CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Industrial Hygiene Study For Coal Slag Abrasive using Clemco's Wetblast Injection System During Open Air Abrasive Blasting

Report Date: October 13, 2015
Test Dates: October 30, 2014 – Clemco's Wetblast Injection System

Purpose: The Purpose Of This Industrial Hygiene Study Is To Determine The Blaster's Exposure to the Hazardous Substances Contained in Coal Slag Abrasive during Wet Blasting Open Air Operations.

Disclaimer: This Industrial Hygiene Study Reports Only On The Test Being Performed And Cannot Be Used To Determine Worker Exposure In The Workplace. This Study Is Intended To Provide General Knowledge Of Worker Exposure During Abrasive Blasting Operations Using Coal Slag Abrasive During Open Air Blasting. Employers And End Users Shall Perform Their Own Industrial Hygiene Study To Ascertain Their Exposure To The Hazardous Substances Contained In Coal Slag Abrasive During Wet Blasting Operations.

Coal Slag: 30/60 Mesh, 100 pound bags

Hazardous Constituents	Cas #	Percent
Aluminum Oxide	1344-28-1	17-25
Beryllium	7440-41-7	0-0.001
Cadmium	7440-43-9	0-0.001
Calcium Oxide	1305-78-8	3-15
Iron Oxide	1309-37-1	7-31
Magnesium Oxide	1309-48-4	0- 4
Manganese	7439-96-5	0-0.05
Potassium Oxide	12136-45-7	0- 3
Silicon Dioxide (Amorphous Silica)	7631-86-9	41-53
Silicon Dioxide (Crystalline Silica)	14808-60-7	<0.1
Titanium Dioxide	13463-67-7	0- 2

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Blasting Equipment:

Wetblast Injection System

Test Equipment:

Galson Laboratory Rental Program

3 each Sampling SKC AirCheck 52 Air Pumps		3 of each Cassette 2 Cassettes For Test & 1 Control
SKC AirCheck 52 @ 2.0LPM	For	MPW 2 Piece Cassette To Sample Aluminum Oxide Titanium Dioxide
SKC AirCheck 52 @ 2.0LPM	For	MPW 3 Piece Cassette To Sample Beryllium Cadmium Calcium Oxide Iron Oxide Magnesium Oxide Manganese
SKC AirCheck 52 @ 2.5LPM	For	M37MCE Cassette To Sample Silica Dioxide (Crystalline & Amorphous) Quartz, Cristobalite, Tridymite

CLEMCO ZERO Blast Cabinets INDUSTRIAL Blast Facilities by CLEMCO AEROLYTE Systems

CLEMCO®
INDUSTRIES CORP.
One Cable Car Drive, Washington, MO 63090
636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Test Layout:

Test Procedure:

The purpose of this Industrial Hygiene Audit was to determine the level of exposure to the hazardous constituents commonly found in 30/60 mesh coal slag abrasive.

Set up:

Three monitoring cassettes were set up 3.5 feet away from the test panel and 3.5 feet above the ground. A #8 CXD Nozzle was placed 3.0 feet away from the test panel and 3.5 feet above the ground. The cassettes were secured to the nozzle/test cart. The test panel was a flat high carbon steel plate. The WIS operator set the blast machine pressure at 90psi, then adjusted the metering valves to obtain the optimum strip rate of approximately 3.0 square feet per minute. The abrasive metering valve was turned three full turns and the water metering valve was turned ½ of a turn. Once the optimum strip rate was obtained the nozzle was secured to the nozzle/test cart, next to the sampling cassettes. Prior to starting the test, the blast machine was loaded with 4 each, 100 pound bags of coal slag, and the 30 inch diameter water tank was filled to ¾ full, and a mark was placed at the top fill line.

Procedure:

