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DUST SAMPLING INSTRUMENTS AND DUST STANDARDS IN THE UNITED STATES OF AMERICA FOR ASBESTOS

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Threshold limit values for airborne asbestos and the associated sampling instruments have undergone changes in the United States of America during the past year.

In the United States, because of concurrent jurisdiction, several different agencies have responsibility for establishing and enforcing standards or guides for the working environment. Thus we find standards and guides being established or enforced, or both, by the respective states as well as by many Federal departments including the Department of Health, Education and Welfare, the Department of Interior, the Department of Labor and the Department of Defense.

The standards, *per se*, adopted by these agencies are those recommended by authoritative groups established for this purpose, such as the American Conference of Governmental Industrial Hygienists (ACGIH), United States of America Standards Institute, and the Advisory Center on Toxicology of the National Research Council. Thus the standards in use have a reasonable degree of uniformity among the respective jurisdictional agencies.

THRESHOLD LIMIT VALUES FOR ASBESTOS

The first threshold limit value established by the ACGIH for asbestos in the United States was 5.0 million particles per cubic foot (mppcf) of air. Samples were collected by the impinger method and counted by the light-field counting technique. The value was based primarily on the report of Dreessen *et al.*[1] and was established for the prevention of asbestosis. All particulates were counted, both fibrous and nonfibrous, and the value did not necessarily relate to asbestos fibers as the significant agent for control. In fact, the nonfibrous particulates were several-fold greater than the fibrous particulates. The value as an index of exposure was only relative, since the ratio of nonfibrous to fibrous particulates fluctuates greatly, depending on the source and grades of fibers as well as processing techniques.

The fact that asbestosis was still in evidence in the 1960's and the increasing concern with malignancies as a risk of the asbestos worker, caused a renewal of interest in the asbestos standard. That there was excessive disease in asbestos workers was not surprising as data had revealed that exposures before the 1940's often greatly exceeded the 5.0 mppcf value and were generally over that value. Also, associated exposures to other substances that may have been significant were not defined. In addition, the long latent period of 25 years and longer from initial exposure to the onset of disease is significant in evaluating asbestos exposures.

Another factor influencing the need for taking a new look at the asbestos standard was the development of a method by the British Asbestosis Research Council for collecting and counting asbestos fibers and their observation that this was a much better index of exposure to asbestos than the measurement of total particulates. This observation was confirmed by the asbestos study being conducted by the Bureau of Occupational Safety and Health, Consumer Protection and Environmental Health Service, Department of Health, Education and Welfare.

The Threshold Limit Value Committee, ACGIH, in 1968, reviewed the background of the asbestos threshold limit value of 5.0 mppcf along with data that had emerged since the study of Dreessen *et al.*[1] and decided the asbestos value should be revised. To this end, the Industrial Hygiene Foundation of America, Incorporated, sponsored a meeting at the Kettering Laboratory, University of Cincinnati, in cooperation with the Threshold Limit Committee. Among those who submitted pertinent and relevant data and opinions was Dr. S. A. Roach. He discussed the hygienic standards for chrysotile asbestos dust developed by the Committee on Hygienic Standards of the British Occupational Hygiene Society.

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After considering emerging data on the biological effects of asbestos, the Threshold Limit Value Committee, ACGIH, recommended a change in the TLV for asbestos, which was incorporated in the report of the Committee under the Notice of Intended Changes. The Committee report was approved by the Conference. The revised TLV, approved by the Conference establishes a time-weighted average fiber count limit of 12 fibers per ml. greater than 5 microns in length, or a limit of 2 mppcf for total particulates. As explained in the Documentation of Threshold Limit Values[2];

'The intent of the revised limit is to reduce to an insignificant risk, the occurrence of asbestos disease among those exposed for 30 years to all forms of asbestos.'

Current data are too meager and are too much based on subjective judgments to permit their use as a basis for a permanent threshold limit value for asbestos. For example, epidemiologic data are lacking on the effects of exposure to asbestos of various types for prolonged periods of 25 years and over at the levels of the revised values. In addition, many changes have taken place since the 1940's in both the physical nature of the fibers used and in the processing and consumer-use techniques. Patterns have changed, not only in decreased hours of work per week, but also in the decreased years of work by employees in the industry.

