Here's an update on asbestos . . .

By G.S. Rajhans, P.Eng., Occupational Health Branch, Occupational Health Engineering Services, Toronto, Ontario.

There has always been an attempt on the part of scientists to establish a hygienic standard for asbestos that is biologically most appropriate in limiting the hazard. However, since asbestos was established as a human carcinogen, it has been difficult to establish a no-risk level, either for occupational exposure or non-occupational exposure. There is always some small risk to health as long as there is any airborne dust in the environment.

Nevertheless, an allowable exposure level must be set and defined by an index based on the theory that exposure up to certain levels can be tolerated without incurring undue risks. This article will offer a critical review of the existing and proposed occupational and non-occupational standards for asbestos.

OCCUPATIONAL STANDARDS The occupational or work-environment level is normally referred to as a Threshold Limit Value (TLV) or Time-Weighted Average (TWA). These values refer to time-weighted concentrations for a 7- or 8-hour work day and 40-hour work week. They refer to airborne concentrations under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect.

In 1946, the American Governmental Industrial Hygienists proposed that the TLV for asbestos dust be set at 5 mppcf (million particles per cubic foot), as determined from impinger samples.[1] This value was recommended by Dressen, Dallavalle, Edwards, Miller and Sayers after a study of 541 employees in three asbestos textile plants using chrysotile asbestos.[2]

In 1960 an occupational standard for asbestos was published in the U.K. by the Minister of Labour.[3] This was taken from the annual list of TLV's published by the ACGIH. In 1965 The British Occupational Hygiene Society (BOHS) formed a Hygiene Standard Committee.[4] This committee, after critical examination of the ACGIH standards, recommended the use of the ACGIH standard for asbestos for the time being, until they have established their own standard.

In 1967, Cooper[1] observed that the TLV of 5 mppcf for asbestos rests on shakier evidence than most TLV's. His chief argument was that a large proportion of asbestos fibres have diameters below the resolving power of the light microscope used for impinger counts and are therefore not counted at all. He further reported that asbestosis appeared in insulation workers who were exposed to concentrations much below the time-weighted average of 5 mppcf. Leathart and Sanderson[5] also considered the TLV of 5 mppcf to be too high. In January of 1968 the ACGIH issued the following statement:

> "A limit to 5 mppcf, based on impinger samples counted by light-field techniques is satisfactory to control exposures to most forms of asbestos. Crocidolite, however, has been shown to produce mesotheliomas in addition to the common asbestotic inflammations. Since no safe limit can be estalished for this form of asbestos at this time, until more definitive data are obtained, it is recommended that workers exposed to crocidolite be equipped with air-

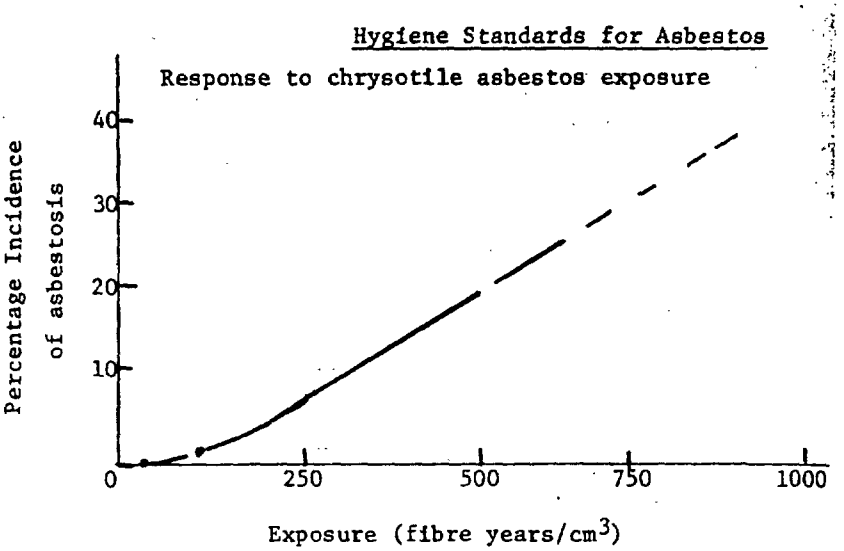

Fig. 1. Response to chrysotile asbestos exposure

supplied helmets.[6]

TEXTILE STUDY However, by this time, the Hygiene Standards Committee of the BOHS under the chairmanship of Professor Lane had already completed an environmental and medical study at an asbestos textile factory in England, in which investigations were made of 290 of the men employed in the period of 1933–1966.[7] The asbestos dust concentrations to which different workers had been exposed varied from 1 fibre/cc to 27 fibres/cc measured by the membrane filter (MF) technique in which the number of fibres greater than 5u in length were counted.

