ANALYSIS OF THE COST EFFECTIVENESS OF THE OSHA REGULATION OF NONASBESTIFORM AMPHIBOLES WITH RESPECT TO SELECTED SECTORS OF THE DOMESTIC MINERALS INDUSTRY

by

Richard S. Gillette and Robert L. Virta

Division of Policy Analysis, Division of Mineral Commodities

U.S. Bureau of Mines

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EXECUTIVE SUMMARY

On June 20, 1986, the Occupational Safety and Health Administration (OSHA) published a final rule titled "Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules." The regulation, which was amended in September 1988, established exposure limits for asbestos and the nonasbestiform varieties of the amphibole minerals actinolite, tremolite, and anthophyllite (AT&A). In addition, under the OSHA regulation, all products containing a specified concentration of these minerals must be labelled as having a constituent that is a carcinogen. A fourth administrative stay granted by OSHA in the application of the regulation to AT&A is due to expire on November 30, 1990.

A study was undertaken by the Bureau of Mines in April 1989 in an effort to contribute to OSHA's final asbestos standard. The Bureau analysis questions whether OSHA has conclusively demonstrated a health risk associated with AT&A and, consequently, that these minerals should be regulated at all given that no discernible net benefits will result. The Bureau study has also identified a basic inconsistency between OSHA's definition of asbestos and its asbestos standard. The regulation will result in economic impacts on several minerals industry sectors and major technical and legal uncertainties which will affect the economic performance of the domestic minerals industry.

With few exceptions, the OSHA asbestos regulation does not apply to the mining industry because mining and milling operations are regulated by the Mine Safety and Health Administration (MSHA). Given OSHA's present regulation, however, mineral producers must inform their customers of the AT&A content of their products. Because nonasbestiform amphiboles are very common in nature and occur in a variety of geologic environments, a large number of U.S. mineral producers will have to sample and test their products. On this score, confusion and uncertainties in the minerals industry have resulted because of OSHA's lack of guidance on an acceptable bulk sampling procedure.

Businesses that use mine and mill products in their production processes must adhere to provisions of the OSHA regulation. Included are major segments of the minerals industry, such as smelters, as well as other consumers of mineral products such as ready-mix concrete plants, and bulk commodity transfer facilities.

The economic impact of the OSHA regulation is expected to be greatest on the aggregates industry. Due to product liability considerations, it is expected that preliminary deposit evaluation and deposit sampling of some kind would have to be done at about 1,325 quarries, or one fourth of the crushed stone quarries in the

United States. It is estimated that about 780 quarries, or 15 percent of U.S. quarries, would need to conduct detailed testing. The annualized cost of preliminary deposit evaluation and deposit sampling of the 1,325 quarries is estimated at $22 million. The detailed testing component of this cost estimate pertains to only 435 of the 1,325 quarries, or nine percent of U.S. quarries. Significantly, the Bureau analysis concludes that the remaining 345 of the 780 quarries subject to detailed testing, or seven percent of all U.S. quarries, would be financially unable to afford the cost of the required detailed testing because of their small size. These quarries, which produced an estimated 16.6 million tons in 1987 valued at $72.5 million, f.o.b. plant, could be forced to close. Sales losses in the aggregates industry are possible and would be contingent on the availability and cost of material that is essentially free of AT&A and the liability concerns associated with using products containing AT&A.

It is estimated that the domestic talc industry could lose up to $12 million in sales over a period of several years because of substitution arising from product liability concerns of consumers. The iron ore industry could lose sales of minor amounts of ore, in the form of direct shipping ore and concentrates, and the steel industry would have to monitor exposed employees at sinter plants and at some blast furnaces.

The OSHA regulation sets a precedent in the regulation of asbestos. If MSHA, which does not currently regulate AT&A as asbestos, follows OSHA in the upcoming revision of its air quality regulations for mines, the overall impact on the mining industry would be far more significant. For example, 31 percent of 1987 U.S. copper mining capacity could be affected given the geology of these deposits.

The OSHA asbestos regulation, which may be unnecessary given no conclusive evidence of any resultant health benefits and which contains mineralogical errors in its definitions, will result in considerable costs to the domestic minerals industry in ways that the agency did not consider in its formulation. In the concluding section, recommendations are offered to OSHA in an effort to contribute to a regulation, if one is needed, that can be more appropriately applied to the minerals industry.

INTRODUCTION

On June 20, 1986, the Occupational Safety and Health Administration (OSHA) published a final rule titled "Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules" (51 Fed. Reg. 22612). The regulation, which was amended in September 1988 (53 Fed. Reg. 35610), established exposure limits for asbestos and the nonasbestiform varieties of the amphibole minerals actinolite, tremolite, and anthophyllite (AT&A).[1] In addition, under the regulation, all products containing a specified concentration of these minerals must be labelled as having a constituent that is a "cancer and lung disease hazard" (51 Fed. Reg. 22699, 22736).[2]

In response to the regulation, a domestic talc producer filed a petition in the U.S. Court of Appeals for the Second Circuit challenging the portion of the regulation pertaining to AT&A. The case was transferred to the U.S. Court of Appeals for the District of Columbia Circuit.

On July 18, 1986, in response to submissions from the talc company, trade associations, and the National Institute for

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[1]The nonasbestiform varieties of the amphibole minerals actinolite, tremolite, and anthophyllite will be referred to as "AT&A" in this report.

[2]See Appendix A for a more detailed description of the provisions of the regulation.

Occupational Safety and Health (NIOSH), OSHA granted a temporary stay of nine months in the application of the regulation to AT&A. This administrative stay was subsequently extended three times and is due to expire on November 30, 1990 (54 Fed. Reg. 30704).

During the stay, OSHA is enforcing its 1972 asbestos rule, which is less stringent than the 1986 regulation. The 1972 regulation, however, specifically defined AT&A as asbestos. Since OSHA admitted in a 1984 proposed rule that its 1972 asbestos definition was mineralogically incorrect, and that it was the only governmental agency to regulate AT&A as asbestos (49 Fed. Reg. 14122), the agency is paradoxically perpetuating an error that it previously acknowledged.

Due to the presence of AT&A in many ore types, the domestic minerals industry could be adversely impacted by the June 20, 1986 OSHA asbestos regulation. In an effort to contribute to any OSHA decision on AT&A, this study, undertaken in April 1989, evaluates OSHA's asbestos regulation in light of the agency's regulatory mandate, reviews evidence as to whether health benefits would result from the regulation, identifies and examines the inconsistency between OSHA's definition of asbestos and its asbestos standard, the technical and legal uncertainties this has imposed on the domestic minerals industry, and the economic impact on several sectors of the industry. The cost and market impact estimates were developed by Bureau analysts based on data obtained

from the literature and conversations with experts in government, trade groups and unions, consultants and academe, and industry. Implications to the domestic minerals industry of the possible adoption of the regulation by the Mine Safety and Health Administration (MSHA), OSHA's sister agency in the Department of Labor, are also analyzed. In the concluding section, recommendations are offered to OSHA in order to contribute to a regulation, if one is actually needed, that can be more appropriately applied to the minerals industry.

ANALYSIS OF BENEFITS FROM THE OSHA REGULATION OF AT&A

OSHA's Regulatory Mandate

The Occupational Safety and Health Act of 1970 (P.L. 91-596) was passed to assure safe and healthful working conditions in the United States, as far as possible. The Act charges the Secretary of Labor with promulgating safety and health standards to meet this objective. In a 1980 Supreme Court ruling (Industrial Union Department, AFL-CIO v. American Petroleum Institute, 448 U.S. 601, 65 L. Ed. 2d 1010, 100 S. Ct. 2844), however, OSHA was required to find the existence of a significant safety or health risk under a current standard before issuing a new regulation and to demonstrate that a new standard would reduce or eliminate the risk. Specifically, the Court stated that ". . . Before he can promulgate any permanent health or safety standard, the Secretary [of Labor] is required to make a threshold finding that a place of employment

Summary of the Medical Literature on Exposure Risks

Unlike asbestos, AT&A rarely occurs in sufficient quantities in deposits to be economically valuable by themselves. Miners are exposed to AT&A only when a deposit is mined for the recovery of other minerals. In most of the epidemiological studies, the authors noted that exposure to other minerals such as quartz also occurs frequently and that smoking and previous work experience are other critical factors in the interpretation of the health studies.

