

### Weld Shop Ventilation

New Flyer Industries Canada ULC

Oct 5, 2017



- REGULATED MANGANESE EXPOSURE LEVELS
  - In 2010 the ACGIH placed manganese on the Notice of Intended Changes (NIC) list.
  - In 2013 the recommended respirable manganese TLV was officially reduced from 0.2 mg/m3 to 0.02 mg/m3, a 90% reduction;
  - Welders and areas previously in compliance were now above the TLV.





 existing wall around weld shop eliminated weld flash in other departments, but fugitive weld fumes migrated over the top of the wall;







- In both Canada and the US, if industrial hygiene testing indicates employees are exposed to chemicals above the regulated values, the hierarchy of control methods are essentially the same:
  - Elimination or substitution of the chemical with a less harmful substance;
  - Engineering controls to eliminate or reduce the exposure below regulated levels;
  - Work Practice controls to eliminate or reduce the exposure below regulated levels;
  - Personal Protective Equipment Respiratory protection for weld fumes is generally the first response to exposure issues and makes sense because it provides immediate employee protection while additional control measures are investigated and implemented. PPE should never be considered the permanent control measure.





- ELIMINATION OR SUBSTITUTION:
  - Low manganese S3 weld wire was extensively tested in Winnipeg with good results for both manganese exposures and product quality.
  - Some S6 weld wires were found to contain more than twice as much manganese as compared to the S3 wire.
  - Limited in-house testing shows a direct correlation between weld wire manganese content and weld fume generation rates. Testing was conducted in the same stations, with the same welders. Personal welding techniques can have a major influence on measured weld fume exposures.
  - The chromium content of stainless and ferritic steels can't be changed so there will always be potential for the generation of carcinogenic hexavalent chromium weld fumes.





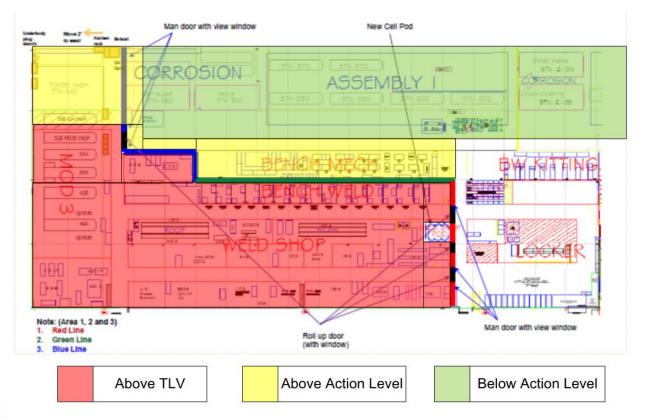
- ENGINEERING CONTROLS
  - The Winnipeg weld shop is in the south west corner of our plant and shared a common ventilation system with the remainder of the plant;
  - Weld fumes were generally in control with limited welding odour beyond the shop. Previous test results never indicated welding impacts beyond the weld shop;
  - Industrial hygiene testing focused on the new manganese exposure levels painted a different picture. Ambient exposure levels exceeded the new criteria up to 150 feet beyond the weld shop and produced measureable levels up to 500 feet away;
  - Our in-house testing using total metals scans appears to indicate that the manganese fraction of the weld fume is more mobile than the remainder of the metals;
  - These results heavily influenced our decision to physically isolate the weld shop from the remainder of the plant;





#### Weld Fume Impact Zones

#### Manganese





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- ENGINEERING CONTROLS (continued)
  - The ventilation system was designed to create a slight negative pressure relative to the remainder of the plant so that no fugitive emissions occur;
  - Eliminating cross drafts (fans) and introducing fresh air at floor level assists the natural convective rise of the weld fumes which generally reduces the ambient concentrations;
  - For a dedicated weld shop 6-10 air changes per hour are required to achieve good ambient air quality levels. General ventilation levels are not likely to significantly impact welder exposures.
  - Work tables and small work stations can generally be designed with fixed extraction systems that effectively control welder exposures.





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# Fresh Air Supply Ducts







#### **Backdraft Work Tables**







- ENGINEERING CONTROLS (continued)
  - Local exhaust ventilation has been proven to reduce employee exposure levels below regulated values;
  - However, constant monitoring is required to ensure the welders are continuously positioning the extractor within 18 inches of their work. Our experience indicates these systems are not practical on large fixtures requiring extensive movement.
  - Welders complain about having to constantly move the exhaust and about the noise generated at the extraction point;





#### Local Exhaust Ventilation

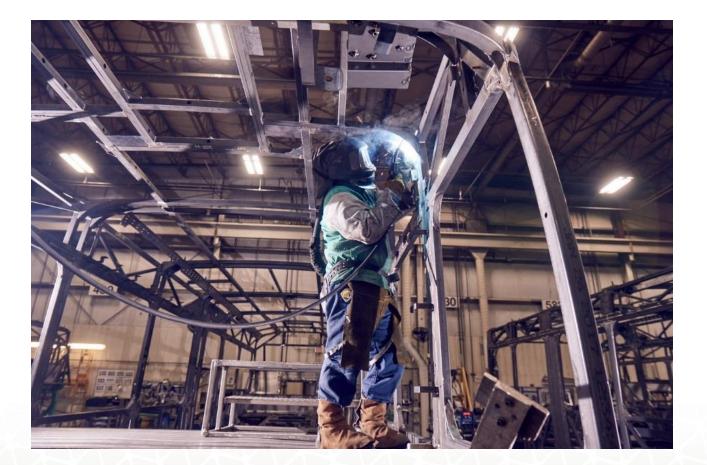




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#### **Restricted Access to Large Weldments**





