Controlling Exposure to Manganese in Welding Fume

White Paper

OVERVIEW

Arc welding fume contains very small particles from the consumables, base metal and base metal coating. The substances in the fume particles vary depending upon the constituents of the electrode and the chemistry of the base metal being welded, including any coatings, paint or plating. The most common compounds in arc welding fume when welding on mild or carbon steel are complex oxides of iron, silicon and manganese, although many other compounds may also be in welding fume. Welders who are overexposed to substances in welding fume may potentially be at risk for various short-term (acute) or long-term (chronic) health issues.

The two most common US exposure limits are established by OSHA in the form of Permissible Exposure Limits (PEL) and by the American Conference of Governmental Industrial Hygienists (ACGIH) in the form of Threshold Limit Values (TLV). Your employer is required by OSHA to keep exposures below the PEL and may choose voluntarily to keep exposures below the TLV, if it's lower than the PEL.

This white paper will focus on what employers and welders can do to help control exposure levels to welding fumes, and highlight manganese in particular because in 2013 the ACGIH adopted a new, lower TLV for manganese.

The new TLV for manganese

The change by the ACGIH was published in the 2013 Edition of its TLVs and Biological Exposure Indices (BEIs) publication. The new TLV of 0.02 mg/m3 for respirable manganese, which is applicable to welding fumes, represents a ten-fold reduction from the previous 0.2 mg/m3 TLV. The new TLV for manganese includes a 0.1 mg/m3 limit for inhalable manganese particulate.

The Permissible Exposure Limit (PEL) of 5.0 mg/m3, ceiling, remains the US exposure limit for manganese enforced by OSHA. Lincoln Electric continues to recommend that exposures in the workplace be controlled to the TLV or the applicable regulatory exposure limit standard (in the US, the PEL), whichever is the more conservative.

Methods for controlling exposure

To thoroughly explore your welding fume control options, you should identify and assess your actual needs and operating conditions. Start by having an industrial hygienist take and analyze the appropriate number of samples of the air in the workers' breathing zone to give you a baseline relative to any exposure level. This is particularly important if you are welding with stainless or hardfacing products, which contain greater amounts of substances that have low exposure limits, for example, manganese and chromium. Be sure to check the safety data sheet for the products you use. It's important to not only evaluate the exposure to the welder, but also material handlers, stock keepers and others working in the facility. Fumes are not exclusive to the welder's work area as they may migrate to areas where other workers may be exposed. When measuring to a TLV limit, the measurements should be averaged throughout the worker's shift, which is typically eight hours. Where exposures are assessed to be over the TLV, many approaches can be considered to reduce exposures to acceptable levels.

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Engineering controls

If there is any potential employee exposure to manganese or other compounds above their respective PELs, OSHA requires that engineering and work practice controls be installed first. The various types of control options for arc welding fumes are described below. The control options listed below should be used before considering a respirator. The use of ventilation/exhaust is often the most feasible method for controlling exposures. Respirators can further reduce exposures and can only do so to those who wear them.

1. Substitution – Review your current welding process, consumable, gas, welding procedure and equipment technology to determine if it's feasible and practical to replace it to generate less welding fume.

2. Isolation – Review your welding operation to determine if it's feasible and practical to isolate and separate the operation by moving it to a regulated area, by automating/ventilating the welding process and/or placing a barrier between the worker(s) and the source.

3. Ventilation/Exhaust – Review the welding fume path to determine if it's feasible and practical to control the path between the source and the worker through source, local and/or general shop ventilation/ exhuast equipment.