The problem of relating prevalence of asbestosis with concentration and with duration of exposure was resolved by assuming that the cumulative amount of asbestos remaining in the lungs from a given exposure is equally dependent on the dust concentration and on the duration of exposure to that concentration. Thus, the exposure of an individual was expressed as fibre-years/cc, that is the product of the average concentration during working hours and his years of exposure. Exposure expressed in this way was compared to the prevalence of asbestosis and a curve was developed.[8] *(Fig. 1)*

One criticism of this curve was the use of a continuous scale starting at zero. Doses which give zero response are never, in fact, known with absolute certainty since the sensitivity of a measuring instrument is limited. However, the main conclusion from the curve was that for an accumulated exposure of 100 fibre-years/cc, it is probable that the risk of being affected, to the extent of having the earliest clinically demonstrated signs, is less than 1%. That is, 2 fibres/cc for 50 years, 4 fibres/cc for 25 years or 10 fibres/cc for 50 years, 4 fibres/cc for 25 years or 10 fibres/cc for 10 years.

ACGIH In 1969 the ACGIH proposed a TLV of 12 fibres greater than 5 um in length per cc by the MF technique or 2 mppcf by the impinger technique. This was probably based on the work of Lynch, Ayer and Johnson[9] in asbestos textile plants where 1 mppcf (impinger) was shown to be equal to 5.9 fibres/cc. In 1970[10] the ACGIH proposed a lower asbestos dust limit of 5 fibres/cc by the MF technique and eliminated the impinger standard. However, this TLV remained on the intended changes list until 1973 when it was first adopted as the TLV and continues to be the one today. This TLV, if continued, would result in an accumulated exposure of 250 fibre-years/cc over 50 years and an extrapolation of the curve shown above would indicate that this would result in more than 2% risk of contracting asbestosis.

In 1972 NIOSH recommended the following criteria for asbestos dust.[11]

"Occupational exposure to airborne asbestos dust shall be controlled so that no worker shall be exposed to more than 2.0 asbestos fibres per cubic centimeter (cc) of air based on a count of fibres greater than 5 micrometers (> 5 um) in length determined by the membrane filter method at 400-450× magnification (4 mm objective) phase contrast illumination, as described in Appendix 1, determined as a time-weighted average (TWA) exposure for an 8-hour work day, and no peak concentration of asbestos to which workers are exposed shall exceed 10.0 fibres/cc greater than 5 um as determined by a minimum sampling time of fifteen minutes."

Along with the above recommendation the NIOSH also issued several other statements:

TABLE I

Category	Dust Concentration f/cc
Negligible	0-0.4
Low	0.5-1.9
Medium	2-10.0
High	over 10.0

(1) The standard is amenable to techniques that are valid, reproducible and available to industry and governmental agencies. It will be subject to review and will be revised as necessary.

(2) The recommended standard is designed primarily to prevent asbestosis. For other diseases associated with asbestos, there is insufficient information to establish a standard to prevent such diseases including asbestos-induced neoplasms by any all-inclusive limit other than one of zero. Nevertheless, a safety factor has been included in arriving at the concentration level that will reduce the total body burden and should more adequately guard against neoplasms.

LATENCY A ceiling value of 10.0 fibres/cc that was not to be exceeded was included to reduce the possibility of the short-term heavy exposures to asbestos that have been reported to cause mesotheliama. In addition, this should reduce the likelihood of diseases (malignant and non-malignant) resulting from exposure in excess of 30 years with very long latent periods. The U.S. Government published the following in the Federal Register, Vol. 36, No. 234, December 7, 1971.[11]

"The 8-hour time-weighted average airborne concentration of asbestos dust to which employees are exposed shall not exceed 5 fibers per milliliter greater than 5 microns in length, as determined by the membrane filter method at 400-450× magnification (4 millimeter objective) phase contrast illumination. Concentrations above 5 fibres per milliliter but, not to exceed 10 fibres per milliliter, may be permitted up to a total of 15 minutes in an hour for up to 5 hours in an 8-hour day."

On June 7, 1972[12] the OSHA promulgated a standard which limits the worker exposure to an 8-hour time-weighted average (TWA) of five asbestos fibres per cc of air; and the ceiling limit of 10 fibres/cc. They also mentioned that effective July 1, 1976, the 1972 rule would reduce the exposure limit to an 8-hour exposure limit of 2 fibres/cc. Selikoff et al[13] criticized the standard on the basis that the fibres are made of fibrils 300 to 350 Angstroms in diameter and cannot be seen with the optical microscope, being far below the limits of its resolution.

In 1973 the Hygiene Standard Committee reviewed the 1968 BOHS standard for chrysotile and recommended that no changes be made at the present time, but the standard be kept under review.[14] They also reviewed the information on the results of human exposure to airborne amosite asbestos with animal experiments. They recommended that the standards for amosite be the same as those for chrysotile.

It was further recommended that the following table (Table I) be used to designate certain ranges of dustiness.

On October 9, 1975 the Federal Register[15] proposed a standard of 0.5 fibres per cc for an 8-hour TWA (or 500,000 fibres per cubic meter) and likewise a reduced ceiling of 5 fibres per cc (or 5 million fibres per cubic meter) for any period not exceeding 15 minutes.

IHPR The proposed standard did not apply to the construction industry and separate rulemaking to revise the asbestos standard for construction

industry was planned. The Insulation Hygiene Progress Report[16] critically reviewed the proposed OSHA standard and issued the following statement:

> "This recognition that the construction industry is unique is highly desirable. Earlier data on the effectiveness of monitoring in the construction industry (see Insulation Hygiene Progress Reports, Summer 1973), have shown that few dust counts are ever taken in this segment of the Industry. Thus, specification of procedures is of much greater importance here. Individual workers must be able to judge whether or not they are working in a safe environment on the basis of materials and methods rather than dust counts.
>
> "As much of insulation is now asbestos-free, work practices for installation of new material can be developed that would lead to a time-weighted average exposure less than that proposed in the new standard. With care, even ripout can be done safely, but special precautions must be taken. Wetting techniques have now been developed that would allow removal of asbestos to be accomplished within the proposed regulations."

