

Welding Fume Analysis  
 NASSCO Welding Engineering  
 Michael J. Sullivan  
 September 6, 2000

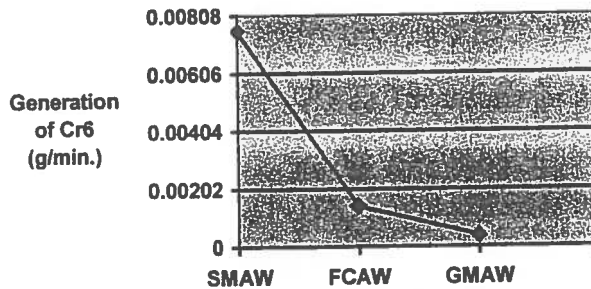
Revised September 18, 2000

ESAB completed fume analysis testing of three weld processes for stainless steel welding with 309 filler material at NASSCO's request. The fume generation rate testing was performed in accordance with AWS F1.2:1999. The three weld processes were SMAW, GMAW, and FCAW CO<sub>2</sub> shielding.

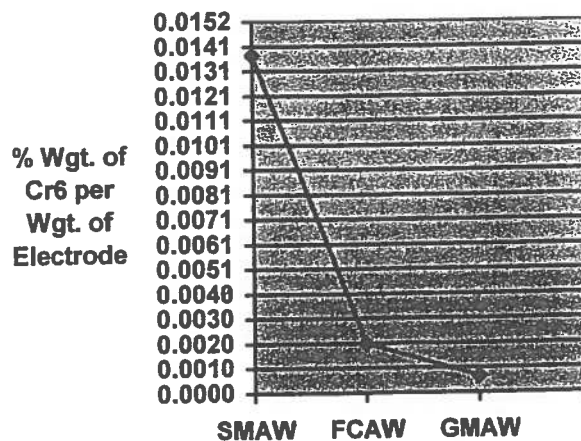
This data shows a comparison of the fume generation rates and the analysis of the weld fume, which includes hexavalent chrome.

The results are detailed in the table and graphs below.

	FUME GENERATION RATE (g/min.)	% OF Cr6 IN FUME	GENERATION OF Cr6 (g/min.)
SMAW	0.178	4.245%	$7.55 \times 10^{-3} = .00755$
FCAW	0.548	0.26%	$1.42 \times 10^{-3} = .00142$
GMAW	0.246	0.165%	$.40 \times 10^{-3} = .0004$



	% ELECTRODE COVERED TO FUME	% OF Cr6 IN FUME	% WGT. OF Cr6 PER WGT. OF ELECTRODE
SMAW	.327%	4.245%	$1.38 \times 10^{-4} = .0138\%$
FCAW	.779%	0.26%	$2.02 \times 10^{-5} = .00202\%$
GMAW	.414%	0.165%	$6.83 \times 10^{-6} = .000683\%$



Summary: Although the fume generation rate FCAW is greater than SMAW it produces a lower amount of hexavalent chrome

**ESAB Welding & Cutting Products**

801 Wilson Ave., Hanover, PA 17331

**FAX**No. of pages including this: 

1
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**To** Name: Mr. Mike Sullivan Date: September 26, 2000  
Company: NASSCO Fax: 9-1-619-544-7516

**From** Name: Roger Bushey Toll-Free 800/933-7070  
Company: ESAB Welding & Cutting Products Tel: 717/637-8911  
Fax: 717/630-3493

Subject : Fume Report of August 28, 2000

cc: S. Ferree  
K. Smith

The following are answers to your questions concerning the fume data presented by Stan Ferree.

## A) Units for the Numbers ?

The numbers presented for the fume analysis are as stated by Stan reported as weight percent.

## B) Testing procedure ?

The testing for these fumes was done in compliance with AWS F1.2:1999 as you required.

## C) Adding up to 100% ?

With regard to the numbers in the report not adding up to 100% by weight.

- 1) The values reported are analyzed as elements, however during the welding operation they really form oxides. Since they are presented as elements the total will not add up to 100% unless the oxygen was also factored in.
- 2) Secondly not all elements present in the fumes are analyzed for. Certainly the ones with the highest percentage are tested but there are always going to be some residual oxides and other compounds formed as result of the welding that will be captured in the fumes that are not reported.

I hope this clarifies some of the confusion. If I can be any other assistance please let me know.

Best regards,

Roger Bushey



ESAB Welding &  
Cutting Products

August 28, 2000

Mr. Mike Sullivan, Chief Welding Engineer  
NASSCO  
P.O. Box 85278  
San Diego, CA 92186-5278

Dear Mike:

The tests you requested on our 309L stainless products were completed and the results are given in Table I and the weld fume reports from our chemistry lab.

