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Electromotive Phenomenon in Metal and Mineral Particulate Exposures: Relevance to Exposure to Asbestos and Occurrence of Cancer

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Exposures to metallic particulates, individually and in alloys, along with mineral particulates may give rise to an electromotive phenomenon wherein high levels of biologically active cations are produced at localized tissue sites. The relative position of the involved metals in the electromotive series along with the nature of the associated metals and other minerals will influence the nature and concentration of the cations. This phenomenon may account for otherwise unexplained exacerbations of diseases, sensitization reactions, carcinogenicity, latency periods, and other responses. The potential role of this phenomenon in exposure to metals in asbestos is recognized, and supporting data are presented.

Introduction

LITTLE ATTENTION has been given to the biologic effects of exposures to metal particulates other than to their direct acute and chronic toxicity. Although increased attention is being given to the effects of metal cations on proteins and enzymes in the study of mechanisms of biologic response and injury, these seldom relate to the potential influence of metal particulates on the biologic response to multiple minerals and metals through concurrent or separate and intermittent exposures.

The electromotive properties of metals are well established. Metals going into solution undergo reaction wherein metal cations are formed and electrons are released. If an electrolyte of a metal lower in the electromotive series is present, the released electrons will migrate to the metal cations of this electrolyte, causing their change to an elemental and un-ionized metal. As an example, the interaction of metal manganese on a nickel compound may be depicted:

$$Ni^{++} + Mn^{\circ} \rightarrow Ni^{\circ} + Mn^{++}$$

The same phenomenon may relate to the interaction of two dissimilar metals. The degree of reactivity will depend on the differences in the potentials of the metals, surface areas of the particulates, nature of the solutes, etc. The phenomenon will continue until the more active metals have dissolved. Generally, the greater the difference in electrode potential between the two metals, the more active is the displacement reaction. Table I lists a number of metals, in descending order, in the electrochemical (electromotive) series, their reactions, and their standard reduction values. Although the metals lower in the electromotive series and their compounds will have a tendency to go into solution and ionize, the concentration of cations from this source will be decreased by the reaction on them of electrons from the more active metals continuing to go into solution. The immediate effect will be in-

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Table I
Electrochemical Series[a]
(Standard Reduction Potentials)

Reaction	Potential (volts)
$Mg^{2+} + 2e \rightleftharpoons Mg$	−2.375
$Be^{2+} + 2e \rightleftharpoons Be$	−1.70
$Al^{3+} + 3e \rightleftharpoons Al$	−1.706
$Ti^{2+} + 2e \rightleftharpoons Ti$	−1.63
$V^{2+} + 2e \rightleftharpoons V$	−1.2
$Mn^{2+} + 2e \rightleftharpoons Mn$	−1.029
$Zn^{2+} + 2e \rightleftharpoons Zn$	−0.7628
$Cr^{3+} + 2e \rightleftharpoons Cr$	−0.557
$Fe^{2+} + 2e \rightleftharpoons Fe$	−0.409
$Cd^{2+} + 2e \rightleftharpoons Cd$	−0.4026
$Co^{2+} + 2e \rightleftharpoons Co$	−0.28
$Ni^{2+} + 2e \rightleftharpoons Ni$	−0.23
$Sn^{2+} + 2e \rightleftharpoons Sn$	−0.1364
$Pb^{2+} + 2e \rightleftharpoons Pb$	−0.1205
$Cu^{2+} + 2e \rightleftharpoons Cu$	+0.3420

[a] Values taken from *Handbook of Chemistry and Physics*, 51st ed., The Chemical Rubber Company, Cleveland Ohio (1970-71).

creased levels of cations of the higher metals. The lesser reactive metals will subsequently go into solution and form cations as the electromotive influence of higher metals decreases. The concentration of cations during any phase of the interaction will depend on the dynamics of the system including the electrode potentials of specific metals involved and of the minerals in the electrolyte. This electromotive phenomenon may thus effect a change in the concentration of the several dissolved metals and minerals as well as the concentration of metal cations at any one period in time.

A schema depicting the influence of the electromotive phenomenon on the interactions of metals and minerals and their biochemical activity is presented in Figure 1. A hypothesis is developed with supporting data relating the biological activity associated with asbestos fibers to the electromotive interaction of the metals and minerals present. Relevance of this phenomenon to other exposures to metals and minerals is discussed.

Metals Associated with Asbestos Fibers

Several investigations have shown that biologically active metals and minerals are associated with asbestos fibers. The minerals and metals are derived both from the mineralogy in the formation of the fibers and from the abrasive action of the fibers on the alloy metals of the equipment in which they are processed.[1-7] These are primarily the metals and compounds of nickel, chromium,

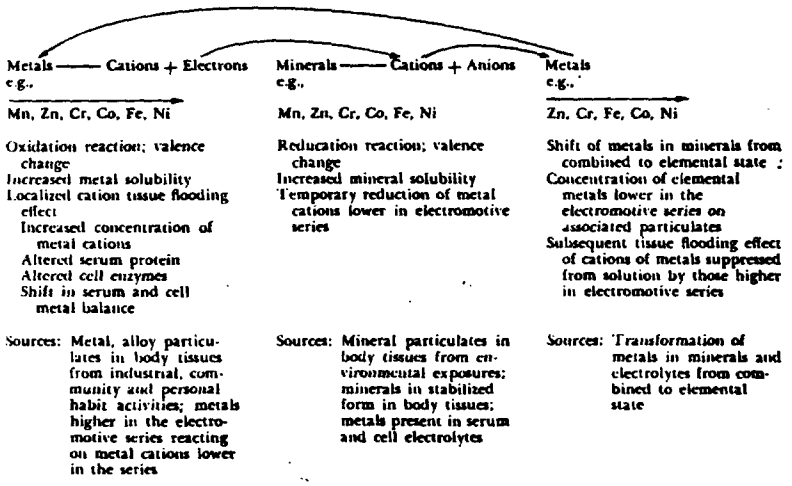

Figure 1. Schema: Electromotive phenomenon and biochemical activity of metals and minerals.