In Minnesota, iron ore miners are exposed to the amphibole minerals cummingtonite-grunerite, actinolite, riebeckite, and hornblende. Generally, the cummingtonite-grunerite and actinolite are elongate but not asbestiform, and riebeckite is nonasbestiform. Two reports suggest that asbestiform riebeckite (crocidolite) and ferroactinolite are present in small amounts in parts of the deposit.

Clark et al. (1980) studied 249 workers who were exposed to taconite dust for over 20 years at the Reserve Mine operation. No symptoms characteristic of asbestos were reported. Lung disease was attributed to cigarette smoking and silicosis. Higgins et al. (1983) studied over 5,751 workers at the Reserve Mine operation and found no association between mortality and exposure to dust. Although the number of deaths from lung cancer was lower than the control population and no mesothelioma cases were observed, they cautioned that exposures to total dust, silica dust, and fibers were low and the average time since initial exposure was relatively short. Cooper et al. (1986) studied 3,444 workers and found that the death rates were lower than the control populations for lung cancer and respiratory tract cancer. Clark noted that exposures to amphiboles were unknown.

South Dakota miners at the Homestake gold mine are exposed to cummingtonite-grunerite, actinolite, and hornblende. These amphiboles are elongate but not asbestiform. Gillam (1976) reported excess deaths and respiratory malignancies among a study group of 439 workers. He attributed the malignant disease to these amphiboles, with cigarette smoking as a possible cofactor and the nonmalignant disease to amphiboles and possibly free-silica dust. Swent et al. (1976) refuted the study, indicating that NIOSH had underestimated the amount of smoking, that most of the nonmalignant disease reported as asbestosis by NIOSH was classified as silicosis on death certificates, and that exposures to silica were above standards in the past. McDonald et al. (1978) studied 1,321 employees with over 21 years of service with Homestake. Although there was an elevated death rate for respiratory cancers and pneumoconiosis, exposure to silica rather than asbestos was suggested as the cause. Brown et al. (1985a, 1985b) studied 3,328 miners at Homestake. Lung cancer deaths were similar to those of the control population. Respiratory diseases were attributed to exposure to free silica. The Brown report was contested by one coauthor because of the control group used, difficulty in diagnosing the diseases, and ignoring the latency period of asbestos-related diseases.

In New York, talc miners are exposed to anthophyllite and tremolite. These minerals are elongate but not asbestiform. Brown and Wagoner (1980) examined 398 workers who had worked for Gouverneur Talc Co. between 1947 and 1959. They found excess deaths from lung cancer and nonmalignant disease. Several of the workers who died of lung cancer, however, had worked at Gouverneur Talc for less than one year. It was later shown that the number of workers who smoked was greater than expected for a

blue-collar work force (Gamble et al., 1979). Stille and Tabershaw (1982) examined records on 655 workers and concluded that the number of overall deaths and deaths attributed to lung cancer were not significantly greater than the control group.

In Labrador, iron ore miners are exposed to cummingtonite-grunerite and anthophyllite, which are nonasbestiform although some elongated particles are present. Edstrom and Rice (1982) examined radiographs for 2,455 workers with three or more months of employment. They found patterns consistent with pneumoconiosis in 46 of the workers. They also indicated that some workers showed asbestotic symptoms although it was not mentioned in a later report summarizing the findings (Chittai et al., 1983). A later review of 61 of the radiographs indicated that symptoms were consistent with silicosis, siderosis, or a mixed-dust pneumoconiosis and not suggestive of asbestosis.

Relatively few animal studies of the nonasbestiform amphiboles have been conducted. Pott (1974) injected a primarily nonasbestiform actinolite intraperitoneally into laboratory rats and observed no tumors. Smith (1979) implanted both asbestiform and nonasbestiform tremolite into hamsters. Two samples contained 50 percent and 90 percent nonasbestiform tremolite, one sample contained acicular tremolite cleavage fragments, and two samples were asbestiform. No tumors were observed with the primarily nonasbestiform tremolite samples. Tumors were observed with the asbestiform samples. Wagner et al. (1969, 1982) injected two nonasbestiform and one asbestiform tremolite samples into the pleural cavity of rats. Tumors were observed with asbestiform tremolite samples. No tumors were observed with the nonasbestiform tremolite samples.

Finally, Stanton (1981) implanted two talc samples that contained 30 percent to 50 percent nonasbestiform tremolite into the pleural cavities of rats and observed no excess tumors with these samples.

In summary, the health community appears to be split as to the risk that exposure to nonasbestiform amphiboles poses. The lack of control over factors other than exposure to amphiboles, such as smoking history, appears to confound data interpretation. The results of animal studies, however, suggest that the nonasbestiform amphiboles may not be health hazards. Because arguments can be made both for and against health risks associated with exposure to nonasbestiform amphiboles, there is an obvious need for further study in this area. To date, therefore, OSHA has not conclusively demonstrated a health risk associated with nonasbestiform amphiboles.

AT&A in the Workplace

To investigate the extent to which OSHA had measured levels of AT&A in the workplace, and therefore whether the agency had met its mandate of finding a perceived risk before promulgating its regulation, the Bureau of Mines formally requested OSHA inspection data from 11 four-digit industry SIC codes representing industries believed to handle material that could contain AT&A.[3] The data received represent OSHA's sampling effort for

[3]These industry SIC codes include Highway and Street Construction, Except Elevated Highways (SIC 1611), Bridge, Tunnel, and Elevated Highway Construction (1622), Paints, Varnishes, Lacquers, Enamels, and Allied Products (2851), Tires and Inner Tubes (3011), Concrete Block and Brick (3271), Concrete Products, Except Block and Brick (3272), Ready-Mixed Concrete (3273), Lime (3274), Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills (3312), Primary Smelting and Refining of Copper (3331), and Primary Smelting and Refining of Nonferrous Metals, Except Copper and Aluminum (3339).

"asbestos (all forms)" in these industries during the period October 1983 through April 1989. No personal samples,[4] which is the type required of employers under the provisions of the regulation, were taken in six of these industry groups: the two construction groups (SIC 1611 and 1622), ready-mixed concrete, lime, and the two smelting groups (SIC 3331 and 3339).

Only 47 personal samples were taken by OSHA in the five other industry groups over the five-year period. Of these samples, only five, or 11 percent, taken at 18 operations exceeded the action level of the proposed regulation. Two of the five samples were "ceiling" samples, which are measured over a 15-minute period instead of an eight-hour time-weighted average, and represent a short, perhaps sudden exposure rather than exposure over an eight-hour shift. In addition, at least one of the five samples that exceeded the action level was for asbestos, rather than AT&A.

In summary, OSHA has not fulfilled its mandate to conclusively demonstrate a health risk from AT&A before promulgating a regulation. The equivocal nature of the health literature and the inadequate amount of sampling done by OSHA in some industry groups where AT&A could be present render the benefits of such a regulation questionable at the present time.

[4] A personal sample is one in which a measuring device is attached to a worker over an eight-hour period to measure the worker's exposure during a work shift.

DEFINITION OF ASBESTOS

In its 1986 regulation, OSHA defined asbestos as "chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered" (51 Fed. Reg. 22733). This seemingly circular definition of "asbestos" as ". . . tremolite asbestos, anthophyllite asbestos, actinolite asbestos . . ." confounds the issue of what constitutes asbestos.