If you have any questions, please contact me.

Best regards,

A handwritten signature in cursive script that reads "Stan Ferree".

Stan E. Ferree  
Vice President, Technical

SEF/jls

Enclosures

Copies to: R. Bushey  
J. Heagey  
E. Jan  
G. Lawson

COMPANY  
ESAB Welding & Cutting Products

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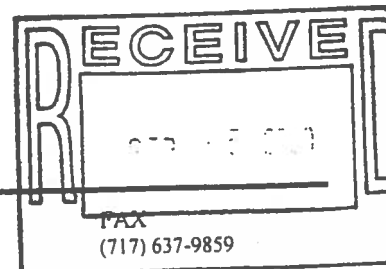


TABLE I

FUME GENERATION DATA FOR

ARCALOY 309L-16, ARCALOY ER309L, AND SHIELD-BRIGHT 309L X-TRA

<u>Product</u>	<u>Arcaloy 309L-16</u>	<u>Arcaloy ER309L</u>	<u>Shield-Bright 309L X-tra</u>
Size	1/8"	0.045"	0.045"
Lot Number	1D005B06	M612135	10930
Process	SMAW	GMAW	FCAW
Current (A)	90	175	185
Voltage (V)	23	26	29
Wire Feed Speed (ipm)	--	300	400
Shielding Gas	--	100% CO <sub>2</sub>	100% CO <sub>2</sub>
ESO	--	3/4"	3/4"
Fume Gen.Rate (g/min.)	0.178	0.246	0.548
Wt.% Electrode To Fume (%)	0.327	0.414	0.779

- NOTES:
1. Used 3/4" descaled A131 for weld test plate.
  2. Power source was L-Tec 650 CVCC using DCRP.
  3. Results are averages of three tests.

# ESAB Welding and Cutting Products

801 Wilson Ave., Hanover, PA 17331

To: S. E. Ferree

Date: 08-Aug-00

From: C. E. Bixler  
J. R. Bowers

Copies: K. S. Smith

Subject: Analysis of 0.125 ARCALOY 309L-16 Weld Fume

Fume Test No.: 1530  
R-NUMBER: R78485  
Lot: 1D005B06

Shielding Gas Used:  
Amps: 90  
Volts: 23

Analysis				
Element	Average	A	B	Method
Li				
B				
C				
F-	16.45	16.30	16.60	12
H2O sol F				
Na	6.58	6.54	6.62	10
Mg				
Al	0.9145	0.91	0.92	19
Si	4.785	4.77	4.80	7
S				
K	21.7	22.20	21.20	19
Ca	3.725	3.71	3.74	19
Ti	3.48	3.46	3.50	19
V				
Total Cr	6.105	5.87	6.34	19
H2O sol Cr6	4.2	4.18	4.22	9
H2O ins Cr6	0.047	0.05	0.04	9
Total Cr6	4.245	4.23	4.26	9
Total Cr3	1.86	1.64	2.08	14

Analysis				
Element	Average	A	B	Method
Mn	8.165	8.12	8.21	19
Fe	5.505	5.3	5.7	19
Co				
Ni	0.4975	0.50	0.49	19
Cu				
Zn				
As				
Sr				
Zr				
Nb				
Mo				
Cd				
Sn				
Sb				
Cs				
Ba				
W				
Hg				
Pb				
Bi				

Note: (-) negative sign means less than

**Remarks:**

Total Cr3 is a calculated value = Total Cr by Method 19 - Total Cr6 by Method 9

VALUES ARE TO BE CONFIRMED

**Methods List:**

Method No. Method

- 1 Na2CO3 Fusion / DCP
- 2 Graphite Furnace / AA
- 3 Water Soluble / ISE
- 4 Na2CO3 Fusion / ISE
- 5 Aqua Regia / Gravimetric
- 6 ASTM E38-85 / Titration
- 7 Na2O2 Fusion / Gravimetric
- 8 Aqua Regia Soluble / DCP
- 9 Lincoln Electric Method

Method No. Method

- 10 HNO3 + HF to Dryness / HNO3 / DCP
- 11 Ceric Sulfate Titration
- 12 Na2CO3 : K2CO3 Fusion / ISE
- 13 1, 5 Diphenylcarbohydrazide Colorimetric
- 14 Other, see remarks
- 15 Sodium Arsenite Titration
- 16 LECO Combustion
- 17 Na2CO3 Fusion / AA
- 18 Na2CO3 + H3BO3 Fusion / AA
- 19 Na2CO3 + H3BO3 Fusion / DCP

