For trade journal "ISHN". Due March 10, 2009
Title: Hot Work Health Hazards in Construction
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One of the provisions in the recently passed economic stimulus package is money for infrastructure work. Whether it is new construction, renovation or demolition of existing structures, "hot work" (e.g. welding, brazing, flame cutting or other fire/spark producing operations), and the health hazards they can generate, will likely be a part of most projects. Engineering controls, when feasible, are preferred as a control method for safety and health hazards. However, due to the nature of construction work, personal protective equipment is the control method used most often. Most hot work will require, at a minimum, eye protection. Occupational Safety and Health Administration (OSHA) regulations in 29 CFR 1910.133 and 29 CFR 1926.102 detail task specific eye protection for general industry and construction respectively. Depending on the base metals, the type of hot work, and any protective coatings in place, exposures to particles, gases and vapors may also require the use of respiratory protection. 29 CFR 1910.134 covers regulations for the proper use of respiratory protection for both general and construction industry.

Adding to the complexity is that many times this work is performed in enclosed or confined spaces. OSHA's regulation 29 CFR 1926.21 defines a construction confined or enclosed space as: "any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere." This may include "storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines and open top spaces more than 4 feet in depth such as pits, tubs, vaults and vessels."

While OSHA's construction standards do not currently have an overall construction permit required confined space entry regulation similar to general industry, 29 CFR 1926 Subpart C – General Safety and Health Provisions and Subpart J Welding and Cutting do have confined space requirements that contractor safety professionals need to be aware of and implement to help ensure both the welders and surrounding workers are protected from these hazards. While the discussion here is limited to hot work, contractors should be aware of other OSHA confined space requirements in 29 CFR 1926 such as Subpart P – Excavation; Subpart S – Underground construction and Subpart V- Power transmission and distribution. Also, some state OSHA plans (e.g. Minnesota) may have general confined space entry regulations that extend to construction.

Health Hazard Assessment

Hot work can generate a variety of health hazards that the welder or surrounding workers may be exposed to. These include heavy metals such as iron oxide from steel, zinc oxide from galvanized steel and hexavalent chromium and nickel from stainless steel. Older

steel structures can still have primers or top coats that contain lead, cadmium or chromium which may become airborne when heated. Other coatings that may appear to be paint, may actually contain polymers such as Teflon. Heating these coatings may release fluorinated compounds such as hydrofluoric acid. Work in a confined or enclosed space with poor ventilation can concentrate these contaminants and increase exposure levels experience by the worker. Contractors engaged in work that requires disturbing of coatings should request that facility owners supply analytical results of any testing of these coatings as part of the bid information package.

Depending on the type of welding, the base metals and shield gas used, gases such as ozone, oxides of nitrogen and carbon monoxide may be generated. Gas Tungsten Arc Welding (GTAW or "TIG") when using argon as a shield gas can generate high levels of ultra violet (UV) radiation. Excessive exposure to UV radiation is a health hazard in itself necessitating eye and skin protection. However, the UV can also react with oxygen in the air to generate significant levels of ozone. In very small confined spaces with poor ventilation, the argon released may also create an oxygen deficient atmosphere. Cutting through coating containing isocyanate binders may generate nitrogen dioxide, carbon monoxide and carbon dioxide.

Air monitoring can help determine worker exposure levels to these contaminants. Monitoring for particulates such as metal fumes requires the samplers be placed on the worker with the samples subsequently sent to a laboratory for analysis. Welding fume monitoring is unique in that the presence of the welding helmet as discussed by Harris (2002) "affects airflow patterns around the face and may deflect some of the contaminant plume away from the breathing zone" and may reduce worker exposure several fold. Because of this, it is common to place the sampler under the welding helmet. Safety professionals may wish to refer to the American Welding Society *Method for Sampling Airborne Particulates Generated by Welding and Allied Processes F1.1 (2006)* for further discussion on location of air monitors for welding fume. For compliance purposes OSHA requires sampling inside the helmet. (OSHA 1995). Be aware however, OSHA has also stated that if the welding helmet is part of a respirator system (i.e. the helmet is simultaneously the respirator headgear) they will sample outside the helmet. This may lead to the awkward situation where a person wearing a powered air purifying respirator (PAPR) augmented weld helmet, with the sample taken outside the helmet, has an exposure assessment over the permissible exposure limit (PEL). Conversely a worker doing the exact same task using a standard welding helmet, with the sample taken inside the helmet, may have an exposure assessment at or below the action level.

