**Manganese OELs**

One of the most critical size-differentiations in welding fume exposure relates to manganese in which the ACGIH has published a TWA of 0.02 mg/m³ for respirable-sized particles. This TWA is typically applied to the smallest manganese particles associated with the generation of fume created during welding. The TWA of 0.1 mg/m³ for inhalable sized particles can more accurately estimate the total size-range of manganese generated during welding. It is common for welding operations to include grinding tasks which often makes the interpretation of results difficult.

**Statement of Purpose**

Compare manganese exposures in various welding operations using total, respirable, and inhalable sampling methodologies. Manganese was chosen due to the prevalence of manganese in welding. Manganese is included on the list of priority toxicology contaminants determined by the ACGIH. Currently, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) for manganese are 0.02 mg/m³ for respirable-sized particles and 0.1 mg/m³ for inhalable-sized particles.

**Why**

Occupational exposure limits (OELs), specifically many TLVs, are now targeting both respirable and inhalable fractions along with total workplace exposures. The National Institute for Occupational Safety and Health (NIOSH) Welding and Manganese, 2008 states that “current focus is on the fraction of the airborne particulate that is less than 10 µm in diameter and small enough to penetrate the pulmonary region (median particle size of 3 to 4 µm). Inhalable particulates is defined as the fraction of total workplace aerosol actually entering the respiratory tract (median cut point of 15 µm).”

**Manganese Toxicology**

The ACGIH TLV for manganese is based upon current toxicological studies which indicate potential neurological system impairment that may include changes in mood and short-term memory, altered reaction time, and reduced hand-eye coordination after prolonged exposure. NIOSH Welding and Manganese, 2008 states, “A TLV-TWA of 0.02 mg Mn/m³, respirable particulate matter is recommended for manganese and its inorganics compounds to reduce the potential for neurological, auditory, neurophysiological and neuropsychological effects in exposed workers.”

**Travellers Study Methods**

Size-selective samples were collected during welding only, and with grinding with grinding operations at various locations throughout the United States in 2017 and 2020. Multiple samples (2 to 3) were taken on individual welders when possible to gain side-by-side size-selective data for the same true source. A variety of sampling devices were used including closed face cassettes, cyclones, PPIs, DRSs, and IOM samplers. Refer to Air Sampling Methodology for details. Samplers were positioned on the collars of the welders, near or inside the welding helmets to gain information on welding fume exposures. The objective was to place the samplers within the breathing zone of the welder thereby gaining the most accurate respirable size information.

Samples were collected for durations up to 480 minutes for comparison to eight-hour time-weighted average OELs.

**Results**

From our collection and analysis of 122 welding operations samples, we found that when using the Respirable sampling methodology 37 percent (41) of samples exceeded the respirable ACGIH Respirable Mn TLV of 0.02 mg/m³. When using Total sampling methodology, 70% of samples exceeded the respirable TWA of 0.02 mg/m³. When comparing side-by-side results using Total and Respirable sampling methodologies, the Respirable results also exceeded the TWA. When comparing side-by-side results using Total and Respirable sampling methodologies, the Respirable results exceeded the ACGIH TWA for respirable manganese of 0.02 mg/m³, between the Respirable TWA and Inhalable TWA of 0.1 mg/m³, and above the inhalable TWA are displayed. Results using the Total methodology may overestimate the exposures as exceeding the respirable OELs. The Inhalable results are inconclusive due to the limited sample size.

**Conclusions**

Using three size-selective sampling methodologies (Total, Respirable and Inhalable) for welding fume exposures, 92% of the sample results were greater than the ACGIH TWA for respirable manganese of 0.02 mg/m³. From our collection of 122 samples, we found that when using the Respirable sampling methodology, 57% of samples exceeded the Respirable TWA. When using Total sampling methodology, 70% of samples exceeded the Respirable TWA. When comparing side-by-side results using Total and Respirable sampling methodologies, the Respirable results exceeded the ACGIH TWA for respirable manganese of 0.02 mg/m³, between the Respirable TWA and Inhalable TWA of 0.1 mg/m³.

The inhalable method results are inconclusive due to the limited sample size. The information gained through this study suggests that using Total sampling methods for welding fume exposure may be a reasonably conservative approach for comparison with size-selective OELs.

**Future Studies**

Conduct studies that compare size-selective sampling results for welding only or welding with grinding combinations to better understand the contribution of fume versus grinding particulates to the total concentration of airborne manganese.

Conduct studies with larger side-by-side sample sizes, with emphasis on Respirable and Inhalable sampling methods for comparison with current ACGIH OELs for manganese.

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**References**


NIOSH Method 7603, Elements by ICP (Plasma-Inductive-Discharge) As each.

NIOSH Welding and manganese, http://www.cdc.gov/niosh/topics/welding/