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Director, Division of Standards Development
and Technology Transfer
National Institute for Occupational Safety and Health
Robert A. Taft Laboratories
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Cincinnati, Ohio 45226-1998

Dear Dr. Niemeier:

Enclosed is the U.S. Bureau of Mines consolidated response to the draft National Institute for Occupational Safety and Health document "Criteria for a Recommended Standard: Occupational Exposure to Respirable Coal Mine Dust." This review represents comments from experts in the Bureau's Occupational Health Research Program, as well as those from the Generic Mineral Technology Center for Respirable Dust.

I hope you will find these comments useful in finalizing the draft criteria document. If we can be of additional assistance, or if you require further clarification on any of these comments, please contact Robert A. Jankowski of our Pittsburgh Research Center at (412) 892-6691.

Sincerely,

Acting Director

Enclosure

Review of Draft Document

CRITERIA FOR A RECOMMENDED STANDARD: OCCUPATIONAL EXPOSURE TO RESPIRABLE COAL MINE DUST

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer
Cincinnati, OH

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BACKGROUND

The National Institute for Occupational Safety and Health (NIOSH) of the U.S. Department of Health and Human Services prepared a draft Criteria Document that recommends, *inter alia*, reducing the Federal respirable dust standard from the current 2.0 mg/m^3 concentration to 0.9 mg/m^3 and reducing the respirable crystalline silica dust standard from the current 0.1 mg/m^3 to 0.05 mg/m^3. A driving force behind the NIOSH recommendation is that its studies have indicated that lower standards will continue to lower the incidence rate of lung diseases in mineworkers. NIOSH stated that evaluation of the economic feasibility, including consideration of the cost of upgrading or retrofitting mining equipment or of reduced production levels, are beyond the purview of the agency. Therefore, researchers of the U.S. Bureau of Mines (USBM) reviewed this recommendation to determine whether NIOSH has considered all the literature relevant to the establishment of a recommended exposure limit, to review NIOSH's interpretations of USBM dust control research and NIOSH's recommendations for USBM research, and to determine ultimate economic and technical feasibility of the proposed standards should the Mine Safety and Health Administration (MSHA) elect to promulgate the standards. This report represents the coordinated USBM response.

USBM RESPONSE TO THE NIOSH DRAFT CRITERIA DOCUMENT

1. Is the derivation of the Recommended Exposure Limit (REL) supported by the scientific data?

The NIOSH draft Criteria Document fails to present adequate scientific data to explain or support the derivation of proposed REL's. The following remain unclear:

- Which exposure data were used as part of the epidemiological studies to relate exposure to incidence?
- Which specific data were used to determine incidence levels?
- Was exposure determined from the 1969 USBM study?
- Was the MIDAS data base used for exposure levels?
- Was the NIOSH National Study of Coal Workers Pneumoconiosis used to determine incidence rates?
- How does the low participation in Rounds 3 and 4 affect the validity of these data?

Revision of current standards requires support from epidemiological data showing that the present standards does not offer adequate worker protection, and that a new standard will provide this protection.

The NIOSH document needs to more fully explain the view that "substantial risk" of lung diseases still exists with current PEL's. It states that "some risk of PMF remains even at 0.9 mg/m^3." The document only cites these studies and does not adequately report or explain their contents. Questions that remain are:

- What is the level of risk at 0.9 mg/m^3?
- On what basis is this an assumed acceptable level of risk?
- On what basis was the level of risk at 1.2 mg/m^3 or higher determined to be an unacceptable level of risk?

The report states that "a definitive determination cannot be made from the chest radiograph alone as to whether changes consistent with pneumoconiosis have resulted from carbonaceous dust or silica dust," that "silica exposure may be a factor in the rapid progression from coal workers pneumoconiosis (CWP) to pulmonary massive fibrosis (PMF)," and that "among miners with PMF, 20% had no radiographic evidence of simple CWP at the beginning of the previous 5-year period." This seems to indicate that silica is the key agent in the development of PMF and supports the recommendation to reduce the silica dust standard to 0.05 mg/m^3. However, the rationale for proposing the elimination of the 5% quartz trigger approach has not been presented. Reducing the quartz PEL would require a particular body of data not addressed within this document. No analysis of ambient quartz levels is presented. Depending on specific location, weather conditions, and level of human activity, current or proposed quartz PEL's may be exceeded in various ordinary environments. The validity of occupational PEL's for quartz has never been evaluated in this context. The lower the proposed quartz PEL, the more relevant the issue of ambient quartz exposure to the general population.

