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Developing Emission Factors for Shipyard Welding Operations

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NSRP All Panel Meeting
Philadelphia, PA
September 16, 2009





Presentation Outline

- Project Team
- Background
- Project Review
 - Objectives
 - Approach
 - Accomplishments to Date
- Survey Results and Electrode Selection Process
- Analysis of Weld Fumes
- Path Forward
- Upcoming Events
 - Emission Factor Improvement Process
- Questions?





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 Laboratories, Inc



Background

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

- Current data used for rulemaking decisions contained inaccuracies and gaps
 - 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 force EPA to use conservative assumptions that increase the calculated risk that industry presents to public health
 - Past modeling efforts demonstrated a reduction in risk when the data developed by the EPA was replaced with actual facility specific shipyard data
 - What effect do the current emission factors developed by the EPA have on the calculated risk to public health



Industry Need

- The previous NSRP RRR project identified the industry need for high quality emission factors for 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 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 eventual release of new welding regulations, it is critical that shipyard emissions be reported accurately to avoid non-compliance issues.



Response to Industry Need

- 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 development of the white paper from various members of the previous NSRP 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 SME oversight
- The panel project was awarded by ATI on January 1, 2009



Project Objectives

- Identify commonly used shipyard welding electrodes that currently lack high quality emission factors
- Develop an electrode selection process based on:
 - Shipyard request
 - Current lack of high quality emission factors
 - Potential to emit Hexavalent Chromium and/or Manganese, the primary constituents driving shipyard offsite public health risks
- Develop high quality emission factors for the selected electrodes that can be submitted to the U.S. EPA for use in regulatory reporting procedures



Project Approach

- **Task 1 – Identify Electrodes for Evaluation**
 - Survey the industry to request information on electrodes they would like evaluated under this project
 - Prioritize the electrodes, based on the following:
 - Number of individual shipyard requests
 - Lack of a high quality emission factor data
 - Potential to drive shipyard offsite public health risks
- **Task 2 – Collect and Analyze Weld Fume Samples**
 - Develop a Sampling and Analysis Plan that will be used to collect and analyze welding fumes
 - Conduct weld fume sampling and analysis
- **Task 3 – Develop Emission Factors for Tested Electrodes**
 - Develop emission factors for selected electrodes based on analyzed data
 - Prepare detailed Final Project Technical Report
 - Provide report to the NSRP for submittal to the U.S. EPA



Project Accomplishments to Date

- Developed and distributed three surveys
 - Survey 1: Electrode Identification
 - 18 out of 46 shipyards responded; 39% response rate
 - Survey 2: Electrode Prioritization
 - 13 out of 18 shipyards responded; 72% response rate
 - Survey 3: Electrode Supplier Identification
 - 5 out of 18 shipyards responded; 28% response rate
- Completed a down-selection process to identify five process/electrode combinations for development of emissions factors
- Prepared Electrode Usage Summary and Selection Report
- Developed Sampling and Analysis Plan (SAP)
 - Submitted to U.S. EPA for review and comment on 6/09/09
 - Received comments on 8/03/09
 - Responded to comments 9/11/09
- Scheduled testing for September 2009 at CTC, Johnstown, PA



Survey Results

Tabulated Results for Surveys 1 and 2

Process	Electrode	Total # of Requests	Ranking Count		
			#1-3	#4-6	#7-10
SMAW	7018	11	8	3	0
	11018	8	2	1	5
	309	7	2	1	4
	308	5	1	2	2
GMAW	70S	5	3	0	2
	100S-1	5	1	1	3
FCAW	71T	10	7	3	0
	309	8	5	1	2
	308	8	1	6	1
	316	7	0	2	5



Survey Results

Tabulated Results for Survey 3

Process/Electrode	ESAB	Lincoln	Hobart	Trimark	Sandvik	ARCOS	Unibraze	Select Arc
SMAW 7018	4	2	0	0	0	0	0	0
SMAW 11018	4	0	0	1	0	0	0	0
SMAW 309	3	0	1	0	0	2	0	0
SMAW 308	3	0	1	0	0	2	0	0
GMAW 70S	4	1	0	0	0	0	1	0
GMAW 100S-1	2	2	0	0	0	0	0	0
FCAW 71T	4	1	2	3	0	0	0	1
FCAW 309	4	0	0	0	0	0	0	0
FCAW 308	4	0	0	0	1	0	0	0
FCAW 316	4	1	0	0	1	0	0	0
Total	36	7	4	4	2	4	1	1