2 FIBRE OSHA invited comments on appropriateness and feasibility from the asbestos industry. On February 4, 1976[17] some 65 representatives from companies and trade associations representing manufacturers and processes of asbestos products in the United States participated in a meeting held in Washington, D.C. and overwhelmingly endorsed that the "2 fibre" level has been or can be attained by application of engineering technology but the proposed "0.5 fibre" level is unnecessary, impracticable and lacks medical justification.

In a letter dated December 15, 1976[18] to the OSHA, Dr. Finklea of the NIOSH recommends that the OSHA reduce the standard for occupational exposure to asbestos to 0.1 fibres per cc. Dr. Finklea said the previous recommendation of a 2 fibres/cc was designed primarily to prevent asbestosis since insufficient information then existed to establish a standard to prevent asbestos-related diseases such as pulmonary, pleural and peritoneal neoplasms. The 0.1 fibre per cc recommendation is based on lowest concentration at which asbestos fibres can be monitored reliably using phase contrast microscopy. Our study[19] indicates that it is not possible to monitor the levels at 0.1 fibres/cc reliably.

CANADA In Canada there is no uniform standard, all provinces have their own asbestos standards. An attempt is made here to summarize the provincial standards.

Quebec[20]—The standard to be applied is 5 fibres/cc but the Beaudry commission has suggested a reduction to 2 fibres per cc or the equivalent.

Ontario[21]—They followed the ACGIH recommendation until 1972 and then they lowered the standard to 2 fibres/cc for chrysotile mainly due to the following:

(1) The U.K. has been using this standard since 1971.

(2) The NIOSH criteria document recommended this limit.

(3) The toxicities of various types of asbestos is not well understood and hence a built-in safety factor was needed.

air as determined by the membrane filter method of evaluation at 400-500× magnification using phase contrast illumination.

British Columbia[22]—The B.C. Government have had a standard of 5 mppcf (impinger) for a long time. However, they have now their standard and recommended a TLV of 2 fibres per cc greater than 5 um in length for chrysotile and 0.2 fibres/cc for crocidolite in the Second Draft Amendments, Workmen's Compensation Board, Industrial Health and Safety Regulations, February, 1976. They have also mentioned a ceiling of 5 fibres/cc for 15-minute exposure. This is ½ the ceiling level of 10 fibres/cc recommended by Ontario.

Saskatchewan[23]—The province has a TLV of 2 fibres/cc for all asbestos varieties.

Nova Scotia[24]—At present, the standard is 5 fibres/cc but new facilities will be required to meet the standard of 2 fibres/cc.

TABLE 2

REGULATING AGENCY	ASBESTOS-CONCENTRATION STANDARD
CALIFORNIA	
+ Air and Industrial Hygiene Laboratory, California State Department of Health	Total fibre count downwind of an asbestos emission source must not exceed 10 times the total fibre count upwind of that source.
CONNECTICUT	
+ Department of Environmental Protection, State of Connecticut	30 ng/m³ (based on 30-day average sample)
ONTARIO	
Ontario Ministry of the Environment Air Resources Branch	Interim guideline of 5 μg/m³

For crocidolite the standard is 0.2 fibres/cc. They also have a ceiling value of 10 fibres per cc for a 15-minute exposure.

Alberta[25]—On April 15, 1975 Alberta officially promulgated the following occupational health standards:

(A) For asbestos dust or fibre, all forms, the time-weighted average airborne concentration shall not exceed 2 fibres greater than 5 micrometers in length per cubic centimeter of air, as determined by the membrane filter method of evaluation at 400-450× magnification using phase contrast illumination.

(B) For asbestos dust or fibre, all forms, the maximum (ceiling) airborne concentration shall not exceed 10 fibres greater than 5 micrometers in length per cubic centimeter of

The Working Group on Asbestosis[26] recognized the documented and suspected health hazards associated with asbestos exposures and recommended a uniform early acceptance of a maximum tolerable level of 2 fibres/ml., time-weighted average. The practical objective, however, should be to reduce asbestos dust in the workplace to the lowest possible level.

Feasibility of 2 fibres/cc Standard

A standard should not be promulgated on whether it is feasible to meet it or not. Almost anything is feasible if it is necessary. However, it is a worthwhile exercise to analyse if the standard is feasible. It should also be realized that 2 fibres/cc is a TWA over an 8-hour period. In other words some excursion during the period can be permitted, but the excursion is limited to 10 fibres/cc. Now, if one supposes

that a worker is exposed to 10 fibres/cc for 15 minutes he could be exposed to 1.7 fibres/cc for the rest of his shift, i.e. $5 \times 10\ 465 \times 1.7 = 480 \times 2$.