It would appear that silica is the critical component of respirable coal mine dust that must be controlled. The epidemiological data presented in the report do not seem to build a strong case for the impact of coal dust. Exposure to coal dust may have an impact on the development of CWP; however, PMF is most affected by exposure to silica dust. Information in the Criteria Document appears to support reducing the silica dust standard, but may not contain sufficiently valid scientific data to support reducing the coal mine dust standard to the proposed 0.9 mg/m^3 level. Recent studies by the Generic Mineral Technology Center for Respirable Dust also appear to support this indication. The Center has been conducting studies on:

- "Interaction of Coal Dust and Nonhuman Primate Lungs";
- "Human Alveolar Macrophage and Coal Mine Dust Interactions";
- "Intervention in the Production of Fibrotic Mediators by the Dust-Exposed Alveolar Macrophage";
- "Molecular and Biochemical Studies of Dust Lung Interactions";
- "Dust-Lung Interaction in Coal Miners—Airway Reactivity in Coal Miners";
- "Immunological and Inflammatory Pulmonary Mechanisms Associated with Chronic Coal Dust Inhalation in Coal Miners."

The results of these Generic Mineral Technology Center for Respirable Dust studies should be considered in developing this document.

The report states that cigarette smoking is a major cause of COPD and that the relative contribution of coal mine dust exposure to decrement of lung function cannot be determined. The report also states that the effectiveness of reducing exposure among coal miners with early development of airways obstruction (before such changes become irreversible) remains to be determined. No sufficiently valid scientific data appear to exist to support the recommendations concerning chronic obstructive pulmonary disease. Additional studies may be needed before a valid recommendation can be proposed.

The inadequacy of existing PEL's is not proven, especially considering the health experience of other nations. Cost and technical considerations aside, the document does not give a compelling health argument for changing PEL's and does not draw adequately on convincing epidemiological records.

2. Are the REL's for respirable coal mine dust and respirable crystalline silica technically feasible?

This question cannot be answered in the abstract. Existing PEL's often present significant technical challenges. For example, no known technology exists to control airborne respirable dust on a longwall mining operation stemming from face spalls. Each individual mining operation has varying levels of respirable dust from the various dust sources. What has proved to be an effective control at one operation may not be effective at another operation if the rank of the source proportionment is not identical. While the NIOSH document reassures that many mine environments would already meet "draft recommended" standards, of more significance is that many existing exposures *do not yet meet current standards*. The document claims that one-third to one-half of compliance samples were below 1.0 mg/m^3. The document presents no evidence that bringing the remaining samples into compliance is technically feasible. Recent studies, Organiscak (1992), have shown that the physical parameters of the coal seam itself can impact the level of airborne respirable dust by an order of magnitude. Thus, even if the source proportionment is equal between two mines, mine A may have as much as 10 times more airborne respirable dust to control than mine B. Because one mine can reduce dust levels to 1.0 mg/m^3, it is invalid to assume that all other mines are able to obtain this level. Existing dust control technology can barely cope with current noncompliance situations despite many years of research and implementation. If dust REL's are cut in half, ordinary intake air may be considered a significant problem. If quartz REL's are cut in half, trace quartz in limestone rock dust may become a problem.

The report states that "for most strip mine occupations, the average concentration of respirable crystalline silica exceeds the recommended REL of 0.05 mg/m^3. Thus, control of respirable crystalline silica should be a priority for surface coal mining operations." The above cited factors apply equally to surface mining operations.

In both cases it is impossible to render a sound scientific judgment without an in-depth analysis of the technical feasibility for the coal mining industry to meet the recommended dust standards.

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

The report contains results of studies and discussions conducted by the ISO, CEN, and ACGIH. The data presented in figure 5-2(a) do not present convincing evidence that the ISO-CEN-ACGIH definition fits the data any better than the ACGIH definition of 1985. The new definition may eventually become the only globally accepted criterion for epidemiological data. In that case, superior instruments based on the definition must be developed. Based on these presumed eventualities, the United States may wish to take the lead by adopting the new definition. However, new dust sizing criteria have generated more curiosity than conviction. Currently, there is no compelling reason to adjust the definition of respirable dust, and NIOSH must make a specific argument for its choice. The basis for the argument must be whether the United States should propagate or follow the momentum for new dust definitions. Also, the new definitions should have enduring global acceptance so they will not be revised repeatedly.