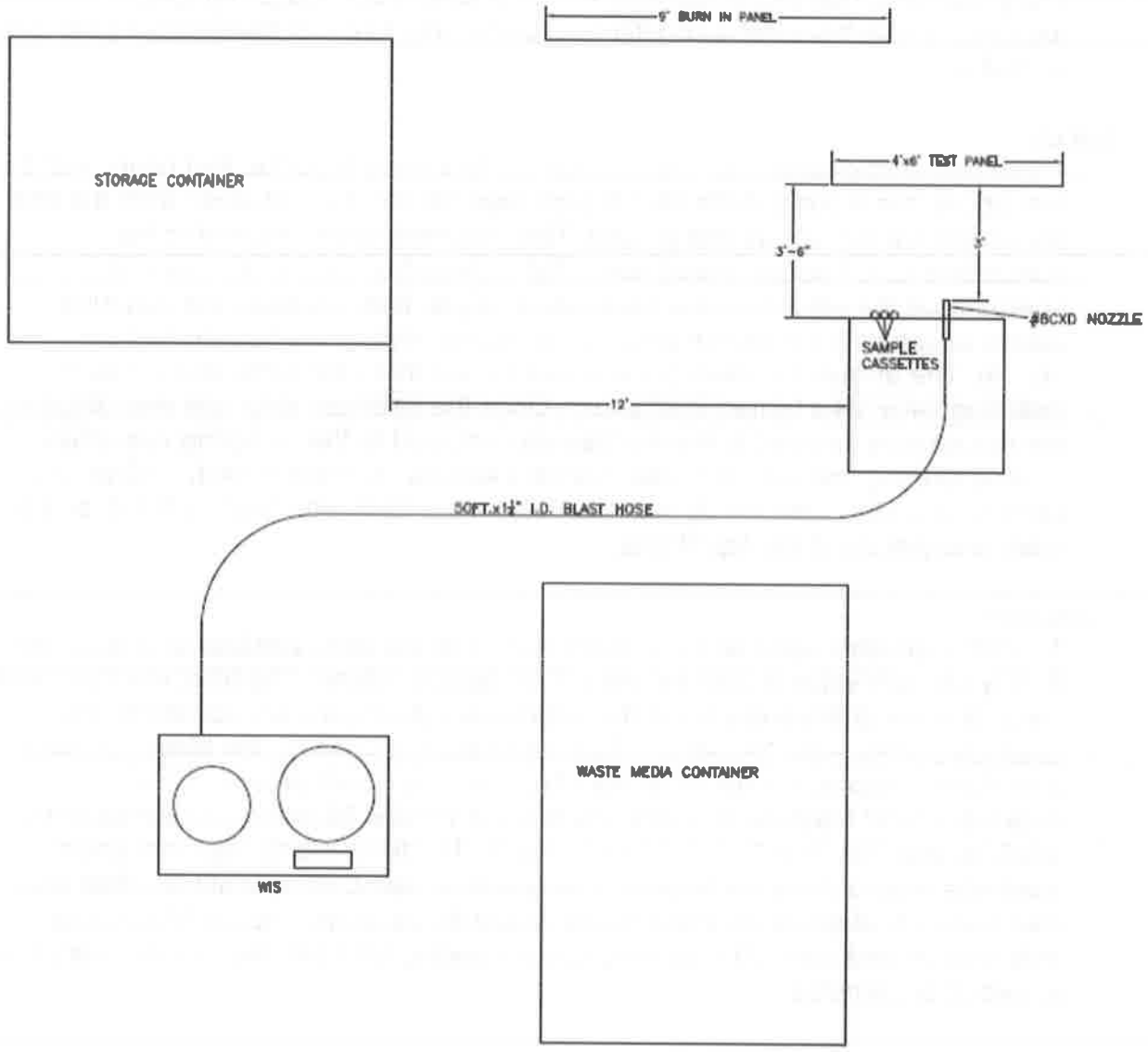
The WIS operator secured the remote control to the open position and used the Safety pit-cock valve to turn on and off the blast machine. The blast machine was set at 90psi and the pressure at the nozzle was checked and read 80psi. The cassette pumps were turned on, then the operator turned on the blast machine and allowed it to blast until it ran out of media. The operator was allowed to choke the blast machine to verify it was out of media. Blasting until the full blast machine was empty was considered a cycle. The time, media use and water level was recorded for each cycle. The pressure was continuously checked and maintained at 90psi at the blast machine and 80 psi at the nozzle. Monitoring only took placed during the blasting cycle. Loading time between cycles were not recorded or sampled.

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Testing Diagram:



CLEMCO · ZERO Blast Cabinets · INDUSTRIAL Blast Facilities by CLEMCO · AEROLYTE Systems

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Cycle Data:

Time (Minutes)	Bags Used	Water Use (Inches)	Lbs. of Media Per Hours	Gallons of Water Per Hour
23	4	3/4	1,043	6.0
24	3	3/4	750	5.7
20	4	3/8	1,200	3.4
19	4	1	1,263	9.7
16	4	3/4	1,500	8.6
16	4	1/2	1,500	5.7
16	4	3/4	1,500	8.6
23	4	1-1/2	1,043	12.0
16	4	3/4	1,500	8.6
Total/Average				
173	35	7-1/8	1,214	7.6

Hazardous Constituents Exposure:

Coal Slag: 30/60 Mesh, 100 pound bags

Hazardous Constituents	Cas #	Percent %	TWA mg/m³	OSHA PEL mg/m³
Aluminum Oxide	1344-28-1	17-25	170.0000	15.000
Beryllium	7440-41-7	0-0.001	0.00037	0.002
Cadmium	7440-43-9	0-0.001	<0.00004	0.005
Calcium Oxide	1305-78-8	3-15	25.00000	5.000
Iron Oxide	1309-37-1	7-31	9.00000	10.000
Magnesium Oxide	1309-48-4	0-4	4.40000	15.000
Manganese	7439-96-5	0-0.05	0.03700	15.000
Potassium Oxide	12136-45-7	0-3	170.0000	15.000
Silicon Dioxide (Amorphous Silica)	7631-86-9	41-53	<0.0120	0.800
Silicon Dioxide (Crystalline Silica)	14808-60-7	<0.1	0.0170	0.098
Titanium Dioxide	13463-67-7	0- 2	170.000	15.000

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Concentration Of Hazardous Constituents And Associated Permissible Exposure Limits

Constiuent	Pounds/Hour & mg/m^3												
	100	200	300	400	500	600	700	800	900	1000	1100	1200	PEL
Aluminum Oxide	14.17	28.33	42.50	56.67	70.83	85.00	99.17	113.33	127.50	141.67	155.83	170.00	15.000
Beryllium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Cadmium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
Calcium Oxide	2.08	4.17	6.25	8.33	10.42	12.50	14.58	16.67	18.75	20.83	22.92	25.00	5.000
Iron Oxide	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00	10.000
Magnesium Oxide	0.37	0.73	1.10	1.47	1.83	2.20	2.57	2.93	3.30	3.67	4.03	4.40	15.000
Manganese	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	5.000
Potassium Oxide	14.17	28.33	42.50	56.67	70.83	85.00	99.17	113.33	127.50	141.67	155.83	170.00	15.000
Silicon Dioxide (Amorphous Silica)	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.800
Silicon Dioxide (Crystalline Silica)	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.098
Titanium Dioxide	14.17	28.33	42.50	56.67	70.83	85.00	99.17	113.33	127.50	141.67	155.83	170.00	15.000

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Test Photos:

Cassette & Nozzle Placement

Pump Placement

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Location of Target From Cassettes & Nozzle

Blasting Against Target

CLEMCO · ZERO Blast Cabinets · INDUSTRIAL Blast Facilities by CLEMCO · AEROLYTE Systems

Quality Management System - ISO 9001:2008 certified

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Conclusion:

Dry blasting with Coal Slag requires a type CE Supplied Air Respirator at all times. This is required by:

1910.94(a)(5)(i)
Employers must use only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) under 42 CFR part 84 to protect employees from dust produced during abrasive-blasting operations.