Lemen et al[24] showed that more than 50% of the operations in textile operations were able to meet the 2 fibres/cc limit and control technology to meet the 2F/cc level existing in all operations in the friction product industry. A study has been carried out in Ontario to determine the technological feasibility of the 2 f/cc standard[25] as is the Beaudry Commission in Quebec.[20] The Ontario report[22] shows that the level of 2 fibres per milliliter is technologically feasible in the five major plants studied.

COSTS Our studies in Ontario would seem to indicate that the industry is well able to bear significantly increased control costs without enormous dislocations in the industry. We enforce asbestos standard as strict as that presently used anywhere in the world. At the present time, it would seem that our asbestos using industries are economically healthy and perfectly capable of working under the necessary constraints imposed upon them.

Other Occupational Standards

(1) The BOHS has recommended a level of 0.2 fibres/cc for crocidolite.[26]

(2) The BOHS also gives the following alternative indices for chrysotile asbesots.[26] Respirable mass:

−0.03 mg magnesium/m^3
−0.04 mg SiO_2/m^3
−0.10 mg ash/m^3
−0.12 mg asbestos/m^3
Thermal Precipitator: 25 ppcc greater than 1 um after incineration.
Impinger: 10 ppcc
Royco Particle Counter: 2 ppcc greater than 4 um.

It should, however, be realized that the above standards refer to conditions in textile factories using chrysotile asbestos and the equivalents may not be applicable in other places.

The joint ACGIH–AIHA Aerosol Hazards Evaluation Committee[26] after reviewing various standards including the mass concentration concluded that "at present the only practical way to determine fibre concentration is by counting fibres which have been mounted on a suitable substrate so that they can be identified as individual fibres."

ENVIRONMENTAL STANDARDS In 1971 the Environmental Protection Agency, U.S. Government proposed emission standards concerning the following:

(1) Emissions shall not exceed those which would be emitted from operations if proper engineering control had been installed (i.e. fabric filter, cyclone gas cleaning devices).

(2) Visible emissions of particulate.

(3) Spraying of asbestos.

(4) Use of asbestos for surfacing or resurfacing of roads.

The use of procedural standards and visible emissions as the basis for evaluation for compliance with the standard are designed to minimize emission to the atmosphere. At about the same time the USA, through the Air and Industrial Hygiene Laboratory, California State Department of Health, asks that the total fibre count downwind of an asbestos source not exceed 10 times the total fibre count upwind of that source. The Department of Environmental Protection, State of Connecticut U.S. Environmental Protection Agency, had the problem under study, and required only that there be no visible emission or certain specified control equipment must be used, e.g. a baghouse, high energy scrubber, etc.

Ontario has an emission guideline[7] which is 5 micrograms per cubic metre averaged over a half hour at point of impingement. This guideline refers to

the maximum concentration of asbestos averaged over a half hour resulting from the plume from any source, stack or vent, impinging on any receptor, a school, shopping centre, ground, etc., at the time when the wind is blowing from the source directly toward the receptor.

Since wind direction is variable and since more than one source may impinge on a given receptor at one time, the emission guideline is developed to encompass these variables in such a way that, if every source meets the emission guideline, the ambient air quality guideline will not be exceeded. Thus, there is no direct numerical relationship between the emission guideline and the ambient air quality guideline. The ambient air quality guideline is the maximum concentration, averaged over 24 hours, to be found anywhere in the community.

Table II summarizes some of the air quality standards in force today.

The Final National Emission Standards for Hazardous Air Pollutants–Asbestos and Mercury, promulgated by the U.S. Environmental Protection Agency, were published in the Federal Register of October 14, 1975[28] and are effective as of that date. Initially the standards appeared in the Register of April 6, 1973.[28] The amendments thereto were proposed October 25, 1974.

The following are some of the highlights of this new document as it concerns asbestos.

(1) The "no visible emissions" clause for the waste disposal of asbestos materials remains in effect.

(2) Asbestos mills are exempt from the requirement to wet tailings when disposal site temperatures are below 15°F.

(3) Only asphalt concrete manufacturing plants that use commercial asbestos are affected.

(4) Local exhaust ventilation systems may be used during certain renovation operations.

(5) Containers of asbestos waste may display either an EPA or an OSHA warning label.

(6) Clarification is given of the definitions for "planned renovation" and "emergency renovation" operations.

(7) Wastes generated by operations that use sprayed-on materials containing less than 1% of asbestos by weight to insulate or fireproof buildings, structures, pipes and conduits are not covered by the new ruling. **OH&S**

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EPA PROPOSES ADDITIONAL ASBESTOS RESTRICTIONS; CLARIFIES DISPOSAL REGULATIONS

The spraying of all materials containing more than 1% asbestos would be prohibited on buildings, structures, structural members, pipes and conduits under proposed Environmental Protection Agency amendments to the Clean Air Act. Amendments, which appeared in the March 2 *Federal Register*, would extend current demolition and renovation provisions of the Clean Air Act -- which cover spraying and removal of asbestos-containing materials used in fireproofing and insulation -- to include decorative coatings.

Amendments were proposed in response to recent information EPA has received showing that asbestos used in certain types of decorative spray-on materials contains 29-64% asbestos. Because these materials may crumble easily, EPA says they could be a "major source of asbestos emissions during renovation and demolition operations."

