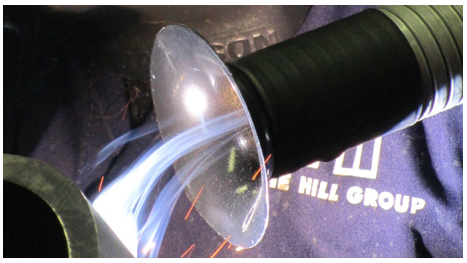
Research Results Prove...

Local Exhaust Ventilation (LEV) WORKS

Welding generates hazardous metal fumes that can cause serious illnesses. The best solution is Local Exhaust Ventilation (LEV) that captures dangerous metal fumes at the source.* Today dozens of portable LEV systems are commercially available.



Lincoln hood used with all LEV units

CPWR – The Center for Construction Research and Training has worked with construction contractors, industrial hygienists, labor unions and equipment manufacturers to select and evaluate the performance of some commercially available LEV systems. The industry partnership chose the most likely LEV units to be used on jobsites. Using personal exposure monitoring, the team evaluated how effectively LEV systems protected workers from hazardous metal fumes while performing shielded metal arc, or stick welding, on both stainless and mild steel.

The team has evaluated three portable LEV systems:

Trion Air Boss One-Man Portable

Listed Capacity: 220 Cubic Feet/Minute
Actual: 118 – 134 cfm
Specs: 45 lbs, 12"x 27"x19"

RESULTS:

- Reduced Manganese exposures during ***mild steel*** welding by 59%
- Reduced Hexavalent Chromium exposures during ***stainless steel*** welding by 88%

Lincoln Electric X-Tractor 1C

Listed Capacity: 115 Cubic Feet/Minute
Actual: 144 – 158 cfm
Specs: 37 lbs, 13"x 27"x13"

RESULTS:

- Reduced Manganese exposures during ***mild steel*** welding by 97%
- Reduced Hexavalent Chromium exposures during ***stainless steel*** welding by 94%

Eurovac

Listed Capacity: 103 Cubic Feet/Minute
Actual: 112 – 124 cfm
Specs: 115 lbs

RESULTS:

- Reduced Manganese exposure during ***mild steel*** welding by 74%
- Reduced Hexavalent Chromium exposures during ***stainless steel*** welding by 56%

There are many commercially available portable LEV systems designed for welding, most carrying a retail price between $1,000 and $3,000. For more information on these trials, contact lead investigator Pam Susi at pamsusi@comcast.net or visit www.cpwr.com and search "AIMS."

Warning – Welding can also generate hazardous gases or result in displacement of oxygen, especially in confined spaces. These LEV systems are designed to capture and filter metal fumes and other small particles but do not capture and filter gases.

Detailed equipment results on following pages.

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Evaluation: Welding Fume Local Exhaust Ventilation

THE TRION AIR BOSS

Trion Air Boss One-Man Portable
Air Purifiers, Inc., Rockaway, NJ

CPWR evaluated the first selected local exhaust ventilation (LEV) system for welding fumes on August 28-30, 2012 at Pipefitters Local 597 Training Center in Mokena, IL. Pam Susi, CPWR, John Meeker, Univ. of Mich., and Tanushree Chakvarty, Colden Corp. made up the industrial hygiene team. John Leen, Training Director, and Dave Hintz, Welding Coordinator for Pipefitters Local 597, provided access to the training center, senior apprentice welders, welding material and guidance on the welding process.

The first system evaluated was the Trion Air Boss One-Man Portable LEV unit manufactured by Air Purifiers, Inc., Rockaway, NJ with a ball shaped hood. This system rated highly among those most likely to be used on jobsites by labor and industry representatives attending the CPWR Welding Partnership for Advancing Control Technologies (PACT) meeting on June 8th 2012. Five randomized trials were used to measure manganese and iron during mild steel welding with and without LEV and another five randomized trials were used to measure hexavalent chromium, manganese and nickel during stainless steel welding with and without LEV. Shielded metal arc welding or "stick" welding was used for all trials. Results for some key metals are below.

Welding Mild Steel With and Without LEV – Manganese

	Average (mg/m³)	Range	Hazard Ratio (mean/2012 TLV)
With LEV	0.029	0.010 – 0.066	15% of the TLV
Without LEV	0.070	0.014 – 0.31	35% of the TLV

Use of LEV during mild steel welding reduced average manganese exposures by 57%. Put another way, the average manganese level **without LEV** was 2.3 times the average manganese level with use of LEV. The 2012 American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 0.2 mg/m^3 for manganese was used as a benckmark for this study which began in 2010. Exposures without LEV were 35% of the 2012 TLV compared to exposures with LEV, which were 15% of the 2012 TLV.

Welding Stainless Steel With and Without LEV – Hexavalent Chromium

	Average (ug/m³)	Range	Hazard Ratio (mean/PEL)
With LEV	1.1	0.55 – 1.6	22% of the PEL
Without LEV	8.8	0.16 – 13	1.8 times the PEL

Average hexavalent chromium exposures during stainless steel welding were reduced by 88% with use of LEV. Average exposures without LEV were 1.8 times the OSHA Permissible Exposure Limit (PEL) of 5 ug/m^3 and 8.8 times average exposures with LEV, which were about 1/5th the PEL. Although the listed flow rate was 220 cfm, we measured flow rates between 118 – 134 cfm. Using our evaluation criteria of an exposure reduction of 50% or more and/or reducing exposure levels to below the most appropriate occupational exposure limit, the Trion Air Boss One-Man Portable proved to be effective in reducing both manganese exposures associated with shielded metal arc welding of mild steel and hexavalent chromium exposures generated from shielded metal arc welding of stainless steel.