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subsequently go into solution, and the cations will exist at higher concentration levels than when they were present and in ionic equilibrium as mineral electrolytes. The galvanic action will govern the solubility of the metals and minerals, increase the concentration of metal cations near the fiber, and set up a localized flooding effect on a serial basis. This phenomenon will accordingly increase appreciably both the residence time and the relative biologic response of metals such as nickel. Asbestos fiber will behave differently biologically according to the milieu of metals and minerals associated with the fibers. Mixtures of different types of asbestos may have biological responses quite different from those of any of the individual types alone. Since the asbestos fiber may translocate and become fixed in a tissue, the potential for the cations to build up prolonged and high localized concentrations and to react with enzymes and proteins is greatly enhanced. The following data are presented to support the above hypothesis.

Data Supporting Hypothesis

Epidemiologic data on the prevalence of cancer in workers exposed to specific and predominantly single types of asbestos in which some metal exposure parameters are known relate predominantly to the mining and milling of chrysotile in Canada, Italy, and Cyprus; to the chrysotile textile industry in England, Italy, and the United States; and to the mining and milling of crocidolite in the Transvaal and North Cape regions of South Africa. In the studies from which the data are drawn, the author had the privilege of securing samples of the related asbestos for determining metal analyses on the respirable fraction not only of the milled asbestos but also of the unopened fiber, material from the adjacent zones of contact, and country rock. A major problem in evaluating past exposures is the lack of definitive data on the magnitude of these exposures and the composition of the alloy in the processing equipment in the 1930's and earlier, as a 25- to 30-year latency period is involved. It is known that past dust exposures have been heavy and that equipment replacement in the industry was more frequent than at the present time. Present data on exposure to metals and minerals in the asbestos industry are important, though, since they will give some parameters on which to base past exposures.

McDonald *et al.*[19] in a study of chrysotile mine and mill workers in Quebec reported a threefold difference in respiratory cancer between workers maximally and minimally exposed. Vigliani[20] in a study of workers mining and milling chrysotile in Italy reported in preliminary data that 3.0% of the workers who died had cancer of the lung. Gilson[21] in an investigation of chrysotile mine and mill workers in Cyprus, where the work force was stable and had worked for many years in the mine and in which the only exposure to asbestos was chrysotile, reported that available medical evidence indicated that the incidence of respiratory disease of any type related to exposure to asbestos was likely to be low or very low.

In each of the above studies, much of the exposure of the workers to chrysotile in the past twenty years and earlier had been heavy to massive, though definitive quantitative data during this period were not available. In a recent study of trace metal exposures of workers mining and milling asbestos in Quebec, Gibbs *et al.*[22] showed average mill airborne dust concentrations for total nickel ranging from 15.7 to 41.6 $\mu g/m^3$, total chromium ranging from 3.9 to 53.4 $\mu g/m^3$, total cobalt ranging from 1.6 to 2.5 $\mu g/m^3$, and total manganese ranging from 1.7 to 23.7 mg/m^3. Exposures prior to 1950 were estimated at four to ten times as high as those reported. Although no information could be obtained on the relative source of these metals—that is, minerals present in the asbestos versus abrasion of the alloy metals in processing—observations as well as management experience in the replacement of worn processing parts indicated that there was only minimal to moderate abrasion of equipment and that most of the metals apparently come from the minerals associated with the asbestos.

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manganese, and iron, though a number of others such as vanadium, zinc, cobalt, and copper are present in smaller and less uniform amounts.

The biologic role of these metals and minerals in asbestos exposure is confused, since any dose-response factor extrapolated from past research is obscure. The amounts and solubility in serum of these metals and their compounds vary widely from one type of asbestos to another and within the same type of asbestos.[5,8] Yet, it is known that some metals[9-16] associated with asbestos have carcinogenic properties, and evidence[17,18] indicates a dose-response relation for some types of asbestos to both fibrosis and carcinogenicity; that is, a lowering of worker exposure to the asbestos results in a corresponding lowering of associated asbestosis and cancer. Most of the past research on asbestos, however, has not been designed to relate to the associated biologically active metals and minerals present, and no rationale or model has been presented upon which to design such research so that the data would relate to worker exposure. The hypothesis presented could account for the differing biological responses observed in past epidemiologic and animal research on asbestos exposure.

Hypothesis

The biologic response of asbestos is governed appreciably by the metal and mineral contaminants associated with the inhaled fiber interreacting in body fluids at tissue sites. The metals and minerals associated with the fibers set up an electromotive reaction whereby cations of biologically active metals are formed and become available to react with cell enzymes and serum proteins. A three-component system is involved: (1) asbestos fibers, (2) minerals associated with the fibers during their formation, and (3) metallic alloys associated with the fibers during their formation or arising from the abrasive action of the asbestos on the alloy processing equipment.

In the lungs or other tissue sites to which the fiber may translocate, the associated minerals go into solution in the serum as electrolytes and into ionic equilibrium. In the absence of significant amounts of elemental metals higher in the electromotive series, such as manganese, the minerals containing nickel, chromium, cobalt, etc., will go into solution and into an ionic equilibrium between the mineral molecules and their cation–anion components. The concentration of such metal cations will depend on the nature and amount of the minerals present, their surface area, solubility, etc. The metal cations will be competitive, depending on their relative reactivity and their affinity for biomolecular materials present.

