WELDING FUMES

*N.O.C.**

TLV-TWA, 5 mg/m³, Total particulate**

This TLV refers only to manual metal arc or oxy-acetylene welding of iron, mild steel or aluminum. In electric or oxy-gas welding or iron or sheet, galvanized iron or aluminum, the chief components of the fume are ordinarily oxides of iron, zinc or aluminum. Other fumes,[1] as well as toxic gases,[2-5] may be present in significant amounts, however. Manganese, silicate and organic binders are commonly present in the coatings of welding rods for ferrous metals; fluoride in those for aluminum. Elements such as arsenic and copper are sometimes found. Many aluminum rods contain appreciable quantities of silicon and some have traces of beryllium. In shielded arc welding, ozone is often formed, and carbon monoxide has been reported when CO_2 was utilized as a shield gas.[6,7]

In welding mild steel the fume may consist of metallic oxides from the metal being welded and from the rod itself and its coating. Numerous other substances are frequently present. These may include as many as 18 different substances contributed by the fluxes including manganese, silica, titanium, and fluoride, sodium and potassium silicates. In a study of the effects of welding fume in the rat Hewitt and Hicks,[8] using a rutile iron rod with a coating containing limestone, manganese dioxide, kaolin and cellulose powder bound by sodium and potassium silicates, found that the welding fume contained decomposition products of both the welding rod and the work piece and some of the elements of the rod coating.

In one study of welding fume conducted by Michigan's Environmental and Occupational Health Services Administration,[9] only an average of 47.76% of the fume was found to be Fe_2O_3. Welding types considered were manual metal arc, semi-automatic, CO_2 wire welding, MIG, and butt. The balance of the fume was considered to be contributed by the rod coatings, other metal oxides, such as copper on coated MIG wire.

Because of the additional hazard created by toxic gases and small amounts of fumes of more toxic elements,[10] the total fume concentration, when welding iron, mild steel or aluminum, should not exceed 5 mg/m³ in the breathing zone of the welder or others in the area.

The fumes from *stainless steel, cadmium or lead coated steel, and other metals such as copper, nickel and chrome are considerably more toxic and concentration should generally be kept at a lower level, depending on the TLVs of the metal involved.* In addition, in the shielded-arc welding of aluminum, relatively large amounts of ozone may be generated and the concentration of this gas may largely determine the health hazard.

Studies conducted by three different investigators have indicated that there is a marked difference in the concentration of contaminants when simultaneous samples are obtained inside and outside the welding helmet. Johnson[11] concluded that samples taken outside the helmet were considerably higher than those within. Alpaugh *et al*,[12] in their studies, made the following conclusions: 1) concentrations of particulate, i.e., iron oxide, outside the helmet were erratic; and 2) measurements within the helmet were considerably less variable, concentrations of NO_2 were less under the helmet. In respect to ozone they concluded that the helmet offered enough protection to significantly reduce concentrations. Van Sandt and Sharenbroch[13] describe a modified welding helmet for sampling fume and gases such as carbon monoxide, nitrogen dioxide and ozone. A modified helmet for inside sampling has also been described by Johnson.[11] Recent investigations of welding fume have been conducted by sampling within the conventional welding helmet.[14-16]

In view of the above, it is the intent of the Committee that the limit of 5 mg/m³ be applied to samples obtained *inside* the welding helmet.

* Not otherwise classified.

** Retention of the adopted TWA proposed in 1985

References

1. **Vorpahl, K.W. et al:** *Am Ind. Hyg. Assoc. J. 37*:566 (1976).
2. **Ferry J.J. and G.B. Ginther:** *Am. Ind Hyg Assoc Q. 13*:196 (1952)
3. **Ferry, J.J.:** *Ibid. 15*.73 (1954)
4. **Silverman, L.:** *Ibid 17*:333 (1956).
5. **Homer, F. et al:** *Ibid. 18*.19 (1957).
6. *Engineering Control of Welding Fumes.* NIOSH Research Dept., Div. Laboratories and Criteria Development, Cincinnati, OH.
7. *The Welding Environment,* Sept. 4, 1974. The American Welding Society, 2501 Northwest 7th Street, Miami, FL 33125 (1973).
8. **Hewitt, P.J. and R. Hicks:** *Ann. Occup. Hyg. 16* (1973).
9. Unpublished data submitted to the TLV Committee (1983).
10. **Hewitt, P.J. and R. Hicks:** *Ann. Occup. Hyg. Assoc. J. 16*:213-221 (1973)
11. **Johnson, W.S.:** *Am. Ind. Hyg. Assoc J. 20*:194 (1959).
12. **Alpaugh, E.L. et al:** *Ibid. 29*:551 (1968).
13. **Van Şandt, W. and I. Sharenbroch:** *Ibid. 33*:435 (1972).
14. **Ulvarson:** *Scand. J Work Environ. Health 7*:2 (1981).
15. **Vorpahl, K.W.:** *Am. Ind. Hyg Assoc. J. 37* (1976).
16. **Goller, J.W. and N.W. Paik:** *Am Ind Hyg. J. 46*(2):89-93 (1985).