Electrode Selection Process

Rankings Based on Combined Survey Results

Rank	Process Electrode	Rank Based on Total # of Requests	Rank Based on # of Top 3 Requests
1	SMAW 7018	1	1
2	FCAW 71T	2	2
3	FCAW 309	3	3
4	SMAW 11018	3	5
5	FCAW 308	3	6
6	SMAW 309	4	5
7	GMAW 70S	5	4
8	SMAW 308	5	6
8	GMAW 100S-1	5	6
9	FCAW 316	4	7



Electrode Selection Process

Current Emission Factor Data for Top 10 Electrodes

Process	Electrode	Electrode Type Listed in AP-42	Total Fume Emission Factor (g/kg of electrode consumed)	Total Fume Emission Factor Rating	HAP Emission Factor (10 ⁻¹ g/kg of electrode consumed)					HAP Emission Factor Rating	Proposed ¹ using 95% UCL (10 ⁻¹ g/kg of electrode consumed)				
					Cr	Cr(VI)	Mn	Ni	Pb		Cr	Cr(VI)	Mn	Ni	Pb
SMAW	E7018	E7018	18.4	C	0.06	ND	10.3	0.02	ND	C	0.0667	0.037	11.8	0.371	2.15
	E11018	E11018	16.4	C	ND	ND	13.8	ND	ND	C	0.0667	0.037	11.8	0.371	2.15
	E309	Not Listed									8.11	1.68	5.34	1.04	2.15
	E308	E308	10.8	C	3.93	3.59	2.52	0.43	ND	D	8.11	1.68	5.34	1.04	2.15
GMAW	E70S	70S	5.2	A	0.01	ND	3.18	0.01	ND	A	0.067	0.003	3.96	0.371	2.15
	E100S	Not Listed									0.067	0.003	3.96	0.371	2.15
FCAW	E71T	E71T	12.2	B	0.02	ND	6.62	0.04	ND	B	0.067	0.007	9.85	0.371	2.15
	E309	Not Listed									30	0.593	5.21	5.16	2.15
	E308	E308LT	9.1	C	ND	ND	ND	ND	ND	ND	30	0.593	5.21	5.16	2.15
	E316	E316	8.5	B	9.7	1.4	5.9	0.93	ND	B	30	0.593	5.21	5.16	2.15

¹Proposed Emission Factors, Serageldin, August 9, 2005

ND = No data



Electrode Selection Process

Rankings Based on Quality of EPA AP-42 Emissions Factors

Rank	Process Electrode	Rank Based Quality of Total Fume Emission Factor	Rank Based Quality of HAP Emission Factor
1	SMAW 309	1	1
2	GMAW 100S-1	1	1
3	FCAW 309	1	1
4	FCAW 308	2	1
5	SMAW 308	2	2
6	SMAW 11018	2	3
6	SMAW 7018	2	3
7	FCAW 71T	3	4
7	FCAW 316	3	4
8	GMAW 70S	4	5

Highest Ranking (1) assigned to electrodes currently lacking emission factors, with priority then assigned to electrodes that currently hold low quality emission factors.



Electrode Selection Process

Rankings Based on Composition as Listed on MSDS

By Cr(VI) Content

Rank	Process	Electrode	Cr(VI) Content (%)
1	SMAW	309	23.0 - 25.0
2	FCAW	309	21 - 24
3	SMAW	308	19.5 - 22.0
4	FCAW	308	17 - 20
4	FCAW	316	17 - 20
5	GMAW	100S-1	0.1
6	SMAW	11018	<0.5

By Mn Content

Rank	Process	Electrode	Mn Content (%)
1	SMAW	11018	2-3
2	FCAW	308	1 - 3
2	FCAW	309	1 - 3
2	FCAW	316	1 - 3
3	SMAW	308	1 – 2.5
3	SMAW	309	1 – 2.5
4	SMAW	7018	1 - 2
4	GMAW	70S	1
4	GMAW	100S-1	1
5	FCAW	71T	0.2 - 1



Down Selection Process

Rank	Shipyard Request	Emission Factor Need	Potential to Drive Max. Individual Risk for Cancer	Potential to Drive Hazard Indices for Non-Cancer Risks
1	SMAW 7018	SMAW 309	SMAW 309	SMAW 11018
2	FCAW 71T	GMAW 100S-1	FCAW 309	FCAW 308 / FCAW 309 / FCAW 316
3	FCAW 309	FCAW 309	SMAW 308	SMAW 308 / SMAW 309
4	SMAW 11018	FCAW 308	FCAW 308 / FCAW 316	SMAW 7018 / GMAW 70S / GMAW 100S-1
5	FCAW 308	SMAW 308	GMAW 100S-1	FCAW 71T
6	SMAW 309	SMAW 11018 / SMAW 7018	SMAW 11018	
7	GMAW 70S	FCAW 71T / FCAW 316		
8	SMAW 308 / GMAW 100S-1	GMAW 70S		
9	FCAW 316			