The presence of reactive metals in the milieu of the asbestos fibers, however, will have a profound influence on the concentration of cations from the dissolved minerals and other metals lower in the electromotive series that may be associated with the asbestos. These metals include, in descending order of activity, manganese, chromium, iron, and nickel, though other metals such as zinc and vanadium, which are also contained in processing alloys, may also be involved. The metals from the alloy particulates or other sources which are associated with the fibers set up a myriad of miniature galvanic electrolytic cells. Through the ensuing oxidation action, the metals from the alloy particulates dissolve, but the cations of the lesser active metals are precipitated on the more active metal particulate surfaces and thus are prevented from reacting with the biomolecular materials present. The lesser reactive metal cations will continue to be converted to the elemental metals and precipitated and concentrated on the fibers and associated particulates until the influence of the more reactive metals has ceased. Thus the metals manganese, zinc, chromium, iron, cobalt, and nickel, in descending order, on going into solution and through electron transfer, will affect a change in the cations derived from the metals lower in the series and their minerals, transforming them into an elemental state with subdued solubility. These lesser reactive metals remaining at the tissue sites will

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In contrast to the lower rate of cancer of the lungs in workers mining and milling chrysotile, Doll[23] showed that in a group of chrysotile textile workers in England, deaths from cancer of the lung were about ten times the number expected. Vigliani[20] reported that 13.5% of the deaths in 223 male textile and friction product workers compensated for asbestosis in Italy were caused by cancer of the lung, a fivefold increase over those working in asbestos mining.

As in chrysotile mining, exposures of workers to chrysotile in the asbestos textile industry during the past twenty years and earlier were also generally heavy to massive. In a study by Cralley *et al.*[5] in a chrysotile textile plant where operations simulated those of the 1930's, the airborne dust concentration of nickel was higher by 5-fold, chromium by 3-fold, and manganese by 2.5-fold over that in the fiber entering the carder. Corresponding increases were observed at fiber preparation and spinning operations, with lesser increases at twisting and weaving operations. The increased metal content arose from the abrasive action of the asbestos on the alloy processing equipment.

Data on the occurrence of mesotheliomas in asbestos mine workers are most interesting. Webster[24] reported that, of 179 cases of mesothelioma recognized up to the end of 1968, 51 were from miners working in crocidolite mines in the Northern Cape area, 3 were from workers is amosite mines, 21 were from workers in asbestos and manganese mines, and 2 were from workers in manganese mines only. None were from workers in the crocidolite mines in the Transvaal area. The author suggested that another mineral such as manganese or iron may play a part in the carcinogenic agent(s) involved. Samples of the adjoining country rock, unopened fiber, and milled crocidolite fibers from both the Northern Cape and Transvaal areas were analyzed for metals. The fraction passing through a 10-μ mesh sieve of three samples of milled crocidolite from the Transvaal area averaged, per gram of fiber, 342 μg of nickel, 99 μg of chromium, 81 μg of cobalt, 633 μg of manganese, and 286 mg of iron. In contrast, the fraction passing through a 10-μ mesh sieve of three samples of milled crocidolite from the Northern Cape area averaged, per gram of fiber, 270 μg of nickel, 155 μg of chromium, 85 μg of cobalt, 1834 μg of manganese, and 306 mg of iron. The most significant difference was the 3-fold increase of manganese in the Northern Cape over the Transvaal crocidolite. It was observed that the rock surrounding the Northern Cape fiber is much harder than the rock sorrounding the Transvaal fiber and requires harsher treatment in freeing the fiber. That the increased manganese content is from the Northern Cape ore passing through the high-speed hammer mill is further attested in data from a special test which showed a 7-fold increase of manganese in the fine dust of the crocidolite leaving the hammer mill over the unopened crocidolite and country rock entering the hammer mill. The need for replacing the hammers in the mills at the end of the shift reflects the abrasive effects of the ore on the mills. The electromotive influence of the excess elemental manganese in the respirable dust of the North Cape crocidolite over that in the respirable dust of the Transvaal crocidolite could account for the unusual biologic activity of the former.

Laboratory research data of the past have generally not related the metal content of the asbestos to biologic response. Some data, however, are available on this aspect. Smith *et al.*[8] introduced equal doses by weight of soft chrysotile, harsh chrysotile, and amosite intrapleurally and intratracheally into hamsters in testing the relative carcinogenicity of these agents. In groups of 15 hamsters given single intrapleural injections of 25 mg of each type of asbestos, pleural mesotheliomas developed in 3 receiving the amosite, 2 receiving the harsh chrysotile, and none receiving the soft chrysotile. No tumors had appeared in the hamsters receiving the intratracheal injections of the three types of asbestos. An analysis of the soft and harsh chrysotile showed that in the cutting and comminution of the fibers using the rotating knives of a blender, the fraction passing through a 10-μ mesh sieve of the harsh chry-

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sotile has a several-fold increase of nickel, chromium, manganese, and iron over that of the soft fiber: soft chrysotile—46 μg/gm of nickel, 157 μg/gm of chromium, and 230 μg/gm of manganese; harsh chrysotile—230 μg/gm of nickel, 414 μg/gm of chromium, and 480 μg/gm of manganese. Although the amosite was not analyzed, this phenomenon would be expected to occur, since it is a harsh fiber compared to chrysotile.

Gross *et al.*,[25] in exposing rats by inhalation to asbestos dust, reported that 35% of the 72 rats surviving 16 months or more of the dust exposure developed lung cancer. The chrysotile in the exposure chamber had been comminuted to the desired size by recycling through a hammer mill. An analysis of the comminuted asbestos showed that the original fibers had picked up an increase of 82% nickel, 145% cobalt, and 34% chromium from the hammer mill.

Wagner *et al.*[26] introduced 20 mg of amosite, chrysotile, and crocidolite intrapleurally into rats to contrast the percentage of rats developing mesotheliomas. Of 96 rats in each group, 31% of those inoculated with amosite, 69% inoculated with chrysotile, and 68% inoculated with crocidolite developed mesotheliomas. The induction period—that is, the time from inoculation to development of mesotheliomas—was dust-dependent. The induction period was shortest for the chrysotile, intermediate for the crocidolite, and longest for the amosite. An analysis of the samples showed the 20-mg doses to contain the following: chrysotile—33.8 μg of nickel, 21.8 μg of chromium, 1.6 μg of cobalt, 8.5 μg of manganese; crocidolite—0.3 μg of nickel, 0.6 μg of chromium, 16.5 μg of manganese; amosite—1.6 μg of nickel, 1.9 μg of chromium, 84.2 μg of manganese.

