

Shipbuilding and Ship repair –Residual Risk

PROPOSED EMISSION FACTORS FOR ABRASIVE MATERIALS

- 1. Bar Shot**
- 2. Coal Slag**
- 3. Copper Slag**
- 4. Garnet**
- 5. Specialty Sand**
- 6. Steel Grit**

July 26, 2005 Conference call

1:00 p.m. to 3:00 p.m. (E.T)

Address comments to:

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Overview of this workbook (abrasive blasting HAP emissions). Revised 2/25/2005 Mserageldin

- 1 This workbook calculates HAP emissions from abrasive blasting.
- 2 The summary worksheet is titled, "Abrasive Blast HAP Emissions". That worksheet calculates emissions for the hazardous air pollutants (HAPs) of chromium, hexavalent chromium, manganese, nickel and lead.
- 3 Other worksheets in this workbook include:
 - * "TSP EFs, 95 pct UCL" --Calculates the 95 percent upper confidence limit (UCL) values for total suspended particulate (TSP) from abrasive blasting using 6 abrasive blasting media: steel shot, coal slag, copper slag, garnet, sand, and steel grit.
 - * "HAP concentrations, all media"--Summarizes the average HAP concentrations for all the media (where each abrasive medium has its own worksheet listing all available concentration data).
 - * "coal slag HAP concentrations"--Gives all available data for HAP concentrations in coal slag, and calculates average values for each HAP. There are actually 6 worksheets of this type; there is one worksheet of this type for each of the 6 abrasive media.
 - * "PM-10 fraction, sand blasting"--Determines the PM-10 fraction for sand blasting, based on Reference 1 in EPA AP-42 Background Document for abrasive blasting.
 - * "PM-10 fraction, all media"--Takes the results from PM-10 fractions reported in NSRP 0552,
- 4 The "Abrasive Blast HAP Emissions" worksheet contains the following columns:
 - * Columns A to D identify the shipyard and the type of abrasive medium.
 - * Column E gives the abrasive usage, in Megagrams (Mg) per year.
 - * Column F gives the locations, and the proportions of usage that should be ascribed to each location.
 - * Columns G to K gives the HAP concentrations in each of the media, in parts per million (ppm). These data are from the "HAP concentrations, all media" worksheet (which in turn summarizes the averages for each of the 6 media).
 - * Column L gives the 95 percent upper confidence limits for the TSP emission factors, from the worksheet titled, "TSP EFs, 95 pct UCL"
 - * Column M gives the PM-10 fraction for the abrasive medium in question.
 - * Column N gives the PM-10 emissions, which are the product of usage times TSP emission factor times PM-10 fraction.
 - * Column O gives the fractional control for PM-10, where 1.00 equals 100 percent control, and 0.0 equals zero percent control. If shrouds were used, but not ducted to a control device zero percent control was used. If control devices were used, fractional control as reported by the shipyards in their Information Collection Request responses were used.

- * Column P gives the Controlled PM-10 emissions, in Mg/yr.
- * Columns Q through U give the HAP emissions (after controls), in kg/yr. This is the product of the controlled PM-10 emissions times the HAP concentration in the abrasive medium being considered.

5 References used for this workbook:

- a Kura, Bhaskar, 2004. "Environmentally-Friendly Abrasives," for University of New Orleans and Gulf Coast Region Maritime Technology Center, Final Report, November 2004.
- b NSRP, 1999. "NSRP 0552: Particulate Emission Factors for Blasting Operations and Other Potential Sources," September 18, 1999.
- c Kinsey, John S., 1989. "Assessment of Outdoor Abrasive Blasting," Interim Report, EPA Contract No. 68-02-4395, Work Assignment No. 29, U.S. EPA, Research Triangle Park, NC, September 11, 1989. (This is "Reference 1" in the EPA Background Document for Abrasive Blasting.)
- d U.S. EPA, 1997. "Emission Factor Documentation for AP-42 Section 13.2.6: Abrasive Blasting," Final Report, September 1997. Available at:
<http://www.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02-6.pdf>

PLEASE REVIEW THIS DOCUMENT AS WE PLAN TO
DISCUSS IT DURING THE STAKEHOLDER MEETING
ON JULY 26, 2005. M.S.