1910.94(a)(5)(ii) **Abrasive-blasting respirators shall be worn** by all abrasive-blasting operators:

1910.94(a)(5)(ii)(a) When working inside of blast-cleaning rooms, or

1910.94(a)(5)(ii)(b) When using silica sand in manual blasting operations where the nozzle and blast are not physically separated from the operator in an exhaust ventilated enclosure, or

1910.94(a)(5)(ii)(c) Where concentrations of toxic dust dispersed by the abrasive blasting **may** exceed the limits set in 1910.1000 and the nozzle and blast are not physically separated from the operator in an exhaust-ventilated enclosure.

1910.94(a)(5)(iii) Properly fitted particulate filter respirators, commonly referred to as dust-filter respirators, may be used for short, intermittent, or occasional dust exposures such as cleanup, dumping of dust collectors, or unloading shipments of sand at a receiving point, when it is not feasible to control the dust by enclosure, exhaust ventilation, or other means. The respirators used must be approved by NIOSH under 42 CFR part 84 for protection against the specific type of dust encountered.

1910.94(a)(5)(iii)(a) Dust-filter respirators may be used to protect the operator of outside abrasive-blasting operations where nonsilica abrasives are used on materials having low toxicities.

1910.94(a)(5)(iii)(b) Dust-filter respirators shall not be used for continuous protection where silica sand is used as the blasting abrasive, or toxic materials are blasted.

1910.94(a)(5)(iv) For employees who use respirators required by this section, the employer must implement a respiratory protection program in accordance with 29 CFR 1910.134.

As a general guideline users of Coal Slag for Abrasive Blasting will exceed the Permissible Exposure limits

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Industrial Hygiene Study For Coal Slag Abrasive During Open Air Abrasive Blasting Using Clemco's Dry Blasting Machine

Report Date: October 13, 2015
Test Dates: October 31, 2014 – Clemco's Dry Abrasive Blast Machine

Purpose: The Purpose Of This Industrial Hygiene Study Is To Determine The Blaster's Exposure to the Hazardous Substances Contained in Coal Slag Abrasive during Dry Blasting Open Air Operations.

Disclaimer: This Industrial Hygiene Study Reports Only On The Test Being Performed And Cannot Be Used To Determine Worker Exposure In The Workplace. This Study Is Intended To Provide General Knowledge Of Worker Exposure During Abrasive Blasting Operations Using Coal Slag Abrasive During Open Air Blasting. Employers And End Users Shall Perform Their Own Industrial Hygiene Study To Ascertain Their Exposure To The Hazardous Substances Contained In Coal Slag Abrasive During Dry Blasting Operations.

Coal Slag: 30/60 Mesh, 100 pound bags

Hazardous Constituents	Cas #	Percent
Aluminum Oxide	1344-28-1	17-25
Beryllium	7440-41-7	0-0.001
Cadmium	7440-43-9	0-0.001
Calcium Oxide	1305-78-8	3-15
Iron Oxide	1309-37-1	7-31
Magnesium Oxide	1309-48-4	0- 4
Manganese	7439-96-5	0-0.05
Potassium Oxide	12136-45-7	0- 3
Silicon Dioxide (Amorphous Silica)	7631-86-9	41-53
Silicon Dioxide (Crystalline Silica)	14808-60-7	<0.1
Titanium Dioxide	13463-67-7	0- 2

Blasting Equipment:

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Clemco Blast Machine

Test Equipment:

Galson Laboratory Rental Program

3 each Sampling SKC AirCheck 52 Air Pumps

SKC AirCheck 52 @ 2.0LPM For
SKC AirCheck 52 @ 2.0LPM For
SKC AirCheck 52 @ 2.5LPM For

3 of each Cassette
2 Cassettes For Test & 1 Control
MPW 2 Piece Cassette To Sample
- Aluminum Oxide
- Titanium Dioxide

MPW 3 Piece Cassette To Sample
- Beryllium
- Cadmium
- Calcium Oxide
- Iron Oxide
- Magnesium Oxide
- Manganese

M37MCE Cassette To Sample
- Silica Dioxide (Crystalline & Amorphous)
- Quartz, Cristobalite, Tridymite

CLEMCO ZERO Blast Cabinets INDUSTRIAL Blast Facilities by CLEMCO AEROLYTE Systems

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Test Layout:

Test Procedure:

The purpose of this Industrial Hygiene Audit was to determine the level of exposure to the hazardous constituents commonly found in 30/60 mesh coal slag abrasive.

Set up:

Three monitoring cassettes were set up 3.5 feet away from the test panel and 3.5 feet above the ground. A #8 CXD Nozzle was placed 3.0 feet away from the test panel and 3.5 feet above the ground. The cassettes were secured to the nozzle/test cart. The test panel was a flat high carbon steel plate. The operator set the blast machine pressure at 90psi, then adjusted the metering valves to obtain the optimum strip rate of approximately 4.0 square feet per minute. The abrasive metering valve was turned three full turns. Once the optimum strip rate was obtained the nozzle was secured to the nozzle/test cart, next to the sampling cassettes. Prior to starting the test, the blast machine was loaded with 4 each, 100 pound bags of coal slag.