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?

The scientific community should always be open to documented improvements in dust sampling devices. Convincing data must exist, however, to prove that design change or implementation will truly represent an improvement. However, one must answer the question: "Is there a valid technical need?" If so, how may this be offset by enforcement and administrative issues?

Regarding metal versus nylon cyclones, static charge is not the only consideration. Metal cyclones are not necessarily more dependable or more desirable dust collectors. Differences in surface textures will affect surface particle interception and particle collection. Metal and nylon collectors may therefore be subject to errors of similar magnitude, but from different physical phenomena. In recent years, countries that have traditionally used all-metal collectors are adopting more nylon components, Gautam (1993). This trend seems to weaken opinions that all-metal construction is inherently superior.

Some discussion was presented regarding whether samplers should simulate lung penetration or lung deposition and retention. If samplers were required to simulate lung deposition, and deposition of charged particles in the lung can increase up to 30%, then perhaps the sampler should simulate that increased deposition by passing more particles to the filter. It is unclear from the discussions on page 111 of the NIOSH document whether charged particles are removed by the cyclone system more or less efficiently. If the effects of charge are variable, going to conductive material may generate more reproducible results. However, if the bias follows lung deposition behavior, perhaps the nylon cyclone may be more appropriate. The lack of answers in this regard indicates a deficiency in the document or a need for more research.

Development of performance criteria for the approval of more than one type of sampling device would be desirable. Regulations that do not specify specific instruments or technologies will provide an incentive to apply the latest technologies to dust measurement.

With regard to sample flow rate, a limited mathematical exercise appears to validate the conversion factor cited in the report. However, this is only for the particle size range cited in the report. The use of cited aerosol mass size distribution data for coal mine dust [Burkhart et al. (1987) and Mutmansky and Lee (1987)] to derive a correction factor between results using the current MSHA sampling methods and those using the ISO-CEN-

ACGIH sampling criteria needs to be reexamined with coal mine aerosol size distributions measured with other than the Sierra Model 298 sampler [Rubow, Cantrell, and Marple (1990)]. The Sierra sampler has severe limitations in the high dust concentration level environment of underground coal mines, and measurements using this device are subject to challenge. Again, the absence of answers in this area points to a deficiency in the document or a need for more research.

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?

With regard to "statistical validity":

- It is unclear how requiring the mine operator to submit a written dust control plan every 6 months would improve the current system. If the operation is in compliance at the established REL, what is the value of resubmitting the plan?

- It is unclear what biweekly sampling by coal mine operators would accomplish. What is the scientific basis for requiring biweekly sampling?

- It is unclear why mine operator sampling cannot be used for noncompliance. What is the scientific basis for recommending a distinction between compliance sampling by coal mine operators and noncompliance sampling by MSHA inspectors?

- The report states "whenever changes in operational conditions might result in exposure concentrations above the REL, air sampling shall be conducted by the mine operator as if it were an initial monitoring survey." How does one define "changes which might result?" The report also states " a sufficient number of samples shall be collected to characterize each miner's exposure." How does one define "a sufficient number of samples?"

- The recommendation that "noncompliance be determined on the basis of single full-shift concentrations, including a statistical comparison of the probability that the single sample exceed the REL" appears to be technically valid.

With regard to "practical considerations":

- The report recommends that "the mine operator shall conduct an initial monitoring survey to determine the exposure of miners to respirable coal mine dust and respirable crystalline silica," and that "every two weeks, the mine operator shall measure the exposure of each DO, DA, DWP, and/or Part 90 miner." Who will be responsible for processing and certifying the results of this sampling? What is the potential financial and administrative burden on MSHA if the agency is to process these samples?

- The report recommends that "the number of samples analyzed for respirable crystalline silica should be increased to one sample per biweekly sampling period for roof bolters, drillers, and other "high-risk" occupations for exposure to respirable crystalline silica" and that "sampling and analysis for respirable crystalline silica should be performed in accordance with NIOSH method 7500 or 7602." Who will be responsible for processing and certifying the results of this sampling? What is the potential financial and administrative burden on MSHA if the agency is to process these samples?

- The report recommends that "medical records be maintained for workers for at least 40 years after termination of employment, and that copies of environmental exposure records for each worker must be included with the medical records." Who will be responsible for maintaining these records if the mining

company no longer exists? Will these records move with the individual as the individual changes employment from mine to mine? Again, what is the potential financial and administrative burden associated with this recommendation?

