PB99-105553

EVALUATION OF SUBSTITUTE MATERIALS FOR SILICA SAND IN ABRASIVE BLASTING

CONTRACT No. 200-95-2946

Prepared For:

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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September 1998

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50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. PB99-105553

4. Title and Subtitle: Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting	5. Report Date: 1998/09/00
	6.
7. Author(s): Anonymous	8. Performing Organization Rept. No.
9. Performing Organization Name and Address: KTA-Tator, Inc. 115 Technology Drive Pittsburgh, Pennsylvania 15275-1085	10. Project/Task/Work Unit No.
	11. Contract(C) or Grant(G) No. (C) 200-95-2946 (G)
12. Sponsoring Organization Name and Address: National Institute for Occupational Safety and Health 4676 Columbia Parkway Cincinnati, Ohio 45226	13. Type of Report & Period Covered
	14.

15. Supplementary Notes

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16. Abstract (Limit: 200 words)

Abrasive blasters using silica sand are at high risk of developing silicosis. Although NIOSH recommended in 1974 that silica sand be banned in abrasive blasting, it is still the highest used blasting abrasive in the United States. However, little objective data exists regarding the effectiveness, operating costs, and concentrations of health-related agents for abrasive blasting substitutes. This study's objective was to compare (in environmentally-controlled laboratory) silica sand's performance characteristics, operating costs, and airborne and bulk concentrations of thirty health-related agents to ten substitute abrasives (coal slag, copper slag, crushed glass, garnet, nickel slag, olivine, specular hematite, staurolite, and steel grit). Performance characteristics included: cleaning rate, consumption rate, surface profile, breakdown rate, abrasive embedment, microhardness, and conductivity. Most substitute abrasives performed equivalent to or better than silica sand. The alternative abrasives had lower cleaning costs, with the exception of crushed glass and specular hematite. All of the substitute abrasives had reduced concentrations of respirable quartz. However, all but two (crushed glass and specular hematite) showed substantially higher levels of at least one other health-related agent, as compared to silica sand. This study suggests consideration of establishing a broad, health standard encompassing all health hazards associated with abrasive blasting operations.

17. Document Analysis a. Descriptors

NIOSH-Publication; NIOSH-Contract; Contract-200-95-2946; Minerals; Silicates; Silica-dusts; Respirable-dust; Respiratory-system-disorders; Heavy-metals; Metal-dusts; Abrasives; Abrasive-blasting; Lung-disorders; Silicosis

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Available to the public	Unclassified	
	20. Security Class (This Page) Unclassified	22. Price

ACKNOWLEDGEMENT

Project: Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Contract Number 200-95-2946

This is to acknowledge the extensive effort of the Project Officer, Mr. Mark Greskevitch and Contracting Hazard Surveillance Team Leader, Mr. Dennis Groce. Mr. Greskevitch provided extensive direction throughout the project and participated in the design and startup of each phase of the project.

The project team who worked closely with Mr. Greskevitch was headed by Principal Investigator Mr. Kenneth A. Trimber, Vice President of KTA-Tator, Inc., past-President of the Society of Protective Coatings (SSPC, an industry trade organization), and Chairman of the Surface Preparation Committee C-2 of the SSPC. Mr. Trimber was assisted by Project Technical Advisor, Mr. Daniel P. Adley CIH, CSP, in all matters relating to industrial hygiene and worker safety.

Project Manager, Mr. Michael F. McLampy, coordinated overall project management and worked closely with Mr. Greskevitch in the design and startup phases of the project and also managed the project on a day by day basis.

All industrial hygiene procedures were designed by Project Certified Industrial Hygienist, Mr. Scott D. Ecoff, and approved by Mr. Greskevitch. Implementation of these procedures was performed primarily by Industrial Hygiene Technician, Mr. William D. Corbett, and assisted by Industrial Hygiene Technician, Mr. Alan Blasko. These men assured and provided for thorough record keeping, pre-run cleanliness, and assured the least amount of health and safety risk to those who participated in this project.

Project Supervisor, Mr. Edward Sperow, provided the day to day supervision of this project and ensured that all material and personnel were ready at the appointed time and that the project progressed smoothly. Blast Cleaning Technician, Mr. Leon Farbotnik, was the selected operator throughout the project. Mr. Farbotnik provided the least variability in work practices to ensure reliable data collection and repeatability of the test procedures. Mr. Sperow and Mr. Farbotnik were assisted by project staff: Mr. Al Janis, Mr. Donald Points, Mr. Stanford Galloway, and Mr. Adam Smolski. Data entry and verification was performed by Ms. Laura Kelley and Ms. Carol Gileot. Final report preparation was performed by Ms. Nancy Dewey.

Additional acknowledgement is due to the various suppliers of abrasive blast cleaning media for their patience and efforts in providing data and comments for this project.

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INTRODUCTION

For over 50 years, silica sand has been the traditional media used for abrasive blast cleaning and has become an integral component of surface preparation operations for the removal of paint, rust, mill scale and other debris from steel surfaces prior to application of protective coatings. As a blasting abrasive, silica sand is naturally occurring, readily available, economical to use, and effective. It is a relatively hard media and is available in a variety of screen sizes that are capable of providing an angular roughness in the steel substrate ranging from shallow to deep. The degree of surface cleaning and roughening provided by the abrasive media is critical to the long term corrosion protection afforded by industrial protective coatings. Silica sand has economically satisfied these attributes for many years.

Silica sand does have inherent limitations and disadvantages. Silica sand is an expendable abrasive, as the breakdown rate after one use is considerable. Also, the quantity of airborne dust generated is high. More importantly, silica sand commonly contains high concentrations of free (crystalline) silica, which poses a health hazard to improperly protected workers and potentially to the surrounding public if they are in close proximity to the area of exposure.

The National Institute for Occupational Safety and Health (NIOSH) has long recognized the adverse health effects of overexposure to free silica. The friable characteristic of silica sand during abrasive blast cleaning results in the generation of respirable airborne particulate which, if inhaled can become deposited in lung tissue and can lead to silicosis. Bridge authorities such as Ohio Turnpike Commission[1] and The Port Authority of New York and New Jersey[2] do not permit the use of silica sand for preparation of steel surfaces in their project specifications due to concerns over the safety of workers performing abrasive blasting.

As a result of these concerns, the Centers for Disease Control and Prevention (CDC) and the National Institute for Occupational Safety and Health (NIOSH) issued an Invitation for Proposal entitled, "Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting", dated June 9, 1995. Subsequently, KTA-Tator, Inc. (KTA) responded to the invitation with a proposal entitled, "Technical Proposal for Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting", dated July 14, 1995. On September 29, 1995, Contract No. 200-95-2946, issued by the Centers for Disease Control and Prevention (Atlanta, Georgia), was awarded to KTA. The Contract directed KTA to conduct a three-phase study for the purpose of investigating relative levels of 30 different health-related agents and other attributes of surface preparation of the alternative abrasives to silica sand.

Phase 1 involved a laboratory study, Phase 2 a field study, and Phase 3 a comparison of the data collected during Phases 1 and 2. This report addresses the data collected during the laboratory study (Phase 1) of the Contract.

Phase 1 was conducted at the KTA-Tator, Inc. Corporate Headquarters and laboratories, located at 115 Technology Drive, Pittsburgh, PA 15275. The blast cleaning portions of Phase 1 were conducted beginning April 10, 1996, and were completed on August 30, 1996. Upon completion of blast cleaning, airborne particulate and bulk abrasive samples were analyzed, data entered and evaluated, and the report prepared.

The objective of the study was to collect (in an environmentally-controlled laboratory) industrial hygiene airborne levels and bulk ingredient data for thirty health-related agents; and economic and technical data; and compare the alternative abrasives' results to silica sand's results. It is critical that worker exposures to airborne dust, free silica, and other toxic metals during abrasive blast cleaning be assessed on a controlled basis to ensure reproducible results. This study characterizes the emissions generated by the various abrasives, enabling sound, scientific conclusions to be drawn relating to exposure hazards. This study compares the total operating costs of silica sand to the total operating costs of the alternative abrasives for the environmentally-controlled laboratory conditions used in this study.

Specifically, the study entailed the collection of airborne particulate (total and respirable fractions) generated during open nozzle dry abrasive blast cleaning operations conducted on hot rolled, mill scale bearing carbon steel. Additionally, the study investigated the production characteristics of silica sand, silica sand treated with dust suppressant and 11 alternative abrasive materials for surface cleanliness (visual), cleaning and consumption rates, breakdown rates and recyclability characteristics, surface profile generation, abrasive particle embedment, and water soluble contamination.

A total of 40 blast cleaning abrasive materials (selected by NIOSH) were studied under Phase 1. Specifically, 13 generic categories of abrasives from suppliers and distributors located throughout the United States were studied. This report addresses the methodologies employed during data collection, and the results of the abrasive media production characteristics and the bulk abrasive and airborne sample data acquired under Phase 1.

EXECUTIVE SUMMARY

The Centers for Disease Control and Prevention (CDC), through the National Institute for Occupational Safety and Health (NIOSH), commissioned KTA-Tator, Inc. to conduct a study entitled "Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting". In conjunction with NIOSH, a project design protocol was developed to evaluate the characteristics that influence abrasive performance from a surface preparation viewpoint and the potential for worker exposures to airborne contaminants. The protocol was used to evaluate 13 generic types of abrasives, including:

- coal slag
- coal slag with dust suppressant
- copper slag
- copper slag with dust suppressant
- crushed glass
- garnet
- nickel slag
- olivine
- silica sand
- silica sand with dust suppressant
- specular hematite
- staurolite
- steel grit

One to 7 individual products from within each of these generic categories (40 products total) were obtained from manufacturers and suppliers throughout the United States. Each of the abrasives was evaluated for 7 performance-related characteristics, including:

- cleaning rate
- consumption rate
- surface profile
- breakdown rate
- abrasive embedment
- microhardness
- conductivity

Bulk samples of the 40 abrasive products were analyzed for 30 potential contaminants prior to and following use. During use, they were evaluated for airborne concentrations of the same 30 contaminants:

aluminum	calcium	lead*	nickel*	sodium	yttrium
arsenic*	chromium*	lithium	phosphorous	tellurium	zinc
barium	cobalt	magnesium	platinum	thallium	zirconium
beryllium*	copper	manganese*	selenium	titanium*	quartz*
cadmium*	iron	molybdenum	silver*	vanadium*	cristobalite

* While data was collected for 30 contaminants, eleven of them were selected by NIOSH for detailed analysis.

In order to ensure that the only major variable being evaluated for each of the performance characteristics and airborne contaminants was the individual abrasive, stringent controls over operator work practices and equipment operation were implemented and maintained.

Most of the alternative abrasives evaluated have performance characteristics that are equivalent to or better than silica sand. Average cleaning costs, based on blast cleaning steel in a blast room involving the stringent controls employed in the study, showed all of the alternative abrasives to be less expensive to use as a class with the exception of crushed glass and specular hematite. In both cases, only one abrasive was evaluated and in both cases there was at least one silica sand abrasive that proved to be more costly. It should also be recognized that all of the costs are artificially high due to the controls imposed on the study (blast nozzle size, operating pressure, nozzle to work piece distance). Adjustments to any of the study variables can be expected to result in substantial cost reductions for each of the abrasives. For example, increasing the nozzle size alone with a coal slag abrasive, resulted in a cost reduction of nearly 60%.

While this study collected data on 30 potential contaminants, the analysis focused on eleven health-related agents selected by NIOSH including: arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, respirable quartz, silver, titanium, and vanadium. While no single abrasive category had reduced levels of all eleven health-related agents, all the substitutes offer advantages over silica sand with regard to respirable quartz. All but two (crushed glass and specular hematite) of the alternative abrasives have substantially higher levels of some other health-related agents, as compared to silica sand. There is considerable individual product variability within the generic types of abrasives evaluated. This limits the possibility of developing recommendations regarding airborne concentrations of hazardous health-related agents based upon broad generic categories of abrasives.

The overall findings of this study are eye opening and potentially far reaching. In recent years, much of the industry focus has been directed at protecting workers from the hazards of lead and other metals in the coatings removed during abrasive blasting. NIOSH and OSHA have also directed increased attention to the hazards of silica sand. The findings of this study suggest that a much broader and holistic approach to protecting workers performing any form of abrasive blast cleaning needs to be taken. In addition to a continued focus on alternatives to silica sand abrasives or the hazard of lead in paint, consideration should be given to the establishment of a broad, vertical health standard encompassing all health hazards associated with abrasive blasting operations.

STUDY DESIGN AND TEST METHODS

Description

The study was performed in strict accordance with the NIOSH-approved Phase 1 Study Design/Protocol developed specifically for this project (copy attached as Appendix 1). The protocol provided controls and documentation forms for:

- Purchasing and receipt of the steel substrate test panel material,
- Solvent cleaning and random numbering of the test panel material,
- Collection of both bulk and freshly fractured abrasive samples for additional analysis by NIOSH. A total of 40 different abrasives were included in the study (refer to the Products and Materials section of this report for a listing of the specific abrasives),
- Selection of a single operator to conduct all of the trial runs,
- Consistent operation of all blast cleaning and ventilation equipment,
- Consistent blast cleaning technique and cleanliness (SSPC SP-10, Near White),[18]
- Consistent cleaning of all equipment and facilities to prevent cross-contamination between runs,
- Analysis of particle size distribution, abrasive break-down rates, cleaning rates, abrasive consumption rates, surface profile, embedment, hardness, and water soluble content,
- Recyclability analysis with a design limitation of a maximum of 25 recycles,
- Collection of samples for total airborne dust, respirable crystalline silica, respirable radiochemical activity, total airborne radiochemical activity, and total airborne elements. A total of 28 metals/elements, and respirable quartz and cristobalite were evaluated by KTA (refer to the Industrial Hygiene Sampling portion of this report for a listing of the elements analyzed, and for information on the number of samples collected, locations of the sampling media, the type of media used, and pump flow rates. The analysis of the filters was managed by NIOSH, using other testing laboratories.), and
- Developing total cost calculations.

Abrasive suppliers expressed concerns with certain aspects of the protocol involving the restrictions on nozzle size, nozzle to substrate distance, angle of blast, nozzle pressures, the use of a predetermined metering valve settings, and restrictions on

the number of recycles in the case of steel grit. Letters received from the suppliers are attached as Appendix 2.

Products and Materials

Steel Substrate Test Surfaces

The study was performed on 3/16" thick mill scale bearing carbon steel plates (2' x 2'). The plates were initially prepared in accordance with SSPC-SP 1 "Solvent Cleaning"[19] and numbered sequentially. Nine panels were used for each abrasive trial resulting in a maximum surface area of 72 square feet available for abrasive blast cleaning.

The influence of an abrasive on the preparation of metal surfaces is highly dependent on the physical and mechanical properties of the metal. These properties include hardness, ductility, yield strength, and density. In the case of hot rolled carbon steel, the presence of mill scale also effects the performance of blast cleaning abrasives. One of the most critical objectives in the study was to collect airborne particulate for subsequent analyses. In order to make valid comparisons between the abrasive media, the variability in the type and quantity of the particulate generated had to be restricted to the media itself, not within the substrate being cleaned. Therefore, all steel panels were purchased from the same supplier. The supplier furnished certification that the steel was supplied from the same heat or melt of steel. The homogenous nature of the steel ensured that the chemical constituents of the steel were similar, if not identical. The panels were also chosen from the same mill rolling to ensure consistency in the thickness and characteristics of the mill scale (see Appendix 3). The iron (97.3%), manganese (.96%), copper (0.01%), chromium (0.01%), nickel (0.01%), phosphorous (0.006%), molybdenum (0.004%), and vanadium (0.004%) content in these steel plates may influence the results of these same elements when analyzed for airborne concentrations. The above steps reduced to a minimum any variation that might be introduced to the testing process due to the substrate material. To further ensure homogeneity of the steel material, 10 randomly chosen sample panels were submitted to NIOSH for metallurgical evaluation, if needed.

Abrasive Selection

The study involved 40 different abrasives representing 13 generic types. While the abrasives selected for the evaluation represent a broad range of the types of products used for blast cleaning, all possible generic types were not evaluated. Further, additional products within a given generic category are also available. As a result, the results of the study should not be construed to represent all abrasive blast cleaning media.

All products were commercially available materials. Abrasives reported by the suppliers as typically being used more than one time to prepare steel surfaces for painting were classified as recyclable. All other abrasives were classified as expendable. One exception involves the specular hematite (crystalline iron oxide) which may be classified

as a recyclable abrasive, but was treated as an expendable abrasive in this study. The abrasives containing dust suppressant had already been treated prior to purchase. The generic types of abrasive, the alpha code assigned to each type, and the number of individual products evaluated under each type are as follows:

Expendable Abrasives

Coal Slag (CS)	7 products
Coal Slag with Dust Suppressant (CSDS)	2 products
Crushed Glass (CG)*	1 product
Nickel Slag (N)	2 products
Olivine (O)	1 product
Silica Sand (SS)	7 products
Silica Sand with Dust Suppressant (SSDS)	3 products
Specular Hematite (SH)	1 product
Staurolite (S)	2 products

*Crushed glass abrasive was mixed window and plate, post industrial.

Recyclable Abrasives

Copper Slag (CP)	4 products
Copper Slag with Dust Suppressant (CPDS)	1 product
Garnet (G)	7 products
Steel Grit (SG)	2 products

Relatively large variations can exist within the same generic abrasive type with regard to factors such as productivity, consumption rate, breakdown rate, dust generation, embedment, and water soluble contamination. Variations can stem from the geographic locations where the material is mined or produced, in addition to differences in manufacturing, processing, and material handling techniques. Not only do products vary between manufacturers, but products provided by the same manufacturers can also exhibit differences. Because of these variations, several abrasives within each generic category were typically obtained from suppliers in different geographic regions. Exceptions include specular hematite, staurolite, and olivine. Since the number of companies supplying these abrasives is limited, only one of each type was evaluated. In addition, only one crushed glass abrasive and one copper slag treated with dust suppressant were utilized due to limitations in the size of the project.

The nominal size of the abrasive media can effect productivity, consumption rate, and resulting surface profile. Therefore, abrasive suppliers were requested to provide materials in a nominal mesh size to achieve a surface profile of 2 to 3 mils based on information provided to them regarding the blast cleaning equipment (1/4" nozzle) and operating conditions (100 psi nozzle pressure) that would be employed. The suppliers were also asked to provide the abrasive metering valve setting for their product and to express any concerns they had with the test protocol which was discussed with them in

advance. A copy of the standard letter formally requesting the participation of the abrasive suppliers is attached as Appendix 4.

Blast Cleaning Equipment and Facilities

The blast cleaning facility at the KTA corporate offices in Pittsburgh, Pennsylvania was used to conduct all abrasive blast cleaning trials. Throughout all abrasive trials, variability of the blast cleaning environment was controlled by using the same blast room and abrasive blast cleaning equipment. A diagram of this facility is provided in Appendix 8 and photographs of the facility and equipment employed are provided in Appendix E. The equipment utilized for the study included:

- A clean, enclosed, illuminated 12' by 8' by 8' high walk-in blast room equipped with a 5800 cubic feet per minute (cfm) Torit-Donaldson dust collection system. Airflow through the blast room was controlled at 50 to 75 feet per minute average crossdraft for each trial run, measured using an Alnor Model RV rotating vane anemometer.

- A Clemco 6 cubic feet gravity feed abrasive hopper fitted with a specially designed abrasive metering valve. The metering valve plate designed by KTA utilized five fixed settings ranging from 1/4" to 1/2" in 1/16" increments. This allowed for the use of a precise valve setting for each trial run. Each abrasive supplier was asked to recommend the orifice for their product and mesh size. If the supplier did not furnish this information, the 1/2" size was used.

- A 170 cfm Atlas Copco air compressor. The compressed air line was equipped with moisture and oil separators. Prior to each abrasive trial, the supplied air was evaluated for moisture and oil in accordance with ASTM D4285, Standard Test Method for Indicating Oil or Water in Compressed Air[20]. No moisture, oil, or other visible contamination was detected during any of the blotter tests.

- Two 15 foot lengths of reinforced air/abrasive hose (7/8" inside diameter), and two Boride brand No. 4 (1/4 inch orifice size) venturi blast nozzles. After each abrasive trial, the blast hoses were flushed, washed inside and out with potable water, then dried with compressed air before the next trial. The use of two hose/nozzle assemblies allowed sufficient drying time of the washed hoses between trials.

- A Clemco nozzle orifice gage. The gage was used to monitor the nozzle orifice size prior to each abrasive blasting trial. Both nozzles maintained the 1/4"orifice size throughout the laboratory study, and neither nozzle showed signs of uneven wear. The 1/4" nozzle was selected for the Phase 1 laboratory study to obtain enough blast cleaning time during each trial to obtain accurate exposure monitoring data. While the use of a larger nozzle would have substantially increased productivity, the reduced operating time would have provided inadequate sampling time for the industrial hygiene data.

- A Clemtex Model 352-02 hypodermic needle pressure gage. The gage was used to measure the blasting pressure at the nozzle prior to each abrasive trial. The pressure was maintained at 100 pounds per square inch (psi) throughout the abrasive study. A fixed pressure of 100 psi was selected in order to minimize the number of variables involved with the collection of the data, in an effort to enhance the reproducibility of the test methods.

- A Dickson Model THDX 24 hour recording hygrometer for continuous monitoring of relative humidity and dew point, and an Atkins Model 33035-F digital thermocouple for monitoring the surface temperature of the steel panels. Barometric pressure was also documented. A sample Blast Cleaning Inspection Report is attached as Appendix 5. The completed reports are provided separately from this report.

- A Lunardini Vac-U-Claimer, an abrasive media vacuuming reclaiming system. The equipment was used to clean the interior surfaces of the blast room after each trial. After thorough vacuuming and cleaning, industrial hygiene personnel inspected the room in accordance with the procedures described later in this section.

  For trials involving abrasive recycling, the adjustable air curtain feature of the reclamation system was used to separate abrasive fines from larger, re-usable abrasive particles. A summary of blast room environmental data and ventilation velocity for each trial is summarized in Appendix 8.

Blast Operator Selection

The use of an "automated blast cleaner" for the Phase 1 study was considered in order to reduce the potential risk to human subjects and to reduce the variability between abrasive trials. However, it was concluded that although robotics could be designed for the laboratory study, it would not be representative of the manner in which the majority of blast cleaning operations are conducted in industry, nor is it representative of the nature of operations in the field. In addition, the Phase 2 study (field study) must be performed using human operators to assess exposures when cleaning under field conditions to properly assess productivity and effectiveness. The blast cleaning effort required to achieve the desired level of cleanliness in the field will vary from one point on a structure to the next. The human operator can immediately react to this difference, while a machine will not. Other variables such as operator visibility and its influence on productivity will not be appropriately recognized when using robotics. Finally, for Phase 3 (comparison of Phases 1 and 2) to be meaningful, Phases 1 and 2 need to be conducted in a similar manner, so that appropriate comparisons can be made. In order to gain meaningful data in Phases 1 and 2, it was essential that human operators be used for all phases of the study.

It is recognized that variability exists between human operators. In an effort to reduce the variability between individual operators and within a single operator (and thus increase the validity of both the production related and health related test results), a study was conducted to evaluate several operators in order to select one operator for the project.

Five abrasive blasting operators were evaluated. Each operator performed five abrasive blasting trials in accordance with the Phase 1 study design and protocol. Operators were randomly scheduled for these trials, and operators were not informed of the schedule. This was done to help ensure that the operators could not prepare (i.e., get more or less rest the previous day), and so that the operators' attitudes concerning their work would not be reflected in the results (i.e., operator having a good or bad day). The abrasive media used for the operator variability study was a coal slag abrasive of the same nominal size from one supplier to ensure that any variation in the results would be attributed to operator technique. Area and worker exposure monitoring data as well as abrasive and steel samples were collected during the operator variability study.

The operators were ranked from least to greatest variation in results for the following four attributes:

1. Total Abrasive Blasting Time (seconds)
2. Amount of Surface Area Cleaned (square feet)
3. Rate of Abrasive Consumption (pounds per square foot)
4. Abrasive Cleaning Rate (square feet per minute)

The objective was to select the operator who displayed the least variation across all four attributes combined. All attributes were given an equal weighting for the analysis. It should be noted that a demonstration of least variability in a given attribute does not always correlate with the most desirable performance characteristic. For example, the operator showing least variability in cleaning rate (productivity) may not be the most productive cleaner.

The test results for each of the above attributes are shown in the tables that follow:

TABLE 1
OPERATOR VARIABILITY STUDY – TOTAL BLAST CLEANING TIME (SECONDS)

Operator Number	1	2	3	4	5
Trial 1	4121	3365	2619	5325	3270
Trial 2	3592	3922	3583	3722	4754
Trial 3	4220	4590	3969	4328	4573
Trial 4	4545	5016	3699	4354	4577
Trial 5	4266	4844	4364	4330	4928
Average	4148.8	4347.4	3646.8	4411.8	4420.4
Standard Deviation	348.8	688.9	648.3	575.9	659.6
Ranking	1	5	3	2	4

TABLE 2
OPERATOR VARIABILITY STUDY – SURFACE AREA CLEANED (SQUARE FEET)

Operator Number	1	2	3	4	5
Trial 1	46.80	44.10	42.30	56.20	45.17
Trial 2	44.00	48.73	52.40	48.90	44.30
Trial 3	56.30	42.83	45.70	47.30	37.30
Trial 4	48.00	45.75	45.70	50.10	38.70
Trial 5	44.60	38.50	60.00	39.70	38.50
Average	47.94	43.98	49.22	48.44	40.79
Standard Deviation	4.95	3.78	7.05	5.93	3.65
Ranking	3	2	5	4	1

TABLE 3
OPERATOR VARIABILITY STUDY – CONSUMPTION RATE (POUNDS PER SQUARE FOOT)

Operator Number	1	2	3	4	5
Trial 1	10.60	11.25	11.73	8.83	10.18
Trial 2	11.27	10.18	9.47	10.14	12.83
Trial 3	8.81	11.58	10.85	10.49	13.30
Trial 4	10.33	10.84	10.85	9.90	11.20
Trial 5	11.12	12.88	8.27	12.49	10.98
Average	10.43	11.35	10.23	10.37	11.70
Standard Deviation	0.98	1.00	1.36	1.34	1.31
Ranking	1	2	5	4	3

TABLE 4
OPERATOR VARIABILITY STUDY – CLEANING RATE (SQUARE FEET PER MINUTE)

Operator Number	1	2	3	4	5
Trial 1	0.680	0.670	0.970	0.630	0.710
Trial 2	0.730	0.640	0.880	0.790	0.490
Trial 3	0.800	0.510	0.690	0.660	0.490
Trial 4	0.630	0.570	0.740	0.690	0.580
Trial 5	0.630	0.530	0.820	0.550	0.550
Average	0.694	0.584	0.820	0.664	0.564
Standard Deviation	0.072	0.069	0.111	0.088	0.090
Ranking	2	1	5	3	4

The results of the operator variability study were statistically analyzed for each abrasive trial to determine the arithmetic mean, and the standard deviation from that mean for each operator. The operators were given a ranking from 1 to 5 in each production category, with a ranking of 1 representing the least variation, and a 5

representing the most variation. Since the variance of any data set is equal to the standard deviation value squared, the variability each operator exhibited could be determined on the basis of standard deviation alone. The results of these rankings were summed to give each operator a "score". The following table illustrates the rankings and scores assigned to each operator.

TABLE 5
OPERATOR VARIABILITY STUDY – COMPOSITE RANKINGS PER OPERATOR

Operator Number	Total Blast Cleaning Time	Square Feet Cleaned	Consumption Rate	Cleaning Rate	**SCORE**
1	1	3	1	2	**7**
2	5	2	2	1	**10**
3	3	5	5	5	**18**
4	2	4	4	3	**13**
5	4	1	3	4	**12**

The results shown in the above table reveal only minor differences in the deviation between operator number 1 and operator number 2 for both consumption rate and cleaning rate. To further ensure that the most consistent operator for all four parameters was selected for use during the study, the analysis was performed using only four abrasive trials, with the value furthest from the mean eliminated from the data. The following table illustrates this approach:

TABLE 6
OPERATOR VARIABILITY STUDY – COMPOSITE RANKINGS BASED ON FOUR BEST TRIALS*
*(values furthest from the mean were eliminated)

Operator Number	Total Blast Cleaning Time	Square Feet Cleaned	Consumption Rate	Cleaning Rate	**SCORE**
1	3	1	1	2	**7**
2	4	2	2	3	11
3	2	5	5	5	17
4	5	4	3	4	16
5	1	3	4	1	9

Based on the results of the statistical analysis, Operator Number 1 was chosen for the Phase 1 abrasive blast cleaning study. NIOSH was in full agreement with the selection of the operator.

Abrasive Media Test Methods

A series of test methods was used to control the abrasive blast cleaning process and to evaluate the physical characteristics and performance of the abrasives. Each method is described below:

Blast Cleaning Procedure and Process Control Checks

Nine 3/16" x 2' x 2' mill scale bearing panels were used for each trial. The panels were mounted in a specially designed rotary holder which accommodated three sets of three panels each. This enabled the operator to abrasive blast clean both sides of the nine panels at a working height of 3 feet to 5 feet, for a total available surface area of 72 square feet. The operator blast cleaned one set of three panel faces then rotated the mounting fixture to expose the next group of three faces and resumed blast cleaning. After the last series of three panels was cleaned, the fixture was rotated 180 degrees to expose the back sides of the panels and the cleaning resumed.

The distance that the blast nozzle was held from the steel plates was maintained at a constant 18 inches for all abrasive blasting. This was accomplished through the use of a small rod attached to the blast hose that extended to the wall behind the operator. The operator kept the blast nozzle perpendicular to the steel substrate at all times. This was done to provide the maximum amount of abrasive ricochet, simulating a worst case airborne dust condition. All cleaning was performed to SSPC-SP 10 "Near-White Metal Blast Cleaning[18]" or better.

In order to improve the validity of the test results and the repeatability of the abrasive blast cleaning process, statistical process control measures were implemented throughout the entire project. Five randomly scheduled process checks were used. The process checks using a blind control abrasive were conducted following the exact testing protocols used for the actual abrasive trials. The same abrasive material (coal slag) used for the operator variability study was used for the process control checks. This allowed for a comparison of the process control check data with the same data produced by the same operator during the operator variability study. Control charts were established using the data from the five abrasive trials conducted by the operator (operator No. 1) during the operator variability study. Separate control charts were developed for the following process characteristics: cleaning rate, abrasive consumption rate, amount of surface area cleaned, and the elapsed trial time. As agreed upon with NIOSH, the upper control limit (UCL) and lower control limit (LCL) used for the control charts were set at +/- three standard deviations from the mean of the results for the initial five abrasive trials conducted for the operator variability study. The results for the selected operator (Operator 1) from the operator variability study are summarized in the table below for convenience.

TABLE 7
TEST RESULTS OBTAINED BY OPERATOR NO. 1 DURING OPERATOR VARIABILITY STUDY

	Trial Time (seconds)	Surface Area (square feet)	Consumption Rate (pounds/square foot)	Cleaning Rate (square feet/minute)
Trial 1	4121	46.80	10.60	0.680
Trial 2	3592	44.00	11.27	0.730
Trial 3	4220	56.30	8.81	0.800
Trial 4	4545	48.00	10.33	0.630
Trial 5	4266	44.60	11.12	0.630
Mean	4148.8	47.94	10.43	0.694
Standard Deviation	348.8	4.95	0.98	0.072

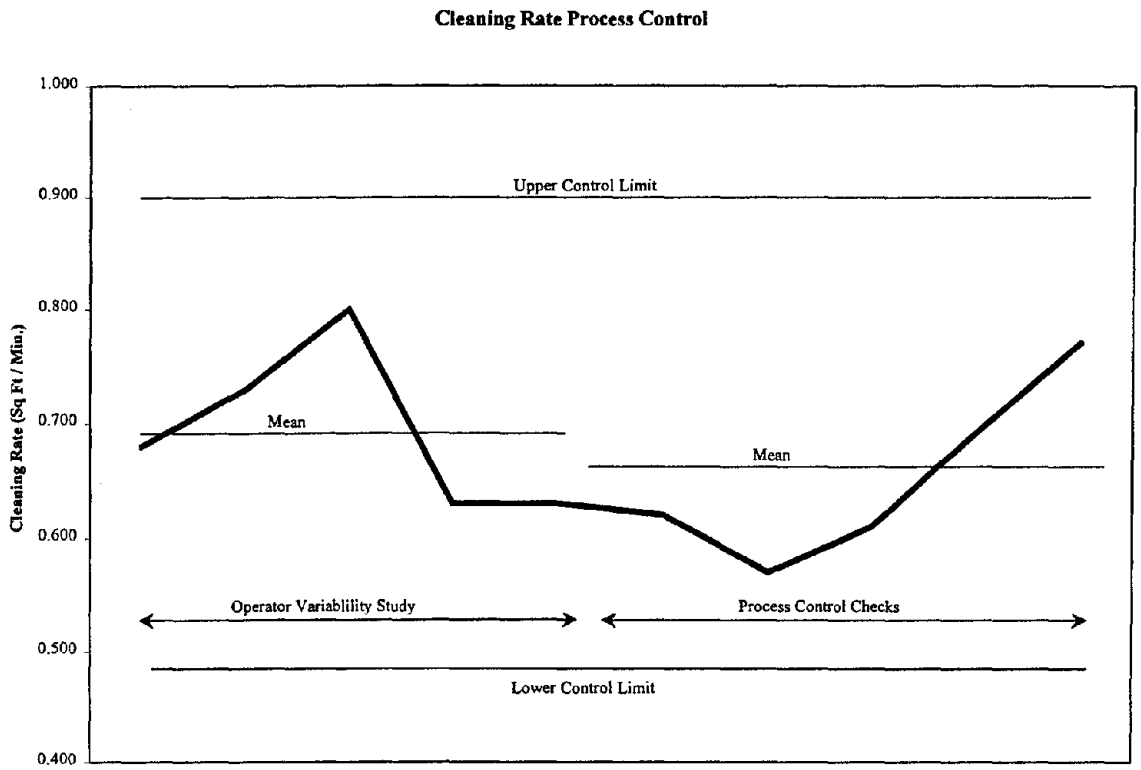
The results for each of the same attributes for the process control checks conducted during the actual study are summarized in the following table:

TABLE 8
TEST RESULTS OBTAINED BY OPERATOR NO. 1 DURING THE PROCESS CONTROL CHECKS

	Trial Time (seconds)	Surface Area (square feet)	Consumption Rate (pounds/square foot)	Cleaning Rate (square feet/minute)
Process Check 1	4824	49.80	9.92	0.620
Process Check 2	4722	45.10	11.09	0.570
Process Check 3	4110	41.50	12.05	0.610
Process Check 4	4692	54.30	9.12	0.690
Process Check 5	3888	50.00	10.00	0.770
Mean	4447.2	48.14	10.44	0.652
Standard Deviation	419.5	4.94	1.14	0.079

The control chart for blast cleaning rate is shown on the next page. The left half of the control chart shows the cleaning rate values obtained by the operator during the operator variability study. The right half of the control chart illustrates the cleaning rate values obtained during the five process control checks. Throughout the five process control checks, no values were found higher than the upper control limit or less than the lower control limit. This is true for all of the production categories (the control charts for trial time, surface area, and consumption rate are attached as Appendix 6. The control chart for cleaning rate shown below is also repeated in Appendix 6 for convenience). The data also did not reveal any trends that would indicate that the process was approaching a loss of control. Statistical analysis showing mean, standard error, median, mode, standard deviation, variance, kurtosis, skewness, range, minimum, maximum, and 95% confidence level for each production related attribute for the process checks is also attached as Appendix 6.

TABLE 9
PROCESS CONTROL CHART FOR CLEANING RATE



Cleaning Rate

Abrasive cleaning rate was calculated from the measured amount of area blast cleaned divided by the total elapsed time of the abrasive trial (square feet per hour). The surface cleanliness of each panel was verified using SSPC VIS1-89[21] pictorial standards. The abrasive trial time was defined as the amount of time to clean both sides of all 9 panels (72 square feet of surface area) or to clean as much of the panel surfaces as possible until all of the abrasive media had discharged from the abrasive hopper. The time was measured to the nearest second using a digital stopwatch. The total amount of time required to rotate the panels was typically 45 seconds. This time was not deducted from the totals. Since a small blast nozzle (No. 4) was used, cleaning rates, as expected, were much less than rates obtained during normal field abrasive blast cleaning operations. A smaller nozzle was intentionally used in order to obtain enough blast cleaning time for the collection of the industrial hygiene samples that were required.

Consumption Rate

A measured (weighed) amount of abrasive media was loaded into the abrasive blast pot for each abrasive trial. The abrasives were stored in a climate controlled shop prior to use to minimize differences that residual moisture may have on the weight. The

initial weight of abrasive media varied due to differences in the bulk density of the types of abrasive, but a sufficient quantity of media was loaded to permit a continuous 30 to 40 minute blast sequence or to clean all surfaces of the steel panels, whichever occurred first. In the event that the entire amount of abrasive was not discharged during the abrasive trial (i.e. the entire 72 square feet of steel surface was blast cleaned without depleting the supply), the abrasive remaining in the hopper and blast hose was collected and weighed. The amount of abrasive consumed during each trial was calculated by deducting this amount from the initial amount loaded. The abrasive consumption rate was calculated as the weight of abrasive used during the trial divided by the measured surface area prepared (pounds per square feet).

As indicated above, the use of a 1/4" nozzle effected productivity. The small nozzle, together with the use of pre-established abrasive metering valve settings, also effected abrasive consumption rates.

Surface Profile

The surface profile resulting from each abrasive trial was measured in accordance with Method C of ASTM D4417-93 "Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel[22]." Coarse and X-Coarse Testex replica tape and a spring micrometer were used. Two surface profile measurements were obtained on one side of three of the nine test panels (resulting in a total of 6 profile readings) for each abrasive run.

The nine panels used for each abrasive trial were assigned a number from one to nine. A computer-generated table of random numbers (numbers from one to nine in random order) was used to select specific panels for surface profile measurements. Surface profile measurements were obtained on the first three panels identified by the random number table. In the event the selected panel had not been completely blast cleaned, the random numbers were accessed in order, until three blast cleaned panels were selected. The side of the panel to be measured consistently alternated from front to back starting with the front side for the first abrasive run. That is, the measurements for the first abrasive run were taken on the front side of the first panel selected, back side of the second panel, and the front side of the third panel. The sequence continued for the measurements for the second run (i.e., starting with the back side of the first panel selected). A permanent identification number stamped into the steel designated the front side of the panel.

Abrasive Particle Size Distribution

A one hundred pound sample of each abrasive, as received from the supplier or distributor, was riffled three times to ensure a homogeneous mixture of abrasive particle sizes. A one hundred gram sample of this virgin abrasive was removed from the homogeneous mix and analyzed for particle size distribution in accordance with ASTM C136 "Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates"[23]. The abrasive sample was tamped and shaken through a series of sieves

for seven minutes. The sieve sizes used were 10, 12, 16, 20, 30, 40, 50, 60, 70, 100, 140, 200, 270, with a pan at the bottom. An electric Ro-Tap Model B aggregate shaker was used.

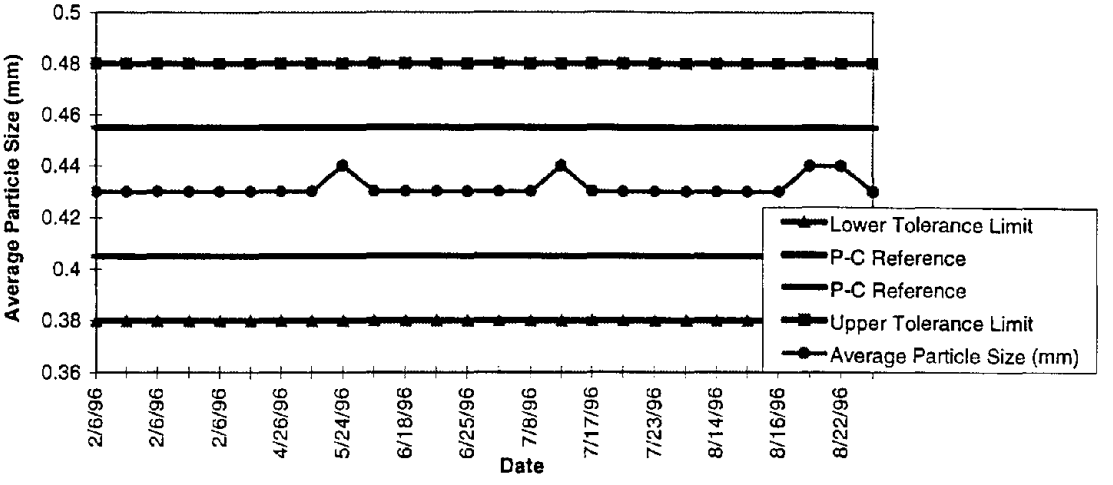
The abrasive retained on each screen was emptied into numbered and tarred sample cups. The underside of each screen was cleaned with a brass brush to loosen trapped particulate, and the particulate was added to the appropriate sample cups. The content of each sample cup was weighed to the nearest tenth of a gram and documented. This value (weight of particles retained on each screen) was multiplied by the screen size opening (in millimeters). These numbers were summed and divided by the cumulative weight of the sample to establish an average particle size for each lot of abrasive. The average value represents the size, above which and below which, approximately 50 % of the mass of the abrasive is found.

A statistical process control was used to ensure repeatability and validity of the sieve analysis portion of the abrasive testing. Since the screens used for sieve analysis are constructed of fine wires with very close tolerance spacing, it was critical to verify that the screen size openings were not affected by repeated use. Three 100 gram samples were drawn from the same riffled mixture of one of the abrasives at the beginning of the project. The samples were sieved five times to develop a control capability analysis for each sample. Sample A had an average particle size of 0.43 mm with no variation. Sample B had an average particle size ranging from 0.41mm to 0.42 mm, and Sample C was 0.42 with no variation.

After the first 15 analyses were performed, Sample A was sieved using the identical process. After sieving, the abrasive was collected in a sealed container and reintroduced into the process after the next 15 analyses were completed. These checks continued throughout the entire project. As indicated above, the results of the initial five sieve analyses of control Sample A were an average particle size of 0.43 mm with no variation. During approximately 370 individual sieve analyses performed during this study, the variation in average particle size of control Sample A was 0.01 mm. This is displayed in the control chart shown in Table 10 following this paragraph. Sample B was introduced after 75 and 150 analysis had been completed. In both cases, the average particle size was 0.42 mm, which was consistent with the initial five analyses that ranged from 0.41 mm to 0.42 mm. Sample B was also retained for additional use in the event two replicates of Sample A displayed non-conformance, but this never occurred. Sample C was used to ensure control at the completion of the testing. At the completion of testing, the analysis of Sample C showed an average particle size of 0.42 mm which is identical to its initial value.

The following figure displays a control chart for the first sieve control sample (Sample A).

TABLE 10
SIEVE ANALYSIS PRE-CONTROL CHART



The lines labeled P-C Reference are used in Pre-Control theory to indicate loss of control is approaching and adjustments to the process should be made. Based on the results obtained, it is evident that the screens used during sieve analysis displayed highly consistent measurements.

Abrasive Breakdown Rate

At the completion of each abrasive run, a one hundred pound sample of the spent abrasive was collected from several areas of the enclosed blast room floor and riffled three times to obtain a homogeneous mixture. A 100 gram sample was removed and analyzed for particle size distribution using the identical process as described in the section entitled "Abrasive Particle Size Distribution". The amount of abrasive breakdown was determined by comparing the average particle size of the pre-blast (virgin) abrasive to the average particle size of the post-blast abrasive. The abrasive breakdown rate was calculated and is reported as the percentage change in average particle size.

Abrasive Embedment

Abrasive embedment is defined as the percentage of abrasive particles that remain affixed to the prepared substrate and cannot be removed by cleaning with a stiff bristle brush or a focused stream of compressed air. The amount of abrasive embedment was evaluated on the same three panels selected for the surface profile measurements. A 12.7 mm (1/2") x 12.7 mm (1/2") piece of transparent mylar with a printed grid of 100 squares (each 1.3 mm x 1.3 mm in size) was placed on the surface and viewed through a 10X illuminated magnifier to make the determination. Each of the 100 squares was evaluated for the presence of embedded abrasive particles. In the event an embedded particle fell

between two or more squares, only one of the squares was counted. The number of squares containing one or more embedded particles was summed to determine the number of squares out of 100 that exhibited embedded abrasive particles. This number was reported as a percentage. Five locations were evaluated on each panel. The locations were selected by dropping the mylar grid onto the panel surface from a distance of approximately one foot, and making the assessment at the point where the grid came to rest on the surface.

Abrasive Recyclablity Evaluation

Abrasives reported by the suppliers as typically being used more than one time to prepare steel surfaces for painting were evaluated for recyclablity. An initial run with each abrasive was made to determine cleaning rate, consumption rate, surface profile, particle size, embedment and relative industrial hygiene health-related agent levels. The spent abrasive was collected, weighed, and returned to the abrasive hopper. Without the use of an operator, the abrasive was impinged on a clean steel plate within a specially designed blast reclamation chamber. An illustration of this blast chamber is attached as Appendix 7 and photograph number 13 in Appendix E. The larger (thus heavier) particles of abrasive settled in the base of the chamber and fine particles were collected in the dust bag. The weight of both the settled material and the fine material captured in the dust bag was recorded after each trial run. In addition, samples of the settled abrasive were sieved to determine the particle size distribution. The material at the base of the chamber was then vacuumed, reclaimed and classified using the Lunardini air curtain classifier. The reclaimed abrasive was weighed prior to returning it to the blast pot for reuse, and a sample of the reclaimed abrasive was also sieved. All of the above information is recorded in the Blast Cleaning Reclaim report. A sample report is attached as Appendix 5. The completed reports are provided separately from this report.

This recycling process was repeated until the change in average particle size of the spent abrasive at the bottom of the blast chamber exceeded 50%, or for a maximum of 25 recycles for the steel grit abrasives, or 5 recycles for the copper slag and garnet abrasives. The limitation on the maximum number of recycles was established in advance for testing purposes. It is acknowledged that recyclable abrasives such as steel grit can be productively recycled many fold over the test design maximum. At the completion of the resulting number of recycles, the abrasive media was returned to the abrasive hopper for a final blast cleaning run using the blast operator and nine steel panels. The attributes of abrasive cleaning rate, consumption rate, surface profile, particle size, and embedment and relative industrial hygiene health-related levels were again evaluated for the final run.

Abrasive Bulk and Substrate Samples

One pound bulk samples of both pre-blast (virgin) abrasive material and post-blast abrasive material were obtained for each abrasive trial and submitted to NIOSH for analysis. Homogeneous pre-blast samples were collected as described above in the section entitled "Abrasive Particle Size Distribution." Homogeneous post-blast samples were collected as described in the section entitled "Abrasive Breakdown Rate."

One, 4"x 4" sample of the blast cleaned substrate from each abrasive trial was dry cut from one of the nine panels prepared in each trial. The panel selected and the sample location was determined using a computer-generated table of random numbers. The samples were sealed in plastic bags for future analysis if deemed essential by KTA or NIOSH in the future.

Abrasive Microhardness

The relative hardness of an abrasive can effect several production related characteristics including cleaning rate, consumption rate, and breakdown rate, and may also effect the amount of dust produced by an abrasive. Samples of each abrasive were removed from the riffled homogeneous mixture of pre-blast (virgin) abrasive and analyzed to determine the hardness of the abrasive particles in accordance with ASTM E384 "Standard Test Method for Microhardness of Materials"[3]. Results are reported in units of Knoop microhardness. Hardness increases as the Knoop number increases. 500 Knoop is approximately 6 on the Mohs hardness scale. Industrial Testing Laboratory Services Corporation in Pittsburgh, Pennsylvania performed the abrasive hardness testing.

Water Soluble Contaminants

Water soluble contaminants residing in abrasives in sufficient concentrations can be transferred to the substrate during cleaning, leading to reduced coating system performance. Conductivity analysis provides a means for determining whether water soluble materials are present in an abrasive. Conductivity assessments were performed on samples of the riffled pre-blast (virgin) abrasive in accordance with ASTM D4940 "Standard Test Method of Conductimetric Analysis of Soluble Ionic Contamination of Blasting Abrasives"[4]. This analysis involves combining approximately 300 milliliters of deionized water with 300 milligrams of the abrasive, and agitating the mixture for approximately one minute. The sample remains undisturbed for eight minutes, and is agitated again for approximately one minute. The sample is then filtered and the liquid portion is tested using a conductivity bridge. An Altex Model RC16C conductivity bridge was used for this analysis.

Industrial Hygiene Sampling

A proposed exposure monitoring protocol was developed to ensure collection of adequate data on airborne total dust levels of 28 metals/elements, and respirable quartz and cristobalite. The specific analytes included:

aluminum	calcium	lead	nickel	sodium	yttrium
arsenic	chromium	lithium	phosphorous	tellurium	zinc
barium	cobalt	magnesium	platinum	thallium	zirconium
beryllium	copper	manganese	selenium	titanium	quartz
cadmium	iron	molybdenum	silver	vanadium	cristobalite

The protocol was also designed to ensure the reproducibility of the test methods and to prevent cross-contamination from abrasive media. The elements of the approved assessment protocol included:

- Protection of Human Subjects
- Sample Collection Methodology and Filter Media Positioning
- Calibration of Sampling Pumps
- Background Monitoring
- Preparation of Test Facilities
- Sample Collection During Abrasive Trials
- Post Sample Collection Procedure

A trial run was conducted over a two day period prior to the start of the actual study. The trial run was used to determine the optimum sampling duration necessary to obtain quantifiable data without overloading filters. The final test protocol was modified as necessary, based upon the results of the trial run.

Protection of Human Subjects

Protection of human subjects (e.g. blasters, laborers, quality control personnel) was monitored throughout the study. Prior to initiation of the operator variability study, assigned project personnel were trained in the health effects of arsenic, cadmium, chromium, copper, iron, lead, nickel, silica, and zinc. Proper use of personal protective equipment, respiratory protection, and decontamination procedures were also reviewed. Finally, a medical surveillance program was initiated to help ensure that project personnel were adequately protected during the study. Medical surveillance consisted of: blood lead and zinc protoporphyrn (ZPP) levels; cadmium in blood and in urine (grams of creatinine and beta-2 microglobulin); spirometry testing (FEV and FVC); blood chemistry profile; and complete blood count with differential. Pre- and post-project medical surveillance testing was performed by Health-on-Site of Youngstown, Ohio.

Personal protective equipment utilized by the blaster(s) included a Bullard Model 77 Type CE supplied air helmet (APF of 1000) with Grade D breathing air supply, cotton coveralls, gloves, boots and hearing protection (NRR 29). Separate work clothing was worn beneath coveralls, and no food, beverages, tobacco or cosmetics were permitted in the test facility. Support personnel were similarly outfitted, except that half-face, negative-pressure, air-purifying respirators with HEPA filtration were worn, (APF of 10), instead of the blast helmet. All project personnel washed hands and face prior to eating, drinking or smoking, and showered at the end of the workshift.

Sample Collection Methodology and Filter Media Positioning

During each abrasive trial, airborne samples were collected in the blast room as well as on the operator. Blast room samples consisted of: total airborne dust, 28 airborne metals/elements; respirable crystalline silica and cristobalite; respirable radiochemically

active materials; and total airborne radiochemically active materials. Sampling was conducted under the NIOSH methods[5]: 7500 for respirable quartz, 7300 for elements, 0500 for total dust, 0600 for respirable dust; and the WR-IN-314 standard operating procedures entitled "The Determination of Radium-226 in Solids by Alpha Spectrometry" for respirable radioactivity[6].

A total of twenty-nine (29) samples (8 make-up air area; 8 operator area; 8 exhaust area; 2 passive samples for collection of ricochet in the blast room operator area; and 3 within the operator's breathing zone) were collected for each abrasive trial. A passive sample is one placed in the operator sampling area without a pump attached. The following samples were collected at each area (or fixed station) for each abrasive trial: four total dust samples, one elemental sample, one respirable crystalline silica sample, one respirable radioactivity sample, and one total airborne radioactivity sample. The following samples were collected within the operator's breathing zone for each abrasive trial: one total dust sample, one elemental sample, and one respirable crystalline silica sample. One virgin and spent bulk sample were collected for each abrasive trial and analyzed for thirty health-related agents. The airborne and bulk samples were analyzed by the following NIOSH methods[5]: 7500 (x-ray diffraction) for respirable quartz; 7300 for all elements, except the graphite furnace method for arsenic, beryllium, cadmium, and lead; the WR-EP-325 standard operating procedure entitled "Determination of Gamma Emitting Isotopes" for radioactivity in bulk samples[7] and WR-IN-314 standard operating procedures entitled "The Determination of Radium-226 in Solids by Alpha Spectrometry" for respirable radioactivity in airborne samples[6]. Greater than 75% of the total dust samples had filter weights greater than the recommended sample filter weight for NIOSH method 0500. Therefore, the total dust results will not be provided in this report.

Airborne sampling was conducted using Gilian, SKC and GAST Hi-Flow sampling pumps, tygon tubing and the appropriate collection device/filter media. In order to prevent pump damage from airborne dust concentrations inside the blast facility, all area sampling was performed remotely by traversing 32' 4" lengths of tygon tubing (3/8" O.D.) through a dividing wall, across the top and down through the ceiling of the blast room to three fixed station locations. Head loss was tested for the 32'4" length tubes and compared to standard length 3' tubes at flow rates of 1.0, 1.7, and 2.0 liters per minute. The comparative head loss was determined to be minimal. Eight to ten sample holders were positioned inside the blast room in each of three (3) areas, identified as the make-up air area (fixed station #1), operator area (fixed station #2), and exhaust area (fixed station #3). Sample holders were mounted 12" from the blast room wall, at breathing zone height (5- 6 feet). Individual samples were separated from each other by a clearance of 6 inches (see drawing attached as Appendix 8). The sampling pumps were positioned on the opposite side of the dividing wall, on a laboratory bench top. Each tygon tubing was identified using a unique number (1-39); and each pump was identified using a unique letter (A-U). Independent of pump location and filter media position, all tygon tubing was of the same length and diameter.

Sampling within the blaster's breathing zone was conducted using three (3) SKC programmable sampling pumps mounted on the waist of the blaster. Tygon tubing traversed from the pump up the worker's back, over the shoulders and into the breathing zone, defined as a 6-9" hemisphere from the nose downward, and forward of the shoulders. All tygon tubing for the breathing zone sampling was the same length and diameter (3' x 3/8"O.D.). The filter media for elemental sample collection was positioned over the right shoulder for each abrasive trial. The filter media for collection of total dust was positioned over the left shoulder for each trial. A 10mm nylon cyclone equipped with PVC filter media for collection of respirable crystalline silica was positioned between the two other samples, centered beneath the chin area on the worker. All filter media was positioned outside the blast helmet in a downward position, forward of the shoulder, attached to the blast helmet cape using collar clips.

Calibration of Sampling Pumps

The Gilian, SKC and GAST sampling pumps were calibrated prior to each sampling period (through the filter media) using a Gilian Model 800271 Gilibrator precision flow bubble meter equipped with a standard flow cell (20cc to 6 l/m). Each sampling pump was equipped with the respective filter media, then connected to the Gilibrator. Adjustments to each pump were made using the flow adjustment screw or flow restrictor valve (GAST pumps) until the target flow was achieved. Subsequently, five (5) flow measurements were recorded, then averaged for each sampling pump. The data was recorded on a Pump Calibration Report (example attached in Appendix 5).

The sampling pumps equipped with 10mm cyclones for collection of respirable crystalline silica and respirable radiochemically active material were calibrated in accordance with the Occupational Safety and Health Administration (OSHA) Technical Manual Chapter 1, "Personal Sampling for Air Contaminants"; Section C, Technique 3.[8] Briefly, the filter media was mounted in MSA 10mm nylon cyclones. The filter media and cyclone were then placed in a one liter vessel with two (2) ports in the screw top lid. A 12" section of tygon tubing was connected from one port on the glass vessel to the Gilibrator precision flow bubble meter. The sampling pump was connected to the second port on the vessel using the appropriate length of tygon tubing (32' 4" for area sampling in the blast room and 3' for breathing zone monitoring on the worker) and the sampling pump adjusted to maintain a flow rate of 1.7 L/min.

The sampling pumps for collection of total airborne dust were targeted for calibration at 1.0 liter per minute through pre-weighed, 0.5 micron pore size, 37mm diameter polyvinyl chloride (PVC) filter media encased in 37mm plastic cassettes. The sampling pumps for collection of metals/elements were targeted for calibration at 2.0 liters per minute through 0.8 micron pore size, 37mm diameter, mixed cellulose ester (MCE) membrane filter media, also encased in 37mm plastic cassettes. The sampling pumps for collection of respirable dust and respirable radiochemically active material were targeted for calibration at 1.7 liters per minute through pre-weighted, 0.5 micron pore size, 37mm diameter PVC filter media encased in 37mm plastic cassettes. Finally, the sampling pumps for collection of total radiochemically active material were targeted

for calibration at 4.0 liters per minute through pre-weighed, 0.5 micron pore size, 37mm diameter, PVC filter media encased in 37mm plastic cassettes.

Background Monitoring

Prior to initiation of the study, background sampling was conducted for eight (8) hours to determine the existing airborne concentrations of total dust, targeted metals/elements, respirable crystalline silica and radiochemically active materials, and total radiochemically active materials. The ventilation system was activated, drawing 50-75 feet per minute average cross-sectional air flow through the facility. Otherwise, the blast room remained undisturbed during background monitoring.

Preparation of Test Facilities

To prevent cross-contamination of abrasive media after each abrasive trial, the blast facility was vacuumed to collect spent abrasive debris and dust. Subsequently, the surfaces within the blast room were damp-wiped using sponges to collect any residual dust clinging to the walls, ceiling, floor, sample holders, test plate rack, or other surfaces. Subsequently, after drying and prior to each abrasive trial, the blast facility was visually inspected for the presence of abrasive debris from the previous blast trial. Additionally, a "white glove" examination was conducted on a minimum of five (5) random surfaces. The presence of "swipe marks" left by the glove was case for rejection and recleaning as necessary.

In addition to the blast facility, support equipment used for the blast cleaning process was also cleaned and visually examined for residual dust. This equipment included the blast nozzles, blast hoses, blast pot, abrasive reclaimer (when applicable) personal protective equipment (blast helmet and cape), protective clothing, and substrate material.

In addition to qualitative inspection for surface cleanliness, wipe samples were obtained to quantitatively assess surface cleanliness. Three (3) wipe samples were obtained after every fifth trial by randomly placing a one square foot template on the wall, ceiling, and floor and collecting a wipe sample from each square foot area using non-alcohol, non-aloe containing baby wipes. The wipe samples were collected, then stored in plastic screw-cap conical tubes.

After the cleanliness inspection, a ventilation system inspection was performed by measuring the cross-sectional air flow through the blast facility using an Alnor Model RV Rotating Vane Anemometer. Twelve (12) measurements of cross-draft air flow were obtained midway through the blast room. Four (4) measurements were obtained near the ceiling (7-8' above floor level), four (4) measurements were obtained at the breathing zone height (5' above floor level), and four (4) measurements were obtained 6-12" from the floor. The twelve measurements were averaged to ensure that the cross-draft ventilation was maintained at 50-75 feet per minute. The results of the ventilation assessment and blast facility cleanliness were recorded on a Mechanical Ventilation

Evaluation Form and Industrial Hygiene Report Form, respectively (examples attached in Appendix 5). The arithmetic mean for each group of measurements are presented in Appendix 8.

Sample Collection During Abrasive Trials

Prior to initiating each blast trial, the unique number assigned to each filter media by NIOSH was transcribed to the Industrial Hygiene Report Form. Concurrently, a position number was assigned to each filter media to ensure proper positioning/tygon tubing connection once inside the blast facility. Each filter cassette/cyclone assembly was carefully mounted in the holders inside the blast room. The inlet ports of the cassettes remained plugged until the operator was ready to begin blast cleaning (exception - cyclone-mounted media). Subsequently, the operator personal pumps were mounted on the blaster and the cassette inlet port plugs were removed.

The three (3) personal sampling pumps mounted on the blaster were programmable SKC personal sampling pumps. The pumps were programmed to initiate sampling 3 minutes after the abrasive trial began in order to provide time to allow airborne concentrations of dust to equilibrate, and to stop sampling 24 minutes into the sampling period (to prevent overloading of the filter media). The total elapsed time of 27 minutes was based on information collected in a pilot study to estimate the best sampling rates to avoid overloading of the sample filters for total dust and to allow enough time to collect a minimum of respirable crystalline silica dust.

Similarly, the sampling pumps collecting airborne debris in the make-up air, operator, and exhaust areas were also turned on after 3 minutes had elapsed and stopped 24 minutes later.

To reduce the quantity of "total dust" collected on the filter media located in the three areas inside the blast room, four (4) 6 minute samples of total dust were collected rather than one (1) 24 minute sample. To reduce the number of sampling pumps required to perform this task, the following procedure was utilized:

1. Pumps identified as A, B, G, H, M, and N were used together with hoses numbered 1, 2, 3, 4, 14, 15, 16, 17, 27, 28, 29, and 30.
2. After a 3 minute delay, pumps A, G, and M were connected to hoses 1, 14, and 27, and started.
3. After six minutes, pumps A, G, and M were stopped and pumps B, H, and N started (connected to hoses 3, 16, and 29).
4. Hoses 1, 14, and 27 from pumps A, G, and M were disconnected, and hoses 2, 15, and 28 were connected to pumps A, G, and M, respectively.
5. After the second six (6) minute sampling period, pumps B, H, and N were simultaneously stopped and pumps A, G, and M restarted.
6. Hoses 3, 16, and 29 were disconnected from pumps B, H, and N, and hoses 4, 17, and 30 were connected to pumps B, H, and N, respectively.

7. After the third - six (6) minute sampling period, pumps A, G, and M were simultaneously stopped and pumps B, H, and N started.
8. After the fourth - six (6) minute sampling period, pumps B, H, and N were stopped.