OSHA's definition of a fiber as "a particulate form of asbestos, tremolite, anthophyllite, or actinolite, 5 micrometers or longer, with a length-to-diameter ratio of at least 3 to 1" (51 Fed. Reg. 22733) is not consistent with its mineralogical definition of asbestos because nonasbestiform particles can be classified as asbestos given this definition.[5] Minerals such as feldspars, wollastonite, and pyroxenes typically cleave into fragments with aspect, or length-to-diameter, ratios of 3 to 1 or greater and will incorrectly be identified as AT&A based on aspect ratio alone. Additionally, these minerals will be identified as asbestos if only aspect ratio is used in OSHA's analytical procedure.

[5]OSHA added the aspect, or length-to-diameter, ratio criterion to its fiber definition to conform with the practices of NIOSH, the American Industrial Hygiene Association, and the U.S. Public Health Service. Use of the 3 to 1 aspect ratio originated in the United Kingdom when three asbestos manufacturers arbitrarily selected it to facilitate the counting of asbestos particles by optical microscopy (Dupré, 1984). This can work well in an environment characterized by a known sample population, such as a textile mill where asbestos is woven into cloth, but is extremely misleading in a less restricted environment such as mineral production where a greater variance of material types is common.

A mineralogically correct definition of asbestos according to Bureau of Mines experts is:

> a term applied to six naturally occurring serpentine- and amphibole-group minerals that are exploited commercially because they crystallize into long, thin, flexible fibers that are easily separable when crushed or processed, can be woven, are resistant to heat and chemical attack, and are good electrical insulators.
>
> The six serpentine- and amphibole-group minerals commonly referred to as asbestos are chrysotile, grunerite asbestos (amosite), riebeckite asbestos (crocidolite), anthophyllite asbestos, tremolite asbestos, and actinolite asbestos. When viewed under light microscopy, these asbestos particles typically possess aspect ratios ranging from 20:1 to 100:1 or higher for particles longer than 5 um and widths of 0.5 um or less and have two or more of the following characteristics: bundles of parallel fibers, fibers with splayed ends, matted masses of individual fibers, and curved fibers.

It follows from this mineralogical definition and the characteristics of asbestos that the 3 to 1 aspect ratio criterion alone should not be used to classify a particle as asbestos as suggested by OSHA in its final rule. In addition to aspect ratio, analysis of a sample should include a search for the presence of the characteristics listed above.

If OSHA decides to continue its practice of only considering aspect ratio, the 3 to 1 criterion is acceptable for phase contrast microscopy if it is applied to all occupational settings where asbestos, as defined above, is present in the crude form, where asbestos or asbestos-containing materials are intentionally used in a manufacturing process to enhance the properties of a product, and where asbestos-containing products are used or are being removed. The 3 to 1 aspect ratio is acceptable under these conditions because low aspect ratio fiber bundles frequently are observed in these occupational settings and a 3 to 1 aspect ratio has been demonstrated to ensure the health of workers encountering asbestos in the work environment. An aspect ratio criterion of 10 to 1 should be used under all other conditions because it has been shown to adequately distinguish between asbestiform and nonasbestiform amphibole particulates.

In its final rule, OSHA

> acknowledges that some particles with an aspect ratio of less than 10 to 1 or 5 to 1 are not asbestos fibers, but OSHA does not regard this as a deficiency in using the 3 to 1 definition. As noted, the 3 to 1 aspect ratio has been successfully used for years. In addition, changing the ratio to 5 to 1 or greater as suggested by some commenters, would mean that OSHA would have to change the quantitative risk assessment and feasibility findings (51 Fed. Reg. 22681).

Thus, OSHA apparently refused to remedy the definitional problem associated with its regulation because doing so would involve revising previous risk and feasibility analyses. The agency should therefore reconsider its use of the aspect ratio criterion and base its decision on factors other than convenience.

GENERAL ECONOMIC IMPACT ON THE MINERALS INDUSTRY OF THE OSHA REGULATION

In its final economic impact assessment, OSHA analyzed "primary manufacturing, secondary manufacturing, automotive brake and clutch repair, shipbuilding and ship repair, and construction" (51 Fed. Reg. 22650), applications that use chrysotile. However, the agency did not specifically address impacts on the minerals industry, whose products sometimes contain AT&A. By not doing so, OSHA may be unaware of potential unintended impacts of its asbestos standard. To contribute to more effective regulatory rulemaking, the Bureau of Mines has assessed these impacts, the results of which are presented below.

OSHA Jurisdiction

With few exceptions, the OSHA asbestos regulation does not apply to the mining industry because minerals producers are generally regulated by MSHA under the Federal Mine Safety and Health Act of 1977 (P.L. 95-164), or Mine Act. The minerals processing industry, however, is subject to the OSHA asbestos regulation under the authority of the Occupational Safety and Health Act of 1970 (P.L. 91-596), or OSH Act. In 1979 these two Department of Labor agencies settled jurisdictional matters emanating from their legislative mandates in an interagency agreement (44 Fed. Reg. 22827). The Mine Act, administered by MSHA, generally applies to mine sites and milling operations. The OSH Act governs mines and mills where provisions of the Mine Act do not cover or apply to occupational safety and health hazards on these sites, such as hospitals on mine sites, or where there are no MSHA standards relevant to a particular condition on a mine or mill site.

Milling processes regulated by MSHA include crushing, grinding, pulverizing, sizing, concentrating, washing, drying, roasting, pelletizing, sintering, evaporating, calcining, kiln treatment, sawing and cutting stone, heat expansion, retorting, leaching, and briquetting. Disputes regarding what constitutes milling are resolved between the two agencies to "reflect Congress' intention . . . of inclusion of a facility within the coverage of the Mine Act" (44 Fed. Reg. 22828).

OSHA authority applies to gypsum board plants, brick, clay pipe and refractory plants, ceramic plants, fertilizer products, asphalt-mixing plants, concrete ready-mix or batch plants, custom stone finishing, smelting, electrowinning, and refining.

Extent of the Impact

Despite the fact that the OSHA asbestos regulation does not pertain to mining and milling operations, it will affect the businesses that consume mine and mill products in their production processes. This includes major segments of the minerals industry, such as smelters, as well as other consumers of mineral products, such as ready-mix concrete plants. Bulk commodity transfer facilities such as receiving docks, port storage yards, barge terminals, and railroad freight yards could also be impacted by the regulation. Mineral producers must be concerned with the AT&A content of their products since consumers of mineral products will likely demand to know the AT&A content of the material they purchase from mineral producers to protect themselves against product liability suits.

The severity of the problem becomes evident upon consideration of the geology of the United States and the likelihood of the occurrence of

AT&A. AT&A may be found in hydrothermally altered igneous rocks and in metamorphic rocks, which constitute the bedrock of about 40 percent of the contiguous United States. In addition, weathering processes erode these rocks and transport AT&A, which then become part of the sedimentary rock record or persist in soils and dust (Dunn, 1989b).

Due to the widespread occurrence of AT&A, air samples taken in mines and manufacturing plants that use mineral products often show signs of AT&A; this is supported by MSHA analyses. Fifty two percent of 381 air samples taken at stone quarries and sand and gravel pits by MSHA contained AT&A in excess of the OSHA "action level" (0.1 fibers per cubic centimeter of air).[6] These levels were found at 45 percent of the 163 operations sampled (Bailey, 1988). As was described earlier, OSHA inspection data sharply contrast with MSHA data on AT&A air concentrations. The inadequate level of sampling done by OSHA makes it difficult to generalize and may be indicative of the agency's apparent lack of consideration of minerals-related issues in its asbestos rule making.