No information was available on the precise forms in which these metals existed in the above different samples of asbestos. The higher levels of elemental manganese in the crocidolite and amosite resulting from abrasion during processing would, though, have an off-setting influence on the higher metal content of the chrysotile in relation to the metal cation concentrations and residency time of the nickel and chromium at the local tissue site with respect to the different forms of asbestos. This is reflected in the induction periods observed.

Serum solubility data clearly reflect the electromotive influence of one metal on the solubility in serum of another metal or mineral. In the following table, limited data are presented to show the effects on solubility of designated amounts of particulate materials that were introduced into 15 ml of bovine serum and held for 30 days.

Material	Micrograms of Particulate Material Introduced into Serum	Percent of Particulate Material Soluble in Serum
Manganese metal	800	100.0
Nickel metal	1000	97.0
Manganese metal	1000	80.0
Nickel metal	1700	1.1
Aluminum metal	700	*
Manganese metal	1400	30.0
Nickel metal	1200	0.4
Chrysotile (Cyprus)		
Manganese (total)	2	100.0
Chromium (total)	02	2.0
Nickel (total)	110	52.0
Manganese (total)	2	*
Chromium (total)	70	0.0
Nickel (total)	124	14.0
Manganese metal added	2000	

* Not analyzed.

In another test 5 mg of nickel chloride in solution and 5 mg of metal manganese were added to 15 ml of bovine serum. After holding for 4 days, 18 μg of nickel was recovered on the particulate manganese.

Discussion

In the past it has been generally assumed that the asbestos fiber per se was the causative agent for both the asbestosis and the cancer observed in asbestos workers. It was not until differences were noted in the prevalence of cancer among workers in different asbestos industries with prolonged and heavy exposures to the same type of asbestos that other agents appeared to be involved and that the asbestos fiber was implicated as a possible carrier of these

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agents to various tissue sites. This is borne out by the relatively low rate of bronchogenic cancer observed among workers mining and milling chrysotile in Canada, Italy, and Cyprus in contrast to the several-fold increase in bronchogenic cancer among chrysotile textile workers in England, Italy, and the United States during prolonged periods of employment in the industry when exposures to asbestos in both groups were very heavy. Another example is the experience in South Africa in the mining and milling of crocidolite where all the mesothelioma occurs in the asbestos workers in the North Cape area, in contrast to none in the Transvaal area.

Although several reports showed distinct differences in the various total metals associated with asbestos types—that is, chrysotile, crocidolite, amosite, and anthophyllite—it wasn't until the equivalent respirable-size fractions were analyzed that those differences were found to be more pronounced than was at first realized. It became evident that these metals and minerals were concentrated in the respirable fraction and appeared to relate to the harshness with which the fibers were treated in their opening and processing. The greater amount of certain metals in the airborne asbestos dust in textile operations in contrast to the asbestos being processed is cited. Also, there is a great increase in certain metals in the milling of North Cape crocidolite where the ore is much harder and is treated more severely in hammer mills than in the softer Transvaal crocidolite.

The meaning of the presence of these metals and minerals was confusing however, because most of the animal research data did not show a good correlation between the amount of cancer observed and the total amount of these metals involved either individually or combined. This was not surprising, since the specific nature of the associated minerals, the alloys in the equipment, the respirable particle sizes of the metals and minerals, and their solubility were essentially unknown. A single exposure parameter expressed as total metals, including both elemental and combined forms, in the respirable fibers and accompanying particulates obviously is not a good index of this relationship. It is quite evident, also, that the qualitative and quantitative milieu of the asbestos fibers to which the workers were exposed varied greatly according to industry, type of process, and form of fiber and that these asbestos exposures were often quite different from the asbestos specially prepared and used in laboratory research.

The concept of the role of metals through their electromotive properties in altering and governing the solubility of minerals and metals and their cation concentrations at a given tissue site gives a rationale from which to interpret the meaning of their presence as well as the design of laboratory and epidemiologic research. Especially important in this concept is the property of metals higher in the electromotive series to convert the metal constituents, lower in the series, of the minerals present to their elemental form and thus concentrate them at a local site. Thus, depending on the metals and minerals present, those lower in the electromotive series will serially be concentrated with prolonged residency time at localized tissue sites. The cations from the less reactive metals subsequently going into solution will exist at a greater concentration than when they were present and in ionic equilibrium as mineral electrolytes. In addition to a carcinogenic response this phenomenon may relate to altered fibrogenic response, tissue sensitization, formation of ferruginous bodies, and other biologic reactions.

It is rational to conclude that, if the metals higher in the electromotive series do influence the concentration of metals lower in the series and their residency time at tissue sites and if the latter is of significance in the biologic response, it follows that the judicious selection of metals of less biologic activity and higher in the electromotive series may have application in the control of the effects of this phenomenon.

The hypothesis on the electromotive influence of metals on each other and on concurrently present minerals has application

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to chemical, mineral, and other metal exposure situations even though fibers are not one of the parameters of exposure. Deposition in the lungs of elemental metals and alloys along with minerals could set up an electromotive reaction wherein high levels of biologically reactive selective metal cations could result with increased residency time at local tissue sites. Owing to differences in removal and migration mechanisms, these sites of reaction may differ from that when fibers are involved.

It should be recognized, however, that other factors in addition to the electromotive phenomenon are undoubtedly involved in the interactions of metals and minerals that relate to their physical and chemical behavior in serum and subsequent biological response. As an example, small amounts of metallic aluminum have been shown to inhibit the solubility of silica through the conversion of the metal aluminum into hydrated aluminum oxide and the subsequent coating of the quartz particle with an impermeable gelatinous hydrated oxide of aluminum. The same may be true in instances of other metals such as manganese, though the presence of metal manganese in the respirable dust did not show any protection against the mesotheliomas occurring in the workers mining and milling crocidolite in the North Cape area of South Africa. Coprecipitation of relatively insoluble compounds may likewise be involved in the behavior of metals and minerals in serum.