This procedure resulted in the collection of four (4) 6 minute samples, in each of three areas in the blast facility.

Finally, two (2) samples consisting of 0.5 micron pore size, 37mm diameter PVC filter media in 37mm plastic cassettes were mounted in the operator area without hose or sampling pump connection to determine if ricochet debris entered the filter cassettes during the trial runs.

Post Sample Collection Procedure

Post sample collection procedures included sample security, removal of samples from the operator and blast facility, pump flow rate verification and sampling equipment cleaning. Sample security was accomplished by plugging the inlet port of the filter media, then removing the media from the sampling hose and plugging the outlet port. This procedure was conducted on the operator first, then the blast facility samples. Support personnel were prohibited from entering the blast facility until all inlet ports were sealed. Subsequently, the cyclones were carefully removed, kept in a vertical position, then placed in a customized holder. The holder kept the cyclones vertical to ensure the large debris which accumulated in the grit pot at the base of the cyclones did not come in contact with the PVC filter media. The filter cassettes were removed from the blast facility, and the cassettes sealed using 9/16" x 3-7/16" labels, each containing the date and technician's initials. This was done to prevent tampering with the samples, as well as accidental dislodging of the inlet port caps. The samples were sorted according to required analysis, then boxed for transportation to NIOSH in Morgantown, West Virginia for analysis in accordance with the appropriate NIOSH analytical methods. Samples were routinely transported to NIOSH by KTA personnel. A Sample Submittal Form and Chain-of-Custody accompanied each batch of samples (example included in Appendix 5). Additionally, 20% field "blank" samples were added to each shipment (also categorized by type of analysis). Forty-nine field blanks were submitted and analyzed for each of the 30 health-related agents listed in Appendix B. For all of the 30 health-related agents, the analytical results were so low and sporadic that no adjustment for field blanks was implemented. Chromium, nickel, vanadium, respirable quartz, respirable cristobalite, and lithium were not detected in any of the forty-nine field blanks. The results for the remaining 24 agents would not have altered the rankings of any of the individual abrasives or categories of abrasives, but would slightly decrease the magnitude of the results for all of these 24 health-related agents. The adjustment would be the same for all samples associated within a given health-related agent, but the proportion of that adjustment would be substantially greater for the results near the limit of detection (LOD) or limit of quantification (LOQ) as opposed to results which were much greater than the LOD or LOQ.

After all samples were secure, post-sampling pump flow rate verification was conducted by connecting each pump to the Gilian Gilibrator precision flow bubble meter (through the respective media) and recording five flow rates as well as the average flow rate (in LPM) on the Pump Flow Verification Report Form. The pre- and post-sampling flow rates for each pump were averaged to create an average flow rate for the actual sampling period. This flow rate was reported to NIOSH to calculate the total volume of air sampled on each filter cassette.

If the post-sampling flow rate verification results were relatively unchanged, the results were used as the pre-calibration for the next abrasive trial, provided another trial was being conducted that same work day. If the flow rate changed significantly, a separate calibration procedure was conducted.

After post-calibration, operator breathing zone pumps and hoses were wiped with a dampened cloth to remove residual dust. The 10mm nylon cyclones were cleaned in accordance with the OSHA Technical Manual, Chapter 1, Section C.3(6)e. "cyclone cleaning"[8]. The grit pot was removed from the base of the cyclone and gently tapped on a counter top to remove the large particles. The size selective inlet was disassembled and the components were thoroughly rinsed using tepid tap water. Subsequently, all nylon components were cleaned in a 22-watt ultrasonic bath manufactured by Fisher Scientific (Model FS-3). A mild solution of Alconox detergent powder in tap water was used to clean the parts for approximately ten (10) minutes. Each component was then thoroughly rinsed with tepid tap water and dried in a laboratory oven pre-set at approximately 100°F. After drying, the cyclones were inspected for wear, then reassembled for the next abrasive trial.

Documentation

The following documentation report forms were used for the collection of all data. Examples of each form are included in Appendix 5. Actual forms completed during the study were provided to NIOSH under separate cover.

Blast Cleaning Inspection Report # QPF-WDC345R.1 – Report form is for collection and record keeping of all data and variables associated with first and last runs during abrasive testing.

Blast Cleaning Reclaim Report # QPF-346r.0 – Report form is for collection and record keeping of all data and variables associated with reclaiming of spent abrasives and any abrasive breakdown cycles performed.

Sieve Analysis Report # MATF 100R.2 – Report form is for the collection and record keeping of data associated with screening for particle size. Calculations to develop average particle size and charting results are also included on report form.

Industrial Hygiene Report – Report form is for collection of data and acts as a checklist to ensure completion of pretest industrial hygiene practices. The report records air filter cassette sample numbers, type of filter media, duration of air flow over cassette, and total volume of air to flow over air sample media.

Pump Calibration Report – Report of calibration and actual air flow prior to test.

Pump Flow Verification Report – Report to verify post run actual air flow.

Mechanical Ventilation Evaluation # J95331 – Form used for collection and calculation of air flow through the blast room.

Sample Submittal Form – Used to provide sample identification and sample collection parameters for submission to NIOSH for corresponding industrial hygiene analysis.

Chain-of-Custody – Used to verify the integrity of the samples and resulting data throughout the collection, transport, and analysis activities.

Concerns

The size and scope of the testing program resulted in a few deficiencies in both the development of the testing protocol and execution of the abrasive blasting trials. Each concern, its cause, and resolution is described in the sections that follow. Letters from individual abrasive supplies discussing these concerns are included in Appendix 2.

Abrasive Metering Valve

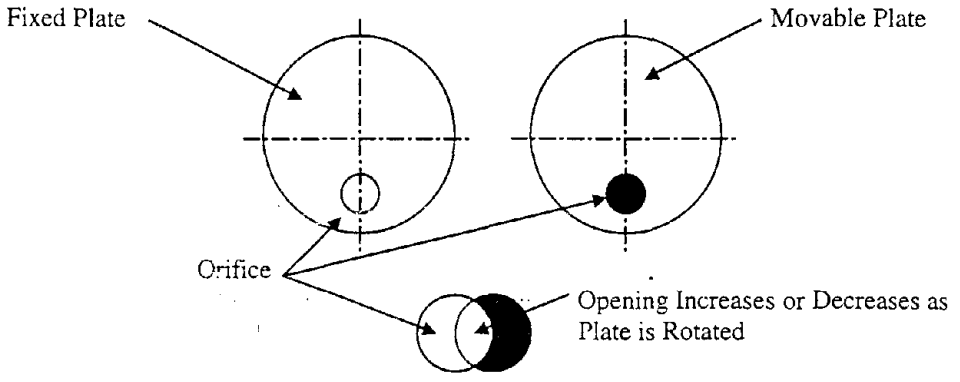
The abrasive metering valve is an integral part of any blast cleaning pressure pot. The purpose of valve is to meter the amount of abrasive that is fed into the stream of compressed air, which propels the abrasive particles.

The adjustment of the metering valve is critical to abrasive blast cleaning productivity. Too little abrasive introduced into the air-stream results in an incompletely filled blast pattern, which slows production and leaves areas on the substrate or item being cleaned untouched by the abrasive particles. Too much abrasive causes abrasive particles to collide, which wastes energy and disperses particles unevenly within the blast pattern. A metering valve setting that is too rich in abrasive also unnecessarily wastes abrasive. A properly adjusted metering valve ensures that the maximum amount of cleaning is gained from each abrasive particle. In typical field abrasive blast cleaning operations, the proper metering valve setting is determined by a trial and error procedure, which relies heavily on the experience of the blast machine operator. This procedure begins with the metering valve closed (only air is flowing through the blast hose and

nozzle). The metering valve is then slowly opened. The proper setting is determined using both visual and audible experience. A proper setting will show slight discoloration of abrasive leaving the nozzle. Experienced blast operators can also hear a steady abrasive flow. Too little abrasive causes a high-pitched sound, while too much abrasive causes an erratic, pulsating sound. The metering valve adjustment process typically takes several minutes.

The typical construction of most abrasive metering valves is shown in Figure 1. Two concentric circular steel plates are used. Each plate has a one-inch diameter orifice. One of the plates is fixed in position, while the other is allowed to rotate. The valve is adjusted by rotating the plate. When the valve is fully open, the centers of each orifice are aligned.

FIGURE 1 – TYPICAL METERING VALVE CONSTRUCTION



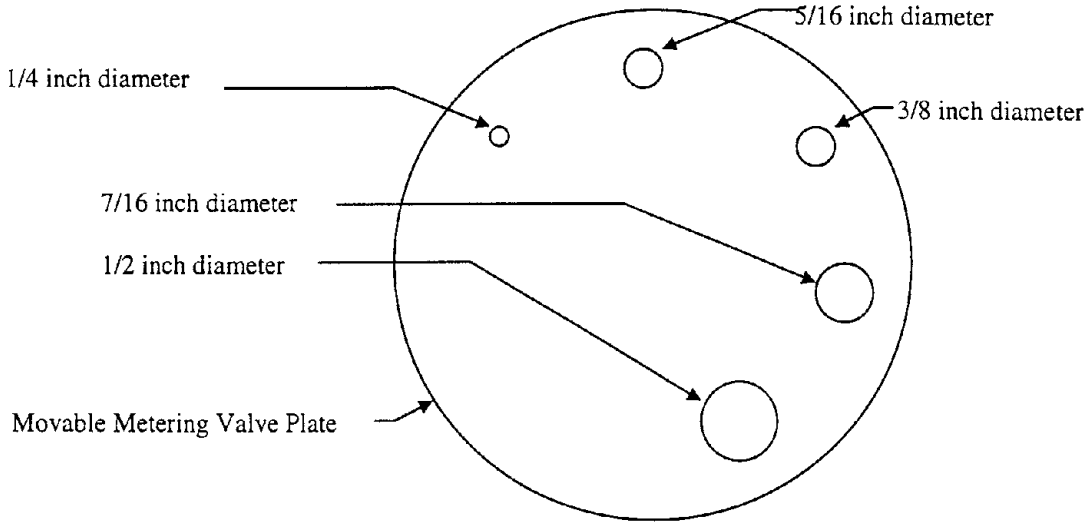
The study protocol developed for this abrasive testing program prohibited the use of traditional methods for setting abrasive metering valves for several reasons:

- Operator Variability Study – The purpose of this part of the study was to measure the difference in the blast operator's technique independent of the blast equipment setup. Therefore, constantly adjusting the metering valve to suit the operator's individual performance would not reliably evaluate the consistency of an individual blast operator or the performance of one operator versus another.

- Process Control Checks – Variability caused by abrasive metering valve adjustments would invalidate the in-process control checks of operator variability.

KTA designed and fabricated a metering valve plate and established a procedure which could address the deficiencies listed above. The new plate configuration is shown in Figure 2.

FIGURE 2 – SPECIALLY DESIGNED METERING VALVE CONFIGURATION



The metering valve plate has five fixed settings, which result in a much higher level of valve adjustment consistency. Each abrasive supplier was then asked to recommend the orifice for his or her product and mesh size. The sizes were as follows (if the supplier did not furnish this information, the 1/2 inch size was used):

CG-01	3/8"	S-02	1/4"	CP-2	3/8"
CS-01	1/2"	SH-01	5/16"	CP-3	3/8"
CS-02	7/16"	SS-01	1/2"	CP-4	5/16"
CS-03	1/2"	SS-02	1/2"	CPDS-1	3/8"
CS-04	7/16"	SS-03	1/2"	G-1	3/8"
CS-05	1/2"	SS-04	1/2"	G-2	7/16"*
CS-06	1/2"	SS-05	1/2"	G-3	3/8"
CS-07	1/2"	SS-06	1/2"	G-4	3/8"
CSDS-01	1/2"	SS-07	1/2"	G-5	1/4"
CSDS-02	1/2"	SSDS-01	1/2"	G-6	7/16"
N-01	7/16"	SSDS-02	1/2"	G-7	3/8"
N-02	3/8"	SSDS-03	1/2"	SG-1	3/8"**
O-01	1/2"	CP-1	3/8"	SG-2	3/8"
S-01	1/4"				

* Last abrasive run - metering valve reduced by 1/16" to promote abrasive flow.
** Last abrasive run – metering valve reduced by 1/8" to promote abrasive flow.

Although the new metering valve plate was tested prior to the start of the operator variability study without fault, the valve clogged during two abrasive trials (OV-1 and OV-3). The metering valve plate used for these initial trials allowed abrasive to build up around the opening, restricting the flow of abrasive. The valve was redesigned to prevent the build up of material. Abrasive trials OV-1 and OV-3 were re-performed, and no further problems with the abrasive metering valve were encountered.

Production Rates

The cleaning rate and consumption rate results were much lower than published rates in the NSRP Report[9] and lower than what KTA has experienced in both field and laboratory projects. There are many factors that affect the cleaning and consumption rates of any abrasive blast cleaning system as previously discussed in this report and in the appended article "Achieving Productivity from Abrasive Blast Cleaning Systems" (Appendix 8). This article was published in the September 1989 edition of the Journal of Protective Coatings & Linings[10]. The factors that effect abrasive blast cleaning productivity are:

- Metering Valve Setting – As discussed above the use of a pre-determined meter valve setting, versus trial and error to account for the equipment set up can significantly affect the cleaning and consumption rates of the various abrasives.

- Nozzle Size – Abrasive blast nozzles with larger openings produce a larger blast pattern on the surface being cleaned. Blast nozzles typically range in size from 1/8 inch to 1/2 inch orifice diameter, in 1/16 inch increments. Larger sized nozzles also permit more abrasive impacts since more abrasive particles exit the nozzle over a given unit of time. Therefore, productivity increases as a function of the nozzle size. The limiting factor is that larger nozzles require larger volumes of compressed air. Each 1/16 inch increase in nozzle orifice diameter requires approximately twice as much air volume flow for a given blast pressure. During this study, KTA used a 1/4 inch nozzle to provide ample blast cleaning time to collect the industrial hygiene data. As a result the study resulted in lower cleaning rates.

- Nozzle Type – There are currently two types of blast nozzles used during field blasting operations. These are categorized by the nozzle geometry. Straight bore nozzles have a constant orifice diameter for the length of the nozzle. Venturi nozzles converge to the nozzle's size at a point approximately half of the nozzle's length and then diverge for the remainder of the nozzle. The converging portion of the nozzle accelerates the air and abrasive particles resulting in increased impact energy which, in turn, enhances productivity. The diverging portion of the venturi nozzle provides an increase blast pattern. KTA used a venturi nozzle for all abrasive trials.

- Standoff Distance – The standoff distance is the distance that the nozzle is held in relation to the item being cleaned. This distance is critical to abrasive blasting production. Blast operators typically optimize the distance to achieve the desired blast pattern and cleaning rate. This distance could range from 6 inches to 24 inches. Generally, nozzles are held closer to the substrate to clean tightly adherent mill scale or coatings which require a smaller blast pattern to achieve the specified surface cleanliness. When surfaces being cleaned exhibit loosely adherent coatings or flaking mill scale and rust, the larger blast pattern produced at greater standoff distances allows faster cleaning. During the abrasive trials the standoff distance was held constant for all abrasive trials at 18 inches to measure the effectiveness of the

different abrasives independent of the operators skill or experience. This would also provide consistent, repeatable results, but the fixed distance will affect the ability of different abrasives to clean.

- Angle of Attack – The angle of attack is the angle that the nozzle is held to the work-piece. Most field abrasive blast cleaning is performed with the nozzle held between 60° to 120° to the surface. Nozzles held perpendicular (90°) to the surface provide more impact energy, which fractures tightly adherent coatings and mill scale. Nozzles held at angles greater than or less than 90° scour the surface. Experienced abrasive blast operators use a combination to achieve high productivity. During this abrasive study, the KTA operator held the nozzle perpendicular to the panels being cleaned so that the greatest amount of dust would be produced for industrial hygiene monitoring. Such restrictions, however, can affect cleaning rates.

- Dwell Time – Dwell time is the amount of time required to achieve the desired surface cleanliness before the nozzle can be moved to the next area on the substrate. This factor is highly influenced by the size of the blast pattern. For small blast patterns, where the nozzle is held close to the surface being cleaned, the dwell time is very short. When a larger blast pattern is used, the dwell time may be longer. Once again, the operator's skill and knowledge of the cleanliness specification help to reduce dwell time; thus increase productivity. Some of this control was removed from the operator by fixing the nozzle distance and angle of attack.

- Nozzle Pressure – The pressure of the air/abrasive stream during blasting operations greatly influence the cleaning productivity. For most abrasives, increased pressure results in increased production. Generally, abrasive blasting pressure is increased to the maximum capacity of the air compressor used with the exception of abrasives such as steel grit. Diminishing returns occur at pressures significantly above 100 psi. Some abrasives however, efficiently produce the desired surface cleanliness at lower pressures. Most of the garnet suppliers used during the study wanted KTA to use nozzle pressures in the range 60 to 80 psi in order to reduce breakdown rate and improve the reuse characteristics. During each abrasive trial run conducted as a part of this study, the nozzle pressure was held constant at 100 psi. This was necessary to limit the number of variables in the study.

Each of these factors affected the cleaning rate and consumption rate results. Many of the factors are dependent on the skill or experience of the blast nozzle operator. The goal of KTA's study design was to produce comparable abrasive blast cleaning results with the abrasive type being the only variable. Also, the operator used for the study was chosen based upon consistent results obtained during the operator variability study, not the operator displaying the highest productivity or having the most experience.

Number of Abrasive Recycles

Limitations were placed on the number of times that the steel grit abrasives would be recycled during the abrasive study due to time and cost restraints. The steel grit

abrasives were recycled 25 times. Steel grit abrasive suppliers suggest that their products may be recycled in excess of 200 times. In fact, KTA uses steel grit abrasives for preparation of test panels for laboratory testing. The steel grit is used a minimum of three days per week all year long with no significant change in the surface profile obtained. The advantage to recycling any abrasive is reduced material cost and reduced waste disposal cost. Costs for each abrasive are addressed under the Test Results and Discussion section of this report.

The steel grit suppliers were also concerned with the setup and operation of KTA's abrasive reclamation and classification system. The suppliers felt that the Lunardini reclamation system removed too much abrasive fines (small particle sizes). The average particle size of SG-01 was 46.03 mm. The average size of the abrasive fines removed by the reclamation system was 0.34 mm. The average particle size of SG-02 was 51.38. The average size of the abrasive fines removed by the reclamation system was 0.23 mm.

Cost Analysis

The data regarding abrasive consumption, productivity, and the resulting cost/square foot are only valid as measures of the performance of each unique abrasive relative to the study parameters. A comparison of performance between abrasives is valid only as it relates to the study design. It is not an indication as to how one abrasive will perform relative to another when the optimum operating conditions are selected for each. The results have no relationship to true field performance, and should not be used for that purpose, either directly, or through relative comparisons.

In conclusion, KTA developed the Study Design/Protocol to measure the concentrations of health-related agents and effectiveness of 40 different abrasives. The factors affecting the abrasive blast cleaning process were held constant so that a comparative evaluation of the abrasives could be made independent of the substrate, surface cleanliness, equipment setup, or operator. KTA did not deviate from the Study Design/Protocol during the entire laboratory testing phase of the project.

TEST RESULTS AND DISCUSSION

This section presents and analyzes the results of the physical property evaluation of the abrasives and the industrial hygiene data that was collected. A total of 40 different abrasives representing 13 different generic types were evaluated in this study. For convenience, the generic abrasive types, an alpha code assigned to each, and the number of individual products evaluated under each type are as follows:

Expendable Abrasives

Coal Slag (CS)*	7 products
Coal Slag with Dust Suppressant (CSDS)	2 products
Crushed Glass (CG)	1 product
Nickel Slag (N)	2 products
Olivine (O)	1 product
Silica Sand (SS)	7 products
Silica Sand with Dust Suppressant (SSDS)	3 products
Specular Hematite (SH)	1 product
Staurolite (S)	2 products

*Mixed window and plate post industrial

Recyclable Abrasives

Copper Slag (CP)	4 products
Copper Slag with Dust Suppressant (CPDS)	1 product
Garnet (G)	7 products
Steel Grit (SG)	2 products

The testing clearly demonstrated that a wide range in physical properties and in heavy metal content exists in the individual abrasives tested within all generic types. Although only 1 abrasive was evaluated for crushed glass, olivine, specular hematite, and copper slag with dust suppressant, it is expected that similar variability within these generic types of abrasive will exist as well.

Physical Property Evaluations

The results of abrasive media testing are summarized from the "Blast Cleaning Inspection Reports" prepared for each abrasive trial. The data was obtained in order to quantify the production and performance-related attributes of each of the abrasives tested. The specific attributes examined were:

- Abrasive cleaning rate
- Abrasive consumption rate
- Surface profile

- Abrasive breakdown rate (pre and post blast average particle size comparison)
- Abrasive embedment
- Abrasive recyclability (for abrasives designated as recyclable only)
- Microhardness
- Conductivity (water soluble contaminates)

Many of these attributes affect the amount of time that abrasive blast operators are subject to possible inhalation and ingestion hazards. Additionally, these attributes affect the cleanliness of prepared surfaces, the amount of waste generated, and cost of abrasive blast cleaning operations. Since abrasive blast cleaning is most often used for preparing surfaces to properly accept coating systems, an evaluation of particle embedment and water-soluble contaminants was performed because contaminants carried from abrasives to the surface being prepared can lead to premature coating failures. Premature failures of the paint system will unnecessarily subject workers to additional exposures by virtue of the unscheduled repair work that will be required.

The results of the testing for each of the individual abrasives are presented in the tables attached as Appendix A. Separate tables have been prepared for each of the attributes evaluated. This section describes the type of information found in each of the tables, and provides a general summary and discussion of the results.

The results are categorized by generic abrasive type and whether the abrasive is typically recycled (used more than one time). Refer to the Abrasive Media Test Methods section of this report for a description of the test methods and associated industrial standards used for each of the evaluations.

Abrasive Cleaning and Consumption Rates

Table A1 (Appendix A) provides the results of the cleaning and consumption rates for each of the expendable abrasives tested. Table A7 provides the results for the same testing conducted on the recyclable abrasives. Both tables present the length of time that each trial was conducted for each individual abrasive, the amount of abrasive used and surface area cleaned. From this data, the cleaning rate in square feet/hour and the abrasive consumption rate in pounds per square foot have been calculated. The results for the individual abrasives are combined according to their generic categories and summarized as a class in Table A13.

As indicated in the Study Design and Test Methods section of this report, the blast cleaning trials were conducted using a 1/4" orifice nozzle at 100 psi. Blast distance was fixed at 18" from the surface with the nozzle maintained at right angles at all times. Such restrictions were invoked in order to control as many variables as possible between each of the runs. One variable that was not held constant involved the metering valve setting. The metering valve was set uniquely for each abrasive at a predetermined opening based upon recommendations from the abrasive manufacturers. A 1/2" opening was used as the default setting when no recommendations were given. It became apparent that it is difficult, if even possible, for manufacturers' to confidently pre-select metering valve

settings. Instead, the settings need to be determined through experimentation for each equipment set up and unique project condition.

While all of the controls previously described were designed to allow for a more accurate comparison of the properties between abrasives, a disadvantage emerged. The equipment and operational controls proved to severely restrict productivity and adversely affect abrasive consumption rates when compared with industry data and experience. As a result, the information is only valid as it relates to the performance of a given abrasive relative to the stringent controls placed on the Study Design. The data should not be construed as being representative of field expectations, nor are relative comparisons between abrasives meaningful. When optimum operating conditions for each abrasive are selected for field use, dramatically different cleaning and consumption rates will result, both in an absolute and relative sense.

Cleaning Rates - As can be seen in Tables A1 (expendable) and A7 (recyclable), the cleaning rates derived from the study show:

- Crushed glass exhibited a cleaning rate of 33 square feet/hour.
- The cleaning rates for the 7 coal slag abrasives ranged from 28 to 42 square feet/hour. The abrasives can be categorized as follows: 1 sample at 28 square feet/hour; 4 samples from 31 to 34 square feet/hour; 2 samples at 41 and 42 square feet/hour.
- The cleaning rates for the 2 coal slag abrasives treated with dust suppressant were 35 and 38 square feet/hour. This was an increase over the untreated counterpart in one case (38 vs. 28 square feet/hour), and a decrease in the other (35 vs. 41 square feet/hour).
- The cleaning rates for the 2 nickel abrasives were 35 and 47 square feet/hour.
- The cleaning rate for the olivine abrasive was 44 square feet/hour.
- The cleaning rates for the 2 staurolite abrasives were 44 and 49 square feet/hour.
- The cleaning rate for the specular hematite abrasive was 32 square feet/hour.
- The cleaning rates for the 7 silica sand abrasives ranged from 25 to 37 square feet/hour.
- The cleaning rates for the 3 silica sand abrasives treated with dust suppressant ranged from 26 to 39 square feet/hour. This represents an increase over the untreated counterpart in one case (39 vs. 37 square feet/hour), a decrease in another (26 vs. 34 square feet/hour), and no change for the third (34 square feet/hour for both runs).

- The cleaning rates for the 4 copper slag abrasives ranged from 28 to 61 square feet/hour at the time of initial use (28, 40, 48, and 61). After uses, the cleaning rate increased in each case to a range from 33 to 92 square feet/hour (33, 52, 54, 92).

- The cleaning rates for the copper slag abrasive treated with dust suppressant was 31 square feet/hour. This increased to 40 square feet/hour after 2 uses. These rates show a decrease in cleaning rate compared with the untreated counterpart for the initial use (31 vs. 40 square feet/hour), and after reuse (40 vs. 54 square feet/hour).

- The cleaning rates for the 7 garnet abrasives ranged from 24 to 62 square feet/hour for the initial use. The abrasives can be categorized as follows: 2 samples at 24 and 26 square feet/hour; 2 samples at 31 to 34 square feet/hour; 2 samples from 43 to 44 square feet/hour; 1 sample at 62 square feet/hour.

- After 2 to 3 uses, the cleaning rates increased for 6 of the 7 abrasives to a range from 31 to 75 square feet/hour. The exception involved an abrasive that became too pulverized after 2 uses to evaluate.

- The initial cleaning rates for the steel grit abrasives were 27 and 39 square feet/hour. After 25 uses, the rates increased in both cases: 27 increased to 31 square feet/hour and 39 increased to 44 square feet/hour.

The cleaning rates for the 7 silica sand abrasives ranged from 25 to 37 square feet/hour. Industry data[9] suggest that cleaning rates for silica sand and the alternative abrasives tested will be 2 or more times the rates obtained from this study (due to the restrictions on equipment and operating procedures described above). Based on the study parameters, generic abrasive types having one or more products that exceeded the highest cleaning rate for silica sand included: (Again, it must be emphasized that when unique equipment and operating adjustments are made for each abrasive, the relative and absolute productivity of the abrasives will vary from the values obtained from the study. For example steel grit will be much more productive.)

- crushed glass (0 of 1 products exceeded)
- coal slag (2 of 7 products exceeded)
- coal slag with dust suppressant (1 of 2 products exceeded)
- nickel slag (1 of 2 products exceeded)
- olivine (1 of 1 products exceeded)
- staurolite (2 of 2 products exceeded)
- specular hematite (0 of 1 products exceeded)
- copper slag – initial use (3 of 4 products exceeded)
- copper slag – after 2 uses (3 of 4 products exceeded)
- copper slag with dust suppressant – initial use (0 of 1 exceeded)

- copper slag with dust suppressant – after 2 uses (1 of 1 exceeded)
- garnet – initial use (3 of 7 products exceeded)
- garnet – after 2 to 3 uses (4 of 7 products exceeded)
- steel grit – initial use (0 of 2 products exceeded)
- steel grit – after 25 uses (0 of 2 products exceeded)

Consumption Rates - As can be seen in Tables A1 (expendable) A7 (recyclable), the consumption rates derived from the study show:

- Crushed glass exhibited a consumption rate of 10.99 pounds/square foot.

- The consumption rates for the coal slag abrasives ranged from 9.05 pounds/square foot to 12.35 pounds/square foot.

- The consumption rates for the 2 coal slag abrasives treated with dust suppressant were 10.64 and 12.20 pounds/square foot. This represented an increase in the consumption rate compared with the untreated counterparts (12.20 vs. 11.63 pounds/square foot and 10.64 vs. 9.12 pounds/square foot).

- The consumption rates for the 2 nickel abrasives were 12.50 and 15.83 pounds/square foot.

- The consumption rate for the olivine abrasive was 8.02 pounds/square foot.

- The consumption rates for the 2 staurolite abrasives were 7.51 and 9.90 pounds/square foot.

- The consumption rate for the specular hematite abrasive was 6.60 pounds/square foot.

- The consumption rates for the 7 silica sand abrasives ranged from 9.05 to 13.48 pounds per square foot, with a single abrasive at 26.32 pounds/square foot. The abrasives can be categorized as follows: 4 abrasives from 9.05 to 11.36 pounds/square foot; 2 abrasives at 13.04 and 13.48 pounds/square foot; 1 abrasive at 26.32 pounds/square foot.

- The consumption rates for the 3 silica sand abrasives treated with dust suppressant ranged from 8.74 to 13.89 pounds/square foot. This represents a decrease in consumption rates for 2 of the abrasives compared with their untreated counterparts (8.74 vs. 9.05 pounds/square foot and 10.67 vs. 11.36 pounds/square foot), and an increase in the other (13.89 vs. 10.42 pounds/square foot).

- The consumption rates for the 4 copper slag abrasives ranged from 12.95 to 24.29 pounds/square foot for the initial use (12.95, 16.30, 19.44, 24.29). After 2 uses, the consumption rates for 2 of the abrasives decreased (15.37 vs.

16.30, and 15.47 vs. 19.44), 1 rate increased (25.80 vs. 24.29), and 1 remained constant (12.96 vs. 12.95).

- The consumption rate for the copper slag abrasive treated with dust suppressant was 15.64 pounds/square foot for the initial use, and 14.54 pounds/square foot after 2 uses. This is a reduction in consumption for the initial use (15.64 vs. 16.30) and a reduction in consumption after 2 uses (14.54 vs. 15.37).

- The consumption rates for the 7 garnet abrasives ranged from 7.43 to 14.42 pounds/square foot. The abrasives can be categorized as follows: 3 samples from 7.43 to 9.21 pounds/square foot; 2 samples at 10.64 and 10.80 pounds/square foot; 2 samples at 12.92 and 14.42 pounds/square foot.

  After 2 to 3 uses, the consumption rate decreased to a range from 7.12 to 9.60 pounds/square foot. One sample was too pulverized after the second use to be analyzed.

- The initial "consumption rates" for the steel grit abrasives were 27.71 and 21.53 pounds/square foot. These rates increased slightly after 25 uses: 27.71 increased to 28.75 pounds/square foot, and 21.53 increased to 21.77 pounds/square foot. Note that "consumption" refers to the amount of abrasive that was used to clean each square foot, rather than the amount actually consumed and disposed.

The consumption rates for the 7 silica sand abrasives on a weight basis ranged from 9.05 to 26.32 pounds/square feet. Industry data[9] suggest that the consumption rates for silica sand and the alternative abrasives tested are less than the rates obtained from this study (due to the restrictions on equipment and operating procedures described above). Based on the study parameters, generic abrasive types having one or more products that utilized less (or comparable) abrasive per square foot than the lowest silica sand on a weight basis included: (Again, it must be emphasized that when unique equipment and operating adjustments are made for each abrasive, the relative and absolute consumption rates will vary from the values obtained during the study.)

- crushed glass (0 of 1 rates less than the lowest silica sand)
- coal slag (3 of 7 had consumption rates similar to the lowest silica sand)
- coal slag with dust suppressant (0 of 2 had rates lower than the lowest sand)
- nickel slag (0 of 2 had rates less than the lowest silica sand)
- olivine (1 of 1 had rates less than the lowest silica sand)
- staurolite (2 of 2 had rates less than or comparable to the lowest silica sand)
- specular hematite (1 of 1 had rates less than the lowest silica sand)
- copper slag – initial use (0 of 4 had rates less than the lowest silica sand)
- copper slag – after 2 uses (0 of 4 had rates less than the lowest sand, but the ability to reuse the abrasive results in a net consumption rate less than silica sand)
- copper slag with dust suppressant – initial use (0 of 1 had rates less than sand)

- copper slag with dust suppressant – after 2 uses (0 of 1 had rates less than sand, but the ability to reuse the abrasive results in a net consumption rate less than silica sand)
- garnet – initial use (3 of 7 products had rates less than or comparable to the lowest silica sand)
- garnet – after 2 to 3 uses (6 of 7 products had rates less than or comparable to the lowest sand. The other product was reduced to an unusable powder after 2 uses)
- steel grit – initial use (waste per square foot not calculated, but will be substantially less than silica sand because of the multiple recycles)
- steel grit – after 25 uses (waste per square foot not calculated, but will be substantially less than silica sand because of the multiple recycles)

Cleaning and Consumption Rate Summary

The test results can be summarized as follows:

1 – The cleaning and consumption rates obtained from the study are not representative of industry standards and experience due to the study design's equipment and operating constraints. The cleaning rates are less than can be expected and the relative rankings between abrasives may not be applicable when transferred to field production operations.

2 - The cleaning and consumption rates for the individual abrasives within each generic type varied considerably. Typical cleaning and consumption rates for generic abrasive types did not emerge. Each abrasive needs to be evaluated individually for its own cleaning and consumption rates rather than rely on generalized characteristics.

3 - The data show that 13 of the 30 alternative abrasives exhibit cleaning rates equivalent to or in excess of the most productive silica sand (based on a 1 time use for the recyclable abrasives). When the cleaning rates after recycling are included in the analysis, 15 of the 30 alternate abrasives exhibit cleaning rates equivalent to or in excess of the most productive silica sand. All 30 of the alternative abrasives exhibited cleaning rates in excess of the least productive silica sand.

4 - The data show that 10 of the 30 alternative abrasives exhibit consumption rates (on a weight basis) less than or equivalent to the most efficient silica sand (based on a 1 time use for the recyclable abrasives). When the cleaning rates after recycling are included in the analysis, 20 of the 30 alternate abrasives exhibit consumption rates less than or equivalent to the most efficient silica sand. All 30 of the alternative abrasives exhibited consumption rates less than the least efficient silica sand.

5 - The productivity of the recyclable abrasives increased after reuse, while the consumption rate decreased with reuse.

6 – Dust suppressant was used on 2 coal slag samples. The cleaning rate compared with the untreated counterparts showed an increase for one sample and a decrease for the other. The consumption rate showed an increase for both samples. Conclusions regarding the effect of dust suppressant on cleaning rates can not be made, but the

limited data suggests that consumption rates may increase with the use of dust suppressant.

7 - Dust suppressant was used on 3 silica sand abrasives. The cleaning rate compared with the untreated counterparts showed an increase for the first sample, a decrease for the second sample, and no change for the third sample. The consumption rates increased for one sample and decreased for the other two. Conclusions regarding the effect of dust suppressant on cleaning and consumption rates can not be made from the data.

8- Dust suppressant was used on 1 copper slag abrasive that was used 2 times. The cleaning rate compared with the untreated counterpart was reduced both on initial use and upon reuse. The consumption rate was also reduced for the initial use and after reuse. The limited data available suggests that the dust suppressant reduces cleaning and consumption rates.

Surface Profile

The results of the six individual and average surface profile measurement for each of the abrasives is shown in the attached Table A2 for expendable abrasives and Table A8 for the recyclable abrasives.

The abrasive manufacturers' were asked to provide an abrasive sized to provide a surface profile from 2 to 3 mils which is a typical profile for most paint systems. Deeper profiles will also generally reduce cleaning rates. The results of the expendable and recyclable abrasives as a class are summarized below:

- 14 of 26 expendable abrasives met the average profile requirement.
- 1 of 14 recyclable abrasives met the average profile requirement at the time of initial use. The profile for 13 of 14 of the abrasives exceeded the 2-3 mil design criteria. After recycling, with the exception of one steel abrasive, the average profile depths of the abrasives were reduced, with 8 of the 14 falling between 2 and 3 mils.

The results of the individual generic abrasive types are as follows:

- 1 of 1 crushed glass samples met the criteria with an average profile of 2.72 mils.
- 4 of the 7 coal slag samples met the criteria with the average profiles ranging from 2.67 mils to 2.97 mils. The average profiles of the remaining 3 samples from 3.13 to 3.72 mils.
- 0 of the 2 coal slag samples with dust suppressant met the criteria. The average profiles were 3.13 and 3.42 mils.

- 0 of 2 nickel slag samples met the criteria. The average profiles were 3.25 and 3.87 mils.

- 1 of 1 olivine samples met the criteria with an average profile of 3.03 mils.

- 2 of 2 staurolite samples met the criteria with average profiles of 2.02 and 2.08 mils.

- 1 of 1 specular hematite samples met the criteria with an average profile of 2.77 mils.

- 2 of 7 silica sand samples met the criteria with average profiles of 2.73 and 2.80 mils. The average profiles of 4 of the remaining samples ranged from 3.30 mils to 3.73 mils, and the profile of the final sample measured 4.40 mils.

- 3 of 3 silica sand samples with dust suppressant met the criteria with average profiles ranging from 2.83 to 3.02 mils.

- 0 of 4 copper slag samples met the criteria upon initial use with average profiles ranging from 3.68 mils to 3.92 mils. After recycling, the average profile of 1 of the samples was reduced to 2.98 mils, with the average profile of the remaining samples was reduced to a range of 3.15 to 3.43 mils.

- 0 of 1 copper slag samples met the criteria upon initial use with an average profile range of 3.95 mils. After recycling, the average profile was reduced to 2.93 mils.

- 1 of 7 garnet samples met the criteria with an average profile of 2.68 mils. The average profile of 4 of the remaining samples ranged from 3.10 to 3.40 mils, and the average profile of the 2 remaining samples measured 3.93 and 4.15 mils. After recycling, the average profile of 5 of the 7 samples was reduced to a range of 2.07 to 2.77 mils. Of the remaining 2 samples, 1 could not be measured (useable abrasive did not remain after 2 uses), and the other measured 3.32 mils.

- 0 of 2 steel abrasive samples met the criteria upon initial use with average profiles of 3.08 and 3.17 mils. After recycling, the average profile of one of the samples measured 2.88 mils. The profile of the other sample measured 3.4 mils (an apparent increase from the initial average profile of 3.08 mils).

The consistency of the 6 profile readings obtained with each product was evaluated. The data below shows the total spread in profile readings between the minimum and maximum measurements obtained for each generic abrasive type. When more than one abrasive was evaluated within a generic type, the results of the measurements for each of the individual abrasives are shown in parenthesis:

- crushed glass - 0.4 mils (0.4 mils)
- coal slag - 0.2 to 1.0 mils (0.2, 0.4, 0.4, 0.4, 0.5, 0.6, 1.0 mils)
- coal slag with dust suppressant - 0.6 to 0.7 mils (0.6, 0.7 mils)
- nickel slag – 0.6 mils (0.6, 0.6 mils)
- olivine – 0.6 mils (0.6 mils)
- staurolite – 0.2 to 0.4 mils (0.2, 0.4 mils)
- specular hematite – 0.5 mils (0.5 mils)
- silica sand – 0.1 to 0.9 mils (0.1, 0.2, 0.3, 0.4, 0.4, 0.6, 0.9 mils)
- silica sand with dust suppressant – 0.2 to 1.4 mils (0.2, 0.3, 1.4 mils)
- copper slag – initial use – 0.2 to 0.7 mils (0.2, 0.2, 0.7, 0.7)
- copper slag – after 2 uses – 0.3 to 0.6 mils (0.3, 0.4, 0.4, 0.6 mils)
- copper slag with dust suppressant – initial use – 0.3 mils (0.3 mils)
- copper slag with dust suppressant – after 2 uses - 0.4 mils (0.4 mils)
- garnet – initial use – 0.1 to 0.4 mils (0.1, 0.2, 0.2, 0.3, 0.4, 0.4, 0.4 mils)
- garnet – after 2 to 3 uses – 0.1 to 0.8 mils (0.1, 0.4, 0.4, 0.7, 0.7, 0.8, one pulverized)
- steel grit – initial use – 0.1 to 0.5 mils (0.1, 0.5 mils)
- steel grit – after 25 uses – 0.5 to 0.6 mils (0.5, 0.6 mils)

The surface profile results can be summarized as follows:

1 – Fifteen of the 40 abrasives evaluated provided an average surface profile from 2 to 3 mils (14 of 26 expendable abrasives and 1 of 14 recyclable abrasives after one time use). After recycling, the average profile depths for 8 of the 14 recyclable abrasives fell within the 2 to 3 mil range, resulting in 22 of the 40 abrasives meeting the criteria.

2 – Twenty-five of the 40 abrasives exceeded the target profile of 2 to 3 mils (12 of 26 expendable abrasives and 13 of 14 recyclable abrasives after one time use). The average profile of 23 of the 25 abrasives that exceeded the target profile ranged from 3.13 to 3.95 mils. The profile of 1 garnet abrasive was 4.15 mils, and 1 silica sand abrasive was 4.40 mils. After recycling, 5 of the 14 recyclable abrasives exceeded the target profile. The average profiles of the abrasives ranged from 3.13 to 3.73.

3 -Dust suppressant was used on 2 coal slag samples. The surface profile compared with the untreated counterparts showed an apparent increase in one sample (2.8 to 3.13 mils) and an apparent decrease in the other (3.72 to 3.42 mils). It can not be concluded from the limited data whether the use of dust suppressant effects profile.

4 - Dust suppressant was used on 3 silica sand abrasives. The surface profile compared with the untreated counterparts showed an apparent increase for the first sample (2.73 to 2.92 mils), an apparent decrease for the second sample (3.42 to 3.02 mils), and no change for the third sample (2.80 vs. 2.83 mils). It can not be concluded from the limited data whether the use of dust suppressant effects profile.

5- Dust suppressant was used on 1 copper slag abrasive that was used 2 times. The surface profile compared with the untreated counterpart showed an apparent increase upon initial use (3.68 to 3.95) and an apparent decrease after recycling (3.43 to 2.93). It can not be concluded from the limited data whether the use of dust suppressant effects profile.

6 – The consistency in surface profile readings across the surface varied considerable with the specific product. As a generic class, the consistency of the silica sand abrasives ranged from a profile spread of 0.1 mils to a spread of 0.9 mils (based on 7 individual products). All of the alternative abrasives fell within this range with the exception of 1 coal slag abrasive (1.0 mil spread). One silica sand with dust suppressant also exceeded this range (1.4 mil spread).

7 – The most controlled profiles as a class of abrasives were staurolite with a range of 0.2 to 0.4 mils (based on 2 samples only) and the initial use of garnet with a range of 0.1 to 0.4 mils (based on 7 samples). Comments can not be made for crushed glass as a class as only 1 sample was evaluated (but the range of 0.4 mils is in line with the above), or for copper slag with dust suppressant as only 1 sample was evaluated (but the range of 0.3 is in line with the above).

8 – After recycling, the control over the range in surface profiles for copper slag abrasives was similar to the initial ranges (0.2 mil to 0.7 mil spread in profile readings for given abrasives initially to a 0.3 to 0.6 mil spread after 2 uses). The control over profiles for garnet tended to worsen with recycling. The initial spread in profile measurements for given garnet abrasives ranged from 0.1 to 0.4 mils. After 2 to 3 recycles, the spread in profiles for given abrasives ranged from immeasurable (a pulverized dust was created in one abrasive after 2 uses) to 0.1 to 0.8 mils. The control over the range in surface profiles with the steel grit was slightly reduced from an initial spread of 0.1 and 0.5 mils (for the 2 abrasives evaluated) to a spread of 0.5 and 0.6 mils.

Breakdown Rate (pre-blast and post-blast average particle size comparison)

Tables A3 (expendable) and A9 (recyclable) show the change in average abrasive particle size after use. The breakdown percentages are reflected in two different manners in the last two columns of the tables. One column shows the spent abrasive in terms of percent reduction in average particle size (Average Particle Size is Reduced by X%). The other shows the average particle size of the spent abrasive as a percent of the original particle size (Average Particle Size is X% of Original). For the purpose of the discussion below, the data entitled, "Average Particle Size is Reduced by X%" is used (the lower the percentage, the more conducive is the abrasive for multiple uses. The lower percentages will also produce less airborne dust):

- The average particle size of the crushed glass was reduced by 51.36% after use.

- The average particle sizes of the 7 coal slag abrasives were reduced by 38.1 to 54.71% after use. The samples fell into two general ranges: 2 samples were reduced by 38.41 and 39.69%, and 5 samples were reduced by 49.97 to 54.71%.

- The average particle sizes of the 2 coal slag samples treated with dust suppressant were reduced by 52 and 53.46%. Both reductions in average particle size were greater than their untreated counterparts: 52% reduction vs. 39.69% and 53.46% vs. 51.36%. The virgin samples treated with dust suppressant also exhibited a greater initial average particle size than their untreated counterparts.

- The average particle sizes of the 2 nickel abrasives were reduced by 51.2 and 53.9% after use.

- The average particle size of the olivine abrasive was reduced by 33.58% after use.

- The average particle sizes of the 2 staurolite abrasives were reduced by 18.06 and 19.63% after use.

- The average particle size of the specular hematite abrasive was reduced by 40.72% after use.

- The average particle sizes of the 7 silica sand abrasives were reduced by 25.58 to 72.88% after use. The abrasives can be categorized as follows: 1 sample reduced by 25.58%, 2 samples reduced by 40.75 and 46.38%; 4 samples reduced by 59.65 to 72.88%.

- The average particle sizes of the 3 silica sand samples treated with dust suppressant were reduced by 31.28, 46.28, and 66.54% after use. This reduction was greater than the untreated counterpart in one case, equivalent in another, and less in the third: 66.54% reduction vs. 25.58%, 46.86% reduction vs. 46.38%, and 31.28% reduction vs. 40.74%. The samples treated with dust suppressant also exhibited a greater initial average particle sizes than their untreated counterparts.

- The average particle sizes of the 4 copper slag abrasives were reduced by 51.80 to 52.36% after initial use. After recycling 2 times, the average particle sizes were reduced by 58.14 to 69.53% from the original.

- The average particle size of the copper slag sample treated with dust suppressant was reduced 60.36% after use. This reduction was greater than its untreated counterpart: 60.36% vs. 51.80%. After recycling two times the average percentages were reduced by 69.46%. The sample treated with dust

suppressant also exhibited a greater initial average particle size than the untreated sample.

- The average particle sizes of the 7 garnet abrasive were reduced by 20.74 to 60.05% after use. The abrasives can be categorized as follows: 1 sample reduced by 20.74%; 4 samples reduced by 36.49 to 47.03%; 2 samples reduced by 55.93 and 60.05%. After recycling (from 2 to 3 times) the average particle sizes were reduced by 40.11 to 75.81% from the original.

- The average particle sizes of the 2 steel grit abrasives were reduced by 4.30 and 7.86%. After recycling for the maximum test design of 25 times, the average particle sizes were reduced 8.72% from the original in one case. For the other sample, the data indicates an increase in size. The reason for this is unknown.

The results can be summarized as follows:

1 – The typical breakdown (average particle size reduction) percentage for silica sand is 40.75 to 72.88% (although 1 of the 7 abrasives showed a lower value of 25.58%). Using 25.58% as the lower limit, the abrasives showing lower breakdown percentages are the 2 staurolite abrasives (18.06 and 19.63% reduction in particle size), 1 garnet abrasive (20.74% reduction upon initial use), and both steel grit abrasives (4.30 and 7.86% reduction upon initial use and 8.72% reduction after 25 recycles).

2 – Based on breakdown percentages after first use, the hierarchy of abrasives most likely to be used more than one time (arbitrarily using 40.00% reduction in average particle size as the threshold) are: steel grit (4.30 and 7.86% reduction in average particle size), 2 staurolite abrasives (18.06 and 19.63% reduction), 2 garnet abrasives (20.74 and 36.49% reduction), 1 silica sand (25.58% reduction), 1 silica sand with dust suppressant (31.28% reduction), 1 olivine (33.58% reduction), and 2 coal slag abrasives (38.41 and 39.69% reduction).

3 – The initial particle sizes of the coal slag, silica sand, and copper slag abrasives treated with dust suppressant were greater than the untreated counterparts.

Abrasive Embedment

A total of 15 individual abrasive embedment evaluations were made for each blast cleaning run (5 evaluations on 3 separate panels). The results are attached in Tables A4 (expendable) and A10 (recyclable). The results represent the number of 1.3 mm x 1.3 mm squares out of 100 (covering a surface area of one-half square inch) which contained embedded abrasive particulate. The 5 individual measurements for each of the 3 panels are shown on the table. The results are presented as a percentage, summarized as follows (the lower the number, the less is the embedment):

- The crushed glass abrasive contained an average embedment of 2.1%.

- The 7 coal slag abrasives showed a wide variation in results, ranging from 3.6% to 25.3% embedment. The majority of the samples (5) contained average embedment ranging from 8.4 to 15.7%.

- The 2 coal slag abrasives treated with dust suppressant showed 4.7 and 10.3% embedment. Both are an approximate 50% reduction from their untreated counterparts (8.4 and 25.3% respectively).

- The 2 nickel abrasives showed wide variations in embedment, averaging 1.2 and 27.3%.

- The olivine abrasive showed an average embedment of 15.1%.

- The 2 staurolite abrasives showed an average embedment of 0.1 and 0.2%.

- The specular hematite abrasive showed an average embedment of 0.7%.

- The 7 silica sand abrasives showed average embedment ranging from 0.1 to 12.3%. The majority of the samples (5) ranged from 0.1 to 4.7%. The remaining 2 were 9.2 and 12.3%.

- The 3 silica sand abrasives treated with dust suppressant showed 0.8, 1.2, and 2.7% embedment. This represents essentially no change in two cases compared with the untreated counterparts (1.1 vs. 0.8%, and 2.9 vs. 2.7%), and a slight increase of 1% in the other (0.1% to 1.2%).

- The 4 copper slag abrasives showed two general conditions of embedment upon initial use. Two samples showed 12.5% and 17.0%, and two showed 31.1 and 41.5%. After recycling, the amount of embedment was decreased for 3 of the 4 abrasives: 17.0% decreased to 8.1%, 31.1% decreased to 23.1%, and 41.5% decreased to 21.9%. The increase involved the sample with the lowest amount of initial embedment: 12.5% increased to 17.3%.

- The copper slag abrasive treated with dust suppressant showed a similar amount of embedment initially and after recycling: 19.0 and 19.3%. This represents an increase in the amount of embedment compared with its untreated counterpart (12.5% initially and 17.3% after recycling).

- The 7 garnet samples showed average embedment to range from 0.1% to 36.7%. The majority of the samples (5) ranged from 2.1 to 9.7%. After recycling, the average embedment was reduced in every case except one (0.1% became 0.2%), resulting in a range of embedment from 0.2 to 3.3%.

- The 2 steel abrasives showed initial average embedments of 3.1 and 4.1%. After recycling, both dropped to 1.6 and 2.3% respectively.

The results can be summarized as follows:

1 – The typical embedment percentage for silica sand is 0.1 to 12.3% embedment (5 samples ranged from 0.1 to 4.7%, the remaining 2 were 9.2 and 12.3%). Using 0.1 to 4.7% as the target embedment range, the abrasives showing comparable or lower embedment percentages are crushed glass (2.1%), 2 coal slag abrasives (3.6 and 4.7%), 1 coal slag with dust suppressant (4.7%), 1 nickel abrasive (1.2%), 2 staurolite abrasives (0.1 and 0.2%), 1 specular hematite (0.7%), 3 silica sand abrasives with dust suppressant (0.8 to 2.7%), 3 garnet abrasives after initial use (0.1, 2.1, and 4.7%), 6 garnet abrasives after 2 to 3 uses (1.4 to 4.7%), steel grit after initial use (3.1 and 4.1%), and steel grit after 25 uses (1.6 and 2.3%).

2 – The amount of embedment was reduced after recycling for 3 of the 4 copper slag abrasives, 6 of the 7 garnet abrasives (the 7th abrasive was 0.1 to start with and essentially showed no change), and the 2 steel grit abrasives.

3 – The use of dust suppressant on the coal slag abrasives showed a major decrease in embedment over the untreated counterparts (8.4 to 4.7% and 25.3 to 10.3%), but firm conclusions regarding the influence of dust suppressant on embedment can not be made due to limited data.

4 - The use of dust suppressant on the silica sand abrasives showed essentially no change in embedment in two cases compared with the untreated counterparts (1.1 vs. 0.8%, and 2.9 vs. 2.7%), and a slight increase in the other (0.1% to 1.2%). Conclusions regarding the effect of dust suppressant on embedment can not be made from the limited data.

5 - The use of dust suppressant on the copper slag abrasive showed an increase in the amount of embedment compared with its untreated counterpart (19.0% vs. 12.5% initially and 19.3% vs. 17.3% after recycling), but firm conclusions regarding the influence of dust suppressant on embedment can not be made due to limited data.

Microhardness

Measurements of microhardness were made in accordance with ASTM E384[3]. This method provides results in Knoop units (the higher the number, the harder the abrasive). Tables A5 (expendable) and A11 (recyclable) show the results of the microhardness evaluations. For comparison, 6 on the Mohs hardness scale is approximately 500 Knoop. The results of 2 individual readings are shown together with the maximum reading obtained. In many cases, the two individual readings varied greatly. This is likely due to the selection of an abrasive particle for testing that contained porosity or other discontinuity, leading to an inappropriately low value. For this reason, when summarizing the results, the single maximum microhardness reading is

used, rather than averaging the two together, to avoid biasing the data by virtue of the lower value.

- The crushed glass abrasive showed a maximum microhardness value of 457.5.
- The 7 coal slag abrasives showed maximum microhardness values ranging from 611 to 720.
- The 2 coal slag abrasives treated with dust suppressant showed maximum microhardness values of 594 and 760. This was an apparent increase in one case compared with the untreated counterpart (760 vs. 669), and an apparent decrease in the other (594 vs. 617).
- The 2 nickel slag abrasives showed maximum microhardness values of 545 and 984.
- The olivine abrasive showed a maximum microhardness value of 960.
- The 2 staurolite abrasives showed maximum microhardness values of 219 and 937.
- The specular hematite abrasive showed a maximum microhardness value of 1182.
- The 7 silica sand abrasives showed maximum microhardness values ranging from 1267 to 2469. The abrasives can be categorized as follows: 1 with a maximum microhardness of 1267; 4 with maximum microhardness ranging from 1537 to 1809; and 2 with a maximum microhardness values of 2008 and 2469.
- A total of 3 silica sand abrasives were treated with dust suppressant: 2 showed maximum microhardness values of 643 and 1924. The third could not be evaluated as the material was too porous to be analyzed. There was an apparent increase in one case compared with the untreated counterpart (2008 vs. 1587), and an apparent decrease in another (643 vs. 1809). A comparison for the third can not be made as the treated material sample was too porous to measure. Its untreated counterpart was 1809.
- The 4 copper slag abrasives showed maximum microhardness values ranging from 540 to 769.
- The copper slag abrasive treated with dust suppressant showed a maximum microhardness value of 656. This is an apparent decrease from its untreated counterpart (656 vs. 662).

- The 7 garnet abrasives showed maximum microhardness values ranging from 535 to1809. The abrasives can be categorized as follows: 1 with maximum microhardness values ranging from 535; 1 with a maximum microhardness value of 948; 4 with maximum microhardness values ranging from 1285 to 1587; and 1 with a maximum microhardness value of 1809.

- The 2 steel grit abrasives showed maximum microhardness values of 240 and 823.

The results can be summarized as follows:

1 – The microhardness of the 7 silica sand abrasives ranged from 1267 to 2469. All of the alternative abrasives are softer than silica sand with the exception of 5 of the 7 garnet abrasives (1537 to 2154.4).

2 – Two coal slag abrasives were treated with dust suppressant. One sample showed an apparent increase in microhardness compared with the untreated counterpart (760 vs. 669), and an apparent decrease in the other (594 vs. 617). Conclusions regarding the effect of dust suppressant on microhardness can not be made from the limited data.

3 - A total of 3 silica sand abrasives were treated with dust suppressant. One sample showed an apparent increase in microhardness compared with the untreated counterpart (2008 vs. 1587), and an apparent decrease in another (643 vs. 1809). A comparison for the third sample could not be made as the treated sample was too porous to measure. Conclusions regarding the effect of dust suppressant on microhardness can not be made from the limited data.

4 - One copper slag abrasive was treated with dust suppressant. It showed an apparent decrease from its untreated counterpart (656 vs. 662). Conclusions regarding the effect of dust suppressant on microhardness can not be made from the limited data.

Conductivity (water soluble contaminants)

Conductivity measurements were made in accordance with ASTM D4940[4] in order to evaluate whether water soluble materials are present in the abrasive. Tables A6 (expendable) and A12 (recyclable) show the results of the conductivity measurements in microsiemens (1 microsiemen = 1 micromho/cm). A value less than 1,000 microsiemens is considered to be acceptable. A single test was run for each abrasive since all results were well below the 1,000 microsiemens threshold value. The results can be summarized as follows:

- The crushed glass abrasive measured 112.0 microsiemens.

- 6 of the coal slag abrasives measured from 23.8 to 96.7 microsiemens. One of the coal slag abrasives measured 833.3 microsiemens.

- One of the coal slag abrasives treated with dust suppressant measured 42 microsiemens, which was essentially the same as its untreated counterpart. The other coal slag treated with dust suppressant measured 400.3 microsiemens, which is essentially 50% of its untreated counterpart.

- The nickel abrasives measured 36.3 and 146.7 microsiemens.

- The olivine abrasive measured 96.7 microsiemens.

- The 2 staurolite abrasives measured 87.3 and 213.3 microsiemens.

- The specular hematite abrasive measured 63.3 microsiemens.

- 6 of the 7 silica sand abrasives measured from 18.2 to 96.7 microsiemens. The remaining abrasive measured 708.3 microsiemens.

- The 3 silica sand abrasives treated with dust suppressant measured from 25 to 99.3 microsiemens. Compared to the untreated counterparts, this resulted in an increase of 19.3 microsiemens in one case to decreases of 5.3 and 13 microsiemens in the two others.

- The 4 copper slag abrasives measured 31.8 to 135 microsiemens. After recycling, the values for 2 of the samples increased by 27.5 and 91.6 microsiemens, and the remaining 2 decreased by 1.0 and 15 microsiemens. The highest value after recycling was 223.3 microsiemens.

- The copper slag abrasive treated with dust suppressant measured 26.3 which was 5.5 microsiemens less than its untreated counterpart. After recycling, the value increased by 27 microsiemens.

- 4 of the 7 garnet abrasives measured from 9.0 to 47.0 microsiemens. The remaining 3 samples measured 95.7, 145.0, and 586.7 microsiemens. After recycling, the values for 4 of the samples increased from 0.6 to 26.3 microsiemens. The values for 1 of the samples decreased 41.7 microsiemens, and the sample with the original value of 586.7 microsiemens decreased by 336.7 microsiemens. The final sample was not measured because no usable material remained after recycling.

- The initial values for the 2 steel grit samples were 33.7 and 100.0 microsiemens. After recycling 1 sample remained essentially unchanged and the other (100) decreased by 20 microsiemens.

The results can be summarized as follows:

1 – SSPC AB1 " Mineral and Slag Abrasives"[11] and AB2 "Specification For Cleanliness of Recycled Ferrous Metallic Abrasives"[12] recommends that the conductivity of abrasives

be maintained below 1000 microsiemens. Based on this criteria, all of the abrasives exhibit acceptable levels.

2 – The conductivity of the silica sand abrasives is 18.2 to 96.7 microsiemens (6 of 7 abrasive samples) with 1 sample measuring 708.3 microsiemens. Using a maximum of 96.7 as the threshold, the following abrasives exhibit conductivity levels less than or equivalent to silica sand: 6 of 7 coal slag abrasives, 1 coal slag abrasive treated with dust suppressant, 1 of 2 nickel slag abrasives, 1 of 1 olivine abrasives, 1 of 2 staurolite abrasives, 1 of 1 specular hematite, 1 of 3 silica sand abrasives treated with dust suppressant, 2 of 4 copper slag abrasives prior to initial use, 2 of 4 copper slag abrasives after 2 to 3 uses, 1 of 1 copper slag abrasives treated with dust suppressant both initially and after 2 uses, 5 of 7 garnet abrasives prior to initial use, 4 of 7 garnet abrasives after 2 to 3 uses (1 sample pulverized to an unusable dust after 2 uses), 1 of 2 steel grit abrasives initially, and 2 of 2 steel grit abrasives after 25 uses.

3 – Two coal slag abrasives were treated with dust suppressant. One of the sample abrasives measured 42 microsiemens, which was essentially the same as its untreated counterpart. The other sample measured 400.3 microsiemens, which is essentially 50% of its untreated counterpart. Conclusions regarding the effect of dust suppressant on conductivity can not be made from the limited data.

4 – A total of 3 silica sand abrasives were treated with dust suppressant. The samples measured from 25 to 99.3 microsiemens. Compared to the untreated counterparts, this resulted in an increase of 19.3 microsiemens in one case, and decreases of 5.3 and 13 microsiemens in the other two. Conclusions regarding the effect of dust suppressant on conductivity can not be made from the limited data.

5 – One copper slag abrasive was treated with dust suppressant. The sample measured 26.3 microsiemens, which was 5.5 microsiemens less than its untreated counterpart. After recycling, the value increased by 27 microsiemens over the untreated counterpart. Conclusions regarding the effect of dust suppressant on conductivity can not be made from the limited data.

Comparisons Between Abrasive Types

A comparison of the general performance characteristics of the 40 abrasives is presented below. Since many characteristics of an abrasive effect its performance, selection of abrasive type should not be restricted to only a single characteristic. Experimental results were graphed in order to determine the influence that one abrasive attribute has on another. A linear regression was performed for various combinations of attributes to determine trends. These graphs are attached in Appendix C. The conclusions presented below are based upon this analysis for the removal of mill scale.