The minerals industry and its customers are faced with problems, costs, and uncertainties stemming from this neglect. Several specific problems deserve discussion. First, regulating some, but not all, nonasbestiform amphiboles does not make sense from a chemical and physical perspective.[7] Regulation of only three of these minerals results in

[6]MSHA's fiber definition is the same as OSHA's, but MSHA performs more detailed analytical work to determine the identity and physical characteristics of a fiber before issuing a citation for asbestos.

[7]Five nonasbestiform amphibole minerals that can occur in an asbestiform habit (actinolite, tremolite, anthophyllite, riebeckite, and cummingtonite-grunerite) are similar, being hydrous silicates with varying amounts of iron, magnesium, calcium, and sodium. They are also similar physically, exhibiting the typical amphibole cleavage pattern.

costly analytical procedures to determine the mineral identity and whether the mineral in question is regulated by OSHA. Second, OSHA's definition of a fiber and the method of counting fibers in a sample, as previously discussed, can cause materials other than AT&A to be counted in the analysis of a sample. This imposes an unnecessary regulatory burden on an operation. Third, triggering of the labelling requirement when the AT&A content of a product exceeds 0.1 percent by weight confounds the intent of the regulation, which is to limit the airborne concentration of the minerals. The sampling procedure that a mineral producer must carry out to certify that its product contains less than 0.1 percent AT&A is exceedingly complex and costly. The lack of a sampling guideline by the regulatory agency is one of the greatest contributors of uncertainty associated with the regulation.

In summary, mineral producers will be affected by the proposed OSHA regulation because they must inform their customers, who are directly regulated by OSHA, of the AT&A content of their products. Nonasbestiform amphiboles are very common in nature and occur in a variety of geologic environments. Consequently, a large number of U.S. mineral producers will have to sample and test their products. OSHA's lack of guidance on an acceptable bulk sampling procedure and its definition of a fiber, which can result in false-positive analytical results, have created confusion and uncertainties in the minerals industry.

ECONOMIC IMPACT ON THE AGGREGATES, TALC, AND IRON ORE AND STEEL INDUSTRIES

A more detailed analysis was undertaken to identify and quantify specific economic impacts of the OSHA regulation on the aggregates, talc, and iron ore and steel sectors. These industries were singled out by Bureau of Mines commodity specialists and industry experts as industries that could be considerably impacted by the regulation.

Methodology

Six possible cost categories were identified for analysis after considering flow diagrams for mining, milling, and post-mill processing and determining impact points likely to result from the requirements of the OSHA regulation for the aggregates, talc, and iron ore and steel industries. The cost categories include: product sampling and analysis; purchase of safety equipment (e.g., respirators), employee training, and medical surveillance; product liability and effects on company insurance coverage; changes in production methods and effects on production rates; sales losses and reduction in market share; and mine closures and bankruptcy.

Costs were estimated by the Bureau of Mines based on data obtained from the literature and from conversations with 82 experts in government, trade groups and unions, consultants and academia, and industry.[8] In all cases, it is assumed that the estimated costs represent the incremental impact of the regulation of AT&A. In other words, it is

[8] Of the 82 people contacted, 34 were from government (41 percent), nine from trade groups and unions (11 percent), seven from consulting firms and academia (nine percent), and 32 from industry (39 percent).

assumed that industry is already complying with the portion of the regulation that was not stayed and is, therefore, in effect.

The costs considered in the analysis are not necessarily additive because not all of them apply to all three industries studied and to the same degree (table 1). For example, the purchase of safety equipment,

Table 1. Cost increases resulting from the regulation, by industry

Cost Category	Industry		
	Aggregates	Talc	Iron Ore & Steel
Sampling and analysis	Y	Y	Y
Safety equipment, etc.	N	N	Y
Product liability	Y	Y	Y
Production methods/rates	U	U	U
Sales/market impacts	Y	Y	U
Closures/bankruptcy	Y	Y	U

Y Yes
N No
U Uncertain

employee training, and medical surveillance applies only to plants directly regulated by OSHA. Mines and mills would therefore not be impacted, but sintering plants and blast furnaces in the steel industry might be.

The necessity for product sampling and analysis differs between industries. In the aggregates industry, Bureau analysts concluded that pits and quarries would have to be extensively sampled in order to determine the AT&A content of their products, whereas talc producers would need to undertake only modest sampling programs if the stay is lifted.

Changes in production methods and effects on production rate, sales losses and reduction in market share, and mine closures and bankruptcy

were not explored in any detail for each of the three mineral sectors. However, maximum sales losses were approximated by estimating the number of firms that may be impacted by the regulation.

Product liability and effects on company insurance coverage are costs that cannot be quantitatively estimated, but are potentially very significant given the litigious nature of American society. For example, Manville Corp., a former asbestos producer that went into Chapter 11 bankruptcy due to the filing of about 30,000 asbestos claims against it, will pay an estimated $2.5 billion over the next 26 years to settle the claims. The ongoing experience of a domestic talc company also serves to illustrate the drastic nature of product liability costs. In a brief filed with the United States Court of Appeals for the District of Columbia Circuit on April 27, 1989, to lift the "abeyance pending agency reconsideration" and for "a stay pending judicial review," the company maintained that because the asbestos standard

> improperly treats nonasbestos minerals as if they were asbestos, [its] economic viability has been, and is continuing to be, undermined (and irreparably harmed) through lost customers, lost good will, and lost insurance coverage, as well as through the expense of having to defend itself against over 2,000 "asbestos" claims filed against it (R.T. Vanderbilt v. OSHA et al., 1989).

The fact that a company has lost its general liability insurance coverage and is a defendant in numerous personal injury cases as a result of a regulation, that is yet to be settled, dramatically demonstrates the potential severity of this impact on the minerals industry.

Impact on the Aggregates Industry

The aggregates industry consists of crushed stone and sand and gravel producers. Preliminary Bureau of Mines estimates indicate that crushed stone production totalled 1.22 billion short tons valued at $5.6 billion, f.o.b. plant, in 1988, up from 1.20 billion tons valued at $5.2 billion in 1987. In 1987, employment in the industry, not including office workers, was 68,645, according to MSHA (1988) statistics. In 1988, construction sand and gravel production reached an estimated 881 million tons valued at $3.1 billion, down from 896 million tons valued at $3.0 billion. In 1987, employment in the industry, not including office workers, stood at about 35,200.

Aggregates-producing operations would not be subject to the OSHA regulation because, as indicated earlier, MSHA inspects pits and quarries. Consumers of aggregates, however, would have to adhere to the regulation and would undoubtedly want to know the specific AT&A content of the products they use. It is assumed that the aggregates producers would have to inform their customers of the AT&A content of their products, presumably through a Material Safety Data Sheet.

Recent legislation indicates the degree to which aggregates producers could be held liable for the content of their products. For example, in 1986 a bill was introduced in the County Council of Prince George's County, Maryland "for the purpose of prohibiting the use of asbestos-bearing aggregate and providing that each supplier of aggregate shall be conclusively presumed to warrant it to be free of asbestos

content" (County Council of Prince George's County, Maryland, 1986; emphasis added).[9]

An analysis was done to estimate the sampling costs that crushed ston producers could incur in order to determine the AT&A content of their products.[10] Bureau of Mines analysts estimated that about 1,325 quarries, or one fourth of the quarries in the United States, would be impacted by the OSHA regulation given the geology of domestic crushed stone deposits and the likelihood that AT&A can be found in them. Bureau analysts also estimated that about 780 of these quarries, or 15 percent of all U.S. quarries, would need to have detailed testing (i.e., drilling) done. The cost of preliminary deposit evaluation and detailed testing of the 1,325 quarries was estimated by the Bureau at $173 million. Because of the substantial drilling costs involved, it is assumed that companies would amortize some of these expenditures. Selecting ten and twenty year periods for amortizing the two types of drilling programs assumed, and choosing a ten percent discount rate, the first-year cost to the industry would be $24 million. The annual cost for the next nine years would be $22 million.