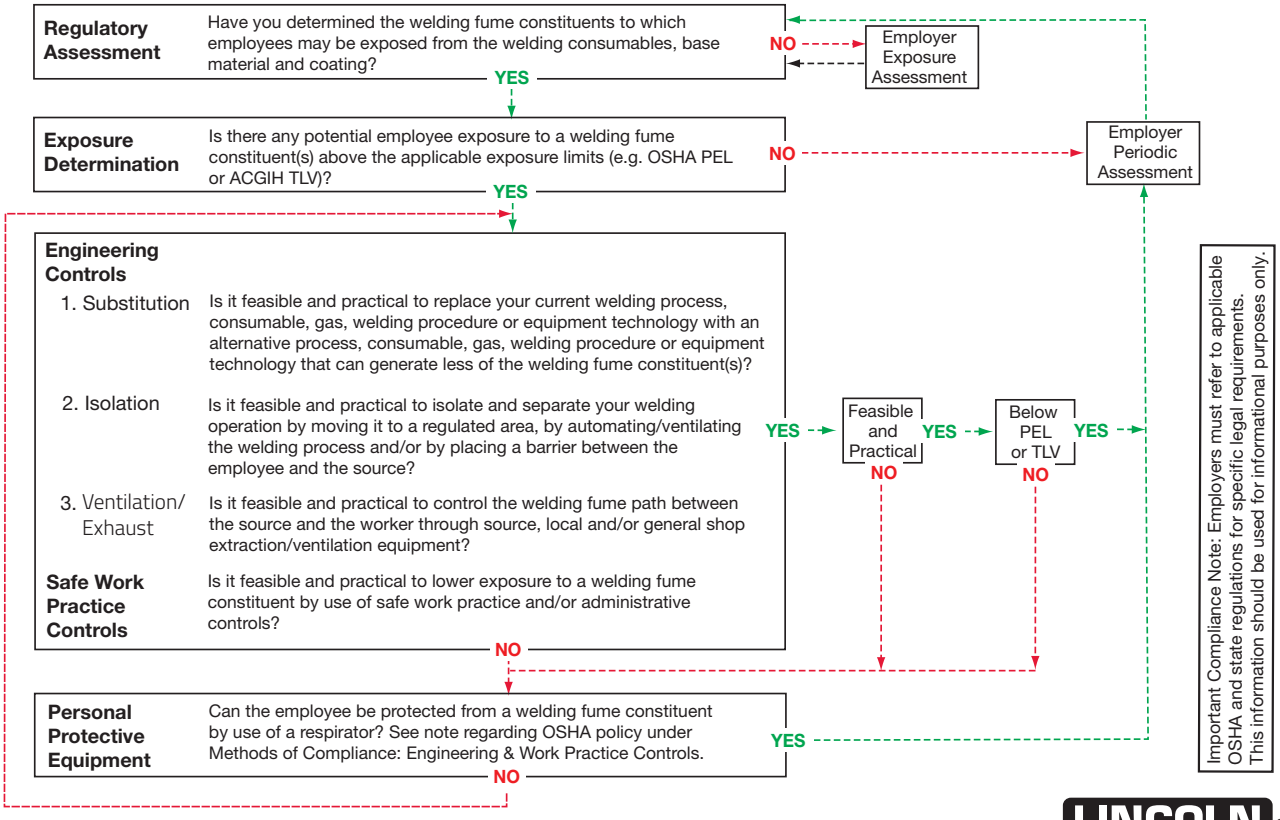
Work practice controls

This involves adjustments in the way a task is performed, as well as the periodic inspection and maintenance of engineering control equipment. Work practice controls should complement engineering controls in providing employee protection. These practices include safe welding habits (keeping your head out of the fumes, keeping fumes and gases away from your breathing zone and proper training and use of fume extraction equipment) as well as housekeeping, maintenance and general administrative procedures, such as scheduling operations/tasks at a time to minimize potential exposure.

Personal Protective Equipment (PPE)

After you have considered and implemented the options listed above that are best suited to your workplace, conduct additional exposure monitoring and compare the results with the exposure limit you are trying to achieve. If adequate ventilation is not feasible, it may be necessary to protect employees with the use of personal protective equipment (PPE), such as a respirator.

Suggested Welding Fume Methodology



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Suggested Welding Fume Methodology, cont'd.
Many Lincoln Electric material safety data sheets (MSDS) have a Maximum Fume Exposure™ guideline number and the substance upon which it is determined. The purpose of this guideline is to provide the industrial hygienist with insight into which material is likely to be the principal chemical of hygienic significance detected during fume monitoring and the approximate total fume exposure at which the recommended exposure limit is reached. It's provided as a tool to be used for helping to control the exposure levels in the workplace. The lower the fume guideline number, the better the engineering controls must be to control the exposure.

The Lincoln Electric Maximum Fume Exposure guideline number does not consider any paint or plating on the work because that information is only available when the specific application is known. It is best to remove paint, plating or other contaminants from the base metal before welding, if that is possible. If the base metal cannot be cleaned before welding, the composition of the coating should be evaluated. In addition, the fumes should be collected and analyzed to determine what compounds from the surface preparation are in the fume, and to measure the amount of exposure to those compounds.