- Surface profile was directly proportional to the abrasive particle size (the larger the abrasive particle size, the deeper the profile)

- Cleaning rate was inversely proportional to the abrasive particle size (the larger the abrasive particle size, the slower the cleaning rate)

- Consumption rate was directly proportional to the abrasive particle size (the larger the abrasive, the greater was the abrasive consumption on a weight per square foot basis)

- Breakdown rate was directly proportional to microhardness (the harder the abrasive, the greater its friability)

Based upon these observations, optimal abrasive materials for the removal of mill scale would be as small as possible while maintaining the surface profile requirements. (It should be noted that when removing heavy rust scale and heavy paint, the size of the abrasive is often increased to benefit from the greater mass of the abrasive in removing the heavy material, rather than "wearing it" away as is would be the case with the smaller abrasive.) If the objective is to reuse the abrasive and/or reduce dusting, the hardness should be considered. Harder abrasives (with the exception of steel) tend to break down more rapidly than softer abrasives. Abrasives should also be low in soluble contaminants in order to minimize negative effects on coatings performance.

With consideration of the above, the attributes of the 12 alternative generic abrasive types are reviewed.

Crushed Glass

One crushed glass abrasive was evaluated, making it difficult to make conclusions regarding this class of abrasive as a whole. Based on the product evaluated, the cleaning and consumption rates (33 square feet/hour and 10.99 pounds/square foot) are similar to silica sand as a class (25 to 37 square feet/hour and 9.05 to13.48 pounds/square foot). The surface profile averaged 2.72 mils, which complied with the study target of 2-3 mils, and is acceptable for coating performance. The variation in profile across the surface (spread of 0.4 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils). The breakdown rate (51.36%) was consistent with silica sand as a class (25.58% to 72.88%). Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than crushed glass (1267 to 2469 Knoop vs. 457.5 Knoop). The amount of embedment (2.1%) was comparable to those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (112 microsiemens) is slightly higher than most of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), but still well below the 1000 microsiemen level of concern.

Coal Slag

A total of 7 coal slag abrasives were evaluated. The results demonstrate that there is a wide range in physical properties between the individual abrasives within this class. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results. Based on the products evaluated, the

cleaning and consumption rates (28 to 42 square feet/hour and 9.05 to 12.35 pounds/square foot) are similar to silica sand as a class (25 to 37 square feet/hour and 9.05 to 13.48 pounds/square foot). The surface profile ranged from 2.67 to 3.72 mils which, although in excess of the target 2-3 mils, is not a problem for coating performance. The variation in profile across the surface (spread of 0.2 to1.0 mils) was outside of the tolerances of silica sand as a class (0.1 to 0.9 mils) because of one abrasive. If the single abrasive is eliminated, the remaining 6 abrasives exhibit a spread of 0.2 to 0.6 mils. The breakdown rate (38.1 to 54.71%) was consistent with silica sand as a class (25.58% to 72.88%). Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than coal slag (1267 to 2469 Knoop vs. 611 to 720 Knoop). The amount of embedment (3.6 to 25.3%) was in excess of those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (23.8 to 96.7 microsiemens) is comparable to most of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens) with the exception of 1 coal slag that exhibited a value of 833.3 microsiemens. All coal slag abrasives were below the 1000 microsiemen level of concern.

Coal Slag with Dust Suppressant

A total of two coal slag abrasives treated with dust suppressant were evaluated. The results demonstrate a range in physical properties likely attributable to the coal slag rather than the dust suppressant. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results. Based on the products evaluated, the cleaning and consumption rates (35 and 38 square feet/hour, and 10.64 and 12.20 pounds/square foot) are similar to silica sand as a class (25 to 37 square feet/hour and 9.05 to 13.48 pounds/square foot). The surface profile ranged from 3.13 to 3.72 mils which, although in excess of the target 2-3 mils, is not a problem for coating performance. The variation in profile across the surface (spread of 0.6 to 0.7 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils). The breakdown rate (52 to 53.46%) was consistent with silica sand as a class (25.58% to 72.88%). Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than coal slag treated with dust suppressant (1267 to 2469 Knoop vs. 594 and 760 Knoop). The amount of embedment (4.7 and 10.3%) was in excess of those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (42 and 400.3 microsiemens) is higher than most of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), but still well below the 1000 microsiemen level of concern.

A comparison of the coal slag abrasives treated with dust suppressant versus the untreated counterparts shows no trend for any of the attributes except one. The dust suppressant appears to decrease the amount of embedment. For all other characteristics, the dust suppressant showed both increases and decreases in performance compared with the untreated material.

Nickel Slag

A total of 2 nickel slag abrasives were evaluated. The results demonstrate that there is a variation in physical properties between the individual abrasives within this class. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results. Based on the products evaluated, the cleaning and consumption rates (35 and 47 square feet/hour and 12.5 and 15.83 pounds/square foot) are similar to silica sand as a class (25 to 37 square feet/hour and 9.05 to 13.48 pounds/square foot). The surface profile measured 3.25 and 3.87 mils which, although in excess of the target 2-3 mils, is not a problem for coating performance. The variation in profile across the surface (spread of 0.6 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils). The breakdown rate (51.2 and 53.9%) was consistent with silica sand as a class (25.58% to 72.88%). Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than nickel slag (1267 to 2469 Knoop vs. 545 and 984 Knoop). The amount of embedment (1.2%) in one sample was comparable to those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The other was much greater (27.3%). The conductivity (36.3 and 146.7 microsiemens) is higher than some of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), but still well below the 1000 microsiemen level of concern.

Olivine

One olivine abrasive was evaluated, making it difficult to make conclusions regarding this class of abrasive as a whole. Based on the product evaluated, the cleaning and consumption rates (44 square feet/hour and 8.02 pounds/square foot) are better than silica sand as a class (25 to 37 square feet/hour and 9.05 to13.48 pounds/square foot). The surface profile averaged 3.03 mils, which essentially complied with the study target of 2-3 mils, and is acceptable for coating performance. The variation in profile across the surface (spread of 0.7 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils). The breakdown rate (33.58%) was consistent with silica sand as a class (25.58% to 72.88%). Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than olivine (1267 to 2469 Knoop vs. 960 Knoop). The amount of embedment (15.1%) exceeded those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (96.7 microsiemens) is comparable to most of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), and well below the 1000 microsiemen level of concern.

Staurolite

A total of 2 staurolite abrasives were evaluated. The results demonstrate that there is a variation in physical properties between the individual abrasives within this class. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results. Based on the products evaluated, the cleaning and consumption rates (44 and 49 square feet/hour, and 7.51 and 9.90 pounds/square foot) are an improvement over silica sand as a class (25 to 37 square

feet/hour and 9.05 to 13.48 pounds/square foot). The surface profile measured 2.02 and 2.08 mils, which complied with the study target of 2-3 mils, and is acceptable for coating performance. The variation in profile across the surface (spread of 0.2 to 0.4 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils). The breakdown rate (18.06 and 19.63%) was better than silica sand as a class (25.58% to 72.88%). Silica sand is also much harder than staurolite (1267 to 2469 Knoop vs. 219 and 937 Knoop). The amount of embedment (0.1 and 0.2%) was comparable to those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (87.3 and 213.3 microsiemens) is higher than some of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), but still well below the 1000 microsiemen level of concern.

Specular Hematite

One specular hematite abrasive was evaluated, making it difficult to make conclusions regarding this class of abrasive as a whole. Based on the product evaluated, the cleaning rate (32 square feet/hour) is comparable to, and the consumption rate (6.60 pounds/square foot) is better than, silica sand as a class (25 to 37 square feet/hour and 9.05 to13.48 pounds/square foot). The surface profile averaged 2.77 mils, which complied with the study target of 2-3 mils, and is acceptable for coating performance. The variation in profile across the surface (spread of 0.5 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils). The breakdown rate (40.72%) was consistent with silica sand as a class (25.58% to 72.88%). Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is harder than specular hematite (1267 to 2469 Knoop vs. 1182 Knoop). The amount of embedment (0.7%) was comparable to those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (63.3 microsiemens) is comparable to most of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), and is well below the 1000 microsiemen level of concern.

Silica Sand with Dust Suppressant

A total of 3 silica sand abrasives treated with dust suppressant were evaluated. The results demonstrate a range in physical properties likely attributable to the silica sand rather than the dust suppressant. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results. Based on the products evaluated, the cleaning and consumption rates (26 to 39 square feet/hour and 8.74 to 13.89 pounds/square foot) are similar to untreated silica sand as a class (25 to 37 square feet/hour and 9.05 to 13.48 pounds/square foot). The surface profile ranged from 2.83 to 3.02 mils, which complied with the study target of 2-3 mils, and is acceptable for coating performance. The variation in profile across the surface (spread of 0.2 to 0.3 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils), with the exception of 1 sample which exhibited a spread of 1.4 mils. The breakdown rate (31.28 to 66.54%) was consistent with silica sand as a class (25.58% to 72.88%). The silica sand abrasives tested were harder than the silica sand abrasives treated with dust suppressant (1267 to 2469 Knoop vs. 643 to 1924 Knoop). The amount of embedment

(0.8 to 2.7%) was greater than the silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). The conductivity (25 to 99.3 microsiemens) is comparable to the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens), and well below the 1000 microsiemen level of concern.

A comparison of the silica sand abrasives treated with dust suppressant versus the untreated counterparts shows no trend for any of the attributes. The dust suppressant showed both increases and decreases in performance compared with the untreated materials for each of the characteristics evaluated.

Copper Slag

Copper slag was classified as a recyclable abrasive for the purpose of the study. The various abrasives were recycled 2 times. The limit on recycling was defined as the point where a reduction in average particle size of 50% occurred. Once this value was obtained, recycling was ended. A total of 4 copper slag abrasives were evaluated. The results demonstrate that there is a wide range in physical properties between the individual abrasives within this class. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results.

Based on the products evaluated, the cleaning rates upon initial use (28 to 61 square feet/hour) are higher than silica sand as a class (25 to 37 square feet/hour). The consumption rates (12.95 to 24.29 pounds/square foot) are not valid comparisons since the abrasive can be recycled a few times, and as such, the value represents the amount of abrasive that impacts the surface rather than the amount of abrasive "consumed." As a point of reference, silica sand as a class is 9.05 to 13.48 pounds/square foot, which is less than copper slag if it is used only one time. After 2 uses, the cleaning rates showed further increases (33 to 92 square feet/hour) and "consumption" rates remained essentially unchanged (12.96 to 25.80 pounds/square feet).

The surface profile upon initial use ranged from 3.68 to 3.92 mils which, although in excess of the target 2-3 mils, is not a problem for coating performance. After 2 uses, the profile was reduced to a range of 2.98 to 3.43 mils. The variation in profile across the surface for the abrasives upon initial use (spread of 0.2 to 0.7 mils) and upon recycling (spread of 0.3 to 0.6 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils).

The breakdown rate upon initial use (51.80 to 52.36%) was consistent with silica sand as a class (25.58% to 72.88%). After 2 cycles, the breakdown rate increased to 58.14 to 69.53%. Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than copper slag (1267 to 2469 Knoop vs. 540 to 769 Knoop).

The amount of embedment upon initial use (12.5 to 41.5%) exceeded those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). After 2 uses, the embedment was reduced to a range from 8.1 to 23.1%. The conductivity upon

initial use (31.8 to 135 microsiemens) is higher than a few of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens). After 2 uses, the conductivity increased to 59.3 to 223.3 microsiemens, but still well below the 1000 microsiemen level of concern.

Copper Slag with Dust Suppressant

Copper slag treated with dust suppressant was classified as a recyclable abrasive for the purpose of the study. The abrasive was recycled 2 times. The limit on recycling was defined as the point where a reduction in average particle size of 50% occurred. Once this value was obtained, recycling was ended. Only one abrasive was evaluated, making it difficult to make conclusions regarding this class of abrasive as a whole.

Based on the product evaluated, the cleaning rate upon initial use (31 square feet/hour) is comparable to silica sand as a class (25 to 37 square feet/hour). The consumption rate (15.64 pounds/square foot) is not valid a comparison since the abrasive can be recycled a few times, and as such, the value represents the amount of abrasive that impacts the surface rather than the amount of abrasive "consumed." As a point of reference, silica sand as a class is 9.05 to 13.48 pounds/square foot, which is less than copper slag if it is used only one time. After 2 uses, the cleaning rate increased to 40 square feet/hour and the "consumption" rate dropped slightly to 14.54 pounds/square feet.

The surface profile upon initial use was 3.95 mils which, although in excess of the target 2-3 mils, is not a problem for coating performance. After 2 uses, the profile was reduced to 2.93 mils. The variation in profile across the surface upon initial use (spread of 0.3 mils) and upon recycling (spread of 0.4 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils).

The breakdown rate upon initial use (60.36%) was consistent with silica sand as a class (25.58% to 72.88%). After 2 cycles, the breakdown rate increased to 69.46%. Although a few of the silica sand abrasives exhibited lesser breakdown rates, silica sand is much harder than copper slag treated with dust suppressant (1267 to 2469 Knoop vs. 656 Knoop).

The amount of embedment upon initial use (19.0%) exceeded those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). After 2 uses, the embedment remained constant at 19.3%. The conductivity upon initial use (26.3 microsiemens) is comparable to most of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens). After 2 uses, the conductivity increased to 53.3 microsiemens, but still well below the 1000 microsiemen level of concern.

A comparison of the coal slag abrasive treated with dust suppressant versus its untreated counterpart shows possible trend for four of the attributes tested. Although the data is quite limited, the dust suppressant appears to decrease cleaning and consumption

rates initially and upon reuse, reduce the breakdown rate, and increase the amount of embedment.

Garnet

Garnet was classified as a recyclable abrasive for the purpose of the study. The various abrasives were recycled between 2 to 3 times. The limit on recycling was defined as the point where a reduction in average particle size of 50% occurred. Once this value was obtained, recycling was ended (or when 5 recycles was reached which was the limit of the study design). A total of 7 garnet abrasives were evaluated. It should be noted that 1 of the 7 abrasives became too pulverized after 2 uses to be of value in any of the follow up tests. As a result, all data after recycling is based on 6, rather than 7 abrasives. The results demonstrate that there is a wide range in physical properties between the individual abrasives within this class. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results.

Based on the products evaluated, the cleaning rates upon initial use (24 to 62 square feet/hour) are higher than silica sand as a class (25 to 37 square feet/hour). The consumption rates (7.43 to 14.42 pounds/square foot) are not valid comparisons since the abrasive can be recycled a few times; and as such, the value represents the amount of abrasive that impacts the surface rather than the amount of abrasive "consumed." As a point of reference, silica sand as a class is 9.05 to 13.48 pounds/square foot, which is comparable to garnet if it is used only one time. After 2 to 3 uses, the cleaning rates showed further increases (31 to 75 square feet/hour) and "consumption" rates were further reduced (7.12 to 9.6 pounds/square feet).

The surface profile upon initial use ranged from 2.68 to 4.15 mils which, although generally in excess of the target 2-3 mils, is typically not a problem for coating performance. After 2 to 3 uses, the profile was reduced to a range of 2.07 to 3.32 mils. The variation in profile across the surface for the abrasives upon initial use (spread of 0.1 to 0.4 mils) and upon recycling (spread of 0.1 to 0.8 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils).

The breakdown rate upon initial use (20.74 to 60.05%) was consistent with silica sand as a class (25.58% to 72.88%). After 2 to 3 cycles, the breakdown rate increased to 40.11 to 75.81%. Silica sand is harder than garnet as a class (1267 to 2469 Knoop vs. 535 to 1809 Knoop).

The amount of embedment upon initial use (0.1 to 36.7%) exceeded those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). After 2 to 3 uses, the embedment was reduced to a range from 0.2 to 3.3%. The conductivity upon initial use (9.0 to 586.7 microsiemens) is higher than some of the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens). After 2 to 3 uses, the conductivity was reduced overall to 25 to 250 microsiemens, well below the 1000 microsiemen level of concern.

Steel Grit

Steel grit was classified as a recyclable abrasive for the purpose of the study. A total of 2 abrasives were evaluated. The abrasives were recycled 25 times. The limit on recycling was defined as the point where a reduction in average particle size of 50% occurred. Once this value was obtained, recycling was ended (or when 25 recycles was reached in the case of steel grit which was the limit of the study design). The results demonstrate that there is a wide range in physical properties between the individual abrasives within this class. Prior to use, the specific abrasive of interest should be investigated individually for its own merits rather than rely on generic results.

Based on the products evaluated, the cleaning rates upon initial use (27 and 39 square feet/hour) are comparable to silica sand as a class (25 to 37 square feet/hour). The consumption rates (21.53 and 27.71 pounds/square foot) are not valid comparisons since the abrasive is capable of being recycled well over 100 times, and as such, the value represents the amount of abrasive that impacts the surface rather than the amount of abrasive "consumed." As a point of reference, silica sand as a class is 9.05 to 13.48 pounds/square foot. After 25 uses, the cleaning rates increased (31 to 44 square feet/hour) and "consumption" rates remained essentially unchanged (21.77 and 28.75 pounds/square feet).

The surface profile upon initial use ranged from 3.08 to 3.17 mils which, although in excess of the target 2-3 mils, is not a problem for coating performance. After 25 uses, the profile ranged from 2.88 to 3.4 mils (the reason for the apparent increase is unknown). The variation in profile across the surface for the abrasives upon initial use (spread of 0.1 to 0.5 mils) and upon recycling (spread of 0.4 to 0.6 mils) was within the tolerances of silica sand as a class (0.1 to 0.9 mils).

The breakdown rate upon initial use (4.3 to 7.86%) was far less than silica sand as a class (25.58% to 72.88%). After 25 cycles, the breakdown rate increased slightly to 8.72% for one abrasive, and showed no breakdown for the other (size was comparable to the original size used). None of the silica sand abrasives exhibited lesser breakdown rates. Silica sand is much harder than steel grit abrasives (1267 to 2469 Knoop vs. 240 and 823 Knoop).

The amount of embedment upon initial use (3.1 and 4.1%) was comparable to those silica sand products that exhibited the lower percentages of embedment (0.1 to 4.7%). After 25 uses, the embedment was reduced to a range from 1.6 to 2.3%. The conductivity upon initial use (33.7 and 100 microsiemens) is comparable to the silica sand products (18.2 to 96.7 microsiemens, with 1 measuring 708.3 microsiemens). After 25 uses, the conductivity was reduced to 34 to 80 microsiemens, well below the 1000 microsiemen level of concern.

Calculation of Operating Costs

In order to develop costs for the use of the abrasives based on the production and consumption rates resulting from the study, the cost of cleaning steel plates in a walk in blast room has been calculated. The cost involves the use of one operator to blast clean the steel. The data is presented in Table D1. It is important that this cost data not be misused. In an actual project, larger nozzle sizes will be selected and optimum adjustments of the equipment made to maximize productivity. As a result, costs per square foot will be considerably less than the calculations provided herein. In fact, two additional blast trials involving coal slag abrasive were conducted and are reported in Table D1. The same abrasive used for the process control checks was employed. The average cost to clean the steel for the process control checks was $1.47/sq ft. Increasing the nozzle size from 1/4" to 3/8" reduced the cost to $0.73/sq ft. Note that additional changes (nozzle to work place distance, metering valve setting) could result in further reduction. A discussion of these factors, as well as a brief description of how each factor effects the costs, follows.

Industry Cleaning and Consumption Rates versus Study Rates

As discussed in the "Concerns" section of this report, because of the restrictions placed on the equipment used for the Phase 1 laboratory testing, the cleaning and consumption rates for the abrasives are not representative of field production. They are only representative of productivity and consumption rates for the blast cleaning of steel within a blast room with all variables tightly controlled. The costs are much higher than would actually occur during such a field project, and the relative differences between abrasive costs will also vary. A more accurate assessment of field blast cleaning costs can be found in SSPC NSRP Report 0511[9]. While the NSRP data is believed to be a better representation of actual field performance, there may also be questions regarding the applicability of the shipyard data to all industries. Within the NSRP report, cleaning and consumption rates are available for all of the abrasives included in this study with the exception of specular hematite and the abrasives treated with dust suppressant. The data in the NSRP report show that as the nozzle size increases, cleaning rates increase and consumption rates decrease for each of the generic categories of abrasives. The cleaning and consumption rates based on the Phase 1 Study are presented in Tables A1 and A7.

Abrasive Flow Rate

The abrasive flow rate is the amount of abrasive actually used during the blast cleaning operations. This is commonly expressed in units of tons of abrasive used per hour of operation. This factor is highly dependent on the abrasive material itself, the blast cleaning equipment utilized, nozzle sizes, pressures, equipment adjustments, the number of blast nozzle operators, the type and integrity of the paint coating being removed, and the configuration of the structure being cleaned.

Abrasive Material Cost

The cost of abrasive materials varies by generic type, manufacturer, geographic location, and the quantity of material purchased. Each manufacturer and/or supplier of abrasive media used for this study was interviewed to determine material costs. The unit cost was based on approximately 20 tons without any delivery charge. See Table D1 for an itemization of material costs.

The material costs ranged from $13.00 per ton to $494.00 per ton. Within a single class or type of abrasive, the cost of the most expensive material was up to 64 percent greater than the cost of the least expensive. In all but one case, dust suppressant increased the unit cost of the abrasive by an average of 30 percent. The exception involved one manufacturer's product treated with dust suppressant that was priced less than the same product without the suppressant (the material without the dust suppressant was supplied from a different plant). For the purpose of this cost analysis, the average material cost for each of the generic abrasive types was used. Many factors could affect the final purchase price of the products, but they were not investigated as part of this project.

Abrasive Disposal Cost

The cost to properly dispose of the surface preparation waste varies somewhat by location, but is not dependent on abrasive type. The disposal cost used for this economic analysis was for solid material categorized as non-hazardous. A non-hazardous classification was used since historically abrasive waste free of paint or other constituents has not been tested by the Toxicity Characteristic Leaching Procedure (TCLP)[24]. Since TCLP was not used on the abrasive waste from this study, there is no basis under this cost analysis for assuming that any of the abrasives would test hazardous for disposal. A value of $30.00 per ton was used based upon previous experience with painting project cost estimating and the actual cost for disposal of the abrasive waste generated during this phase of the study.

Equipment Costs

The equipment used for dry abrasive blast cleaning operations is contingent upon whether abrasive recycling will be employed. In both cases, compressed air and a blast pot are required. When abrasives are recycled, highly specialized equipment is typically used to reclaim and clean the abrasive, as well as to remove fine particles in an effort to maintain consistent surface profile. For the purpose of this economic analysis, the equipment necessary to blast clean steel plates in a walk-in blast room was used (based on the equipment used for the study).

6 cubic foot abrasive blast pot – $713/month
125 CFM air compressor – $601/month

Reclaiming system for recyclable abrasives – $1,000/month*[25]

Equipment costs were obtained from rental rates published in the 1998 AEG Green Book[13], published by the Machinery Information Division of K-III Directory Corp. The Green Book averages national rental rates for construction equipment (the 1998 version was the latest book in print at the time of the writing of this report). The costs used for the analysis were based on a rental term of one month, and values were converted to units of dollars per hour assuming a 40 hour work week and a month consisting of four and one third weeks.

Labor Costs

Actual labor rates for an abrasive blast cleaning nozzle operator were averaged from eleven cities. The published prevailing wage rates for Pittsburgh, Pa. were used as the baseline. These rates were adjusted for the various cities using cost of living adjustments provided in Real Estate Tables[14]. The rates for a Pittsburgh painter was $30.15/hour. Adjusted labor rates for the other cities were as follows:

Pittsburgh, Pennsylvania	$30.15	Lincoln, Nebraska	$30.66
New York, New York (Manhattan)	$82.92	Helena, Montana	$28.39
Los Angeles, California	$42.66	Houston, Texas	$27.48
Jacksonville, Florida	$30.59	Bangor, Maine	$30.47
Montgomery, Alabama	$30.25	Seattle, Washington	$33.54
		Anchorage, Alaska	$35.46

The labor rates, in units of dollars per hour, include the costs for benefits and insurance. No provisions were made to account for overtime work.

Number Of Recycles

The number of times the abrasive is used effects the overall abrasive blast cleaning costs. Even if the material unit cost of a recyclable abrasive is higher, the overall cost per square foot will typically be lower due to savings in material quantities and lower waste disposal costs. This factor was recognized during the cost analysis. The following recycling rates were used based on the Phase 1 results: copper slag – 2x, garnet – 2-3x, steel grit – 25x, and all other abrasives – 1x.

Abrasive Cleaning Rate

The abrasive cleaning rate profoundly effects the surface preparation costs, as the cleaning rate influences nearly all of the other economic factors described above. The cleaning rate of an abrasive is dependent upon many variables, including abrasive particle size distribution, shape, hardness, specific gravity, the degree of substrate cleanliness, blast equipment operating conditions, and the type and condition of the substrate (i.e. mill

* Small recycling units are available on a purchase, not rental basis. For the purpose of this analysis, a manufacturers' published rental price of a vacuum blast unit is used as the cost of the reclaimer.

scale, light corrosion, heavy rust and pitting, coated, etc.). Generally, abrasive types and sizes are chosen to obtain an optimum cleaning rate while maintaining the surface profile required for adequate coating adhesion. The cleaning rates in this case were reduced by virtue of the restrictions placed on the Study design.

Cost Analysis

The overall abrasive blast cleaning costs were calculated using the following equation:

$$\text{Cleaning Costs} = \frac{\left[\frac{A(P+D)}{R} + E + L\right]}{X}$$

Where: Cleaning Costs ($/square foot)
A = Abrasive Flow Rate (ton/hour)
P = Material Cost of Abrasive ($/ton)
D = Disposal Cost ($/ton)
E = Equipment Cost ($/hour)
L = Labor Cost ($/hour)
R = Number of Time the Abrasive is Used
X = Abrasive Cleaning Rate (square feet/hour)

The following is an example for the use of the formula based on abrasive SS-01.

A = 1 nozzle x 10.42 lb/sq ft (consumption rate) x 0.562 sq ft/min (cleaning rate) x 60 min/hour ÷ 2000 lb/ton
A = 0.176 ton/hour

P = $22.00/ton

D = $30.00/ton

R = 1

E = [$713/month (blast pot) + $601/month (air)] ÷ (4.33 weeks x 40 hours/week)
E = $7.59/hour

L = $36.60/hour

X = 1 nozzle x 0.562 sq ft/min (cleaning rate) x 60 min/hour
X = 33.72 sq ft/hour

$$\text{Cleaning Costs} = \frac{\left[\frac{0.176(22.00+30.00)}{1}+7.59+36.60\right]}{33.72}$$

Cleaning Costs = $1.58/sq ft

The results of the economic analysis are summarized in Table D1. The results are much higher than costs derived by incorporating the NSRP productivity and consumption rates into the same formula. The cost ranges using the laboratory data are as follows:

	Number of Samples	Cost Range Per Square Foot	Average Cost Per Square Foot
Crushed glass	1 sample	$2.06/sq ft	$2.06/sq ft
Coal slag	7 samples	$1.38 to $2.07/sq ft	$1.69/sq ft
Coal slag with dust suppressant	2 samples	$1.68 to $1.73/sq ft	$1.71/sq ft
Nickel slag	2 samples	$1.62 to $1.71/sq ft	$1.67/sq ft
Olivine	1 sample	$1.41/sq ft	$1.41/sq ft
Staurolite	2 samples	$1.58/sq ft & $1.58/sq ft	$1.58/sq ft
Specular hematite	1 sample	$1.90/sq ft	$1.90/sq ft
Silica sand	7 samples	$1.39 to $2.52/sq ft	$1.82/sq ft
Silica sand with dust suppressant	3 samples	$1.37 to $2.07/sq ft	$1.72/sq ft
Copper slag	4 samples	$0.81 to $1.76/sq ft	$1.34/sq ft
Copper slag with dust suppressant	1 sample	$1.62/sq ft	$1.62/sq ft
Garnet	7 samples	$1.12 to $2.14/sq ft	$1.56/sq ft
Steel grit	2 samples	$1.35 to $1.88/sq ft	$1.62/sq ft

Industrial Hygiene Results

KTA collected a total of 424 airborne dust samples and 106 bulk samples of abrasives (pre and post run) for this study in accordance with the protocol described in the Study Design and Methods portion of this report. Two hundred and twelve of the airborne samples were analyzed for up to 28 metals/elements. In addition, 212 air samples of total and respirable dust were analyzed gravimetrically and for quartz and cristobalite. All airborne and bulk samples were submitted directly to NIOSH for analysis by their contract laboratory, DataChem Laboratories, Inc.[6,7]

The results of all airborne dust and bulk abrasive sample results are presented in Appendix B, with tabs for each analyte evaluated. Within each tab, the results for a single specific analyte (e.g. aluminum) are summarized for all of the forty abrasives included in this study. In addition to a brief description of health hazards and recommended exposure limits[15,16], a total of 4 tables are used to present all of the data associated with each analyte. The general content of each table, and the sequence, in which they occur, is as follows.

Air Sample Results

The Air Sample Results table for each contaminant provides basic information on sampling parameters (e.g. sample number, sample volume; and abrasive code), as well as laboratory analytical results (e.g. mass per filter, detection/quantification limits, and concentration). The results are reported as average concentrations over the sampling period. Any data reported in the "Filter Notes" column 6 as "<LOQ" means that the associated result reported in column 7 is less than the limit of quantification (LOQ), but greater than the limit of detection (LOD). These results are "semi-quantitative", meaning the respective agent could be detected, but the result can only be accurately quantified as being in a range between the LOD and LOQ.

Airborne Sample Data Analysis

The Airborne Sample Data Analysis table is used to present a comparison of the airborne sample results collected at three fixed stations (Make-up Air Area, Operator Area, and Exhaust Area), and Operator's Breathing Zone (OBZ), for each unique abrasive used in the study. While the data presented is not for an 8 hour (time weighted average) period, it provides an indication of the relative concentrations collected during the sampling period.

Bulk Elemental Analysis

The Bulk Elemental Analysis table within each tab provides data on the concentration of the specific analyte (as well as laboratory limits of detection/quantification) in the virgin abrasive and in the post-blast abrasive for each of the individual abrasive media evaluated. In addition, for recyclable abrasives, bulk samples were collected of the virgin abrasive and post-blast "final run" (following the appropriate number of runs to reduce the average particle size to 50% of the original particle size as determined through sieve analysis or for a maximum of 5 uses for copper slag and garnet abrasive, or 25 uses for steel abrasives). Any data reported in the "Notes" columns as "<LOQ" means that the associated results in columns 3 and 6 are less than the

limit of quantification (LOQ), but greater than the limit of detection (LOD). These results are "semi-quantitative", meaning the respective agent could be detected, but the result can only be accurately quantified as being in a range between the LOD and LOQ.

Comparison of Airborne Dust Concentrations to Bulk Concentrations

The Comparison of Airborne Dust Concentrations to Bulk Concentrations table within each tab provides a comparison of the airborne concentrations recorded for the specific analyte at all of the fixed sampling stations (i.e. Make-up Air Area, Operator Area, and Exhaust Area) and the Operator's Breathing Zone to the concentration of the analyte in the virgin abrasive. This table provides an indication of the range of concentrations of the analyte in virgin bulk materials that might be associated with airborne exposure levels.

Identical tabular presentations of all of the data for each of the 28 metals/elements, as well as respirable quartz and cristobalite, are presented in Appendix B. Greater than 75% of the total dust samples collected during trial runs had filter weights greater than the recommended filter weight for NIOSH method 0500 or had loose particulate present. Therefore, the total dust results are not provided in this report. Background air samples were collected and submitted to NIOSH for analysis. In addition, all samples collected for radiochemically active materials were analyzed and are reported by NIOSH in this report.

Health-Related Agent Summary

The goal of the laboratory study was to control blasting and environmental conditions so the difference between airborne sample results would primarily be attributed to the different abrasives used. Therefore, the laboratory results may not be representative of real world conditions, but the results for different abrasives can confidently be compared to each other, and specifically with the silica sand abrasive. For comparison purposes, NIOSH selected 12 health-related agents for comparative analysis, including: arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, respirable quartz, silver, titanium, vanadium, and radium-226.

Figures 3 to 13 on pages 89 to 99 show the range of measured and geometric mean concentrations for the airborne levels of eleven hazardous health-related agents for each of the 40 abrasive products and the associated generic category of abrasives tested. The airborne levels, derived from the airborne sample data analysis tables in Appendix B, include results of four samples that were collected for each blast run conducted for each abrasive product: make-up area sample, operator area sample, exhaust or dust collector area sample, and the personal sample collected in the operator's breathing zone, but outside of the blasting helmet. The recyclable abrasives include the samples collected from both the initial blast run (indicated by the letter A – i.e. Garnet-07A represents the initial blast run conducted for Garnet abrasive #7) and the blast run that was conducted after tests for the recycling capability of the abrasive was completed (indicated by the letter B – i.e. Garnet-07B represents the final blast run conducted for Garnet abrasive #7 after the recycling tests were completed). The range and geometric mean are indicated by a bar chart and a small square, respectively. The shaded bars indicate the range and

geometric mean of the entire generic category of abrasive. Radium-226 is reported separately.

Any abrasive product or generic category of abrasive with all airborne samples having results below the limit of detection (LOD) for the given health-related agent are represented by only a small square (these abrasives will have no bar since there is no range to display). For abrasives having any samples below the limit of detection for the given health-related agent, the geometric mean was calculated by using LOD÷2, which is the method used to estimate the average concentration in the presence of nondetectable values described by Hornung and Reed[17]. The limits of detection for abrasive products sometimes varied slightly when analyzing a given health-related agent. Therefore, it is possible that an airborne concentration for one abrasive detected above the limit of detection could be less than the LOD÷2 for another abrasive which had a higher limit of detection associated with it analysis. The standard for comparison of all health-related agents will use the geometric mean for the silica sand generic abrasive category.

Arsenic

Figure 3 illustrates the range and geometric mean for the airborne levels of arsenic for each of the 40 abrasive products and the associated generic category of abrasive. The following generic categories of abrasives had all airborne results below the limit of detection for arsenic: crushed glass, olivine, staurolite, specular hematite, and silica sand treated with a dust suppressant.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for arsenic, and in order form the highest to the lowest geometric mean level of arsenic include: copper slag, copper slag with dust suppressant, steel grit, nickel slag, coal slag, coal slag with dust suppressant, silica sand, and garnet. The variability of results for individual abrasives within a generic category must be considered in addition to comparisons of combined data for an entire generic category of abrasives.

The silica sand generic abrasive category had 2 out of 28 airborne samples (both with abrasive SS-06) with results above the limit of detection for arsenic. The arsenic levels for these samples were 2.07 and 6.92 $\mu g/m^3$. The geometric mean concentration of arsenic for the silica sand generic abrasive category was 2.039 $\mu g/m^3$. This will be used as the standard of comparison.

The copper slag generic abrasive category had all 32 airborne samples with results above the limit of detection for arsenic. The range and geometric mean levels of arsenic varied considerably within the copper slag generic abrasive category. Copper slags CP-01 and CP-02 have similar ranges and geometric mean levels of arsenic. Copper slag CP-01 had levels of arsenic ranging from 5.98 to 75.35 $\mu g/m^3$ with a geometric mean of 17.84 $\mu g/m^3$ which is nearly 9 times higher than silica sand's geometric mean level of 2.039 $\mu g/m^3$. Copper slag CP-02 had levels of arsenic ranging from 6.6 to 99.54 $\mu g/m^3$ with a geometric mean of 21.78 $\mu g/m^3$, which is over 10 times higher than silica sand's

geometric mean level of 2.039 μg/m^3. Copper slag CP-03 had levels of arsenic ranging from 51.63 μg/m^3 to 1.1 mg/m^3 with a geometric mean of 299.5 μg/m^3, which is over 145 times higher than silica sand's geometric mean level of 2.039 μg/m^3. Copper slag CP-04 had levels of arsenic ranging from 79.56 μg/m^3 to 24.5 mg/m^3 with a geometric mean of 540.8 μg/m^3 which is 265 times higher than silica sand's geometric mean level of 2.039 μg/m^3. The geometric mean level of arsenic for the copper slag generic abrasive category of 89.1 μg/m^3 is 444 times higher than silica sand's geometric mean level of 2.039 μg/m^3.

The treated copper slag (with dust suppressant) generic abrasive category had 7 out of 8 airborne samples with results above the limit of detection for arsenic, ranging from 2.05 to 107.37 μg/m^3. The geometric mean level of arsenic for the treated copper slag generic abrasive category of 14.942 μg/m3 is 7 times higher than silica sand's geometric mean relative level of 2.039 μg/m^3.

The steel grit generic abrasive category had 12 out of 16 airborne samples with results above the limit of detection for arsenic. The range and geometric mean levels of arsenic varied considerably for the steel grit generic abrasive category. Steel grit 1A/B had four out of eight samples with results above the limit of detection for arsenic, ranging from 0.96 to 49.52 μg/m^3, with a geometric mean level of 5.15 μg/m^3. Steel grit 2A/B had all eight samples with results above the limit of detection for arsenic, ranging from 8.09 to 187.7 μg/m^3, with a geometric mean level of 22.31 μg/m^3, which is 10 times higher than silica sand's geometric mean level of 2.039 μg/m^3. The geometric mean level of arsenic for the steel grit generic abrasive category of 10.714 μg/m^3 is 5 times higher than silica sand's geometric mean level of 2.039 μg/m^3.

The nickel slag generic abrasive category had 4 out of 8 airborne samples with results above the limit of detection for arsenic. The range and geometric mean levels of arsenic varied considerably within the nickel slag generic abrasive category. Nickel slag N-01 had all four samples with results below the limit of detection for arsenic. Nickel slag N-02 had all four samples with results above the limit of detection for arsenic, ranging from 19.81 to 170.80 μg/m^3, with a geometric mean level of 45.97 μg/m^3, which is nearly 23 times higher than silica sand's geometric mean level of 2.039 μg/m^3. The geometric mean level of arsenic for the nickel slag generic abrasive category of 9.728 μg/m^3 is 5 times higher than silica sand's geometric mean level of 2.039 μg/m^3.

The coal slag generic abrasive category had 9 out of 28 airborne samples (associated with four coal slag abrasives: CS-01, CS-02, CS-06, and CS-07) with results above the limit of detection for arsenic. The relative arsenic levels for these nine abrasives ranged from 2.08 to 29.13 μg/m^3. The geometric mean relative arsenic levels for the coal slag generic abrasive category of 2.902 μg/m^3 is 1.4 times higher than silica sand's geometric mean of 2.039 μg/m^3.

The treated coal slag generic abrasive category had 1 out of 8 airborne samples (abrasive CSDS-02) with results above the limit of detection for arsenic. The arsenic level for this sample is 4.8 μg/m3. The geometric mean arsenic level for the treated coal

slag generic abrasive category of 2.304 $\mu g/m^3$ is slightly greater (13%) than the silica sand's geometric mean of 2.039 $\mu g/m^3$.

The garnet generic abrasive category had 1 out of 52 airborne samples (abrasive G7A/B) with results above the limit of detection for arsenic. The relative arsenic level for this sample was 2.09 $\mu g/m^3$. The geometric mean relative arsenic level for the garnet generic abrasive category of 1.970 $\mu g/m^3$ is slightly lower (3%) than the silica sand's geometric mean of 2.039 $\mu g/m^3$. The geometric mean arsenic level for the garnet abrasive G-07 of 1.48 $\mu g/m^3$ is less than the geometric mean of the other garnet abrasives which had all sample results less than the limit of detection, since the geometric mean was calculated by using LOD÷2 for all samples which were below the limit of detection (three of the samples associated with garnet abrasive G-07 have lower limits of detection for arsenic than all of the other garnet abrasives).

Beryllium

Figure 4 illustrates the range and geometric mean for the airborne levels of beryllium for each of the 40 abrasive products and the associated generic category of abrasive. None of the generic categories of abrasive had all airborne beryllium results below the limit of detection. However, the individual abrasives silica sand SS-02, silica sand with dust suppressant SSDS-03, and steel grit SG-1A/B had all results below the limit of detection for beryllium.

All of the generic abrasive categories had at least one airborne sample with results above the limit of detection for beryllium, and in order from the highest to the lowest geometric mean level include: coal slag with dust suppressant, coal slag, copper slag, copper slag with dust suppressant, nickel slag, garnet, silica sand, crushed glass, specular hematite, staurolite, silica sand with dust suppressant, steel grit, and olivine. The variability of results for individual abrasives within a generic category must be considered in addition to comparisons of combined data for an entire category of abrasives.

The silica sand generic abrasive category had 17 out of 28 airborne samples with results above the limit of detection for beryllium. The beryllium levels for these samples ranged from 0.03 to 0.36 $\mu g/m^3$. Silica sands SS-01, 02, and 03 had relatively low concentrations of beryllium, ranging from below the limit of detection to 0.10 $\mu g/m^3$. Silica sands SS-04, 05, 06, and 07 had relatively higher concentrations of beryllium, ranging from below the limit of detection to 0.36 $\mu g/m3$. The geometric mean concentration of beryllium for the silica sand generic abrasive category was 0.09 $\mu g/m^3$. This will be used as the standard of comparison.

The coal slag and coal slag with dust suppressant generic abrasive categories had all 36 airborne samples with results above the limit of detection for beryllium. The range and geometric mean levels of beryllium varied considerably. Individual airborne concentrations ranged from a low of 0.19 $\mu g/m^3$ to a high of 25.0 $\mu g/m^3$. The geometric mean for the individual abrasives varied by as much as a factor of 8. The geometric

mean concentration for the coal slag with dust suppressant generic category of abrasive of 2.23 $\mu g/m^3$ is nearly 26 times higher than the geometric mean concentration for the silica sand generic category of abrasives of 0.09 $\mu g/m^3$. However, when a comparison is made between specific pairs of treated and untreated coal slags, this dramatic variance diminishes. The geometric mean concentration for paired data is as follows: untreated CS-06 at 1.93 $\mu g/m^3$ and treated CSDS-01 at 2.27 $\mu g/m^3$; untreated CS-01 at 2.29 $\mu g/m^3$ and treated CSDS-02 at 2.19$\mu g/m^3$. The geometric mean concentration for the coal slag generic category of abrasive of 2.040 $\mu g/m^3$ is slightly more than 23 times higher than the corresponding geometric mean concentration for the silica sand generic category of abrasives.

The copper slag generic abrasive category had 31 of 32 sample results above the limit of detection for beryllium. The range and geometric mean levels of beryllium varied considerably within the copper slag generic category. Copper slag CP-1A/B showed a wide range of measured concentrations, from below the limit of detection to 2.26 $\mu g/m^3$. However, it resulted in the lowest geometric mean level within the generic category at 0.24 $\mu g/m^3$. Copper slags 2A/B and 4A/B showed comparable results, ranging from 0.165 to 6.12 $\mu g/m^3$. The geometric mean concentrations of 0.74 $\mu g/m^3$ and 0.98 $\mu g/m^3$, respectively, are comparable. Copper slag CP-3A/B resulted in the highest range of concentrations of beryllium, from 0.50 to 6.41 $\mu g/m^3$, as well as the geometric mean of 2.19 $\mu g/m^3$. The geometric mean level of beryllium for the copper slag generic abrasive category of 0.78 $\mu g/m^3$ is 9 times higher than silica sands geometric mean level of 0.09 $\mu g/m^3$. The data for the copper slag with dust suppressant is comparable to these results. Measured concentrations of beryllium ranged from 0.24 to 2.89 $\mu g/m^3$, with a geometric mean concentration of 0.64 $\mu g/m^3$, which is over 7 times higher than silica sand's geometric mean level 0.09 $\mu g/m^3$. Geometric means for the paired treated and untreated copper slag were comparable; untreated CP-02 at 0.74 $\mu g/m^3$ and treated CPDS-01 at 0.64 $\mu g/m^3$.

The nickel slag generic abrasive category had 5 of 8 airborne samples with results above the limit of detection for beryllium. The range and geometric mean levels of beryllium varied considerably within the nickel slag generic category. Nickel slag N-01 had only one sample above the limit of detection at a concentration of 0.11 $\mu g/m^3$. In contrast, nickel slag N-02 had all 4 samples with results above the limit of detection for beryllium, ranging from 0.17 to 1.73 $\mu g/m^3$. The geometric mean level of beryllium for the nickel slag generic abrasive category of 0.14 $\mu g/m^3$ is 1.6 times higher than silica sands geometric mean level of 0.09 $\mu g/m^3$.

The garnet generic abrasive category had 30 of 52 airborne samples with results above the limit of detection for arsenic. Garnets G-1A/B, G-2A/B, G-3A, G-5A/B and G-7A/B had relatively consistent measured ranges of concentrations (from less than the limit of detection to 0.25 $\mu g/m^3$) and geometric mean concentrations (0.04, 0.07, 0.05, 0.07, and 0.04 $\mu g/m^3$, respectively). Garnet G-4A/B had measured concentrations of beryllium ranging from 0.20 to 1.27 $\mu g/m^3$ and a geometric mean of 0.53 $\mu g/m^3$. Garnet G-6A/B had measured concentrations of beryllium ranging from 0.10 to 2.29 $\mu g/m^3$ and a

geometric mean of 0.34 $\mu g/m^3$. The geometric mean level of beryllium for the garnet generic abrasive category of 0.10 $\mu g/m^3$ is only slightly higher than silica sands geometric mean level of 0.09 $\mu g/m^3$.

The crushed glass generic category of abrasives had 3 out of 4 airborne sample results with results above the limit of detection for beryllium. Results ranged from 0.03 to 0.13 $\mu g/m^3$, with a geometric mean of 0.08 $\mu g/m^3$. Specular hematite generic category had 1 of 4 samples with results above the limit of detection for beryllium. The measured airborne concentration of 0.44 $\mu g/m^3$ resulted in a geometric mean concentration of 0.06 $\mu g/m^3$. The staurolite generic abrasive category had 3 of 8 airborne samples with results above the limit of detection for beryllium. Samples ranged from 0.03 to 0.30 $\mu g/m^3$, with a geometric mean concentration of 0.06 $\mu g/m^3$. The steel grit generic category of abrasive had 3 of 16 airborne samples above the limit of detection for beryllium. However, all of these measured concentrations were associated with steel grit SG-02, where concentrations ranged from below the limit of detection to 0.52 $\mu g/m^3$. The geometric mean level of beryllium for the steel grit generic abrasive category was 0.05 $\mu g/m^3$. The olivine generic abrasive category had 2 of 4 airborne samples with results above the limit of detection for beryllium. Concentrations ranged from below the limit of detection to 0.12 $\mu g/m^3$, with a geometric mean concentration of 0.03 $\mu g/m^3$. The geometric mean concentrations for each of these generic category of abrasives was less than the geometric mean level of 0.09 $\mu g/m^3$ for the silica sand generic category of abrasives.

Cadmium

Figure 5 illustrates the range and geometric mean for the airborne levels of cadmium for each of the 40 abrasive products and associated generic categories of abrasive. The crushed glass and olivine generic categories of abrasive had all airborne cadmium results below the limit of detection.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for cadmium, and in order from the highest to the lowest geometric mean level include: copper slag, nickel slag, coal slag, garnet, specular hematite, silica sand with dust suppressant, staurolite, steel grit, silica sand, coal slag with dust suppressant, and copper slag with dust suppressant. The variability of results for individual abrasives within a generic category must also be considered in addition to comparisons of geometric mean data for an entire generic category of abrasive.

The silica sand generic abrasive category had 7 out of 28 airborne samples with results above the limit of detection for cadmium. Six of the seven detectable concentrations ranged from 0.1 to 0.17 $\mu g/m^3$. Silica sand SS-01 had a sample result with a measured concentration of 1.99 $\mu g/m^3$. The geometric mean concentration of cadmium for the silica sand generic abrasive category was 0.08 $\mu g/m^3$. This will be used as the standard of comparison.

The copper slag generic abrasive category had 27 of 32 airborne samples with results above the limit of detection for cadmium. The range and geometric mean levels of cadmium varied widely for the individual copper slag abrasives within the generic category. Copper slag CP-2A/B had the lowest range of measured concentrations, from less than the limit of detection to 0.5 $\mu g/m^3$. Copper slags CP-1A/B and CP-3A/B had comparable ranges and geometric means, with airborne concentrations ranging from 0.27 to 3.93 $\mu g/m^3$ and geometric means of 0.88 and 1.68 $\mu g/m^3$, respectively. Copper slag CP-4A/B had the highest range and geometric mean, with measured airborne concentrations ranging from 2.06 to 71.41 $\mu g/m^3$, and a geometric mean of 10.21 $\mu g/m^3$. The geometric mean level for cadmium for the copper slag generic abrasive category of 1.04 $\mu g/m^3$ is 12 times higher than silica sands geometric mean level of 0.08 $\mu g/m^3$.

The nickel slag generic abrasive category had 4 out of 8 airborne samples with results above the limit of detection for cadmium. The range in geometric mean levels of cadmium was widely different between the two individual abrasives within the generic category. Nickel slag N-01 had all four sample results below the limit detection for cadmium. Nickel slag N-02 had all 4 results with concentrations above the limit of detection for cadmium, ranging from 0.52 to 10.21 $\mu g/m^3$. The geometric mean level of cadmium for the nickel slag generic abrasive category of 0.246 $\mu g/m^3$ is nearly 3 times higher than silica sands geometric mean level of 0.08 $\mu g/m^3$.

The coal slag generic abrasive category had 10 out of 28 airborne samples above the limit of detection for cadmium. The range and geometric mean levels, while variable, were considerably more consistent than copper slag or nickel slag. Coal slags CS-01 to 06 had relatively consistent geometric mean concentrations, although measured ranges were notably broader for coal slags CS-05 and CS-06. Copper slag CS-07 had the broadest range of measured concentrations, from less than the limit of detection to 2.71 $\mu g/m^3$. The geometric mean level of cadmium for the coal slag generic abrasive category of 0.13 $\mu g/m^3$ is about 1.6 times higher than silica sand's geometric mean level of 0.08 $\mu g/m^3$.

The garnet generic abrasive category had 25 out of 52 airborne samples with results above the limit of detection for cadmium. While the results range from below the limit of detection to 2.69 $\mu g/m^3$, the individual ranges and geometric means for each of the individual garnet abrasives were relatively consistent. The geometric mean level of cadmium for the garnet generic abrasive category of 0.13 $\mu g/m^3$ is about 1.5 times higher than silica sand's geometric mean level of 0.08 $\mu g/m^3$.

The specular hematite, silica sand with dust suppressant, staurolite, and steel grit generic abrasive categories resulted in somewhat different ranges of measured airborne concentrations, but relatively consistent geometric mean levels between the generic categories of abrasives: 0.10, 0.10, 0.09, and 0.08 $\mu g/m^3$, respectively. The geometric mean levels for cadmium for each of these generic abrasive categories are slightly higher than silica sand's geometric mean level of 0.08 $\mu g/m^3$.

The coal slag with dust suppressant and copper slag with dust suppressant generic categories of abrasive resulted in relatively consistent measured ranges of concentrations and geometric mean levels. The geometric mean levels of 0.08 and 0.08 $\mu g/m^3$, respectively, were essentially identical to silica sand's geometric mean level of 0.08 $\mu g/m^3$.

Chromium

Figure 6 illustrates the range and geometric mean for the airborne levels of chromium for each of the 40 abrasive products and the associated generic category of abrasive. One of the generic categories of abrasives, specular hematite, had all chromium results below the limit of detection.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for chromium, and in order from the highest to the lowest geometric mean level include: nickel slag, steel grit, olivine, copper slag, copper slag with dust suppressant, coal slag with dust suppressant, coal slag, garnet, crushed glass, staurolite, silica sand, and silica sand with dust suppressant. The variability of results for individual abrasives within a generic category must also be considered in addition to comparisons of geometric mean concentrations for the entire generic category of abrasives.

The silica sand generic abrasive category had 8 out of 28 airborne samples with results above the limit of detection for chromium. The chromium concentrations for these samples ranged from 5.02 to 27.16 $\mu g/m^3$. The geometric mean concentration of chromium for the silica sand generic abrasive category was 7.12 $\mu g/m^3$. This will be used as the standard of comparison.

The nickel slag generic abrasive category had 8 out of 8 airborne samples with results above the limit of detection for chromium. The range and geometric mean levels of chromium varied considerably for the individual nickel slags within the generic category. Nickel slag N-01 had levels of chromium ranging 345 to 7036 $\mu g/m^3$ with a geometric mean of 1996 $\mu g/m^3$. Nickel slag N-02 had levels of chromium ranging from 139 to 1270 $\mu g/m^3$, with a geometric mean of 330 $\mu g/m^3$. The geometric mean level of chromium for the nickel slag generic abrasive category of 812 $\mu g/m^3$ is nearly 114 times higher than silica sand's geometric mean level of 7.12 $\mu g/m^3$.

The steel grit generic abrasive category had 14 of 16 airborne samples with results above the limit of detection for chromium. The range and geometric mean levels of chromium varied widely between the individual abrasives. Steel grit SG-1/AB had levels of chromium ranging from below the limit of detection to 227 $\mu g/m^3$, with a geometric mean of 38.2 $\mu g/m^3$. Steel grit SG-2A/B had levels of chromium ranging from 311 to 8551 $\mu g/m^3$, with a geometric mean of 1398 $\mu g/m^3$. The geometric mean level of chromium for steel grit generic abrasive category of 231 $\mu g/m^3$ is nearly 33 times higher than silica sand's geometric mean level of 7.12 $\mu g/m^3$.

The olivine generic abrasive category had 4 out of 4 airborne samples with results above the limit of detection for chromium. The results ranged from 65.9 to 247 $\mu g/m^3$. The geometric mean level of chromium for olivine abrasive of 117 $\mu g/m^3$ is 16 times higher than silica sand's geometric mean level of 7.12 $\mu g/m^3$.

The copper slag generic abrasive category had 32 of 32 airborne samples with results above the limit of detection for chromium. Three of the individual copper slags, CP-1A/B, CP-2A/B, and CP-3A/B, had relatively consistent ranges and geometric mean levels of chromium. Concentrations ranged from 11 to 290 $\mu g/m^3$ and geometric means were 55.6, 56.0, and 40.8 $\mu g/m^3$, respectively. Copper slag CP-4A/B had a considerably higher range of measured concentrations and geometric mean. The CP0-4 had levels of chromium ranging from 104 to 2244 $\mu g/m^3$ and a geometric mean of 360 $\mu g/m^3$. The geometric mean level of chromium for the copper slag generic abrasive category of 82.2 $\mu g/m^3$ is about 11.5 times higher than silica sand's geometric mean level of 7.12 $\mu g/m^3$.

The copper slag with dust suppressant generic abrasive category had 8 of 8 airborne samples with results above the limit detection for chromium. The measured range of concentration of 24.3 to 227 $\mu g/m^3$ closely parallels the range of concentration for the untreated version of this specific product (i.e. CP-2A/B) with a range of concentrations of 20.01 to 290 $\mu g/m^3$. The geometric mean level of chromium for copper slag with dust suppressant of 66.8 $\mu g/m^3$ is slightly over 9 times higher than the geometric mean level of silica sand of 7.12 $\mu g/m^3$.

The coal slag with dust suppressant had 7 out of 8 airborne samples with results above the limit of detection for chromium. The range of concentration and geometric means within the generic category were relatively consistent. Measured concentrations ranged from 5.19 to 137 $\mu g/m^3$. The geometric mean level of chromium for the coal slag with dust suppressant generic category of 39.5 $\mu g/m^3$ is about 5.5 times higher than silica sands geometric mean level of 7.12 $\mu g/m^3$.

The coal slag generic category of abrasives had 26 out of 28 airborne samples with results above the limit of detection. The range and geometric mean levels of chromium varied considerably for the coal slag generic abrasive category. Coal slag CS-01, CS-02, CS-03, CS-06, and CS-07 show relatively consistent ranges and geometric mean concentrations. The overall range for the group was from 10.7 $\mu g/m^3$ to 333 $\mu g/m^3$. CS-04 and CS-05 had very consistent and lower range and geometric mean levels. The range of measured concentrations was from below the limit of detection to 46 $\mu g/m^3$. The geometric mean level for the coal slag generic abrasive category of 38.7 $\mu g/m^3$ is about 5.5 times higher than silica sand's generic mean level of 7.12 $\mu g/m^3$.

The garnet generic abrasive category had 37 out of 52 airborne samples with results above the limit of detection for chromium. The ranges and geometric mean concentrations for each of the individual abrasives varied widely, with garnet G-2/AB showing the lowest range (less than the limit of detection to 13.1 $\mu g/m^3$) and G-6/AB showing the highest range (13.1 to 206 $\mu g/m^3$). The geometric mean level of chromium

for the garnet generic abrasive category of 18.2 $\mu g/m^3$ is slightly more than 2.5 times higher than silica sand's geometric mean level of 7.12 $\mu g/m^3$.

The crushed glass generic abrasive category had 3 of 4 samples with results above the limit of detection for chromium. Crushed glass had levels of chromium ranging from 5.15 to 22.7 $\mu g/m^3$. The geometric mean level of chromium for the crushed glass generic abrasive category of 12.5 is slightly more than 1.5 times silica sands geometric mean level of 7.12 $\mu g/m^3$.

The staurolite generic abrasive category had 3 of 8 samples with results above the limit of detection for chromium. Results ranged from 5.19 to 33.4 $\mu g/m^3$. The geometric mean level of chromium for staurolite abrasive of 8.62 is slightly higher than silica sand's geometric mean level of 7.12 $\mu g/m^3$.

The silica sand with dust suppressant generic category of abrasive had 2 of 12 airborne samples with results above the limit of detection for chromium (10.7 and 15.3 $\mu g/m^3$). The range for the group was from 5.0 to 15.3 $\mu g/m^3$. The geometric mean level of chromium for the silica sand with dust suppressant generic category of 5.96 $\mu g/m^3$ is slightly less than the silica sand geometric mean level of 7.12 $\mu g/m^3$. However, direct comparison of the individual treated and untreated abrasives (SSDS-01 with SS-01; SSDS-02 with SS-04; and SSDS-03 with SS-03) illustrate similar ranges and geometric means.

Lead

Figure 7 illustrates the range and geometric mean for the airborne levels of lead for each of the 40 abrasive products and the associated generic category of abrasive. Only specular hematite had all airborne results below the limit of detection for lead.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for lead, and in order of the highest to the lowest geometric mean level include: copper slag, crushed glass, staurolite, copper slag with dust suppressant, nickel slag, coal slag with dust suppressant, coal slag, silica sand, steel grit, garnet, olivine, and silica sand with dust suppressant. The variability of results for individual abrasives within a generic category must also be considered in addition to comparisons of the combined data for an entire generic category of abrasive.

The silica sand generic abrasive category had 17 of 28 airborne samples with results above the limit of detection. The lead levels for these samples ranged from 0.80 to 10.4 $\mu g/m^3$. The geometric mean concentration of lead for the silica sand generic abrasive category was 2.74 $\mu g/m^3$. This will be used as a standard of all comparisons.

The copper slag generic abrasive category had 29 out of 32 airborne samples with results above the limit of detection for lead. Each of the individual abrasives within the generic category had highly variable ranges and geometric means. Copper slag CP-2A/B had the lowest reported range, from below the limit of detection to 9.75 $\mu g/m^3$. Copper

slag CP-4A/B had the highest reported range from 391 to 120,384 $\mu g/m^3$. The geometric mean level of lead for the copper slag generic abrasive category of 92 $\mu g/m^3$ is 33.5 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$. The geometric mean level of lead for the copper slag generic abrasive category is nearly an order of magnitude or more greater than the corresponding mean concentrations for all of the remaining generic categories of abrasive.

The crushed glass category of abrasive had 4 out of 4 samples with results above the limit of detection for lead. Crushed glass had levels of lead ranging from 3.91 to 26.8 $\mu g/m^3$. The geometric mean level of lead for the crushed glass generic category of 12.2 $\mu g/m^3$ is nearly 4.5 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$.

The staurolite generic category of abrasive had 7 out of 8 airborne samples with results above the limit of detection for lead. While there was some variability in the range of measured concentrations, the geometric means are relatively consistent. The geometric mean level of lead for the staurolite generic abrasive category of 7.7 $\mu g/m^3$ is nearly 3 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$.

The copper slag with dust suppressant (CPDS-1A/B) had a range and geometric mean slightly higher than its corresponding untreated counterpart (CP-2A/B). The reported range was 0.82 to 15.07 $\mu g/m^3$ with a geometric mean of 5.11 $\mu g/m^3$. The range for CP-2A/B was from below the limit of detection to 9.75 $\mu g/m^3$. The geometric mean was 2.25 $\mu g/m^3$. The geometric mean level of lead for the copper slag with dust suppressant category of 5.11 $\mu g/m^3$ is just under 2 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$.

The nickel slag generic category of abrasive had 6 out of 8 samples with results above the limit of detection for lead. The range and geometric mean levels were widely variable within the generic abrasive category. Nickel slag N-01 had measured levels of lead ranging from below the limit of detection to 2.28 $\mu g/m^3$, with a geometric mean of 1.3 $\mu g/m^3$. Nickel slag N-02 had levels of lead ranging from 5.11 to 50 $\mu g/m^3$, with a geometric mean of 14.9 $\mu g/m^3$. The geometric mean level of lead for nickel slag generic category of 4.4 $\mu g/m^3$ is approximately 1.6 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$.

The coal slag with dust suppressant had 6 out of 8 airborne samples with results above the limit of detection for lead. The range of reported concentrations varied, however, the geometric mean levels were relatively consistent between the individual abrasives within this generic category and their untreated counterpart. Coal slag with dust suppressant CSDS-01 had levels of lead ranging from below the limit of detection to 12.7 $\mu g/m^3$, and a geometric mean of 3.18 $\mu g/m^3$. In comparison, the paired, untreated coal slag (CS-06) had levels of lead ranging from below the limit of detection to 4.35 $\mu g/m^3$, and a geometric mean of 2.14 $\mu g/m^3$. Coal slag with dust suppressant CSDS-02 had levels of lead ranging from below the limit of detection to 88.9 $\mu g/m^3$, and a geometric mean of 5.14 $\mu g/m^3$. This corresponds with the untreated version of this coal

slag (CS-01) which had a range of 2.27 to 10.5 $\mu g/m^3$, and a geometric mean of 4.76 $\mu g/m^3$. The geometric mean level of lead for the coal slag with dust suppressant abrasive category of 4.0 $\mu g/m^3$ is approximately 1.5 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$.