Procedure:

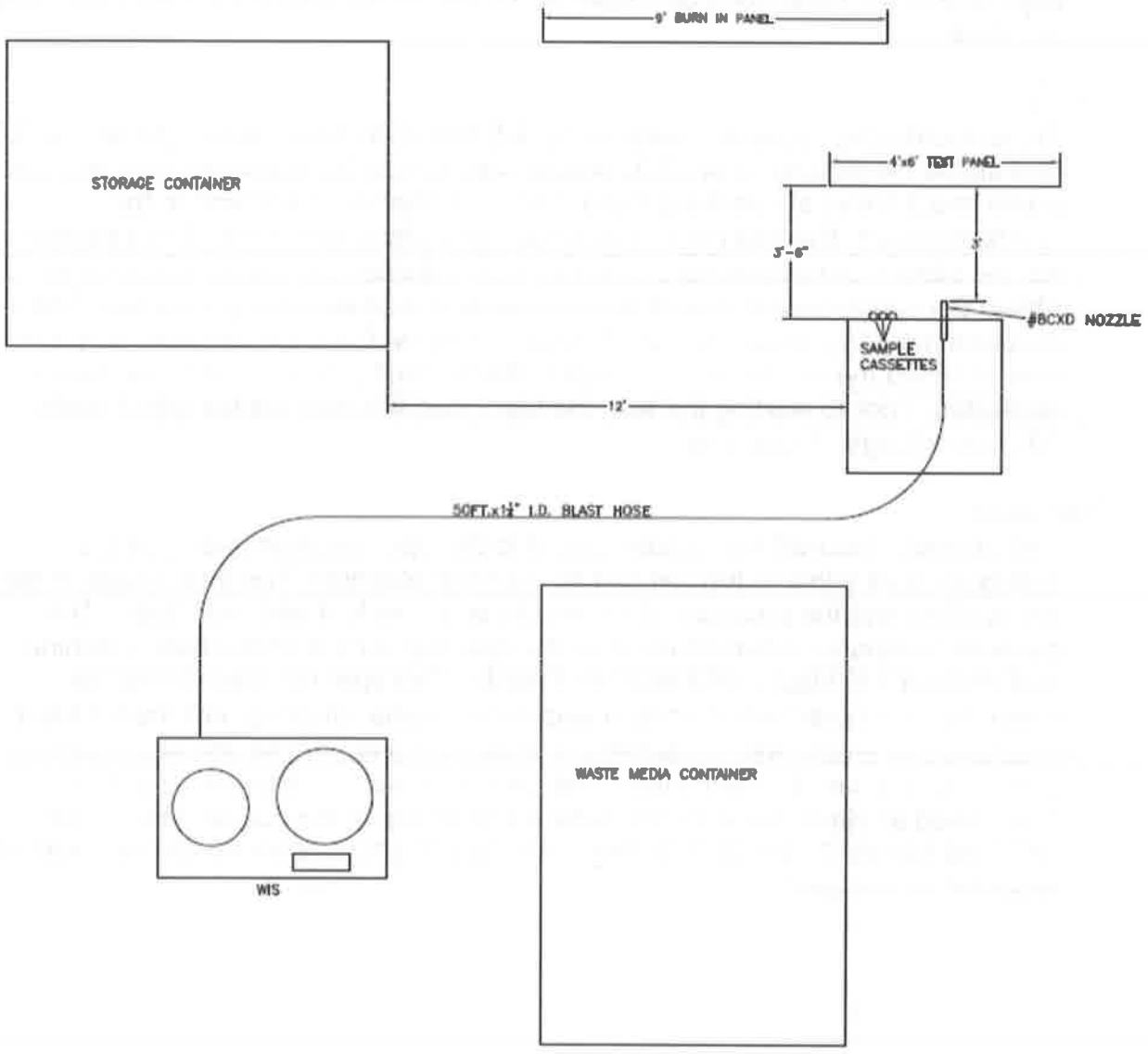
The operator secured the remote control to the open position and used the Safety pit-cock valve to turn on and off the blast machine. The blast machine was set at 90psi and the pressure at the nozzle was checked and read 80psi. The cassette pumps were turned on, then the operator turned on the blast machine and allowed it to blast until it ran out of media. The operator was allowed to choke the blast machine to verify it was out of media. Blasting until the full blast machine was empty was considered a cycle. The time, media use and water level was recorded for each cycle. The pressure was continuously checked and maintained at 90psi at the blast machine and 80 psi at the nozzle. Monitoring only took placed during the blasting cycle. Loading time between cycles were not recorded or sampled.

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Testing Diagram:



CLEMCO · Blast Cabinets · INDUSTRIAL Blast Facilities by CLEMCO · AEROLYTE Systems

CLEMCO®
INDUSTRIES CORP.
One Cable Car Drive, Washington, MO 63090
636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Cycle Data:

Time (Minutes)	Bags Used	Lbs. of Media Per Hours
22	3	818
29	4	827
17	4	1,411
16	4	1,500
17	4	1,411
17	4	1,411
Total/Average		
118	23	1,169

Hazardous Constituents Exposure:

Coal Slag: 30/60 Mesh, 100 pound bags

Hazardous Constituents	Cas #	Percent %	TWA mg/m^3	OSHA PEL mg/m^3
Aluminum Oxide	1344-28-1	17-25	210.0000	15.00 (Total Dust)
Beryllium	7440-41-7	0-0.001	0.0028	0.002
Cadmium	7440-43-9	0-0.001	<0.00006	0.005
Calcium Oxide	1305-78-8	3-15	86.00000	5.000
Iron Oxide	1309-37-1	7-31	46.00000	10.000
Magnesium Oxide	1309-48-4	0-4	16.40000	15.000
Manganese	7439-96-5	0-0.05	0.14000	5.000
Potassium Oxide	12136-45-7	0-3	210.00	15.00 (Total Dust)
Titanium Dioxide	13463-67-7	0- 2	210.00	15.00 (Total Dust

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

INHALATION HAZARDS BY CONSTITUENTS

INAHALATION HAZARDS BY CONSTITUENTS IN mg/m^3													
Constituent	Pounds/Hour												PEL
	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	
Aluminum Oxide	17.5000	35.0000	52.5000	70.0000	87.5000	105.0000	122.5000	140.0000	157.5000	175.0000	192.5000	210.0000	15
Beryllium	0.0002	0.0005	0.0007	0.0009	0.0012	0.0014	0.0016	0.0019	0.0021	0.0023	0.0026	0.0028	0.0020
Cadmium	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0050
Calcium Oxide	7.1667	14.3333	21.5000	28.6667	35.8333	43.0000	50.1667	57.3333	64.5000	71.6667	78.8333	86.0000	5.0000
Iron Oxide	3.8333	7.6667	11.5000	15.3333	19.1667	23.0000	26.8333	30.6667	34.5000	38.3333	42.1667	46.0000	10.0000
Magnesium Oxide	1.3333	2.6667	4.0000	5.3333	6.6667	8.0000	9.3333	10.6667	12.0000	13.3333	14.6667	16.0000	15.0000
Manganese	0.0117	0.0233	0.0350	0.0467	0.0583	0.0700	0.0817	0.0933	0.1050	0.1167	0.1283	0.1400	5.0000
Potassium Oxide	17.5000	35.0000	52.5000	70.0000	87.5000	105.0000	122.5000	140.0000	157.5000	175.0000	192.5000	210.0000	15.0000
Titanium Dioxide	17.5000	35.0000	52.5000	70.0000	87.5000	105.0000	122.5000	140.0000	157.5000	175.0000	192.5000	210.0000	15.0000

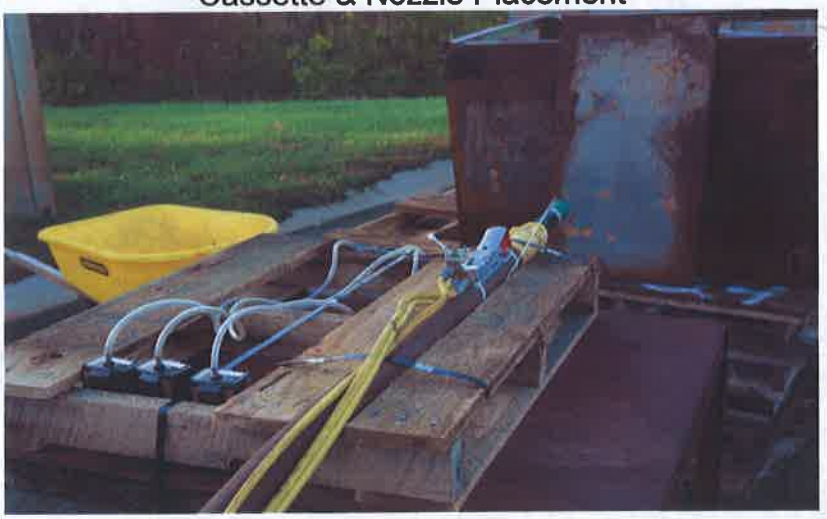
CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Test Photos:

Cassette & Nozzle Placement



Pump Placement

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Location of Target From Cassettes & Nozzle

Blasting Against Target

CLEMCO · ZERO Blast Cabinets · INDUSTRIAL Blast Facilities by CLEMCO · AEROLYTE Systems

Quality Management System - ISO 9001:2008 certified

CLEMCO®
INDUSTRIES CORP.

One Cable Car Drive, Washington, MO 63090

636 239-0300 · Fax: 636 239-0788
Email: info@clemcoindustries.com

Conclusion:

Dry blasting with Coal Slag requires a type CE Supplied Air Respirator at all times. This is required by:

1910.94(a)(5)(i)
Employers must use only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) under 42 CFR part 84 to protect employees from dust produced during abrasive-blasting operations.

1910.94(a)(5)(ii) **Abrasive-blasting respirators shall be worn** by all abrasive-blasting operators:

1910.94(a)(5)(ii)(a) When working inside of blast-cleaning rooms, or

1910.94(a)(5)(ii)(b) When using silica sand in manual blasting operations where the nozzle and blast are not physically separated from the operator in an exhaust ventilated enclosure, or

1910.94(a)(5)(ii)(c) Where concentrations of toxic dust dispersed by the abrasive blasting **may** exceed the limits set in 1910.1000 and the nozzle and blast are not physically separated from the operator in an exhaust-ventilated enclosure.

1910.94(a)(5)(iii) Properly fitted particulate filter respirators, commonly referred to as dust-filter respirators, may be used for short, intermittent, or occasional dust exposures such as cleanup, dumping of dust collectors, or unloading shipments of sand at a receiving point, when it is not feasible to control the dust by enclosure, exhaust ventilation, or other means. The respirators used must be approved by NIOSH under 42 CFR part 84 for protection against the specific type of dust encountered.

1910.94(a)(5)(iii)(a) Dust-filter respirators may be used to protect the operator of outside abrasive-blasting operations where nonsilica abrasives are used on materials having low toxicities.