Frequently asked questions

Why did the American Conference of Governmental Industrial Hygienists (ACGIH) decide to make this change which lowers the TLV for respirable and inhalable manganese?

The ACGIH's change in the manganese particulate TLVs appears to be based on reports of pre-clinical neurobehavioral and neuropsychological changes in workers exposed to chronic low levels of manganese. Some reviewers have pointed out methodological flaws in these studies and that they have demonstrated notably inconsistent findings after several decades of research. Nevertheless, the ACGIH decided to move forward with the reduction in its TLV for manganese.

Does the new Threshold Limit Value (TLV) distinguish manganese in welding fume from other types of manganese?

No, the new TLV does not distinguish between the form of manganese found in welding fume and other forms of manganese.

What is the ACGIH and is it part of the government?

The ACGIH is a non-profit, non-governmental corporation dedicated to promoting worker health and reducing exposures to environmental health stressors in the workplace. Many government employed industrial hygienists are members in the ACGIH.

What exactly is the TLV?

According to the ACGIH, its TLVs represent conditions under which nearly every worker repeatedly can be exposed without adverse health effects. They also caution that TLVs are not intended to represent fine lines between safe and unsafe exposure levels. The ACGIH acknowledges that its TLVs are not consensus standards and do not take into account economic or technical feasibility issues.

Is the TLV a legal or regulatory exposure limit?

No, the TLV is not a regulatory limit such as OSHA's Permissible Exposure Limit (PEL). Some governmental entities utilize its TLVs in adopting standards. The Permissible Exposure Limit (PEL) of 5.0 mg/m3, ceiling, remains the US exposure limit for manganese enforced by OSHA.

Should we follow the new TLV – and if so – why?

The ACGIH is a long-standing body that is comprised of professional industrial hygienists that review applicable health studies, monitor reports related to the health effects and risks of exposure to compounds encountered in the workplace, and advise regarding safe exposure levels. Lincoln Electric continues to recommend that exposures in the workplace be controlled to the TLV or the applicable regulatory exposure limit standard, whichever is the more conservative.

Do countries outside the U.S. adopt the ACGIH TLV as their legal regulatory exposure limit?

In short, yes. For example, many countries, and the State of California, adopt exposure limits that are equal to the ACGIH TLV. Countries with exposure limit standards equivalent to TLVs include, most Canadian provinces, many European countries, Japan, Malaysia, Mexico and much of South America. Some of these will undoubtedly adopt the new TLV for manganese.

How do I know if a welder's exposure is below the TLV?

As an initial observation, the welder's breathing zone and general area should be clear of any visible fume or particulate. The most effective means for confirming that exposures are below the TLV is to have a qualified individual such as a professional industrial hygienist conduct an exposure assessment in your workplace.

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If any exposures are over the TLV, how can they be reduced to acceptable levels?

Many approaches should be considered to control exposure to welding fume constituents for the workplace in order to meet the new TLV limits for manganese. These might include: a change in the welding process or procedure to reduce the rate of fume production where consistent with application requirements, the use of engineering controls such as local exhaust ventilation, work practice improvements and work process design changes. More than one of these may be implemented in most welding applications. Should these or other options prove infeasible or do not adequately control the exposure, respiratory protection may also be necessary, such as the use of positive pressure options like supplied-air and Powered Air Purifying (PAPR) systems.

CONCLUSION

The same solution(s) will not work for everyone because many factors can affect exposure levels; however, you should confirm that welding fume exposures in your work area are well controlled by providing enough ventilation and/or exhaust to keep the worker's exposure to hazardous substances in welding fumes and gases below the applicable exposure level for those substances. If you need further assistance or more information about the new TLV for manganese, direct inquiries can be addressed to MnTLV@lincolnelectric.com or call Lincoln Electric at 888.355.3213 or visit www.lincolnelectric.com.

ABOUT LINCOLN ELECTRIC

Lincoln Electric is the world leader in the design, development and manufacture of arc welding products, robotic arc welding systems, plasma and oxyfuel cutting equipment and has a leading global position in the brazing and soldering alloys market. Headquartered in Cleveland, Ohio, Lincoln has 45 manufacturing locations, including operations and joint ventures in 19 countries and a worldwide network of distributors and sales offices covering more than 160 countries. For more information about Lincoln Electric and its products and services, visit www.lincolnelectric.com.

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