In other action, EPA also issued final amendments to the demolition and renovation provisions of the asbestos standard to make it clear that the 1975 regulations apply to both load-supporting and non-load supporting structural members such as beams, ceilings and walls.

Comments on proposed amendments should be addressed to Emission Standards and Engineering Division, EPA, Research Triangle Park, North Carolina 27711, Attention: Mr. Don R. Goodwin, by May 2.

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AFL-CIO SEEKS FEDERAL STANDARDS FOR WORKERS' COMP; PROPER OSHA ENFORCEMENT

AFL-CIO renewed its recommendation that Congress establish Federal standards for state workers' compensation programs in order to provide adequate coverage for all workers, at its strategy session in Bal Harbour, Fla., late last month. Union also called upon President Carter to rescind Executive Order 11821, issued by President Ford, which requires Occupational Safety and Health Administration to prepare inflationary impact statements before standards can be promulgated. This order "places a dollar value on the lives or workers and has blocked development of occupational health standards," union said. In addition, union urged Carter to require the Secretary of Labor to enforce job safety and health guidelines for Federal employes to set an example for private employers.

In a statement adopted by the AFL-CIO's Executive Council, union criticized workers' compensation system, stating that "many injured workers, their dependents and, in some cases, their survivors are forced to the courts for protection through third party suits for damages, because of inadequacies in state workers' compensation programs." Union said that adoption of Federal standards could eliminate many inadequacies in the present system and restore workers' compensation "as the exclusive remedy of injured workers... making uncertain and often inequitable alternate remedies unnecessary."

AFL-CIO also criticized the past two Administrations for failing to properly administer OSHA and said it was encouraged by President Carter's statements of support for the law and his desire to have OSHA regulations clearly drafted. In the Administration's most recent statement of support for OSHA, Labor Secretary Ray Marshall told United Auto Workers March 2 that "we believe in these laws [job safety and health act of 1970] and we're going to try to make them work. There have been people in the past who did not believe in them and therefore did not try to make them work. It's difficult to administer a law you don't really believe in," Marshall said.

* * *

DISABLING INJURIES IN COAL MINES CLIMB 15% in 1976, MESA REPORTS

Disabling injuries occurring in the coal mine industry in 1976 climbed 15% above the 1975 rate of 31.07 per million man hours of exposure to 36.41 per million man hours, according to preliminary statistics released by the Mining Enforcement and Safety Administration. But the total number of fatalities -- 141 -- was 14 less than in 1975.

Mine operators reported a total of 14,085 disabling work injuries during 1976 and 11,853 nondisabling injuries. One major disaster, the Scotia coal mine tragedy in Kentucky, resulted in 23 deaths. Three other accidents involved double fatalities. Highest injury frequency rates occurred in anthracite coal mines, where there was a rate of 132.04 injuries per million man hours.

FOUR MINERS KILLED, FIVE MISSING AS FLOOD WATERS OVERRUN MINE

Four miners were killed, three seriously injured and five others are still missing as a result of an underground flood which surged through a tunnel of the Kocher Coal Co. mine, 40 miles northeast of Harrisburg, Pa., March 1. Another miner was rescued after spending 116 hours in a tiny coal mine cavity before he could be reached. But rescuers' attempts to pick up sounds from remaining miners in the shaft have been unsuccessful.

Although the source of the flooding remains a mystery, Federal and state mining officials are speculating that water could have come from the runoff of melting snow or from water accumulating in an abandoned mine nearby. Region is filled with abandoned anthracite tunnels, many of which are unmapped. A full investigation into the causes of the flooding will be conducted by Mining Enforcement and Safety Administration when all the missing miners are accounted for. Kocher mine has been in operation since 1968 and has had no fatalities prior to this.

* * *

AROUND THE STATES

CALIFORNIA -- Preliminary survey results of room air in private residential and public buildings in Los Angeles, the Bay Area and Fresno showed no counts of asbestos fibers in excess of existing job safety and health standards, State Health Director Jerome A. Lackner announced. But further sampling of building environments -- particularly in new office buildings which contain considerable amounts of asbestos-coated materials -- will be done to enable department to expand its data base, he said.

CONNECTICUT -- An eight-member panel appointed by Gov. Ella Grasso to study state's three nuclear power installations has criticized Federal reactor safety studies for failure to adequately consider the latent effects of radiation, the possibility of sabotage and the malfunctioning of equipment, according to Dr. Gifford B. Pinchot, a physician and former biology professor who is a member of the panel. Panel will shortly recommend to the state legislature that it create an independently-funded state office on radiation safety. This office would have the responsibility for plant safety, quality assurance, radiation detection, worker health and safety, and transportation of radioactive material. Panel will also recommend that studies be conducted to minimize effect of medical and dental X-rays upon technicians and patients and that additional funding be allocated to study extent of radiation-related diseases among nuclear plant employes and persons residing near plants.