1910.94(a)(5)(iii)(b) Dust-filter respirators shall not be used for continuous protection where silica sand is used as the blasting abrasive, or toxic materials are blasted.

1910.94(a)(5)(iv) For employees who use respirators required by this section, the employer must implement a respiratory protection program in accordance with 29 CFR 1910.134.

As a general guideline users of Coal Slag for Abrasive Blasting will exceed the Permissible Exposure limits

U.S. Department of Labor

Occupational Safety and Health Administration
Washington, D.C. 20210

Reply to the attention of:

AUG 13 2015

Thomas E. Enger
CLEMCO Industries Corp.
One Cable Car Drive
Washington, MO 63090

Dear Mr. Enger:

Thank you for your April 7, 2015, letter to the Occupational Safety and Health Administration (OSHA). Your letter was forwarded to the Directorate of Enforcement Programs for a response. You requested an explanation of the appropriate respiratory protection required by the OSHA Ventilation standard, 29 CFR 1910.94, when using vapor- or wet-abrasive blast machines. This letter constitutes OSHA's interpretation only of the requirements discussed and may not be applicable to any question not delineated within your original correspondence. After a background summary, your paraphrased question and our response are below.

Background: Clemco and other manufacturers have designed or redesigned wet abrasive blast systems and are marketing them as "vapor- or wet-abrasive blast machines." You'd like to know if OSHA requires operators who use these redesigned abrasive blast systems to wear Type CE respirators, as approved by the National Institute for Occupational Safety and Health (NIOSH). The redesigned systems offer a reduction of dust from blast operations. You referenced several anecdotal studies performed using these machines, some of which provided definitive instructions on the use of Type CE continuous flow supplied-air respirators, while others were vague on the requirement.

Question: Is a Type CE continuous-flow supplied-air respirator required when performing wet abrasive blasting where concentrations of toxic dust do not exceed the permissible exposure limits (PELs) in 29 CFR 1910.1000?

Response: OSHA's Ventilation standards, 29 CFR 1910.94 for general industry[1], and 29 CFR 1926.57 for construction, specify the workplace conditions where NIOSH-approved abrasive blasting respirators are required. Particular to the situation you describe, NIOSH-approved abrasive blasting respirators would be required only "(w)here the concentration of toxic dust dispersed may exceed the limits set in § 1910.1000 and the nozzle and blast are not physically separated from the operator in an exhaust-ventilated enclosure." 29 CFR 1910.94(a)(5)(ii)(c). See also, similar requirement at 29 CFR 1926.57(f)(5)(ii)(C).

---

[1] 29 CFR 1910.94 for ventilation also applies on maritime vessels and on shore in shipyards. However, paragraphs 1910.94(a)(2) and (a)(5) are generally preempted on vessels and on shore by 29 CFR 1915.34(c) and 29 CFR Part 1915, Subpart I, Personal Protective Equipment. See OSHA Instruction, CPL 02-00-157, Shipyard Employment "Tool Bag" Directive.

In order to be excluded from the standard described above [1910.94(a)(5)(ii)(c)], where NIOSH-approved respiratory protection is required, the employer must demonstrate compliance with each of the following criteria:

1) The exposure will not exceed the PELs. The exposure data must be:
   a. Personal sample(s) analyzed utilizing accepted methodologies;
   b. Collected outside of the abrasive-blasting unit's shroud in operator's breathing zone (Note: The sampling cassette should be positioned as close as possible to the employee's nose and mouth, i.e., in a hemisphere forward of the shoulders within a radius of 6 to 9 inches);
   c. Representative of the work environment without taking credit for respiratory protection;
   d. Representative of the abrasive blasting procedure with sufficient exposure data; and,
   e. Documented.
2) The abrasive blasting operator is working in an exhaust-ventilated enclosure where the operator is separated from the nozzle and blast.
3) The employer will comply with the requirements of the OSHA Respiratory Protection standard, 1910.134.

You should also know that the definition of Type CE or "abrasive blasting respirators" was changed by OSHA in the Ventilation standards to remove the phrase "continuous flow air-line." [63 Fed. Reg. 1268, January 8, 1998] This changed definition affected both 29 CFR 1910.94(a)(5)(i) and 29 CFR 1926.57(f)(5)(i), which require that only respirators approved by NIOSH be used for abrasive blasting operations. NIOSH had since approved respirators other than "continuous flow air-line" respirators for use in abrasive blasting operations, and so OSHA's change of this definition made a wider range of respiratory protection available to employers. Type CE respirators are defined by NIOSH as supplied-air systems equipped with additional devices to protect the wearer's head and neck against impact and abrasion from rebounding abrasive material. [*NIOSH Pocket Guide to Chemical Hazards (NPG), Definitions for Type C and Type CE Respirators*, DHHS (NIOSH) Publication No. 2005-149]

See also, OSHA's Letter of Interpretation to Larry Janssen, 4/15/1999, enclosed.

For additional information, we are also enclosing a copy of the OSHA Fact Sheet, *Protecting Workers from the Hazards of Abrasive Blasting Materials*.

We commend the development and use of improved vapor- and wet-abrasive blasting techniques and technologies as a means to reduce worker exposure, and we thank you for your interest in occupational safety and health. We hope you find this information helpful. OSHA requirements are set by statute, standards, and regulations. Our letter of interpretation explains these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such

developments, you can consult OSHA's website at http://www.osha.gov.

If you have any further questions, please feel free to contact the Office of Health Enforcement at (202) 692-2190.

