LEAD (as Pb)

$0.15\ mg/m^3$

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Despite the tremendous importance of lead as an occupational hazard, only a handful of papers in the voluminous literature on lead poisoning present meaningful data relating to the threshold limit value. The chief reason for this situation is probably the fact that most authorities rely primarily, if not exclusively, on other tests for estimation of the degree of lead hazard. Urinary and blood leads, urinary coproporphyrin and delta aminolevulinic acid, as well as blood examination for stippled cells and other abnormalities, are among the preferred procedures.

At one time a limit of $0.5\ mg/m^3$ was allegedly used (1), although the source of this value remains obscure. In 1933 Russell et al.(2), following a U.S. Public Health Service survey of a lead storage battery plant proposed a limit of $0.15\ mg/m^3$ for lead dust and fume in this industry. Eight years later Dreessen et al. (3) published results of a follow-up study and considered that their findings confirmed this value. In 1943 Kehoe and other members of the Committee on Lead Poisoning of the American Public Health Association recommended $0.15\ mg/m^3$ as a time-weighted average limit (4).

A number of investigators found the $0.15\ mg/m^3$ value difficult to achieve in many industries, and observation of workers, combined with lead urinalysis and similar studies convinced them that this limit was unnecessarily stringent. Winn and Shroyer (5) concluded that maintenance of the average concentration of lead dust and fume at or below $0.5\ mg/m^3$, combined with a medical program, would assure adequate control. Weber (6) considered the $0.15\ mg/m^3$ too low, but stipulated that $0.3\ mg/m^3$ should not be exceeded (as time-weighted average). He found that an atmospheric concentration of $0.43\ mg/m^3$ corresponded to 0.20 mg/ liter of urine, a level considered by some investigators to represent the upper

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limit of safety. Elkins (7) assembled the data available on lead in air and lead in urine and concluded that a urinary lead concentration of 0.20 mg/liter would, on the average, correspond to an air-lead value of 0.20 mg/m^3.

On the basis of these reports and unpublished data from several sources, the TLV for lead was increased from 0.15 to 0.20 mg/m^3 in 1957. Some authorities continued to use the previous limit, however (8). Schrenk (1) implied that the 0.15 mg/m^3 value was to be preferred. The preponderance of American opinion, however, seems to be that the 0.2 mg/m^3 limit is adequate to prevent episodes of lead intoxication. Thus Kehoe (9), in a discussion of threshold limits for lead, stated that: "Evidence of the validity of the standard (0.2 mg/m^3) has been provided elsewhere and need not be enlarged upon here." He went on to warn that this value is adequate only if ingestion of lead is prevented. Johnstone and Miller (10) refer to the 0.2 mg/m^3 limit as generally accepted.

More recent comparisons of atmospheric and urinary lead concentrations have led to conflicting results. Berg and Zenz (11), in a foundry study, found that air-lead concentrations between 0.14 and 0.18 mg/m^3 resulted in urinary lead values below 0.15 mg/liter; 0.28 mg/m^3 was associated with 0.17 mg/liter of urine. Williams and associates (12), using personal sampling devices for measuring lead in air, reported that 0.20 mg/m^3 resulted in an average blood lead level of 70 μg/100 gm, a urinary lead of 0.143 mg/liter increased urinary coproporphyrin and an aminolevulinic acid (ALA) concentration of 18 mg/liter of urine. An atmospheric lead concentration of 0.15 mg/m^3 related to 60 μg/100 gm blood, 0.118 mg/liter of urine, a lower coproporphyrin, and an ALA level of 14 mg/liter of urine. Statistical analysis of their findings led to the conclusion that 0.15 mg/m^3 is a safe level, while 0.2 mg/m^3 is not.

Tsuchiya and Harashima (13) concluded that for a 48- to 60-hour work week, an average air-lead concentration of 0.10 mg/m^3 would lead to an average urinary lead level of 0.15 mg/liter; and 0.12 mg/m^3 to 0.20 mg/liter. Concentrations of 0.12 to 0.14 mg/m^3 resulted in increased urinary coproporphyrin, some stippling of blood cells and anemia.

Most extensive lead exposure studies have involved lead oxide dust or the fume of metallic lead. Some reports have indicated that the dusts of certain insoluble lead compounds, such as the sulfide (14) and chromate, were less hazardous than more soluble forms of lead. Thus Harrold and associated (15, 16) studied a group of painters exposed to mists of lead chromate in concentrations averaging between 1.2 and 12 mg of lead per cubic meter of air, and found little evidence of lead absorption or intoxication. They also suggested that lead titanate would present relatively little hazard, due to its very low solubility.

On the other hand, Hartogenesis and Zielhuis (17) found blood changes in workers exposed to lead chromate dust at levels above 0.2 mg/m^3 (as lead) and doubtful changes between 0.1 and 0.2 mg/m^3. They consider that the TLV for lead chromate should be the same as that for other inorganic lead compounds.

Curiously there is evidence that lead fume is less harmful than equal amounts of the dust of relatively soluble lead compounds (18). This is presumed to be due to a lesser retention of the extremely fine particles present in the fume.

The International Subcommittee for Occupational Health of the Permanent Commission and International Association of Occupational Health, at a meeting in Amsterdam in November 1968, recommended a limit of 0.15 mg/m^3 for a 40-hour week. This conclusion represented the concensus of 20 experts from 12 nations (19, 20).

Currently, the intake of lead from urban atmospheres has reached a point where it should be considered in relation to lead intake from workplaces. The average lead exposure in Los Angeles basin in 1969 was approximately 3.6 $\mu g/m^3$. In 1970, the California Department of Public Health recommended an ambient air standard of 1.5 $\mu g/m^3$ averaged over 30 days for particulate lead (21) based on the evidence that levels greater than 2 $\mu g/m^3$ may be associated with increased body burden of lead. In part, because the contribution to body burden from urban air could amount to from 2 to 5% of that from workplace exposure, and in part, because the TLV of 0.2 mg/m^3 provides little or no margin of safety for some workers, a TLV of 0.15 mg/m^3 is recommended.

Other recommendations.

The American National Standard Institute's Z-37 Committee established 0.20 mg/m^3 as its acceptable concentration for lead in 1969. Smyth (1956) suggested that even the 0.15 mg/m^3 value was not low enough to prevent mild intoxication. The Soviet limit (1966) is 0.01 mg/m^3. According to Teisinger et al. (22) and Zielhuis (19) the limits in other countries are as follows: East and West Germany, Holland, 0.2 mg/m^3; Great Britain and Jugoslavia, 0.15 mg/m^3; Czechoslovakia, Poland and Japan, 0.05 mg/m^3; Hungary, 0.02 mg/m^3.

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