GEORGIA -- National Center for Disease Control in Atlanta is trying to determine the cause of the recent deaths of two CDC employes who worked at a laboratory where dangerous viruses are studied. George Flowers, 49, who delivered supplies to the laboratory and picked up used glassware that had been sterilized, died of intestinal bleeding that followed high fever, chills, nausea, muscle aches and diarrhea. Robert Dubingon, 43, who had janitorial duties, died of kidney failure after experiencing the same symptoms. A CDC spokesman told JS&HR that both men had very little contact with the viruses that are studied in the laboratory and that both were required to be immunized against the various viruses with which they might come in contact. Legionnaires disease and other more common diseases have been ruled out. Latest speculation is that disease was caused by a rickettsia which can cause Rocky Mountain spotted fever and other diseases. Such diseases are not spread by human contact.

VERMONT -- Vermont has become the sixth state to receive certification from the Occupational Safety and Health Administration that all the developmental steps specified in its state plan for job safety and health are complete. Vermont will receive 50% Federal funding for program operations through Sept. 30, 1977, amounting to $285,666. OSHA will continue to monitor and evaluate Vermont's plan for at least one year to determine whether the program, in operation, is at least as effective as the national program. Final approval of the plan may be granted and Federal jurisdiction in the state withdrawn at the end of the period. But OSHA will continue to monitor and evaluate the program to assure that it remains effective. Certification of the plan, which was first approved in 1973, comes at a time when a bill is pending in the state legislature to abolish the state program (JS&HR, Feb. 7, 1977, p. 22).

News Letter

No. 11, September 1982

LAM 001319

Clayton Environmental Consultants, Inc.

NEW DEVICE MEASURES ASBESTOS FIBER RELEASE

By David Hands, C.I.H.
Senior Industrial Hygienist

Asbestos has long been recognized as a material which has excellent fire-resistant properties, and for many years it was used in building construction where fire-retardant construction was desired. Recently, of course, potential health hazards resulting from exposure to airborne asbestos have been revealed.

However, the mere presence of asbestos containing material may not in itself present a hazard; concern arises when asbestos fibers are released into the air as a result of maintenance activities, vibration, or airflow (the space between the suspended ceiling and the above floor, where structural members and subflooring are coated with the fireproofing, often serves as a return air plenum for building ventilation systems). The integrity of the fireproofing, and its potential for fiber release, may be affected by aging, water damage, past renovation activities, and of course the original composition of the material when it was applied, especially the percentage of asbestos included in the composition. Because the materials were generally prepared onsite, considerable variation in composition often exists even within a building.

Several methods are used to determine whether a building containing asbestos-bearing fireproofing in fact poses a potential asbestos exposure problem to occupants and maintenance personnel or outside contractors. Air sampling in the office areas can be performed, but fiber concentrations are generally very low because the suspended ceiling acts as a barrier to fibers. However, removal of ceiling panels for routine maintenance and inspection has been found to result in measurable fiber concentrations to employees performing the removal. Presumably office occupants would also receive exposure during this apparently innocuous procedure, so air sampling under normal conditions may not reveal an existing potential hazard.

The only standardized method for testing friability, defined as the tendency for a solid material to fragment when subjected to mechanical energy, is designed for coal and has application in material handling. A modified version of this ASTM (American Society for Testing and Materials) method was performed with asbestos at Clayton's laboratory, but results cannot be related to potential occupant exposure because the bulk sample of fireproofing needed for the test must be removed from the building and because the result of the test is expressed as the percentages by weight of the original test sample which fall into certain size categories after the tumbling period. Further, the tumbling does not

(Continued on Page 2)

Cellosolve Exposure Limits Too High?

Recent studies by the National Institute for Occupational Safety and Health (NIOSH) have indicated reproductive effects in male and female test animals from exposure to several glycol ethers and their acetate derivatives. These results, and results of testing prompted by the NIOSH studies by private industry groups, have led the American Conference of Governmental Industrial Hygienists (ACGIH) to recommend lowering the threshold limit values (TLVs) for 2-ethoxyethanol (Cellosolve solvent) and 2-ethoxyethylacetate (Cellosolve acetate) from 50 to 5 ppm. In addition, most manufacturers of these solvents have issued advisory letters to their customers suggesting that exposures be reduced to the greatest extent feasible until the exact nature of the risk is ascertained.

These solvents are widely used by industry and are known under such trade names as Cellosolve, Dowanol EE, Methyl Cellosolve, and Dowanol EM. Use of these solvents and associated worker exposures should be reassessed. This may include reviewing the manufacturer's suggestions or monitoring Cellosolve exposures. For additional information on Cellosolve, please contact the Clayton industrial hygiene department.

Clayton Opens New Jersey Office

Clayton Environmental Consultants, Inc. is pleased to announce the acquisition of Occupational Health Services, the industrial hygiene and laboratory service organization, formerly owned by American Can Company. Fully accredited and licensed laboratory services will now be available from two locations — Southfield, Michigan (main office) and Edison, New Jersey. In addition, the New Jersey office brings the number of Clayton locations to five (other Clayton offices are located in Southfield, Michigan; Atlanta, Georgia; Houston, Texas; and Windsor, Ontario).

Occupational Health Services has long been regarded as a forerunner in the field, and Clayton welcomes the addition of the OHS professionals to its staff.

The new office and laboratory is located at Raritan Center, 160 Fieldcrest Avenue, Edison, New Jersey 08837. The manager of this office is Kirit Vora, who may be reached at (201) 225-6040. Other professionals include Allen Guy, Joseph Pedalino, William Harley, and Lee Schumann.

