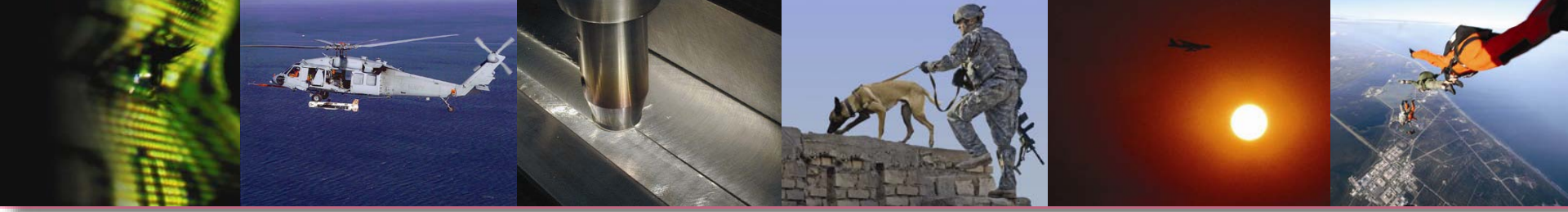


Concurrent Technologies Corporation

Developing Emission Factors for Shipyard Welding Operations

NSRP SP-7 Welding Panel Meeting
Hanover, PA
April 8, 2009

Panel Project Team

- **Supporting Organizations**
  - National Shipbuilding Research Program (NSRP)
  - Advance Technology Institute (ATI)
  - Naval Sea Systems Command (NAVSEA)
  - Naval Surface Warfare Center Carderock Division (NSWCCD)
  - Shipbuilders Council of America (SCA)
  - American Shipbuilding Association (ASA)
- **Navy Shipyards**
  - Norfolk Naval Shipyard (NNSY)
  - Puget Sound Navy Shipyard (PSNS)
- **Commercial Shipyards**
  - Atlantic Marine Jacksonville
  - BAE Systems San Diego – *Program Technical Representative (PTR)*
  - BAE Systems Norfolk Ship Repair
  - Bath Iron Works (BIW)
  - Bollinger Shipyards
  - General Dynamics Electric Boat (EB)
  - General Dynamics (GD) National Steel and Shipbuilding Company (NASSCO)
  - Northrop Grumman Newport News (NGNN)
  - Northrop Grumman Ship Systems (NGSS)
- **Primary Contractor and Subcontractors/Consultants**
  - Concurrent Technologies Corporation *(CTC)*
  - Applied Research Laboratory (ARL) - Penn State Univ.
  - SofTek Systems Inc. (SSI)
  - DataChem

Background

The previous 2007-2008 NSRP Residual Risk Ruling (RRR) project demonstrated that:

- Current data used for rulemaking decisions contained inaccuracies and gaps
  - The RRR effort concentrated on the inaccuracies associated with modeling inputs (stack height, location)
  - **BUT** the uncertainty in the current emission factors remained
- Data gaps and inaccuracies increase the calculated risk that the industry presents to public health
  - Modeling efforts demonstrated a reduction in risk when actual facility specific shipyard data replaced data developed by the U.S. EPA.
  - **What effect do the current emission factors developed by the U.S. EPA have on the calculated risk to public health?**

Industry Need

- A significant result of the previous NSRP RRR project was the identification of industry need for high quality emission factors for common welding operations

- This result was based on the following:
  - Limitations and data gaps were discovered in the current AP-42 data set
  - Current emission factors were being developed statistically using data from multiple studies in which sampling methods varied
  - Lack of data was forcing the U.S. EPA to use conservative assumptions in regulatory decisions
  - Data collected during the NSRP RRR project demonstrated lower emissions than current AP-42 and proposed RRR emission factors
  - U.S. EPA expressed interest in obtaining data to update the existing AP-42 emission factor data set.

With the upcoming release of the RRR, it is critical that shipyard emissions be reported accurately to avoid unnecessary fines for non-compliance.