Comments regarding the sampling strategy components indicated on page 133 of the NIOSH document follow. A major shortcoming of the document is that it presents very little rationale for the individual recommendations.

- Accurate estimates of TWA concentrations are, of course, desirable. The document questions MSHA sampling strategies, gravimetric practices, and analytical techniques. However, the alternatives presented are not adequately defended. Much of the statistical consideration in sampling depends heavily on the writings of Leidel. However, Leidel has stated that his publications have been overused and overemphasized to an extent never intended. The suggestions for greater accuracy in gravimetric measurements are probably justified, but the matter of quartz analysis is not so clear.

- Analysis of all samples for quartz content represents a very demanding practice. Increased sampling and analytical work loads will require innovations probably beyond traditional or established methods. Without further discussion, the document can only recommend a list of desired parameters to help ensure the accuracy of quartz measurement, suggest known methods as candidates, and state the need for further investigation into the technology area. NIOSH has expressed an interest in such innovations that do not appear in this document.

- The desire for "at least" biweekly dust sampling is demanding and perhaps unreasonable. This is particularly true in that CWP is a slow-developing illness. Additionally, the suggested switching of 6-month and biweekly sampling schedules is confusing and will require much clarification to execute. However, an increased sampling rate will improve the statistical validity of the data gathered. At such a high sampling effort, continuous sampling becomes a decisive, attractive alternative and would be more valuable to a dust control feedback loop.

- The emphasis on sampling high-risk occupations is valid, although lower-risk occupations should still have well-documented sampling. There is no other way to confirm and continuously establish the safety of lower-risk workers. The lower exposure data are also needed for continued epidemiological purposes.

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

Both spirometry and radiology have been underutilized to detect incipient dust-induced or dust-aggravated lung diseases. However, the report states that "unlike PMF, chronic occupation pulmonary disease (COPD) also occurs among individuals without occupational exposure," "cigarette smoking is a major cause of COPD," "commonly used spirometric tests may not be useful for identifying specific diseases," "age, height, and cigarette smoking are important nonoccupational factors that affect lung function," and "the relative contribution of coal mine dust exposure to a measured decrement of lung function in an individual cannot be determined." Thus, this issue appears to be debatable. The absence of answers in this regard points to a deficiency in the document or a need for more research.

7. Is the transfer of miners with evidence of Coal Worker's Pneumoconiosis (CWP) or Chronic Obstructive Pulmonary Disease (COPD) to low dust areas of the mine medically justifiable at the recommended concentrations of respirable coal mine dust or respirable crystalline silica?

Transfer of miners may appear to be a logical and medically justifiable approach. However, the report states "some risk of progressive massive fibrosis (PMF) remains even at 0.9 mg/m^3," results of "a study estimated that only .01% of PMF cases would be prevented if all eligible miners transferred to less dusty jobs, these studies indicate that secondary preventive measures such as transfer are not effective in preventing PMF," "studies indicate that PMF may continue to progress even in the absence of further dust exposure," and "the relative contribution of coal mine dust exposure to a measured decrement of lung function in an individual cannot be determined." This issue appears to be debatable. There do not appear to be sufficiently valid scientific data to support the recommendations concerning transfer of miners. Additional studies may be needed before a valid recommendation can be proposed.

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

The apparent original intent of the U.S. Congress, as stated in the Federal Coal Mine Health and Safety Act of 1969 (Public Law 91-173), was to establish an environmental standard to ensure that the environment to which a miner is exposed is maintained at or below an established standard. One must view the proposed recommendations in light of this original intent. The original congressional intent was to provide the mineworker the highest level of protection feasible. One must ensure that these proposed changes do not potentially decrease the health protection currently afforded to the coal mining work force.

Almost every aspect of dust measurement and enforcement would be adjusted, revised, or reformed by the NIOSH document. The burden of proof is therefore on the authors to show in the clearest and most decisive manner that the current compliance program is inadequate and would be inadequate if pursued to its fullest potential. The document fails to present decisive reasons and clear, definitive data for a program overhaul. It ignores the value of simply fulfilling the requirements of current standards and programs—an important and more workable alternative to total program revision.