Research has raised pertinent questions about the role of the asbestos fiber in causing disease. It is now known that there are associated exposures to metals in the processing of asbestos, such as nickel, chromium, cobalt, manganese and iron, arising from the asbestos ore or from abrasion in its processing that must be considered.[3] Cigarette smoking appears to play an important role, especially in the relation of asbestos exposure to lung cancer.[4] Thus the biological effects of the asbestos fiber *per se* and its role as a carrier of other toxic agents to vulnerable tissue sites, which permits long periods of contact, are yet to be clarified.

Even though the interrelation of these many factors, as they relate to the health problems of asbestos workers, has not been established, the Threshold Limit Value Committee, ACGIH, stated that there was sufficient evidence to justify reducing the value for asbestos in accordance with their recommendations. The Committee states in its document of justification:[2]

'There is still asbestos disease appearing in industry. It is not known to what extent this represents a reservoir effect of past exposures, or if the 5 mppcf level is still contributing to the disease incidence. For this reason the 5 mppcf is recommended as a ceiling value (2 mppcf as a time-weighted average) until a more definite value can be established based on medical findings.'

It is generally accepted that the revised limit adopted by the ACGIH and published in Threshold Limit Values of Airborne Contaminants for 1968,[1] listed under Notice of Intended Changes, will take precedence and be uniformly applied in the United States.

Dust Sampling Instrumentation for Asbestos

Any threshold limit value or standard, to be effective, must be used with uniform and equivalent methods and procedures of sample collection and analysis.

Obviously, the fiber is a better index of exposure to asbestos than total particulates, which include both nonfibrous and fibrous materials. For this reason, a threshold limit value based on fiber count is recommended when asbestos is a significant exposure. A value based on a limited portion of the spectrum of the respirable fibers present, such as a limit on fibers longer than 5 microns, serves as an index to control the overall exposure and is predicted on the basis that a reasonable ratio persists in the fibers above and under 5 microns in length and their associated diameters. For practical reasons, the limit must be expressed in terms of fibers visible by optical microscopy, though it is recognized that many fiber diameters are below the limit of visibility of the optical systems. Again, a reasonable ratio must be assumed. Additional research needs to be done to further define these relations, not only with regard to the various grades and processing operations within a single type of asbestos such as chrysotile, but also to the extent that these ratios hold in other forms of asbestos such as amosite and crocidolite. In applying the threshold limit value of 12 fibers per ml. greater than 5 microns in length, the Conference stipulated that the air sample be collected on a membrane fiber and that the counting procedure employ phase contrast illumination at 430 × magnification.[4]

The ACGIH recognized the need, at least during the transitional stage and the tentative period of the revised limit for asbestos, to also express a limit value in terms of total particulates. To keep exposures under the 5 mppcf limit, it was deemed advisable to express the limit in terms of a time-weighted

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average. The Bureau of Occupational Safety and Health's asbestos study in the asbestos textile industry in the United States, showed that this was equivalent to around 2 mppcf where only 5% of the values would exceed the 5 mppcf limit. In applying the 2 mppcf time-weighted average limit, the impinger is used as the sampling instrument and counting is done by the light-field technique at a 100 × magnification.

Judgment factors are involved in choosing whether the fiber count or total particulates count is to be used in assessing exposures where asbestos is encountered. Where asbestos is a significant component, the fiber limit is the one recommended. Even where asbestos is only a minor component or exists in trace amounts, if no other highly biologically reactive material is present, fiber count is recommended. Otherwise, applying the particulate count limit may lead to the use of levels more restrictive than necessary.

It is believed that the application of the revised threshold limits of the ACGIH for asbestos will accomplish much in reducing to an insignificant risk the occurrence of disease among workers exposed to asbestos and will permit the safe use of this vital natural resource in modern technology. The limit will be reviewed periodically in the light of emerging research data and will be revised or refined as indicated. Further research defining the importance of metals and other materials associated with asbestos fibers, smoking habits, etc., quite possibly will influence the nature and parameter of standards relating to asbestos exposures.

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