The coal slag generic category of abrasives had 18 out of 28 airborne samples with results above the limit of detection for lead. While there was some variability in both the reported ranges and the geometric mean concentrations for the individual abrasives, the data within the generic category is relatively consistent. The geometric mean level of lead for the coal slag generic abrasive category of 3.89 $\mu g/m^3$ is approximately 1.4 times higher than silica sand's geometric mean level of 2.74 $\mu g/m^3$.

For the remaining abrasives, including: steel grit, garnet, olivine, and silica sand with dust suppressant, the reported ranges and geometric mean levels of lead are all similar or below that of the silica sand generic category abrasives. The notable exception is within the steel grit generic category of abrasives, where steel grit SG-1A/B had all results below the limit of detection, while steel grit SG-2A/B had a reported range of concentrations from 0.39 to 45.88 $\mu g/m^3$ and a geometric mean of 6.07 $\mu g/m^3$.

Manganese

Figure 8 illustrates the range and geometric mean for the airborne levels of manganese for each of the 40 abrasive products and the associated generic category of abrasive. All of the generic category of abrasives had at least 1 airborne sample result above the limit of detection for manganese, and in order of the highest to lowest geometric mean level include: copper slag with dust suppressant, steel grit, garnet, copper slag, olivine, nickel slag, coal slag, coal slag with dust suppressant, staurolite, specular hematite, crushed glass, silica sand with dust suppressant, and silica sand. The variability of results for individual abrasives within a generic category must also be considered in addition to comparison of the combined data for an entire generic category.

The silica sand generic category had 28 out of 28 airborne samples with results above the limit of detection. The results ranged from 4.61 to 356 $\mu g/m^3$. While the range of concentrations fluctuated, the geometric mean values for all of the individual silica sand abrasives, except silica sand SS-04, were relatively consistent. Silica sand SS-04 had the highest range for manganese, from 37.5 to 356 $\mu g/m^3$, and a geometric mean of 177 $\mu g/m^3$. The geometric mean level of manganese for the silica sand generic abrasive category is 45.7 $\mu g/m^3$. This will be used as the standard of comparison.

The copper slag with dust suppressant generic category of abrasives had 8 out of 8 airborne sample results above the limit of detection for manganese. The measured range for CPDS-1A/B of 932 to 11,357 $\mu g/m^3$, and a geometric mean of 2,718 $\mu g/m^3$can be compared to the untreated counterpart, copper slag CP-2A/B with a reported range of 701 $\mu g/m^3$ to 12,650 $\mu g/m^3$, and a geometric mean of 2,346 $\mu g/m^3$. The geometric mean level of manganese for the copper slag with dust suppressant category of 2,718 $\mu g/m^3$ is about 60 times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The steel grit generic category of abrasives had 16 out of 16 airborne samples with results above the limit of detection for manganese. Once again, there was considerable variation between the individual abrasives. Steel grit SG-1A/B had results that ranged from 14.6 to 3,920 $\mu g/m^3$, with a geometric mean of 458 $\mu g/m^3$. Steel grit SG-2A/B had manganese levels ranging from 1,639 to 41,710 $\mu g/m^3$, with a geometric mean of 7,203 $\mu g/m^3$. The geometric mean level of manganese for the combined steel grit generic abrasive category of 1,815 $\mu g/m^3$ is about 40 times higher than silica sands geometric mean level of 45.7 $\mu g/m^3$.

The garnet generic abrasive category had 52 out of 52 airborne samples with results above the limit of detection for manganese. The reported ranges are highly variable. Garnet G-1A/B had the lowest reported range, from 58 to 954 $\mu g/m^3$. Garnet G-4A/B had the highest reported range, from 579 to 17,670 $\mu g/m^3$. The geometric mean level of manganese for the garnet generic abrasive category of 829 $\mu g/m^3$ is about 18 times higher than the silica sand geometric mean level of 45.7 $\mu g/m^3$.

The copper slag generic category of abrasive had 32 out of 32 airborne samples with results above the limit of detection for manganese. Once again, there was considerable variability within the data. Copper slag CP-1A/B had the lowest reported range from 35 to 447 $\mu g/m^3$. Copper slag CP-2A/B had the highest reported range from 701 to 12,650 $\mu g/m^3$. The geometric mean level of manganese for the copper slag generic abrasive category of 653 $\mu g/m^3$ is about 14 times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

Olivine had 4 out of 4 airborne samples with results above the limit of detection for manganese. The results ranged from 247 to 1,377 $\mu g/m^3$. The geometric mean level of manganese for olivine of 500 $\mu g/m^3$ is just about 11 times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The nickel slag generic category of abrasive had 8 out of 8 airborne samples with results above the limit of detection. The range and geometric means for the individual abrasives were fairly consistent. The geometric mean level of manganese for the nickel slag generic abrasive category of 459 $\mu g/m^3$ is about ten times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The coal slag generic abrasive category had 28 out of 28 airborne samples with results above the limit of detection for manganese. The range of concentrations for the individual abrasives within this category were fairly consistent, from 27 to 874 $\mu g/m^3$. The geometric mean level of manganese for the coal slag generic abrasive category of 149 $\mu g/m^3$ is a little over three times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The coal slag with dust suppressant abrasive category had 8 out of 8 airborne samples with results above the limit of detection for manganese. There was little

variation in the range or geometric mean between the individual abrasives within this category. In addition, the range and geometric means of the treated and untreated version of the same products were similar. The geometric mean level of manganese for the coal slag with dust suppressant generic abrasive category of 133 $\mu g/m^3$ is just under 3 times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The staurolite generic category of abrasives had 8 out of 8 air samples with the results above the limit of detection for manganese. There were considerable differences in the range of reported concentrations. Staurolite S-01 had a broader range, from 19.5 to 522 $\mu g/m^3$. Staurolite S-02 had a narrower range from 52 to 271 $\mu g/m^3$. The geometric mean level of manganese for the staurolite generic abrasive category of 121 $\mu g/m^3$ is just over 2.5 times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The specular hematite abrasive had a reported range of 16 to 249 $\mu g/m^3$ for manganese. The geometric mean level of 61 $\mu g/m^3$ is approximately 1.3 times higher than silica sand's geometric mean level of 45.7 $\mu g/m^3$.

The crushed glass abrasive had a reported range from 13 to 101 $\mu g/m^3$ for manganese. The geometric mean level of 57 $\mu g/m^3$ is slightly higher than the geometric mean level of silica sand of 45.7 $\mu g/m^3$.

The reported ranges and geometric means for the silica sands with dust suppressant were very similar with their untreated counterpart.

Nickel

Figure 9 illustrates the range and geometric mean for the airborne levels of nickel for each of the 40 abrasive products and the associated generic category of abrasive. The following generic category of abrasives had all airborne results below the limit of detection for nickel: crushed glass, staurolite, specular hematite, and silica sand with dust suppressant.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for nickel, and in order from the highest to the lowest geometric mean level include: olivine, nickel slag, steel grit, copper slag with dust suppressant, coal slag, coal slag with dust suppressant, copper slag, garnet, and silica sand. The variability of results for individual abrasives within a generic category must also be considered in addition to comparisons of combined data for an entire generic category.

The silica sand generic abrasive category had 4 out of 28 airborne samples with results above the limit of detection. The nickel level in these samples ranged from 5.02 to 16.3 $\mu g/m^3$. The geometric mean level of nickel for the silica sand generic abrasive category was 5.99 $\mu g/m^3$. This will be used as the standard for comparison.

The olivine abrasive had 4 out 4 airborne samples with results above the limit of detection for nickel. The results ranged from 865 to 4520 $\mu g/m^3$. The geometric mean level of 1,628 $\mu g/m^3$ is 270 times higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

The nickel slag generic abrasive category had 8 out of 8 airborne samples with results above the limit of detection for nickel. The range in geometric mean levels of nickel varied considerably for the specific nickel slag abrasive. Nickel slag N-01 had a reported range from 89 to 2,897 $\mu g/m^3$ and a geometric mean of 606 $\mu g/m^3$. Nickel slag N-02 had a reported range from 613 to 6,040 $\mu g/m^3$ and a geometric mean of 1609 $\mu g/m^3$. The geometric mean level of nickel for the nickel slag generic abrasive category of 987 $\mu g/m^3$ is approximately 165 times higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

The steel grit generic abrasive category had 14 out of 16 airborne samples with results above the limit of detection for nickel. The range and geometric mean was highly variable for the individual abrasives within this generic category. Steel grit SG-1A/B had a reported range from below the limit of detection to 724 $\mu g/m^3$, with a geometric mean of 52 $\mu g/m^3$. The reported range for steel grit SG-2A/B was from 162 to 4,380 $\mu g/m^3$, with a geometric mean of 733 $\mu g/m^3$. The geometric mean level of nickel for the steel grit generic abrasive category of 196 is approximately 33 times higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

The copper slag with dust suppressant generic abrasive category had 6 out of 8 airborne samples with results above the limit of detection for nickel. The reported range of 5 to 116 $\mu g/m^3$ for CPDS-1A/B closely parallels the results for its untreated counterpart, copper slag CP-2A/B (5.2 to 127 $\mu g/m^3$). The geometric mean level for the copper slag with dust suppressant of 30.2 $\mu g/m^3$ is approximately five times higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

The coal slag generic category had 23 out of 28 airborne samples with results above the limit of detection for nickel. The range of reported concentrations varied considerably among the individual abrasives within this category. Coal slag CS-04 had the lowest reported range, from below the limit of detection to 23 $\mu g/m^3$. Coal slag CS-07 had the highest reported range from 17.5 to 354 $\mu g/m^3$. The geometric mean level of nickel for the coal slag generic abrasive category of 28 $\mu g/m^3$ is approximately 4.5 times higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

The coal slag with dust suppressant generic category of abrasives had 6 out of 8 airborne samples with results above the limit of detection for nickel. The reported concentrations, ranging from 5.15 to 83.1 $\mu g/cm^3$, closely paralleled the corresponding untreated coal slag abrasive. The geometric mean level of nickel for the coal slag with dust suppressant generic abrasive category of 25.2 $\mu g/m^3$ is just over 4 times higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

The copper slag generic abrasive category had 21 out of 32 airborne samples with results above the limit of detection for nickel. There was wide variability among the individual abrasives within the generic category. Copper slag CP-1A/B had the lowest reported range, from below the limit of detection to 21.2 $\mu g/m^3$. Copper slag CP-4A/B had the highest reported range, from 14 to 306 $\mu g/m^3$. The geometric mean level of nickel for the copper slag generic abrasive category of 19.2 $\mu g/m^3$ is just over 3 times higher than the silica sands geometric mean level of 5.99 $\mu g/m^3$.

The garnet generic abrasive category had 14 out of 52 airborne samples with results above the limit of detection for nickel. Three of the abrasives had results that were below the limit of detection on all samples collected. The remaining four abrasives had varying ranges of concentration, from 5 to 56 $\mu g/m^3$. The geometric mean level of nickel for the garnet generic abrasive category of 7.4 $\mu g/m^3$ is slightly higher than silica sand's geometric mean level of 5.99 $\mu g/m^3$.

Respirable Quartz

Figure 10 illustrates the range and geometric mean for the airborne levels of respirable quartz for each of the 40 abrasive products and the associated generic category of abrasive. Caution must be used when considering quartz data from the samples described on the first page of the Respirable Quartz Section in Appendix B, since these samples were evaluated by primary or secondary peak height measurement, due to problematical integration data caused by interferences. The following generic categories of abrasives had all airborne results below the limit of detection for respirable quartz: crushed glass, coal slag, coal slag with dust suppressant, nickel slag, olivine, specular hematite, copper slag with dust suppressant, and steel grit. NIOSH did not detect cristobalite in any of the airborne or bulk samples.

The following generic abrasive categories had at least 1 airborne sample with results above the limit of detection for respirable quartz, and in order of the highest to lowest geometric mean level, include: silica sand, silica sand with dust suppressant, garnet, copper slag, and staurolite. The variability of results for individual abrasives within a generic category must also be considered in addition to comparisons of combined data for an entire generic category.

The silica sand generic abrasive category had 27 out of 28 airborne samples with results above the limit of detection for respirable quartz. Silica sand SS-04 had a reported range from below the limit of detection to 13.0 mg/m^3. The remaining abrasives within this generic category resulted in a range of respirable quartz from 2.43 mg/m^3 to 43.2 mg/m^3. The geometric mean level of respirable quartz for the silica sand generic abrasive category was 8.83 mg/m^3. This will be used as the standard for comparison.

The silica sand with dust suppressant generic abrasive category had 9 out of 12 airborne samples with results above the limit of detection for respirable quartz. The range of concentrations varied widely between individual abrasives, with SSDS-03 having the lowest range (from below the limit of detection to 2.1 mg/m^3), and SSDS-01

having the highest reported range (from 5.61 to 30.6 mg/m^3). The geometric mean level of respirable quartz for the silica sand with dust suppressant generic abrasive category of 2,875 is 70% lower than silica sand's geometric mean level of 8.828 mg/m^3. However, the geometric mean concentrations for the corresponding pairs of treated and untreated abrasives (SSDS-01 and SS-01; SSDS-02 and SS-04; and SSDS-03 and SS-03) show relatively consistent geometric mean levels for two of the three individual paired sets.

The garnet generic abrasive category had 17 out of 52 airborne samples with results above the limit of detection for respirable quartz. Caution must be used when considering quartz data from the garnet samples described on the first page of the Respirable Quartz Section in Appendix B, since these samples were evaluated by primary or secondary peak height measurement, due to problematical integration data caused by interferences. Three of the seven specific abrasives within this generic category had no results above the limit of detection for respirable quartz. Of the remaining four, there is considerable variability with garnet G-6A/B showing a range from below the limit of detection to 0.24 mg/m^3 and garnet G-3A showing a range from below the limit of detection to 6.8 mg/m^3. The geometric mean level of respirable quartz for the garnet generic abrasive category of 0.23 mg/m^3 is over 38 times lower than the geometric mean level of 8.83 mg/m^3 for silica sand.

The copper slag generic category of abrasive had 3 out of 32 sample results above the limit of detection for respirable quartz. Only one of the four individual abrasives within the generic category had considerable range of concentrations. Copper slag CP-4A/B had a reported range from below the limit of detection to 0.74 mg/m^3. The geometric mean level of respirable quartz for the copper slag generic abrasive category of 0.15 mg/m^3 is over sixty times lower than silica sand's geometric mean level of 8.83 mg/m^3.

Staurolite abrasive had 1 out of 8 samples with results above the limit of detection. The single sample concentration of 0.49 mg/m^3 resulted in a geometric mean of 0.15 mg/m^3, which is nearly 60 times lower than the geometric mean of 8.83 mg/m^3 for silica sand.

Silver

Figure 11 illustrates the range and geometric mean for the airborne levels of silver for each of the 40 abrasive products and the associated generic category of abrasive. The following generic categories of abrasives had all airborne results below the limit of detection for silver: crushed glass, nickel slag, olivine, staurolite, specular hematite, and silica sand.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for silver, and in order from the highest to lowest geometric mean level include: copper slag, copper slag with dust suppressant, steel grit, coal slag with dust suppressant, coal slag, silica sand with dust suppressant, and garnet. The variability of results for individual abrasives within a generic category must also be

considered in addition to comparisons of the combined data for the entire generic category.

The silica sand generic abrasive category had no measured results above the limit of detection. The geometric mean for the silica sand generic abrasive category equals the limit of detection for each abrasive divided by two, which is 0.84 $\mu g/m^3$. This will be used as the standard for comparison.

The copper slag generic category of abrasive had 20 out of 32 airborne samples with results above the limit of detection for silver. The range was somewhat variable, with a high of 13.79 $\mu g/m^3$ for copper slag CP-2A/B and a high of 77.5 $\mu g/m^3$ for CP-4A/B. Copper slag CP-1A/B had no results above the limit of detection for silver. The geometric mean level of silver for the copper slag generic abrasive category of 3.46 $\mu g/m^3$ is approximately 4 times higher than silica sand's geometric mean level of 0.83 $\mu g/m^3$.

The copper slag with dust suppressant generic category of abrasive resulted in 5 out of 8 airborne samples with results in excess of limit of detection. The results ranged from 0.81 to 9.42 $\mu g/m^3$, which closely parallel the range for the untreated counterpart (copper slag, CP-2A/B) with a range from below the limit of detection to 13.7 $\mu g/m^3$. The geometric mean level for the copper slag with dust suppressant of 2.1 $\mu g/m^3$ is approximately 2.5 times higher than silica sand's geometric mean level of 0.83 $\mu g/m^3$.

The steel grit generic category of abrasive had 1 out of 16 airborne samples with results above the limit of detection. This sample was associated with abrasive SG-1A/B and had a concentration of 15.24 $\mu g/m^3$. The geometric mean level of silver for the steel grit generic abrasive category of 1.64 $\mu g/m^3$ is nearly two times higher than silica sand's geometric mean level of 0.83 $\mu g/m^3$.

The coal slag with dust suppressant generic abrasive category had 2 out of 8 airborne samples with results above the limit of detection for silver. These results were higher than the corresponding untreated coal slag abrasive. For CSDS-01, the maximum concentration of 20.62 $\mu g/m^3$ can be compared to the untreated counterpart coal slag CS-06's maximum concentration of 1.94 $\mu g/m^3$. Similarly, the maximum concentration for CSDS-02 of 1.95 $\mu g/m^3$ can be compared to the non-detectable results for the untreated counterpart CS-01. The resulting geometric mean level of silver for the coal slag with dust suppressant generic category of 1.38$\mu g/m^3$ is approximately 1.6 times higher than silica sand's geometric mean level of 0.83 $\mu g/m^3$.

For the remaining generic categories of abrasives, including coal slag, silica sand with dust suppressant, and garnet, each had only one airborne result above the limit of detection for silver. The corresponding geometric mean levels of silver in the coal slag, silica sand with dust suppressant and garnet were slightly above (1.94, 1.88, and 3.11 $\mu g/m^3$, respectively) the geometric mean level of silver in silica sand (0.83 $\mu g/m^3$).

Titanium

Figure 12 illustrates the range and geometric mean for the airborne levels of titanium for each of the 40 abrasive products and the associated generic category of abrasive. All of the generic abrasive categories had airborne samples with results above the limit of detection for titanium, and in order of the highest to the lowest geometric mean level include: copper slag with dust suppressant, coal slag with dust suppressant, staurolite, coal slag, copper slag, nickel slag, garnet, silica sand, silica sand with dust suppressant, specular hematite, steel grit, olivine, and crushed glass. The variability of results for individual abrasives within a generic category must also be considered when making comparisons using combined data for an entire generic category.

The silica sand generic category of abrasive had 28 out of 28 samples with results above the limit of detection for titanium. The results were highly variable, and ranged from 4.58 to 565 $\mu g/m^3$. The geometric mean level of titanium for the silica sand generic abrasive category was 48.8 $\mu g/m^3$. This will be used as the standard for comparison.

The copper slag with dust suppressant resulted in a range from 790 to 8,879 $\mu g/m^3$, and a geometric mean concentration of titanium of 2,078 $\mu g/m^3$, which is over 40 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$. This measured range and geometric mean concentration is essentially identical to the untreated counterpart (copper slag CP-2A/B) with a range from 578 $\mu g/m^3$ to 9,747 $\mu g/m^3$ and a geometric mean level of 1826 $\mu g/m^3$.

The coal slag with dust suppressant generic category of abrasives had 8 out of 8 airborne samples with results above the limit of detection for titanium. The range of reported concentrations of 332 to 5,589 $\mu g/m^3$ is consistent for one set of paired data (CSDS-02 and CS-01). However, the range for CSDS-01 of 332 to 4,568 $\mu g/m^3$ is far broader than the corresponding matched pair of CS-06 with a range of 813 to 2,010 $\mu g/m^3$. The geometric mean level of titanium for the coal slag with dust suppressant generic category of abrasive of 1581 $\mu g/m^3$ is over 30 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$.

The staurolite generic category of abrasive had 8 out of 8 airborne samples with results above the limit of detection for titanium. The range of concentrations from 228 to 3,769 $\mu g/m^3$ were somewhat variable, but the maximum concentrations for either of the individual abrasives were roughly equivalent. The geometric mean level of titanium for the staurolite abrasive category of 1,565 $\mu g/m^3$ is over 30 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$.

The coal slag generic abrasive category had 28 out of 28 airborne samples with results in excess of the limits of detection for titanium. The range was somewhat variable between the individual abrasives, with coal slag CS-03 resulting in the highest range of 722 to 10,576 $\mu g/m^3$ and geometric mean of 2,830 $\mu g/m3$, and CS-05 resulting in the lowest range of 173 to 1,423 $\mu g/m^3$ and geometric mean of 599 $\mu g/m^3$. The geometric

mean level of titanium for the coal slag generic abrasive category of 1,545 $\mu g/m^3$ was about 30 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$.

The copper slag generic abrasive category had 32 out of 32 airborne samples with results above the limit of detection for titanium. The total reported range of concentrations from 146 to 9,747 $\mu g/m^3$ was fairly broad and variable between the individual abrasives. The geometric mean level of titanium for the copper slag generic abrasive category of 1,240 $\mu g/m^3$ was about 25 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$.

The nickel slag generic abrasive category had 8 out of 8 airborne samples with results above the limit of detection for titanium. The range of measured concentrations was widely variable between the two individual abrasives. Nickel slag N-01 had a reported range of 18 to 290 $\mu g/m^3$ and a geometric mean of 93.6 $\mu g/m^3$. Nickel slag N-02 had a reported range from 347 to 2,708 $\mu g/m^3$ and a geometric mean of 763 $\mu g/m^3$. The geometric mean level of titanium for the nickel slag generic abrasive category of 267 $\mu g/m^3$ is approximately 5.5 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$.

The garnet generic category of abrasives had all 52 samples with results above the limit of detection for titanium. The results were highly variable with garnet G-2A/B resulting in the lowest range from 10 to 114 $\mu g/m^3$ and garnet G-7A/B resulted in the highest range from 160 to 1,252 $\mu g/m^3$. The geometric mean level of titanium for the garnet generic abrasive category of 187 $\mu g/m^3$ is nearly 4 times higher than silica sand's geometric mean level of 48.8 $\mu g/m^3$.

The silica sand with dust suppressant generic abrasive category had 11 out of 12 airborne samples with results in excess of limit of detection for titanium. The recorded range of concentrations, from 2 to 598 $\mu g/m^3$ is similar to the generic category of silica sand of 5 to 565 $\mu g/m^3$. In addition, there is reasonably consistent data between two of the three-paired sets of data (i.e. SSDS-01 with SS-01; and SSDS-02 with SS-04). However, silica sand with dust suppressant SSDS-03 is somewhat lower than its corresponding untreated counterpart silica sand SS-03. As a result, the geometric mean level of titanium for the silica sand with dust suppressant generic category of abrasive of 30.6 $\mu g/m^3$ is 40% lower than the silica sand geometric mean level of 48.8 $\mu g/cm^3$.

The remaining abrasives including specular hematite, steel grit, olivine, and crushed glass all had reported ranges and geometric mean levels below silica sand.

Vanadium

Figure 13 illustrates the range and geometric mean for the airborne levels of vanadium for each of the 40 abrasive products and the associated generic category of abrasive. The crushed glass category of abrasive did not result in any measurements above the limit of detection for vanadium.

The following generic abrasive categories had at least one airborne sample with results above the limit of detection for vanadium, and in order from the highest to the lowest geometric mean level include: copper slag with dust suppressant, coal slag, coal slag with dust suppressant, copper slag, steel grit, nickel slag, garnet, staurolite, silica sand with dust suppressant, silica sand, olivine, and specular hematite. The variability of results for individual abrasives within in a generic category must also be considered in addition to comparisons of combined data for an entire generic category.

The silica sand generic abrasive category had 18 out of 28 airborne samples with results above the limit of detection for vanadium. There is considerable variability in results with silica sands SS-01, SS-02, SS-03, SS-06, and SS-07 ranging from below the limit of detection to the maximum value of 7.52 $\mu g/m^3$, while silica sands SS-04 and SS-05 range from a low of 3.56 to a high of 35.34 $\mu g/m^3$. The geometric mean for the silica sand generic abrasive category was 3.16 $\mu g/m^3$. This will be used as the standard for comparison.

The copper slag with dust suppressant generic abrasive had 8 out of 8 airborne samples with results above the limit of detection for vanadium. The range of concentrations was from 40 to 454 $\mu g/m^3$. This is similar to the corresponding untreated copper slag CP-2A/B which ranged from 31 to 518 $\mu g/m^3$. The geometric mean level of vanadium for the copper slag with dust suppressant of 108 $\mu g/m^3$ is nearly 35 times higher than the silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The coal slag generic category of abrasive had all 28 airborne samples with results above the limit of detection for vanadium. While there was variability within the ranges, the geometric mean concentrations are relatively consistent. The total range of reported concentrations were from 9.46 to 666 $\mu g/m^3$. The range of geometric means was 38.6 to 173 $\mu g/m^3$. The geometric mean level of vanadium for the coal slag generic abrasive category of 70 $\mu g/m^3$ is 22 times higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The coal slag with dust suppressant generic category of abrasive had 8 airborne samples with results above the limit of detection for vanadium. The range of concentrations was much smaller for one pair of untreated and treated coal slags (CS-06 and CSDS-01) and very similar for the second pair (CS-01 and CSDS-02). The geometric mean levels of the two-paired sets were nearly identical. The geometric mean level of vanadium for the coal slag with dust suppressant of 54 $\mu g/m^3$ is just under 20 times higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The copper slag generic category of abrasive had all 32 airborne samples with results above the limit of detection for vanadium. With the exception of copper slag CP-1A/B with a range of 3 to 59 $\mu g/m^3$, the remaining three copper slag abrasives were all within a range from 11.33 to 519 $\mu g/m^3$. The geometric mean level of vanadium for the

copper slag generic category of abrasives of 45.3 $\mu g/m^3$ is nearly 15 times higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The steel grit generic abrasive category had 15 out of 16 airborne samples with results above the limit of detection for vanadium. There was considerable variability between the two abrasives within the category. Steel grit SG-1A/B had a reported range from 3.31 to 142 $\mu g/m^3$ and a geometric mean of 12.1 $\mu g/m^3$. Steel grit SG-2A/B ranged from 15 to 480 $\mu g/m^3$ and a geometric mean of 80.5 $\mu g/m^3$. The geometric mean level of vanadium for the steel grit generic abrasive category of 31.2 $\mu g/m^3$ is about 10 times higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The nickel slag generic abrasive category had all 8 airborne samples with results above the limit of detection for vanadium. The results were somewhat different between the two specific abrasives within the category. The geometric mean level of vanadium for the generic category of 29.1 $\mu g/m^3$ is approximately 6.5 times higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The garnet generic category of abrasives had 50 out of 52 airborne samples with results above the limit of detection for vanadium. The results were highly variable among the individual abrasives with garnet G-2A/B resulting in a maximum reported concentration of 6.43 $\mu g/m^3$ and a geometric mean of 2.82 $\mu g/m^3$, and garnet G-6A/B resulting in a maximum concentration of 121 $\mu g/m^3$ and a geometric mean of 29.3 $\mu g/m^3$. The geometric mean level of vanadium for the garnet generic abrasive category of 10.8 $\mu g/m^3$ is nearly 3.5 times higher than silica sands geometric mean level of 3.16 $\mu g/m^3$.

The staurolite generic category of abrasives had all 8 airborne samples with results above the limit of detection for vanadium. The range of concentration and geometric mean for the individual abrasives within the category were relatively consistent and ranged from 2.28 to 22.96 $\mu g/m^3$. The geometric mean level of vanadium for the staurolite generic abrasive category of 7.3 $\mu g/m^3$ was just over 2 times higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The silica sand with dust suppressant generic category of abrasives had 7 out of 12 sample results above the limit of detection for vanadium. The results within the individual abrasives within this category were highly variable. Silica sand with dust suppressants SSDS-01 and SSDS-03 had similar ranges, from below the limit of detection to 3.71 $\mu g/m^3$. Silica sand with dust suppressant SSDS-02 had a range from below the limit of detection to 2,043 $\mu g/m^3$. The results for SSDS-02 did not compare with the paired untreated silica sand (SS-04) either. The geometric mean level of vanadium for the silica sand with dust suppressant category of 3.29 $\mu g/m^3$ is slightly higher than silica sand's geometric mean level of 3.16 $\mu g/m^3$.

The remaining abrasives including olivine and specular hematite have measured ranges and geometric mean levels below that for silica sand.

FIGURE 3 — ARSENIC AIR SAMPLE RESULTS

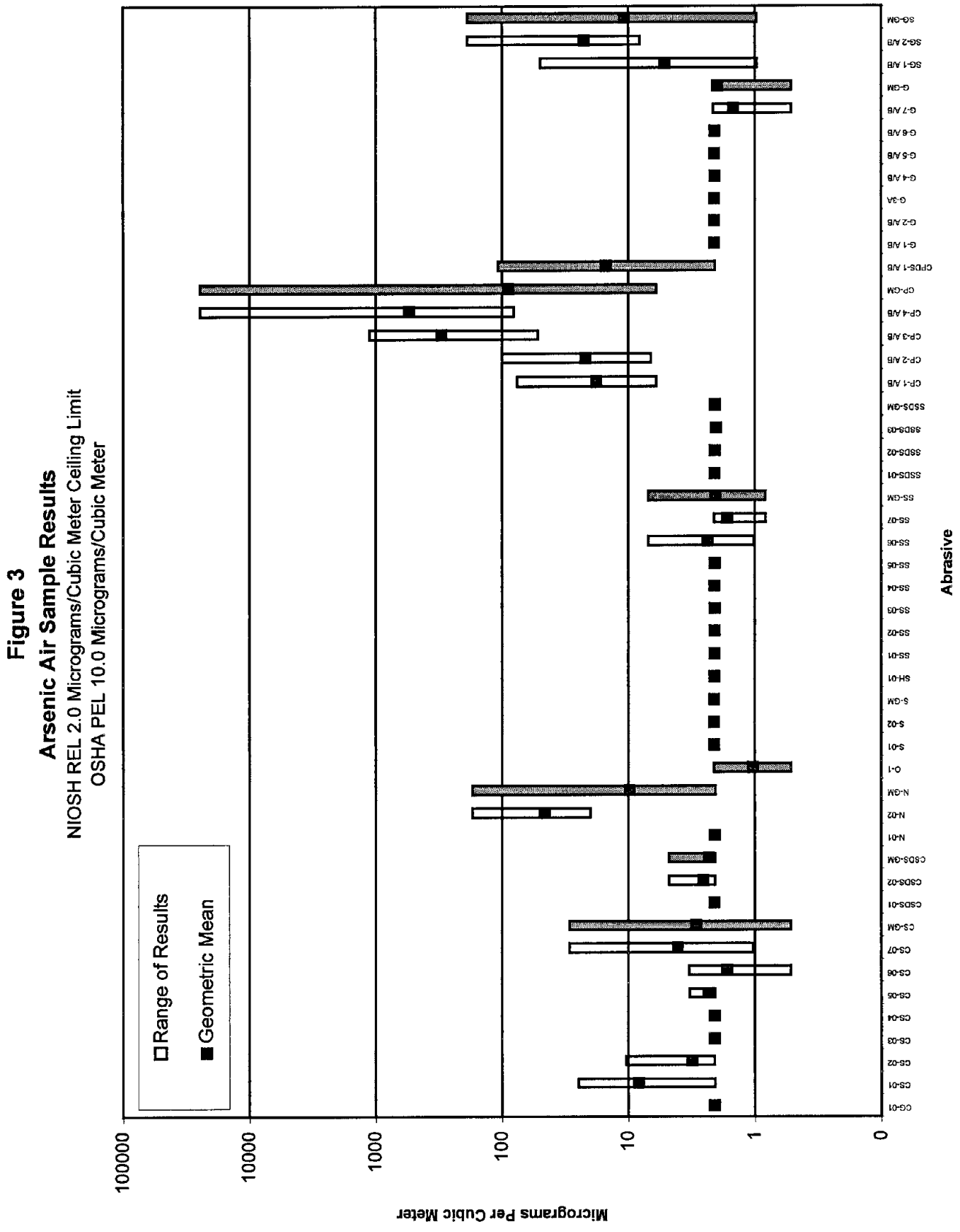


FIGURE 4 —BERYLLIUM AIR SAMPLE RESULTS

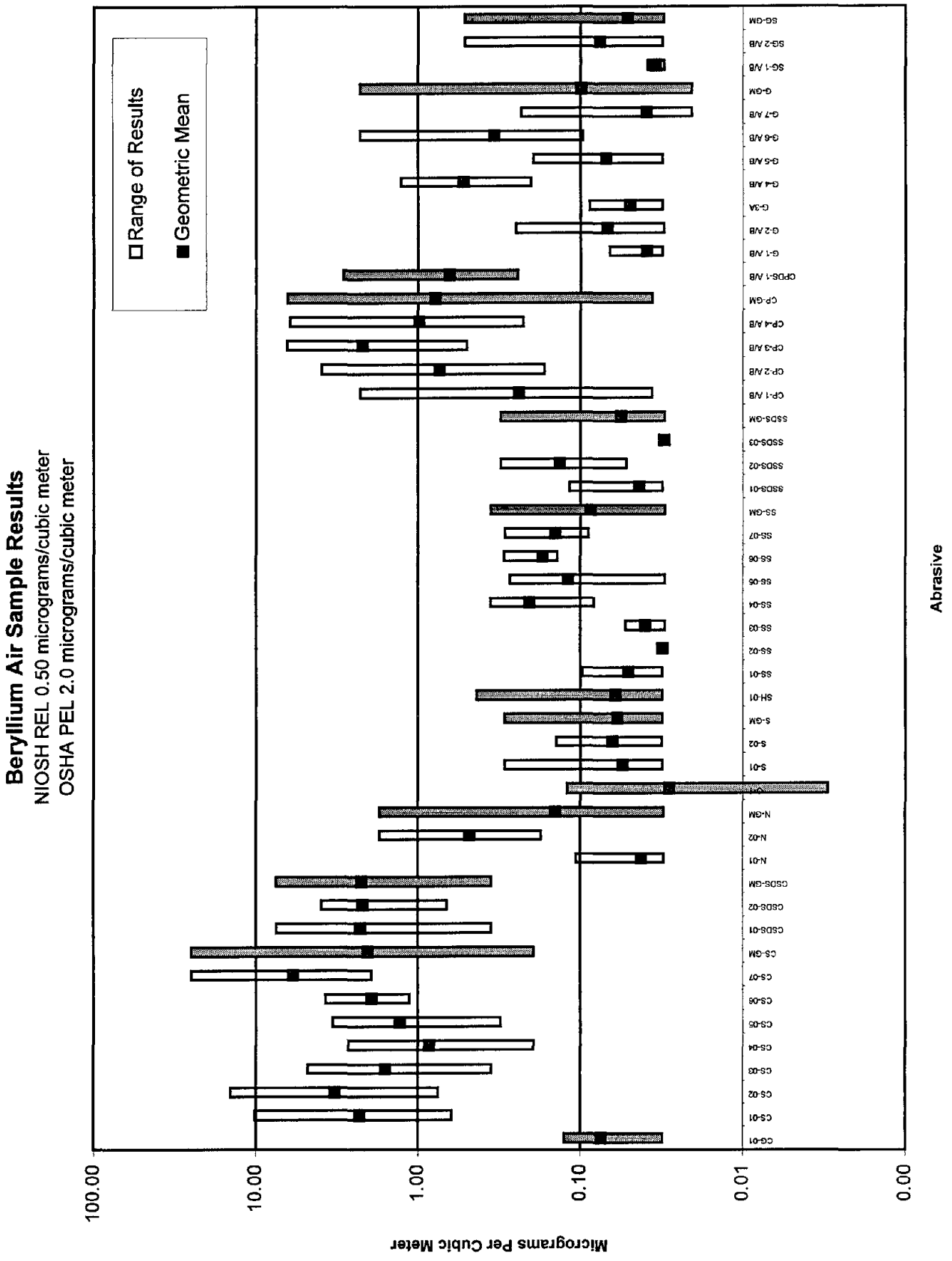


FIGURE 5 — CADMIUM AIR SAMPLE RESULTS

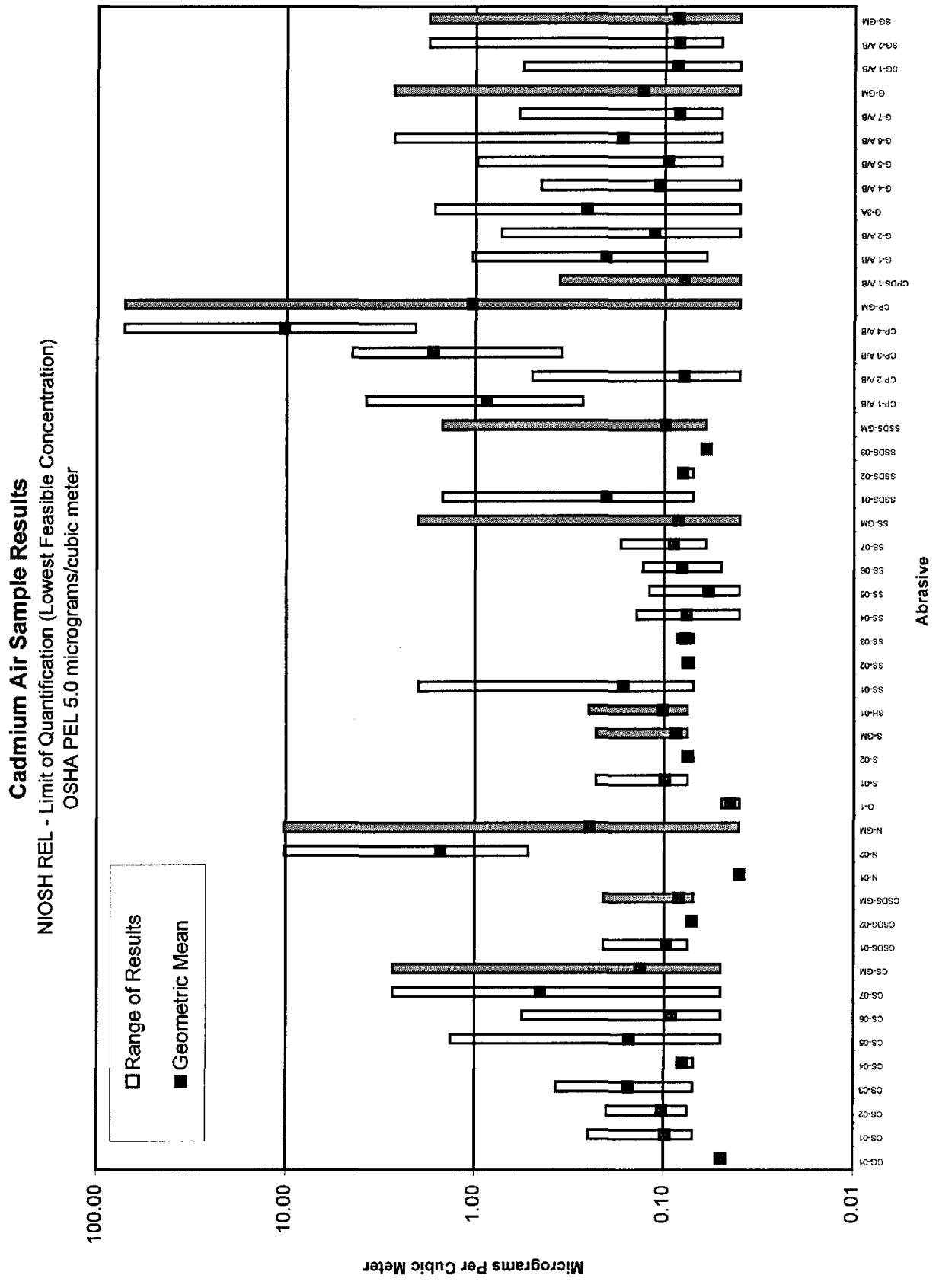


FIGURE 6 — CHROMIUM AIR SAMPLE RESULTS

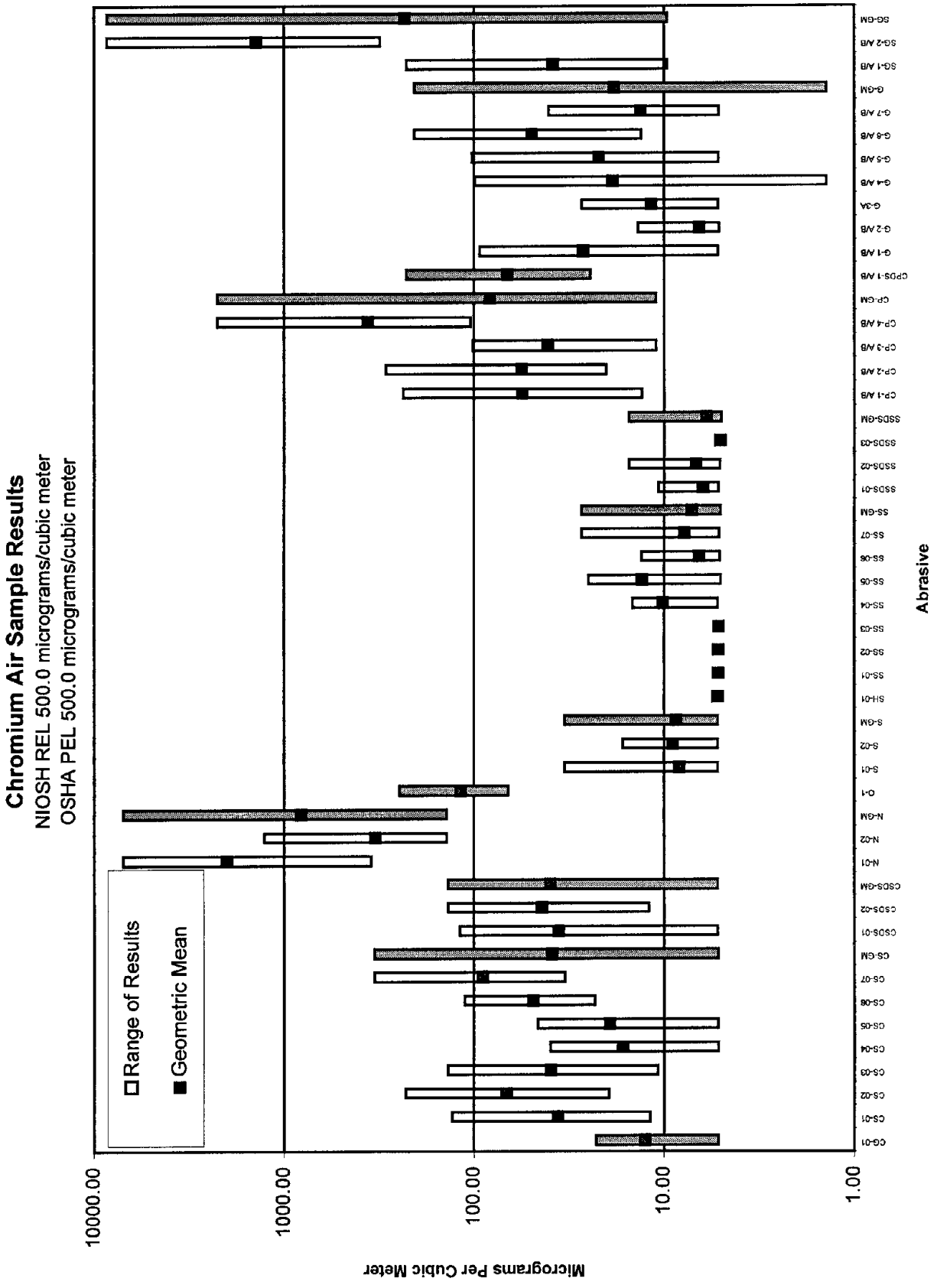


FIGURE 7 — LEAD AIR SAMPLE RESULTS

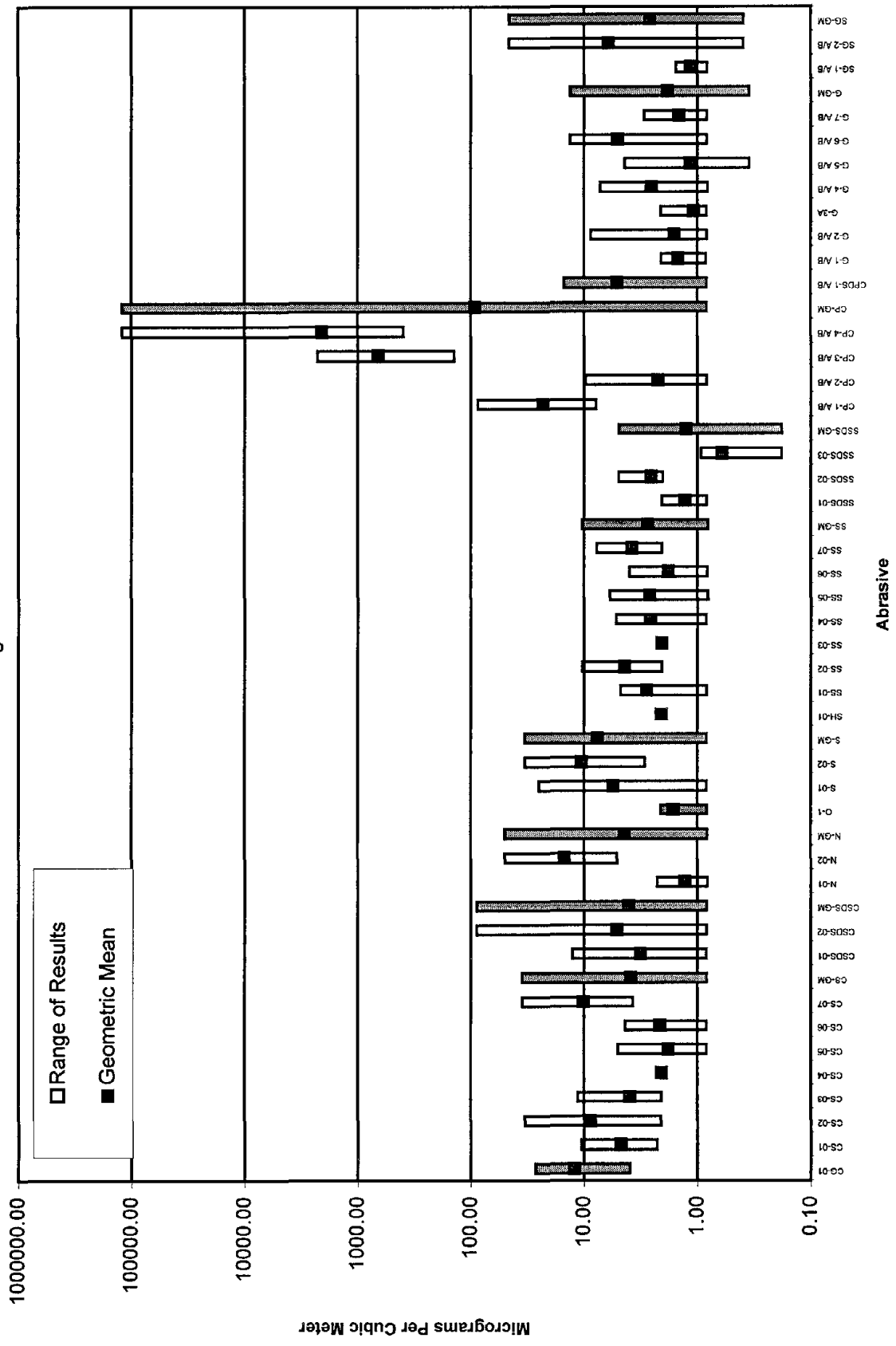


FIGURE 8 — MANGANESE AIR SAMPLE RESULTS

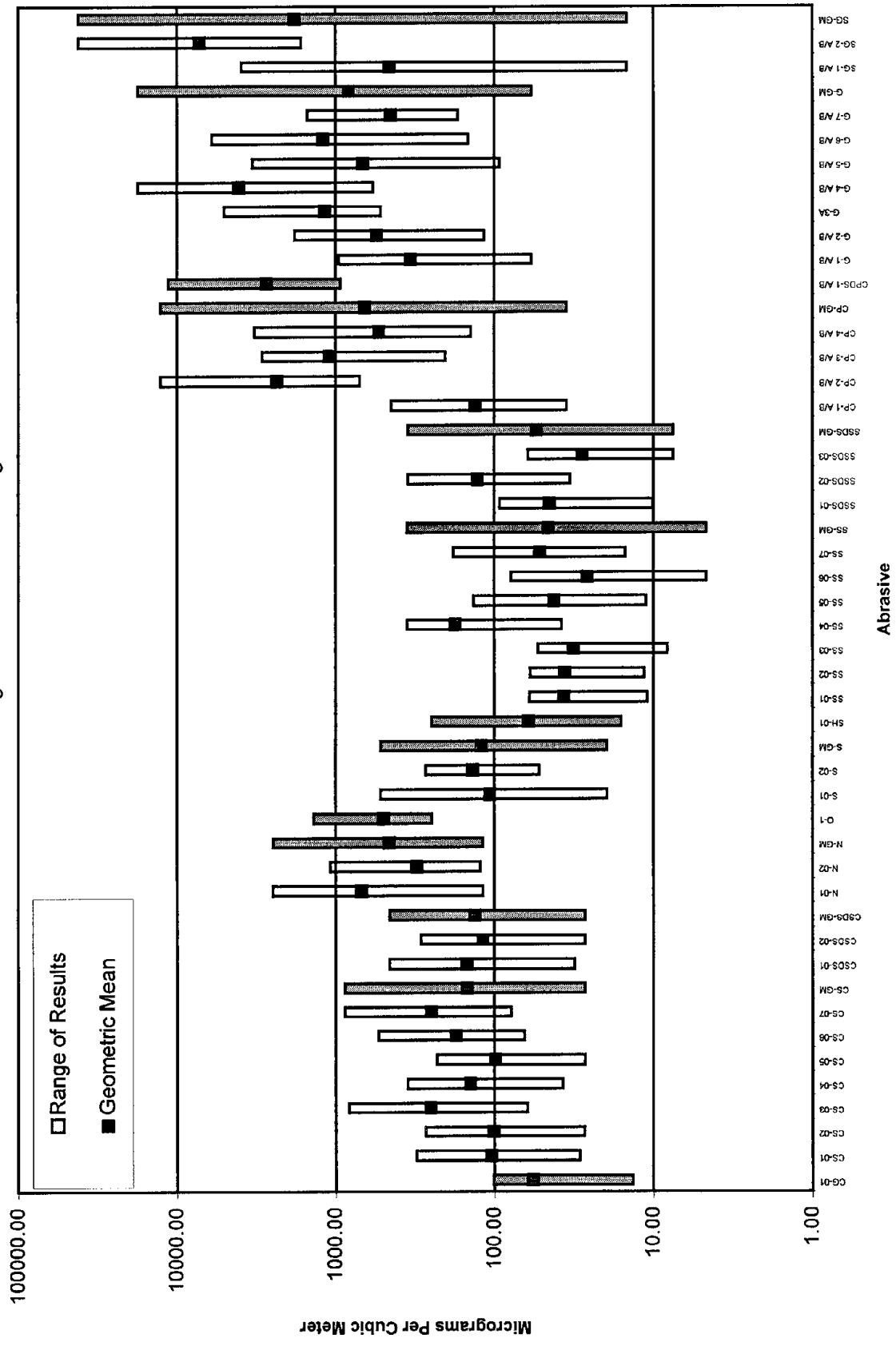


FIGURE 9 — NICKEL AIR SAMPLE RESULTS

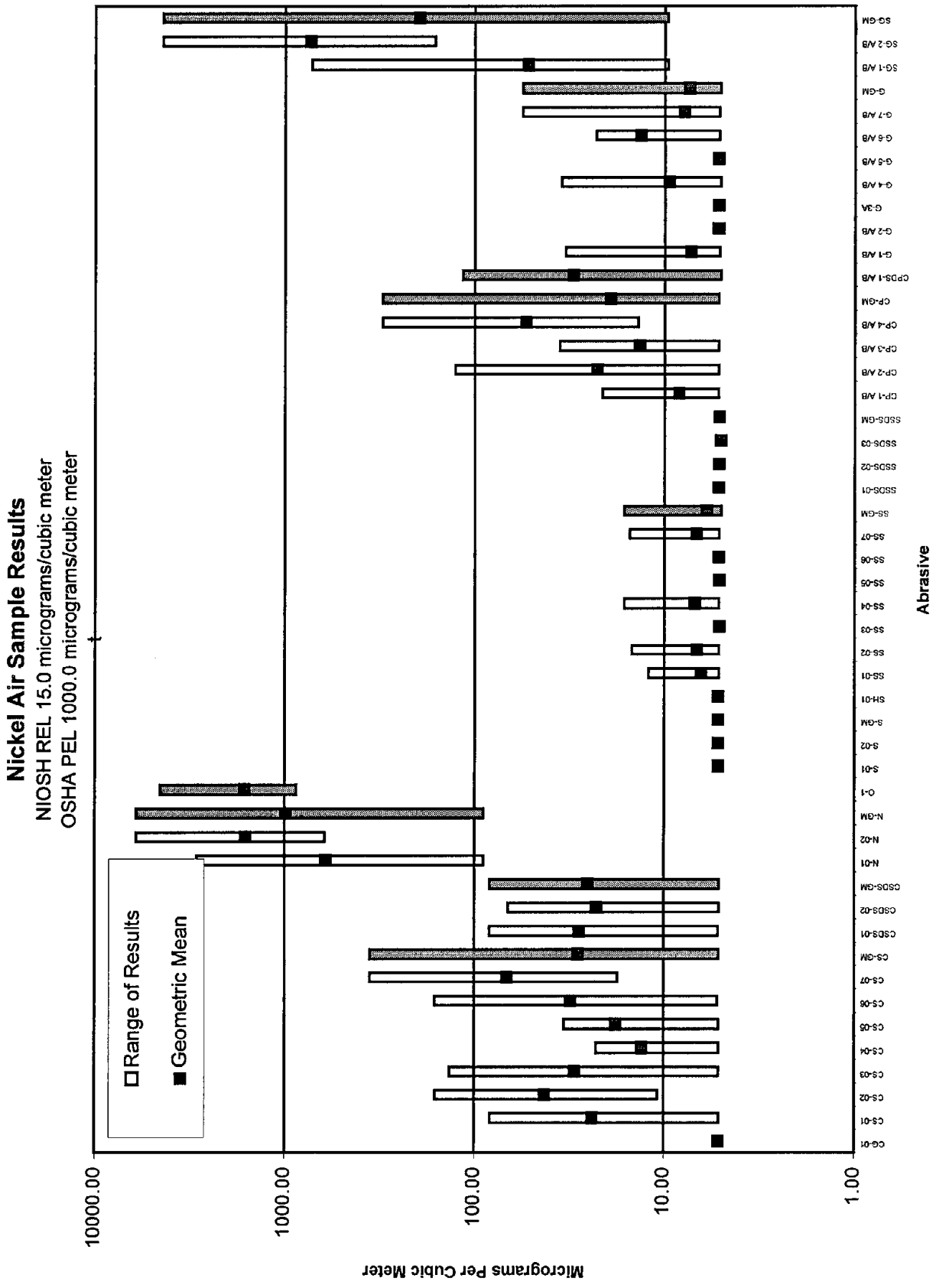


FIGURE 10 — RESPIRABLE QUARTZ AIR SAMPLE RESULTS

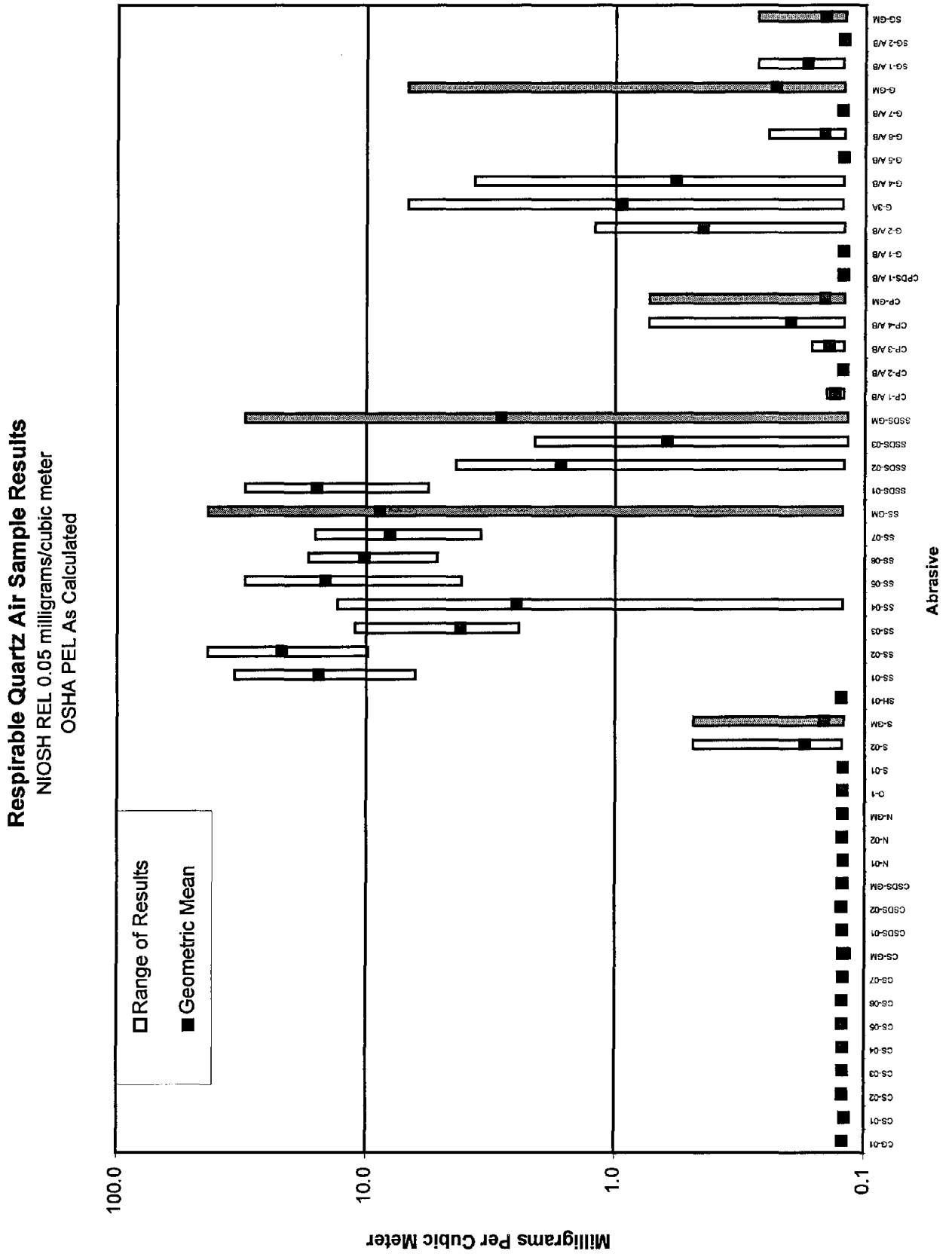


FIGURE 11 — SILVER AIR SAMPLE RESULTS

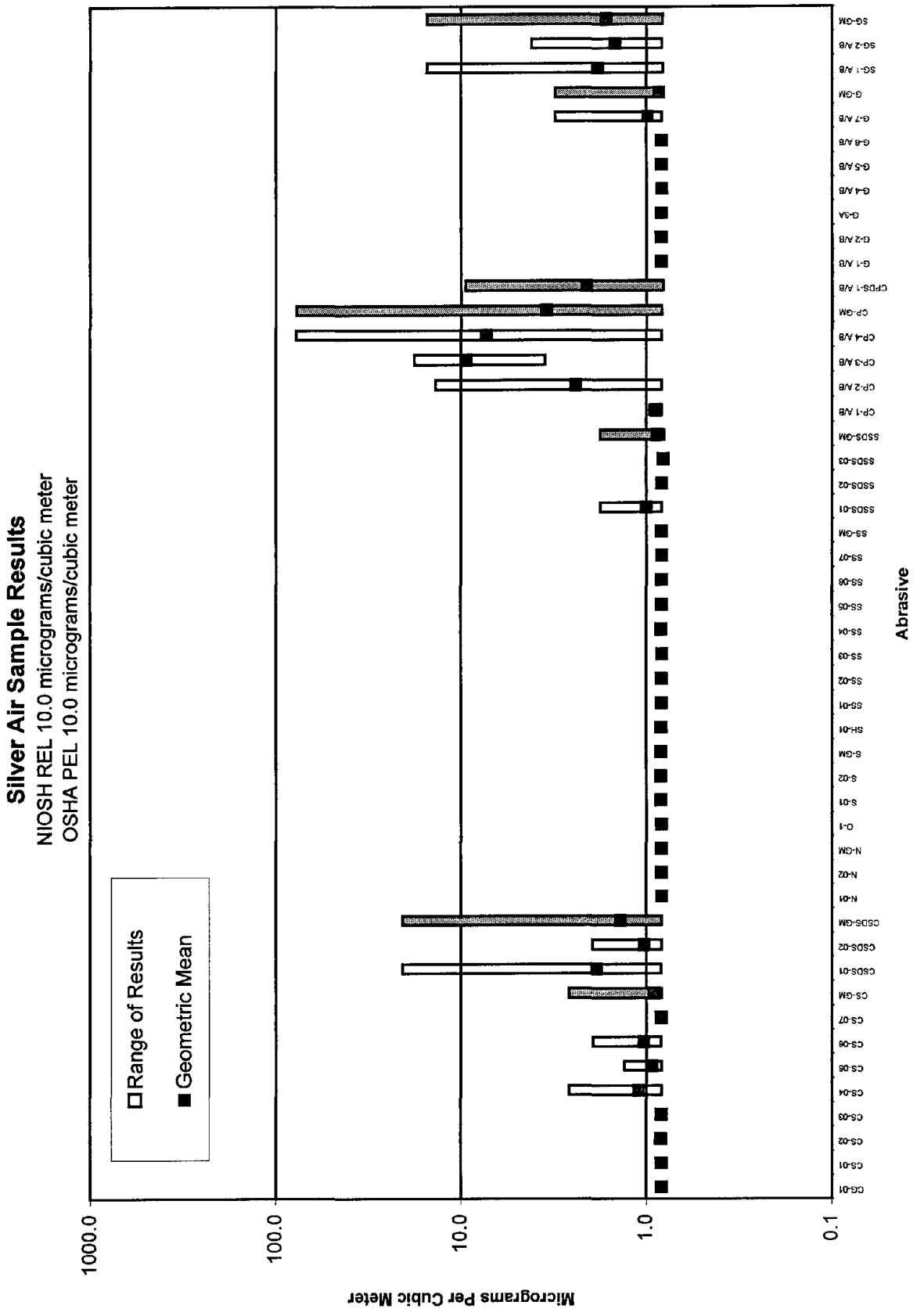


FIGURE 12 — TITANIUM AIR SAMPLE RESULTS

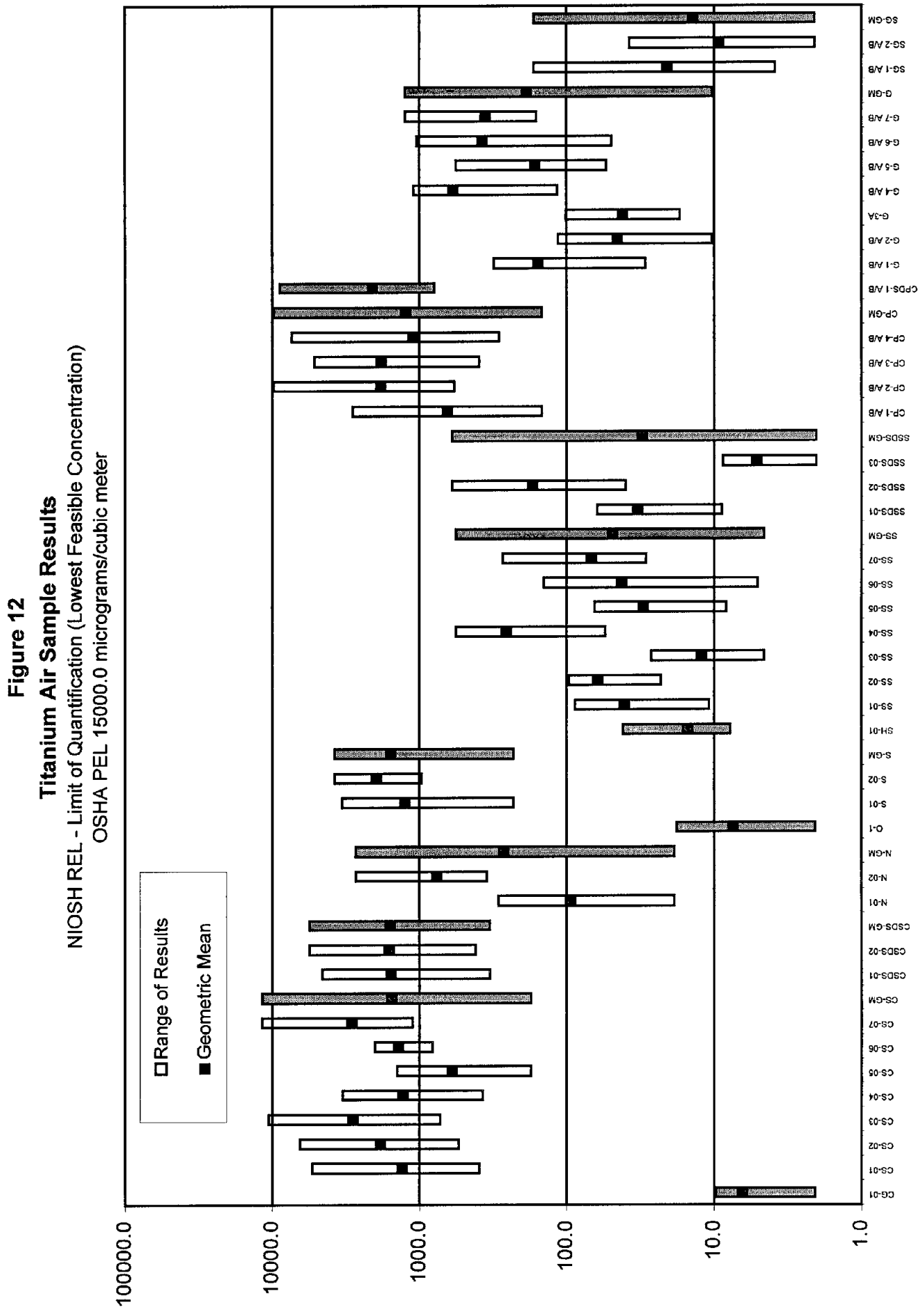
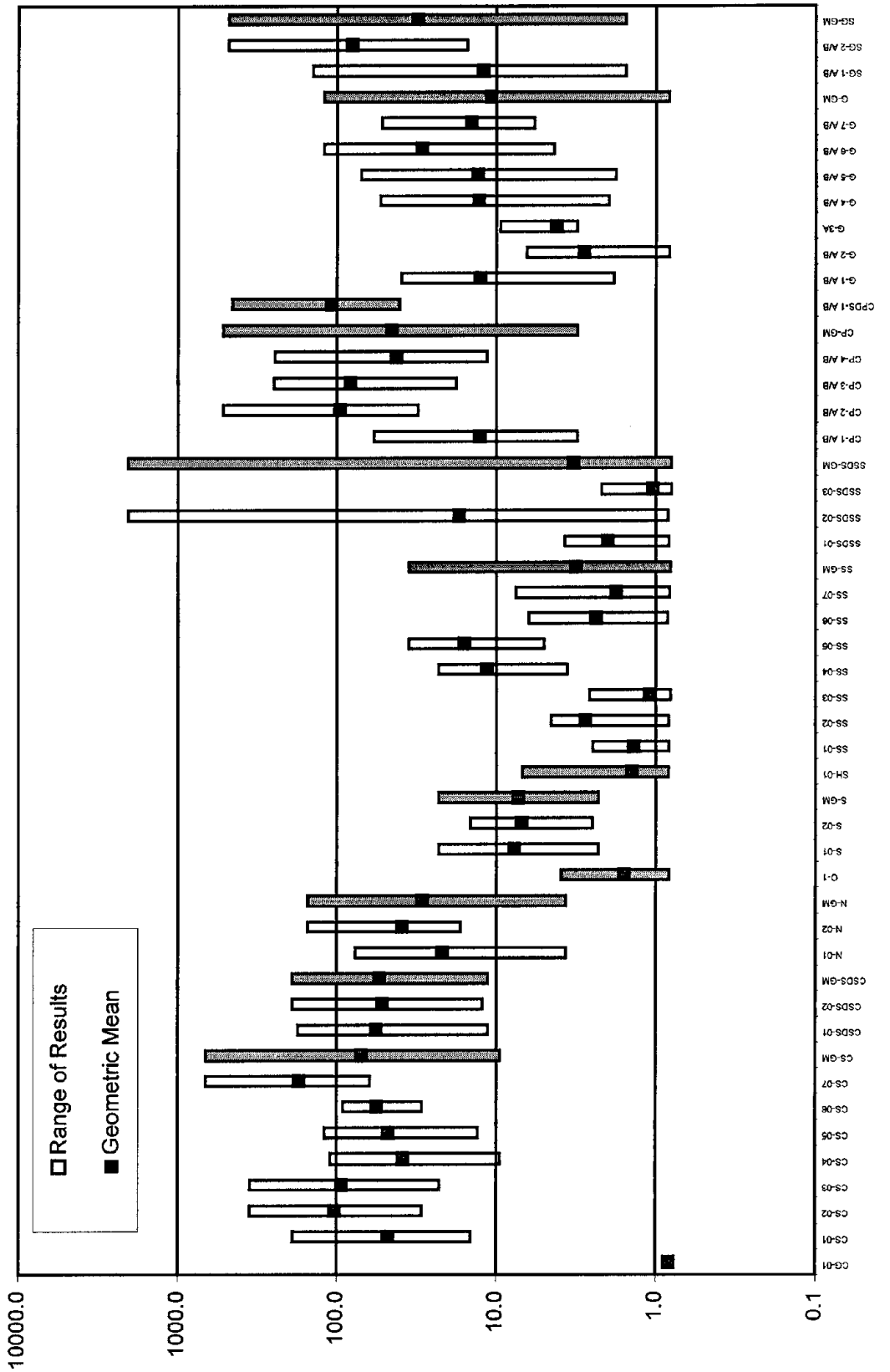