[9]The bill, which was defeated due to a technicality, would have required that aggregates products contain less than one hundred parts per million by volume (i.e., 0.01 percent) of asbestos. Asbestos was defined as actinolite, amosite, anthophyllite, chrysotile, crocidolite, or tremolite. A task force convened by the County Executive deliberated the bill for eighteen months and concluded that only the asbestiform varieties of these minerals should be regulated. In addition, the task force grappled with the sampling requirements of regulating to the 0.01 percent level and questioned whether reliable and consistent measurements could be made on a satisfactory basis to enforce the regulation.

[10]See Appendix B for a more detailed explanation of the cost analysis.

The detailed testing component of the cost described above pertains only to 435 of the 1,325 quarries, or about nine percent of U.S. quarries. Of particular significance, the analysis indicates that the remaining 345 of the 780 quarries subject to detailed testing, or seven percent of all U.S. crushed stone quarries, would be financially unable to afford the costs of the required detailed testing because of their small size.[11] These quarries could be forced to shut down as a result of the burden imposed by the OSHA regulation. Stone production from these quarries in 1987 is estimated at 16.6 million tons valued at $72.5 million, f.o.b. plant.

Since the Bureau of Mines does not collect detailed information on the rock types that constitute sand and gravel deposits, the amount of AT&A in these deposits cannot readily be estimated. One expert suggested that, given the regulation, every sand and gravel deposit in the United States would have to be examined at least at a cursory level at a minimum cost of $1,000 per deposit (Dunn, 1989a). Since there are about 5,800 sand and gravel pits in the country, a minimum cost for sampling would be an estimated $5.8 million.

Losses in aggregates sales are possible and would depend on the availability and cost of material that is essentially free of AT&A as well as the potential legal liability associated with using products containing higher concentrations of these minerals. Given the regional nature of

[11] In the cost analysis, it was assumed that only impacted quarries producing in excess of 100,000 tons annually would be able to afford the cost associated with this activity (see Appendix B).

An estimated 44 percent of U.S. crushed stone quarries produced less than 100,000 tons in 1987.

aggregates markets and the significance of transportation cost to the final price, some areas could have to "import" aggregates from sources hundreds of miles from the market. Complex supply adjustments involving quarries, transportation routes and methods, and consumers would undoubtedly result in the long run. More severe market disruptions could occur in the short run as producers and consumers adjust to the regulation.

Impact on the Talc Industry

Talc was produced in ten states from 25 mines in 1988. Mine and mill employment stood at 980 workers. Geological and industry reports suggest that nonasbestiform amphiboles are present in trace to minor amounts in the working portions of six mines in four states, although it appears that five mines would be affected by the OSHA regulation. Approximately 351,005 tons of crude talc ore, valued at $5,199,000, were produced from these deposits in 1988. The estimated sales value of this ore was $20.8 million, or approximately 17 percent of total domestic talc sales of $119.5 million in 1988.

Most talc producers contacted by the Bureau did not indicate that they would test talc reserves to the extent that aggregate producers would. Therefore, sampling and analysis would be less costly for the talc industry than for the aggregates industry. Sampling and analysis for quality control and mine planning are routinely performed in the talc industry, and samples are analyzed for asbestos and AT&A because of the asbestos controversy. A wide variation in sampling and analysis programs was noted between companies, although most companies contacted could not quantify the costs of sampling and analysis because their mining costs are

not itemized. However, one company estimated analysis costs at approximately $200 per test. This company samples about three times a month. Another company collects and analyzes samples whenever drilling is performed prior to blasting. Drilling is performed on a 30-foot grid system. A third company performs sampling at the mine site, the primary crusher, the secondary crushers, and the bagging operations for quality control.

The major impact on the talc industry from the OSHA regulation would be a loss in sales from the five impacted mines. Bureau analysts estimate that a loss of about 60 percent of the sales of talc from these deposits, or about $12.3 million, could be expected over a period of a few years as consuming industries switched to alternative materials or AT&A-free talc. A minimum of 140 workers could be affected by the OSHA regulation. One producer stated that the OSHA regulation will force it to shut down its mine because of the loss of its customer base. Sales losses could also occur if talc consumers go out of business as a result of the OSHA regulation. CONSAD Research Corp. (1989) estimated that impacts on small companies, employing fewer than 20 workers, in industries such as sanitaryware, pottery products, and hobby slip manufacturing could be severe, with closures possible.

Some sales likely will be lost by the import market because imported talc would also have to be tested for AT&A. Imports accounted for eight percent of apparent domestic consumption in 1988, up from five percent in 1987. A loss in talc export sales of about 120,000 tons valued at $5.0 million could occur if labelling is required. This represents about 30 percent of total talc exports in 1988. Losses in talc import and

export sales would impact domestic transportation and distribution industries in addition to talc producers and consumers. For example, Bureau economists estimate that about 115 direct jobs would be lost in the transportation and wholesale industries if the above export sales loss occurs.

Tremolite, an AT&A mineral, is a desirable component of talc products in some applications. Consumers can expect higher prices for some varieties of sanitaryware, electrical ceramics, and paint if consuming industries decide to eliminate tremolitic talc from their products. The products will exhibit different characteristics during manufacturing and the manufacturing process will have to be modified to compensate for this change. For example, tremolitic talc is used in ceramics. Without tremolite in the formulation, the ceramic will exhibit different shrinkage, moisture adsorption, and firing characteristics. Producers will have to change their manufacturing process and, in some cases, the design of molds to compensate for these differences.

Impact on the Iron Ore and Steel Industries

Domestic iron ore shipments increased from 52.8 million short tons in 1987 to an estimated 67.3 million short tons in 1988. Nonasbestiform amphiboles are common in some of the U.S. iron ore mines. It is expected, however, that the OSHA regulation would not significantly impact the iron ore industry because almost all of the iron ore produced in the United States is pelletized (e.g., about 96 percent in 1987), a pyrometallurgical process that alters or destroys AT&A minerals. Iron ore is almost exclusively pelletized at the mine site, which is regulated by MSHA and therefore not subject to the OSHA regulation.

A number of mines sell direct shipping ore and concentrates for both steel and non-steel end uses, including cement, heavy media, specialty chemicals, agricultural products, pyrites, refractories, fluxes, and ballast. Sales of these products, if they contained AT&A, could be impacted by the OSHA regulation. It is estimated that at least eight of the 16 producers of direct shipping ore and concentrates in 1987 could be impacted by the OSHA regulation, given the geologic information available to the Bureau of Mines. Production of direct shipping ore and concentrates from these eight mines, which employed about 575 mine and mill workers, totalled about 1.9 million tons in 1987. Two of these mines produced iron ore pellets in addition to raw ore and concentrates; it is not known whether they would pelletize their ore in response to the OSHA regulation and incur the necessary associated costs or suffer sales losses significant enough to force closure. Two other iron ore mines included in the above estimate ceased production in 1988 for other reasons.

In the steel industry, which is inspected by OSHA, pig iron production rose from 48.3 million tons in 1987 to an estimated 56.9 million tons in 1988. Steel mill shipments increased from 76.7 million tons in 1987 to 86.0 million tons in 1988. Sinter plants and some blast furnaces use raw iron ore as feed. In 1987 blast furnaces used about 3 million tons of raw iron ore, which represented four percent of the feed material consumed (American Iron and Steel Institute, 1988). Sinter plants used 6.9 million tons of raw ore, 79 percent of which was imported (American Iron Ore Association, 1989). Blast furnaces and sinter plants that use raw ore and concentrates would probably sample feed material or require the mine to perform such sampling. Imported ores and concentrates also would have to be tested for AT&A; contractual arrangements between suppliers and

purchasers would determine how the sampling and analysis costs would be distributed. In addition, initial monitoring of employees at these plant would be the minimum cost incurred under the OSHA regulation.