Thus the interactions of metals and minerals and their subsequent biologic response in serum are undoubtedly more complex than can be accounted for in a single phenomenon such as their electromotive interactions, though the latter is believed to be a very important aspect.

The *in vitro* test in which nickel in solution in bovine serum was precipitated on particulate metal manganese confirmed the electromotive relation of manganese and nickel in serum. Additional investigations need to be done, however, to establish the electromotive relation of metals *in vivo* in serum along with their respective potential values.

Summary

A hypothesis is presented with supporting data which relates the carcinogenicity of asbestos to the electromotive interactions of the alloy metals from the abrasive action of the fibers on processing equipment and other metals and minerals already present. The fiber serves as a transport mechanism for the translocation of the metals and minerals. The subsequent electromotive interactions of these metals and minerals result in carcinogenic metals lower in the series being concentrated, along with their residency time being appreciably increased at localized tissue sites.

The electromotive interactions of metals and minerals on biologic systems has application in other situations where exposures to metals and minerals exist though fibers are not one of the exposure parameters. In addition to carcinogenic response, the phenomenon may relate to altered fibrogenic response and to tissue sensitization reaction and may account for otherwise unexplained exacerbations of diseases, latency periods, and unusual biological responses.

A better understanding of the electromotive phenomenon as it relates to exposures and biologic responses to metals and minerals is needed in the development of rational standards and for the control of exposures to these materials in the strategic metals and minerals industries and the consumer use of their products.

Research is currently underway further defining the electromotive interactions of metals and minerals in relation to their carcinogenicity.*

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No discernable pattern. should there be?

FYI

TBB this whole area is a can of worms. The std. requires only those currently exposed above the limits.

Some plants check those in past exposures, others don't.

2) file

Location	No. of Employees Being Medically Screened Periodically for Past and/or Present Asbestos Exposure
Addy Works	0
Arkansas Operations	0
Alcoa Technical Center	0
Badin Works	81
Cleveland Works	0
Corona Operations	0
Davenport Works	20
Lafayette Works	23
Lancaster Works	0
Lebanon Works	40
Massena Operations	20
Pittsburgh Office	0
Point Comfort Operations	40
Richmond Works	3
Rockdale Works	521
Tennessee Operations	16
Vancouver Operations	80
Vernon Works	0
Warrick Operations	144
Wenatchee Works	12

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Notes:

Lebanon	This number will decrease with the elimination of certain asbestos-based material.
Pittsburgh	26 employees of the William Penn Hotel were screened to see if they could use a respirator last year, but there has been no follow-up.
Pt. Comfort	Total of 40 = 35 Active and 5 Inactive
Richmond	This number is for x-rays of 3 people in 1983.
Tennessee	6 of the total number given are now retired.

[redacted]

[redacted]

[redacted]

File -
Asbestos
A/C Pipe

[redacted]

[redacted]

R. C. HORGER

TO:

Joan -

Thanks for article on proposed asbestos ban - attached clipping on same topic you might find interesting

Bob

ALCOA

1501 Alcoa Building
Pittsburgh, Pennsylvania 15219

SDWA

provide "clear and readily understandable explanations" of failures to comply with the act, of corrective steps, and of population segments who should seek alternative water supplies. Annual notice of the availability of records, reports, and information pertaining to failures to comply must also be given.

AWWA believes that the public should be notified only in instances of persistent and health-related violations of the act. To do otherwise creates public apathy and the potential for public inaction in cases of serious contamination.

Section 107: Civil Actions by Public Water Systems and Other Persons

Public water systems and individuals would be permitted to bring actions in the US District Courts against persons "causing or contributing" to contamination of drinking water.

The association supports the concept of allowing utilities and individuals to bring suit for negligent contamination of drinking water, including unlawful dumping of contaminants into drinking water sources.

However, because of possible misinterpretation of the section, AWWA is unable to support section 107 unless the language is clarified to address the status of lawful waste-discharge permit holders and whether utilities are exempt from suit by customers in those situations in which an unregulated contaminant is introduced into the water supply without the knowledge of the utility.

Title II: Protection of Underground Sources of Drinking Water

AWWA strongly supports all efforts to protect groundwater that may reasonably become a source of drinking water. Recognizing that some states have sound underground injection programs to protect drinking water sources and that underground injection can be a safe, viable, economical means of waste disposal that does not endanger drinking water sources, AWWA elects not to comment on Title II at this time except in regard to section 201, wherein it is believed that the

ASBESTOS REGULATION *(continued from page 1)*

However, the USEPA does not feel that the regulations in place are adequate. In addition, David Mayer, also with USEPA's chemical control division, asserted, "There are exposures [to asbestos] occurring out there that are not regulated."

Mayer explained that there is an interagency task force on asbestos to coordinate federal actions. Part of USEPA's regulatory procedures, he pointed out, require assessment of other federal regulatory programs as well as the development of a compelling rationale for the proposed regulation of a toxic substance—like asbestos—by the USEPA under the toxic control law.

Industry Practices Meet Standards

Welch said that the A-C pipe industry manufactures its products within the limits proposed by the federal government. Current OSHA regulations limit worker exposure to 2 fibers/cubic centimetre of air over an eight-hour period. "We believe that at exposure levels currently existing in A-C pipe plants, the increased incidence of lung cancer and related diseases is not going to be statistically significant," he said.

In addition, Welch said that there is no problem with exposure during installations when approved practices are followed. He cited the industry's support for safe installation practices and AWWA's manual M16, *Work Practices for Asbestos-Cement Pipe*, as a reference.