New Device Measures Asbestos Fiber Release

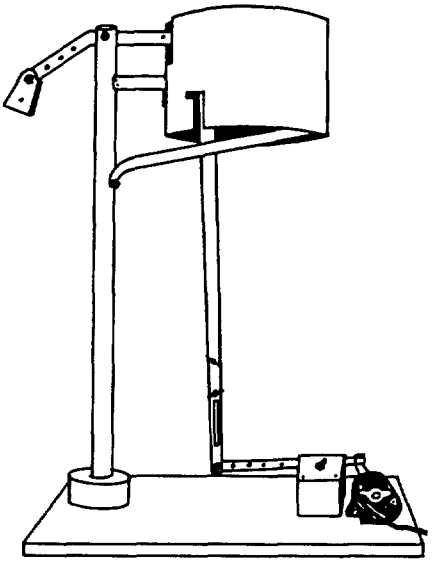
(Continued from Page 1)

simulate the conditions which would be experienced by the material during maintenance or aging.

Two methods exist for assessing some aspect of sprayed-on fireproofing *in situ* (i.e., as it exists in a building), the EPA algorithm and ASTM E736-80, Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members. The EPA algorithm, used widely in schools, weights the condition, accessibility, friability, and asbestos content of the material in percent to derive a number which is used to rank the material. However, the only objective element of the algorithm is asbestos percentage; the remainder of the elements are rather subjective and thus susceptible to being scored differently by different individuals. Finally, no relation between the algorithm results and actual fiber release has been demonstrated. The ASTM test consists of cementing a wide-mouth bottle cap to the fireproofing with a polyurethane foam and then pulling on a hook attached to the cap while measuring the applied force with a spring scale. Although this method is repeatable, it measures only the strength of the bond of the fireproofing to itself (cohesion) and to the structural member (adhesion). These properties may or may not correlate to the tendency of the material to release fibers when subjected to mechanical energy, such as being struck by a tool during maintenance of electrical or heating equipment.

To overcome the lack of a meaningful standardized method for assessing fiber release potential, Clayton has developed a device *(see figure)* which imparts mechanical energy to asbestos-bearing fireproofing while air samples are being collected. Clayton is performing testing on a number of materials to develop an index of fiber release potential. Once the index is developed, it will be possible to compare a given material with others which have been subjected to the test procedure.

The device employs a counterweighted lever to deliver the impact to the material. The impacting lever is connected to and cocked by a cam connected to a gear motor. When a step in the cam is reached, the counterweighted end of the lever falls and the impacting end strikes the fireproofing material with repeatable impacts at the rate of 16 per minute. Three sampling filters are



Clayton Friability Testing Device

arranged slightly below the impact area to collect fibers released. The filters are located within a cylindrical shroud which protects the test area from air currents which often exist in the space between suspended ceilings and the sub-floor above. The device and the sampling pumps operate for 20 minutes at each location, and the fiber concentrations indicated by the three samples are averaged to determine the result for each test.

Preliminary results have been very encouraging. To ensure that the method is indeed repeatable, duplicate sampling has been conducted. That is, two tests have been performed with impact points 1 inch apart. The average fiber concentrations for the first test were compared to the average for the second test. These two averages have been reasonably consistent, indicating that the test procedure is repeatable. In a given building, fiber concentrations generated by the device have also been fairly consistent; occasionally, though, locations within a building were found to have considerably higher fiber releases.

At this point a detailed statistical study of the results has not been conducted, but sampling in progress now will provide sufficient data to develop an index of fiber release. This index will permit comparisons of the fiber release potential of fireproofing in different buildings. The characteristics of these materials may change over time, and this device can also be used to monitor the fiber release potential of a given fireproofing material over time. One further application of this test procedure is the determination of the effectiveness of encapsulation treatments.

Editor's Note: Clayton has applied for a patent for this device.

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LAM 001320

Editor ..... Deborah H. Montgomery
Southfield Office

Accidental Hazardous Chemical Spills — Evaluating Their Community Impact

By David R. Derenzo
Air Pollution Meteorologist

Over the past few years there has been an increase in the use, production, and transportation of a wide variety of chemicals. As a result, the chances of accidental spills and inadvertent releases of these substances into the ambient environment have risen. There have been numerous cases where train tank cars have derailed and tank trucks have overturned, spilling their chemical cargos. Human exposure to these chemicals can result in adverse health effects.

Therefore, in the event of a spill, it is important to be able to estimate the area of impact resulting from the formation and movement of a potentially hazardous chemical cloud.

Computer simulation models specifically developed for this purpose are utilized by Clayton. The models are based on complex mathematical algorithms that describe the manner in which a specific chemical is released from a container and dispersed in the atmosphere.

In general, there are two types of spills — continuous leaks that may persist for some time, and large, sudden releases. These types of spills most often occur from transport lines and/or storage/transportation tanks.

Many of the chemicals used or produced in manufacturing processes are in the form of liquids, and gases, which are usually stored and transported in liquefied form. Therefore, heat and/or mass transfer mechanics, depending on the nature of the chemical spilled, must be utilized to calculate the rate at which the spilled chemical evaporates into the atmosphere when in the ambient environment. The evaporation rate is used as an emission rate in an air dispersion algorithm to estimate downwind chemical concentrations at specific times and locations.