ECONOMIC IMPLICATIONS OF THE POSSIBLE ADOPTION OF OSHA'S ASBESTOS REGULATION BY MSHA

OSHA has acknowledged that it is apparently the only governmental agency that regulates AT&A as asbestos (49 Fed. Reg. 14122). It is possible, however, that other regulatory agencies could follow OSHA's precedent in regulating AT&A as asbestos.[12] Industry sources have expressed concern that MSHA, OSHA's sister agency in the Department of Labor, may do so in the revision of its air quality regulations for mines.[13] The MSHA proposed rule, which is currently under review by the Office of Management and Budget, is due for release in the fall.

If MSHA does regulate AT&A as asbestos, the impact on the domestic minerals industry could be far more significant because AT&A is a common rock-forming mineral. Mines that extract AT&A, even as waste rock, would be affected. The impact on the aggregates industry would be much larger than that estimated earlier because producers would have to monitor their own employees and reduce AT&A levels to the mandated level.

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[12]The asbestos definitions used by several other regulatory agencies are reviewed in Appendix.C.

[13]MSHA currently defines asbestos as "limited to the following minerals: chrysotile, amosite, crocidolite, anthophyllite asbestos, tremolite asbestos, and actinolite asbestos" (30 CFR §57.51(b)). The agency recognizes that processed or crushed asbestos separates into "flexible fibers made up of fibrils."

The domestic copper industry serves as another example of the potential impact of an MSHA regulation of AT&A as asbestos. The ten largest copper producers accounted for 82 percent of total copper mine capacity in 1987, and 80 percent and 79 percent, respectively, of copper mine and mill employment in the fourth quarter of 1987. Based on a review of the geologic literature and consultation with copper-deposit geology experts, it is concluded that four of the largest copper mines could be impacted if AT&A were regulated as asbestos. These four mines accounted for 31 percent of domestic copper mine production capacity in 1987, and 22 percent and 33 percent, respectively, of copper mine and mill employment in the fourth quarter of 1987. Although the economic impacts on these operations have not been estimated, they could be expected to be significant.

SUMMARY

The Occupational Safety and Health Administration has promulgated an asbestos regulation without adequately demonstrating a health risk, as required by the OSH Act of 1970 and a later Supreme Court ruling. This failure, coupled with the paucity of sample data collected at OSHA-regulated worksites where AT&A could be present and the low levels of "asbestos" in the samples that were taken indicate that there are no demonstrable net benefits which would result from the regulation and, therefore, makes the necessity of regulating AT&A doubtful.

OSHA's apparent lack of consideration of minerals-related issues in the formulation of its regulation is reflected in the rule itself, which contains internal inconsistencies due to definitional problems. The

agency's definition of a fiber and its procedure for sample analysis can erroneously lead to the classification of nonasbestiform materials, including AT&A, as asbestos. This leads to potentially significant product liability and insurance concerns and creates problems, costs, and uncertainties for the domestic minerals industry.

OSHA did not investigate the economic impact of its regulation on the domestic minerals industry, as evidenced by the industries covered in its final economic impact assessment. The regulation will impact the various sectors of the domestic minerals industry differently depending on the occurrence of AT&A in mineral deposits, whether AT&A is removed in processing, how customers react to the potential regulatory costs including the product liability issue, and how the producers themselves interpret the regulation given its ambiguities. The uncertainty and confusion created by the labelling requirement is obvious given aggregates producers' impression that they will have to extensively test their deposits, whereas talc producers have indicated that they will not be as rigorous in their sampling. The product liability concern is, perhaps, the issue that will cause the greatest impact on the minerals industry through lawsuits and supply adjustments to avoid suits.

The economic impact of the regulation is expected to be greatest on the aggregates industry, where producers have taken the product liability issue seriously, some having already sampled their deposits even though the regulation is still under administrative stay. It is expected that site visits and deposit sampling could cost the industry an estimated $22 million on an annualized basis and, additionally, could force up to seven percent of U.S. crushed stone quarries to close. Sales losses in

the aggregates industry are possible and would be contingent on the availability and cost of material that is essentially free of AT&A and the liability concerns associated with using products containing AT&A.

It is estimated that the domestic talc industry could lose up to $12 million in sales over a period of several years because of substitution arising from product liability concerns of consumers. The iron ore industry could lose sales of minor amounts of ore in the form of direct shipping ore and concentrates, and the steel industry would have to monitor exposed employees at sinter plants and at some blast furnaces.

The OSHA regulation will set a precedent that other regulatory agencies might follow. Treatment of AT&A as asbestos by other regulatory agencies could have a more widespread impact on the domestic minerals industry. It appears that the Environmental Protection Agency, Department of Transportation, and Consumer Product Safety Commission will not follow OSHA's lead in regulating AT&A as asbestos. However, the Mine Safety and Health Administration does not regulate AT&A as asbestos, but is currently revising its air quality regulations for mines. If the agency decides to go along with OSHA, the impact on the mining industry would be significant.

RECOMMENDATIONS TO OSHA

Based on the Bureau of Mines analysis, it is recommended that OSHA not regulate AT&A as asbestos unless medical data conclusively show that these minerals present a health risk which would be reduced through regulation. In the event that such a determination is made in the future based on

adequate data, the following recommendations are offered to OSHA so that the agency can more appropriately apply its regulation to the minerals industry:

(1) OSHA should revise its asbestos and fiber definitions, as suggested earlier, to make the two terms consistent from a mineralogical standpoint;

(2) OSHA should more extensively sample plants that use mineral products to determine whether and the extent to which employees are actually being exposed to AT&A and, therefore, whether there is a real need to regulate AT&A in OSHA-regulated worksites at all;

(3) OSHA should specifically address the relationship between the AT&A content of a product and the airborne concentration of AT&A;

(4) OSHA should issue sampling guidelines for minerals producers to resolve the confusion created by the labelling requirement; and

(5) OSHA should specifically address the economic impact of its proposed regulation on the minerals industry and weigh these costs against possible benefits before publishing its final standard in November 1990.

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APPENDIX A

PROVISIONS OF THE OSHA ASBESTOS REGULATION

In its 1986 Standard for General Industry,[14] OSHA established an action level for asbestos and AT&A of 0.1 fiber per cubic centimeter of air (f/cc) and a permissible exposure limit (PEL) of 0.2 f/cc, determined as an eight-hour time weighted average (TWA). This standard replaced the agency's 1972 PEL of 2 f/cc. In addition, the 1986 rule mandates that warning labels be "affixed to all raw materials, mixtures, scrap, waste, debris, and other products" containing asbestos and AT&A in accordance with OSHA's Hazard Communication standard, which requires labels unless the minerals are present in concentrations less than 0.1 percent by weight (51 Fed. Reg. 22736). The 1988 amendment to the 1986 final rules set an excursion limit (EL) of 1.0 f/cc over a 30-minute sampling period to further reduce a perceived health risk (53 Fed. Reg. 35610).

The regulation requires that employers of affected operations perform initial and semiannual monitoring of employees expected to be exposed to airborne concentrations of AT&A at or above the action level. One sample must be taken per job category per work shift. Initial monitoring can be excused if monitoring was done within a six-month period immediately prior to issuance of OSHA's final rule or if the employer can demonstrate that the standard will not be exceeded on the basis of "objective data."

If the action level or excursion level is exceeded, the following actions must be taken by the employer: air monitoring every six months,

[14] In its 1986 final rules, OSHA issued separate standards applying to workplaces in general industry, including maritime, and to construction worksites.

annual medical surveillance of affected employees, and employee information and training.