Klein, however, said that where there are viable alternatives, the risk of asbestos exposure is unreasonable. He said the agency projected even more deaths attributable to past asbestos exposures. He pointed out that metal and plastic pipe are used for the same purposes as A-C pipe and therefore represent an alternative to asbestos-containing products. But Welch objected that there are hazards associated with the production of other kinds of pipe, hazards that are not being considered in the determination of alternatives. "EPA is not using the same yardstick for comparison," Welch said.

No Substitute for Asbestos Found

Although the industry has [illegible] substi-

has been found to replace asbestos in A-C pipe manufacture, according to Welch. "Quite frankly, it is a unique material," he said.

Welch is confident that the industry will mount a successful legal campaign against the proposed regulation. "I think [the ban is] far from inevitable. The burden is on EPA to prove that the risk is unreasonable." Welch sees that task as particularly difficult for an agency that is already regulating the substance through other divisions. He also feels that regulation by other agencies, such as OSHA, precludes USEPA's actions.

The USEPA's proposed ban is only half of its approach to asbestos. Perhaps a year from now, the agency will propose a cap on the use of asbestos in other products not covered in the ban. Such a limit on the amount of asbestos processed would depend on the marketplace to control what products would successfully compete for the use of asbestos.

Klein emphasized that when the rules are proposed there will be ample time allowed for full public input.

A-C Pipe in Use Not a Problem

No one is contesting the safety of A-C pipe for conveying drinking water. It is the processing of asbestos that causes concern, not the product.

Also, neither the USEPA nor the pipe producers has any evidence that ingestion of asbestos in drinking water is carcinogenic or even harmful in other ways. Klein was not willing to say that there is no problem with ingested asbestos, just that not enough research has been conducted.

There are some people who feel that existing research does indicate a health hazard from ingested asbestos.

AWWA is considering a policy statement asserting that there is no evidence that ingestion of asbestos in drinking water causes any health problem, and therefore, asbestos in drinking water should not be regulated (see related story, page 7).

The proposed regulations would not affect A-C pipe already in use. "There is no intention of requiring [utilities] to dig up pipe in the ground," Klein said. For many utilities in the West where A-C pipe has been installed in large amounts,

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ROBERT C HORGER
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PITTSBURGH PA 15219

instream

rican Water Works Association

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ee hours and additional water from Kansas down an entire city block. (Terry

tween 2 Cities nergency

imately an hour. D. Michael Phelps, assistant superintendent of operations at BPU, said the flow of water going into Missouri was monitored continually in order to keep the pressure at an optimal level.

When asked if the Missouri utility would be charged for the hour's worth of increased pressure, Phelps said, "They've told us to send them a bill, but I don't think we're going to. It's just a little public relations between water companies."

The formal reciprocal agreement for the two utilities sharing water has been in effect for a number of years. In addition to the recent fire, it was utilized in 1977 for a fire on the Missouri side and in 1976 for a fire on the Kansas side.

Phelps indicated there is a fairly high level of communication between the two utilities and that there would probably be no problem getting any kind of help in an emergency. "We kind of share problems," he said, "common problems that [illegible] have on different sides

EPA Stirs Health Controversy With Proposed Asbestos Ban

The US Environmental Protection Agency will propose a ban on the manufacture of asbestos-cement pipe, according to Edward A. Klein, an agency official involved in the control of toxic substances.

The ban is not imminent but could come within the next few years. The USEPA expects to publish its proposed rule prohibiting the use of asbestos in a number of construction projects, including asbestos-cement (A-C) pipe, next July. At that time public input will be sought on the scientific basis for the rule and on the regulatory procedures in the rule. The next step in USEPA's development of a regulation is consideration of the comments and publication of a final rule.

However, the issue is so controversial that the publication of a final rule may take a long time. John F. Welch, vice president of the A/C Pipe Producers Association, said, "We want out customers to know that we are committing major resources . . . to vigorously oppose this action of EPA."

High Risk Prompts Agency Action

Klein, who is director of the chemical control division in USEPA's Office of Toxic Substances, explained the agency's general position is based on the fact that asbestos exposure through inhalation is a proven human carcinogen. Pinpointing it as the cause of death for many workers who have handled it in manufacturing since the 1930s, Klein said, "Asbestos is very nasty," and he warned, "The risks are high at very low levels of exposure." The agency believes that because of this risk level, "asbestos should not be used in products where there are available substitutes."

Welch disagrees with the agency's conclusions. "We think largely unsupported by the evidence," said the representative of the world organization of A-C pipe producers.

Question Raised: How Much Regulation

Welch noted that although the USEPA is looking at regulating the life cycle of industrial and commercial uses of asbestos, the fibrous mineral is already regulated by the USEPA under the Clean Water Act and by the Occupational Safety and Health Administration, the Mine Safety and Health Administration, and the Consumer Product Safety Commission under various other acts. To regulate asbestos under the provisions of the Toxic Substances Control Act, as the environmental agency is now proposing to do, is redundant, according to Welch.

(continued on page 5)

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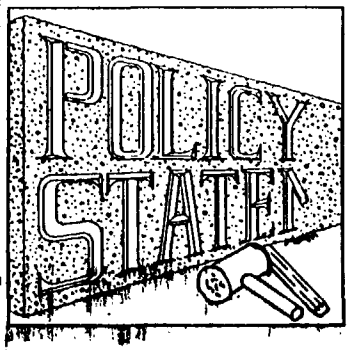


Council Approves Asbestos Policy Statement

The AWWA Technical and Professional Council has approved a new policy statement on asbestos in drinking water.

The association states that no risk to health has been demonstrated for the ingestion of asbestos in drinking water and opposes any regulation for asbestos in drinking water unless a causal relationship between asbestos and an adverse health effect is found. However, the association endorses additional research on asbestos in drinking water.

AWWA also intends to continue its monitoring of asbestos information and urges utilities to communicate fully with their customers and local health officials about asbestos questions. In addition, AWWA urges that utilities minimize the possibility of asbestos fibers, and particulates in general, in drinking water by adhering to the association's water quality goals as a minimum and by following the association's approved methods for the installation of asbestos materials in a drinking water system.