FIGURE 13 — VANADIUM AIR SAMPLE RESULTS



Industrial Hygiene Discussion

Ten generic types of abrasives, plus three generic types treated with dust suppressant, were evaluated for 28 metals/elements, and respirable quartz and cristobalite, through the analysis of airborne dust and bulk materials. For comparison purposes, NIOSH selected twelve health-related agents for comparative analysis, including: arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, respirable quartz, silver, titanium, vanadium, and radium-226. Table 11, found at the end of this discussion on page 120, summarizes the airborne monitoring results for each of these health-related agents except radium-226, which is discussed elsewhere, by generic category of abrasive. Note that the data illustrated on the table may not be representative of each individual abrasive within the generic category as illustrated previously in the Industrial Hygiene Results section of this report. The following is a discussion of key observations concerning this data. It is summarized by generic type of abrasive.

Crushed Glass

Three of the 4 airborne samples of crushed glass had a measured concentration above the limit of detection (LOD) for beryllium. Crushed glass has a geometric mean concentration of beryllium (0.08 $\mu g/m^3$), which is similar (14% less) to that of silica sand (0.09 $\mu g/m^3$).

Three of the 4 airborne samples of crushed glass had a measured concentration above the LOD for chromium. The geometric mean concentration of 12.5 $\mu g/m^3$ is similar (1.8 times greater) to that of silica sand at 7.1 $\mu g/m^3$.

All 4 airborne samples of crushed glass had a concentration above the LOD for lead. The geometric mean concentration of 12.2 $\mu g/m^3$ was 4.4 times greater than that of silica sand at 2.7 $\mu g/m^3$.

All 4 airborne samples of crushed glass had a measured concentration above the LOD for manganese. The geometric mean concentration of 56.9 $\mu g/m^3$ was similar (1.2 times greater) to that of silica sand at 45.7 $\mu g/m^3$.

Three of the 4 airborne samples of crushed glass had a measured concentration above the LOD for titanium. Silica sand's geometric mean airborne titanium concentration (48.8 $\mu g/m^3$) was 7.6 times greater than that of crushed glass (6.4 $\mu g/m^3$).

Arsenic, cadmium, nickel, respirable quartz, silver, and vanadium were not detected above the LOD in any of the crushed glass airborne samples. Crushed glass also has a lower geometric mean concentration than silica sand for beryllium and titanium. Crushed glass had a greater geometric mean concentration than silica sand for only chromium, lead, and manganese; but is only 1.8, 4.4, and 1.2 times greater, respectively.

Based on the industrial hygiene results in the laboratory study, substituting crushed glass for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. The airborne concentrations for the other health-related agents should

also be reduced, with the exception of chromium, lead, and manganese which were slightly higher for crushed glass. Only 1 abrasive was tested for crushed glass, but only 3 major producers currently process and market recycled crushed glass for the abrasive blasting industry. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Coal Slag

Nine of the 28 airborne samples of coal slag had a measured concentration above the LOD for arsenic. The geometric mean concentration of 2.9 $\mu g/m^3$ for the coal slag generic abrasive category was similar (1.4 times higher) to that of silica sand at 2.0 mg/m^3. Coal slag has the fifth highest geometric mean concentration of arsenic; copper slag and copper slag with dust suppressant, steel grit, and nickel slag were higher.

All 28 airborne samples of coal slag had a measured concentration above the LOD for beryllium. The geometric mean concentration of 2.04 $\mu g/m^3$ for the coal slag generic abrasive category was 23 times higher than that of silica sand at 0.09 $\mu g/m^3$. Coal slag had the second highest geometric mean concentration of beryllium, next to coal slag with dust suppressant. The geometric mean concentration of beryllium for coal slag was 2.6 times higher than the next highest generic abrasive category (copper slag).

Ten of the 28 airborne samples of coal slag had a measured concentration above the LOD for cadmium. The geometric mean concentration of 0.13 $\mu g/m^3$ for the coal slag generic abrasive category was similar (1.6 times greater) to that of silica sand at .08 $\mu g/m^3$. Coal slag had the third highest geometric mean concentration of cadmium; behind copper slag and nickel slag.

Twenty-six of the 28 airborne samples of coal slag had a measured concentration above the LOD for chromium. The geometric mean concentration of 38.7 $\mu g/m^3$ for the coal slag generic abrasive category was 5.4 times higher than that of silica sand at 7.1 $\mu g/m^3$. Coal slag has 6 abrasive categories with higher geometric mean concentrations of chromium, and 6 with lower geometric mean concentrations of chromium.

Eighteen of the 28 airborne samples of coal slag had a measured concentration above the LOD for lead. The geometric mean concentration of 3.9 $\mu g/m^3$ for the coal slag generic abrasive category is similar (1.4 times higher) to that of silica sand at 2.7 $\mu g/m^3$. Coal slag had 6 generic abrasive categories with higher geometric mean concentrations of lead, and 6 with lower geometric mean concentrations of lead.

All 28 airborne samples of coal slag had a measured concentration above the LOD for manganese. The geometric mean concentration of 148.7 $\mu g/m^3$ for the coal slag generic abrasive category was 3.2 times higher than that of silica sand at 45.7 $\mu g/m^3$.

Coal slag had 6 generic abrasive categories with higher geometric mean concentrations of manganese, and 6 with lower geometric mean concentrations of manganese.

Twenty-three of 28 airborne samples of coal slag had a measured concentration above the LOD for nickel. The geometric mean concentration of 28.3 $\mu g/m^3$ for the coal slag generic abrasive category was 4.7 times higher than that of silica sand at 6.0 $\mu g/m^3$. Coal slag had the fifth highest geometric mean concentration of nickel; olivine, nickel slag, steel grit, and copper slag with dust suppressant were higher.

Coal slag has only 1 of 28 airborne samples with a concentration (2.6 $\mu g/m^3$) above the LOD for silver. All of silica sand's airborne samples were less than the LOD for silver. Coal slag had the fifth highest geometric mean concentration of silver; copper slag and copper slag with dust suppressant, steel grit, and coal slag with dust suppressant were higher.

All 28 airborne samples of coal slag had a measured concentration above the LOD for titanium. Coal slag's geometric mean concentration of 1545 $\mu g/m^3$ was about 32 times higher than that of silica sand at 48.8 $\mu g/m^3$. Coal slag had the fourth highest geometric mean concentration of titanium; copper slag with dust suppressant, staurolite, and coal slag with dust suppressant were higher.

All 28 airborne samples of coal slag had a measured concentration above the LOD for vanadium. Coal slag's geometric mean concentration of 70.0 $\mu g/m^3$ was about 22 times higher than that of silica sand at 3.1 $\mu g/m^3$. Coal slag had the second highest geometric mean concentration of vanadium; only copper slag with dust suppressant was higher.

All of coal slag's airborne samples were less than the LOD for respirable quartz. Based on the industrial hygiene results in the laboratory study, substituting coal slag for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. However, the coal slag generic abrasive category is not without potential hazardous health-related agent concerns.

Coal slag, as a generic category of abrasives, has a greater geometric mean airborne concentration than that of silica sand for all of the remaining ten hazardous health-related agents, but the coal slag geometric mean of arsenic (1.4x), cadmium (1.6x), lead (1.4x), manganese (3.2x), and silver (1.1x) are only 1.1 to 3.2 times greater than that of silica sand. Out of the thirteen generic abrasive categories, untreated and treated coal slag have the two highest geometric mean airborne concentrations of beryllium, being 23 times greater than that of silica sand and 2.6 times greater than the next highest generic abrasive category (copper slag). All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Coal Slag with Dust Suppressant

One out of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for arsenic. The geometric mean concentration of 2.3 $\mu g/m^3$ was similar (1.15 times higher) to that of silica sand at 2.0 $\mu g/m^3$. Coal slag with dust suppressant had the sixth highest geometric mean concentration for arsenic; copper slag, copper slag with dust suppressant, steel grit, nickel slag, and coal slag were higher.

All eight airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for beryllium. The geometric mean concentration of 2.2 $\mu g/m^3$ was over 25 times higher than that of silica sand at 0.09 $\mu g/m^3$. Coal slag with dust suppressant had the highest geometric mean concentration of beryllium, followed closely by coal slag.

One of eight airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for cadmium. The geometric mean concentration of 0.08 $\mu g/m^3$ was the same as silica sand at 0.08 $\mu g/m^3$. Only copper slag with dust suppressant, crushed glass, and olivine had lower geometric mean concentrations of cadmium.

Seven of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the limit of detection for chromium. The geometric mean concentration of 39.5 $\mu g/m^3$ was about 5.5 times higher than that of silica sand at 7.1 $\mu g/m^3$. Coal slag with dust suppressant had the sixth highest geometric mean concentration of chromium; nickel slag, steel grit, olivine, copper slag, and copper slag with dust suppressant were higher.

Six of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for lead. The geometric mean concentration of 4.0 $\mu g/m^3$ is about 1.5 times higher than that of silica sand at 2.7 $\mu g/m^3$. Coal slag with dust suppressant had the sixth highest geometric mean concentration of lead; copper slag, crushed glass, staurolite, copper slag with dust suppressant, and nickel slag were higher.

All 8 airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for manganese. The geometric mean concentration of 132.6 $\mu g/m^3$ was nearly 3 times greater than silica sand at 45.7 $\mu g/m^3$. Coal slag with dust suppressant is the eighth highest geometric mean concentration for manganese; staurolite, specular hematite, crushed glass, silica sand with dust suppressant, and silica sand were lower.

Six of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the limit of detection for nickel. The geometric mean concentration of 25.2 $\mu g/m^3$ was 4.2 times higher than silica sand at 6.0 $\mu g/m^3$. Coal slag with dust suppressant had the sixth highest geometric mean concentration for nickel; olivine, nickel slag, steel grit, copper slag with dust suppressant, and coal slag were higher.

Two of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for silver. The geometric mean concentration was 1.4 $\mu g/m^3$. There were no measured concentrations of silver above the limit of detection for silica sand abrasives. Coal slag with dust suppressant had the fourth highest geometric mean concentration of 7 abrasive categories with measurable results. Copper slag, copper slag with dust suppressant, and steel grit had higher geometric mean concentrations. Coal slag, silica sand with dust suppressant, and garnet had lower geometric mean concentrations. There was no detectable silver in crushed glass, olivine, staurolite, specular hematite, or silica sand.

Eight of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for titanium. The geometric mean concentration of 1581 $\mu g/m^3$ was 32 times higher than that of silica sand at 48.8 $\mu g/m^3$. Coal slag with dust suppressant had the second highest geometric mean concentration. Only copper slag with dust suppressant was higher.

Eight out of 8 airborne samples of coal slag with dust suppressant had a measured concentration above the LOD for vanadium. The geometric mean concentration of 54.1 $\mu g/m^3$ was 16.9 times higher than that of silica sand at 3.2 $\mu g/m^3$. Coal slag with dust suppressant had the third highest geometric mean concentration of vanadium; copper slag with dust suppressant and coal slag were higher.

All of coal slag's airborne samples were less than the LOD for respirable quartz. Based on the industrial hygiene results and the laboratory study, substituting coal slag for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. However, the coal slag generic abrasive category is not without potential hazardous health-related agent concerns.

Coal slag with dust suppressant as a generic category of abrasive has a higher geometric mean airborne concentration than that of silica sand for all but one of the remaining ten hazardous health-related agents. The geometric mean concentration of chromium was essentially identical for coal slag with dust suppressant and that of silica sand. Out of the 13 generic abrasive categories, coal slag with dust suppressant had the highest geometric mean concentration of beryllium, second highest geometric mean for titanium, and third highest geometric mean for vanadium. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Nickel Slag

Four of the 8 airborne samples of nickel slag had a measured concentration above the LOD for arsenic. The geometric mean concentration of 9.7 $\mu g/m^3$ was 4.8 times higher than that of silica sand at 2.0 $\mu g/m^3$. The geometric mean concentration of nickel

slag was the fourth highest; copper slag, copper slag with dust suppressant, and steel grit were higher.

Five out of 8 airborne samples of nickel slag had measured concentrations of beryllium above the LOD. The geometric mean concentration of 0.14 $\mu g/m^3$ was similar (1.5 times higher) than that of silica sand at 0.09 $\mu g/m^3$. Nickel slag had the fifth highest geometric mean concentration of beryllium; coal slag with dust suppressant, coal slag, copper slag, and copper slag with dust suppressant were higher.

Four out of 8 airborne samples of nickel slag had measured concentrations above the LOD for cadmium. The geometric mean concentration of 0.25 $\mu g/m^3$ is about 3 times higher than silica sand at 0.08 $\mu g/m^3$. Nickel slag had the second highest geometric mean concentration of cadmium; copper slag was higher.

All 8 airborne samples of nickel slag had measured concentrations above the LOD for chromium. The geometric mean concentration of 811.8 is nearly 115 times higher than that of silica sand at 7.1 $\mu g/m^3$. Nickel slag had the highest geometric mean concentration of chromium, and 3.5 times higher than the next highest generic category of steel grit.

Six airborne samples of nickel slag had measured concentrations of lead above the LOD for lead. The geometric mean concentration of 4.4 $\mu g/m^3$ was 1.6 times higher than silica sand at 2.7 $\mu g/m^3$. Nickel slag had the fifth highest geometric mean concentration of lead; copper slag, crushed glass, staurolite, and copper slag with dust suppressant were higher.

All 8 airborne samples of nickel slag had measured concentrations above the LOD for manganese. The geometric mean concentration of 459 $\mu g/m^3$ was nearly 10 times higher than silica sand at 45.7 $\mu g/m^3$. Nickel slag had the sixth highest geometric mean concentration for manganese; copper slag with dust suppressant, steel grit, garnet, copper slag, and olivine were higher.

All 8 of the airborne samples of nickel slag had measured concentrations above the LOD for nickel. The geometric mean concentration of 987 $\mu g/m^3$ was nearly 165 times higher than silica sand at 6.0 $\mu g/m^3$. Nickel slag had the second highest geometric mean concentration of nickel; olivine was higher.

All 8 airborne samples of nickel slag had a measured concentration above the LOD for titanium. The geometric mean concentration of 267.3 $\mu g/m^3$ was nearly 5.5 times higher than silica sand at 48.8 $\mu g/m^3$. Nickel slag had the sixth highest geometric mean concentration of titanium; copper slag with dust suppressant, coal slag with dust suppressant, staurolite, coal slag, and copper slag were higher.

All 8 airborne samples of nickel slag had measured concentrations above the LOD for vanadium. The geometric mean concentration of 29.1 $\mu g/m^3$ was 9 times higher than

silica sand at 3.2 $\mu g/m^3$. Nickel slag had the sixth highest geometric mean concentration of vanadium; copper slag with dust suppressant, coal slag, coal slag with dust suppressant, copper slag, and steel grit were higher.

Respirable quartz and silver were not detected above the LOD in any of the nickel slag airborne samples. Based on the industrial hygiene results in the laboratory study, substituting nickel slag for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. However, the nickel slag generic abrasive category is not without potential hazardous health-related agent concerns.

Nickel slag as a generic category of abrasives had the highest geometric mean concentration of chromium, and second highest concentrations of cadmium and nickel. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Olivine

Two of the 4 airborne samples of olivine had a measured concentration above the LOD for beryllium. The geometric mean concentration of 0.03 $\mu g/m^3$ was approximately 1/3 that of silica sand at 0.09 $\mu g/m^3$. Olivine had the lowest geometric mean concentration of beryllium for all 13 generic categories of abrasives.

All 4 airborne samples of olivine had measured concentrations above the LOD for chromium. The geometric mean of 116.8 $\mu g/m^3$ was nearly 116.5 times higher than silica sand at 7.1 $\mu g/m^3$. Olivine had the third highest geometric mean concentration of chromium; nickel slag and steel grit were higher.

One of the 4 airborne samples of olivine had a measured concentration above the LOD for lead. The geometric mean concentration of 1.6 $\mu g/m^3$ was approximately 60% of the silica sand at 2.7 $\mu g/m^3$. Olivine had the next to the lowest geometric mean concentration of lead for all of the 13 generic categories of abrasives; silica sand with dust suppressant was lower.

All 4 airborne samples of olivine had measured concentrations above the LOD for manganese. The geometric mean concentration of 500 $\mu g/m^3$ was nearly 11 times higher than that of silica sand at 45.7 $\mu g/m^3$. Olivine had the fifth highest geometric mean for manganese; copper slag with dust suppressant, steel grit, garnet, and copper slag were higher.

All 4 airborne samples of olivine had measured concentrations above the LOD for nickel. The geometric mean concentration of 1628.5 $\mu g/m^3$ was 271 times that of silica sand at 6.0 $\mu g/m^3$. Olivine had the highest geometric mean concentration of nickel and was nearly 1.7 times higher than the next highest, nickel slag.

Three out of 4 airborne samples of olivine had a measured concentration above the LOD for titanium. The geometric mean concentration of 7.4 $\mu g/m^3$ was only about 15% that of silica sand at 48.8 $\mu g/m^3$. Olivine had the second lowest geometric mean concentration of titanium, only crushed glass was lower.

Two of 4 airborne samples of olivine had a measured concentration above the LOD for vanadium. The geometric mean concentration of 1.6 $\mu g/m^3$ was approximately half that of silica sand at 3.2 $\mu g/m^3$. Olivine had the third lowest geometric mean concentration of vanadium, only staurolite and crushed glass were lower.

Arsenic, cadmium, respirable quartz, and silver were not detected above the LOD in any of the olivine airborne samples. Olivine had a lower geometric mean concentration than silica sand for arsenic, beryllium, cadmium, lead, respirable quartz, titanium, and vanadium. Olivine had an equivalent geometric mean concentration of silver. Olivine had a greater geometric mean concentration than silica sand for chromium, manganese, and nickel.

Based on the industrial hygiene results in the laboratory study, substituting olivine for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. The airborne concentrations for the other health-related agents should also be reduced, with the exceptions of chromium, manganese, and nickel. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Staurolite

Three of the 8 airborne samples of staurolite had a measured concentration above the LOD for beryllium. The geometric mean concentration of 0.06 $\mu g/m^3$ was approximately 66% that of silica sand at 0.09 $\mu g/m^3$. Olivine had the fourth lowest geometric mean concentration of beryllium; silica sand with dust suppressant, steel grit, and olivine were lower.

One of 4 airborne samples of staurolite had a measured concentration above the LOD for cadmium. The geometric mean concentration of 0.09 $\mu g/m^3$ was essentially identical to silica sand at 0.08 $\mu g/m^3$. There were 6 generic abrasive categories with geometric mean concentrations of cadmium higher than staurolite, and six categories with geometric mean concentrations lower than staurolite.

Three of 8 airborne samples of staurolite had a measured concentration above the LOD for chromium. The geometric mean concentration of 8.6 $\mu g/m^3$ was similar (1.2 times higher) to that of silica sand at 7.1 $\mu g/m^3$. Staurolite was the fourth lowest

geometric mean for chromium; silica sand, silica sand with dust suppressant, and specular hematite were lower.

Seven of the 8 airborne results of staurolite had measured concentrations above the LOD for lead. The geometric mean concentration of 7.7 $\mu g/m^3$ was 2.8 times higher than silica sand at 2.7 $\mu g/m^3$. Staurolite had the third highest geometric mean concentration of lead; copper slag and crushed glass were higher.

All 8 of the airborne sample results for staurolite had measured concentrations above the LOD for manganese. The geometric mean concentration of 121 $\mu g/m^3$ was 2.6 times higher than silica sand at 45.7 $\mu g/m^3$. Staurolite had the ninth highest geometric mean concentration for manganese; specular hematite, crushed glass, silica sand with dust suppressant, and silica sand were lower.

One of the 8 airborne samples of staurolite had a measured concentration above the LOD for respirable quartz. The geometric mean concentration of 0.14 mg/m^3 was less than 2% of that of silica sand at 8.8 mg/m^3. Of the 5 generic categories of abrasives with detectable concentrations of respirable quartz (silica sand, silica sand with dust suppressant, garnet, and copper slag), staurolite had the lowest concentration.

All 8 of the airborne sample results of staurolite had a measured concentration above the LOD for titanium. The geometric mean concentration of 1564 $\mu g/m^3$ was 32 times higher than that of silica sand at 48.8 $\mu g/m^3$. Staurolite had the third highest geometric mean concentration of titanium; copper slag with dust suppressant, and coal slag with dust suppressant were higher.

All 8 airborne samples of staurolite had measured concentrations above the LOD for vanadium. The geometric mean concentration of 7.3 $\mu g/m^3$ was about 2.3 times higher than silica sand at 3.2 $\mu g/m^3$.

Arsenic, nickel, and silver were not detected above the LOD in any of the staurolite airborne samples. Staurolite had a lower geometric mean concentration than silica sand for beryllium, nickel, and respirable quartz. Based on the industrial hygiene results in the laboratory study, substituting staurolite for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. The airborne concentrations for the other health-related agents should also be reduced, except for lead and titanium where staurolite had the third highest geometric mean concentrations. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Specular Hematite

Only 1 of the 4 airborne samples of specular hematite had a measured concentration above the LOD for beryllium. The geometric mean concentration of 0.06 $\mu g/m^3$ was similar (about 31% less) to that of silica sand at 0.09 $\mu g/m^3$.

Only 1 of the 4 airborne samples of specular hematite had a measured concentration above the LOD for cadmium. The geometric mean concentration of 0.1 $\mu g/m^3$ was similar (about 1.3 times greater) to that of silica sand at 0.08 $\mu g/m^3$.

All 4 airborne samples of specular hematite had measured concentrations above the LOD for manganese. The geometric mean concentration of 61.0 $\mu g/m^3$ was similar (about 1.3 times greater) to that of silica sand at 45.7 $\mu g/m^3$.

All 4 airborne samples of specular hematite had a measured concentration above the LOD for titanium. Silica sand's geometric mean concentration of titanium at 48.8 $\mu g/m^3$ was 3.2 times greater than specular hematite at 15.1 $\mu g/m^3$.

Only 1 of the 4 airborne samples of specular hematite had a measured concentration above the LOD for vanadium. Silica sand's geometric mean concentration of vanadium at 3.2 $\mu g/m^3$ was 2.2 times greater than specular hematite at 1.4 $\mu g/m^3$.

Arsenic, chromium, lead, nickel, respirable quartz, and silver were not detected above the LOD in any of the specular hematite airborne samples. Specular hematite had a lower geometric mean concentration than silica sand for beryllium, titanium, and vanadium. Specular hematite had a greater geometric mean concentration than silica sand for cadmium and manganese, but was only 1.3 times greater.

Based on the industrial hygiene results in the laboratory study, substituting specular hematite for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. The airborne concentrations for the other health-related agents should also be reduced, with the exception of cadmium and manganese (which are slightly higher for specular hematite). Only one abrasive was tested for specular hematite, but only one major producer mines specular hematite and markets this product for the abrasive blasting industry. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Silica Sand

Two out of 28 airborne samples of silica sand had measured concentrations above the LOD for arsenic. The geometric mean concentration was 2.0 $\mu g/m^3$, which placed

silica sand third lowest within the 13 generic abrasive categories. Garnet and olivine were lower.

Seventeen of 28 airborne samples of silica sand had measured concentrations above the LOD for beryllium. The geometric mean concentration was 0.087 $\mu g/m^3$. This placed silica sand seventh highest out of the 13 generic abrasive categories, with 6 abrasives having higher geometric mean concentrations and 6 abrasive categories having lower geometric mean concentrations.

Seven out of 28 airborne results of silica sand had measured concentrations above the LOD for cadmium. The geometric mean concentration was 0.08 $\mu g/m^3$. This placed silica sand as fifth lowest geometric mean concentration of cadmium within the 13 generic abrasives. Coal slag with dust suppressant, copper slag with dust suppressant, crushed glass, and olivine had lower concentrations.

Eight out of 28 airborne samples of silica sand had measured concentrations above the LOD for chromium. The geometric mean concentration was 7.1 $\mu g/m^3$. This places silica sand third lowest among the 13 generic abrasives. Silica sand with dust suppressant and specular hematite had lower geometric mean concentrations.

Seventeen out of 28 airborne samples of silica sand had measured concentrations above the LOD for lead. The geometric mean concentration was 2.7 $\mu g/m^3$. This placed silica sand eighth out of 13 generic abrasives. Steel grit, specular hematite, garnet, olivine, and silica sand with dust suppressant, had lower geometric mean concentrations of lead.

All 28 airborne samples of silica sand had measured concentrations above the LOD for manganese. The geometric mean concentration was 45.7 $\mu g/m^3$. This was the lowest geometric mean concentration for manganese out of the 13 generic abrasives.

Four out of 28 airborne sample results had a measured concentration above the LOD for nickel. The geometric mean concentration was 6.0 $\mu g/m^3$. This placed silica sand ninth out of 13 generic abrasives. Staurolite, specular hematite, crushed glass, and silica sand with dust suppressant had lower geometric mean concentrations of nickel.

Twenty-seven out of 28 airborne samples of silica sand had measured concentrations above the LOD for respirable quartz. The geometric mean concentration was 8.8 mg/m^3. Silica sand had the highest geometric mean concentration of respirable quartz of all the generic categories of abrasives.

All 28 airborne samples of silica sand had measured concentrations above the LOD for titanium. The geometric mean concentration was 48.8 $\mu g/m^3$. This placed silica sand eighth out of 13 generic abrasives. Silica sand with dust suppressant, specular hematite, steel grit, olivine, and crushed glass had lower geometric mean concentrations of titanium.

Eighteen out of 28 airborne samples had a measured concentration above the LOD for vanadium. The geometric mean concentration for silica sand was 3.2 $\mu g/m^3$. This placed silica sand tenth out of 13 generic abrasives. Olivine, specular hematite, and crushed glass had lower geometric mean concentrations of vanadium.

Silica Sand with Dust Suppressant

Four out of 12 airborne results of silica sand with dust suppressant had measured concentrations above the LOD for beryllium. The geometric mean concentration of 0.06 $\mu g/m^3$ was about 66% of silica sand at 0.9 $\mu g/m^3$. Silica sand with dust suppressant had the third lowest geometric mean concentration of beryllium; steel grit and olivine were lower.

Two out of 12 airborne samples of silica sand with dust suppressant had a measured concentration above the LOD for cadmium. The geometric mean concentration of 0.1 $\mu g/m^3$ was similar to silica sand (1.25 times higher) at 0.08 $\mu g/m^3$. Silica sand with dust suppressant had the seventh highest geometric mean concentration of cadmium; copper slag, nickel slag, coal slag, garnet, specular hematite, and staurolite were higher.

Two of 12 airborne samples of silica sand with dust suppressant had measured concentrations above the LOD for chromium. The geometric mean concentration of 6.0 $\mu g/m^3$ was approximately 85% of silica sand at 7.1 $\mu g/m^3$. Silica sand with dust suppressant had the second lowest geometric mean concentration for chromium; specular hematite was lower.

Four out of 12 airborne samples of silica sand with dust suppressant had measured concentrations above the LOD for lead. The geometric mean concentration of 1.3 $\mu g/m^3$ was approximately 1/2 that of silica sand at 2.7 $\mu g/m^3$. Silica sand with dust suppressant had the lowest geometric mean concentration of lead of all 13 generic abrasive types.

All 12 airborne sample results for silica sand with dust suppressant had measured concentrations above the limit of detection for manganese. The geometric mean concentration of 54.4 $\mu g/m^3$ was similar to (1.2 times higher) silica sand at 45 $\mu g/m^3$. Silica sand with dust suppressant was the second lowest geometric mean concentration of manganese; only silica sand was lower.

Nine out of 12 airborne samples of silica sand with dust suppressant had measured concentrations above the LOD for respirable quartz. The geometric mean of 2.6 mg/m^3 was approximately 1/3 that of silica sand at 8.8 mg/m^3. The silica sand with dust suppressant abrasive category had the second highest geometric mean concentration of respirable quartz of all 13 generic abrasive types.

Only one of 12 airborne samples of silica sand with dust suppressant had measured concentration above the LOD for silver. The geometric mean of 0.9 $\mu g/m^3$ is essentially identical to that of silica sand at 0.8 $\mu g/m^3$. Silica sand with dust suppressant

had the second lowest geometric mean concentration of silver out of the 7 abrasives with detectable concentrations; garnet was lower.

Eleven of 12 airborne samples of silica sand with dust suppressant had measured concentrations above the LOD for titanium. The geometric mean concentration of 30.6 $\mu g/m^3$ was about 62% of silica sand at 48.8 $\mu g/m^3$. Silica sand with dust suppressant had the fifth lowest geometric mean concentration of titanium; specular hematite, steel grit, olivine, and crushed glass were lower.

Seven out of 12 airborne samples of silica sand with dust suppressant had measurable concentrations above the LOD for vanadium. The geometric mean concentration of 3.3 $\mu g/m^3$ was essentially identical to silica sand at 3.2 $\mu g/m^3$. Olivine, specular hematite, and crushed glass had lower geometric mean of concentrations of vanadium.

Copper Slag

All 32 airborne samples of copper slag had a measured concentration above the LOD for arsenic. The geometric mean concentration of 89.1 $\mu g/m^3$ for the copper slag generic abrasive category was 44 times higher than that of silica sand at 2.0 $\mu g/m^3$. Copper slag had the highest geometric mean concentration of arsenic, being six, eight, and nine times higher than the next three highest generic abrasive categories (copper slag with dust suppressant, steel grit, and nickel slag, respectively). Copper slag was the only generic abrasive category which had all (32 of 32) of its airborne samples above the LOD for arsenic.

Thirty-one out of 32 samples of copper slag had a measured concentration above the LOD for beryllium. The geometric mean concentration of 0.8 $\mu g/m^3$ for the copper slag generic abrasive category was 9 times higher than that of silica sand at 0.09 $\mu g/m^3$. Copper slag had the third highest geometric mean concentration of beryllium; only coal slag and coal slag with dust suppressant were higher.

Twenty-seven of 32 airborne samples of copper slag had a measured concentration above the LOD for cadmium. The geometric mean concentration of 1.0 $\mu g/m^3$ for the copper slag generic abrasive category was about 12 times higher than that of silica sand at 0.08 $\mu g/m^3$. Copper slag had the highest geometric mean concentration of cadmium, which was about four times higher than the next highest generic abrasive category (nickel slag).

All 32 airborne samples of copper slag had a measured concentration above the LOD for chromium. The geometric mean concentration of 82.2 $\mu g/m^3$ for the copper slag generic abrasive category was about 12 times higher than that of silica sand at 7.1 $\mu g/m^3$. Copper slag had the fourth highest geometric mean concentration of chromium; nickel slag, steel grit, and olivine were higher.

Twenty-nine of 32 airborne samples of copper slag had a measured concentration above the LOD for lead. The geometric mean concentration of 92.0 $\mu g/m^3$ for the copper slag generic abrasive category was about 34 times higher than that of silica sand at 2.7 $\mu g/m^3$. The geometric mean concentration of lead was the highest for the copper slag generic abrasive category, being seven times higher than the next highest generic abrasive category (crushed glass).

All 32 airborne samples of copper slag had a measured concentration above the LOD for manganese. The geometric mean concentration of 652.7 $\mu g/m^3$ for the copper slag generic abrasive category was about 14 times higher than that of sand at 45.7 $\mu g/m^3$. Copper slag had the fourth highest geometric mean concentration of manganese; copper slag with dust suppressant, steel grit, and garnet were higher.

Twenty-one of 32 airborne samples of copper slag had a measured concentration above the LOD for nickel. The geometric mean concentration of 19.2 $\mu g/m^3$ for the copper slag generic abrasive category was about 3 times higher than that of silica sand at 6.0 $\mu g/m^3$. Copper slag has the seventh highest geometric mean concentration of nickel; olivine, nickel slag, steel grit, treated copper slag, coal slag, and treated coal slag were higher.

Copper slag was one of five generic abrasive categories with airborne concentrations of respirable quartz above the LOD. However, only one copper slag abrasive (CP-04) had respirable quartz concentrations above the LOD. Silica sand's geometric mean airborne respirable quartz concentration at 8.83 mg/m^3 was about 59 times higher than copper slag's at 0.14 mg/m^3.

Twenty of 32 airborne samples of copper slag had a measured concentration above the LOD for silver. Copper slag had the greatest geometric mean concentration of silver (3.5 $\mu g/m^3$) and is about twice that of the next two highest generic abrasive categories, treated copper slag and steel grit. All of silica sand's airborne samples were less than the LOD for silver.

All 32 airborne samples of copper slag had a measured concentration above the LOD for titanium. Copper slag's geometric mean concentration of 1240 $\mu g/m^3$ was about 25 times higher than that of silica sand at 48.8 $\mu g/m^3$. Copper slag had the fifth highest geometric mean concentration of titanium; copper slag with dust suppressant, staurolite, coal slag with dust suppressant, and coal slag were higher.

All 32 airborne samples of copper slag had a measured concentration above the LOD for vanadium. Copper slag's geometric mean concentration of 45.3 $\mu g/m^3$ was about 14 times higher than that of silica sand at 3.1 $\mu g/m^3$. Copper slag had the fourth highest geometric mean concentration of vanadium; copper slag with dust suppressant, coal slag, and coal slag with dust suppressant were higher.

Based on the industrial hygiene results in the laboratory study, substituting copper slag for silica sand in abrasive blasting should reduce airborne respirable quartz

concentrations. However, the copper slag generic abrasive category is not without potentially hazardous health-related agent concerns. Copper slag has greater geometric mean airborne concentrations than silica sand for all of the remaining 10 hazardous health-related agents. Out of the 13 generic abrasive categories, copper slag has the highest geometric mean airborne concentrations of arsenic, cadmium, lead, and silver. Copper slag has the highest geometric mean concentrations of beryllium, titanium, and vanadium, with the exception of untreated/treated coal slag and treated copper slag. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Copper Slag with Dust Suppressant

Seven out of 8 airborne samples of copper slag with dust suppressant had a measured concentration above the limit of detection for arsenic. The geometric mean of 14.9 $\mu g/m^3$ was approximately 7.5 times higher than silica sand at 2.0 $\mu g/m^3$. Copper slag with dust suppressant had the second highest geometric mean concentration for arsenic; copper slag was higher.

All 8 airborne samples of copper slag with dust suppressant had a measured concentration above the LOD for beryllium. The geometric mean concentration of 0.6 $\mu g/m^3$ was 6.7 times higher than silica sand at 0.09 $\mu g/m^3$. Copper slag with dust suppressant had the fourth highest geometric mean concentration of beryllium; coal slag with dust suppressant, coal slag, and copper slag were higher.

Two of the 8 airborne samples had a measured concentration above the LOD for cadmium. The geometric mean 0.08 $\mu g/m^3$ was essentially identical to silica sand at 0.08 $\mu g/m^3$. Copper slag with dust suppressant had the third lowest concentration of cadmium; crushed glass and olivine were lower.

All 8 airborne samples of copper slag with dust suppressant had measured concentrations above the LOD for chromium. The geometric mean concentration 66.8 $\mu g/m^3$ was about 9.4 times higher than silica sand at 7.1 $\mu g/m^3$. Copper slag with dust suppressant had the fifth highest geometric mean concentration of chromium; nickel slag, steel grit, olivine, and copper slag were higher.

Five of the 8 airborne samples of copper slag with dust suppressant had a measured concentration above the LOD for lead. The geometric mean concentration of 5.1 $\mu g/m^3$ was approximately 1.9 times higher than silica sand at 2.7 $\mu g/m^3$. Copper slag with dust suppressant had the fourth highest geometric mean concentration for lead; copper slag, crushed glass, and staurolite were higher.

All 8 of the airborne samples for copper slag with dust suppressant had a measured concentration above the LOD for manganese. The geometric mean

concentration of 2718 $\mu g/m^3$ was nearly 60 times higher than silica sand at 45.7 $\mu g/m^3$. Copper slag with dust suppressant had the highest geometric mean concentration of manganese.

Six of the 8 airborne samples for copper slag with dust suppressant had a measured concentration above the LOD for nickel. The geometric mean of 30.2 $\mu g/m^3$ was approximately 5 times higher than silica sand at 6.0 $\mu g/m^3$. Copper slag with dust suppressant had the fourth highest geometric mean concentration of nickel; olivine, nickel slag, and steel grit were higher.

Five of 8 airborne samples of copper slag with dust suppressant had a measured concentration above the LOD for silver. The geometric mean concentration of 2.1 $\mu g/m^3$ was about 2.6 times higher than silica sand at 0.8 $\mu g/m^3$. Copper slag with dust suppressant had the second highest geometric mean concentration of silver; copper slag was higher.

All 8 of the airborne samples of copper slag with dust suppressant had measured concentrations above the LOD for titanium. The geometric mean of 2078 $\mu g/m^3$ was about 42 times higher than silica sand at 48.8 $\mu g/m^3$. Copper slag with dust suppressant had the highest geometric mean concentration of titanium.

All 8 air samples of copper slag with dust suppressant had measured concentrations above the LOD for vanadium. The geometric mean concentration of 108 $\mu g/m^3$ was about 34 times higher than silica sand at 3.2 $\mu g/m^3$. Copper slag with dust suppressant had the highest geometric mean concentration of vanadium.

All of the copper slag with dust suppressant airborne samples were less than the LOD for respirable quartz. Based on the industrial hygiene results in the laboratory study, substituting copper slag with dust suppressant for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. However, the copper slag with dust suppressant generic abrasive category is not without potential hazardous health-related agent concerns.

Copper slag with dust suppressant as a generic category of abrasives had the highest geometric mean concentrations of manganese, titanium, and vanadium, and the second highest geometric mean concentrations for arsenic and silver. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Garnet

Only one of 52 airborne samples of garnet had a measured concentration above the LOD for arsenic. The geometric mean concentration of 2.0 $\mu g/m^3$ was essentially

identical to silica sand at 2.0 $\mu g/m^3$. Garnet had the lowest geometric mean concentration of arsenic of all the 8 generic abrasives which had any samples greater than the limit of detection for arsenic.

Thirty of 52 airborne samples had measured concentrations above the LOD for beryllium. The geometric mean concentrations of 0.1 $\mu g/m^3$ was essentially identical (1.1 times higher) to silica sand at 0.09 $\mu g/m^3$. Garnet had the sixth highest geometric mean concentration of beryllium; coal slag with dust suppressant, coal slag, copper slag, copper slag with dust suppressant, and nickel slag were higher.

Twenty-five of 52 airborne samples of garnet had measured concentration above the LOD for cadmium. The geometric mean concentration of 0.13 $\mu g/m^3$ was about 1.6 times higher than silica sand at 0.08 $\mu g/m^3$. Garnet had the fourth highest geometric mean concentration of cadmium; copper slag, nickel slag, and coal slag were higher.

Thirty-seven of 52 airborne samples of garnet had measured concentrations above the LOD for chromium. The geometric mean concentration of 18.2 $\mu g/m^3$ was approximately 2.6 times higher than silica sand at 7.1 $\mu g/m^3$. Garnet had the sixth lowest geometric mean concentration of chromium; crushed glass, specular hematite, staurolite, silica sand, and silica sand with dust suppressant were lower.

Twenty-four of 52 air borne samples of garnet had measured concentrations above the LOD for lead. The geometric mean concentration of 1.84 $\mu g/m^3$ was approximately 68% of silica sand at 2.74 $\mu g/m^3$. Garnet had the third lowest geometric mean concentration of lead; olivine and silica sand with dust suppressant were lower.

All 52 airborne samples of garnet had measured concentrations above the LOD for manganese. The geometric mean of 829 $\mu g/m^3$ was approximately 18 times higher than silica sand at 45.7 $\mu g/m^3$. Garnet had the third highest geometric mean concentration of manganese; copper slag with dust suppressant and steel grit were higher.

Fourteen of 52 airborne samples of garnet had a measured concentration above the LOD for nickel. The geometric mean concentration of 7.4 $\mu g/m^3$ was similar (1.2 times higher) to silica at 6.0 $\mu g/m^3$. Garnet had the sixth lowest geometric mean concentration of nickel; silica sand, specular hematite, staurolite, crushed glass, and silica sand with dust suppressant were lower.

Seventeen of 52 airborne samples of garnet had measured concentrations above the LOD for respirable quartz. The geometric mean concentration of 0.2 mg/m^3 was about 2% that of silica sand at 8.8 mg/m^3. Of the five generic abrasives with detectable concentrations of respirable quartz, garnet had the third highest measured concentration; silica sand and silica sand with dust suppressant were higher. Caution must be used when considering quartz data from the samples described on the first page of the Respirable Quartz Section in Appendix B, since these samples were evaluated by primary or secondary peak height measurement, due to problematical integration data caused by interferences.

Only 1 of 52 airborne samples of garnet had a measured concentration above the LOD for silver. The geometric mean concentration of 0.85 $\mu g/m^3$ was essentially identical to silica sand at 0.83 $\mu g/m^3$. Of the 7 generic categories of abrasives with measured concentrations of silver, garnet had the lowest geometric mean concentration.

All 52 airborne samples of garnet had measured concentrations above the LOD for titanium. The geometric mean concentration of 187 $\mu g/m^3$ was about 3.8 times higher than silica sand at 48.8 $\mu g/m^3$. Six abrasives had higher geometric mean concentrations while 6 other generic categories had lower geometric mean concentrations of titanium.

Fifty of the 52 airborne samples of garnet had measured concentrations above the LOD for vanadium. The geometric mean of 10.8 $\mu g/m^3$ was about 3.4 times higher than silica sand at 3.2 $\mu g/m^3$. An equal number of generic abrasive categories had geometric mean concentrations of vanadium above that of garnet while 6 generic categories of abrasives had geometric mean concentrations below that of garnet.

Based on the industrial hygiene results in the laboratory study, substituting garnet in abrasive blasting should reduce airborne respirable quartz concentrations. However, the garnet generic abrasive category is not without potential hazardous health-related agent concerns.

Garnet had the third highest geometric mean concentration of respirable quartz and manganese, and the fourth highest geometric mean concentration of cadmium. All of the airborne data from the laboratory must be viewed as indicative only relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Steel Grit

Twelve of 16 airborne samples of steel grit had measured concentrations above the LOD for arsenic. The geometric mean concentration of 10.7 $\mu g/m^3$ was over 5 times higher than silica sand at 2.0 $\mu g/m^3$. Steel grit had the third highest geometric mean concentration of arsenic; copper slag and copper slag with dust suppressant were higher.

Three of 16 airborne samples of steel grit had measured concentrations above the LOD for beryllium. The geometric mean concentration of 0.05 $\mu g/m^3$ was approximately 55% that of silica sand at 0.09 $\mu g/m^3$. Beryllium had the second to the lowest geometric mean concentration of beryllium; olivine was lower.

Two of 16 samples of steel grit had measured concentrations above the LOD for cadmium. The geometric mean concentration of 0.08 $\mu g/m^3$ was essentially identical to silica sand at 0.08 $\mu g/m^3$. Coal slag with dust suppressant, copper slag with dust

suppressant, crushed glass, and olivine had lower geometric mean concentrations of cadmium.

Fourteen of 16 airborne samples of steel grit had measured concentrations above the LOD for chromium. The geometric mean concentration of 231 $\mu g/m^3$ was over 32 times that of silica sand at 7.1 $\mu g/m^3$. Steel grit had the second highest geometric mean concentration of chromium; nickel slag was higher.

Eight of 16 airborne samples of steel grit had measured concentrations above the LOD for lead. The geometric mean concentration of 2.6 $\mu g/m^3$ was slightly less than silica sand at 2.7 $\mu g/m^3$. Steel grit had the fifth lowest geometric mean concentration of lead; specular hematite, garnet, olivine, and silica sand with dust suppressant were lower.

All 16 airborne samples of steel grit had measured concentrations above the LOD for manganese. The geometric mean concentration of 1815 $\mu g/m^3$ was nearly 40 times higher than silica sand at 45.7 $\mu g/m^3$. Steel grit has the second highest geometric mean concentration of manganese; copper slag with dust suppressant was higher.

Fourteen of 16 airborne samples of steel grit had measured concentrations above the LOD for nickel. The geometric mean concentration of 196 $\mu g/m^3$ was nearly 33 times higher than silica sand at 6.0 $\mu g/m^3$. Steel grit had the third highest geometric mean concentration of nickel; olivine and nickel slag were higher.

Only one of 16 airborne samples of steel grit had a measured concentration above the LOD for silver. The geometric mean concentration of 1.6 $\mu g/m^3$ was nearly double that of silica sand at 0.8 $\mu g/m^3$. Of the 7 generic categories of abrasives with measured concentrations of silver, steel grit was third highest; copper slag and copper slag with dust suppressant were higher.

Thirteen of 16 airborne samples of steel grit had measured concentrations above the LOD for titanium. The geometric mean concentration of 13.9 $\mu g/m^3$ was approximately 28% that of silica sand at 48.8 $\mu g/m^3$. Steel grit had the third lowest geometric mean of titanium; olivine and crushed glass were lower.

Fifteen of 16 airborne samples of steel grit had a measured concentration above the LOD for vanadium. The geometric mean concentration of 31.2 $\mu g/m^3$ was nearly 10 times higher than silica sand at 3.2 $\mu g/m^3$. Steel grit had the fifth highest geometric mean concentration of vanadium; copper slag with dust suppressant, coal slag, coal slag with dust suppressant, and copper slag were higher.

All of steel grit's airborne samples were less than the LOD for respirable quartz. Based upon the industrial hygiene results in the laboratory study, substituting steel grit for silica sand in abrasive blasting should reduce airborne respirable quartz concentrations. However, the steel grit generic abrasive category is not without potential health-related agent concerns.

Steel grit as a generic category of abrasives had the second highest geometric mean concentrations of chromium and manganese, and the third highest geometric mean concentrations of arsenic, nickel, and silver. All of the airborne data from the laboratory must be viewed as indicative only of the relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of work site conditions. In addition, variability between individual abrasives within a generic category must also be considered prior to drawing any broad health-based conclusions.

Table 11: Summary of Airborne Sample Results of Health Related Elements by Generic Category of Abrasive
Note: Unless Otherwise Noted, All Minimum, Maximum, and Geometric Mean Values are in micrograms per cubic meter

Generic Abrasive	Number of Samples	Arsenic	Beryllium	Cadmium	Chromium	Lead	Manganese	Nickel	Respirable Quartz (mg/m³)	Silver	Titanium	Vanadium
CG	4	2.06 - 2.085 2.070 0	0.031 - 0.126 0.075 3	0.05 - 0.05 0.050 0	5.15 - 22.69 12.524 3	3.91 - 26.82 12.153 4	13.39 - 101.1 56.930 4	5.15 - 5.21 5.174 0	0.12 - 0.122 0.122 0	0.83 - 0.835 0.829 0	2.06 - 9.73 6.425 3	0.825 - 0.835 0.829 0
CS	28	0.52 - 29.13 2.902 9	0.193 - 24.97 2.040 28	0.05 - 2.71 0.134 10	5.145 - 332.9 38.727 26	0.825 - 35.37 3.885 18	26.84 - 873.9 148.723 28	5.15 - 353.7 28.303 23	0.11 - 0.124 0.122 0	0.83 - 2.615 0.907 1	173.4 - 11652 1545.090 28	9.46 - 665.8 69.966 28
CSDS	8	2.06 - 4.76 2.304 1	0.353 - 7.475 2.227 8	0.07 - 0.21 0.083 1	5.19 - 136.6 39.525 7	0.825 - 88.92 4.044 6	26.79 - 456.8 132.656 8	5.15 - 83.06 25.221 6	0.12 - 0.126 0.123 0	0.83 - 20.62 1.379 2	332.2 - 5589 1580.726 8	11.21 - 190.4 54.116 8
N	8	2.03 - 170.8 9.728 4	0.031 - 1.729 0.142 5	0.04 - 10.21 0.246 4	138.9 - 7036 811.832 8	0.815 - 49.99 4.397 6	117.9 - 2483 459.200 8	89.4 - 6040 987.252 8	0.12 - 0.124 0.159 0	0.82 - 0.835 0.826 0	18.49 - 2708 267.299 8	3.66 - 152.1 29.100 8
O	4	0.515 - 2.095 1.037 0	0.003 - 0.121 0.028 2	0.04 - 0.05 0.045 0	65.9 - 246.6 116.812 4	0.82 - 2.095 1.631 1	247.1 - 1377 499.883 4	865 - 4520 1628.467 4	0.12 - 0.123 0.123 0	0.82 - 0.835 0.829 0	2.06 - 17.88 7.409 3	0.825 - 3.9 1.577 2
S	8	2.075 - 2.095 2.087 0	0.031 - 0.292 0.059 3	0.075 - 0.23 0.086 1	5.19 - 33.4 8.621 3	0.83 - 33.33 7.654 7	19.52 - 521.9 120.960 8	5.19 - 5.235 5.215 0	0.12 - 0.486 0.145 1	0.83 - 0.84 0.835 0	228.4 - 3769 1564.573 8	2.28 - 22.96 7.287 8
SH	4	2.075 - 2.09 2.084 0	0.031 - 0.435 0.060 1	0.075 - 0.25 0.101 1	5.18 - 5.225 5.206 0	2.075 - 2.09 2.084 0	15.87 - 248.8 60.964 4	5.18 - 5.225 5.206 0	0.12 - 0.128 0.124 0	0.83 - 0.835 0.832 0	7.73 - 41.46 15.077 4	0.83 - 6.84 1.411 1
SS	28	0.82 - 6.92 2.039 2	0.03 - 0.356 0.087 17	0.04 - 1.99 0.084 7	5.02 - 27.16 7.123 8	0.805 - 10.35 2.744 17	4.614 - 355.6 45.717 28	5.02 - 16.32 5.990 4	0.12 - 43.17 8.828 27	0.81 - 0.84 0.828 0	4.58 - 564.9 48.837 28	0.805 - 35.34 3.161 18
SSDS	12	1.985 - 2.09 2.050 0	0.03 - 0.31 0.056 4	0.06 - 1.49 0.099 2	4.965 - 15.27 5.964 2	0.18 - 4.95 1.263 4	7.478 - 350.8 54.351 12	4.97 - 5.225 5.126 0	0.12 - 30.58 2.633 9	0.8 - 1.78 0.875 1	2.02 - 598.4 30.591 11	0.795 - 2043 3.286 7
CP	32	5.98 - 24485 89.068 32	0.036 - 6.412 0.783 31	0.04 - 71.41 1.041 27	10.95 - 2244 82.231 32	0.825 - 1E+05 91.953 29	35.06 - 12650 652.694 32	5.16 - 306.1 19.227 21	0.12 - 0.735 0.145 3	0.83 - 77.54 3.463 20	146.4 - 9747 1240.066 32	3.09 - 518.5 45.347 32
CPDS	8	2.05 - 107.4 14.942 7	0.243 - 2.891 0.639 8	0.04 - 0.36 0.079 2	24.32 - 227.1 66.750 8	0.82 - 15.07 5.112 5	932.3 - 11357 2717.631 8	5.06 - 115.6 30.219 6	0.12 - 0.125 0.122 0	0.81 - 9.42 2.101 5	790.4 - 8879 2077.501 8	40.54 - 454.3 108.112 8
G	52	0.515 - 2.12 1.970 1	0.021 - 2.289 0.098 30	0.04 - 2.69 0.129 25	1.4 - 206 18.249 37	0.35 - 13.32 1.844 24	58 - 17670 829.383 52	5.08 - 55.99 7.399 14	0.12 - 6.826 0.228 17	0.81 - 3.11 0.852 1	10.25 - 1252 186.754 52	0.82 - 120.7 10.782 50
SG	16	0.96 - 187.7 10.714 12	0.031 - 0.515 0.051 3	0.04 - 1.77 0.085 2	9.61 - 8551 231.112 14	0.39 - 45.88 2.632 8	14.6 - 41710 1815.402 16	9.61 - 4380 196.008 14	0.12 - 0.269 0.144 0	0.82 - 15.24 1.645 1	2.075 - 167.1 13.873 13	1.535 - 479.7 31.177 15

Legend

	Range Min. - Max.
<---	Values
<---	Geometric Mean
<---	Samples > Limit of Detection

Treated Versus Untreated Abrasives

Two coal slags, three silica sands, and one copper slag abrasive were treated with dust suppressant. Table 12 and Figure 14 present a comparison of the measured airborne concentrations of 11 health-related agents for paired sets (i.e. treated and untreated variables of the same products), of six abrasive trials, of the 66 sets of paired data:

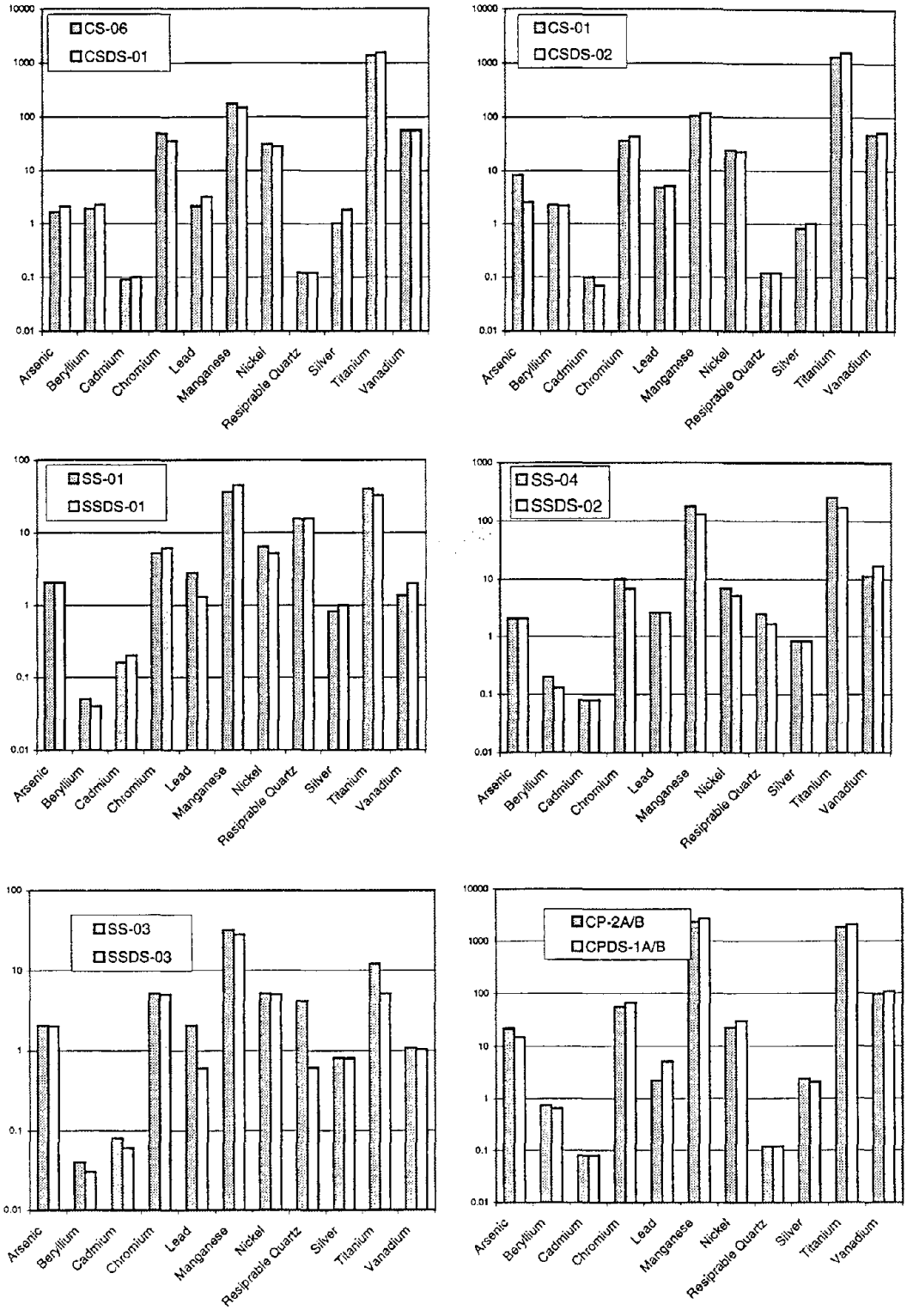
- 32 paired sets of data (48.5%) are essentially identical (i.e. within ± 15%)
- 20 paired sets of data (30.3%) show a decrease in measured concentrations (i.e. greater than 15%) with the treated abrasive
- 14 paired sets of data (21.2%) show an increase in measured concentrations (i.e. greater than 15%) with the treated abrasive

Combined, nearly 70% of the paired data sets indicate measured concentrations of health-related agents either remained the same (i.e. ± 15%) or actually increased (i.e. greater than 15%) for the abrasive treated with dust suppressant over the paired untreated abrasive.