For more information, visit www.cpwr.com, search "AIMS."

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Evaluation: Welding Fume Local Exhaust Ventilation

THE LINCOLN X-TRACTOR 1C

On July 22-24, 2013, CPWR evaluated the performance of the Lincoln Electric X-Tractor® 1GC local exhaust ventilation (LEV) system with a bell shaped hood. Five randomized trials were used to measure manganese and iron during mild steel welding with and without LEV and another five randomized trials were used to measure hexavalent chromium, manganese and nickel during stainless steel welding with and without LEV. Shielded metal arc welding or "stick" welding was used for all trials. Results for some key metals are below.

Lincoln Extractor 1C
Lincoln Electric, Cleveland, OH

Manganese results for mild steel welding are presented in **Table 1.** Use of the Lincoln Electric X-Tractor 1C LEV unit resulted in a 97% reduction in manganese exposures. Average manganese exposure *with* LEV was 19% of the American Conference of Governmental Industrial Hygienists (ACGIH) 2012 Threshold Limit Value (TLV) of 0.2 milligrams per cubic meter of air (mg/m^3). The average manganese exposure *without* LEV was over 6 times the TLV. Three out of five measurements *without* LEV exceeded the TLV. None of samples collected with LEV exceeded the TLV.

Table 1. Welding Mild Steel With and Without LEV – Manganese

	Average (mg/m^3)	Range	Hazard Ratio (mean/2012 TLV)
With LEV	0.037	0.024 – 0.065	19% of the TLV
Without LEV	1.3	0.058 – 3.6	6.5 times the TLV

Hexavalent chromium (Cr VI) measurements collected during stainless steel welding are presented in **Table 2**. The average and highest Cr VI exposure measurements collected *with* use of LEV were below both the OSHA Permissible Exposure Limit (PEL) of 5 micrograms per cubic meter of air (ug/m^3) and Action Level of 2.5 ug/m^3. Average Cr VI exposure measured *without* use of LEV was over the PEL, with the highest measured exposure (31 ug/m^3) over 6 times the PEL. Use of the tested system resulted in a 94% reduction in measured Cr VI exposure levels.

Table 2. Welding Stainless Steel With and Without LEV – Hexavalent Chromium

	Average (ug/m^3)	Range	Hazard Ratio (mean/PEL)
With LEV	0.52	0.24 – 1.5	10% of the PEL
Without LEV	9.1	0.63 – 31	1.8 times the PEL

Although the listed flow rate was 115 cubic feet per minute (cfm), we measured flow rates between 144 – 158 cfm. Using our evaluation criteria of an exposure reduction of 50% or more and/or reducing exposure levels to below the most appropriate occupational exposure limit, the Lincoln Electric X-Tractor 1C proved to be effective in reducing both manganese exposures associated with shielded metal arc welding of mild steel and hexavalent chromium exposures generated from shielded metal arc welding of stainless steel.

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Evaluation: Welding Fume Local Exhaust Ventilation

THE EUROVAC

Eurovac
Concord, Ontario

On June 18-20, 2014, CPWR evaluated the performance of the Eurovac local exhaust ventilation (LEV) system. Five randomized trials were used to measure manganese and iron during mild steel welding with and without LEV and another six randomized trials were used to measure hexavalent chromium, manganese and nickel during stainless steel welding with and without LEV. Shielded metal arc welding or "stick" welding was used for all trials. Summary results for some key metals are below.

Manganese results for mild steel welding are presented in Table 1. Use of the Eurovac LEV unit resulted in a 74% reduction in manganese exposures. Average manganese exposure with LEV was 29% of the American Conference of Governmental Industrial Hygienists (ACGIH) 2012 Threshold Limit Value (TLV) of 0.2 milligrams per cubic meter of air (mg/m3). The average manganese exposure without LEV exceeded the TLV. None of samples collected with LEV exceeded the TLV.

Table 1. Welding Mild Steel With and Without LEV – Manganese

	Average (mg/m^3)	Range	Hazard Ratio (mean/2012 TLV)
With LEV	0.057	0.014 – 0.15	29% of the TLV
Without LEV	0.22	0.078 – 0.52	1.1 times the TLV

Hexavalent chromium (Cr VI) measurements collected during stainless steel welding are presented in Table 2. Cr VI exposure measurements collected with use of LEV were 1.4 times the OSHA Permissible Exposure Limit (PEL) of 5 micrograms per cubic meter of air (ug/m3). Average Cr VI exposure measured without use of LEV was 3.2 times the PEL, with the highest measured exposure (39 ug/m3) almost 8 times the PEL. Use of the tested system resulted in a 56% reduction in measured Cr VI exposure levels.

Table 2. Welding Stainless Steel With and Without LEV – Hexavalent Chromium

	Average (ug/m^3)	Range	Hazard Ratio (mean/PEL)
With LEV	7.1	0.48 – 19	1.4 times the PEL
Without LEV	16	3.2 – 39	3.2 times the PEL

Although the listed flow rate was 103 cfm, we measured flow rates between 112 – 124 cfm. Using our evaluation criteria of an exposure reduction of 50% or more and/or reducing exposure levels to below the most appropriate occupational exposure limit, the Eurovac proved to be effective in reducing both manganese exposures associated with shielded metal arc welding of mild steel and hexavalent chromium exposures generated from shielded metal arc welding of stainless steel.

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