Many of the gases mentioned above such as carbon monoxide, nitrogen dioxide, or oxygen levels can be monitored continuously and in real time. Multi-gas meters are available that can monitor for several of these gases simultaneously and alarm when any one of them approaches a user set limit.

Training and Education

Similar to the General Industry standard, OSHA Construction standard 29 CFR1926.21 require training for workers using personal protective equipment and those entering

confined or enclosed spaces. Workers must be trained in the hazards they may encounter, precautions to be taken and how to properly use safety equipment such as respirators or fall protection equipment that may be required.

Worker Exposure Control

When hot work is done in enclosed spaces, Subpart J of 29 CFR 1926 requires mechanical ventilation – either general dilution or local exhaust ventilation be used, if feasible, to control exposures below the PEL. If the hot work includes working on surfaces that have coatings containing toxic materials such as zinc, lead, cadmium, beryllium or chromium OSHA first requires stripping the coating back at least 4 inches from the area where heat will be applied. If the worker exposure still exceeds the PEL, local exhaust ventilation must be utilized if feasible. If after implementing these two controls, worker exposure still exceeds the PEL, workers must use supplied air respirators. (OSHA 1978) All feasible coating removal and ventilation must still continue to be used even if it is determined that supplied air respirators are necessary. Safety professionals must also be aware that several of these metals have additional requirements that may be triggered during hot work (lead – 29CFR 1926.62; cadmium – 29 CFR 1926.1127; chromium – 29 CFR 1926.1126) and that any surrounding workers exposed to the same environment as the welder must be similarly protected.

As mentioned earlier, while engineering controls are preferred, because of the nature of construction, respiratory protection is often the control method that is implemented. Most respirator manufacturers have products specifically designed for welders. There are disposable filtering face piece respirators that are flame resistant that fit under most welding helmets. Powered air purifying respirators (PAPRs) specifically for welding are available that incorporate the welding helmet as part of the respirator headgear. These have multiple advantages including:

- Higher assigned protection factors (APF). Depending on the design of the PAPR headgear, and manufacturer testing, the APF is either 25 or 1000. This is substantially higher than a negative pressure half face piece respirator APF of 10.
- Eliminates the need to wear a half facepiece respirator under the helmet.
- Improved comfort and reduced breathing resistance compared to a negative pressure respirator.
- Elimination of fit-testing. A welding helmet connected to a PAPR is a loose fitting facepiece that is exempt from OSHA fit-test requirements.
- Some welding/respirator headgear can be equipped with auto darkening welding filters which eliminate the need for the welder to raise the weld helmet to see the work when the arc is off. This also eliminates the “head bob” welders use to lower their helmet without using their hands. Eliminating the head bob may reduce the risk of ergonomic injury to the neck.

Conclusion

As work on America’s infrastructure accelerates, hot work on both new and existing structures will increase. Safety professionals need to be aware of the hazards hot work can generate, the applicable regulations and the added hazard that conducting this work in

a confined or enclosed space may create. However, with proper pre-job analysis, worker training and the use of engineering and personal protective controls workers can be safer building and re-building America.

Harris (2002) *Welding Health and Safety – A Field Guide for OEHS Professionals* AIHA Press Fairfax, VA

OSHA (1978) Standards Interpretation 03-08-001 Welding, Cutting or Heating of Metals Coated with Lead Bearing Paint <www.osha.gov>

OSHA (1995) Standards Interpretation 3/22/1995 Sampling for Lead Welding Fume <www.osha.gov>