Response to Industry Need

- Phase II of the NSRP RRR project was not awarded due to the delay in the release of the new ruling.
- The industry's need for high quality emission factors remained
- *CTC* developed and submitted a white paper to respond to this need by developing high quality emission factors for the industry
  - *CTC* received support in developing the white paper from various members of the past RRR project team.
  - The team that submitted the white paper included:
    - BAE Systems Norfolk Ship Repair – shipyard project support and cost share contributor
    - Bath Iron Works – shipyard project support
    - Penn State University (PSU) Applied Research Laboratory (ARL) – technical support
    - Softek Systems, Inc. – emission factor Subject Matter Expert oversight
- The panel project was awarded by ATI on January 1, 2009.

Project Objectives

- Identify welding electrodes that are commonly used within the industry and determine those that currently lack high quality emission factors.
- Review the identified electrodes to determine their potential to emit Hexavalent Chromium and/or Manganese which are the primary constituents driving shipyard offsite public health risks.
- Develop high quality emission factors for the selected electrodes that will be accepted by the U.S. EPA for use in regulatory calculating and reporting procedures.

Project Approach

Task 1 – Identify Electrodes for Evaluation

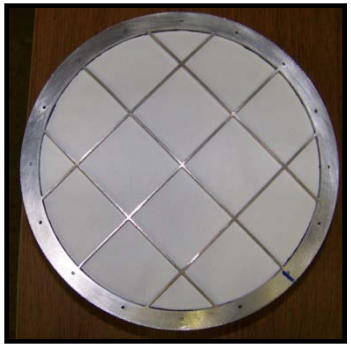
- Develop a survey instrument to inform shipyards of the project, and request information on electrodes that they would like to see evaluated under this project
  - Survey was distributed to 46 shipyards
- Research published emission factor data to determine if emission factors exist for the selected electrodes, and determine the level of quality associated with the emission factors
- Develop a prioritized list of up to 10 electrodes. Priority will be based on
  - The number of individual shipyard requests for the electrode
  - The lack of a high quality emission factors
  - The potential to drive shipyard offsite public health risks
- The final selection of electrodes will be presented to participating shipyards for review and acceptance

Project Approach

Task 2 – Collect and Analyze Weld Fume Samples

- Develop a Sampling and Analysis Plan that will be used to collect and analyze welding fumes
  - Total fume by mass
  - Cr, Cr(VI), Mn by laboratory analysis of filters
  - Review, feedback and acceptance by participating shipyards
  - Submit to the U.S. EPA for review and acceptance prior to sampling
- Conduct weld fume sampling and use the resulting data to develop emission factors

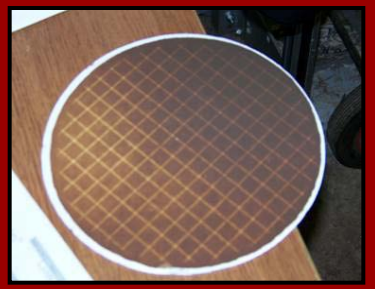
Weld Fume Chamber



Weld Fume Chamber and Sampling Process






Emission Factor =

$$\frac{\text{mg welding fume on filter}}{\text{grams electrode consumed}}$$

Project Approach

Task 3 – Develop Emission Factors for Tested Electrodes

- Utilize data collected during Task 2 to:
  - Validate and expand on the emission factors developed during the previous project to provide additional confidence in their results
  - Expand on the types of electrodes evaluated to be more representative of the entire industry
- Prepare a Final Project Technical Report
  - Objectives of the project
  - Results and emission factors developed
  - Benefits (quantitative and qualitative)
  - Conclusions/recommendations or lessons learned
- Provide report to the NSRP for submittal to the U.S. EPA

Project Accomplishments to Date

- Developed and sent out survey
  - 18 out of 46 shipyards responded; 39% response rate
- Tabulated survey findings