# ESAB Welding and Cutting Products

801 Wilson Ave., Hanover, PA 17331

To: S. E. Ferree

Date: 08-Aug-00

From: C. E. Bixler  
J. R. Bowers

Copies: K. S. Smith

Subject: Analysis of 0.045 ARCALOY ER309L Weld Fume

Fume Test No.: 1528  
R-NUMBER: R78484  
Lot: M612135

Shielding Gas Used: CO2  
Amps: 175  
Volts: 26

Analysis				
Element	Average	A	B	Method
Li				
B				
C				
F-				
H2O sol F				
Na				
Mg				
Al				
Si	3.725	3.67	3.78	7
S				
K				
Ca				
Ti				
V				
Total Cr	17.6	17.20	18.00	19
H2O sol Cr6	0.1225	0.13	0.12	9
H2O ins Cr6	0.041	0.03	0.05	9
Total Cr6	0.165	0.16	0.17	9
Total Cr3	17.4	17.00	17.80	14

Analysis				
Element	Average	A	B	Method
Mn	15	14.90	15.10	19
Fe	29.15	27.9	30.4	19
Co				
Ni	5.1	5.02	5.18	19
Cu				
Zn				
As				
Sr				
Zr				
Nb				
Mo				
Cd				
Sn				
Sb				
Cs				
Ba				
W				
Hg				
Pb				
Bi				

Remarks: Note: (-) negative sign means less than  
Total Cr3 is a calculated value = Total Cr by Method 19 - Total Cr6 by Method 9

### Methods List:

Method No.	Method
1	Na2CO3 Fusion / DCP
2	Graphite Furnace / AA
3	Water Soluble / ISE
4	Na2CO3 Fusion / ISE
5	Aqua Regia / Gravimetric
6	ASTM E38-85 / Titration
7	Na2O2 Fusion / Gravimetric
8	Aqua Regia Soluble / DCP
9	Lincoln Electric Method

Method No.	Method
10	HNO3 + HF to Dryness / HNO3 / DCP
11	Ceric Sulfate Titration
12	Na2CO3 : K2CO3 Fusion / ISE
13	1, 5 Diphenylcarbohydrazide Colorimetric
14	Other, see remarks
15	Sodium Arsenite Titration
16	LECO Combustion
17	Na2CO3 Fusion / AA
18	Na2CO3 + H3BO3 Fusion / AA
19	Na2CO3 + H3BO3 Fusion / DCP

# ESAB Welding and Cutting Products

801 Wilson Ave., Hanover, PA 17331

To: S. E. Ferree

Date: 08-Aug-00

From: C. E. Bixler  
J. R. Bowers

Copies: K. S. Smith

Subject: Analysis of 0.045 SB 309LXTRA Weld Fume

Fume Test No.: 1529  
R-NUMBER: R78483  
Lot: 10930

Shielding Gas Used: CO2  
Amps: 185  
Volts: 29

Analysis				
Element	Average	A	B	Method
Li				
B				
C				
F-	7.76	7.76	7.76	12
H2O sol F				
Na	6.37	6.34	6.40	10
Mg				
Al				
Si	5.255	5.37	5.14	7
S				
K	14.65	14.40	14.90	19
Ca				
Ti	1.75	1.76	1.74	19
V				
Total Cr	9.995	9.89	10.10	19
H2O sol Cr6	0.185	0.19	0.19	9
H2O ins Cr6	0.07	0.07	0.07	9
Total Cr6	0.26	0.26	0.26	9
Total Cr3	9.735	9.63	9.84	14

Analysis				
Element	Average	A	B	Method
Mn	9.73	9.76	9.70	19
Fe	9.045	9.0	9.1	19
Co				
Ni	1.76	1.77	1.75	19
Cu				
Zn				
As				
Sr				
Zr				
Nb				
Mo				
Cd				
Sn				
Sb				
Cs				
Ba				
W				
Hg				
Pb				
Bi				

Note: (-) negative sign means less than

**Remarks:**

Total Cr3 is a calculated value = Total Cr by Method 19 - Total Cr6 by Method 9

**Methods List:**

Method No. Method

- 1 Na2CO3 Fusion / DCP
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- 17 Na2CO3 Fusion / AA
- 18 Na2CO3 + H3BO3 Fusion / AA
- 19 Na2CO3 + H3BO3 Fusion / DCP



# ESAB Welding & Cutting Products

801 Wilson Avenue, Hanover, PA 17331

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15

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From Name: Roger Bushey

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Tel: 717/637-8911

Company: ESAB Welding & Cutting Products

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