1	C	D	G					L	M	N	O	P	V
			HAP concentrations										
2	Product Trade Name	Description	Cr (ppm)	Cr+6 (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	TSP Emiss Factor (g/kg)	PM-10 Fraction	PM-10 Emissions, Uncontrolled (Mg/yr)	Fractional Control (1.0 = 100 pct)	PM-10 Emissions, Controlled (Mg/yr)	Comments
3	Amsteel shot	steel shot	1500	315.00	7950	0.2	7.0	83.8	0.13	0.81	0.00	0.8	
4	Amsteel shot	steel shot	1500	315.00	7950	0.2	7.0	83.8	0.13	0.81	0.00	0.8	
5	Lake sand	silica sand	2.9	0.6	99	9.5	0.66	115	0.23	0.75	0.00	0.7	
6	Lake sand	silica sand	2.9	0.6	99	9.5	0.66	115	0.23	0.75	0.00	0.7	
7	Lake sand	silica sand	2.9	0.6	99	9.5	0.66	115	0.23	0.50	0.00	0.5	
8	Lake sand	silica sand	2.9	0.6	99	9.5	0.66	115	0.23	0.50	0.00	0.5	
9	Copper Slag	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	7.91	0.00	7.9	Shrouding = 85% Control Efficiency
10	Copper Slag	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	7.91	0.95	0.4	Inside Tanks = 95% Control Efficiency
11	Copper Slag	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	3.87	0.00	3.9	Shrouding = 85% Control Efficiency
12	Copper Slag	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	0.00	0.00	0.0	Blast Pit/Shrouding = 65% Control Efficiency
13	Steel Grit	steel grit	1500	315.0	7950	830	7.0	32.1	0.13	0.06	0.00	0.1	Blast Pit/Shrouding = 65% Control Efficiency
14	Copper Slag	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	3.87	0.95	0.2	Inside Tanks = 95% Control Efficiency
15	Steel Shot	steel shot	1500	315.0	7950	830	7.0	83.8	0.13	0.45	0.95	0.0	Inside Tanks = 95% Control Efficiency
16	Steel Grit	steel grit	1500	315.0	7950	830	7.0	32.1	0.13	0.02	0.00	0.0	
17	Steel Grit	steel grit	1500	315.0	7950	830	7.0	32.1	0.13	0.00	0.00	0.0	1999 Not Reported
18	Steel Grit	steel grit	1500	315.0	7950	830	7.0	32.1	0.13	0.00	0.00	0.0	1999 Not Reported
19	Glass Bead	60/100 grit	2.9	0.6	99	9.5	0.66	115	0.23	0.01	0.00	0.0	Arsenic factor = 8.70e-004
20	Blast Room	--	2.9	0.6	99	9.5	0.66	115	0.13	0.00	0.00	0.0	1999 Not Reported
21	Alum Oxide	alum oxide	2.9	0.6	99	9.5	0.66	115	0.13	0.03	0.00	0.0	
22	Vacuum Syst	vacuum blast	2.9	0.6	99	9.5	0.66	69.4	0.13	0.00	0.00	0.0	1999 Not Reported
23	Vacuum Syst	vacuum blast	2.9	0.6	99	9.5	0.66	69.4	0.13	0.00	0.00	0.0	1999 Not Reported
24	#330 Shot	Blast Shot	35.7	7.50	7950	17.5	3.3	69.4	0.13	0.02	0.00	0.0	Emission factor(s) based on
25	#330 Shot	Blast Shot	35.7	7.50	7950	17.5	3.3	69.4	0.13	0.02	0.00	0.0	Title V Permit
26	Black Diamond Grit	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	0.37	0.00	0.4	
27	Black Diamond Grit	copper slag	26.5	5.6	1900	14.6	2.6	59.2	0.06	0.37	0.00	0.4	
28	GMA Garnet	Natural mixture of garnet and other trace minerals	3.4	0.71	150	9.5	0.57	136	0.12	6.16	0.00	6.2	
29	G40	silicate material	2.9	0.61	99	9.5	0.66	115	0.23	0.88	0.00	0.9	Blast media composition based on 1998 Industrial Hygiene testing
30	Aluminum Oxide	fused aluminum oxide - refractory oxide	2.9	0.6	99	9.5	0.66	115	0.23	1.44	0.00	1.4	Blast media composition based on 1998 Industrial Hygiene testing
31	Garnet	silicate material	2.9	0.61	99	9.5	0.66	115	0.23	0.19	0.00	0.2	Blast media composition based on 1998 Industrial Hygiene testing
32	S460	cast steel (Steel Shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.02	0.00	0.0	Blast media composition based on 1998 Industrial Hygiene testing
33	S390	cast steel (Steel Shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.03	0.00	0.0	Blast media composition based on 1998 Industrial Hygiene testing
34	Kleen Blast	Blast material	35.7	7.50	7950	17.5	3.3	69.4	0.13	1.69	0.00	1.7	Composition based on laboratory analysis of disposed blast material; MSDS sheets indicate no toxic air contaminants present.
35	Kleen Blast	Blast material	35.7	7.50	7950	17.5	3.3	69.4	0.13	15.19	0.00	15.2	Composition based on laboratory analysis of disposed blast material; MSDS sheets indicate no toxic air contaminants present.
36	Kleen Blast	Blast material	35.7	7.50	7950	17.5	3.3	69.4	0.13	0.88	0.00	0.9	Composition based on laboratory analysis of disposed blast material; MSDS sheets indicate no toxic air contaminants present.
37	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	17.04	0.00	17.0	DWR called Co.; they reported 6.37 tons of PM-10 for 1999.
38	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	17.04	0.00	17.0	DWR called Co.; they reported 6.37 tons of PM-10 for 1999.
39	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	17.04	0.00	17.0	DWR called Co.; they reported 6.37 tons of PM-10 for 1999.
40	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	17.04	0.00	17.0	DWR called Co.; they reported 6.37 tons of PM-10 for 1999.
41	Coal Slag	Coal Slag	69	14.5	73	71	19	69.4	0.24	65.97	0.00	66.0	

