry in medical monitoring may yield positive results, perhaps more positive than use of the chest x-ray. If spirometry can achieve reversal of COPD, on this basis alone, it would be an improvement over the use of the chest x-ray whose aim is merely to halt progression of CWP.

A potential but solvable problem, however, is the distribution of spirometers and trained technicians in coal mining communities. An effective monitoring program using spirometry would require some sort of certification analogous to that already provided for chest x-ray facilities.

7. Is the transfer of miners with evidence of CWP or COPD to low dust areas of the mine medically justifiable at the recommended concentrations of respirable mine dust or respirable crystalline silica?

The answer to this question is unknown. The use of the chest x-ray with transfer to less dusty areas appears to have marginal benefit. This is due to several factors: low participation in the x-ray surveillance program, a low proportion of miners exercising their option to transfer, a difficult to measure goal (i.e., halting progression of CWP). In addition, there is considerable variation in interpreting chest x-ray films. In short, there are small numbers used to measure subtle changes using a blunt instrument. Under the proposed plan, with dust exposure in the dustiest jobs reduced by half, it could be even more difficult to measure any benefit. Even so, it is intuitively sensible to remove persons from dust exposure (or to impose more stringent controls) if they have early signs of CWP.

For COPD, the situation is quite different. First of all, some aspects of COPD are reversible upon cessation of exposure. That is, the objective can be to actually improve one's clinical status rather than merely halting progression. Second, spirometry is a more objective measure of lung function than is the chest x-ray of lung anatomy. Third, however, COPD is also

caused by smoking so that benefits from removing a miner from exposure to dust could be reduced or eliminated unless the miner can be persuaded to stop smoking.

8. Are there additional issues or interpretations of information that need to be considered in the development of this criteria document?

Doubtless, there are. This could include considering the feasibility of using spirometry, including developing (or adopting ATS's) standards, and certification of facilities and technicians.

EDITORIAL COMMENTS on the RECOMMENDED STANDARD.

The opening sentence of this recommended standard recognizes, as it should, that occupational exposure to coal mine dust causes several respiratory diseases rather than a single disease. These diseases include coal workers pneumoconiosis (CWP), chronic bronchitis, and emphysema, the latter two often encompassed in the generic term, chronic obstructive pulmonary diseases (COPDs). (The plural form of COPDs is noted.) This is a welcome development in two ways: first because it makes explicit that breathing coal mine dust affects miners' lungs in more ways than are apparent with the chest x-ray and, second, because terminology is used appropriately.

This second point requires some explanation. Throughout the history of attempts to prevent "black lung" and to compensate persons disabled by it, many important questions have depended on definitions of terms. Terms that have been subject to intense scrutiny include "pneumoconiosis" and "miner," for example. In the course of debates, scientific documents, such as this one, have been invoked to buttress one side or another. Therefore, I consider it very important to be careful, explicit, and consistent in the use and definition of terms used in this and related documents and to use terms that serve our purpose -- which is to prevent occupational respiratory disease among coal miners. Therefore, I recommend that certain terms in Section 1.1 be defined and used carefully.

Therefore, I suggest the following:

1.1.1 The definition of a miner should include persons who are not currently employed as miners (as defined) but who, at some time past, had worked in a mine and thus were exposed to mine dust. The reasons to include this population arises from two important features of most occupational lung diseases caused

by dusts: they are irreversible and chronic. Thus, a person in retirement or otherwise not working as a miner could have occupational dusts diseases and not be a "miner" under the proposed definition even at the same time that he (or she) was subject to the intent of this standard. Therefore, I suggest that "miner" refer to, in addition to those definitions enumerated, add "or (4) was in such circumstances at some time past." I would not, however, expect a mine operator to provide a medical surveillance services to miners who have retired but I would expect an operator to provide services to miners who were temporarily not employed due, for example, to temporary illness or disability, layoff (for less than a year) subject to recall, labor dispute, or similar situations.

1.1.3 There are innumerable nits to pick in this paragraph. For example, the ILO scheme classifies chest x-ray films on size, shape, and profusion of opacities and not on profusion alone; it provides classes for normal, simple, and complicated pneumoconiosis rather than for simple pneumoconiosis alone; and the twelve point scale is not a twelve point interval scale but rather a three class ordinal scale (normal, simple CWP, and complicated CWP) with fuzzy boundaries. Rather than refine this definition, I suggest eliminating most of this paragraph and adopting the ILO definitions by reference to the latest ILO document.