The document should more clearly differentiate between simple CWP, radiological opacities, and actual impairment and disability. As with workers exposed to iron oxide, radiological opacities are common, but their status is not pathological. The relation of the prevalence of lesions in autopsies and the existence of pathology must also be clarified. The clinical significance of data in the document must be greatly clarified to prove that a revision in REL's is indeed warranted.

Since individual mines and mining companies do not have guaranteed 40-year lives, the question arises regarding how medical records are to be stored and who will be responsible for doing it. Some Federal agency should probably, at a minimum, keep duplicate files, if not the actual primary records. The cost of this activity must be estimated.

The report states that "belt haulageways are a significant source of respirable dust" (NIOSH, 1988). A recent report by the USBM (RI 9426) concludes: "Using the belt entry as an intake entry may result in additional outby dust sources; however, it may also increase the amount of air available for dust dilution. If the belt entry air represents additional air brought to the face, and if belt entry dust levels...are lower than face dust levels, belt entry air may reduce face dust levels. The magnitude of outby dust sources and the dilution effect are mine-specific. Any decision to use the belt entry as an intake entry for dust control should be supported with a field study." Based on this USBM study, one may question whether "belt haulageways are a significant source of respirable dust," as the NIOSH document claims. The other safety concerns expressed in the document are addressed in the "Final Report of the Department of Labor's Advisory Committee on the Use of Air in the Belt Entry To Ventilate the Production Areas of Underground Coal Mines and Related Provisions." This report appears to resolve may of the concerns expressed in the 1988 NIOSH report.

Investigators at the Generic Mineral Technology Center for Respirable Dust have found significant differences in the biochemical activity in animals when exposed to different dust. The Center has also investigated such issues as "new" vs. "old" dust, and the effect of free radicals. Clearly, the biological activity is related to the dust characteristics including silica and geological environment. As such, it is felt that any new American dust standard must rely on sicentific investigations that fully identify the relationship between exposure characteristics including characteristics of dust, mining conditions, worker exposure, etc. in the United States. The American worker employment and exposure since 1969 is most relevant because the Post-1969 American database on these aspects is extensive, and the American standard is the most stringent in the world. Further, the experiences, world-over may be a result of considerably higher allowed dust exposures, and other undefined/unmeasureable factors (see p. 199 of NIOSH report). It is to be recognized that the U.S. experience in this area may also be subject to other undefined/unmeasured factors whose contributions are presently not known and must be identified. They must be studied and evaluated as they may be important to the understanding and eradication of CWP and COPD.

Page 8, section 1.4.1.3: It is unclear as to when or how often miners are to complete the standardized respiratory questionnaire.

Page 14: Who will conduct the initial and daily fit checks of respirators? What does a "quantitative" fit test entail?

Page 28: The composition of respirable coal mine dust can vary significantly in mines using diesel haulage equipment. USBM studies have shown that 40% to 60% of the respirable aerosol can be of diesel origin (Cantrell, 1993).

Page 36: The Bureau's Division of Policy Analysis has identified more recent coal production information than that which was presented in the subject document. In 1991, U.S. Coal production was 993.5 million short tons. Underground coal production was 406.3 million short tons (41 percent of total production) and surface coal production was 587.1 million short tons (59 percent of total production). In 1991, the average number of miners working daily at U.S. coal mines equalled 120,000. The average coal production per miner per shift was 35.18 tons, Coal Production (1991).

Page 41: In 1991, U.S. coal production by rank was as follows, Coal Production (1991):

* Anthracite - 3 million tons
* Lignite - 87 million tons
* Subbituminous - 255 million tons
* Bituminous - 649 million tons

Page 42: In 1991, mines using longwall mining methods accounted for 29 percent of the coal produced in underground coal mines (119 million tons out of a total of 406 million tons produced underground), Coal Production (1991).

Page 55: Are the Dieffenbach 1985-90 and 1990 citations personal communications? They are not cited in the reference list.

Pages 120 and 121: The relative merits of penetration- versus deposition-based sampling were discussed. Research is needed to determine whether deposition-based data correlate more closely with the incidence of disease. One also needs to determine which is more important: the ability to correlate future measurements with historical data, or simulation of lung deposition. The document argues against a deposition-based definition owing to complexity of the required sampler. The sampler complexity required to simulate deposition versus aerodynamic size of particles seems overestimated. Another argument presented against deposition-based data is the individual variability of lung deposition. However, this variability *exists for particle penetration as well.* Therefore, what is the merit in proposing a new penetration-based definition of respirable dust? Additionally,

since the standard is based on mass concentration, how much error in the mass estimate could particles below 2 μm introduce?