Down Selection Process

- **Suggested Process/Electrodes for Evaluation**
 - FCAW 308
 - FCAW 309
 - SMAW 309
 - SMAW 7018
 - SMAW 11018





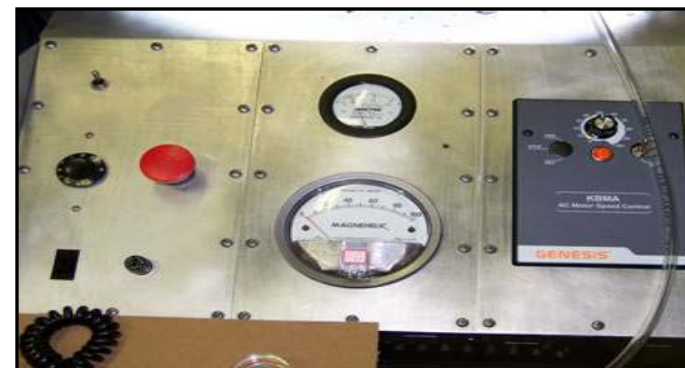
Analysis of Weld Fumes

- Sampling and Analysis Plan (SAP)
 - Completed SAP following feedback provided by U.S. EPA
- Designed study based on completed study under the past RRR project
 - Weld Fume Chamber
 - AWS F1.2:2006
 - Gravimetric Analysis
 - NIOSH 0500
 - TissuQuartz Filters for Cr(VI)
 - Preserve in solution to inhibit conversion of Cr(VI) to Cr(III)
 - OSHA ID-215
 - Glass Fiber Filters for Cr, Mn, Ni and Pb
 - NIOSH 7300



Analysis of Weld Fumes

Sampling Procedure





Analysis of Weld Fumes

Welding Variables to Control and/or Monitor

- FCAW
 - Amps
 - Volts
 - Diameter
 - Travel speed
 - Stick-out
 - Shielding gas
 - Base material cleanliness
- SMAW
 - Amps
 - Volts
 - Diameter
 - Travel speed
 - Base material cleanliness



Analysis of Weld Fumes

Expected Outcome:

High quality emission factor data for the selected electrodes that will be submitted to the U.S. EPA.

- Emission Factors will be developed for
 - Total Fume
 - Hexavalent Chromium
 - Cr, Mn, Ni, Pb



Path Forward

- Complete Testing – September 2009
- Complete Sample Analysis – October 2009
- Complete Final Project Technical Report – November 2009
- Determine the next steps in implementing the developed emission factors at the Federal, State, and Local levels.



Upcoming Events

- U.S. EPA's May 2009 Action Initiation List announced the ***Emissions Factors Program Improvements*** as an action, with a publication date for an ANPRM listed as 12 months or less. <http://www.epa.gov/lawsregs/search/ail.html>

RIN	Action Title	Stage	Contact	Abstract	Projected Publication Date
2060-AP63	Emissions Factors Program Improvements	ANPRM	Tom Driscoll 919-541-5135 Driscoll.Tom@epa.gov	EPA intends to implement a multi-part process to improve the emissions factors program. Emissions factors, based on averaged data from industrial process performance tests, were established to fill emissions data gaps when developing emissions inventories. Currently, most EPA emissions factors reside in a database called AP-42. We believe that implementing this multi-part effort will result in a self-sustaining emissions factors program receiving ongoing data submittals that will greatly improve emissions estimation for regulatory authorities and others to use in: (1) developing emissions inventories, (2) updating emissions standards, (3) identifying and evaluating control strategies, (4) determining applicability of permit and regulatory requirements, (5) assessing risks, and (6) other air pollution control activities. The first part involves further development of the existing electronic reporting tool (ERT) to make it easier for S/LTs, industry, and other stakeholders to accept, assess the quality of, and transmit emissions test data. The second part involves upgrading the AP-42 factors information compilation and retrieval system, making it an interactive, current, and easy to expand and enhance foundation for the internet application renamed WebFIRE. Additionally, to make the emissions factors development process more transparent, EPA plans to rewrite the existing emissions factors development procedures document. Finally (and the primary purpose for this rulemaking), in order to acquire adequate data for the development or improvement of the emissions factors, we are seeking comment on requiring the submission (via electronic reporting) of certain performance testing information conducted by industry. Performance tests are conducted to measure the air pollutant emissions from an industrial process and used as an indicator for compliance with regulations. This last element of the process of improving the emissions factors program will require formal rulemaking and will encompass performance testing required by Federal rules codified in 40 CFR Parts 60, 61, and 63.	12 months or less



