Summary of Welding Research Project

ARB Contract 00-727

In 2001 the Air Resources Board (ARB) identified hexavalent chromium (Cr^{+6}) emissions from welding as a pollutant of concern and contracted with Dr. Dan Chang (UC Davis) to investigate and improve upon existing welding emission estimates. This page is a summary of the 33-page published report from this research project.

Sixty-six tests were performed for several different welding processes using both mild and stainless steel welding electrodes. An enclosure was built so that a welder could stand inside and conduct welding during the sampling period. A filtration system was built to capture the welding fume and standard stack sampling methods were used to measure both hexavalent chromium and particulate matter (total PM and $PM_{2.5}$).

The two key findings from this project were:

- When measuring welding emissions, more than 97% of all chromium emissions can be captured on filters (stack sampling using the costly CARB Test Method 425 impinger method is not necessary). This is important since there was uncertainty about how welding emissions were being captured on filters in other industry studies. We are now confident that filters are sufficient to capture chromium emissions during testing.

- Using a shielding gas during FCAW reduces Cr^{+6} emissions by more than 90%, while particulate emissions increased only slightly. This result confirms another study provided by industry, while very little other Cr^{+6} data was previously cited in the literature regarding this process. We can now use these emission factors to quantify emissions from this type of welding process.

We also found that:

- Cr^{+6} emissions from stainless steel welding are *at least* 30 to 200 times higher than mild steel welding.

- The percentage of particulate greater in size than $PM_{2.5}$ was higher than literature values. The percent greater than PM2.5 was between 20-40% and up to 60% for pulsed GMAW.

- The use of a borate buffer and filtration of the chromium solution improved the analytical method and the limit of detection during testing.

- Larger diameter electrodes produced higher emissions per mass of electrode than smaller electrodes.

- Especially for pulsed GMAW, an increase in fume generation rate correlated with an increase in particle size.

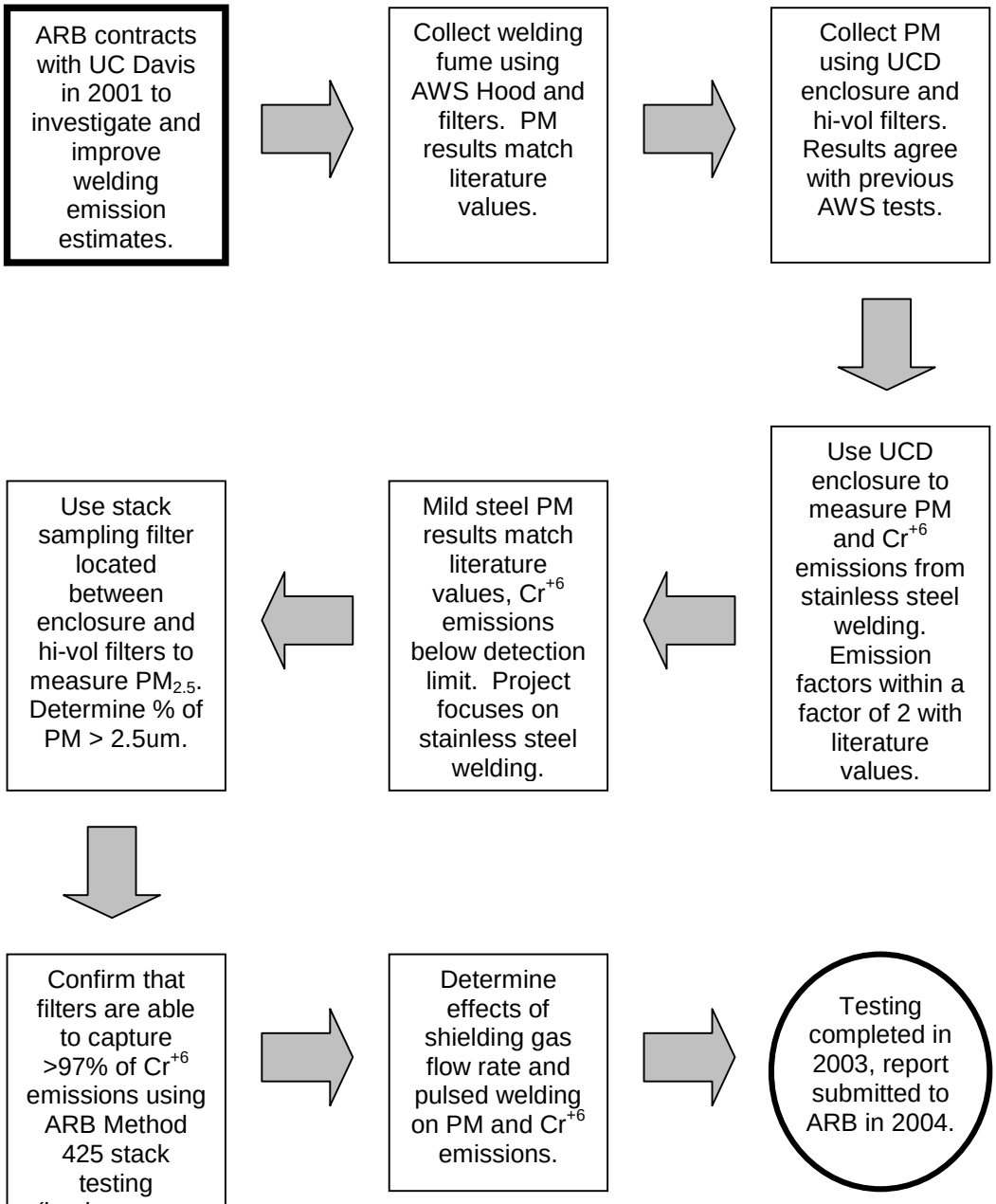
- Average emission factors were calculated as follows:

Process	Grams PM / kg-electrode	Grams Cr^{+6} / kg-electrode
Shielded Metal Arc Welding (SMAW)	4.7	0.18
Flux Core Arc Welding (FCAW)	8.0	0.015
Gas Metal Arc Welding (GMAW)	8.2	0.01 - 0.025
Pulsed GMAW	4.9 – 5.8	0.01 - 0.027

The above average emission factors agree in general with previous literature data. However, most previous tests conducted *either* fume generation *or* fume composition studies, while this research project did both. The complete report is available at: http://www.arb.ca.gov/toxics/welding/welding.htm. For additional information, please send an email to: eibweb.arb.ca.gov.

Flow Diagram of Research Project

The following flow chart represents the major tasks performed in the welding research project:



Consumable (rods and wires)	# of Tests
FCAW: E309LT-1, 0.045 in	16
FCAW: E71T-1C, 0.045 in	4
GMAW: E316L-Si, 0.035 in	9
GMAW: E316L-Si, 0.045 in	7
GMAW: E70S-3, 0.045 in	18
Pulsed MIG: E316L-Si, 0.035 in	5
Pulsed MIG: Mil 308L, 0.045 in	3
SMAW: E316L-16, 4 mm	4
TOTAL # of Tests	66