Table 12
Comparison of Geometric Mean Concentrations of Health-Related Agents for Paired Untreated and Dust Suppressant Treated Abrasives
Note: Unless noted, all concentrations in micrograms per gram

Paired Abrasives	Arsenic	Beryllium	Cadmium	Chromium	Lead	Manganese	Nickel	Resiprable Quartz (mg/m^3)	Silver	Titanium	Vanadium
CS-06	1.65	1.93	0.09	48.6	2.14	175	30.9	0.12	1.03	1,385	56.2
CSDS-01	2.08	2.27	0.10	35.7	3.18	149	28.0	0.12	1.85	1,555	56.5
CS-01	8.27	2.29	0.10	36.1	4.76	104	23.9	0.12	0.83	1,312	47.8
CSDS-02	2.56	2.19	0.07	43.8	5.14	118	22.7	0.12	1.03	1,606	51.8
SS-01	2.07	0.05	0.16	5.18	2.80	36.4	6.39	15.5	0.83	40.5	1.37
SSDS-01	2.07	0.04	0.20	6.21	1.29	45.0	5.18	15.8	1.00	32.9	2.0
SS-04	2.08	0.20	0.08	10.1	2.59	177	6.92	2.49	0.83	256	11.4
SSDS-02	2.06	0.13	0.08	6.77	2.57	128	5.16	1.66	0.83	170	17.1
SS-03	2.06	0.04	0.08	5.15	2.06	31.6	5.15	4.19	0.82	12.1	1.09
SSDS-03	2.02	0.03	0.06	5.04	0.61	27.9	5.04	0.62	0.81	5.1	1.04
CP-2A/B	21.8	0.74	0.08	56.0	2.25	2,346	22.5	0.12	2.40	1,826	95.9
CPDS-1A/B	14.9	0.64	0.08	66.8	5.11	2,718	30.2	0.12	2.10	2,077	108.1

Figure 14
Paired Abrasives - Effect of Treating Abrasives With Dust Suppressants Charts
Note: All units in µg/m^3, except respirable quartz which is in mg/m^3



Bulk Sample Results

Figures 15 to 25 on pages 125 to 135 show the range of measured and geometric means of concentrations for the virgin bulk levels of eleven hazardous health-related agents for each of the 40 abrasive products and the associated generic category of abrasives tested. These are the same eleven hazardous health-related agents that were used for comparative analysis of the airborne concentrations. The recyclable abrasives include the samples collected from both the initial blast run (indicated by the letter A - i.e. Garnet-07A represents the initial blast run conducted for Garnet abrasive #7) and the blast run that was conducted after tests for the recycling capability of the abrasive was completed (indicated by the letter B - i.e. Garnet-07B represents the final blast run conducted for Garnet abrasive #7 after the recycling tests were completed). The range and geometric mean are indicated by a bar chart and a small square, respectively. The shaded bars indicate the range and geometric mean of the entire generic category of abrasive.

Any abrasive product or generic category of abrasive with all bulk samples having results below the limit of detection (LOD) for the given health-related agent are represented by only a small square (these abrasives will have no bar since there is no range to display). For abrasives having any samples below the limit of detection for the given health-related agent, the geometric mean was calculated by using LOD/2, which is the method used to estimate the average concentration in the presence of non-detectable values described by Hornung and Reed[17].

One virgin and one used bulk sample was collected for each abrasive blast trial. Only one individual abrasive was used for the crushed glass, specular hematite, and olivine generic categories. However, specular hematite has one major source to supply the abrasive blasting market and crushed glass was relatively new to the abrasive blasting market when this study commenced. These three abrasive categories will have no range to report since only one virgin bulk sample was analyzed for the eleven health-related agents. The small square for these three abrasive categories will represent the single virgin bulk sample concentration.

Table 13 summarizes the virgin bulk concentrations for each of these health-related agents by generic category of abrasive. These Figures 15 to 25 and Table 13 provide some indication of the source of the airborne concentrations described previously in the industrial hygiene results and discussion sections, along with the iron (97.3%), manganese (.96%), copper (0.01%), chromium (0.01%), phosphorous (0.006%), molybdenum (0.004%), and vanadium (0.004%) content in the steel plates which were blasted.

Caution must be used when considering quartz data from the bulk samples described on the first page of the Respirable Quartz Section in Appendix B, since these samples were evaluated by secondary peak height measurement, long range qualitative scan, or microscopic analysis. These samples were analyzed by these alternative measurements due to problematical integration data caused by interferences.

FIGURE 15 — ARSENIC BULK SAMPLE RESULTS

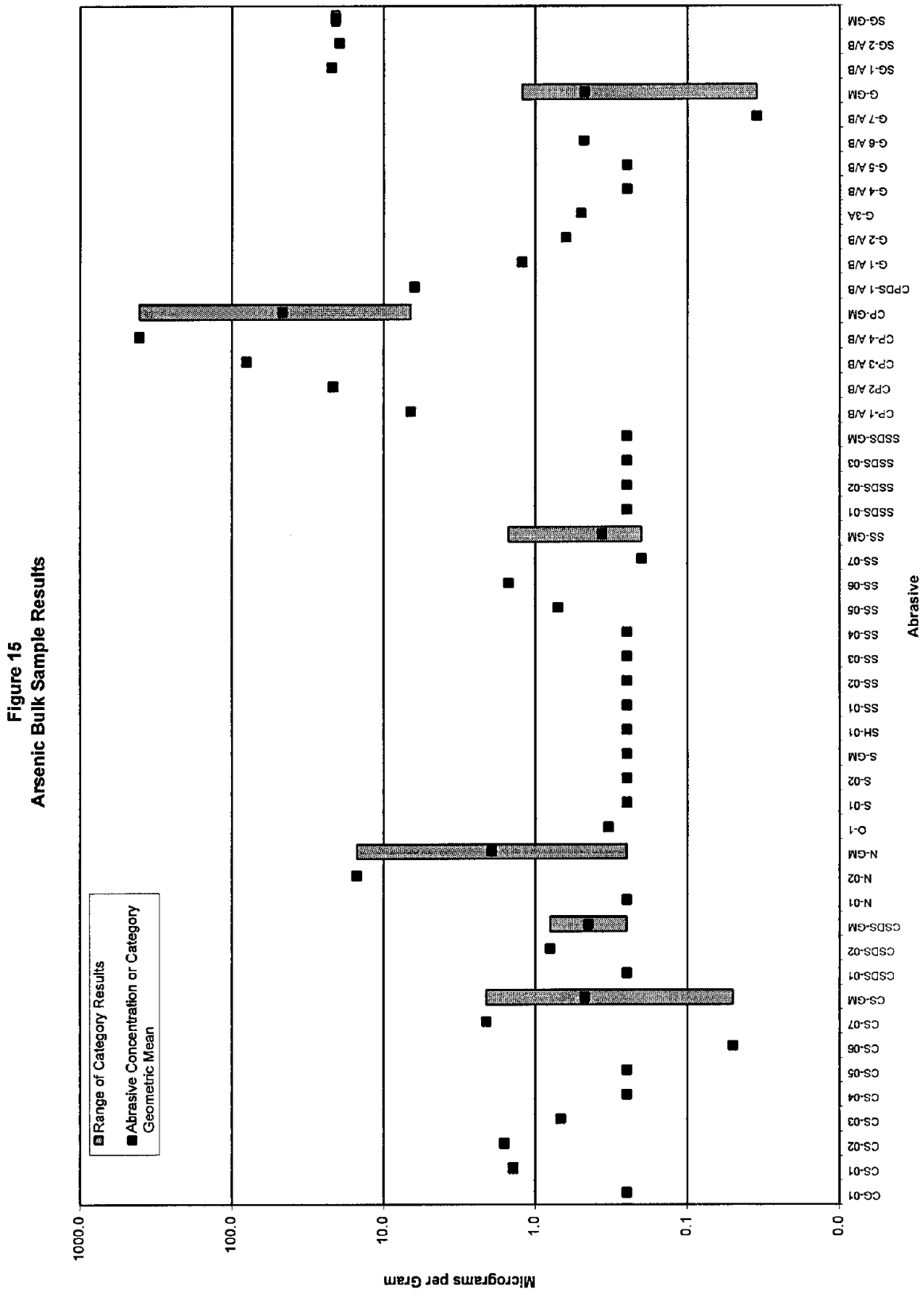


FIGURE 16 — BERYLLIUM BULK SAMPLE RESULTS

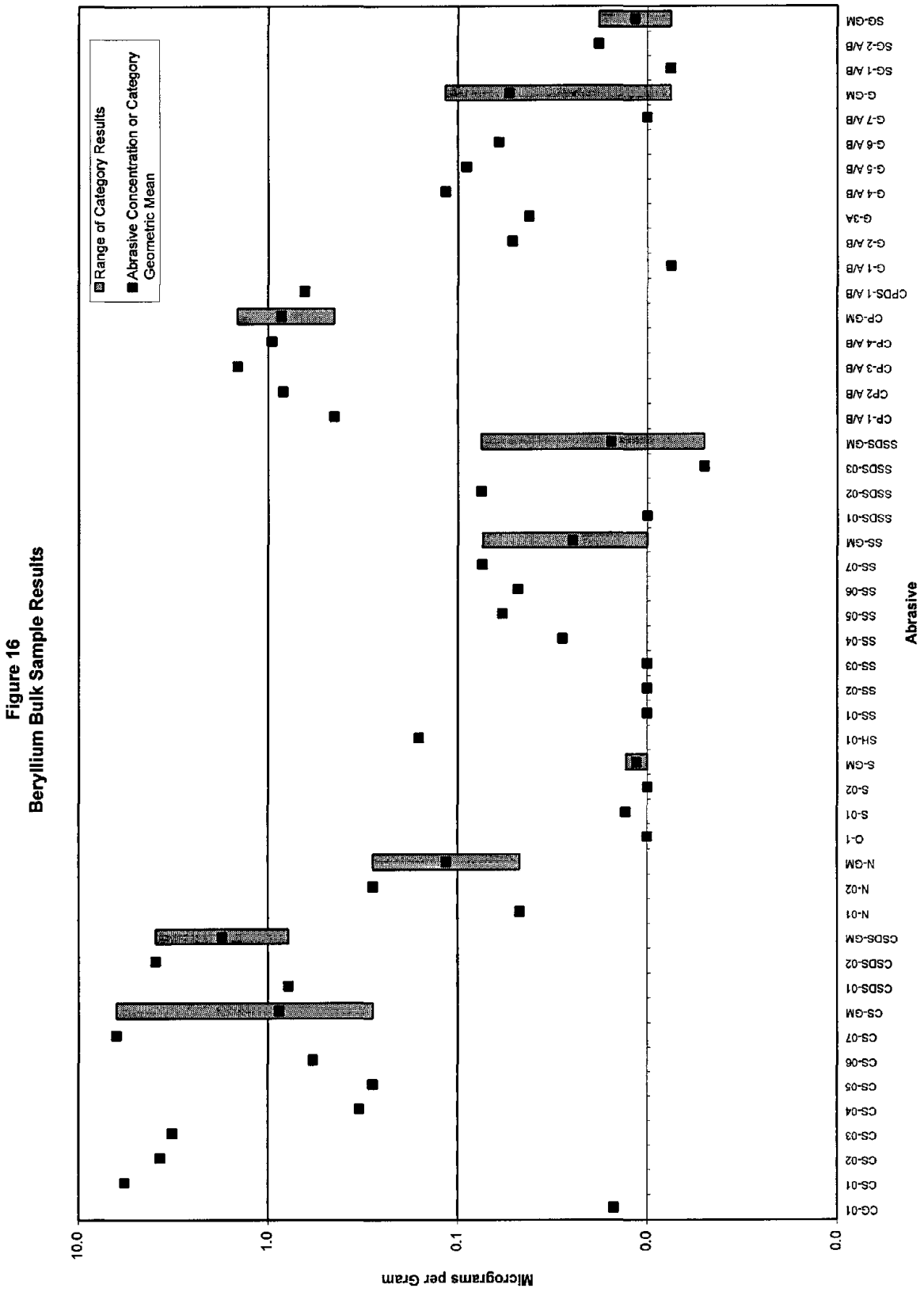


FIGURE 17 — CADMIUM BULK SAMPLE RESULTS

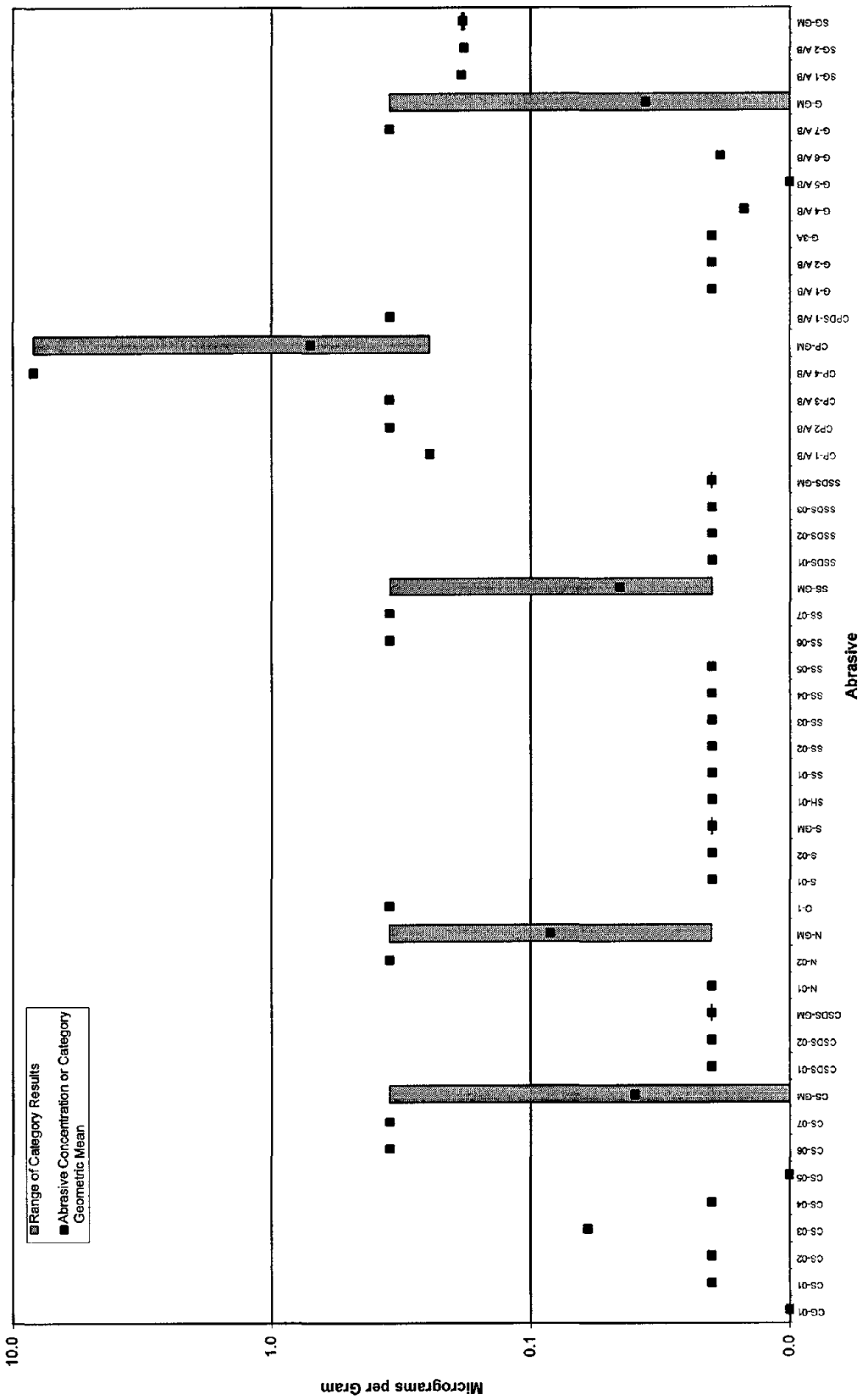


FIGURE 18 — CHROMIUM BULK SAMPLE RESULTS

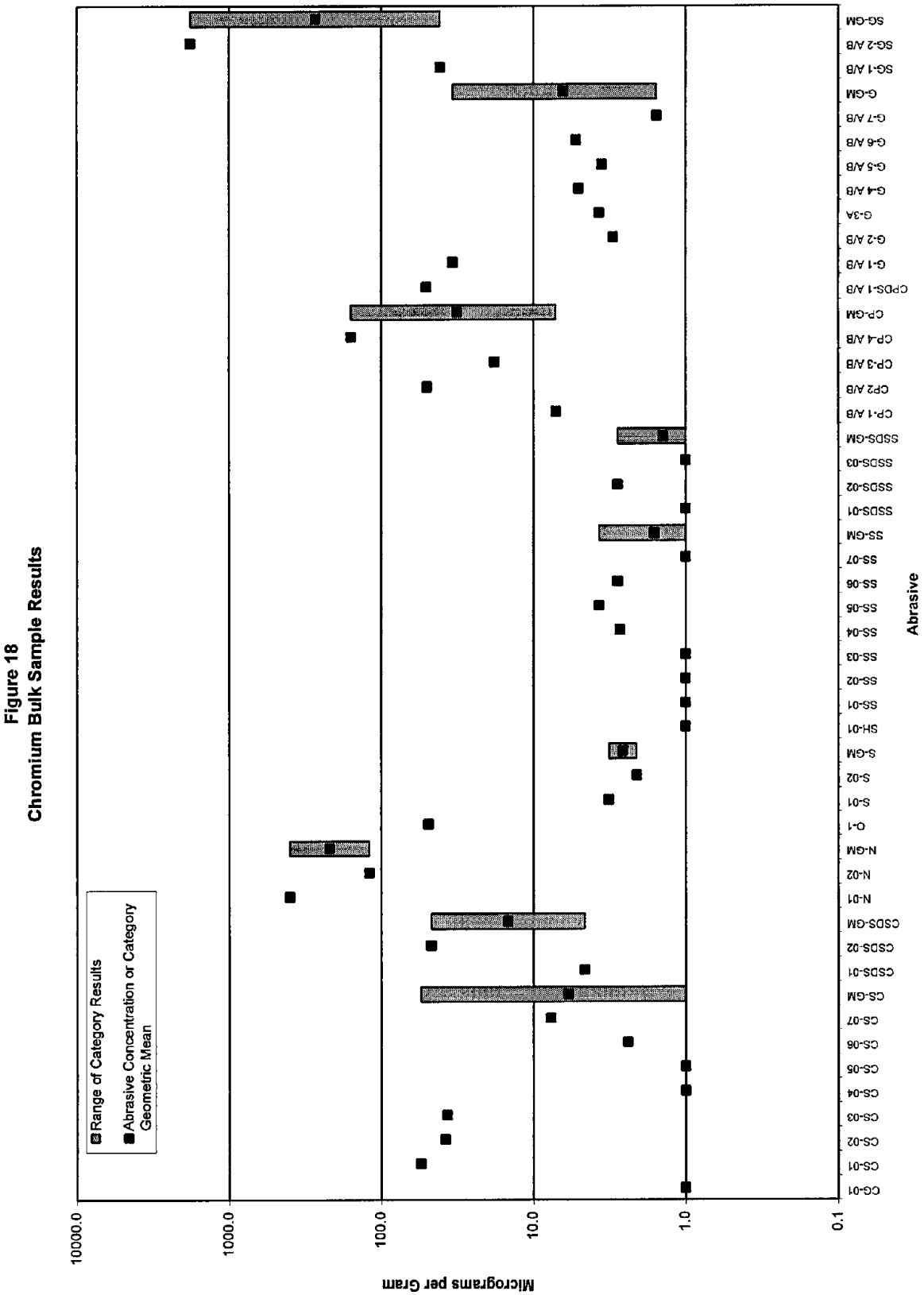


FIGURE 19 — LEAD BULK SAMPLE RESULTS

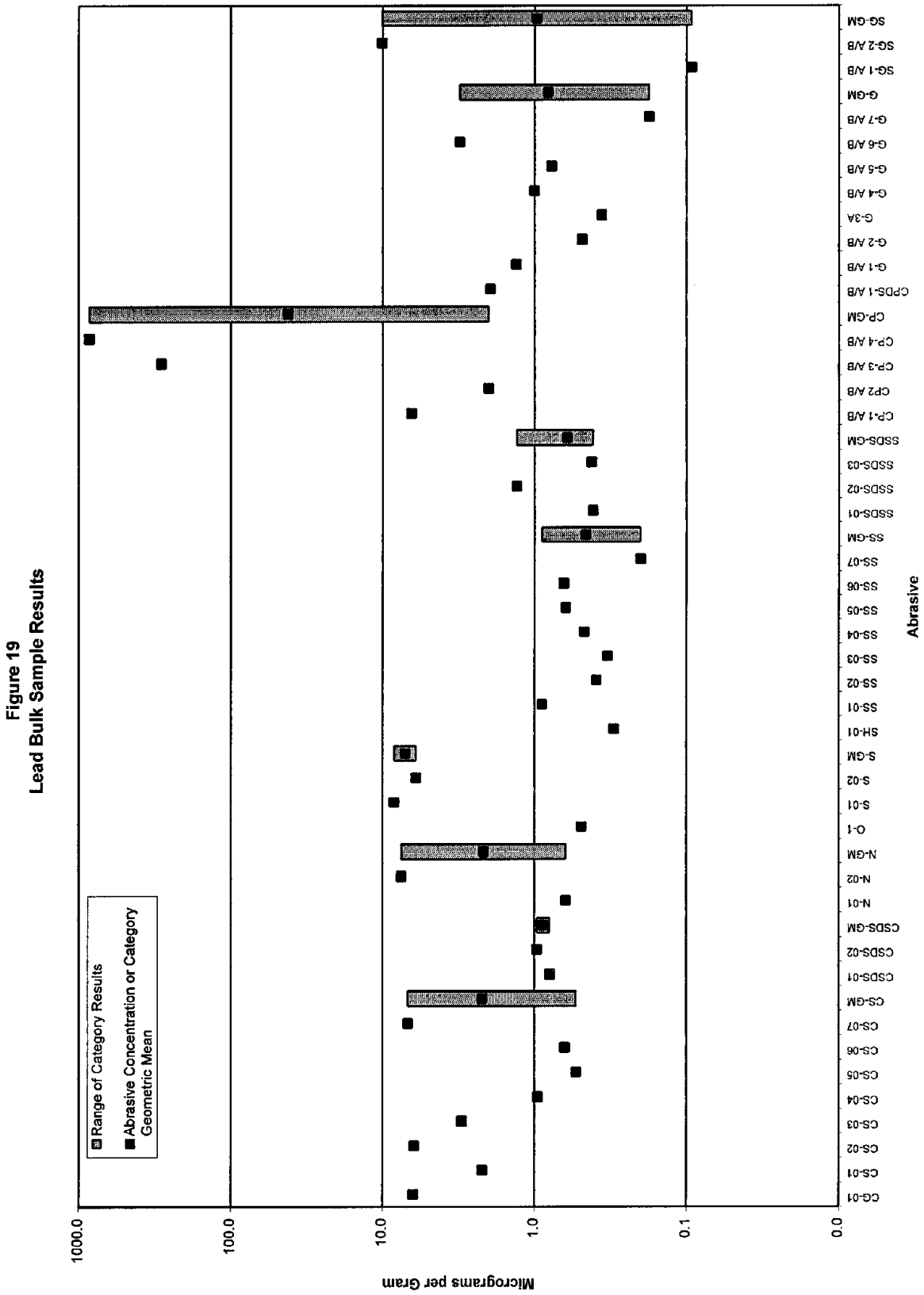


FIGURE 20 — MANGANESE BULK SAMPLE RESULTS

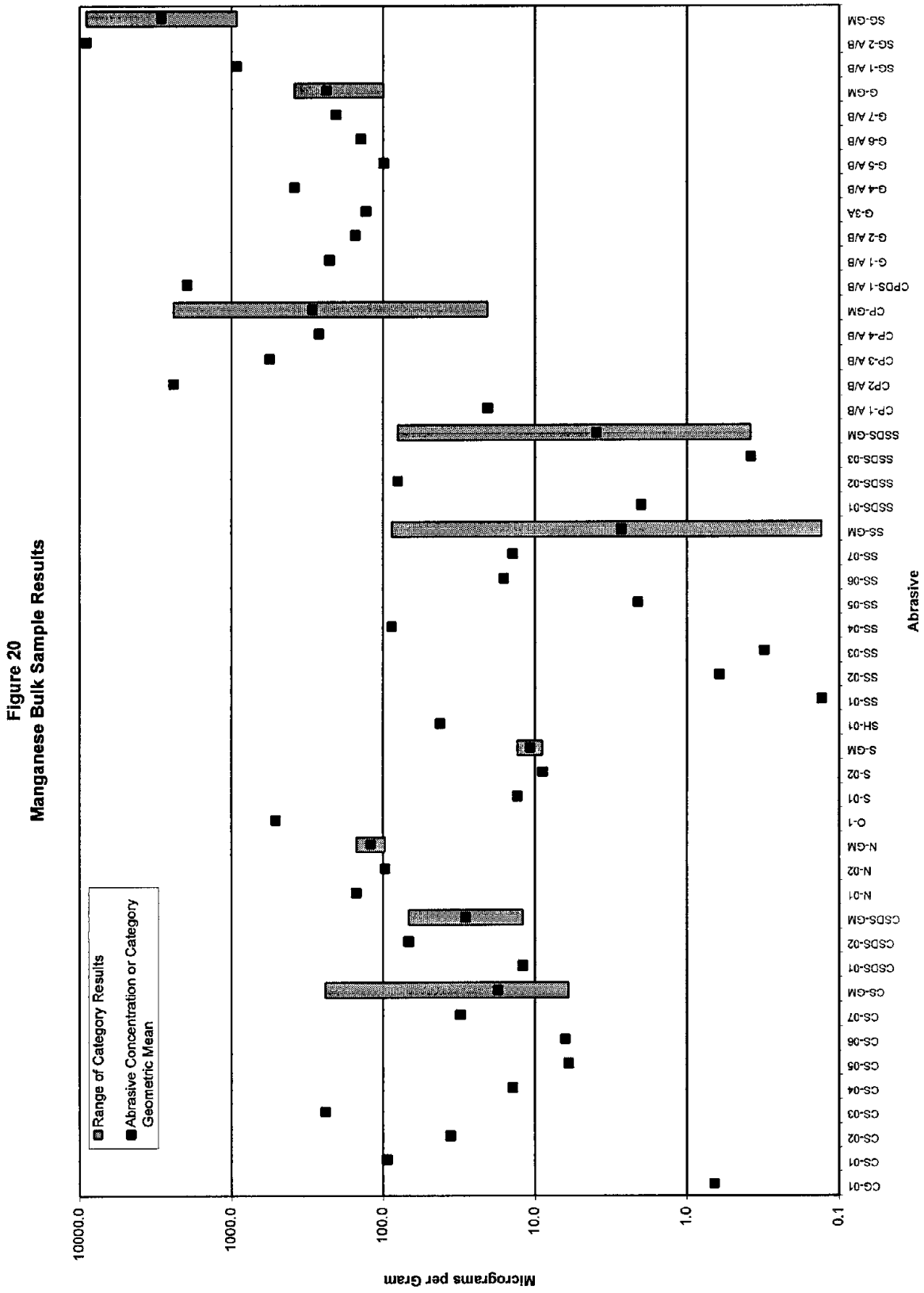


FIGURE 21 — NICKEL BULK SAMPLE RESULTS

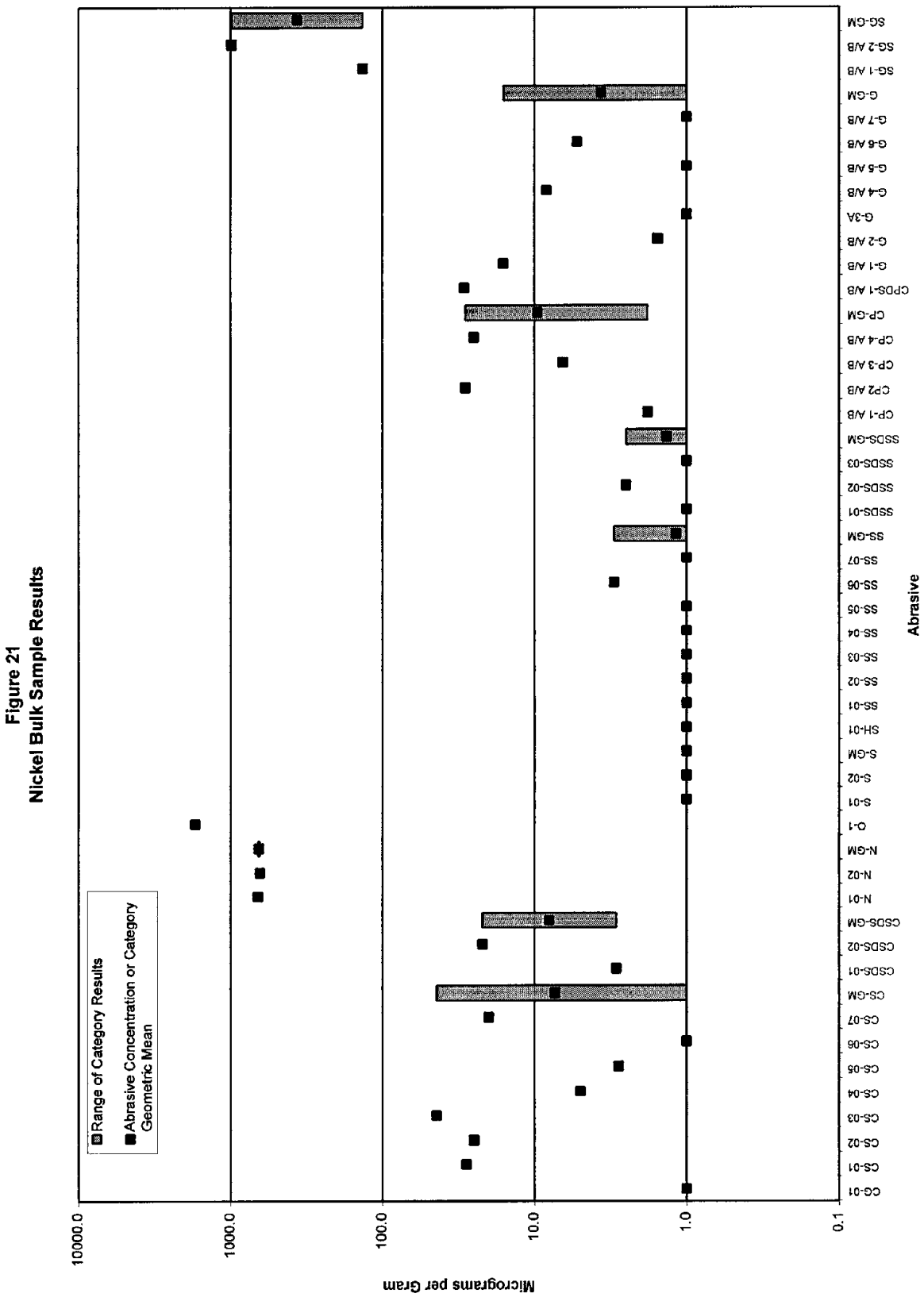


FIGURE 22 — QUARTZ BULK SAMPLE RESULTS

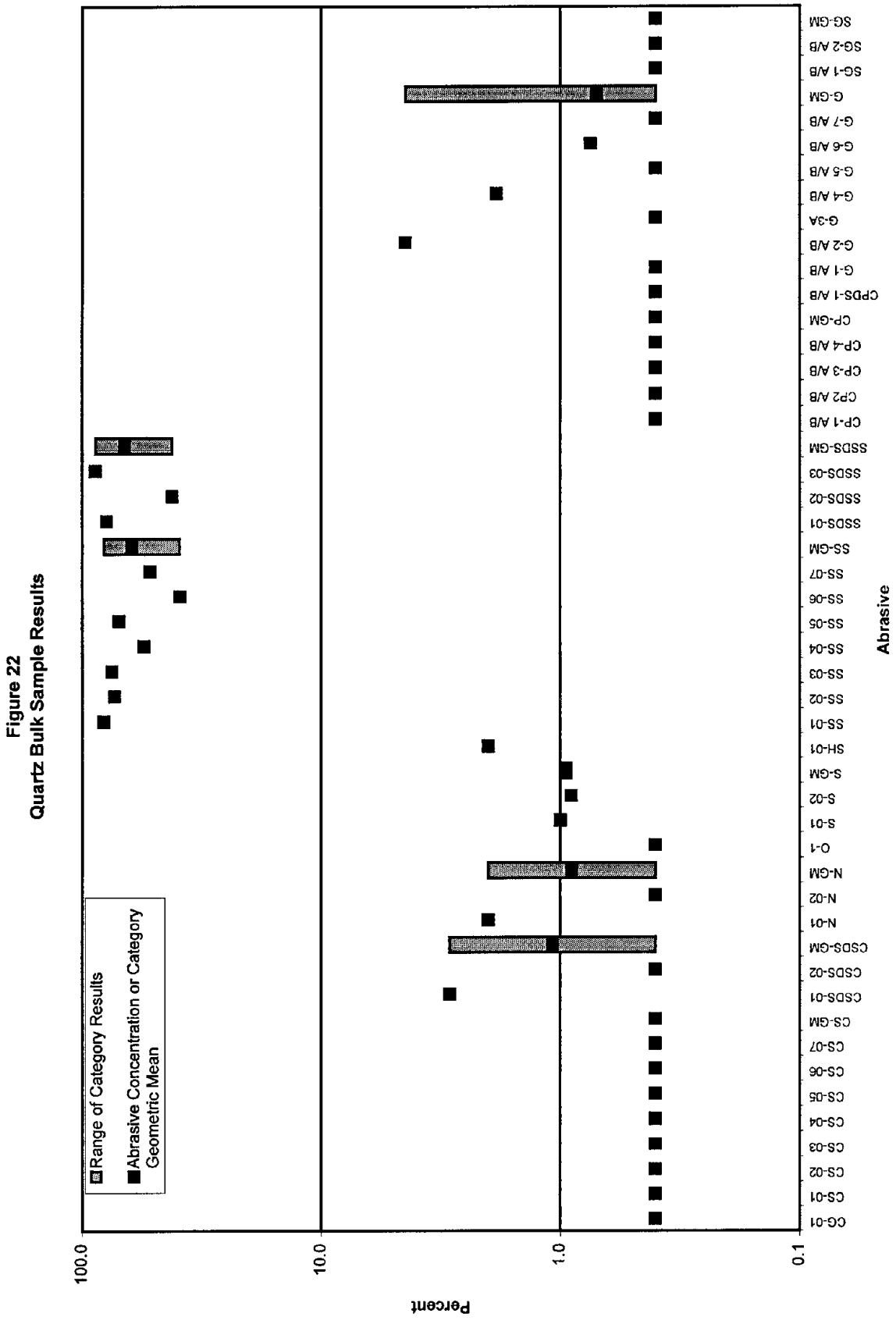


FIGURE 23 — SILVER BULK SAMPLE RESULTS

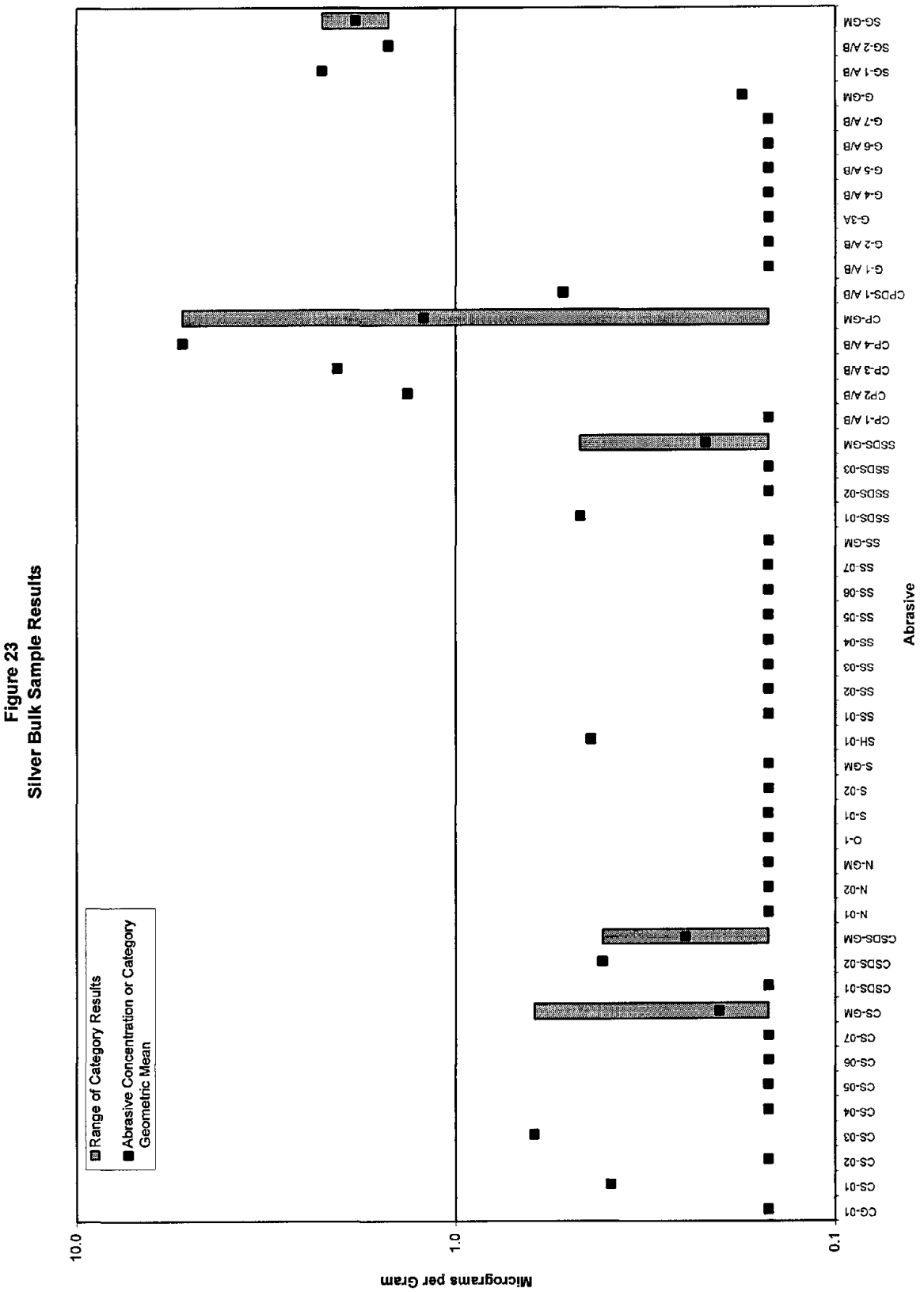


FIGURE 24 — TITANIUM BULK SAMPLE RESULTS

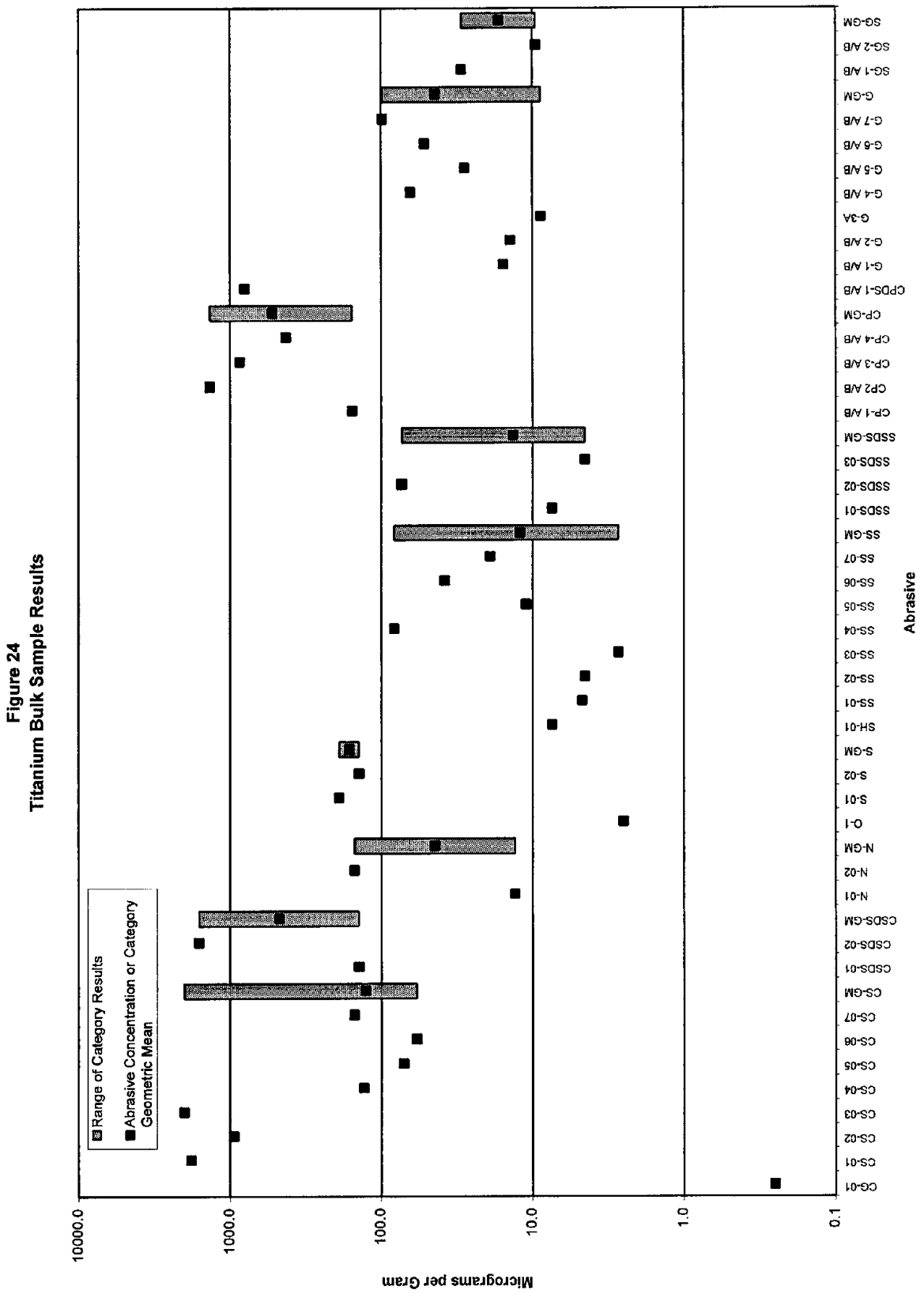


FIGURE 25 — VANADIUM BULK SAMPLE RESULTS

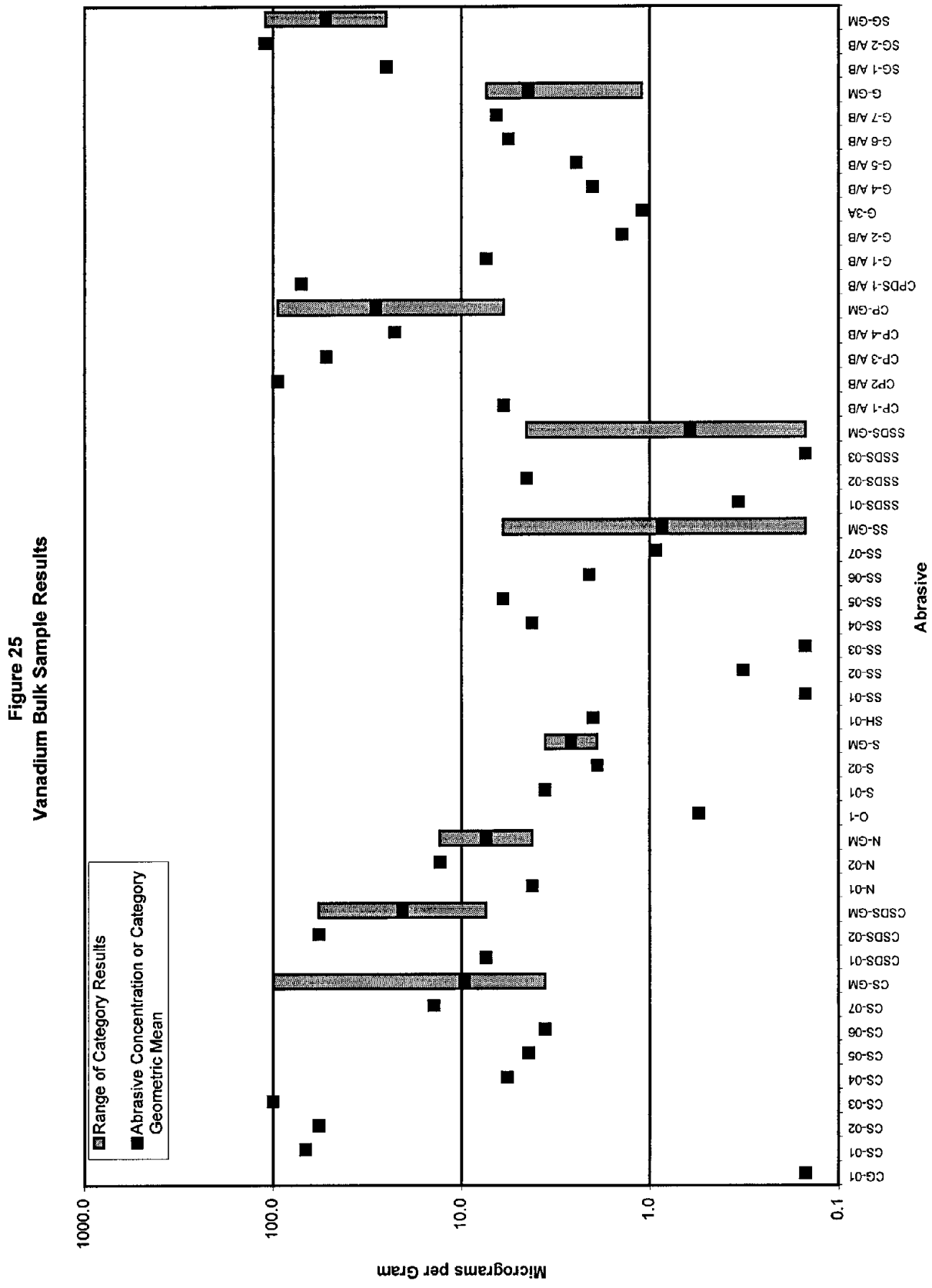


Table 13: Summary of Virgin Bulk Sample Results of Health Related Elements by Generic Category of Abrasive
Note: Unless noted, all concentrations in micrograms per gram

Generic Abrasive	Number of Samples	Arsenic	Beryllium	Cadmium	Chromium	Lead	Manganese	Nickel	Quartz (%)	Silver	Titanium	Vanadium
CG	1	0.25 0.25 0	0.02 0.02 0	0.01 0.01 0	1 1 0	6.3 6.3 1	0.66 0.66 1	1 1 0	0.4 0.4 0	0.15 0.15 0	0.25 0.25 0	0.15 0.15 0
CS	7	0.05 - 2.1 0.47 4	0.28 - 6.3 0.87 7	0.01 - 0.35 0.04 1	1 - 55 5.88 5	0.53 - 6.8 2.2 7	6 - 240 17.5 7	1 - 44 7.36 6	0.4 0.4 0	0.15 - 0.62 0.2 2	58 - 2000 127.06 7	3.6 - 100 9.6 7
CSDS	2	0.25 - 0.8 0.45 1	0.78 - 3.9 1.74 2	0.02 0.02 0	4.6 - 47 14.7 2	0.79 - 0.96 0.87 2	12 - 68 28.57 2	2.9 - 22 7.99 2	0.4 - 2.9 1.08 1	0.15 - 0.41 0.25 1	140 - 1600 473.29 2	7.4 - 57 20.54 2
N	2	0.25 - 15 1.94 1	0.047 - 0.28 0.11 2	0.02 - 0.35 0.08 0	120 - 400 219.09 2	0.62 - 7.5 2.16 2	97 - 150 120.62 2	640 - 660 649.92 2	0.4 - 2 0.89 0	0.15 0.15 0	13 - 150 44.16 2	4.2 - 13 7.39 2
O	1	0.33 0.33 1	0.01 0.01 0	0.35 0.35 0	49 49 1	0.49 0.49 1	510 510 1	1700 1700 1	0.4 0.4 0	0.15 0.15 0	2.5 2.5 1	0.55 0.55 1
S	2	0.25 0.25 0	0.01 - 0.013 0.01 1	0.02 0.02 0	2.1 - 3.2 2.59 2	6 - 8.4 7.1 2	8.9 - 13 10.76 2	1 1 0	0.9 - 1 0.95 2	0.15 0.15 0	140 - 190 163.1 2	1.9 - 3.6 2.62 2
SH	1	0.25 0.25 0	0.16 0.16 1	0.02 0.02 0	1 1 0	0.3 0.3 1	42 42 1	1 1 0	2 2 0	0.44 0.44 1	7.4 7.4 1	2 2 1
SS	7	0.2 - 1.5 0.36 2	0.01 - 0.074 0.02 4	0.02 - 0.35 0.05 0	1 - 3.7 1.61 3	0.2 - 0.89 0.46 7	0.13 - 88 2.69 7	1 - 3 1.17 1	39 - 81 61.85 7	0.15 0.15 0	2.7 - 82 12.06 7	0.15 - 6 0.86 5
SSDS	3	0.25 0.25 0	0.005 - 0.075 0.02 1	0.02 0.02 0	1 - 2.8 1.41 1	0.41 - 1.3 0.61 3	0.38 - 80 3.93 3	1 - 2.5 1.36 1	42 - 88 66.34 3	0.15 - 0.47 0.22 1	4.5 - 73 13.45 3	0.15 - 4.5 0.61 2
CP	8	6.625 - 405 46.35 6	0.448 - 1.45 0.85 8	0.245 - 8.3 0.71 3	7.1 - 158 31.7 8	2 - 850 42.03 8	20.5 - 2400 292.31 8	1.8 - 28.5 9.56 7	0.4 0.4 0	0.15 - 5.25 1.21 6	155 - 1350 525.12 8	5.95 - 94 28.44 8
CPDS	2	6.25 6.25 2	0.64 0.64 2	0.35 0.35 0	50.5 50.5 2	1.95 1.95 2	1950 1950 2	29 29 2	0.4 0.4 0	0.52 0.52 2	795 795 2	70.5 70.5 2
G	13	0.035 - 1.225 0.47 5	0.0075 - 0.116 0.05 9	0.01 - 0.35 0.04 1	1.55 - 34 6.39 10	0.175 - 3.1 0.81 12	99.5 - 385 235.99 13	1 - 16 3.65 6	0.4 - 4.45 0.71 4	0.18 0.18 0	8.8 - 98 43.87 13	1.1 - 7.35 4.41 13
SG	4	19.55 - 22 20.74 4	0.0075 - 0.018 0.01 1	0.18 - 0.185 0.18 0	41 - 1800 271.66 4	0.0925 - 10.1 0.97 2	920 - 9050 2885.48 4	135 - 985 364.66 4	0.4 0.4 0	1.5 - 2.25 1.84 0	9.5 - 29.5 16.74 4	25 - 110 52.44 4

Legend

Range
Min - Max
<---- Values
<---- Geometric Mean
<---- Samples > Limit of Detection

Radiation

Alpha spectrometry measurements have been performed using respirable airborne samples of abrasive blasting materials to determine the content of radium-226 (^{226}Ra). These measurements were analyzed by following the NIOSH contract laboratory Standard Operating Procedure (SOP) WN-IN-314 "The Determination of Radium-226 in Solids by Alpha Spectrometry[6]."

Gamma spectrometry measurements have been performed using virgin and used bulk samples of abrasive blasting materials to determine the content of several gamma-emitting isotopes. These measurements were analyzed by following the NIOSH contract laboratory (SOP) WR-EP-325 "Determination of Gamma Emitting Isotopes[7]."

Alpha and gamma spectrometry methods are usually adequate to evaluate the content of the long-lived radionuclides ^{238}U, ^{232}Th, and ^{40}K as well as their progeny. In fact, the detection of ^{238}U and ^{232}Th using gamma spectrometry is only possible by detection of their photon emitting progeny since the parent radionuclides emit only alpha particles.

Since the concentrations of these radionuclides is typically very low, it is necessary to measure bulk samples having masses of at least a few hundred grams, except for radiochemical analysis of ^{226}Ra, which is usually restricted to analysis of less than 1 gram. Unfortunately, several bulk sample results reported for this study phase were based upon gamma spectrometry measurements of samples having relatively small mass so their results are somewhat uncertain.

Three criteria were adopted to identify positive results:

(1) The reported result for a sample must exceed the range of detection limits for all samples reported in a batch.
(2) The reported result for a sample must exceed three times the reported uncertainty.
(3) If the reported nuclide is a member of a chain, its parent must also be present, especially if the progeny has a short half-life.

In many cases, results were reported without levels of uncertainty, so that the only criteria remaining to determine significance was the detection limits.

^{226}Ra by Radiochemical Separation and Alpha Spectrometry:

Thirteen respirable airborne samples were submitted for specific analysis of ^{226}Ra, representing copper slag CP-1A, copper slag CP-1B , coal slag PC-03 (Black Beauty 2040 coal slag used for the third operator process check), crushed glass CG-01, garnet G-4A, garnet G-4B, olivine O-1, specular hematite SH-01, silica sand with dust suppressant SSDS-02, nickel slag N-01, steel grit SG-1A, and silica sand SS-05. Total dust samples were also submitted for specific analysis of ^{226}Ra for specular hematite SH-01, silica sand with dust suppressant SSDS-02, and nickel slag N-01 since the respirable samples

collected did not have sufficient mass for analysis. Unfortunately, the total airborne sample of specular hematite SH-01 also had insufficient mass to perform the analysis. Respirable and total dust samples were also submitted for analysis of ^{226}Ra for staurolite S-02, but gamma spectrometry analysis for different isotopes was inadvertently conducted.

The respirable airborne samples of nickel slag N-01, copper slag CP-1A, copper slag CP-1B, coal slag PC-03, garnet G-4B, and silica sand SS-05 exceeded the limit of detection (LOD). One sample, copper slag CP-1A, was considerably in excess of the usual concentration of ^{226}Ra. Unfortunately, uncertainty was not reported for these results so it is not possible to determine the reliability of these results.

Radium-226 is part of the 238U chain and is found naturally in all soils at a concentration of approximately 1 pCi g-1. The variability of the concentration is quite large and can range from non-detectable to nearly 5 pCi g^{-1} depending upon local geology. In areas contaminated by naturally occurring barium-radium sludge from crude oil recovery operations, it is not uncommon to find ^{226}Ra concentrations equal to approximately 20 - 50 pCi g^{-1}.

Gamma Spectrometry Analysis:

Airborne Samples

A respirable and a total dust sample of staurolite S-02 was submitted for analysis of several gamma-emitting isotopes. Two filters were dissolved, diluted to 100 g, and counted for approximately 2 hr. The total dust sample was positive for ^{60}Co and ^{137}Cs, indicating the presence of technologically-enhanced radioactive material. Although uncertainty was not reported with these results, the magnitude of the results for ^{60}Co and ^{137}Cs is substantially in excess of the reported detection limits. Other naturally occurring radionuclides are not present, although the counting time is much less than desirable.

Virgin and Used Bulk Samples

Virgin and used bulk samples of the same thirteen abrasives previously described in the Alpha Spectrometry Analysis Section were submitted for analysis of several gamma-emitting isotopes. The samples were directly counted for approximately 2 to 4 hours. The mass of each sample (160 grams) and the uncertainty for each result were only provided for garnet G-4A, steel grit SG-1A, and silica sand SS-05.

Both the virgin and used bulk samples of staurolite S-02 indicate the presence of ^{232}Th (from ^{228}Ac), ^{226}Ra, and the short-lived progeny of ^{226}Ra and ^{224}Ra. The counting time is much less than desirable. The virgin and used samples of garnet G-4A indicate the presence of ^{232}Th (from ^{228}Ac) and ^{212}Pb. However, the presence of ^{212}Pb in the garnet samples cannot be confirmed according to the protocol, because its immediate decay product, ^{212}Bi, was not positive. The bulk samples for the other abrasives were not positive.

Conclusions

Although several samples of abrasive blasting materials have been analyzed for natural and technologically-enhanced radioactive materials, the methods used to perform the analyses may not have been optimized to detect very low concentrations of activity expected to be present in these materials. Typical concentrations of naturally occurring radioactive materials in soil are expected to be approximately 1 - 2 pCi g^{-1}. The concentrations of activity reported for the majority of these samples suggest that each matrix is representative of natural materials with expected amounts of 232Th, 238U, and 40K. However, the small sample size and short counting times preclude a reliable, quantitative assessment of the true concentrations present in each sample.

On the other hand, although 137Cs was identified in a respirable and a total dust sample of staurolite S-02 , no other artificial (i.e., technologically-derived) radioactive contaminants were identified that would likely result in excess risk to workers using these substances.

Gamma spectrometry measurements were not sufficiently sensitive to produce reliable results. The minimum sample size for gamma spectrometry should be approximately 500 g and samples should be counted for at least eight hours each to achieve sufficient measurement sensitivity and reliability to determine the presence of low concentrations of activity expected to be found in these natural matrix materials. The only sample mass reported by the laboratory was only 160 grams and the counting times were either 2 or 4 hours, which made it very difficult to substantiate the validity of results that were reported in excess of the limit of detection.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Conclusions from the study are provided separately below for performance and industrial hygiene issues. The abrasives were evaluated for cleaning rate, consumption rate, surface profile, breakdown, hardness, embedment, and conductivity. The abrasives are grouped below based on similar performance characteristics relative to silica sand.

Abrasive Performance Issues

Coal slag and nickel slag exhibit performance characteristics (e.g. cleaning rates, consumption rates, breakdown, etc.) based on the study parameters that are comparable to silica sand with a few exceptions. They are considerably softer, and the amount of abrasive particulate embedded in the surface increases. The conductivity of the nickel slag and the coal slag treated with dust suppressant is also higher than silica sand.

Olivine and staurolite displayed increased cleaning rates and reduced consumption rates compared with silica sand. They are both softer than silica sand, with staurolite exhibiting less breakdown and olivine more embedment. The conductivity of the staurolite is also greater than silica sand.

Crushed glass and specular hematite exhibit performance characteristics similar to silica sand with a few exceptions. Both are softer materials and the consumption rate of specular hematite was lower. The conductivity of the crushed glass was slightly higher than silica sand.

The remaining products (copper slag, garnet, and steel grit) were tested as recyclable products. As a result, the ultimate consumption rates per square foot will be much less than silica sand. The copper slag and garnet also exhibited increased cleaning rates. All were softer than silica sand (with garnet being the hardest of the group) and with the exception of steel grit, displayed an increase in particle embedment. Steel grit also showed the lowest breakdown rate of the group. Conductivity of the copper slag and garnet was greater than silica sand.