1	C	D	G	H	I	J	K	L	M	N	O	P	V
	Product Trade Name	Description	HAP concentrations					TSP	PM-10 Fraction	PM-10 Emissions, Uncontrolled (Mg/yr)	Fractional Control (1.0 = 100 pct)	PM-10 Emissions, Controlled (Mg/yr)	Comments
Cr (ppm)			Cr+6 (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	Emiss Factor (g/kg)						
42	Coal Slag	Coal Slag	69	14.5	73	71	19	69.4	0.24	13.74	0.00	13.7	
43	Coal Slag	Coal Slag	69	14.5	73	71	19	69.4	0.24	13.74	0.00	13.7	
44	Coal Slag	Coal Slag	69	14.5	73	71	19	69.4	0.24	13.74	0.00	13.7	
45	Black Beauty	95 %Coal Slag (+ steel shot + garnet)	69	14.5	73	71	19	69.4	0.24	68.52	0.00	68.5	
46	Black Beauty	95 %Coal Slag (+ steel shot + garnet)	69	14.5	73	71	19	69.4	0.24	17.12	0.00	17.1	
47	Not provided	Not provided (assumed to be coal slag)	69	14.5	73	71	19	69.4	0.24	45.80	0.00	45.8	
48	Not provided	Not provided (assumed to be coal slag)	69	14.5	73	71	19	69.4	0.24	29.15	0.00	29.1	
49	Not provided	Not provided (assumed to be coal slag)	69	14.5	73	71	19	69.4	0.24	8.33	0.00	8.3	
50	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	5.22	0.00	5.2	
51	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	5.22	0.00	5.2	
52	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	5.22	0.00	5.2	
53	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	5.22	0.00	5.2	
54	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	5.22	0.00	5.2	
55	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	5.22	0.00	5.2	
56	Not provided	(Default = 50% steel shot)	1500	315.00	7950	0.2	7.0	83.8	0.13	5.22	0.00	5.2	
57	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
58	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
59	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
60	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
61	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
62	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
63	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.23	7.65	0.00	7.6	
64	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
65	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
66	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
67	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
68	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
69	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
70	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
71	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
72	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
73	Not provided	(Default = 50% steel shot)	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	
74	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
75	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
76	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
77	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
78	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
79	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
80	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
81	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
82	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
83	Not provided	(Default = 50% coal slag)	69	14.5	73	71	19	69.4	0.24	8.93	0.00	8.9	
84	Coal Slag	Coal Slag	69	14.5	73	71	19	69.4	0.24	77.38	0.00	77.4	Controls = curtains on each end of drydocks
85	Coal Slag	Coal Slag	69	14.5	73	71	19	69.4	0.24	8.59	0.00	8.6	Controls = curtains on each end of drydocks
86	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	34.86	0.00	34.9	Control = Baghouse (99% efficient)
87	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	6.54	0.00	6.5	Control = Baghouse (99% efficient)
88	Garnet + Coal Slag	Garnet + Coal Slag	69	14.5	73	71	19	69.4	0.24	3.33	0.00	3.3	Uncontrolled
89	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	0.60	0.00	0.6	Tanks: 100% capture & 100% control
90	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	0.03	0.00	0.0	Tanks: 100% capture & 100% control
91	Garnet	Garnet	3.40	0.71	150	9.5	0.57	136.0	0.12	28.64	0.00	28.6	Keel: 100% capture & 100% control
92	Black Beauty	Coal Slag	69	14.5	73	71	19	69.4	0.23	4.02	0.00	4.0	Tanks: 100% capture & 99.8% control