Sincerely,

Thomas Galassi

Thomas Galassi, Director
Directorate of Enforcement Programs

Enclosures

OSHA® FactSheet

Protecting Workers from the Hazards of Abrasive Blasting Materials

Abrasive blasting uses compressed air or water to direct a high velocity stream of an abrasive material to clean an object or surface, remove burrs, apply a texture, or prepare a surface for the application of paint or other type of coating. Employers must protect workers from hazardous dust levels and toxic metals that may be generated from both the blasting material and the underlying substrate and coatings being blasted. This fact sheet provides information on abrasive blasting material, health hazards, and methods to protect workers.

Abrasive Blasting Materials

The decision to use a certain type of abrasive material can depend on factors such as cost, job specifications, environment, and worker health.

Commonly used abrasive materials:

- Silica sand (crystalline)
- Coal slag
- Garnet sand
- Nickel slag
- Copper slag
- Glass (beads or crushed)
- Steel shot
- Steel grit
- Specular hematite (iron ore)

Alternative, less toxic blasting materials include:

- Dry ice
- Plastic bead media
- Sponge
- Sodium bicarbonate (baking soda)

Abrasive blasting creates high levels of dust. Photo courtesy of NIOSH.

- Ground walnut shells, ground corn cob and other biodegradable materials
- High pressure water

****** CAUTION ******

Abrasive blasting creates high levels of noise that can cause substantial hearing loss. Always wear hearing protection. Employers must administer a hearing conservation program as required by the OSHA Occupational Noise standard.

Health Hazards

Abrasive blasting operations can create high levels of dust and noise. Abrasive material and the surface being blasted may contain toxic materials (e.g., lead paint, silica) that are hazardous to workers.

- Silica sand (crystalline) can cause silicosis, lung cancer, and breathing problems in exposed workers.
- Coal slag and garnet sand may cause lung damage similar to silica sand (based on preliminary animal testing).
- Copper slag, nickel slag, and glass (crushed or beads) also have the potential to cause lung damage.
- Steel grit and shot have less potential to cause lung damage.
- Slags can contain trace amounts of toxic metals such as arsenic, beryllium, and cadmium.

How to Protect Workers from Exposure to Abrasive Blasting Materials

Each abrasive blasting operation is unique, involving different surfaces, coatings, blast material, and working conditions. Before beginning work, employers should identify the hazards and assign a knowledgeable person trained to recognize hazards and with the authority to quickly take corrective action to eliminate them. Use engineering and administrative controls, personal protective equipment (PPE), including respiratory protection, and training to protect workers involved in abrasive blasting activities. Engineering controls, such as substitution, isolation, containment, and ventilation are the primary means of preventing or reducing exposures to airborne hazards during abrasive blasting operations. Administrative controls, including the use of good work and personal hygiene practices, can also reduce exposure. When engineering and administrative controls cannot keep exposures to hazardous materials below OSHA permissible exposure limits, respiratory protection must be used.

Abrasive blasting using a dust collection system with multiple exhaust ducts. (Photo courtesy of Flexaust, Inc. This equipment is shown for illustrative purposes only and is not intended as an endorsement by OSHA of this company, its products or services.)

Engineering Controls

1. Substitution

- Use a less toxic abrasive blasting material.
- Use abrasives that can be delivered with water (slurry) to reduce dust.

2. Isolation and Containment

- Use barriers and curtain walls to isolate the blasting operation from other workers.
- Use blast rooms or blast cabinets for smaller operations.
- Use restricted areas for non-enclosed blasting operations.
- Keep coworkers away from the blaster.

3. Ventilation

- Use exhaust ventilation systems in containment structures to capture dust.

Employers can use OSHA's free On-Site Consultation Program for advice on safety and health issues.

Administrative Controls

Perform routine cleanup using wet methods or HEPA filtered vacuuming to minimize the accumulation of toxic dusts.

- Do not use compressed air to clean as this will create dust in the air.
- Clean and decontaminate tarps and other equipment on the worksite.
- Schedule blasting when the least number of workers are at the site.
- Avoid blasting in windy conditions to prevent the spread of any hazardous materials.

Personal Hygiene Practices

- Prohibit eating, drinking, or using tobacco products in blasting areas.
- Provide wash stations so workers can wash their hands and face routinely and before eating, drinking, or smoking.
- Vacuum or remove contaminated work clothes before eating, drinking or smoking.

- Provide accommodations for end-of-shift showers and change areas with separate storage facilities for street clothes, protective clothing and equipment.
- Keep contaminated clothing and equipment out of the clean change area.

Respiratory Protection

An abrasive-blasting respirator must cover the wearer's head, neck, and shoulders to protect the wearer from rebounding abrasive. Workers must use only respirators approved by NIOSH to provide protection from dusts produced during abrasive-blasting operations.

- Type CE NIOSH-certified blasting airline respirator with positive pressure blasting helmet.

Support personnel involved in cleanup and other related activities may also need respiratory protection.

When respirators are used, employers must establish a comprehensive respiratory protection program as required by the OSHA Respiratory Protection standard (29 CFR 1910.134).

Personal Protective Equipment

- Hearing protection
- Eye and face protection
- Helmet
- Leather gloves that protect to full forearm and aprons (or coveralls)
- Safety shoes or boots

Worker Training and Hazard Communication

- Provide training to abrasive blasters and support personnel on blasting health and safety hazards, how to use controls, personal hygiene practices, safe work practices and the use of PPE and respirators.
- Manufacturers are required to include appropriate health hazard information on the blasting materials on safety data sheets (SDS) as required under OSHA's Hazard Communication standard (29 CFR 1910.1200).
- Obtain and read the manufacturer's SDS for health hazard information on the abrasive blasting material you are using.