Although the amount of data is limited, the use of dust suppressant on silica sand appears to have no consistent effect relative to its performance characteristics (e.g. cleaning rates, consumption rates, breakdown, etc.). For each attribute, at least one of the treated silica sand abrasives displayed improved performance relative to its untreated counterpart, and at least one showed reduced performance. For the coal slags, the same inconclusive results were produced with one exception. Based on the limited data, the dust suppressant appears to reduce embedment. Only one copper slag treated with dust suppressant was evaluated, and as a result, trends can not be determined. Based on the

single sample, the dust suppressant reduced cleaning and consumption rates, reduced breakdown, and increased embedment.

Cost data was developed based on the preparation of steel plates in a laboratory blast room. The values are only valid for the specific conditions under which the data was collected (controlled metering valve setting, 100 psi nozzle pressure, 18 inch nozzle-to-workplace distance, #4 nozzle, and fixed blast cleaning angle). The results, both in an absolute and relative sense will have no applicability to field conditions. The cost analysis revealed a wide range in results between individual abrasives within a given generic type. For example, the cost of using the seven silica sand abrasives ranged from $1.37/square foot to $2.49/square foot. When averaging the costs for each abrasive type as a generic category, all abrasives with the exception of crushed glass and specular hematite were less costly to use than silica sand. In the case of crushed glass and specular hematite, only one abrasive from each type was evaluated, and in both cases, at least one of the silica sand abrasives was more expensive to use.

Industrial Hygiene-Related Issues

While the study analyzed 30 potential contaminants, the analysis focused on eleven health-related agents selected by NIOSH including: arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, respirable quartz, silver, titanium, and vanadium. All of the airborne data from the laboratory must be viewed as indicative only of relative potential for the presence of health-related agents, since the laboratory conditions were not necessarily representative of worksite conditions. In addition, variability between individual abrasives within a generic abrasive category must also be considered prior to drawing any broad conclusions regarding airborne concentrations of hazardous health-related agents. The attributes of the specific abrasive, rather than the generic class of abrasive, must be considered when making any health based comparisons.

Based on the industrial hygiene results collected in the laboratory study, silica sand abrasives exhibited the highest levels of respirable quartz. The relative airborne concentrations of the other 10 health-related agents in silica sand varied, and were indirectly proportioned to the concentration of quartz in the virgin abrasive. However, since 1974, NIOSH has recommended that silica sand or other material containing greater than 1.0% crystalline silica (quartz) be prohibited as a media for abrasive blasting. Substituting any of the alternative abrasives for silica sand should significantly reduce airborne respirable quartz concentrations for abrasive blasting. This respirable quartz reduction could serve as a major step in preventing the occurrence of silicosis in abrasive blasting.

Substitution of crushed glass and specular hematite for silica sand in abrasive blasting should also reduce the airborne concentrations for <u>most</u> of the hazardous, health-related agents studied. However, crushed glass and specular hematite do not differ greatly from silica sand with respect to airborne cadmium, chromium, lead, and/or manganese concentrations. The remaining alternative abrasives had at least one

hazardous health-related agent which resulted in a considerably higher geometric mean concentration of the agent than that of silica sand as described below.

Coal slag and coal slag with dust suppressant had greater geometric mean airborne concentrations than those of silica sand for the eleven hazardous health-related agents, except respirable quartz (all samples were below the LOD for respirable quartz). However, the treated/untreated coal slag geometric mean airborne concentrations of arsenic, cadmium, lead, manganese, and silver are only 1.1 to 3.2 times greater than that of silica sand. Out of the thirteen generic abrasive categories, untreated and treated coal slag have the two highest geometric mean airborne concentrations of beryllium, being 23 times greater than that of silica sand and 2.6 times greater than the next highest generic abrasive category (copper slag). These two categories of coal slag abrasives (i.e., untreated and treated) also had elevated levels of titanium and vanadium.

Nickel slag, as a generic abrasive category, had greater geometric mean airborne concentrations than that of silica sand for the eleven hazardous health-related agents, except respirable quartz (all samples were below the LOD for respirable quartz). Nickel slag had the highest geometric mean concentration of chromium, second highest geometric mean concentrations of cadmium and nickel, and fourth highest geometric mean concentrations of arsenic.

Olivine had lower or similar geometric mean concentrations of beryllium, lead, silver, titanium, and vanadium, than that of silica sand. Olivine had the third, fifth, and highest geometric mean concentrations of chromium, manganese, and nickel, respectively, all of which were greater than that of silica sand. Arsenic, cadmium, respirable quartz, and silver were not detected above the LOD in any of the olivine airborne samples.

Staurolite had lower or similar geometric mean concentrations of beryllium and cadmium, than that of silica sand. However, staurolite had the third highest geometric mean concentrations of lead and titanium; which were greater than that of silica sand. Arsenic, nickel, and silver were not detected above the LOD in any of the staurolite airborne samples.

The copper slag and copper slag with dust suppressant generic abrasive categories had considerably greater geometric mean airborne concentrations, compared to silica sand, for the eleven hazardous health-related agents, except cadmium and respirable quartz. Out of the thirteen generic abrasive categories, untreated/ treated copper slag had the two highest geometric mean airborne concentrations of arsenic and silver; and the highest geometric mean concentrations of beryllium, titanium, and vanadium, with the exception of untreated/ treated coal slag.

Garnet, as a generic abrasive category, had higher geometric mean concentrations, compared to silica sand, for the eleven hazardous health-related agents, except beryllium, lead, nickel, respirable quartz, and silver. Garnet had the third highest

geometric mean concentrations of manganese and respirable quartz (the highest of the alternative abrasives), and the fourth highest geometric mean concentration of cadmium.

Steel grit, as a generic abrasive category, had higher geometric mean concentrations than that of silica sand for the eleven hazardous health-related agents, except beryllium, cadmium, lead, and respirable quartz (all samples were below the LOD for respirable quartz). Steel grit had the second highest geometric mean concentrations of arsenic, nickel, and silver.

When comparing the effect of a dust suppressant to reduce dust generations, nearly 70% of the paired data sets indicate measured concentrations of health-related agents either remained the same (i.e. ± 15%) or actually increased (i.e. greater than 15%) for the abrasive treated with dust suppressant over the paired untreated abrasive.

In summary, while no single abrasive category had reduced levels of all health-related agents, all the substitutes offer advantages over silica sand with regard to respirable quartz. All but two of the alternative abrasive categories (crushed glass and specular hematite) have substantially higher levels of some other health-related agents, as compared to silica sand. In addition, even within a given generic category, there was considerable variability between the individual abrasives.

These variations are likely the result of varying raw material sources (e.g. coal slags derived from different coal streams) and/or manufacturing process (e.g. variations in copper or nickel smelting processes). Unfortunately, the data on the concentration of these contaminants in the virgin abrasive (on a percent by weight basis) was insufficient to establish definitive thresholds for use in materials selection, as described below.

For 110 out of 998 measured airborne concentrations (of the eleven health-related agents) above the LOD, the contaminant in the virgin bulk abrasives was non-detectable (excludes data from final run of recycled abrasives). Other sources of contamination may be possible (e.g. blast substrate). Data in Appendix 4 suggest that iron (97.3%), manganese (.96%), copper (0.01%), chromium (0.01%), nickel (0.01%), phosphorous (0.006%), molybdenum (0.004%), and vanadium (0.004%) should be the only other sources of contaminants in the substrate that was blasted on. The analytical technique for the raw materials and the air samples are the same, but the limit of detection for the bulk samples is reported in different units (μg/gm) than those reported for the air samples μg/filter). Therefore, the results based on the limits of detection for the airborne samples do not necessarily correlate to the results based on the limits of detections for the bulk samples. For the bulk samples that were reported as non-detected for a given health-related agent and a corresponding airborne level was detected for the same agent; most of the airborne levels were below the limit of quantification or barely above the limit of quantification. Obviously, if a minimum threshold cannot be established, selection criteria based upon elemental analysis of virgin abrasives will be of limited benefit. Furthermore, a statistically valid correlation between the concentration of the contaminant and the corresponding airborne concentrations must first be demonstrated in

order for a selection criteria to be developed. The data from this study is not sufficient to evaluate this correlation, but provides some indication that a correlation may exist.

Recommendations

Based upon the above conclusions, consideration should be given to the following recommendations:

1. In order to reduce the airborne concentrations of the eleven hazardous health-related agents, consider the use of crushed glass or specular hematite. In addition, staurolite and olivine might be considered as alternatives to silica sand to reduce airborne concentration to most of the eleven hazardous health-related agents.

2. When coal slag, nickel slag, copper slag, garnet and/or steel grit abrasives are used as alternatives to silica sand, select specific products from within the generic category which limit worker exposure to multiple toxic contaminants and which optimize desired performance characteristics. As indicated throughout this study, the attributes of the individual products within a generic classification varied widely.

3. While no direct correlation can be established at this time, comparison of the relative concentration of health-related agents in the virgin abrasive, and assessment of the source of the raw materials and/or the manufacturing process, should be used as initial selection criteria for all of the abrasives and in particular for coal slag, nickel slag, copper slag, garnet, and steel grit abrasives.

4. Given the potential exposures to multiple contaminants from both the abrasive, as well as a painted steel surface, worker protection programs should be expanded to address all potential metals (e.g. as opposed to the current focus on worker lead protection programs). Perhaps a comprehensive vertical health standard for industrial maintenance painting operations addressing the use of abrasives, or classes of generic abrasives, should be developed. The standard would automatically invoke the necessary levels of protection and work practices without the need to uniquely evaluate each abrasive for all possible metals.

In addition to the fundamental recommendations described above, this study identified the need for additional research. The recommended studies should be used to:

5. Investigate the relationship between the concentration of quartz in silica sand abrasives with airborne concentrations of other hazardous health-related agents, including an assessment of relative health risks.

6. Evaluate the potential for correlations between the concentration of health-related agents in all virgin abrasives and in particular coal slag, nickel slag, copper slag, garnet and steel grit, and the resulting airborne concentrations, for use as a selection criteria.

7. Conduct further evaluations of crushed glass, staurolite, specular hematite and olivine because this study evaluated only 1 supplier of each of these abrasives (note that staurolite and specular hematite are each provided from only one source).

8. Further studies should be considered to improve the quality of data regarding cleaning rate, consumption rate, and cost. The protocol should be modified to allow selection of blast nozzle size, meter valve setting, and nozzle pressure for each individual abrasive, set experimentally in conjunction with the suppliers. While such variations limit the strict reproducibility of the study and introduce subjective design criteria, these detractions will result in improved cleaning rate, consumption rate, and cost data.

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APPENDIX 1

PHASE 1
STUDY DESIGN/PROTOCOL

Based on an understanding of the project objectives, KTA/SET Environmental (KTA/SET) has developed a revised study protocol for the Phase 1 laboratory portion of the project. The protocol is based on the stated research objectives, the pilot industrial hygiene study conducted by NIOSH and KTA/SET during February 1996, and KTA/SET experience in conducting abrasive blast cleaning studies.

The project requires stringent controls over many variables. Exhaustive quality assurance/control measures will be maintained throughout this phase in order to obtain valid meaningful data. Because of these requirements, the study will be under the direct supervision of Daniel P. Adley, a Certified Industrial Hygienist (CIH). The principal investigator will be Kenneth A. Trimber.

It is acknowledged that NIOSH is concerned over the use of human operators to conduct the scope of work described herein. In response to this concern, the use of an "automated operator" was evaluated and considered. KTA/SET concluded that although robotics could be designed for the laboratory study, it would not be representative of the manner in which the majority of blast cleaning operations are conducted in industry, nor is it representative of the nature of operations in the field. In addition, Phase 2 (field study) must be performed using human operators to assess exposures when cleaning various structural configurations and to properly assess productivity and effectiveness. The blast cleaning effort required to achieve the desired level of cleanliness will vary from one point on a structure to the next. The human operator can immediately react to this difference, while a machine will not. Other variables such as operator visibility and its influence on productivity will not be appropriately recognized when using robotics. Finally, for Phase 3 (comparison of Phases 1 and 2) to be meaningful, Phases 1 and 2 need to be conducted in a similar manner, so that appropriate comparisons can be made. In order to gain meaningful data in Phases 1 and 2, it is essential that human operators be used in the study.

Protection of human operators will be a top priority. Operators will be provided with proper training and personal protective equipment to ensure their safety and health. Implementation of project specific training on the hazards associated with the various abrasive blast cleaning media, use of properly maintained ventilation systems during the laboratory phase, observation of work practices including personal hygiene, and adequate respiratory protection (Bullard Series 88 Type CE supplied air respirator with an assigned protection factor of 1,000) will help ensure the safety of human operators. This will be complimented by a medical surveillance program designed to assess worker health status prior to and following the project.

KTA/SET has reviewed the provisions of 45 CFR 46 for the protection of human subjects, and is currently setting up an Institutional Review Board. Applicable requirements of 45 CFR 46 will be addressed and complied with prior to activities involving human subjects in the abrasive testing process.

PHASE 1 (LABORATORY STUDY) PROTOCOL

1. Blast Cleaning Facilities

1.1. KTA/SET will use the blast cleaning room at its corporate facility in Pittsburgh, PA, to conduct Phase 1 of the study. The blast facility will include a clean, enclosed, illuminated 12' x 8' x 8' walk-in blast room equipped with a Torit-Donaldson 5800 CFM dust collection system.

1.2. The blast cleaning equipment will include a production Clemco 600 pound gravity feed abrasive hopper equipped with an abrasive metering valve and a 15 foot length of reinforced air/abrasive hose. A new section of hose will be assembled prior to the initiation of Phase 1. The hose will be flushed, washed, and dried inside and out prior to use with each new abrasive or a new hose will be used. A Boride brand No. 4 (1/4" orifice) nozzle will be used for the laboratory study. The nozzle orifice size will be monitored throughout Phase 1 using a Clemco nozzle orifice gage. The nozzle will be replaced if the orifice diameter increases by one size (to 5/16" or when uneven wear is observed). The metering valve setting will vary, depending upon each abrasive manufacturer's specification. If one is not specified, a 1/2" setting will be used.

1.3. The volume of air supply (cubic feet per minute) will be maintained throughout the project by employing an Atlas Copco 170CFM air compressor. The air supply will be examined for oil and water contamination in accordance with ASTM D4285 (blotter test) prior to each abrasive study.

1.4. Operators will be equipped with a Bullard Series 88 Type CE supplied air respirator (blast helmet), which has an assigned protection factor (APF) of 1,000. The breathing air will be evaluated for Grade D quality prior to initiating Phase 1.

1.5. Blast cleaning air pressure will be maintained at 90-100 psi at the blast nozzle and will be held constant for each abrasive. Actual blast cleaning air pressure will be measured using a hypodermic needle pressure gage and the results documented for each abrasive.

1.6. The blast cleaning study will be performed on 3/16" x 24" x 24" uncoated carbon steel plates containing intact mill scale. Nine panels will be available for each trial run with the capability of both sides being cleaned to an SSPC-SP 10, "Near White Metal" blast condition (for a potential total of 72 square feet). Blasting will be conducted until the entire 72 square feet of panel is blasted, or the blaster utilizes all of the abrasive in the pot, whichever occurs first. The panels will be mounted in a specially designed rotary holder. This mounting fixture will enable the operator to perform blast cleaning operations of all 18 surfaces at a 3'-5' work height. Three panel faces will be presented to the operator at one time. The operator will blast three faces, rotate the mounting fixture 180 degrees to reverse the panels, then clean the back sides of the three panels. The operator will then rotate the mounting fixture to expose the next group of three

panels, and the process will be repeated. The panels will be held in the mounting fixture using clamps located near the middle of two edges. As a result, an area approximately 1/2" by 1-1/2" on two edges of each plate will not be blast cleaned.

1.7. The nozzle to work piece distance will be held at a consistent distance (18 inches) throughout the study. A small wire rod will be mounted on the blast nozzle and extended to the wall behind the operator. The operator will use this rod to maintain the nozzle-to-substrate distance. The operator will be instructed to keep the nozzle perpendicular to the substrate, producing the greatest amount of abrasive ricochet, simulating a worst-case airborne dust condition.

1.8. The blast cleaning room will be ventilated throughout the study. Cross draft ventilation will be used. Target air flow will be 50 to 75 feet per minute (fpm) for each abrasive trial. Actual cross-sectional air flow will be measured and recorded prior to each abrasive trial using a rotating vane anemometer.

1.9. Environmental conditions within the blast room will be recorded prior to each abrasive trial. Environmental conditions will be assessed using a 24-hour recording hygrometer (stationed inside the blast cleaning room), and a digital thermocouple-equipped surface temperature thermometer. Barometric pressure will also be recorded.

1.10. A Lunardini Vac-U-Claimer abrasive media vacuuming/reclaiming system will be used to collect the abrasive debris and to vacuum all blast room surfaces after each abrasive trial.

2. Abrasive Media

2.1. The generic types of abrasives and number of each to be studied are as follows:

Abrasive Type	No. of Abrasives
Silica Sand	7
Silica Sand w/Dust Suppressant	3
Coal Slag (2 w/Dust Suppressant)	9
Copper Slag (1 w/Dust Suppressant)	5
Nickel Slag	2
Garnet	7
Staurolite	2
Steel Grit	2
Specular Hematite	1
Olivine	1
Crushed Glass	1
TOTAL	40

2.2. Abrasive media product brochures and material safety data sheets (MSDS) will be obtained prior to initiating Phase 1.

3. Substrate Material

3.1. All steel panels used for the substrate material will be purchased from the same supplier. Certification stating that the steel is from the same heat or melt will be

obtained. The substrate material will also be chosen from the same mill rolling, to ensure that the characteristics of the tightly adhering mill scale is consistent. Ten (10) randomly chosen sample panels will have a 4" by 4" segment removed and submitted to NIOSH for evaluation, to evidence that the same heat of material is used.

3.2. Steel panels will be 3/16" x 24" x 24" in size. Each abrasive trial will include nine (9) panels mounted in a rotating fixture which will provide the operator access to 18 surfaces (72 square feet of surface area).

3.3. 757 steel panels will be used during the Phase I Study. The panels will have any sharp edges ground and will be cleaned per SSPC-SP 1, "Solvent Cleaning". Each panel will be stenciled with a random number from 1 to 757.

3.4. Substrate material usage. The following table presents the usage of the substrate material.

No. of Plates	Usage
225	Operator Variance
234	Cleaning Study
126	Recyclability Testing (Initial)
126	Recyclability Testing (Post)
45	Process Checks
10	NIOSH Elemental Analysis

4. Health Screenings and Training of Human Subjects (Blast Operators)

4.1. Prior to initiating the laboratory study, human subjects will receive the following health screening:

4.1.1. Pulmonary Function Test

4.1.2. Blood Test for Lead, Zinc Protoporphryn (ZPP), and cadmium

4.1.3. Urinalysis for Cadmium

4.1.4. Qualitative Respirator Fit Testing

4.1.5. Other medical screening as deemed necessary by physician (see attached letter)

4.2. Prior to initiating the laboratory study, human subjects will receive training in the following areas:

4.2.1. Health Hazards of Lead, Chromium, Cadmium, Arsenic

4.2.2. Proper Use of Respirators

4.2.3. Hygiene Practices

4.2.4. Review of Project Testing Protocol- Roles/Responsibilities

5. Protocol for Assessment of Operator Variability

5.1. KTA/SET will conduct an initial study to evaluate five (5) operators and subsequently select one operator for the abrasive trials. The blast surfaces will be identical to those targeted for the comprehensive study. Each of the five operators will conduct five separate abrasive blast cleaning trials for a minimum, continuous 30 minute blast sequence, or to clean 72 square feet. If the entire 72 square feet of steel surface is cleaned to an SSPC-SP 10, "Near White Metal" blast condition before the supply of blast media is consumed, then the blasting will end at that point. This will be conducted using one selected coal slag abrasive. Industrial hygiene (air sampling) and productivity data will be collected as outlined in Section 6 and 8 of the Phase 1 Study Design. The 25 trials (five operators at five runs each) will be scheduled on a random basis.

5.2. At the completion of the trials, a single operator will be selected from the five (based on the lowest variability in productivity) to conduct the remaining Phase 1 studies with the candidate abrasives. Repeatability using the selected blast cleaning operator will be verified throughout Phase 1 by rerunning the same brand of coal slag abrasive and documenting the productivity results for comparison with the initial blast cleaning trials of the selected operator.

6. Protocol for Abrasive Trials

6.1. Assessment of Blast Room Conditions

6.1.1. Environmental conditions within the blast room will be assessed prior to each abrasive evaluation. The conditions that will be monitored include air temperature, relative humidity, dew point, surface temperature, and barometric pressure. Data will be acquired using a thermocouple equipped digital surface temperature thermometer, a barometer, and a 24-hour recording hygrometer (stationed inside the blast cleaning room).

6.1.2. The blast cleaning room will be ventilated throughout the study. Cross draft ventilation will be used. A cross-sectional assessment of air flow will be conducted and documented prior to abrasive evaluations using an Alnor Rotating Vane Anemometer. Target ventilation will be 50 to 75 feet per minute.

6.2. Testing Protocol for Each Abrasive Media

6.2.1. Upon receipt of each abrasive shipment, the manufacturer, supplier, trade name, size and grade will be recorded in a log book. Each abrasive media will be assigned a unique number (e.g. J95331-01).

6.2.2. Nine (9) 2' x 2' steel plates will be mounted in the rotating fixture. The plate numbers will be documented.

6.2.3. A one hundred pound sample of abrasive, as received, will be riffled to ensure homogeneity, then a one-pound sample will be collected from the homogenous mix for submittal to NIOSH for analysis.

6.2.4. A second 100 gram sample will be collected from the riffled quantity and a sieve analysis conducted in accordance with ASTM C 136 "Standard Test method for Sieve or Screen Analysis of Fine and Coarse Aggregates".

6.2.4.1. The grit will be tamped and shaked through a series of sieves (screen numbers 10, 12, 16, 20, 30, 40, 50, 60, 70, 100, 140, 200, 270 and a pan at the bottom) for seven minutes. The abrasive collected on each screen will be emptied into numbered and tared sample cups. The underside of each screen will be cleaned with a brass brush to loosen trapped particles which will also be collected into the appropriate sample cups. The contents of each sample cup will be weighed and documented.

6.2.5. The abrasive media will be loaded into the 600 pound Clemco abrasive hopper. A sufficient quantity of media will be loaded to attain a continuous 30 - 40 minute blast sequence or to clean 72 square feet, whichever occurs first.

6.2.6. The air pressure utilization (in psi) at the nozzle will be measured and recorded using a hypodermic needle pressure gage prior to each abrasive trial.

6.2.7. Prior to initiating blast cleaning operations, operator and area sampling pumps will be calibrated and the filter media loaded onto the sample holders, or onto the operator (as required). See Industrial Hygiene Protocol (Section 8.0).

6.2.8. The operator will blast clean both sides of nine 24" by 24" steel panels (72 square feet total surface area), or the surface area when the blast pot is emptied.

6.2.9. Upon completion of the sampling durations described in Section 8, the operator and area sampling pumps will be turned off and the time of day recorded. The sampling media will be removed from the operator and blast room when the blast cleaning is completed, and immediately sealed to prevent contamination.

6.2.10. The quantity of time required to blast clean 72 square feet will be recorded. If less than 72 square feet is cleaned, the actual square footage cleaned will be measured and recorded, along with the total elapsed time.

6.2.11. The sample plates will be removed from the rotating fixture and retained for further analyses.

6.3. Collection of Blast Cleaning Data

6.3.1. Each panel will be inspected to verify the required SSPC SP10 "Near-White Metal" blast condition has been achieved. SSPC VIS1-89 pictorial standards for assessing surface cleanliness (reference Photograph ASP10) will be used.

6.3.2. Surface profile will be measured in accordance with ASTM D 4417-93 "Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel" Method C. Coarse and X-Coarse Testex replica tape and a spring micrometer will be used. Two measurements will be obtained and documented on three randomly selected test plates.

6.3.3. Three of the nine panels will be randomly selected for an assessment of abrasive embedment. Five locations on each plate will be examined using a 10x illuminated magnifier and a 1/2" x 1/2" grid containing 100 squares. The number of squares containing embedded material will be quantified in each of the five areas on each plate, and a total percentage of embedment calculated and documented.

6.3.4. One randomly chosen panel will be sampled by dry cutting a 4" x 4" section from the corner of the plate. The sample will be identified and forwarded to NIOSH.

6.3.5. The abrasive remaining in the blast hose and abrasive hopper will be collected and weighed to calculate the total consumption rate of the abrasive media (by comparison with original weight used to fill the hopper).

6.3.6. A Lunardini Vac-U-Claimer abrasive media vacuuming reclaiming system will be used to collect the abrasive debris after each individual evaluation. Approximately one hundred pounds of spent abrasive and debris, as vacuumed prior to reclaiming, will be riffled (to ensure homogeneity), then a one-pound sample will be collected from the homogenous mix for submittal to NIOSH for analysis.

6.3.7. A 100 gram sample of the riffled spent abrasive and debris will be used for sieve analysis in accordance with ASTM C 136 "Standard Test method for Sieve or Screen Analysis of Fine and Coarse Aggregates". The sample will be tamped and shaked through a series of sieves (screen numbers 10, 12, 16, 20, 30, 40, 50, 60, 70, 100, 140, 200, 270 and a pan at the bottom) for seven minutes. The material collected on each screen will be emptied into tared, numbered sample cups. The underside of each screen will be cleaned with a brass brush to loosen trapped particles which will also be collected into the appropriate sample cups. The contents of each sample cup will be weighed and documented.

6.4. Cleaning Procedure Between Abrasive Trials

6.4.1. The abrasive hopper, blast hose and nozzle will be cleaned by exhausting clean, dry compressed air through the system for approximately one minute with the ventilation system in operation. The blast hose will be rinsed with fresh water and dried with compressed air. Two blast hoses will be used and alternated to allow thorough drying prior to use.

6.4.2. The walls, floor, and ceiling of the blast room will be thoroughly vacuumed with the Vac-U-Claimer system between abrasive media trials. The worker will

also decontaminate the blast helmet, coveralls, gloves and boots after each abrasive trial.

6.4.3. An industrial hygiene technician, under the direction of a Certified Industrial Hygienist (CIH), will witness blast room cleaning procedures and inspect the blast room after each cleaning to ensure prevention of sample cross contamination. The inspection will include visual assessments by running gloved fingers across surfaces at 5 random locations and inspecting the surface for any evidence of a path left by the gloved fingers.

6.4.4. Additional cleaning with damp cloths will be used, as necessary. In addition to the visual inspection, wipe samples will be collected in three locations on every fifth abrasive trial and submitted to NIOSH for analysis .

6.4.5. The Vac-U-Claimer will be wiped clean between abrasive trials to prevent cross contamination. The IH Technician will verify cleanliness of the equipment.

6.5. Photographic/Videographic Documentation

6.5.1. 35mm slide photography and 8mm videography will be employed throughout the testing protocol to record typical operations. Each step of the protocol will be recorded.

7. Recyclable Abrasives Testing Protocol

7.1. Without the use of an operator, the nozzle will be fixed in place and the candidate recyclable abrasive impinged on a clean steel substrate. When the abrasive supply from the hopper is depleted, it will be vacuumed, cleaned, and returned to the hopper for reuse.

7.2. This recycling process will be repeated until the material breaks down to 50% of the original size, or 25 times (which ever is sooner) using steel grit abrasives, and 5 times (maximum) using copper slag and garnet abrasives.

7.3. At the completion of the above blasting cycles, the abrasive media will be returned to the abrasive hopper for a final trial using the protocols outlined in Section 6.0 and 8.0.

8. Industrial Hygiene Monitoring Protocol

8.1. Industrial Hygiene monitoring will be conducted prior to project initiation (background), during the operator variability study, and during each abrasive trial. Monitoring will entail collection of airborne samples for :

8.1.1. Total Airborne Dust

8.1.2. Respirable Crystalline Silica

8.1.3. Respirable Radiochemical Activity

8.1.4. Total Airborne Radiochemical Activity

8.1.5. Total Airborne Elements

8.2. Prior to each abrasive trial, sampling pumps will be calibrated using a Gilian Gilibrator-2 primary calibration precision flow bubble meter equipped with a standard flow cell (20cc-6 lpm). Calibration will be conducted through the representative filter media. The actual flow rates for each pump will be documented on the pump calibration report (attached).

8.3. Verification of flow rates will be conducted upon completion of each abrasive trial. Post trial pump flow rates will be measured and documented on the pump flow verification form (attached).

8.4. Filter media will be positioned in sample holders in three areas within the blast room, and include :

8.4.1. Make-up Air Panel of Blast Room

8.4.2. Operator Area

8.4.3. Exhaust (ventilation) Panel of Blast Room

8.5. Sample bank holders will be mounted 12" from the side wall, at breathing zone height (5-6'). Samples will have a 6" clearance from each other.

8.6. Filter media positioned in the operator's breathing zone will be mounted in a hemisphere 6-9" from the nose/mouth, forward of the shoulders in a downward direction, outside of respiratory protection.

8.7. Sampling for Total Dust

8.7.1. Total airborne dust samples will be collected on 37mm, 0.5 micron pre-weighed PVC filter media. Four-six minute samples will be collected in each of the three areas inside the blast room at a flow rate of 1.0 liter per minute.

8.7.2. Sampling for total dust will commence after three minutes of blast time has elapsed to facilitate equilibrium within the blast room.

8.7.3. After a six minute sampling period, the following sequence will occur: (note that pump identification and hose number will change depending on the area)

8.7.3.1. Simultaneously stop Pump A and start Pump B

8.7.3.2. Disconnect Hose 1 from Pump A

8.7.3.3. Connect Hose 3 to Pump A

8.7.3.4. After 6 minutes has elapsed, simultaneously stop Pump B and restart Pump A

8.7.3.5. Disconnect Hose 2 from Pump B

8.7.3.6. Connect Hose 4 to Pump B

8.7.3.7. After 6 minutes has elapsed, simultaneously stop Pump A and restart Pump B

8.7.3.8. After 6 minutes has elapsed, stop Pump B

8.7.4. Total airborne dust samples will be collected in the operator's breathing zone. One - 24 minute sample will be collected at 1.0 liter per minute. A programmable SKC pump will be used and programmed to begin after 3 minutes of blasting time and to stop after 27 minutes blasting time (24 minute sample).

8.7.5. Analysis for total dust will be conducted by NIOSH laboratories in accordance with the NIOSH Method 0500.

8.7.6. Sampling of respirable airborne dust to obtain freshly fractured samples.

8.7.6.1. Respirable airborne dust samples will be collected in one (1) area (operator area) to obtain freshly fractured samples for in vitro assays and animal pathology studies. All sampling will be performed by NIOSH personnel.

8.7.6.2. Immediately after sampling, the collected samples will be sealed and driven to NIOSH laboratories in Morgantown, West Virginia. The precise times of day (beginning and completion of blast) will be recorded and submitted with the samples.

8.8. Sampling for Respirable Dust and Respirable Crystalline Silica

8.8.1. Respirable crystalline silica samples will be collected in each of the three areas in the blast room and within the breathing zone of the operator using MSA 10mm nylon cyclones equipped with 37mm, 0.5 micron pore pre-weighed PVC filter media, at a flow rate of 1.7 liters per minute. Sampling for crystalline silica will commence after three minutes of blast time has elapsed, to facilitate equilibrium in the blast room. Twenty four (24) minute samples will be obtained.

8.8.2. Samples will be analyzed for respirable dust and silica. Analysis for respirable crystalline silica will be conducted in accordance with NIOSH method 7500 (x-ray diffraction); analysis for respirable dust will be conducted by NIOSH laboratories in accordance with NIOSH Method 0600.

8.9. Sampling for Respirable Radiochemical Activity

8.9.1. Respirable radiochemical activity samples will be collected in each of three areas in the blast room using MSA 10mm nylon cyclones equipped with 37mm, 0.5 micron pore pre-weighed PVC filter media, at a flow rate of 1.7 liters per minute.

8.9.2. Sampling for respirable radiochemical activity will commence after three minutes of blast time has elapsed, to facilitate equilibrium in the blast room. Twenty four (24) minute samples will be obtained.

8.9.3. Analysis for respirable radiochemical activity will be conducted by NIOSH laboratories.

8.10. Sampling for Total Radiochemical Activity

8.10.1. Total radiochemical activity samples will be collected in each of three areas in the blast room using pre-weighed 37mm, 0.5 micron pore PVC filter media at a flow rate of 4.0 liters per minute.

8.10.2. Sampling for total radiochemical activity will commence after 3 minutes of blast time has elapsed, to facilitate equilibrium in the blast room. Twenty-four (24) minute samples will be obtained.

8.10.3. Analysis for total radiochemical activity will be conducted by NIOSH laboratories.

8.11. Sampling for Elements

8.11.1. Elemental samples will be collected in each of the three areas in the blast room and within the breathing zone of the operator using sampling pumps equipped with 37mm, 0.8 micron pore mixed cellulose ester membrane filter media. Sampling will be conducted at a flow rate of 2.0 liters per minute.

8.11.2. Sampling for elements will commence after three minutes of blast time has elapsed, to facilitate equilibrium in the blast room. Twenty-four (24) minute samples will be collected.

8.11.3. Analysis for elements will be conducted by NIOSH laboratories in accordance with NIOSH Method 7300.

8.12. Sampling of Ricochet Abrasive/Debris

8.12.1. For each abrasive trial, two (2) pre-weighed 0.5 micron pore, 37mm diameter filter cassettes will be mounted in the operator area without hose/pump connection. The purpose of the media placement will be to determine if ricochet abrasive/debris can enter the opening of the filter cassette without being drawn in by pump flow.

8.13. Background Monitoring

8.13.1. Prior to initiating the operator variance testing, background monitoring will be conducted for eight (8) hours. Airborne samples for total dust, respirable dust, respirable crystalline silica, respirable radiochemical activity, total radiochemical activity and elements will be collected in each of three areas in the previously cleaned blast room, with the ventilation system in operation. The air flow (in fpm) will be measured and documented for the background study.

Flow rates will be similar to those targeted during actual blast cleaning operations.

9. Economic Data Analysis

9.1. Economic data for abrasive blast cleaning will be calculated based on work conducted in the following regions:

9.1.1. Portland, Oregon

9.1.2. Los Angeles, California

9.1.3. Houston, Texas

9.1.4. Pittsburgh, Pennsylvania

9.1.5. Baltimore Maryland

9.1.6. Hartford, Connecticut

9.2. Data to be acquired will include:

9.2.1. Abrasive media cost.

9.2.2. Disposal cost (bulk, non-hazardous).

9.2.3. Labor costs (blasters).

9.2.4. Costs of equipment rental and purchase.

10. Technical Method for Total Cost Calculation

10.1. The economic factors described in Section 9.0 and the data collected during the study will be assessed, then the cleaning cost calculated using the mathematical formula below.

Cleaning costs ($/sq.ft.) = (((A(P+D))+E+L)/R)/X)))
A=Abrasive flow rate, ton/hr.
P=Delivered price of abrasive, $/ton.
D=Abrasive disposal cost, $/ton.
E=Equipment costs, $/hr.
L=Labor costs, including cleanup, $/hr.
R=Number of times abrasive is used.
X=Abrasive cleaning rate, sq.ft./hr.

11. Report Format

11.1. Upon completion of all testing procedures and receipt of analytical data from the NIOSH laboratory, a written report will be prepared. The report will be formatted as follows:

11.1.1. Introduction

11.1.2. Executive Summary

11.1.3. Description of Abrasive Media Test Procedures

11.1.4. Description of Industrial Hygiene Monitoring Procedures

11.1.5. Results of Abrasive Media Testing

11.1.6. Results of Industrial Hygiene Analysis

11.1.7. Calculation of Operating Costs based on Economical Factors

11.1.8. Statistical Analysis of Operator and Area Exposure Monitoring Data.

11.1.9. Quality Assurance/Quality Control Procedures Implemented to Ensure Validity of Testing

11.1.10. Testing Errors, Deficiencies or Deviations Encountered

11.1.11. Conclusions and Recommendations

11.1.12. Photographic Documentation

APPENDIX 2

GLASS BROKERS INC.
182 RADCLIFF DRIVE
EAST NORWICH, NEW YORK 11732
516-624-2474 FAX# 516-624-2337

EMANUEL V. SORGE Ph.D. PRESIDENT

DECEMBER 13,1996

TO: MICHAEL MELAMPY
KTA
115 TECHNOLOGY DRIVE
PITTSBURGH, PA. 15275
FAX# 412-788-1306

FR: DR. E.V.SORGE

RE: ADDENDUM TO YOUR NIOSH REPORT (AT YOUR DISCRETION)

POSSIBLE TITLES

NOT ALL GLASS ABRASIVES ARE ALIKE

GLASS - THE NEW "HEAVY DUTY" ABRASIVE

GLASS ABRASIVES - KEEPING AN OPEN MIND

VIA FACSIMILE AND EXPRESS MAIL

GLASS ABRASIVES- KEEPING AN OPEN MIND

WITHIN THE ABRASIVE INDUSTRY, THE MENTION OF GLASS AS AN ABRASIVE MEDIUM OFTEN EVOKES SIMILAR TYPE RESPONSES: " IT'S MUCH TOO SOFT", "IT'S NOT GOOD FOR HEAVY INDUSTRIAL APPLICATION" "GLASS SHOULD BE USED SOLELY FOR PEENING, LIGHT CLEANING OR POLISHING", "JUST WON'T PROVIDE THE DESIRED SURFACE PROFILE".

THESE RESPONSES REFELECT THE INDUSTRIES PRIOR EXPERIENCE BASED ON WHAT WAS, AT THE TIME, THE ONLY COMMERCIAL GLASS AVAILABLE IN BULK VIZ., GLASS BEAD.

HOWEVER, RECENT ADVANCES IN GLASS RECYCLING TECHNOLOGY HAVE RESULTED IN THE PRODUCTION OF 'FINE GRIND','PULVERIZED', 'DISINTEGRATED', OR 'POWDERIZED' CULLET, SUGGESTING THAT GLASS IS READY TO COMPETE AND COMPETE EFFECTIVELY (BASED ON RECENT INDEPENDENT SHIPYARD TESTING OF GLASSBLAST BY GLASS RECYCLING INC., GEORGIA) AGAINST SANDS, SLAGS, GARNETS AND MINERAL OXIDES. [RESULTS OF INDEPENDENT TESTING AVAILABLE FROM GRI].

WITH YEARS OF ABRASIVE FIELD EXPERIENCE, OPERATORS HAVE COME TO RECOGNIZE THAT NOT ALL ABRASIVES ARE ALIKE EVEN WITHIN A SPECIFIED CATEGORY SUCH AS SANDS, SLAGS, GARNETS,ETC. EACH COMMERCIAL BRAND NAME CARRIES WITH IT ITS' OWN UNIQUE PROPERTIES THAT SERVE TO DISTINGUISH IT FROM OTHER ABRASIVES WITHIN ITS OWN FAMILY GROUP. FOR EXAMPLE, VARIATIONS IN THE PHYSICAL SHAPE OF THE ABRASIVE PARTICLE WILL HAVE A DEFINITE EFFECT ON THE CLEANING RATE OBTAINED AND THE SURFACE PROFILE PRODUCED. SAND, DEPENDING ON THE BRAND, IS AVAILABLE IN ROUND, OBLONG, IRREGULAR, ANGULAR AND SUB-ANGULAR CONFIGURATIONS EACH PROVIDING DIFFERENT CUTTING ACTIONS AND DIFFERENT PROFILE DEPTH. THE MORE SUB-ANGULAR THE BETTER THE CUTTING ABILITY AND THE DEEPER THE ANCHOR PATTERN. THE SAME CAN BE SAID FOR THE VARIOUS BRANDS OF GLASS ABRASIVES NOW APPEARING WITHIN THE MARKET.

LIKEWISE THE FRIABILITY OR BRITTLENESS OF THE ABRASIVE BECOMES AN IMPORTANT FACTOR IN REUSE, DUSTING, AND ENVIRONMENTAL AND WORKER HEALTH CONCERNS ASSOCIATED WITH THE RELEASE OF FREE SILICA AND ITS' ASSOCIATED HEALTH PROBLEM SILICOSIS. TYPE A CONTAINER GLASS USED AS AN ABRASIVE RESOLVES THESE DIFFICULTIES. IT IS ENVIRONMENTALLY FRIENDLY (HAVING NO FREE SILICA), AND PRODUCES MINIMAL DUST WHICH ALLOWS FOR PRODUCT REUSE.

THE ABRASIVE TESTS OF THE TYPE REPORTED HERE BY NIOSH AND KTA NOT ONLY CONCERNED THEMSELVES WITH THE MERITS OF EACH ABRASIVE AS TO CLEANING RATE (SQ.FT./HR.), OR DESIRED PROFILE/ANCHOR PATTERN 2-3 MILS, OR MEDIA UTILIZATION RATE (LBS.USED/HR.) BUT FOCUSED AS WELL ON THE ENVIRONMENTAL HAZARDS ASSOCIATED WITH ABRASIVE USE.

IN THIS NIOSH TEST REPORT, OF THE 41 ABRASIVES TESTED ONLY ONE GLASS SAMPLE WAS INCLUDED VIZ., WHITE BLAST PRODUCED BY STRATEGIC MATERIALS INC., FORMERLY ALLWASTE, TEXAS)

REGARDLESS HOW THESE TEST RESULTS TURN OUT, NO ONE COMMERCIAL PRODUCT SHOULD SERVE AS THE GENERALIZED STANDARD OR THE "MIND SET" FOR THE ABRASIVE INDUSTRY. AS NO TWO SANDS OR SLAGS ARE ALIKE, SO TOO NO TWO COMMERCIALLY AVAILABLE GLASS ABRASIVES OR GLASS PROCESSING TECHNOLOGIES ARE ALIKE. IN THE RECYCLING INDUSTRY, PLATE AND WINDSHIELD GLASS (THE PRIMARY CONSTITUENTS OF WHITE BLAST) ARE KNOWN TO BE HIGHLY FRIABLE AND WOULD BE EXPECTED TO CREATE EXCESS DUSTING DURING PROCESSING. HOWEVER, THE GLASS DUST PRODUCED SHOULD BE SILICA FREE AND CLASSIFIED MORE AS A NUISANCE DUST THAN AS A HAZARDOUS MATERIAL.

IN CONTRAST, TYPE A SODA-LIME-SILICATE CONTAINER GLASS WILL, DEPENDING ON THE PROCESS EMPLOYED TO CREATE THE DESIRED ANGULAR OR SUB-ANGULAR SHAPE, NOT ONLY CUT AND CLEAN FASTER THAN MOST EXISTING ABRASIVES BUT WILL DO SO WITH MINIMAL NON-HAZARDOUS DUSTING.

I WOULD ENCOURAGE NIOSH, THE SHIPBUILDING AND SHIPYARD INDUSTRIES AND THE STEEL INDUSTRY TO TAKE A CLOSER LOOK AT THE DIFFERENT COMMERCIALLY AVAILABLE GLASS ABRASIVES NOW BEING PRODUCED AND PACKAGED ACCORDING TO SIEVE (MESH) SIZE TO MEET THE INDUSTRIES NEEDS. THEY INCLUDE: WHITEBLAST, FASTBLAST, GLASSBLAST, VITRO-GRIT AND THE FAMILIAR GLASS BEAD. TOGETHER WITH PROCESSING TECHNOLOGIES THAT 'PULVERIZE', 'DISINTEGRATE', 'GRIND', OR 'POWDERIZE'- WORDS USED TO DESCRIBE THE UNIQUENESS OF THESE PATENTED PROCESSES. ALL HAVE THE ABILITY TO PRODUCE FINE GLASS PARTICLES IN MESH SIZES RANGING FROM 4 TO BELOW 200.

MICROSCOPIC EXAMINATION OF SEVERAL SAMPLES TOGETHER WITH LITERATURE DESCRIPTION OF THE REMAINDER CLEARLY SUGGESTS THAT EACH PROCESSOR WILL PRODUCE A GLASS ABRASIVE WITH A PHYSICAL SHAPE UNIQUE FOR THAT PROCESS REGARDLESS OF THE TYPE OR VARIETY OF GLASS PROCESSED.

1. THE ANDELA PULVERIZER SYSTEM, NEW YORK WHICH ACCORDING TO THEIR LITERATURE PRODUCES"A DISTINCTIVELY DIFFERENT PRODUCT: A ROUNDED GLASS PARTICLE... EASY TO HANDLE...NOT SHARP."
2. THE MICRO SOURCE SYSTEM BY DONICO INTERNATIONAL, PA. POWDERIZES GLASS SUCH THAT IT " COMES OUT WITH NO SHARP EDGES ".
3. WHEREAS GLASS RECYCLING INC., GEORGIA, PRIDES ITSELF ON A BOTTLE DISINTEGRATOR SYSTEM THAT PRODUCES A "SUB-ANGULAR" PARTICLE GIVING ITS HEAVY DUTY ABRASIVE PRODUCT GLASSBLAST THE "BEST CUTTING POWER... AT A LOW PRESSURE OF 80-90 PSI. "ITS SHAPE CREATES AN ANCHOR PROFILE BETWEEN 2.5-4.0 MILS AND CUTS AGGRESIVELY IN BOTH DRY BLAST AND SLURRY BLASTING.
4. REMCO'S GLASS MAX SYSTEM, CALIFORNIA, PRODUCES A FINE GRIND GLASS PARTICLE BY UTILIZING A COMBINATION AUTOGENETIC GRINDER WITH DIFFERENTIAL GRINDING CAPABILITIES TO PRODUCE FURNACE READY CULLET. PARTICLE SHAPE APPEARS MORE CUBOIDAL THAN ROUND.

REMCO MARKETS MACHINERY ONLY AND HAS NOT FOCUSED ON AN END USE OF ITS FINE GRIND CULLET AS AN ABRASIVE.

6. TRI-VITRO,WASHINGTON, PRODUCES AN ABRASIVE UNDER THE BRAND NAMES VITRO-GRIT AND VITRO HUE UTILIZING BOTH RECYCLED CONTAINER GLASS AND MIXED PLATE GLASS IN THEIR PRODUCTION.
7. UNIVERSAL GROUND CULLET, OHIO, MANUFACTURERS OF A GLASS ABRASIVE UNDER THE BRAND NAME FASTBLAST EMPLOYS PRIMARILY TYPE A CONTAINER GLASS ALONG WITH SOME PLATE GLASS ABRASIVES.
8. GLASS BEADS PRODUCED BY POTTER INDUSTRIES, ONE OF MANY COMPANIES PRODUCING THIS STYLE MEDIUM MAKES NOTE IN ITS' LITERATURE " THE GREATEST USE OF GLASS BEADS FOR GENERAL CLEANING, DEBURRING AND DECORATIVE FINISHING.....ALONG WITH PEENING."

LIKE SANDS, SLAGS AND GARNETS NOT ALL GLASS ARE ALIKE. THE PHYSICAL AND MECHANICAL PROPERTIES CHARACTERISTIC OF DIFFERENT TYPE GLASS ARE A FUNCTION OF GLASS COMPOSITION. BY TAKING A STANDARD SODA-LIME-SILICATE GLASS FORMULATION AND ADDING ALUMINA DURABILITY WILL BE ENHANCED; BY ADDING BORON, THE TENDENCY FOR GLASS TO CRYSTALLIZE IS REDUCED. CROWN GLASS FOR WINDOWS IS A HARDENED WHITE SODA-LIME-SILICATE GLASS. WHEREAS, FLINT GLASS FOR WINDOWS IS A HIGHLY TRANSPARENT SODA-LIME QUARTZ GLASS. NEW COMPOSITIONS OF SILICATE GLASSES ARE ALWAYS BEING DEVELOPED FOR NEW APPLICATIONS. ADDITIVES ACCOUNT FOR OR ALTER PROPERTIES SUCH AS BRITTLENESS, DURABILITY, ELECTRICAL CONDUCTIVITY, LOWER MELTING TEMPERATURES WHICH IN TURN PROVIDE FOR TOUGHENED OR HARDENED GLASS, LAMINATED OR WIRED GLASS, WINDOW OR PANE GLASS, WINDSHIELD AND PLATE GLASS,LAMP ENVELOPES, TEMPERED GLASS, MIRRORS, INSULATING GLASS, GLASS FIBER AND SO ON.

LIKEWISE THE COMPOSITION OF THE ABRASIVE AND ITS PHYSICAL CHARACTERISTICS WILL BE DEPENDENT ON THE TYPE OF GLASS BEING RECYCLED AND TO A CERTAIN EXTENT THE RATIO OF DIFFERENT TYPES OF GLASS WITHIN THE MIX. IN ORDER TO INSURE QUALITY AND RELIABILITY THE MANUFACTURER OF A GIVEN BRAND WOULD HAVE TO ASSURE ITS CLIENTS THAT THE COMPOSITION OF ITS MIX WOULD BE MAINTAINED A CONSTANT IN ORDER TO INSURE RELIABLE AND PREDICTABLE RESULTS FROM BATCH TO BATCH.

THE NEEDS OF THE ABRASIVE INDUSTRY IS RAPIDLY CHANGING AND THE ABRASIVE THEY USE MUST ALSO KEEP PACE. ENVIRONMENTAL AND WORKER HEALTH ISSUES ARE BECOMING PARAMOUNT. TYPE A CONTAINER GLASS APPEARS TO BE ONE ANSWER. IT IS AN INERT MEDIUM, CONTAINS NO FREE SILICA OR HEAVY METALS, PRELIMINARY EVIDENCE SUGGESTS THAT IT IS NEARLY DUSTLESS, REUSEABLE AND BOTH ENVIRONMENTAL AND WORKER FRIENDLY. COUPLED WITH A PROCESS THAT PROVIDES THE PROPER PHYSICAL SHAPE FOR THE ABRASIVE PURPOSE INTENDED, GLASS CAN BE AN ECONOMICAL ALTERNATIVE TO SILICA SAND, SLAGS, GARNET, AND OTHER TYPE MEDIA.

FOR THE NIOSH STUDY TO BE ALL ENCOMPASSING OR COMPLETE, IT WOULD BE NECESSARY TO PROVIDE THE NEWCOMERS VIZ., GLASS ABRASIVE MANUFACTURERS AN OPPORTUNITY TO BE TESTED IN A SIMILAR FASHION AS SAND, SLAGS OR GARNETS USING THE SAME KTA TEST PROTOCOLS ASSIGNED TO THIS FIRST GROUP OF 41 ABRASIVES. IN LIGHT OF THE SPARCITY OF GLASS ABRASIVE REPRESENTATION IN THIS INITIAL NIOSH STUDY, I WOULD SUGGEST THE INDUSTRY LEADERS - KEEP AN OPEN MIND FOR GLASS WILL BE THE FUTURE AS SAND AND SLAGS ARE PHASED OUT.

DuPont White Pigment
and Mineral Products
1007 Market Street
Wilmington, DE 19898

DuPont White Pigment
and Mineral Products

April 18, 1996

Mr. Michael F. MeLampy
KTA/SET Environmental
115 Technology Drive
Pittsburgh, PA 15275
Fax 412-788-1306

Dear Mr. MeLampy,

Thank you for selecting Starblast as one of the blasting abrasive to be tested under your contract with NIOSH. The completed questionnaire is included with this fax. I will send product information along with an MSDS by mail.

I have indicated that we prefer the 0.25 inch orifice in the metering valve used for testing. Please be aware this is an estimate only because, as I'm sure you know, your method of feeding abrasive through an orifice is unique. Unfortunately, due to the tight timing requirements of your testing I was unable to more accurately determine which orifice is appropriate. I have asked one of our distributors to do some testing to better determine the best orifice size but that won't be completed for at least a week. I will call you if I feel you should use a different orifice size with Starblast than the 0.25 inch.

Optimal blasting conditions for Starblast and how to achieve them differ considerably from other blasting abrasives such as coal slag or silica sand. The reason for these differences are due to the nature of the Starblast particle. Since those particles are heavier than most sands and are sub-angular (rounded) instead of having sharp points, Starblast removes rust, scale and coatings by impingement or peening. The speed the Starblast particle is moving when it hits the surface being blasted along with its heavy weight causes a lot of energy to be transferred from the particle to the surface, knocking off the rust, scale or coating. This action is different than sharp particles of sand or slag that actually cut through the coating.

Understanding the way Starblast works helps explain what needs to be done to optimize its performance. You must use a very lean mixture of Starblast in the air stream. Normally, we recommend you close the abrasive feed valve to the point where you can hardly see the Starblast exiting the blast nozzle, then close the feed valve just a little more. (If you start to hear a whistling sound from the nozzle you have closed the valve too much.) When blasting with Starblast be sure you blast at the proper angle, about 15-30 degrees off perpendicular, and at a distance of 2-3 feet. If the Starblast doesn't seem to be working well, blasting is too slow or it has difficulty removing the coating, make small

adjustments to the abrasive feed. In most cases, the best adjustment is to REDUCE the amount of Starblast being fed to the blast nozzle. This is opposite to what most blasting abrasives require for improved performance. However, if too much Starblast is fed it will overwhelm the air flow and the sand will come out the nozzle in slugs. Since Starblast is heavier than most sands, the same amount of air accelerates less Starblast to the proper particle speed for efficient blasting than other lighter abrasives. Starblast particles at a lower blasting speed will reduce efficiency greatly. Remember, more is not better with Starblast.

Please call me on 615-831-0091 if you have any questions. Thank you again for this opportunity.

Sincerely,

John R Crowder
Abrasives Manager

BARTON

Barton Mines Corporation
P.O. Box 591
Lake George
New York 12845

Telephone 518 798 5462
Facsimile 518 798 5728

April 23, 1996

Mr. Michael F. MeLampy
Project Supervisor
KTA/SET Environmental
115 Technology Drive
Pittsburgh, PA 15275

Dear Mike:

Thank you for your time on the phone yesterday. I have enclosed a copy of the NIOSH Abrasive Substitutes Study Questionnaire that I faxed to you on Thursday, April 18. You will also find enclosed some technical information and a MSDS for Barton GMA garnet.

As mentioned in my fax of April 18, 1996 and our phone conversation yesterday, Barton Mines has a few concerns over how the study is being conducted. We feel that testing of individual abrasives should be done according to the recommendations of abrasive suppliers . Of particular concern for Barton Mines is the method being used to meter abrasive flow. Because of the number of variables involved in blasting, Barton Mines recommends that metering be adjusted by the operator to achieve an appropriate balance between productivity and abrasive consumption. I have enclosed a copy of General Blasting Guidelines for GMA Garnet which summarizes our recommendations for maximizing the performance of Barton GMA garnet. We feel that any effort to measure the economic effectiveness of GMA garnet should be undertaken using practices consistent with our recommendations.

Regarding the list of distributors provided on the questionnaire, Barton Mines has a number of other distributors which carry our GMA garnet, but none of them serve the cities you have listed. In the cities where we do not have distributors, both small and large quantities of Barton GMA garnet can be supplied at competitive prices on a direct basis.

Barton Mines looks forward to suppling GMA garnet for this study and I would be happy to discuss any of the above items at your convenience.

Sincerely,

BARTON MINES CORPORATION

Timothy Q. Conboy
Manager - Blast Media

Encs.

Permission has been obtained from the company to reproduce and disseminate the information in this telefax.

CHESAPEAKE SPECIALTY PRODUCTS
3055 NORTH POINT BLVD./ BALTIMORE, MD 21219
(410) 388-5055 Fax (410) 388-5194

595331-14R

FACSIMILE COVER SHEET

DATE: May 29, 1996 TIME: 3:00p

TO: Mike MeLampy

FROM: Bill Hitzrot

NUMBER OF PAGES INCLUDING COVER SHEET: 3

COMMENTS: Our comments concerning the NIOSH test program. Please call and we can discuss.

Thanks, Bill

CONFIDENTIALITY NOTICE: This facsimile contains confidential information which may also be legally privileged and which is intended only for the use of the Addressee(s) named above. If you are not the intended recipient, or the employee or agent responsible for delivering it to the intended recipient, you are hereby notified that any dissemination of copying of this facsimile, or the taking of any action in reliance on the contents of this telecopied information, may be strictly prohibited. If you have received this facsimile in error, please notify us immediately by telephone and return the entire facsimile to us at the above address via U.S. Postal Service. Thank you.

CHESAPEAKE SPECIALTY PRODUCTS
5055 NORTH POINT BLVD./ BALTIMORE, MD 21219
(410) 388-5055 Fax (410) 328-5194

May 29, 1996

Mr. Michael F. MeLampy
KTA/SET Environmental
115 Technology Drive
Pittsburgh, Pennsylvania 15275

Dear Mr. MeLampy:

Thank you for selecting Chesapeake Specialty Products' METgrain steel abrasive for testing in the NIOSH test program. As I mentioned to you we, at Chesapeake Specialty Products, have some strong reservations about the way this test program is being conducted. Let me outline the source of these reservations.

- If the purpose of the program is to reduce airborne silica dust then use any of the available low free silica abrasives available on the market. This does not require a major test program.
- If dust generation is the major problem, then conduct the test in a confined space and compare visibility during blasting.
- If production rates during blasting are the issue then use nozzle pressures that take advantage of an abrasives ability to perform at pressures >100 psi.
- Abrasive particle size can make a significant impact on cleaning rate; small particles at high (>120 psi) nozzle pressure will increase cleaning rates 50% or more.
- For recyclable abrasives, a working mix will out-perform new abrasive. For example, evaluating new G-40 steel abrasive is not a valid indication of performance.
- Angle of attack is also critical. Blasting at 90° to the surface will not give as good a performance as blasting say at 70-80° to the surface.
- Surface condition prior to blast determines whether a round or angular, soft or hard, coarse or fine abrasive should be used.
- The ability of the blaster to recognize differences in blasting rates and therefore move faster or slower to compensate for the differences.

CHESAPEAKE SPECIALTY PRODUCTS

These are just a few of the problems we see with this generalized approach to evaluating abrasive performance. Your limit of 100 psi and a single orifice does not allow for the full potential of most abrasive products.

Let me know your thoughts.

Very truly yours,

Bill Hitzrot,
Vice President

File: CSPCorr/KTASET

CHESAPEAKE SPECIALTY PRODUCTS
5055 NORTH POINT BLVD./ BALTIMORE, MD 21219
(410) 388-5055 Fax: (410) 388-5194

DON E. SANCHEZ
President

December 19, 1996

Mr. Kenneth Trimber
KTA/SET Environmental
115 Technology Drive
Pittsburgh, PA 15275

Dear Mr. Trimber:

Based on the information you presented at the SSPC Conference, concerning the NIOSH Test comparing various abrasives, it is obvious that the test was poorly conceived and executed. As knowledgeable as KTA/SET claims to be about blasting , it is amazing that you did not call off the presentation of the preliminary results when the results were clearly contrary to common knowledge of experienced blasters. The conclusions that were presented, even though couched as preliminary were very damaging to the image of Steel Abrasive and the marketing of Chesapeake Specialty Products METgrain abrasive. We at Chesapeake have had a continual problem with overcoming misconceptions and misinformation in the bridge blasting industry about METgrain. Regrettably much of our problems have come from KTA/Set personnel. What is particularly disturbing is that anyone with knowledge of blasting with steel should recognize that the conclusions of the test were contrary to actual results in the field. If KTA/SET were applying proper science it would have gone through the proper steps of scientific experimentation before releasing any data which is intuitively wrong. Using the excuse of a limited NIOSH budget is not acceptable.

You will note that the enclosed letter sent by Bill Hitzrot on May 29, prior to the test run, stated that we had serious reservations about the test procedures contemplated. We also had a phone conversation with Mr. MeLampy, pointing out other reservations which were totally ignored.

Enclosed is our suggested protocol for testing abrasives for the NIOSH Test program. While it is not perfect, it will at least provide a more accurate indication of what can be expected in field application with various abrasives. We are willing to assist in the test procedures and will be glad to meet with you and representatives of NIOSH to establish appropriate protocol for testing.

Please call my office after you have had an opportunity to review the attached.

Sincerely,

/s/ Don E. Sanchez

Protocol for Abrasive Test

Objective: Evaluation of Substitutes for Silica Sand and other potentially hazardous abrasive media which may place abrasive blasters at risk.

I . Ascertain the system that provides the optimum production rate for each type of abrasive given the following variables;

A. Nozzle pressure of 1) 100 psi; 2) 125 psi; 3) 150 psi
B. Nozzle type: 1) # 6 straight 2)# 8 bazooka
C. Determine optimum metering valve setting to maximize production rate for each of the six variables by adjusting an adjustable feed metering valve (such as Schmidt) by experimentation at selected valve openings.
D. Hose size - 11/2 inch, no whip.

II. PRODUCTIVITY TEST: Procedure will be to test blast 25 sq. ft. test plate containing mill scale and light rust to an SP-5, using the optimum metering valve setting for each variable listed above.

A. Readings for profile and elapsed time for each test will be taken.
B. Video recording of each test will be made to assure proper blasting technique for each test run and record visible dust emissions.
C. Video will also be used to confirm production rates.

III. DUST GENERATION TEST: Utilizing the optimum system production rate setup based upon the above results, for each type of abrasive, quantify the amount of dust generated per square foot cleaned.

A. Procedure will be to blast a fixed steel plate in a contained blast cabinet utilizing 50 lbs. of abrasive utilizing a fixed nozzle, 18 inches from blast surface.
B. Remove any remaining abrasive from blast pot and weigh.
C. All used media will be recovered and screened on 140 mesh screen. Weight of abrasive retained on screen shall be subtracted from 50 lbs. (beginning weight) minus any abrasive left in blast pot to determine quantity of dust generated.
D. Samples of abrasive dust (minus 140 mesh) will be collected and tested at laboratory for hazardous content

IV. Abrasive recyclability shall be determined by screening used abrasive recovered from blast cabinet and screening on 70 mesh screen and weighing abrasive retained thereon and recording. All retained abrasive will be replenished with additional abrasive to total 50 lbs., then blasted. and the process repeated. Test will be repeated maximum of 10 times and recyclability will be projected by extrapolation for any abrasive which does not require cumulative of 50 lbs. of make up abrasive.

V. Calculate abrasive application rate per sq. ft. cleaned and the abrasive consumption rate per square foot cleaned based upon recyclability.

VI. Calculate the cost per square foot for abrasive media consumed based upon published selling price divided by the number of calculated recycles.