	C	D	G	H	I	J	K	L	M	N	O	P	V
1	Product Trade Name	Description	HAP concentrations					TSP Emiss Factor (g/kg)	PM-10 Fraction	PM-10 Emissions, Uncontrolled (Mg/yr)	Fractional Control (1.0 = 100 pct)	PM-10 Emissions, Controlled (Mg/yr)	Comments
2			Cr (ppm)	Cr+6 (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)						
93	Black Beauty	Coal Slag	69	14.5	73	71	19	69.4	0.23	8.90	0.00	8.9	Sub int.: 100% capture & 99.17% control
94	Garnet	Garnet	3.40	0.71	150	9.5	0.57	136	0.12	0.04	0.00	0.0	Sub ext.: 100% capture & 100% control
95	Aluminum Oxide	Aluminum Oxide	2.9	0.6	99	9.5	0.66	115	0.23	0.18	0.00	0.2	Sub tanks: 100% capture & 100% control
96	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	0.18	0.00	0.2	Shapes: 100% capture & 99% control
97	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.13	0.06	0.00	0.1	Plates: 100% capture & 95% control
98	Garnet	Garnet	3.40	0.71	150	9.5	0.57	136	0.12	0.53	0.00	0.5	Dust collector: 100% capture & 100% control
99	Aluminum Oxide	Aluminum Oxide	2.9	0.6	99	9.5	0.66	115	0.23	0.32	0.00	0.3	Dust collector: 100% capture & 100% control
100	Aluminum Oxide	Aluminum Oxide	2.9	0.6	99	9.5	0.66	115	0.23	3.04	0.00	3.0	Dust collector: 100% capture & 100% control
101	Aluminum Oxide	Aluminum Oxide	2.9	0.6	99	9.5	0.66	115	0.23	1.34	0.00	1.3	Dust collector: 100% capture & 100% control
102	Garnet	Garnet	3.40	0.71	150	9.5	0.57	136	0.12	1.26	0.00	1.3	Dust collector: 100% capture & 95% control
103	Aluminum Oxide	Aluminum Oxide	2.9	0.6	99	9.5	0.66	115	0.23	3.45	0.00	3.5	Dust collector: 100% capture & 95% control
104	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.23	0.11	0.00	0.1	Dust collector: 100% capture & 95% control
105	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.23	0.24	0.00	0.2	Parts: 100% capture & 99% control
106	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.23	0.02	0.00	0.0	Parts - tumblast machine: 95% control
107	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.23	0.02	0.00	0.0	Parts - tumblast machine: 95% control
108	Steel Shot	Steel Shot	1500	315.00	7950	830	7.0	83.8	0.23	0.12	0.00	0.1	Parts- wheelabrator: 95% control
109	Med. Grade Grit	Med. Grade Grit	69	14.5	73	71	19	69.4	0.23	0.77	0.00	0.8	Enclosure: 100% capture & 100% control