Emissions Factors Program Improvements

- EPA intends to implement a multi-part process to improve the emissions factors program.
- EPA believe that this will result in a self-sustaining emissions factors program that will greatly improve emissions estimation for regulatory authorities and others to use in:
 - developing emissions inventories,
 - updating emissions standards,
 - identifying and evaluating control strategies,
 - determining applicability of permit and regulatory requirements,
 - assessing risks, and
 - other air pollution control activities.



Emissions Factors Program Improvements

- The first part involves further development of the existing electronic reporting tool (ERT) to make it easier for S/L/Ts, industry, and other stakeholders to accept, assess the quality of, and transmit emissions test data.
- The second part involves upgrading the AP-42 factors, making it an interactive, current, and easy to expand internet application renamed WebFIRE.



Emissions Factors Program Improvements

- In an attempt to make the emissions factors development process more transparent, EPA plans to rewrite the existing emissions factors development procedures document.
- Finally (the primary purpose for this rulemaking), in order to acquire adequate data for the development or improvement of the emissions factors, EPA is seeking comment on requiring the submission of certain performance testing information conducted by industry.
 - This element of the process will require formal rulemaking and will encompass performance testing required by Federal rules codified in 40 CFR Parts 60, 61, and 63.



Whitepaper Project Concept

- Provide support at the Federal level
 - Support NSRP with the incorporation of the data from the current NSRP Panel Project.
 - Support to the NSRP in responding to the U.S. EPA's request for comments on the ANPRM for transition of EPA's AP-42 to "Web Fire", which is scheduled for release before June 2010.
- Provide support at the State level
 - Determine which States use alternative emission factors and what those factors are based on.
 - Prioritize States that have the highest need (e.g., poorest quality EFs) for the implementation of updated emission factors.
- Provide support at the Local level
 - Complete a comprehensive review of the local emission reporting/regulatory process in up to two States, one being California due to increased regulatory concerns.
 - Determine the process for submitting updated emission factors, support shipyards through this process.
- Develop Path Forward on how other shipyards can proceed with the implementation of updated emission factors.



Questions?



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Back Up Slides



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A&WMA Conference Highlights

- AP-42 will become WebFIRE
 - Within the next few weeks an ANPRM will be published requesting comments on the U.S. EPA's plan to improve the current emission factor program
- Questions to be addressed
 - Is quality important
 - Should U.S. EPA group all emission factor data in one source
 - Should emission factor data be used only from traditional source test monitoring
 - Should U.S. EPA require the submission of performance test data
 - How often should the emission factors be updated
 - How should emission factors be developed (min, max, avg)
- Improvement goals
 - Be more transparent
 - Develop a more user-friendly system (Electronic Reporting Tool to submit data to the U.S. EPA)
 - Begin to replace the low quality emission factors



Analysis of Weld Fumes

Sampling Strategy

Process	Electrode	Base Metal	Filter	# of Runs		Analysis	
				Welding	Mass on Filter	Total Metals: Cr, Mn, Ni, Pb	Cr(VI)
FCAW	308	304 SS	TissuQuartz	6	6	---	---
	308	304 SS	TissuQuartz	6	---	---	6
	308	304 SS	Glass Fiber	6	6	6	---
FCAW	309	304 SS	TissuQuartz	6	6	---	---
	309	304 SS	TissuQuartz	6	---	---	6
	309	304 SS	Glass Fiber	6	6	6	---
SMAW	309	304 SS	TissuQuartz	6	6	---	---
	309	304 SS	TissuQuartz	6	---	---	6
	309	304 SS	Glass Fiber	6	6	6	---
SMAW	7018	DH 36	TissuQuartz	6	6	---	---
	7018	DH 36	TissuQuartz	6	---	---	6
	7018	DH 36	Glass Fiber	6	6	6	---
SMAW	11018	DH 36	TissuQuartz	6	6	---	---
	11018	DH 36	TissuQuartz	6	---	---	6
	11018	DH 36	Glass Fiber	6	6	6	---