Individual onsite systems have been developed for facilities that utilize hazardous chemicals in order to provide real-time data on the movement and impact of a vapor cloud resulting from an actual spill. These systems utilize a microcomputer programmed with the model that continuously monitors atmospheric and wind conditions. When an accident occurs, the current weather and spill data are input to the model to determine the impact on the surrounding environment as the spilled material moves downwind. This information is used in a program to immediately notify community officials and businesses in the area to establish evacuation zones and take necessary precautions.

Similar highly movable systems have been and are being developed for use by emergency response teams to evaluate spills from ruptured transportation tanks and other sources.

To apply the model to a particular situation, data on the spill and dispersion conditions are required. For example, chemical name, spill size, rate at which the spilled substance flows out of its container, duration of a continuous leak, wind speed, and atmospheric stability are used as inputs to the model.

The simulation computer program can be used and adapted to obtain data for a variety of uses. Hypothetical spill scenarios from chemical sources within a plant can be evaluated to determine if the resulting vapor cloud has the potential to be hazardous to anyone within or outside the facility's confines. This type of information is important to management in determining potential liabilities, appropriate insurance coverage, and plant expansion, and to acquire immediate surrounding property (if the opportunity arises) to establish or expand a "buffer" zone between the plant and the nearest residential areas.

LAM 001321

PC/PLM Provides Qualitative Analysis of Asbestos Air Samples

By Jeanne Bedrosian
Chemical Technologist

The current method for analyzing asbestos in air samples adopted by the Occupational Safety and Health Administration (OSHA) is by phase-contrast microscopy using the National Institute for Occupational Safety and Health (NIOSH) Method P&CAM 239. The method counts all fibers having a length-to-width ratio of 3:1 and being longer than 5 micrometers.

Therefore, cellulose, fiberglass, cotton, and wool may be counted as well as asbestos. This is often a problem since high fiber counts do not always indicate high asbestos fiber concentrations.

To overcome this drawback and to identify specifically asbestos fibers, scanning electron microscopy (SEM) or transmission electron microscopy (TEM) has been used. With these methods, fibrous forms are classified by morphology and identification is confirmed by energy-dispersive X-ray spectroscopy and/or selected area electron diffraction.

The disadvantages to these methods are the high cost and length of time for analysis.

However, polarized-light microscopy (PLM), which has been used extensively for analysis of asbestos bulk samples, combined with phase-contrast microscopy, now appears to be very promising in the qualitative analysis of asbestos air samples.

In switching from phase contrast to polarized light, there is some loss in fiber resolution, which results in a lower fiber count, so the method should be considered semi-qualitative at best. Presently, Clayton performs the analysis only on filters which indicate total fiber counts greater than 0.1 fibers/cc when the PC method is used.

The analysis is also limited by the mounting solution currently specified by NIOSH. The difference in refractive indices between the mounting solution and asbestos does not allow the use of dispersion staining, which is commonly used in asbestos verification.

Despite these shortcomings, the method is attractive because it is faster and less costly than other qualitative methods. In addition, the development of a more appropriate mounting solution should enhance the reliability and usefulness of this technique.

Clayton News Briefs

Staff News

Clayton Environmental Consultants, Inc. is pleased to announce that **Kenneth F. Cherry**, P.E., C.I.H., has joined Clayton as Manager of Environmental Engineering Services (EES). The EES Department incorporates our waste management, air pollution, and engineering design groups. Mr. Cherry has extensive experience with the evaluation and design of pollution control systems with several major engineering firms and with the Ohio Environmental Protection Agency where he was previously employed. He has authored a number of articles on pollution control, is the author of a recent book on plating waste treatment (Ann Arbor Science), and has received five patents ranging from an air pollution control device to ergonomics. Mr. Cherry has degrees in both Chemical Engineering and Economics.

Mr. Timothy W. Ferrel, an Industrial Hygiene Technologist with the Southfield office, has passed the core exam in industrial hygiene given by the American Board of Industrial Hygiene. The exam was given at the American Industrial Hygiene conference in June.

A paper prepared by **Mr. Paul V. Harvath**, Environmental Chemist at the Southfield laboratory, will be presented at a poster session at the Seventh International Symposium on Polynuclear Aromatic Hydrocarbons October 26 through 28, 1982. His paper is entitled "Use of Repeating Chromatographic Profiles in the Quantitative Analysis of PAH in the Coal Conversion Environment." The symposium, which is sponsored by Battelle Columbus Laboratories, will be held in Columbus, Ohio.

Publications

The results of extensive Clayton research into two timely environmental issues have recently been published. "Medical Management of Chemical Exposures in the Petroleum Industry," prepared by Clayton under contract to the American Petroleum Institute, is designed to assist the health specialist in considering and recognizing the role of various environmental stresses and hazards in worker health problems in the petroleum environment.

"Evaluation of the Relationship between Formaldehyde Emissions from Particleboard Mobile Home Decking and Hardwood Plywood Wall Paneling in Experimental Mobile Homes" was prepared by Clayton under contract to the U.S. Department of Housing and Urban Development subsequent to a 2-year study of formaldehyde in mobile homes.

For further information on these two publications, contact the Southfield office.

LAM 001322