2/14/2005 (text revised)

Painted Steel Panels: We used for each material 27 test values from the UNO 2005 report on abrasive blasting to calculate emission factors (95 % UCL of the mean). The UNO test runs were performed under a range of nozzle pressures (80, 100, & 120 Psi) and abrasive flow rates: (3,4,&5 Turns).

No.	Abrasive Material	Statistics			95% UCL (g/kg)	Comments
		Mean (g/kg)	Maximum (g/kg)	Sample Size		
1	Bar Shot	77.3	118	27	83.8	Student's UCL
2	Coal Slag	65.4	85.8	27	69.4	Student's UCL
3	Copper Slag	55.4	81.5	27	59.2	Student's UCL
4	Garnet	123	182	26	136	Student's UCL (Potential Outlier: 258 g/kg, removed base on non-parametric boxplot)
5	Specialty Sand	98.2	211	27	115	Student's UCL
6	Steel Grit	32.1	62.3	26	36.8	Student's UCL (Potential Outlier: 76.10 g/kg, removed base on non-parametric boxplot)

Note: Data presented to 3 significant figures

Report: "Environmentally -Friendly Abrasives, University of New Orleans and Gulf Coast Region Maritime Technology Center, Final Report, January 2005, by Dr. Bhaskar Kura

Abrasive Type	Total Chromium (ppm)	Hex. Chromium (ppm)	Manganese (ppm)	Nickel (ppm)	Lead (ppm)
Steel Shot	0.25	0.053	1.0	?	?
Coal Slag	69	14.5	73	71	19
Copper Slag	26.5	5.6	1900	14.6	2.6
Garnet	3.4	0.71	150	9.5	0.57
Silica Sand	3	0.61	99	10	0.66
Steel Grit	1500	315	7950	830	7.0

Note: All hexavalent chromium values are 21 percent of total chromium values, based on reporting by Atlantic Marine for coal slag. Atlantic Marine reported 0.77 ppm of hexavalent chromium, for 3.6 ppm of total chromium.

Species:	Total Chromium (ppm)		Hex. Chromium (ppm)	Manganese (ppm)	Nickel (ppm)		Lead (ppm)	
	KTA Report	NAASCO Transmittal			KTA Report	NAASCO Transmittal	KTA Report	NAASCO Transmittal
Data Source:								
Sample number								
1	46.0	0.6		2200	24	0.9	1.9	3.5
2	33.0			1600	19		3.2	
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
Average (all samples)	26.5			1900	14.6		2.6	

Species:	Total Chromium (ppm)					Hex. Chromium (ppm)	Manganese (ppm)		Nickel (ppm)		Lead (ppm)	
Data Source:	EPRI Technical Report ¹	Harsco	Newport News Shipyard	Atlantic Marine	KTA Report	Atlantic Marine	EPRI Technical Report ¹	KTA Report	EPRI Technical Report ¹	KTA Report	EPRI Technical Report ¹	KTA Report
Sample number							average					
1	143	3.5	24	3.6	2.4	0.77	66	6.3	31	9.5	8	0.63
2	130	37			1.1		66	2.8	75	9.5	8	0.31
3	158	8.4					66		31		8	
4	122	78					66		138		8	
5	55	39					66		102		102	
6	213	17					66		177		45	
7	223	22					66		78		8	
8		3.5					270		63		8	
9		150					66		62		8	
10		12										
11												
12												
Average (all samples)		69				0.77		73		71		19