If the permissible exposure level (PEL) or excursion level (EL) is exceeded, employers are required to: (1) establish and implement a written program to reduce employee exposure; (2) establish regulated areas demarcated from the rest of workplace, marked by warning signs (i.e., hazard communication), and supply each person entering the regulated area with a respirator; (3) implement engineering controls and work practices (e.g., local exhaust ventilation, wet methods) to reduce exposure to the PEL and EL or, if not feasible, to the lowest levels achievable, supplemented by respirators; (4) issue protective work clothing and equipment (e.g., coveralls, gloves, head coverings) to workers; and (5) construct hygiene facilities, including clean changerooms, showers, lunchroom facilities (with positive-pressure filtered air supply).

APPENDIX B

COST ESTIMATE FOR CRUSHED STONE PRODUCERS

An estimate for the number of quarries that would incur costs to test for AT&A was based on the rock type associated with each quarry and the probability that AT&A can occur in each rock type (table B-1). For example, Dunn (1989a) estimated that there is a five percent chance that limestone and dolomite deposits can contain AT&A greater than or equal to 0.1 percent, the concentration that would trigger the labelling requirement. Multiplying this probability by the number of limestone and dolomite quarries yields the estimated number of impacted quarries producing this rock type. Assuming uniform production among quarries because the actual production distribution is not known, the expected production and value of production impacted by the regulation are obtained by multiplying the occurrence probability by the 1987 production and value of production. This was done for each rock type for which probabilities were available; 97 percent of 1987 production was represented using this method. It is estimated that 26 percent of the quarries would be impacted, representing 17 percent of 1987 production.

Sampling costs were based on a contract study done for the National Stone Association by Dunn Geosciences Corporation, a consulting company that specializes in aggregates and industrial minerals. For sedimentary rock quarries, it is expected that a field check and laboratory investigation would have to be performed at every impacted quarry. The estimated cost, assuming that AT&A occurs stratigraphically and is evenly distributed within particular rock layers, is $2,000 if the results are negative. If AT&A is found at a concentration close to 0.1 percent,

detailed testing in the form of drilling reserves would be necessary. Dunn Geosciences Corporation (1988) costed the drilling and analysis of a ten-year, 16-acre reserve at $90,000, and estimated that ten percent of the sedimentary rock quarries would incur this cost.

Every impacted igneous and metamorphic quarry would have to be field checked. Dunn Geosciences Corporation (1988) estimated that this would cost $500 and entail a brief site visit or a single sample analysis if AT&A was abundant in the deposit. Such a determination would make it unnecessary to conduct a drilling program because it would already be known that the quarry products would trigger the labelling requirement. Bureau experts suggested that both sampling and a field check would be carried out. Dunn's cost estimate was consequently raised to $1,000. Dunn estimated that 25 percent of the igneous and metamorphic rock quarries contain abundant AT&A and would not be subject to further testing.

Seventy five percent of the igneous and metamorphic rock quarries would need to have more detailed work done to determine whether the AT&A content is less than 0.1 percent. The costs would most likely be higher than for sedimentary deposits because AT&A would be more irregularly distributed throughout the deposit. Based on actual data from a company that recently drilled and analyzed the AT&A in a deposit, Dunn estimated the cost at $400,000. Since this cost was for a "modest-sized property," the number is used here as an average cost to provide an estimate of the impact on the industry. It is recognized that this will provide only an order-of-magnitude impact estimate.

In addition to the initial sampling of quarries, Dunn estimated that 65 percent of igneous and metamorphic rock quarries would have to monitor production on a continuous basis because of the nonuniform distribution of AT&A in such deposits. The capital cost of laboratory facilities was estimated by Dunn at about $52,000 and the annual operating cost at $146,000. Bureau experts disputed the notion that 65 percent of all igneous and metamorphic quarries would test the deposits continuously to such an extent. It is likely that only large quarries would be able to do so; for this reason the Bureau estimated that continuous monitoring would be done by 65 percent of igneous and metamorphic rock quarries having annual production in excess of 2 million tons.

The results of the analysis using the above costs are displayed in table B-2. The initial sampling costs are divided according to rock type. The number of impacted quarries is taken from table B-1 and multiplied by the percent of quarries subject to the type of sampling and the cost of sampling to yield a total industry cost. For example, a site visit and laboratory test is assumed to be performed at all of the 329 sedimentary quarries at a cost per quarry of $2,000. The total cost is therefore $658,000. It is assumed that all quarries, regardless of size, would expense this cost when it is incurred, so the total cost is treated as a first-year cost.

To estimate the number of quarries that would perform detailed testing (i.e., drilling), it was assumed that only impacted quarries that produce in excess of 100,000 tons annually would be able to afford the cost associated with this activity.[15] Because the Bureau of Mines reports

[15]The average price for crushed stone in 1988, $4.60 per ton, means that

data on the size of operations rather than the size of quarries,[16] it was necessary to estimate the number of impacted quarries producing greater than 100,000 tons from the number of operations producing this amount. The expected number of quarries impacted by the OSHA asbestos regulation that produce greater than 100,000 tons annually is therefore calculated as the product of the ratio of operations producing greater than 100,000 tons annually to the total number of operations (the "operation ratio") and the number of impacted quarries, presented in table B-1. The number of impacted quarries that would perform detailed testing is calculated by multiplying the operation ratio, the number of impacted quarries, and the percentage of these quarries expected to perform the testing.

Thus, the number of sedimentary rock quarries expected to perform detailed testing is 329 x (1933/3473) x 0.1, or 18 quarries (see table B-2). At a cost of $90,000 per quarry, the total cost would be $1.6 million. It is expected that this cost would be amortized rather than expensed in the first year. The annual cost over a ten-year period, chosen because the drilling is assumed to be for a ten-year reserve, at a ten percent discount rate is $264,000.

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total revenues for companies that produce under 100,000 tons would be less than $460,000. It is unlikely that quarries of this size would be able to obtain financing for a $90,000 or $400,000 sampling project, unless they are owned by large companies. Even a large company might balk at such a large cost given the small amount of production involved.

[16] An operation is defined as a business location that usually represents one pit or quarry and has a unique Bureau of Mines/MSHA identification number. Occasionally, several quarries, sometimes producing different rock types, may be covered under one identification number. The purpose of assigning these identification numbers is to identify distinct business units and their locations.

The cost calculations for igneous and metamorphic rock quarries is similar to that for sedimentary rock deposits, except the cost of detailed testing is amortized over 20 years instead of ten years because it was assumed that a 20-year reserve would be drilled. As was previously noted, continuous monitoring costs are applied to quarries with annual production in excess of 2 million tons. It is assumed that the number of operations producing at such a level correspond to the number of quarries. Further, it is estimated that of the 84 quarries producing 2 million tons or more annually, 25 percent produce igneous or metamorphic rock products. The number of quarries that would monitor continuously, therefore, is estimated at 84 x 0.25 x 0.65, or about 14 quarries. The capital cost of $728,000 (14 x $52,000) associated with setting up a laboratory is annualized over 20 years at a ten percent discount rate, yielding an annual cost of $86,000.

The total sampling and monitoring cost is the sum of the individual costs, or about $173 million. The first-year cost of $24 million is the sum of the costs that would be expensed in the first year and the cost amortized in the first year. The annualized cost of $22 million represents the annual cost amortized over the next nine years.

A summary of the number of quarries that would be impacted by the OSHA regulation is presented as table B-3. It is estimated that 26 percent of the 5,109 quarries that accounted for 97 percent of 1987 crushed stone production will be impacted by the regulation. About 15 percent of the 5,109 quarries will be subject to detailed testing. Significantly, about seven percent of the 5,109 quarries will be subject to detailed testing and will be financially unable to undertake the testing. Stone production

from these 346 quarries in 1987 is estimated at 16.6 million tons valued at $72.5 million, f.o.b. plant.[17]

[17]The size-range distribution of the 1,540 operations, and the percentage of this total in each category, that produced under 100,000 tons annually in 1987 is: 0-25,000 tons -- 764 operations (50 percent); 25,000-50,000 tons -- 331 operations (21 percent); 50,000-75,000 tons -- 248 operations (16 percent); and 75,000-100,000 tons -- 197 operations (13 percent).