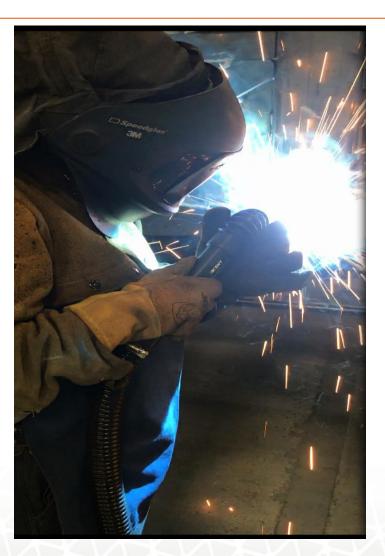


- ENGINEERING CONTROLS (continued)
  - On-Gun extractors can be very effective; depending on the weld position this type of fume control can achieve 40-80% capture rates.
  - The extra bulk of the extraction hose can create some ergonomic issues where welding in multiple planes or tight corners is required;
  - The size and flexibility of on-gun extraction systems has improved significantly in the past couple of years.





#### **On-Gun Weld Fume Extraction**





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- ENGINEERING CONTROLS (continued)  $\succ$ 
  - Pulse Welding Limited Industrial Hygiene testing indicates reduction potential for ٠ heavier gauge welding.
  - Light gauge steel welding yielded highly variable results. ٠





### Constant Voltage vs. Pulse Welding







- WORK PRACTICE CONTROLS:
  - Jig and fixture design can have a direct influence on exposure levels;
  - Positioning the welder above the work definitely increases exposures;
  - Controlled testing indicated that positioning work 4 inches further away reduced exposure levels by 40%; however, working with extended arms is not practical;





#### Fixture Design and Welder Positioning









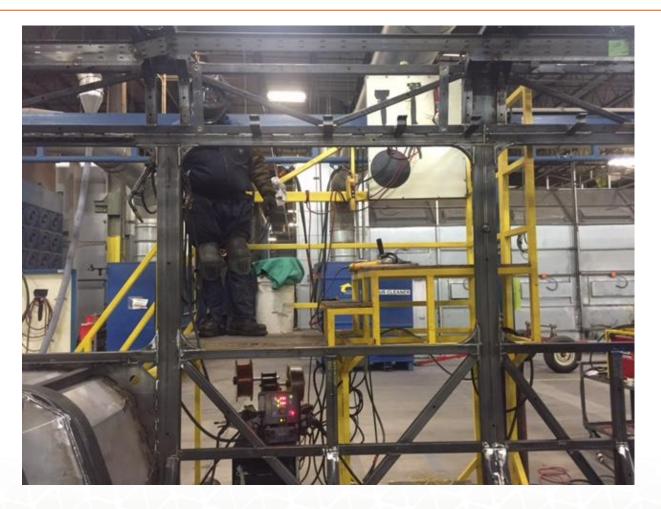
#### Mobile Cart Travels Length of Bus Frame







#### Carts Position Welders at Optimum Levels







- WORK PRACTICE CONTROLS (continued):
  - Fans can help to control individual welder exposures, but generally result in increased ambient weld fume levels;
  - Eliminating cross drafts (fans, open doors, etc.) in conjunction with introducing fresh air at floor level assists the natural convective rise of the weld fumes which generally reduces the ambient concentrations;





- PERSONAL PROTECTIVE EQUIPMENT:
  - Variable ambient conditions can have significant influence on exposure levels;
  - 1/2 face respirators provide a 10x protection factor, but they place a significant heat and respiratory load on the welder.
  - Heavy gauge welding can easily produce manganese exposures >10x criteria;
  - Mandatory respirator use may be the most practical approach to ensure welder protection in all scenarios.





- PERSONAL PROTECTIVE EQUIPMENT:
  - Loose fitting supplied air respirators provide a 25x protection factor and when used in conjunction with Vortex coolers they have been very well received and production levels have been maintained in warm weather;
  - A small percentage of our welders find the cool dry air uncomfortable and we supply those individuals with Vortex heaters;
  - Supplied air respirators require a minimum of 6 cfm and the addition of a Vortex cooler or heater requires an additional 10-15 cfm so make sure your breathable compressed air system has enough capacity.













- PERSONAL PROTECTIVE EQUIPMENT (continued):
  - The use of PAPR or Supplied Air Weld Helmets seems to increase measured welder exposures.
  - Given the increased protection levels, there seems to be a tendency for the welder to encroach on their work without respiratory or eye irritation;
  - When dealing with carcinogens such as the hexavalent chromium associated with stainless and ferritic steel welding, respiratory protection should be mandatory.





- CONCLUSIONS:
  - Work station design and process controls can greatly influence welder exposure ٠ levels and ambient conditions;
  - Cross drafts and the use of fans in the weld shop typically results in increased ٠ ambient fume concentrations;
  - Large complex weldments such as bus frames present significant challenges for any ٠ type of engineering controls;
  - Supplied air weld helmets with Vortex coolers are generally very well accepted with ٠ complaints limited to mobility in large work stations;





#### Built to Rely On."