Species:	Total Chromium (ppm)	Hex. Chromium (ppm)	Manganese (ppm)	Nickel (ppm)	Lead (ppm)
Data Source:	Jeffboat ICR Response	Jeffboat ICR Response	Jeffboat ICR Response	Jeffboat ICR Response	Jeffboat ICR Response
Sample number					
1	0.25		1.3	0.2	
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Average (all samples)	0.25		1	0.2	

Species:	Total Chromium (ppm)	Hex. Chromium (ppm)	Manganese (ppm)	Nickel (ppm)	Lead (ppm)
Data Source:	KTA Report	KTA Report	KTA Report	KTA Report	KTA Report
Sample number					
1	1700		8900	980	9.2
2	1300		7000	680	4.7
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Average (all samples)	1500		7950	830	7.0

Garnet HAP Concentrations

Species:	Total Chromium (ppm)	Hex. Chromium (ppm)	Manganese (ppm)	Nickel (ppm)	Lead (ppm)
Data Source:	KTA Report	KTA Report	KTA Report	KTA Report	KTA Report
Sample number					
1	3.7		130	9.5	0.82
2	3.0		170	9.5	0.31
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Average (all samples)	3.4		150	9.5	0.57

Silica Sand HAP Concentrations

Species:	Total Chromium (ppm)	Hex. Chromium (ppm)	Manganese (ppm)	Nickel (ppm)	Lead (ppm)
Data Source:	KTA Report	KTA Report	KTA Report	KTA Report	KTA Report
Sample number					
1	2.7		88	9.5	1.0
2	3.0		110	9.5	0.31
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Average (all samples)	2.9		99	9.5	0.66

	Emission Factor (kg/kg)			Fraction of Total PM		
	Total PM	PM-10	PM-2.5	Total PM	PM-10	PM-2.5
<u>Clean Surface</u>						
5 mph	0.029	0.017	0.0024	1.00	0.59	0.08
10 mph	0.068	0.0081	0.0022	1.00	0.12	0.03
15 mph	0.092	0.0045	0.0009	1.00	0.05	0.01
Average	0.063	0.0099	0.0018	1.00	0.16	0.03
<u>Painted Surface</u>						
5 mph	0.027	0.0059	0.001	1.00	0.22	0.04
10 mph	0.07	0.052	0.00086	1.00	0.74	0.01
15 mph	0.091	0.0091	0.0013	1.00	0.10	0.01
Average	0.063	0.022	0.0011	1.00	0.36	0.02
<u>Oxidized Surface</u>						
5 mph	0.025	0.0057	0.0018	1.00	0.23	0.07
10 mph	0.026	0.014	0.0011	1.00	0.54	0.04
15 mph	0.089	0.003	0.00026	1.00	0.03	0.00
Average	0.047	0.008	0.0011	1.00	0.16	0.02
Average, all surfaces	0.057	0.013	0.0013	1.00	0.23	0.023
5 mph	0.027	0.013	0.0013	1.00	0.49	0.05
10 mph	0.055	0.013	0.0013	1.00	0.24	0.02
15 mph	0.091	0.013	0.0013	1.00	0.15	0.01
Average, all wind speeds	0.058	0.013	0.0013	1.00	0.23	0.023
<u>From NSRP 0552 (for sand)</u>						
80 psi				0.00753	0.00133	
122 psi				0.00843	0.00123	
Average				0.0080	0.0013	
Ratio, AP-42 Ref. 1 to NSRP 0552					28.8	17.8

<u>Abrasive Medium</u>	<u>NSRP PM-10 fraction (2)</u>	<u>EPA PM-10 Fraction for Sand (3)</u>	<u>Adjusted PM-10 fraction</u>
steel shot (1)	0.439		0.13
coal slag	0.835		0.24
copper slag	0.213		0.06
garnet	0.412		0.12
silica sand	0.798	0.23	0.23
steel grit (1)	0.439		0.13

Notes:

- (1) NSRP 0552 does not have values for steel shot or steel grit, so value for "hematite" is used.
- (2) NSRP PM-10 fraction is from table on pages "Task 5 Page 2" and "Task 5 Page 3" of NSRP 0552.
- (3) EPA PM-10 fraction for sand is from EPA AP-42 background document, table