Assuming that the size-range distribution of the 346 quarries producing under 100,000 tons annually is the same as that for operations, the number of quarries in each size-range category is: 0-25,000 tons -- 173 quarries; 25,000-50,000 tons -- 73 quarries; 50,000-75,000 tons -- 55 quarries; and 75,000-100,000 tons -- 45 quarries.

A weighted-average tonnage associated with the 346 quarries, assuming production at the maximum of each size class, is (173 quarries x 25,000 tons) + (73 quarries x 50,000 tons) + (55 quarries x 75,000 tons) + (45 quarries x 100,000 tons), or 16.6 million tons. The value of this material at the 1987 average price of $4.37 per ton, f.o.b. plant, is $72.5 million.

Table B-1. Impact on quarries, by rock type

Rock Type	(1) Number of Quarries in 1987 1/	(2) Production (1000 st) in 1987 1/	(3) Value ($ 1000) in 1987 1/	(4) Probability of >= 0.10% AT&A 2/	(5) Estimated Number of Impacted Quarries [(1)x(4)]	(6) Production Impacted (Expected) (1000 st) [(2)x(4)]	(7) Value Impacted (Expected) ($ 1000) [(3)x(4)]
SEDIMENTARY							
Limestone and dolomite	2617	841,104	3,456,617	0.05	131	42,055	172,831
Sandstone	495	27,096	129,135	0.40	198	10,838	51,654
METAMORPHIC							
Marble	51	5,576	62,335	0.90	46	5,018	56,102
Quartzite	28	5,399	28,799	0.65	18	3,509	18,719
Slate	10	2,330	14,258	0.05	1	117	713
IGNEOUS							
Granite	735	179,972	900,682	0.25	184	44,993	225,171
Traprock	813	103,413	505,187	0.90	732	93,072	454,668
Volcanic cinder and scoria	360	3,657	14,952	0.05	18	183	748
TOTAL	5109	3/ 1,168,547	5,111,965	NAp	1,327	199,785	980,605

NAp Not applicable

1/ Source: Tepordei (1989)

2/ Source: Dunn (1989a)

3/ represents 97 percent of total 1987 production

Table B-2. Sampling and monitoring costs

	Impacted Quarries 1/		Sampling/Monitoring Cost			
	Percent 2/	Number	Per Operation 2/ ($ 1000)	Total ($ 1000)	Annualized 3/ ($ 1000)	First Year ($ 1000)
INITIAL SAMPLING						
Sedimentary						
Site visit/lab test	100%	329	2	658		658
Detailed testing 4/	10%	18	90	1,620	264	264
Igneous/Metamorphic						
Site visit/lab test	100%	998	1	998		998
Detailed testing 4/	75%	417	400	166,800	19,592	19,592
CONTINUOUS MONITORING 5/	65%	14				
Capital			52	728	86	86
Operating			146	2,044	2,044	2,044
TOTAL				172,848	21,986	23,642

1/ impacted quarries as determined in table B-1 (column 5), unless otherwise noted

2/ Source: adapted from Dunn Geoscience Corp. (1988) estimates

3/ detailed testing costs for igneous/metamorphic deposits and continuous monitoring capital costs are annualized at 10 percent over 20 years; detailed testing costs for sedimentary deposits are annualized at 10 percent over 10 years

4/ assumed that this will be done by impacted quarries with annual production exceeding 100,000 st
- EXPECTED number of such QUARRIES is estimated as the product of the percentage of OPERATIONS with annual production exceeding 100,000 st (1933/3473) and the number of impacted quarries
- e.g., average number of impacted sedimentary QUARRIES with annual production exceeding 100,000 st equals (1933/3473) x 329, or 183

5/ of impacted igneous and metamorphic quarries with annual production exceeding 2 million st
- estimated that the 84 OPERATIONS with annual production exceeding 2 million st represents 84 QUARRIES
- estimated that about 25 percent of these quarries are igneous/metamorphic

Table B-3. Number of impacted quarries

	Sedimentary	Igneous/ Metamorphic	Total Impacted Quarries 1/	Percent of Total Quarries 2/
Number of Impacted Quarries	329	998	1,327	26.0%
Subject to Detailed Testing 3/	33	749	781	15.3%
>100,000 st	18	417	435	8.5%
=< 100,000 st 4/	15	332	346	6.8%

1/ Data may not add to totals shown due to independent rounding.
2/ 5,109 quarries; represents 97 percent of total 1987 production
3/ 10 percent of impacted sedimentary quarries, 75 percent of impacted igneous/metamorphic quarries
4/ assumed that these smaller quarries will be financially unable to perform detailed testing

APPENDIX C

ASBESTOS AND OTHER REGULATORY AGENCIES

Environmental Protection Agency

The Environmental Protection Agency (EPA) officially defines asbestos as "the asbestiform varieties of serpentine (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite, anthophyllite, and actinolite-tremolite" (40 CFR §61.141). The agency's definition of a fiber and therefore the definition of "asbestiform" is equivocal. The EPA does use the fiber definition espoused by OSHA (i.e., aspect ratio greater than 3 to 1), but recognizes that the aspect ratio in "natural samples," or samples that have not been crushed, is much higher than 3 to 1. The morphology of asbestiform fibers is considered in sample analysis.

The EPA regulates asbestos under the Toxic Substances Control Act (TSCA), the Clean Water Act, and the National Emission Standards for Hazardous Air Pollutants (NESHAPS). There is, however, apparently no statutory requirement for each division within the agency to define asbestos identically. For example, despite the official agency definition, the only asbestos mineral regulated by the Effluent Guidelines Division (i.e., water regulations) is chrysotile. An agency official indicated that chrysotile is a form of asbestos that everybody agrees is asbestos and is a fiber that can be identified and counted fairly easily.

The apparent intent of EPA in regulating asbestos is not to include AT&A. The rule announced in July 1989 under TSCA to phase out the use of asbestos products lists products containing asbestos, such as

asbestos-cement pipe and asbestos clothing, and not AT&A, which has little or no commercial value and therefore is not used in products. Under its NESHAPS regulation, EPA is currently only inspecting public schools for asbestos.

Department of Transportation

The Department of Transportation (DOT) defines asbestos as "any of the following hydrated mineral silicates: chrysotile, crocidolite, amosite, anthophyllite asbestos, tremolite asbestos, and actinolite asbestos, and every product containing any of these minerals" (49 CFR §173.1090). The DOT does not incorporate OSHA rules in its regulations. The Sciences Branch Chief in the Department's Office of Hazardous Materials Transportation indicated that DOT would not regulate asbestos if it is not of commercial value or is in a fixed form (i.e., in a binder). In addition, DOT does not regulate AT&A.

Consumer Product Safety Commission

The Consumer Product Safety Commission (CPSC) defines asbestos as "a group of mineral fibers composed of hydrated silicates . . . [a]mosite, chrysotile, crocidolite, anthophyllite asbestos, actinolite asbestos, and tremolite asbestos" (16 CFR §1304.3(b)). Treatment of AT&A by the CPSC, at least with regard to nonasbestiform tremolite, is clear. In January 1989, the CPSC denied a petition filed by a New Jersey physician to ban consumer goods containing tremolite in excess of 0.01 percent in granular and pulverized limestone products. In its denial, the CPSC cited its review of the epidemiologic literature and its conclusion that nonasbestiform tremolite cleavage fragments do not pose a carcinogenic

health hazard. A program manager in the CPSC Office of Program Management and Budget said that the CPSC would deny other petitions concerning nonasbestiform tremolite as the result of its study, but would review the medical literature if petitions were filed regarding other AT&A minerals.