	FCAW	SMAW	GMAW
Common shipyard electrodes as identified in RRR project	E71T-1C E81T1-K2CJ H8 E71T-1M-HY E309T-1 101TM	7018M 11018M 310-16 E8018 9N10	E70C-6M L-56 EN67 E100S-1 ER316L
Electrodes recommended on survey (2 or more shipyards)	308 309 316 71T	308, 309 316 6010 7024 10018M 10718M	308 316 70S E100S

- Currently downselecting to final 10 electrodes for testing

Path Forward

- Prioritize identified electrodes and make final selection
- Complete the Electrode Usage Summary and Selection Report - April 30
- Develop the Sampling and Analysis Plan (SAP) - May 31
- Complete testing - June
- Complete sample analysis - July 30
- Complete Final Project Technical Report - August 28

Previous Work Conducted Under the RRR Project

Demonstration and Evaluation of Commercially Available Weld Fume Extraction Technologies

Emission Control Technology Demonstration

Bath Iron Works

February 4-8, 2008

Atlantic Marine Alabama

February 18-22, 2008

Emission Control Technology Demonstration

Materials

- **Control Technologies**
  - Miniflex (High Vac/Low Vol)
  - Mobiflex 200 (Low Vac/ High Vol)

- **Welding Processes and Electrodes**
  - Bath Iron Works
    - FCAW – 71T1, 309
    - SMAW – 7018, 309
    - GMAW – 70C-8M, 316
  - Atlantic Marine Alabama
    - FCAW – 71T1, 81T1, 309
    - SMAW – 7018, 309, 310

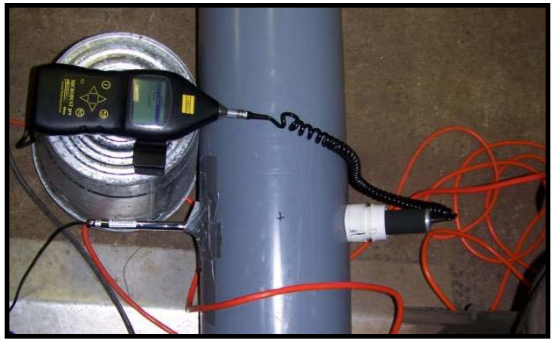
Miniflex
High Vac Low Vol

Mobiflex 200
Low Vac/ High Vol

Control Technologies / Capture Efficiency

Mobiflex

Miniflex



Mobiflex Capture Efficiency

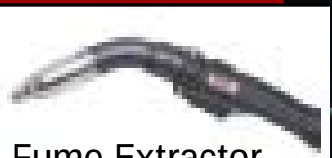
$$\text{Capture Efficiency} = \frac{\text{mg fume captured by CT / gram weld rod consumed}}{EF_{uncontrolled}} \times 100$$

Miniflex Capture Efficiency

EN 20 Extraction Nozzle

Capture Efficiency =

$$\frac{\text{mg fume captured by CT / gram weld rod consumed}}{EF_{uncontrolled}} \times 100$$



Fume Extractor Gun

Miniflex Fume Gun Test

FCAW, 71T1/0.052”, AH36 carbon steel base plate, CO_2 shielding gas

100% suction
0% draft



100% draft



Control Technologies Capture Efficiency

Summary

- Conducted 5 welding runs for each selected process/electrode combination with each control technology
  - Miniflex
    - EN-20 Nozzle was used for SMAW welding.
      - Demonstrated a capture efficiency of approximately 60%
    - Fume Extractor Gun was used for FCAW & GMAW welding.
      - Fume gun had varied results and in some cases affected weld quality. More work is needed on this combination.
  - Mobiflex
    - Used with all process/electrode combinations.
    - Demonstrated a capture efficiency of approximately 95%.
- Shipyard welders were comfortable using both units, and felt that the Miniflex would be more useful on a vessel or in a drydock and the Mobiflex would be more useful in a shop location.

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Questions?