Other definitions that should be considered include "pneumoconiosis," "coal workers' pneumoconiosis," "silicosis," and "coal mine dust." These are terms that refer to fundamental and generic concepts of outcome and exposure. I suggest that NIOSH not define "pneumoconiosis" because it is already defined in the Mine Act and in Regulations in ways that are not entirely satisfactory to scientists. Rather than fight this issue, I suggest ignoring it altogether and defining the terms "coal workers' pneumoconiosis" or CWP and "silicosis" instead.

For CWP and silicosis, I suggest adopting or incorporating by reference, a definition taken from a standard medical text and adding, for clarity's sake, the proviso that in practice, the definitions of CWP and of silicosis depend on results of a biopsy, autopsy, or, most often, the interpretation of a chest x-ray film combined with an occupational history of exposure. This focuses attention on the what I believe is the common practice of referring to interpretation of the chest x-ray film as the definition CWP or silicosis. And it makes it possible to refer to COPDs as distinct and different entities that are caused by exposure to dust rather than caused by CWP or silicosis. CWP and silicosis are effects, not causes.

In such a definition, there should be no reference to "impairment" or "disability" connected with a diagnosis of either CWP or silicosis. "Impairment" is a measure of limitations on a

person's normal range of physical activity that is caused by exposure to dust, and "disability" is a term left for the lawyers to masticate. Interpretation of the chest x-ray measures lung anatomy, not impairment.

"Coal mine dust" requires a definition as well both to be precise about whether referring to respirable or other dust and to be precise about exposure to silica. The current term, "respirable dust," (in 30 CFR 72.xxx) refers neither to mining, nor coal, nor to anything medical. It merely defines it as dust collected by a sampler selected by NIOSH. This is a bureaucratic definition, not a scientific one.

I suggest defining "coal mine dust" as a mixed dust found in coal mines. It contains particles of coal and may contain any of several other mineral species including kaolinite, illite, calcite, pyrite, and silica as described later in this document at 3.1.1. "Respirable" dust refers to the fraction of coal mine dust that can penetrate to the portions of the lung where gas exchange occurs (where one stage of respiration occurs, hence, "respirable"). I suggest that it is more precise to refer to exposure to "coal mine dust" (as defined) rather than to "respirable dust" (as defined) as the cause of CWP, silicosis, and COPDs. (NIOSH's proposal of adopting the new international consensus definition achieves the same purpose.)

With these terms defined, we can systematically refer to using the chest x-ray as a monitor of the occurrence of the uniquely occupational diseases (CWP or silicosis) and to measuring exposure to respirable coal mine dust as a monitor of the dust most precisely known to cause them. And it makes for a clearer (I hope) discussion of COPDs and their likely cause, the less precise "coal mine dust." Incidentally, I suggest that the title of the document merely refer to coal mine dust rather than respirable coal mine dust.

1.1.6. The definition of coal preparation facilities should be separated from the definition of surface work areas of an underground mine. Some prep plants are facilities that process coal from either surface or underground mines and some are quasi-independent entities. A definition should reflect these factors.

Since the term "engineering controls" is introduced later (1.2.1), it should also be defined. This definition should refer to any of the usual techniques for reducing the generation or dispersion of dust. These include variations in coal cutting methods, ventilation, and the use of water. It would not include the use of respirators or administrative controls such as rotating workers out of dusty jobs.

1.2.1. Prevention of CWP and of COPDs are appropriate goals of setting an exposure limit. But it should be recognized that

by controlling exposure to mine dust, it is possible to prevent CWP entirely but it allows one to prevent only that portion of COPDs that are caused by inhaling coal mine dust. COPDs are, as is recognized in the document, also caused by non-occupational exposures.

Furthermore, to emphasize that an exposure limit is a ceiling to exposure and not a target, mine operators should be urged to reduce exposure to as low a level as possible, not to exceed the limit of 0.9 mg/m³.

Therefore, I suggest rewriting this sentence as follows:

"To prevent CWP and to reduce the risk of COPDs in coal miners, NIOSH recommends that the exposure to respirable coal mine dust be as low as possible, not to exceed 0.9 milligrams of dust per cubic meter of air as a time-weighted average for up to ten hours per day during a 40 hour work week. . . "

The reference to a 40 hour work week requires some explanation. Does it mean that after forty hours in a work week an exposure limit might be proportionally reduced? If so, this could raise some significant problems with measurement of exposure and enforcement. Proposed MSHA policy is to proportionately reduce an 8 hour shift limit if the miner works a longer shift. This limit could be enforced by allowing the sampler pump to run for the entire shift and making appropriate adjustments in the limit and calculating the concentration of dust. This seems simpler and more practical than applying some sort of limit over 40 hours as is implied in the proposed language.

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