The policy statement has been submitted to the AWWA General Policy Council. Before the GPC may take action and send a recommendation to the Board of Directors, the proposed policy statement must be presented to the membership for comment. Any comments should be sent to Paul A. Schulte, Deputy Executive Director, AWWA, 6666 W. Quincy Ave., Denver, CO 80235, by Jan. 15, 1984.

* * *

Asbestos in Drinking Water

The AWWA believes that there is no demonstrated risk associated with the ingestion of asbestos in drinking water.

In accordance with this policy, the association intends to keep its members informed on the subject of asbestos in drinking water and makes the following recommendations:

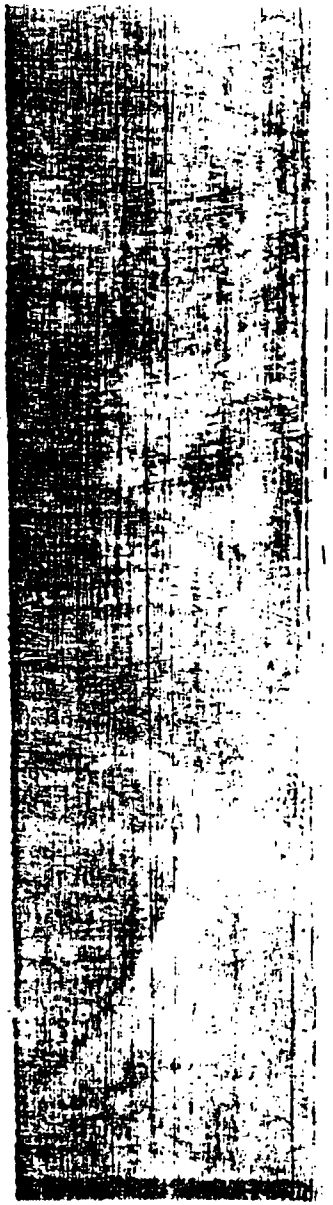
1. Water utilities should share this information with their customers and with local health authorities when appropriate.
2. Every water utility should be prepared to respond promptly to public inquiries made about asbestos in the local drinking water supply.
3. Utilities using materials containing asbestos in their water systems should follow work practices for handling, cutting, machining, and tapping of such materials as recommended in AWWA Manual M16, *Work Practices for Asbestos-Cement Pipe.*
4. Utilities should minimize the possibility of particulates, including asbestos fibers, in drinking water by adopting water quality goals for corrosivity and turbidity that are consistent with the association's policies on water quality goals and on treatment of public water supplies.
5. Unless a definite causal relationship between asbestos in drinking water and adverse health effects is demonstrated, standards and regulations for asbestos in drinking water should not be promulgated.
6. Research on asbestos in drinking water should continue.

Highly Rated Management Institute Offers Scholarships

Outstanding evaluations and sharply increased enrollments during the past four years at AWWA's Water Utility Management Institutes attest to the program's usefulness for managers wanting to sharpen their management skills. Part of the program's success can be [illegible] curriculum that appraisal; employee relations; time management; stress and conflict management; personal and mass communications; and several problem-solving workshops.

AWWA's director of education, Bill D. Haskins, noted that the management institutes are intended to cover the more func-





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[redacted]

Earl- 1/18

Here's the article on proposed ban of asbestos (A-C pipe). I sent a copy to Tim Alkire yesterday.

Joan

[redacted] Good move sending to Tim. You & I should talk about paints. R

H & S
Industrial Hygiene

JAN 18 1984

BDD	SC
EER	DEH
TBB	CD
RMJ	PW
JES	LMN
JD	EDS
BEP	

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EPA reporter

Issue No. 106 October 25, 1983

H&S
Industrial Hygiene

BDD SC
EER DEH
TBB CD
RMJ JAN 16 1983 PW
JES LMN
MJV EDS

CC: to T.I Allen
54/1/17

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- Phase-Out Of Remaining Asbestos Uses To Be Proposed
- Pollution Control Deadline Extended
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- Air Standards Set For Label-Makers

POLLUTERS PAYING 80 PERCENT OF CLEANUP, ENVISIONS EPA

The Environmental Protection Agency has proposed new guidelines designed to ensure that polluters pay their fair share of cleanup costs at leaking toxic-waste dumps.

Under that proposal, companies generally would have to offer payment of at least 80 percent of the total projected cleanup at a specific site before EPA officials could start negotiations for possible settlement of pollution charges. The guidelines also would spell out the legal and technical criteria the EPA intends to use in settling with polluters.

The proposed guidelines are largely the same as the informal ones the EPA has been using recently, but they are more stringent than earlier policy guidelines or the rules some officials from the chemical and other industries hoped would be announced. The main reason for the proposal, agency officials acknowledged at a news conference, is to reassure critics in Congress and elsewhere that there won't be a repeat of improprieties and settlements favorable to industry.

The proposed rules, for example, mean the agency won't accept one company's offer to pay its share of cleanup costs unless it is part of a larger settlement offer that covers at least 80 percent of the total amount. And it precludes companies from escaping litigation with relatively modest settlement offers. Formerly, the EPA was under fire from Congress, state officials and environmental groups for failing to adhere to tough settlement guidelines.

Gene Lucero, head of the EPA's toxic waste enforcement office, said the agency's policy, whenever possible, is to require "100 percent cleanup by the responsible parties." But when government attorneys determine they don't have a strong legal case, the proposed rules allow them to settle for less. In contrast with many previous settlements, however, the EPA would be required to justify the decision publicly and to give nearby residents and other interested parties a chance to raise objections to it.

After public comment and further internal agency reviews, the final version of the guidelines will go into effect.

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Old Saybrook, CT 06475-9988

Like all final decisions, this one will depend on an evaluation of individual circumstances. EPA will not necessarily act in the order the sites are currently listed.