Care must be taken in dismissing the difference between deposition-based samplers and those designed to approximate penetration into the lungs. In the special case of diesel-equipped coal mines, as much as one-half of the respirable aerosol mass lies between 0.05 and 0.8 μm. This is a region in which the retention efficiency curve dips to 20%. By including this aerosol in an exposure measurement, an overestimate of as much as 40% can occur for lung deposition.

Page 154: In the special case of diesel-equipped mines, as much as 50% of the aerosol mass occurs in the size range of less than 0.9 μm. As a result, any correction factor applied to the total respirable aerosol sample mass will cause a bias in the measurement results. This is because the correction factor is determined for coal dust aerosol alone. In the case of diesel-equipped mines, such correction factors should only be applied to the coal dust portion of the respirable sample, i.e., aerosol size greater than approximately 0.9 μm. This implies that aerosols in these mines should be sampled in such a way that diesel and mineral dust portions can be resolved [Rubow, Cantrell, and Marple (1990)].

Page 156: Diesel aerosol is predominately less than 1.0 μm with a mass median diameter of 0.2 μm. In mines using diesel equipment, the 0.5 μm and smaller fraction is generally larger than 10%. How will diesel aerosol affect the proposed correction factor? Anytime there is a significant contribution (>10%) from a different aerosol source, such as diesel aerosol, the correction factor should only be applied to the aerosol fraction >1.0 μm.

Page 216: The USBM 1987 reference is the same as Watts, WF and Parker, DR, 1987, which is also cited.

The data scatter in figures 5-4, 5-8, and 5-9 regarding applicability of a new definition of respirable dust and use of correction factors is very disconcerting. The potential for major error is very real for individual samples or dust distributions with particular characteristics. There is nothing in the text to dispel such concerns.

Tables 3 and 4 show the 1992 MSHA data broken down by mining method. These data imply that a proposed recommended exposure limit (REL) may not be feasible at this time. More than 70% of operator and inspector samples collected at longwall shearing operations exceed 1.0 mg/m^3, and 38% and 48% of operator and inspector samples, respectively, exceed 1.0 mg/m^3 at continuous miner operations.

Table 5 shows operator-collected coal dust data for 1992. Operators submitted 69,578 samples from 1,725 mines (identified by the unique seven-digit MSHA mine identification number).

Tables 6-9 provide the 1992 data for comparison to with the tables shown on pp. 218-222 of the NIOSH document.

Pages 223-225: These tables show the MSHA respirable quartz data. Quartz concentration estimates based on the MSHA quartz data are biased because of the sample selection process, e.g., no sample with a mass weight gain <0.5 mg is analyzed (the "O" or observed quartz concentrations are shown in tables 10-11). Thus, only relatively high-weight gain samples are analyzed, which leads to high exposure estimates. However, the percent of quart determined in each sample is not a biased measurement. If the occupation mean quartz percentage is multiplied by the inspector or operator occupation mean dust concentration a better estimate of quartz exposure may be obtained (the "P" or predicted quartz concentrations are shown in tables 10-11). This is illustrated in tables 10-11 using CY 1984-89 MSHA data. These data were reported by Watts and Dieffenbach at the 1991 American Industrial Hygiene Conference. The ratio of observed to predicted quartz concentration ranged from 1.2 to 2.9 for inspector and 1.3 to 2.4 for operator samples. This bias should be discussed in the NIOSH document.

The recommended exposure limits for respirable coal mine dust of 0.9 mg/m^3 and 0.05 mg/m^3 may have significant impact on the domestic economy, both in terms of its impact on the coal mining industry and in terms of its impacts upon the overall national economy and selected regions of the country. While the Bureau of Mines recognizes that the evaluation of the economic feasibility of complying with the recommended exposure levels is beyond the purview of NIOSH, the potential national and regional economic impacts (such as reduced economic output or employment associated with reduced coal production) should be evaluated during the regulatory development process.

REFERENCES

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3. Gautam, A., et al., Evaluation of Sampling Errors in the Nylon Cyclone. Annual Report of the Generic Technology Center for Respirable Dust, 1993.

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5. Rubow, K.L., B.K. Cantrell and V.A. Marple, Measurement of Coal Dust and Diesel Exhaust Aerosols. Proc. VIIth International Pneumoconioses Conf. Pittsburgh, PA, 1990, pp. 645-650.