For more information on abrasive blasting and control measures see: OSHA's guidance document: "Abrasive Blasting Hazards in Shipyard Employment" (2006); and eTool: Mechanical Removers (Ship Repair).

Disclaimer: This OSHA Fact Sheet provides a general overview of the requirements in OSHA standards related to abrasive blasting. It does not alter or determine compliance responsibilities in these standards or the Occupational Safety and Health Act of 1970. Since interpretations and enforcement policy may change over time, the reader should consult current OSHA interpretations and decisions by the Occupational Safety and Health Review Commission and the courts for additional guidance on OSHA compliance requirements.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For assistance, contact us. We can help. It's confidential.

OSHA® Occupational Safety and Health Administration

U.S. Department of Labor

www.osha.gov (800) 321-OSHA (6742)

DSG FS-3697 11/2013

Applicable OSHA Standards and Safety and Health Topic Pages

The following table provides links to several OSHA standards (not all-inclusive) that may contain requirements that apply to abrasive blasting operations. For example, the removal of lead paint by abrasive blasting will likely require employers to follow provisions of the OSHA Lead standard. Safety and health topic pages listed here provide employers and workers with information that may be useful for safely conducting abrasive blasting.

General Industry	Shipyard Industry	Construction Industry	OSHA Topics Page(s)
1910.94, Ventilation	1915.33 & 1915.34, Chemical & Mechanical paint removers	1926.57, Ventilation	Ventilation
1910.1000, Air Contaminants	1915.1000, Air Contaminants	1926.55, Gases, Vapors, Fumes, Dusts, and Mists	Permissible Exposure Limits (PELs)
Table Z-1, Limits for Air Contaminants Table Z-2, Toxic and Hazardous Substances Table Z-3, Mineral Dusts	Table Z – Shipyards	Appendix A, Threshold Limit Values of Airborne Contaminants for Construction	Hazardous and Toxic Substances
1910.1025 Lead	1915.1025 Lead	1926.62 Lead	Lead (General Industry) Lead (Construction)
1910.1018 Inorganic Arsenic	1915.1018 Inorganic Arsenic	1926.1118 Inorganic Arsenic	Arsenic
1910.1027 Cadmium	1915.1027 Cadmium	1926.1127 Cadmium	Cadmium
1910.1026 Chromium(VI)	1915.1026 Chromium(VI)	1926.1126 Chromium(VI)	Hexavalent Chromium
Respiratory Protection (1910.134).	1915.154 Respiratory Protection (refers to 1910.134)	1926.103 Respiratory Protection (refers to 1910.134)	Respiratory Protection
1910.95 Occupational Noise Exposure	1910.95 Occupational Noise Exposure (per Shipyard "Tool Bag" Directive, CPL 02-00-182)	1926.52 Occupational Noise Exposure 1926.101 Hearing Protection	Noise
Beryllium See 1910.1000 Table Z-1	Beryllium See 1915.1000 Table Z	Beryllium See 1926.55 Appendix A	Beryllium
Silica See 1910.1000 Table Z-3	Silica See 1915.1000 Table Z	Silica See 1926.55 Appendix A	Silica
1910.1200 Hazard Communication	1915.1200 Hazard Communication (refers to 1910.1200)	1926.59 Hazard Communication (refers to 1910.1200)	Hazard Communication
1910.132 Personal Protective Equipment	1915 Subpart I Personal Protective Equipment	1926 Subpart E Personal Protective Equipment	Personal Protective Equipment
1910.141 Sanitation	1915.88 Sanitation	1926.51 Sanitation	

• **Standard Number:** 1910.94(a)(1)(ii); 1910.94(a)(5)(i); 1926.57(f)(1)(ii); 1926.57(f)(5)(i)

April 15, 1999

Mr. Larry L. Janssen, CIH
Technical Service Specialist
3M Occupational Health & Environmental Safety Division
3M Building 260-3B-09
St. Paul, MN 55144-1000

Dear Mr Janssen:

This is a response to your letter dated December 29, 1998, and addressed to the Occupational Safety and Health Administration's (OSHA's) Directorate of Compliance Programs. I apologize for the delay of this response. You requested clarification of OSHA's definition of "abrasive-blasting respirators" in light of the changes made to the ventilation standards (29 CFR 1910.94 and 1926.57) in the January 8, 1998 Federal Register.

As you mentioned, the original definition of abrasive-blasting respirators read: "A continuous flow air-line respirator constructed so that it will cover the wearer's head, neck and shoulders to protect him from rebounding abrasive." When the definition was revised, the phrase "continuous flow air-line" was removed because the old definition could potentially contradict a later paragraph in the standard, namely (a)(5)(i).

Both ventilation standards state in paragraph (a)(5)(i) that "Employers must use only respirators approved by NIOSH under 42 CFR part 84 to protect employees from dusts produced during abrasive-blasting operations." NIOSH has approved more than just "continuous flow air-line respirators" for abrasive-blasting; many of these approved respirators could be excluded by the old definition. The revised definition allows the use of respirators which have been approved for abrasive blasting, but were technically prohibited by our standards because they were not "continuous flow air-line respirators."

Other types of respirators which NIOSH has approved for abrasive-blasting include several powered-air purifying respirators and some pressure demand respirators. The last combination you suggested in your letter (a canvas shroud added to a negative pressure, full facepiece air-purifying respirator) does not satisfy the approval requirement and is still not permitted under the revised definition.

I hope this clarifies OSHA's intention with this revision to the abrasive blasting standard. If you have any further questions, you may contact OSHA's Office of Health Compliance Assistance at (202) 693-2190.

Sincerely,

Richard E. Fairfax
Director
Directorate of Compliance Programs