The listing is based on HRS scores of 28.5 or higher, selected because it would yield about 400 priority sites, the number suggested by law. They're listed in order of their scores, but with a notice that the scores are only rough guides, and small differences should be ignored.

EPA rejected one suggestion that it give higher priorities to sites where private cleanup actions already are in progress. The agency says it lacks the resources to determine the progress of all these projects, and that the idea could give undue emphasis to partial solutions.

However, should the private project be completed, the site will be removed from the list.

SULFUR TEST ALTERNATIVE CLARIFIED

A new air quality test for sulfur-processing plants is available to any source which oxidizes elemental sulfur, or an ore that contains it, and uses air to supply oxygen.

The Environmental Protection Agency is including those specifications in its final provisions for the testing alternative, in response to requests that it be more specific about exactly which plants are eligible.

The newly approved method lets you monitor SO_2 or sulfuric acid mist emissions by measuring these substances, and the amount of oxygen, in the plant's exhaust. It is offered as an optional alternative to qualifying plants.

PHASE-OUT OF REMAINING ASBESTOS USES TO BE PROPOSED

The Environmental Protection Agency intends to propose in the next few months a ban or phase-out of asbestos in the few products that still contain it.

EPA Administrator William Ruckelshaus agreed in principle with a package of proposed regulations against the carcinogen that goes beyond any action the Reagan administration was considering only a few months ago, agency officials said.

Nevertheless, any such ban would come long after the asbestos industry—battered by thousands of suits from asbestos workers and users—has shrunk severely. About 300 companies once used asbestos in their products, but use has decreased as the dangerous effects of asbestos have become known. The U.S. Bureau of Mines said U.S. consumption reached a high of 795,000 metric tons in 1973; according to the EPA, current annual consumption is about 127,000 metric tons.

The EPA intends to ban all uses of certain construction products such as cement pipes, roofing materials and floor coverings that contain asbestos, a fibrous mineral used in fireproof materials. In addition, the agency is writing proposed regulations that place a cap on the amount of asbestos used for all other products and set up a timetable for phasing out all but a few minor uses over the next few years.

In the past, senior Reagan administration appointees at the EPA have argued that there wasn't adequate scientific evidence to warrant tough action against asbestos. They also asserted that banning or phasing out the material would be too costly in most instances, and they wanted voluntary action by industry to reduce public exposure to asbestos.

But Edward Klein, director of the office that is drafting the proposals, said the EPA now considers asbestos to be a "proven carcinogen" that should be phased out quickly. He noted that industry has developed a variety of substitutes.

Denver-based Manville Corp., the major asbestos-products maker, said the EPA action probably would have "very little impact on us" because the company has been replacing asbestos with such materials as fiberglass.

Manville filed for protection under Chapter 11 of the federal Bankruptcy Code last year to ward off thousands of lawsuits from plaintiffs who claimed injury or death of relatives from asbestos. The material can cause cancer and asbestosis, an emphysema-like disease

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that gradually impairs breathing through scarring of the lungs.

Manville, once known as the largest asbestos company in the Western world, recently sold its large Canadian asbestos-mining operations.

In Danbury, Conn., Union Carbide Corp. said it didn't know how any EPA action would affect its mining operations in Colorado, where it operates a small asbestos mine. Moreover, Union Carbide said, it "probably won't have much of an effect on us because our kind of asbestos is of high purity." But the company said its asbestos is used in floor tiles and corking materials, usages that EPA apparently will ban.

Raymark Corp., Trumbull, Conn., asserts that its use of asbestos probably wouldn't be affected immediately. The company said its asbestos is used mainly in friction materials, like car brakes and clutches.

In a related development, the Labor Department said its Occupational Safety and Health Administration will expand workplace inspections seeking possible violations of its asbestos-exposure rules. The job-safety agency estimated it will triple such inspections to about 700 over the next year in the construction and manufacturing industries, focusing on demolition sites and manufacturers with records of asbestos violations.

OSHA said it will inspect demolition sites that have notified the EPA that asbestos demolition or removal will occur. Previously, OSHA inspectors often didn't know about possible asbestos-rule violations at such sites because the work was completed quickly. The cooperative effort with the EPA is to last six months.

In the 1970's, the government banned certain sprays containing abestos used for insulation and decoration of new buildings. And the EPA ordered schools to perform safety checks to determine if fibers from asbestos insulation posed a health threat to students. Recently, the EPA has been under increasing pressure from lawmakers, environmental groups and cancer experts at other federal agencies to crack down on future use of the material.

POLLUTION CONTROL DEADLINE EXTENDED

The Environmental Protection Agency has restored the original deadline, by which the electronic crystals industry must install the best available technology to control water pollution.

In practical effect, the extension may affect only one plant, whose owner was surprised when EPA recently moved up the deadline.

The BAT requirement is based on using precipitation and clarification to control fluoride. EPA imposed it earlier this year, and set an outside compliance deadline of July 1, 1984. The permit writer actually sets these deadlines, based on the circumstances at individual plants, but this is the latest possible date.

On reason EPA chose this deadline: With only one exception, the industry already had these controls in place, and EPA assumed it would be easy for the remaining plant to comply as well.

That assumption was wrong, that plant's owners complained. As proposed, the rule would have given the owners nearly three years to comply; the originally planned deadline was 31 months from the date the rule was issued. EPA actually allowed only 15 months, a move that came as a surprise.

The revised regulation restores the 31 months, if the company needs it. The permit writer still is free to specify an earlier deadline, but not a later one.

INDUSTRIAL TURBINE STANDARDS TO BE REVIEWED

New air pollution standards may be on the way for industrial gas turbines, but the Environmental Protection Agency says it isn't sure yet what they might be.

EPA says it wants to review two aspects of the current new source performance standards:

—The performance, and applicability, of dry or wet controls for larger turbines, and those which see continued high-output service.

—The increasing use of turbines in combined cycle and cogeneration service.

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