VII. Calculate the cleaning rate (sq. ft./ hr) for each test run.

VII. Submit data for technical review and comment of all abrasive manufacturers who submit product for test prior to publication.

NIOSH PROJECT- - - - - 1996

EVALUATION OF SUBSTITUTES FOR SILICA SAND IN ABRASIVE BLASTING

5/1/96: (EAB) OBSERVATIONS RE TEST PROCEDURE WHEN COMPARING CAST STEEL SHOT/GRIT VS. SILICA SAND OR OTHER NON-METALLIC SUBSTITUTES.

THE GOAL OF THE PROJECT: "TO DEVELOP COMPARATIVE HEALTH-RELATED, ECONOMIC, AND TECHNICAL DATA REGARDING SILICA SAND AND SEVEN SUBSTITUTES FOR SILICA SAND WHICH COULD HELP PREVENT SILICOSIS AND DEATHS FROM SANDBLASTING."

THE TECHNICAL AND ECONOMIC FACTORS TO BE EVALUATED WILL INCLUDE: PRICE PER TON OF DELIVERED ABRASIVE; RECYCLABILITY AND NUMBER OF RE-USES; EQUIPMENT COST; LABOR COST; CLEANING RATE IN SQUARE FEET PER HOUR; DISPOSAL COST; AND TOTAL OPERATING COST COVERING ALL FACTORS.

EVALUATION WILL BE MADE BOTH IN A CONTROLLED LABORATORY OR ENCLOSED BOOTH SIMULATING AN ACTUAL ABRASIVE BLASTING OPERATION- - -AND IN A FIELD SITE STUDY AT ACTUAL WORK SITES, WITH THE SAME FACTORS USED IN THE LABORATORY STUDY.

THERE IS MUCH ABOUT THIS PROJECT THAT BRINGS TO MIND YOGI BERRA'S "IT'S DEJA VU ALL OVER AGAIN." IN THE MID-1930'S <u>IN-PLANT</u> SANDBLASTING WAS PROHIBITED BECAUSE OF THE SILICOSIS HAZARD- - -METAL SHOT AND GRIT (THEN CAST-IRON, BUT CAST STEEL TODAY) WAS THE SUBSTITUTE UNIVERSALLY ADOPTED AND ACCEPTED AS THE SOLUTION TO THE PROBLEM. INTERESTINGLY, THE REASON CAST IRON ABRASIVE WAS AVAILABLE AS A SUBSTITUTE WAS BECAUSE YEARS EARLIER IT HAD BECOME THE SUBSTITUTE FOR SAND USED IN SAWING AND POLISHING GRANITE. WHY? BECAUSE OF THE ECONOMICS: IRON ABRASIVE COULD BE RECYCLED MANY TIMES- - - ONE TON DID THE WORK OF SEVERAL HUNDRED TONS OF SAND, AND DID ITS WORK MANY TIMES FASTER.

TECHNICALLY, THIS NEW NIOSH STUDY MIGHT BETTER BE DESCRIBED AS SEEKING SUBSTITUTES FOR SILICA SAND USED IN <u>OUTDOOR (FIELD) BLASTCLEANING OPERATIONS</u> (BRIDGES, TANKS, ETC.). THE OBVIOUS QUESTION: SINCE CAST STEEL SHOT/GRIT HAS PROVED EFFECTIVE, BOTH ENVIRONMENTALLY AND ECONOMICALLY, FOR OVER 40 YEARS FOR <u>IN-PLANT</u> BLASTCLEANING APPLICATIONS, WHY HAS IT NOT BEEN MORE WIDELY ADOPTED FOR <u>OUTDOOR</u> APPLICATIONS?

EAB RECALLS A CONVERSATION HELD WITH A MAJOR SANDBLASTING CONTRACTOR IN 1977. WHEN ASKED WHY- - -GIVEN THE POSITIVE BENEFITS REALIZED ON BOTH THE ECONOMIC AND ENVIRONMENTAL ASPECTS WHEN CONVERTING FROM SAND TO METALLIC ABRASIVES WITH IN-PLANT BLASTCLEANING- - -WHY HADN'T MORE PROGRESS BEEN MADE IN CONVERTING FIELD BLASTCLEANING TO RECYCLABLE METALLIC ABRASIVES, THE RESPONSE WAS: (1) "THE CAPABILITY FOR RECOVERING AND RECYCLING HAS NOT YET BEEN DEVELOPED- - -IT IS STILL A ONE-TIME USE, AND THEREFORE A NEGATIVE VS. SAND;" (2) "THERE IS GREAT CONCERN THAT OSHA WOULD PUT SMALL CONTRACTORS OUT OF BUSINESS, BECAUSE CAPITAL REQUIREMENTS WERE TOO AGGRESSIVE."

IN A DISCUSSION WITH A MANUFACTURER OF BLASTCLEANING EQUIPMENT IN 1980,THE PARTY WAS KNOWLEDGEABLE ABOUT BLASTCLEANING IN GERMANY- - -"CONVERSION THERE TOOK PLACE SIMPLY BECAUSE IT WAS FORCED UPON THE INDUSTRY." (THIS MIRRORS THE EXPERIENCE IN THE U.S. IN THE 1930'S.) IT WAS STATED THAT THE SAND-BLAST INDUSTRY IN 1980 WAS MADE UP OF MOSTLY SMALL, INDEPENDENT CONTRACTORS WHO WOULD FIND THE COST OF CONVERSION PROHIBITIVE.

MORE RECENTLY, DISPOSAL OF CONTAMINATED WASTE FROM BLASTCLEANING OPERATIONS HAS BECOME A MAJOR FACTOR IN ASSESSING TOTAL COSTS OF BLAST-CLEANING. ARTICLES APPEARING IN THE "JOURNAL OF PROTECTIVE COATINGS AND LININGS" IN 1991 AND 1992 ARE OF INTEREST. HERE ARE SOME QUOTES:

"RECYCLABLE STEEL GRIT BLASTING PROVIDES THE LOWEST COST METHOD FOR A NEAR WHITE SURFACE PREPARATION AND YET COMPLIES WITH ALL THE ENVIRONMENTAL REGULATIONS THAT RESTRICT CONVENTIONAL BLASTING TODAY. NEW GENERATIONS OF RECYCLING MACHINES MAY CLEAN THE RECYCLED GRIT MORE THOROUGHLY, THEREBY MINIMIZING THE NEED FOR EXPENSIVE CONTAINMENT AND MACHINERY TO ACHIEVE NEGATIVE AIR PRESSSURE. OUR COUNTRY CANNOT AFFORD TO BE ENVIRONMENTALLY IRRESPONSIBLE WHEN ALTERNATIVE METHODS SUCH AS RECYCLING EXIST THAT ARE COST-EFFECTIVE AND SAFE."

FROM A CONTRACTOR INTERESTED IN BIDDING ON A BRIDGE PROJECT: "THE PROJECT SEEMED TO BE ONE THAT COULD BE DONE EFFECTIVELY WITH OUR NEW EQUIPMENT FOR USING RECYCLABLE STEEL GRIT. THE COUP DE GRACE TO OUR PLANS FOR USING THE NEWLY DEVELOPED MACHINES: THE COST FOR DISPOSAL OF THE SANDBLAST RESIDUE WOULD BE PAID BY THE STATE- - -ANY AMOUNT OF WASTE GENERATED WOULD BE PAID BY THE STATE AT A UNIT PRICE PER TON. CONTRACTORS BIDDING ON THE PROJECT DO NOT HAVE TO CHANGE THE BLAST SYSTEM OR TRY TO REDUCE THE AMOUNT OF WASTE BECAUSE THEY ARE BEING PAID TO CREATE WASTE. HOW COULD THE CONTRACTOR WHO DID SPEND MONEY ON NEW TECHNOLOGIES COMPETE AGAINST THE CONTRACTOR WHO WILL CONTINUE TO USE THE OLD METHODS AND NOT SUFFER ANY CONSEQUENCES?"

"GOVERNMENTAL REGULATIONS IN THE AREA OF HAZARDOUS WASTE, BOTH STATE AND FEDERAL, HAVE BROUGHT US TO THE NORM TODAY WHERE RECYCLABLE ABRASIVES ARE BEING USED IN MOST TANK LINING AND CONTAINMENT WORK. EQUIPMENT DESIGNED TO USE STEEL GRIT RELIES ON THE CLASSIFIER TO CLEAN THE GRIT FOR REUSE. THE LAST SEVERAL YEARS HAVE SHOWN GREAT ADVANCES IN THE CLASSIFICATION OF THE GRIT. RECYCLABLE ABRASIVES, SUCH AS STEEL GRIT, REDUCE THE AMOUNT OF HAZARDOUS WASTE AND THEREFORE THE COST OF DISPOSAL, WHICH CAN COMPRISE A LARGE PART OF THE COST OF ANY COATING PROJECT.

"THE ECONOMICS OF DISPOSAL MADE US AWARE THAT RECYCLABLE ABRASIVES WERE ECONOMICALLY FEASIBLE. THEY INCREASED PRODUCTION AS WELL, AN INSIGHT SHOP BLASTING OWNER/OPERATORS HAD KNOWN ABOUT FOR YEARS. THE FIELD USE OF OF RECYCLABLE ABRASIVES, (I.E., STEEL GRIT) HAD BEEN RESISTED FOR YEARS BY MOST COATING CONTRACTORS. PROBLEMS WITH CONTAINMENT OF THE GRIT, MOISTURE, THE NEED FOR SPECIALIZED EQUIPMENT, AND THE FEAR OF CHANGE ITSELF WERE ALL CITED AS REASONS CONTRACTORS WOULD NOT USE RECYCLABLE ABRASIVES IN THE FIELD."

NEWS FROM THE FIELD- - -REPORT ON A COMPLETED CONTRACT WHERE STEEL GRIT WAS USED: "SAVING IN STEEL GRIT AND IN DISPOSAL COSTS WERE RECOGNIZED, EXCEEDING EXPECTATIONS. IF A NON-RECYCLABLE ABRASIVE HAD BEEN SPECIFIED IN LIEU OF THE RECYCLABLE STEEL GRIT, THE COST OF THE PROJECT WOULD HAVE BEEN INCREASED BY AN ESTIMATED $1.3 MILLION. THE ABRASIVE AND PAINT DEBRIS COLLECTED WAS REDUCED BY NEARLY 98% OF WHAT COULD HAVE BEEN EXPECTED HAD NON-RECYCLABLE ABRASIVES BEEN USED."

UNDOUBTEDLY CONTRIBUTING TO RELUCTANCE ON PART OF CONTRACTORS TO CONVERT TO STEEL GRIT IS PUBLISHED TEST DATA BASED ON FAULTY TEST PROCEDURES, WITH RESULTS THAT ARE TOTALLY CONTRARY TO ACTUAL RESULTS IN SHOP PRACTICE AS EXPERIENCED SINCE THE 1930'S. FOR EXAMPLE:

ABRASIVE CONSUMPTION SAND @ 2.6 LBS/SQ.FT.
STEEL GRIT @ 5.5 LBS/SQ.FT.

PRODUCTION RATE: SAND @ 285 SQ.FT./HOUR
STEEL GRIT @ 184 SQ. FT./HOUR

AND ANOTHER TEST REPORT CIRCULATED:

USAGE RATE: SAND @ 5.5 LBS/SQ. FT.
STEEL GRIT @ 6.3 LBS/SQ. FT.

ABRASIVE COST: SAND @ $0.20 PER SQ. FT.
STEEL GRIT @ $1.48 PER SQ. FT.

(THIS DATA WOULD CERTAINLY MAKE A CONTRACTOR THINK MORE THAN TWICE BEFORE JUMPING ON THE CONVERSION BANDWAGON. IT WAS IN THE INTEREST OF WANTING TO MAKE SURE THE NIOSH TESTING CONDUCTED IN THE CURRENT PROJECT DOES NOT MAKE THE SAME MISLEADING TEST-PROCEDURE ERRORS THAT OCCURRED IN THESE ABOVE TESTS, THAT WE CONTACTED MARK GRESKEVITCH AT NIOSH, AND UPON HIS RECOMMENDATION, ALSO CONTACTED MIKE MELAMPY AT KTA/SET ENVIRONMENTAL.

AS LONG AS THE ENVIRONMENTAL RESTRICTIONS AND REQUIREMENTS FOR OUTDOOR (FIELD) BLASTCLEANING ARE NOT AS STRINGENT AS FOR IN-PLANT OPERATIONS, THE PRIMARY INCENTIVE TO CHANGE TO CAST STEEL SHOT/GRIT IS THE "ECONOMICS" FACTOR. THE OBVIOUS FIRST ECONOMIC ADVANTAGE FOR CAST STEEL SHOT OR GRIT IS ITS RECYCLABILITY. (THIS IS ONE FACTOR THAT THE ABOVE TESTS FAILED TO TAKE INTO ACCOUNT- - -FLOW RATE WAS CONSIDERED AS CONSUMPTION, AS IT IS WITH SAND, BUT NOT WITH STEEL ABRASIVES.)

TO TAKE ADVANTAGE OF STEEL'S GREATER USE-LIFE, PROVISION MUST BE MADE TO RECAPTURE IT AND CAREFULLY MONITOR THE AIR-WASH SEPARATOR TO ASSURE THAT ONLY SPENT ABRASIVE AND PULVERIZED CONTAMINANTS ARE SENT TO THE DUST COLLECTOR, AND USABLE ABRASIVE IS RETURNED FOR RECYCLING, ALONG WITH THE NEW ABRASIVE ADDITION, THUS DEVELOPING THE PROPERLY BALANCED WORK-MIX SO ESSENTIAL FOR FAST AND EFFECTIVE CLEANING-PROFILING. (THIS IS ANOTHER FACTOR THE ABOVE TESTS FAILED TO RECOGNIZE- - -THAT STEEL GRIT DEVELOPS A WORK-MIX THAT CAN HAVE UP TO FOUR TIMES MORE PARTICLES PER POUND VS.THE NEW GRIT USED IN THEIR TESTS.)

FOR CONTRACTORS USED TO "ONE PASS AND GONE" WHEN USING SAND, INVESTMENT IN PROPER CONTAINMENT FACILITIES AND AN EFFECTIVE AND EFFICIENT AIR-WASH SYSTEM MAY SEEM OVERWHELMING, JUST AS IT MUST HAVE TO THOSE IN-PLANT OPERATORS BACK IN THE 1930'S. YET, WITHOUT EXCEPTION, THE CHANGE PROVED TO HAVE TREMENDOUS ECONOMIC ADVANTAGE. ONE TON OF CHILLED IRON SHOT OR GRIT WAS FOUND TO DO THE WORK OF 40-PLUS TONS OF SAND! THAT WAS THEN- - -THE ECONOMIC AND ENVIRONMENTAL GAIN POTENTIAL IS MUCH, MUCH GREATER TODAY.

FROM THE STANDPOINT OF HEALTH-RELATED CONCERNS, SAND NOT ONLY HAS THE SILICOSIS HAZARD FOR THE OPERATOR DUE TO THE MANY POUNDS PER HOUR OF SAND DISINTEGRATING INTO DUST DURING BLASTING, BUT IT ALSO GENERATES MANY, MANY TIMES THE AMOUNT OF CONTAMINATED WASTE TO BE DISPOSED OF COMPARED TO STEEL GRIT, AS REPORTED IN THE STORY QUOTED EARLIER.

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BEFORE MAKING THE SWITCH FROM SAND TO STEEL ABRASIVE, THESE ARE SOME OF THE FACTORS THAT MUST BE CONSIDERED AND UNDERSTOOD:

IN 1870, GENERAL BENJAMIN TILGHMAN OBTAINED A PATENT FOR "A METHOD OF IMPELLING SAND BY A PRESSURE BLASTING SYSTEM." TO DESCRIBE HOW THE SYSTEM PERFORMED ITS FUNCTION, HE STATED: "IT IS AN IMPACT CLEANING OPERATION THAT IS NEITHER CUTTING, GRINDING, NOR ABRADING. IT IS ESSENTIALLY A POUNDING, BATTERING, OR BOMBARDING OF THE WORK SURFACE BY SUCCESSIVE IMPACT OF THE FLYING ABRASIVE."

THE FORMULA FOR KINETIC ENERGY (OR, IMPACT POWER) IS:
ONE HALF MASS TIMES VELOCITY SQUARED.

THUS, THE AMOUNT OF WORK BLASTCLEANED-PROFILED IN AN HOUR DEPENDS ON THE RELATIVE MASS OF THE MEDIA- - -ITS VELOCITY- - -AND, THE NUMBER OF PARTICLES THROWN AT THE WORK PER HOUR.

MASS IS DETERMINED BY MEDIA SIZE AND DENSITY. IMPORTANT TO KNOW:
CAST STEEL HAS 2-1/2 TIMES THE DENSITY OF SAND.

THUS, SIZE FOR SIZE, AND THROWN AT THE SAME VELOCITY, EACH PARTICLE OF STEEL SHOT OR GRIT DELIVERS 2-1/2 TIMES THE IMPACT POWER, OR CLEANING POWER, OF THE SAND PARTICLES.

AT THE SAME VOLUME OF STEEL OR SAND IN AN AIR-BLAST POT, THE STEEL WILL WEIGH 2-1/2 TIMES MORE THAN THE SAND- - -I.E. A FULL POT HOLDING 3,000 POUNDS OF SAND, WOULD HOLD 7,000 POUNDS OF STEEL SHOT/GRIT. AND, SIZE FOR SIZE, A POT FILLED WITH SAND OR WITH STEEL (THE SAME VOLUME), WOULD CONTAIN THE SAME NUMBER OF PARTICLES.

IF THE SAME WEIGHT OF STEEL OR SAND IS PUT IN A POT, THE SAND LEVEL IN THE POT WILL BE 2-1/2 TIMES HIGHER THAN THE STEEL, AND THE SAND WILL HAVE APPROXIMATELY 2-1/2 TIMES THE NUMBER OF PARTICLES. THUS, SIZE FOR SIZE, EACH POUND OF SAND WILL HAVE 2-1/2 TIMES THE NUMBER OF PARTICLES, BUT- - - - - - - - - -

WHEN USING SAND (ONE PASS AND GONE), ONLY ORIGINAL SIZE SAND IS THROWN AT THE WORK. HOWEVER, WHEN USING STEEL, NOT ONLY IS ALL ORIGINAL SIZE SHOT OR GRIT RECYCLED, BUT FRACTURED SMALLER PARTICLES ARE ALSO RETAINED IN THE WORK-MIX AND RECYCLED. DUE TO STEEL'S HIGH DENSITY FACTOR, THESE SMALLER PARTICLES STILL CAN DELIVER SUFFICIENT IMPACT POWER TO REMOVE MILL SCALE, ETC. (THE LARGE, ORIGINAL SIZE STEEL PARTICLES BREAK AND LOOSEN THICK, TIGHTLY ADHERING CONTAMINANTS- - -THE SMALLER PARTICLES PROVIDE THE COVERAGE NECESSARY FOR FAST REMOVAL OF THE LIGHTER CONTAMINANTS, AND SCOUR AND CLEAN RUST, ETC. FROM MINUTE SURFACE PITS AND CREVICES.) THE SMALLER THE SIZE PARTICLE, THE GREATER THE NUMBER OF PARTICLES PER POUND- - -THUS, THE PROPER MIX OF SIZES IN A STEEL SHOT OR GRIT WORK-MIX CAN RESULT IN A PARTICLE COUNT PER POUND EQUAL TO OR GREATER THAN THAT OF SAND.

IN CENTRIFUGAL BLASTCLEANING, VELOCITY IS DETERMINED BY WHEEL DIAMETER AND RPM. MOST COMMONLY, THE VELOCITY IS APPROXIMATELY 245 FEET PER SECOND, WHICH HAS BEEN FOUND TO REMOVE CONTAMINANT RAPIDLY AND PRODUCE THE REQUIRED PROFILE, WITH THE BEST BALANCE BETWEEN CLEANING SPEED AND ABRASIVE LIFE. (IN AIR-BLAST, IT HAS BEEN CALCULATED THAT AT 85-90 PSI, THE VELOCITY WILL ALSO APPROXIMATE 245 FPS AVERAGE.)

IN THE CASE OF SAND, IT IS STILL "ONE PASS AND GONE" WHETHER THE VELOCITY IS 200 FPS OR 300 FPS. HOWEVER, WHEN USING STEEL ABRASIVE, INCREASING VELOCITY ABOVE THE 245 FPS, HAS THE NEGATIVE EFFECT OF INCREASING ABRASIVE CONSUMPTION (10% GREATER VELOCITY CAN INCREASE CONSUMPTION BY AS MUCH AS 20%). BUT, SINCE INCREASED PSI WILL INCREASE THE ABRASIVE VELOCITY AND FLOW RATE, IT THEN BECOMES A MATTER OF CHOICE BETWEEN FASTER CLEANING AND HIGHER ABRASIVE USAGE. BUT, EITHER WAY, STEEL SHOT OR GRIT OFFERS TREMENDOUS ECONOMIC ADVANTAGE OVER NON-METALLICS.

THE VERSATILITY OF STEEL ABRASIVE ENABLES THE BLASTCLEANING OPERATOR TO TAILOR HIS SELECTION OF ABRASIVE TO SPECIFIC PRIORITIES. OF COURSE, FINISH & PROFILE IS ALWAYS THE #1 PRIORITY, BUT SPEED OF CLEANING AND ABRASIVE CONSUMPTION ARE IMPORTANT SECONDARY PRIORITIES. IN ADDITION TO THE CHOICE AS TO WHETHER A SHOT OR GRIT FINISH IS PREFERRED, THERE IS A WIDE SELECTION OF SIZES OF BOTH SHOT AND GRIT TO CHOOSE FROM, AND FOUR CHOICES OF ABRASIVE HARDNESS. 40-50 Rc IS MOST COMMONLY USED- - - HIGHER HARDNESS MAY CLEAN FASTER, BUT INCREASES ABRASIVE CONSUMPTION.

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IN THE MORE THAN 50 YEARS OF EXPERIENCE WITH IN-PLANT BLASTCLEANING WITH IRON AND STEEL SHOT AND GRIT- - -CLEANING STRUCTURAL STEEL (PLATES AND BARS, ETC.) RAILCARS, AS WELL AS FERROUS & NON-FERROUS CASTINGS, AND FORGINGS- - - MANY MAJOR CHANGES AND IMPROVEMENTS HAVE OCCURRED SINCE THE 1930'S.

NOT ONLY HAS THERE BEEN THE MAJOR IMPROVEMENT IN ABRASIVE QUALITY WITH THE CHANGE FROM IRON TO CAST STEEL ABRASIVES MADE IN ACCORDANCE WITH SAE SPECIFICATIONS, BUT EQUALLY GREAT IMPROVEMENT HAS OCCURRED IN BLASTCLEANING EQUIPMENT AIR-WASH SYSTEMS.

THE MOST DIFFICULT CHALLENGE FOR BLASTCLEANING OPERATORS SWITCHING FROM SAND TO CAST STEEL SHOT OR GRIT WAS HAVING TO DEAL WITH A PROPERLY BALANCED "WORK-MIX," WHICH REQUIRED COMPLETELY CHANGING THEIR AIR-WASH PRACTICE. WHEN USING "ONE PASS AND GONE" SAND, EVERY-THING WENT TO THE DUST COLLECTOR AND WASTE BIN- - -NOTHING WAS RECYCLED FOR RE-USE.

EARLY ON, AIR-BLAST SYSTEMS COULDN'T FINE-TUNE THE AIR-WASH SEPARATOR TO PULL OUT OF THE SYSTEM ALL THE CONTAMINANT-DUST, AND STILL RETAIN PARTICLES EQUIVALENT IN SIZE TO G-50 AND G-80 STEEL GRIT. AND, DESPITE THE FACT THAT G-40 SIZE STEEL GRIT WEIGHED 2-1/2 TIMES AS MUCH AS SAND OF THE SAME SIZE, THEY ALL TOO OFTEN PULLED ORIGINAL SIZE STEEL GRIT OUT OF THE SYSTEM, TOO. EVEN SO, IN THE 1930'S AND 1940'S, AIR-BLAST OPERATORS SWITCHING FROM SAND TO IRON FOUND THAT ONE TON OF CHILLED IRON DID THE WORK OF 40 TONS OF SAND.

WITH THE ADVENT OF CENTRIFUGAL BLASTCLEANING EQUIPMENT IN THE LATE 1930'S, THE MAIN CONCERN RELATIVE TO AIR-WASH SEPARATORS WAS TO MAKE SURE ALL CONTAMINANT WAS EXTRACTED, AS IT WAS FOUND THAT AS LITTLE AS ONE PERCENT FINE CONTAMINANT RETAINED IN THE RECYCLED WORK-MIX COULD DOUBLE THE WEAR ON THE BLAST-WHEEL COMPONENTS. UNFORTUNATELY, THE TENDENCY WAS TO PLAY SAFE ON THE CONTAMINANTS, WHICH MEANT EXCESS AIR FLOW PULLED OUT AND WASTED USABLE SHOT OR GRIT.

IN THE 1950'S STEEL ABRASIVES CAME INTO GENERAL USE. THE COMBINATION OF STEEL'S INHERENT GREATER DURABILITY VS. IRON, RESULTED IN BLASTCLEAN-ING OPERATORS FINDING THAT SWITCHING TO STEEL FROM SAND NOW MEANT, DEPENDING ON THE HARDNESS OF THE STEEL GRIT, THAT ONE TON OF CAST STEEL SHOT OR GRIT DID THE WORK OF 100 TO 200 TONS OF SAND.

DESPITE THE INEFFICIENCY IN AIR-WASH SYSTEMS, THE ECONOMIC ADVANTAGE OF CAST STEEL ABRASIVE OVER SAND WAS OBVIOUS, GIVEN THE RATIO OF 1:100 OR 1:200. BUT, THE HIGHER COST OF STEEL ABRASIVE COMPARED TO THE COST OF IRON, MADE IT IMPERATIVE THAT NO USABLE STEEL SHOT OR GRIT BE WASTED. BECAUSE OF THIS, CENTRIFUGAL BLAST SYSTEMS WERE REDESIGNED AND GREATLY IMPROVED, WITH EMPHASIS ON AIR-WASH SEPARATORS BEING ABLE TO REMOVE CONTAMINANTS FINER THAN 80-MESH, FOR EXAMPLE, WITHOUT PULLING OUT 80-MESH USABLE STEEL ABRASIVE.

NOW, IN THE 1990'S, MOST IN-PLANT BLASTCLEANERS CAN MAINTAIN PROPERLY BALANCED WORK-MIXES, WITH THE RESULT THAT CAST STEEL SHOT AND GRIT CAN BE RECYCLED MORE THAN 2,000 TIMES BEFORE ULTIMATELY BEING BROKEN DOWN, STAGE BY STAGE, INTO HALF-SIZE, QUARTER-SIZE, EIGHTH-SIZE, ETC., UNTIL FINALLY BECOMING EXHAUST-SIZE AND GOING TO THE DUST COLLECTOR.

TODAY, CAST STEEL HAS TOTALLY REPLACED IRON ABRASIVES. THANKS TO THE HIGH QUALITY ASSURED BY MEETING SAE SPECIFICATIONS FOR CAST STEEL ABRASIVES, PLUS THE EFFECTIVE AND EFFICIENT AIR-WASH SYSTEMS AVAILABLE, BLASTCLEANING WITH CAST STEEL SHOT AND GRIT IS BY FAR THE LEAST COSTLY.

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THE SUCCESS STORY OF TODAY'S LOW COST OF USING CAST STEEL ABRASIVES IN CENTRIFUGAL BLAST-EQUIPMENT SHOULD BE MADE KNOWN TO OUTDOOR(FIELD) AIR-BLAST OPERATORS- - -NOT TO SUGGEST CONVERTING TO CENTRIFUGAL BLASTCLEANING, BUT TO ALERT THEM TO THE NEED FOR IMPROVED CONTAINMENT SYSTEMS AND IMPROVED AIR-WASH SEPARATORS. CONSIDER THE FOLLOWING:

THE MAJOR U.S. MANUFACTURERS OF CENTRIFUGAL BLASTCLEANING EQUIPMENT HAVE ESTABLISHED A TARGET CONSUMPTION RATE FOR SAE QUALITY CAST STEEL SHOT AND GRIT OF STANDARD HARDNESS (40-50 Rc) WHEN USED IN ACCORDANCE WITH RECOMMENDED PRACTICES, SUCH AS: FULL ABRASIVE FLOW RATE; PROPER AIM OF THE ABRASIVE BLAST-STREAM; MAINTAINING BALANCED WORK-MIX VIA OBSERVING RECOMMENDED ADDITIONS PRACTICE AND AIR-WASH CONTROL; WITH ABRASIVE VELOCITY NOT EXCEEDING 245 FPS.

THEIR TARGET CONSUMPTION RATE IS .33 TO .35 POUNDS CONSUMED PER HP PER WHEEL HOUR (FOR A TIGHTLY CONTROLLED OPERATION). WE USE A MUCH MORE CONSERVATIVE NUMBER, .5 LB/HP/HR, IN ORDER TO ALLOW FOR LESS-THAN-PERFECT OPERATION. (FOR 55-60 Rc GRIT WE USE .75 LB/HP/HR.) THE HP RATING GOVERNS BOTH THE POUNDS OF ABRASIVE IN THE SYSTEM (APPROX 100 POUNDS PER HP) AND THE ABRASIVE FLOW PER MINUTE (APPROX 25 POUNDS PER HP).

EXAMPLE: 30 HP WHEEL AT .5 LBS/HP/HOUR EQUALS 15 LBS PER WHEEL-HOUR CONSUMPTION- - -WITH 3,000 POUNDS IN THE SYSTEM- - - AND 750 POUNDS PER MINUTE FLOW.

AT 750 LBS/MIN ABRASIVE FLOW, A TOTAL OF 45,000 LBS/HOUR IS THROWN. WITH ONLY 3,000 LBS IN THE SYSTEM, THIS MEANS THAT THE 3,000 LBS IS BEING CYCLED <u>15 TIMES PER HOUR</u>, ONCE EVERY FOUR MINUTES. THUS, EACH PARTICLE OF STEEL SHOT OR GRIT IS SUBJECTED TO 15 IMPACTS PER HOUR. AT 15 LBS/HR CONSUMPTION RATE, DIVIDED BY 3,000 LBS = .005 LBS/HR, DIVIDED BY 15 CYCLES EQUALS A USAGE RATE OF <u>.00033 LBS PER IMPACT PER HOUR.</u>

TO CONVERT CENTRIFUGAL-BLAST CONSUMPTION RATES FOR STEEL GRIT TO AIR-BLAST CONSUMPTION RATES, THE VELOCITY FACTOR MUST BE THE SAME, OR 245 FPS, (85-90 PSI). WITH BOTH THE MASS AND THE VELOCITY BEING THE SAME, THE IMPACT-POWER DELIVERED TO THE WORK-PIECE IS THE SAME- - -<u>AND THE ABUSE TO THE ABRASIVE PARTICLES, OR BREAKDOWN RATE PER IMPACT, WILL BE THE SAME,</u> WHETHER CENTRIFUGAL OR AIR-BLAST.

CALCULATION: SG-40 (40-50 Rc) CAST STEEL GRIT

ASSUMING 50 LBS/MIN FLOW (90 PSI & 1/2" NOZZLE) AND 3,000 POUNDS IN THE POT = 3,000 LBS/HR THROWN (ONE IMPACT/HR) TIMES .00033 LBS/IMPACT/HR- - - - -
= 1.0 LB PER HOUR (1 IMPACT).

CALCULATION: LG-40 (55-60 Rc) CAST STEEL GRIT
= 3,000 LBS X .0005 LBS/IMPACT/HR
= 1.5 LB PER HOUR (1 IMPACT).

CALCULATION: SAND
ASSUMING 31 LBS/MIN FLOW (PER TABLE FOR 90 PSI & 1/2" NOZZLE) AND 3,000 POUNDS IN THE POT = 1860 LBS/HR THROWN (ONE IMPACT) @ ONE PASS AND GONE
= 1,860 LBS PER HOUR (1 IMPACT).

WHAT THESE CALCULATIONS SHOW IS THAT IF - - -IF AN OUTDOOR AIR-BLAST OPERATION HAD CONTAINMENT AND AIR-WASH CAPABILITIES EQUAL TO THOSE OF IN-PLANT CENTRIFUGAL-BLAST EQUIPMENT, THE CONSUMPTION RATES FOR SG AND LG STEEL GRIT WOULD BE 1.0 LB/HR AND 1.5 LBS/HR, RESPECTIVELY, COMPARED TO 1,860 LBS/HR USING SAND. THAT REPRESENTS RATIOS OF ONE TON OF STEEL GRIT DOING THE WORK OF 1,860 TONS OF SAND, OR 1-1/2 TONS DOING THE WORK OF 1,860 TONS OF SAND. FROM THE ENVIRONMENTAL STANDPOINT, IT TRANSLATES TO 1,860 TONS OF CONTAMINATED SAND HAVING TO BE DISPOSED OF, COMPARED TO ONE OR 1-1/2 TONS OF CONTAMINATED GRIT HAVING TO BE DISPOSED OF!

CENTRIFUGAL-BLASTING WITH G-40 CAST STEEL GRIT STRIVES FOR A BALANCED WORK-MIX THAT WOULD APPROXIMATE 50% G-40 SIZE, 25% G-50 SIZE, AND 25% G-80 SIZE. WE KNOW FROM IN-PLANT OPERATIONS THAT WERE FOUND TO BE OUT OF CONTROL ON AIR-WASH, THAT LOSING THE G-50 AND G-80 SIZE WORK-MIX TO THE DUST COLLECTOR ALMOST TRIPLED THEIR CONSUMPTION RATE. BUT, EVEN THEN, THE DISPOSAL PROBLEM OF CONTAMINATED CAST STEEL GRIT IS ONLY 3 TO 4-1/2 TONS OF GRIT COMPARED TO THE 1,860 TONS OF CONTAMINATED SAND. AT THREE TONS OF SG-40 DOING THE WORK OF 1,860 TONS OF SAND, THE USE AND DISPOSAL RATIO WOULD BE ONE TON OF STEEL FOR 620 TONS OF SAND- - -AND AT 4-1/2 TONS OF LG-40 DOING THE WORK OF 1,860 TONS OF SAND, THE RATIO WOULD BE 1 TON OF STEEL FOR 413 TONS OF SAND.

WHILE IT IS NOT REALISTIC TO EXPECT OUTDOOR CONDITIONS TO COME VERY CLOSE TO THE CONTAINMENT POSSIBLE IN ENCLOSED CABINETS OR ROOMS INSIDE A BUILDING, THE CALCULATIONS DO POINT OUT THAT THERE IS MUCH THAT CAN AND SHOULD BE DONE, BOTH BY BLASTCLEANING OPERATORS AND AIR-BLAST EQUIPMENT MANUFACTURERS, TO IMPROVE OPERATING CONDITIONS TO BRING THEM CLOSER TO THE OPERATING COSTS EXPERIENCED WITH IN-PLANT OPERATIONS.

# # #

OBSERVATIONS ON EARLIER TEST PROCEDURES FOR CAST STEEL GRIT

(TESTS RUN PRIOR TO 1996)

TESTS PREVIOUSLY CONDUCTED COMPARING CAST STEEL SHOT OR GRIT VS. SAND OR OTHER NON-METALLICS, INVARIABLY FAILED TO TAKE INTO ACCOUNT THIS ONE MAJOR DIFFERENCE:

WITH SAND AS THE MEDIA, IT IS THE AS-RECEIVED PRODUCT THAT DOES THE WORK- - -AND IT IS ONE PASS (OR ONE IMPACT) AND IT'S ON THE WAY TO THE DUST COLLECTOR.

WITH STEEL GRIT AS THE MEDIA, THE AS-RECEIVED PRODUCT (WHICH HAS 2-1/2 TIMES THE DENSITY OF SAND OF THE SAME SIZE) SERVES AS THE "RAW MATERIAL" THAT DEVELOPS THE WORK-MIX THAT DOES THE WORK. INSTEAD OF "ONE PASS AND GONE," STEEL IS SUBJECTED TO MANY IMPACTS (SEVERAL HUNDRED) BEFORE A PROPER WELL-BALANCED WORK-MIX IS DEVELOPED.

FOR EXAMPLE, WHEN SAE-SIZE G-40 CAST STEEL GRIT IS USED, A PROPERLY BALANCED WORK-MIX IDEALLY SHOULD CONTAIN APPROXIMATELY 50% SAE G-40 SIZE- - -25% SAE G-50 SIZE- - -25% SAE G-80 SIZE. THE IMPACT-POWER DEVELOPED BY PROPELLING HIGH DENSITY STEEL GRIT AT A VELOCITY OF 245 FPS, NOT ONLY GRADUALLY BREAKS THE ORIGINAL G-40 INTO THE SMALLER SIZES, BUT ALSO CHANGES ITS SHAPE CHARACTERISTICS AND INCREASES ITS APPARENT DENSITY (APPROXIMATELY 20% GREATER). A BALANCED WORK-MIX CLEANS BETTER AND FASTER THAN THE NEW GRIT FROM WHICH IT WAS DEVELOPED.

TESTING SAND BY FILLING A POT AND THEN BLASTING AGAINST A TARGET PLATE, DOES RATHER FAIRLY DUPLICATE WHAT HAPPENS IN FIELD PRACTICE, IN THAT THE AS-RECEIVED SAND IMPACTS THE PLATE AND WHATEVER VOLUME OR WEIGHT OF SAND THAT IS THROWN IS CONSIDERED AS CONSUMED. BUT, PUTTING NEW, AS-RECEIVED STEEL GRIT IN THE POT, AND PROPELLING THAT AT THE PLATE, CAN IN NO WAY REPRESENT THE TRUE PERFORMANCE CAPABILITY OF A PROPERLY BALANCED WORK-MIX OF STEEL GRIT.

SOME OTHER FACTORS THAT MUST BE TAKEN INTO ACCOUNT:

WHEN TESTING STEEL GRIT, IF THE SAME VOLUME IS PUT IN THE POT, THERE WILL BE 2-1/2 TIMES THE NUMBER OF POUNDS OF STEEL GRIT VS. THE SAND.

IF THE SAME WEIGHT IS PUT IN THE POT, THEN THERE WILL BE 2-1/2 TIMES THE VOLUME OF SAND IN THE POT.

SINCE THE BLASTCLEANING PROCESS IS, AS GENERAL BENJAMIN TILGHMAN DESCRIBED IT- - -"IMPACT-CLEANING"- - -THE REMOVAL OF CONTAMINANT AND THE PROFILING OF THE WORK-PIECE (WITH VELOCITY BEING THE SAME) THEN RELATES TO THE DIFFERENCE IN THE MASS OF THE MEDIA AND THE NUMBER OF PARTICLES THROWN AT THE WORK PER UNIT OF TIME.

SIZE FOR SIZE, STEEL AND SAND HAVE THE SAME NUMBER OF PARTICLES PER UNIT OF VOLUME, BUT SAND HAS 2-1/2 TIMES THE NUMBER OF PARTICLES PER UNIT OF WEIGHT. SINCE THE SAND THROWN AT THE WORK IS ALL ONE SIZE, AND THE WORK-MIX OF G-40 STEEL GRIT HAS THREE SIZES (G-40, G-50 & G-80), WE NEED TO KNOW HOW THIS WORKS OUT WITH RESPECT TO THE RELATIVE IMPACT-POWER AND THE NUMBER OF PARTICLES THROWN PER MINUTE. THE CALCULATIONS THAT FOLLOW WILL SHED LIGHT ON THIS QUESTION.

IF WE MAKE THE FOLLOWING ASSUMPTIONS (ALL REASONABLY CLOSE), WE CAN CALCULATE BOTH THE PARTICLE COUNT AND THE RELATIVE IMPACT-VALUES OF A G-40 STEEL WORK-MIX VS. SAND EQUIVALENT TO G-40 SIZE:

SIZE		# PER LB.	PERCENT
G-40	.024" AV.	500,000	50%
G-50	.016" AV.	1,500,000	25%
G-80	.010" AV.	6,000,000	25%

G-40 STEEL BALANCED WORK-MIX	2,125,000 PARTICLES/LB
SAND (G-40 SIZE) (@ 2-1/2 MORE VOLUME/LB)	1,250,000 PARTICLES/LB
G-40 W/M WITHOUT G-80 (60% G-40 & 40% G-50)	900,000 PARTICLES/LB
G-40 W/M WITHOUT G-80 & G-50 (100% G-40)	500.000 PARTICLES/LB

.024" AV. STEEL = 2-1/2 TIMES THE IMPACT-POWER OF .024" AV. SAND
.016" AV. STEEL = 73% OF THE IMPACT-POWER OF .024" AV. SAND
.010" AV. STEEL = 18% OF THE IMPACT-POWER OF .024" AV. SAND

PARTICLES THROWN PER MINUTE, AIR-BLAST @ 90 PSI & 1/2" NOZZLE:

G-40 STEEL, BALANCED W/M, @ 54 LB/MIN	=	115 MILLION/MIN
SAND (G-40 SIZE) @ 31 LB.MIN	=	39 MILLION/MIN
G-40 W/M WITHOUT G-80 @ 54 LB/MIN	=	49 MILLION/MIN
G-40 W/M WITHOUT G-80 & G-50	=	27 MILLION/MIN
SAND (G-25 SIZE) @ 31 LB/MIN	=	6 MILLION/MIN

NOTE: FROM THE ABOVE DATA, IT CAN BE UNDERSTOOD WHY AND HOW A BALANCED WORK-MIX OF G-40 STEEL GRIT- - -WITH GREATER BLAST-STREAM COVERAGE (115 MILLION PARTICLES THROWN PER MINUTE), AND WITH THE G-40 PORTION (50% OF THE WORK-MIX) HAVING 2-1/2 TIMES MORE IMPACT-POWER THAN THE SAND- - - CAN CLEAN FASTER AND BETTER THAN SAND.

THE TREMENDOUS DURABILITY ADVANTAGE THAT STEEL SHOT AND GRIT HAS OVER SAND CAN BETTER BE UNDERSTOOD WHEN THE <u>RATE OF LOSS PER IMPACT</u> IS EXPRESSED IN TERMS OF THE NUMBER OF CYCLES REQUIRED TO REDUCE A POUND OF CAST STEEL GRIT TO DUST FINER THAN 80-MESH.

THE CONSUMPTION RATE OF .00033 POUNDS PER IMPACT , OR .033% PER IMPACT, FOR SG-GRIT (40-50 Rc) MEANS EACH POUND ABSORBS 3,030 IMPACTS BEFORE IT WINDS UP IN THE DUST COLLECTOR.

THE CONSUMPTION RATE OF .0005 POUNDS PER IMPACT, OR .05% PER IMPACT, FOR LG-GRIT (55-60 Rc) MEANS EACH POUND ABSORBS 2,000 IMPACTS BEFORE WINDING UP IN THE DUST COLLECTOR.

DURABILITY TESTS RUN IN THE ERVIN SHOT TESTER- - -THE 100% REPLACEMENT TEST- - - CONSISTENTLY SHOW THAT 3,000 OR MORE CYCLES ARE REQUIRED TO REDUCE 40-50 Rc STEEL GRIT TO EXHAUST SIZE DUST. GIVEN THE GREAT NUMBER OF CYCLES REQUIRED, IS IT FEASIBLE FOR THE NIOSH PROJECT TO UNDERTAKE RUNNING THE TEST ON STEEL GRIT LONG ENOUGH TO: (A) GENERATE A PROPERLY BALANCED WORK-MIX; OR (2) RUN IT LONG ENOUGH TO CONFIRM THAT THE SG-CAST STEEL GRIT CAN BE RECYCLED AS MANY AS 3,000 TIMES BEFORE BEING REDUCED TO USELESS DUST?

CERTAINLY, IN VIEW OF THE PURPOSES OF THE NIOSH PROJECT, PARTICULARLY WITH RESPECT TO THE ENVIRONMENTAL ASPECTS, THERE SHOULD BE GREAT INTEREST IN THE POTENTIAL FOR HAVING ONE TON, TWO TONS, OR EVEN THREE TONS OF CAST STEEL GRIT DO THE WORK OF HUNDREDS OF TONS OF SAND, AND HAVING TO DISPOSE OF ONLY A FEW TONS, RATHER THAN SEVERAL HUNDRED TONS OF CONTAMINATED SAND.

SPECIFICS RELATIVE TO THE NIOSH TEST PROJECT AND QUESTIONS REGARDING THE TESTING OF CAST STEEL GRIT

IT IS OUR UNDERSTANDING THAT KTA/SET ENVIRONMENTAL PLANS TO CONDUCT THE TESTS IN ACCORDANCE WITH THE FOLLOWING:

THE TARGET TO BE CLEANED IS 22 SQ.FT., AND IS "STANDARD MILL SCALE BEARING STEEL." 2-3 MIL PROFILE IS DESIRED.

ALL MEDIA WILL BE TESTED IN AN AIR-BLAST SYSTEM WITH A POT OF 4-1/2 TO 5 CUBIC FEET- - -AT 100 PSI, WITH 1/4" VENTURI NOZZLE.

THE POT WILL BE FILLED TO FULL LEVEL FOR EACH TEST- - -I.E., THE SAME VOLUME OF ABRASIVE WILL BE USED FOR EACH TEST.

ALL AS-RECEIVED MEDIA WILL BE SUBJECTED TO A SCREEN ANALYSIS TO DETERMINE THE "AVERAGE PARTICLE SIZE."

ONE SET OF TESTS WILL BLAST THE TARGET PLATE WITH "AS-RECEIVED" MEDIA.

A SECOND SET OF TESTS WILL APPLY TO MEDIA DESIGNATED AS "RECYCLABLE." TO TRY TO SIMULATE A WORK-MIX TYPICAL OF THE RECYCLABLE ABRASIVES, EACH RECYCLABLE MEDIA WILL BE BLASTED UNTIL THE AVERAGE PARTICLE SIZE IS REDUCED TO HALF-SIZE. THEN, THAT SIMULATED WORK-MIX WILL BE USED TO BLASTCLEAN THE TARGET PLATE. BREAKDOWN RATE OF THE MEDIA WILL BE MEASURED BY DETERMINING THE AMOUNT THAT IS STILL HALF-SIZE, POST-TEST.

THE AIR-BLAST TEST EQUIPMENT INCLUDES AN AIR-WASH SYSTEM CONSIDERED TO BE EFFECTIVE RELATIVE TO DUST REMOVAL.

SOME QUESTIONS THAT COME TO MIND:

WHEN ON-SITE FIELD TESTING IS UNDERTAKEN SUBSEQUENT TO THE LABORATORY TESTS, WILL THE FIELD EQUIPMENT BE ABLE TO AIR-WASH AS EFFECTIVELY? IT IS MOST LIKELY THAT CONTAINMENT IN THE FIELD WILL NOT BE CLOSE TO LAB CONDITIONS. YET, THE MAJOR KEY TO THE ECONOMICS OF RECYCLABLE MEDIA IS EFFECTIVE CONTAINMENT AND CLOSELY CONTROLLED AIR-WASH SEPARATION?

THE WORK-MIX TYPICAL OF SG-40 CAST STEEL GRIT- - -AS RECOMMENDED BY MANUFACTURERS OF CENTRIFUGAL BLAST EQUIPMENT, FOR CLEANING STEEL PLATE, BARS, ETC.- - - IS DEVELOPED BY USING A REMOVAL SIZE OF .007" OR .0059". IF ADDITIONS OF NEW MATERIAL ARE MADE FREQUENTLY IN AN AMOUNT EQUAL TO THE ABRASIVE PULLED OUT OF THE SYSTEM WITH THE .007" REMOVAL SIZE, THE WORK-MIX SHOULD CONTAIN APPROXIMATELY 50% ORIGINAL SIZE SG-40, AND APPROXIMATELY 25% EACH OF SAE G-50 AND SAE G-80.

WITH RESPECT TO THE SERIES OF TESTS USING AS-RECEIVED MEDIA, WE ARE CONCERNED ABOUT USING AS-RECEIVED CAST STEEL SG-40 GRIT. AS INDICATED, THE FULL EFFECTIVENESS AND EFFICIENCY OF USING CAST STEEL ABRASIVE IS GAINED ONLY WHEN THE PROPER WORK-MIX IS DEVELOPED AND USED. TESTING AS-RECEIVED SG-40 WOULD IN NO WAY BE REPRESENTATIVE OF THE CLEANING CAPABILITY OF A PROPER WORK-MIX, EITHER AS TO SPEED OF CLEANING OR TOTAL SCALE REMOVAL. THE REASON: TOO FEW PARTICLES OF GRIT THROWN AT THE WORK-PIECE PER MINUTE. A BALANCED G-40 WORK-MIX WILL THROW AS MUCH AS FOUR TIMES THE NUMBER OF PARTICLES VS. THROWING NEW GRIT.

YET, WE HESITATE TO SUPPLY A PRE-MIX OF 50% SG-40, 25% EACH OF SG-50 AND SG-80, FOR FEAR THE AIR-WASH MAY NOT BE CAPABLE OF REMOVING ONLY THE MINUS .007" SPENT ABRASIVE. IF IT ISN'T THAT SENSITIVE, IT COULD BE PULLING OUT ALL THE G-80, TOO, ADVERSELY AFFECTING CLEANING PERFORMANCE, AND OBVIOUSLY INCREASING THE CONSUMPTION RATE.

A COMPROMISE MIGHT BE TO USE A MIX OF SG-40 AND SG-50 GRIT FOR THE TEST OF "AS-RECEIVED" MATERIAL. WHILE THIS STILL WOULD NOT BE TRULY REPRESENTATIVE OF THE IDEAL SG-40 WORK-MIX, IT STILL WOULD BE MORE MEANINGFUL THAN TESTING AS-RECEIVED SG-40.

WE HAVE CONCERNS, TOO, ABOUT THE SERIES OF TESTS ON RECYCLABLES , WHERE IT IS PLANNED TO SIMULATE A WORK-MIX BY BREAKING THE MEDIA DOWN TO HALF THE ORIGINAL AVERAGE PARTICLE SIZE. IF WE WERE TO ESTIMATE THAT SG-40 CAST STEEL GRIT WOULD HAVE AN AVERAGE PARTICLE SIZE OF .0234" WITH THE TOTAL RANGE BEING PLUS/MINUS .008" - - - - HALF THE .0234" AVERAGE SIZE WOULD THEN BE .0117" WHICH IS THE BOTTOM END OF SAE G-50. YET, G-50 GRIT IS NOT THE SIZE WE WOULD RECOMMEND FOR THE TEST, AS IT WOULD BE TOO FINE TO MEET THE 2-3 MIL PROFILE REQUIREMENT.

WE WONDER HOW MUCH OF ORIGINAL SIZE G-40 WOULD STILL BE IN THE MIX, AS IT IS THIS MATERIAL THAT WOULD HAVE TO BREAK DOWN TO REDUCE THE AVERAGE PARTICLE SIZE TO HALF? THE KEY TO THE EFFECTIVENESS AND EFFICIENCY OF STEEL GRIT COMPARED TO NON-RECYCLABLE MEDIA IS DUE TO THE 50% OF ORIGINAL SIZE GRIT HAVING 2-1/2 TIMES THE IMPACT POWER OF EQUIVALENT SIZE SAND- - -WITH THE REMAINING 50% HAVING MANY MORE PARTICLES PER POUND THROWN VS. SAND. IT IS THE 50% OF ORIGINAL SIZE G-40 THAT IS DOMINANT IN BREAKING UP THE HEAVIER SCALE AND IN DETERMINING PROFILE HEIGHT- - -THE 50% OF G-50 AND G-80 PROVIDE THE COVERAGE THAT INSURES THE OPTIMUM CLEANING RATE.

WE HAD THOUGHT THAT A COMPROMISE MIGHT BE TO USE THE MIX OF G-40 AND G-50 GRIT FOR THIS SERIES OF TESTS ON RECYCLABLES, BUT, THE PROCEDURE OF BLASTING TO HALF AVERAGE PARTICLE SIZE WOULD MAKE THE RESULTING MIX MUCH TOO FINE AND FAR FROM BEING REPRESENTATIVE OF THE PERFORMANCE OF A PROPERLY BALANCED G-40 WORK-MIX.

UNDOUBTEDLY, THE MOST MEANINGFUL METHOD FOR CREATING A SIMULATED STEEL GRIT WORK-MIX FOR THE TESTS ON RECYCLABLES, WOULD BE TO "CONDITION" AS-RECEIVED STEEL GRIT BY BLASTING AS PLANNED, BUT SETTING THE AIR-WASH TO REMOVE ALL MINUS .007" FINES, AND ADDING NEW GRIT EVERY FEW CYCLES IN AN AMOUNT THAT REPLACES THE MINUS .007 FINES. THIS IS WHAT WOULD HAPPEN IN ACTUAL FIELD PRACTICE. BUT, UNDOUBTEDLY, THIS WOULD REQUIRE SEVERAL HUNDRED CYCLES TO REACH A BALANCED WORK-MIX, SO WE SUSPECT THAT SUCH AN EXTENDED TEST IS HARDLY FEASIBLE, GIVEN ECONOMIC AND TIME CONSTRAINTS ON THE TEST PROJECT?

A POSSIBLE SOLUTION: INSTEAD OF BREAKING AS-RECEIVED GRIT DOWN TO HALF ORIGINAL PARTICLE SIZE BY THE COSTLY AND TIME-CONSUMING BLASTIING PROCESS, MIGHT NOT THE BEST SOLUTION BE FOR US TO SUPPLY THE PRE-MIX MENTIONED ABOVE TO SIMULATE THE WORK-MIX? THEN, IT WOULD NOT BE NECESSARY TO GO THROUGH THE PROCESS OF BLASTING FOR SIZE REDUCTION, AS THE MIX WOULD ALREADY APPROXIMATE WORK-MIX SIZE.

A SUGGESTION: TO DETERMINE RECYCLABILITY OF THE STEEL GRIT, USE AN ERVIN SHOT TESTER, OPERATED IN ACCORDANCE WITH SAE ESTABLISHED PROCEDURES. A TESTER CAN BE MADE AVAILABLE FOR KTA-SET TO RUN THE TESTS, OR ARRANGEMENTS CAN BE MADE FOR THE TESTS TO BE RUN BY ERVIN, WITH KTA/SET PERSONNEL AS OBSERVERS. THE ERVIN TESTER IS SAE-APPROVED, AND IS USED BY HUNDREDS OF COMPANIES IN THE U.S. AND ABROAD FOR TESTING STEEL ABRASIVE. IN AN HOUR OR TWO, A 100% REPLACEMENT TEST COULD PROVIDE SUITABLE RECYCLABILITY INFORMATION THAT WOULD OTHERWISE REQUIRE COUNTLESS HOURS OF TESTING AT THE KTA/SET FACILITY.

****

WITH RESPECT TO MEDIA RECYCLABILITY, THOSE WHO ARE FAMILIAR WITH THE USE OF SAND AS THE MEDIA IN BLASTCLEANING STEEL PLATE SUCH AS WILL BE USED IN THE NIOSH TEST PROJECT, AND KNOW THAT SAND, UPON FIRST IMPACT WITH THE TARGET PLATE, WILL SHATTER AND LITERALLY EXPLODE INTO USELESS DUST, UNDOUBTEDLY WILL HAVE GREAT DIFFICULTY IN UNDERSTANDING HOW STEEL GRIT CAN BE RECYCLED THE 2,000 AND 3,000 OR MORE TIMES INDICATED IN OUR COMMENTS.

THE MECHANISM OF STEEL SHOT OR GRIT FAILURE MERITS EXPLANATION. WHAT MUST BE UNDERSTOOD IS THAT THE STEEL GRIT DOESN'T WITHSTAND THOSE 2,000 OR 3,000 IMPACTS AND THEN SUDDENLY SHATTER AND EXPLODE INTO DUST AS HAPPENS TO SAND UPON ITS FIRST IMPACT.

INSTEAD, STEEL, AFTER A GREAT NUMBER OF IMPACTS, GRADUALLY FATIGUES, THEN FRACTURES- - -INTO PIECES GENERALLY 1/2 OR 1/3 ITS ORIGINAL SIZE. THESE SMALLER PARTICLES HAVE MUCH LESS MASS (1/2 THE MASS = ONLY 1/8 THE KE OR IMPACT-POWER OF THE ORIGINAL SIZE), SO THEY ABSORB LESS ABUSE UPON SUBSEQUENT IMPACT. THUS, IT MAY REQUIRE THREE OR FOUR TIMES THE NUMBER OF IMPACTS IT TOOK TO FRACTURE THE FIRST TIME, BEFORE THEY RE-FRACTURE INTO EVEN SMALLER PARTICLES - - -AND THEN AN EVEN GREATER NUMBER OF IMPACTS BEFORE THESE SMALLER PARTICLES RE-FRACTURE ONCE MORE.

IT CAN REQUIRE 300 TO 600 OR MORE IMPACTS FOR THAT VERY FIRST FRACTURE TO OCCUR, DEPENDING ON INITIAL SIZE (THE SMALLER THE SIZE, THE MORE IMPACTS REQUIRED)- - -AND WITH SUBSEQUENT RE-FRACTURING REQUIRING SO MANY MORE IMPACTS, IT CAN BE SEEN THAT IT CAN EASLY REQUIRE 2,000 OR 3,000 OR MORE TOTAL IMPACTS BEFORE IT FINALLY REACHES THE REMOVAL SIZE.

IN ACTUAL BLASTCLEANING PRACTICE, AS THE AIR-WASH REMOVES THE SPENT STEEL FINES, NEW SHOT OR GRIT IS ADDED- - -THUS THE WORK-MIX ALWAYS IS A MIXTURE OF FRESH MATERIAL FROM THE MOST RECENT ADDITION, AND MATERIAL FROM THE MANY PREVIOUS ADDITIONS. IN OTHER WORDS, IT IS A MIXTURE OF FRESH MATERIAL AND MATERIAL IN THE VARIOUS STAGES OF FATIGUE TO THE PARTICLE READY TO FAIL FOR THE LAST TIME. STABILIZATION IS REACHED- - -I.E, A CONSISTENT LOSS RATE MATCHED BY AN EQUAL ADDITIONS RATE. (THE SAE-APPROVED 100% REPLACEMENT TEST RUN IN THE ERVIN SHOT TESTER SIMULATES ACTUAL BLASTCLEANING PRACTICE IN THIS SAME MANNER.)

APPENDIX 3

ALLAN STEEL Products Company
800 BEAVER AVENUE
P.O. BOX 99267
PITTSBURGH, PA 15233-0267
PHONE: (412) 323-0923
FAX: (412) 323-0926
800-837-0933

PAGE 1 OF 2 DATE 1/2/96

TO: KTA TATOR INC.

CERTIFICATION OF TEST RESULTS

YOUR PO # 95JV086
DATED 12/20/95
ALLAN STEEL PRODUCTS INVOICE # 174284

CHEMICAL & PHYSICAL TEST OF 840 pcs 3/16" A36 24" x 2'0" - 2E9031

John M. Matig
JOHN M. MATIG
VICE PRESIDENT

GENEVA STEEL KTA.

Metallurgical Test Report

"ALL SMELTING, MELTING AND MANUFACTURING PROCESSES OCCURRED IN THE U.S.A. WITH RAW MATERIALS OF U.S.A. ORIGIN."

EQ. JOB, CONTRACT NO.	P.O. DATE	PURCHASE ORDER NO.
	11/30/94	03445 ADD

SHIPPERS NO.	MILL ORDER NO.	TALLY NO.
GP19884C 01-08-95	EL36646	GP19884C

VEHICLE IDENTITY: ATSF 7041

SOLD TO:
GENEVA STEEL
P.O. BOX 2500
PROVO, UTAH 84603

J ALLAN STEEL PRODUCTS CO
P O BOX 99397
PITTSBURGH PA 15233-4397

SHIP TO:
J ALLAN STEEL PRODUCTS CO
3400 NEVILLE ROAD
GATE 21 NEVILLE ISLAND
PITTSBURGH PA 15225

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECTS.

Edward T. Bradley
CORPORATE DIRECTOR, QUALITY
DATE 01-09-95

SPEC. & REV. PLATE ASTM A36-93A AND ASME SA-36 1992 EDITION 1993 ADDENDA

01 MILL CERTIFIED T/R

ITEM NO.	MATERIAL DESCRIPTION: THICKNESS OR SECTION	WIDTH, DIA. OR FT. WT.	LENGTH	QUANTITY	WEIGHT	HEAT NO.	TEST OR PIECE IDENTITY	YIELD PT. KSI	TENSILE STR. KSI	ELONGATION % IN 8"	ELONGATION % IN 2"	% RED. OF AREA	BEN
05	.1875"	96.0000"	288.0000"	21	30870#	2E9026	.1875"	39.6	61.2	28.0			
							.2500"	40.2	59.4	25.0			
							.1875"	46.1	66.1	25.0			
							.2500"	48.0	66.1	28.0			
	.1875"	96.0000"	288.0000"	29	42630#	2E9031	.1875"	40.8	60.3	28.0			
							.1875"	44.9	64.5	27.0			
							END OF DATA						

HEAT NO.	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	SN	AL	N	V	B	TI	CB	CO
2E9026	HEAT	19	97	006	009	013	01	01	01	004		031		004			004	
2E9031	HEAT	19	95	006	010	014	01	01	01	004		043		004			004	

GENEVA STEEL COMPANY CERTIFIES ALL SMELTING, MELTING AND MANUFACTURING PROCESSES OCCURRED IN THE USA.

END OF DATA

019308 DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN VERTICAL DOTTED LINE OF ... PAGE 01

JAN-02-'96 TUE 13:24 J ALLAN STEEL 8800 TEL NO:412 923 2923 #922 P02

APPENDIX 4

March 26, 1996

Mr.

Subject: NIOSH Project - Evaluation of Substitutes for Silica Sand in Abrasive Blasting

Dear :

The purpose of this letter is to inform you that one of your <type> abrasive has been selected for the above mentioned project. As such, KTA/SET Environmental (KTA/SET) requests a recommendation for your product size and designation which will provide a 2-3 mil profile on standard mill scale bearing steel using 100 psi nozzle pressure. Please forward your recommendation, along with the product literature, material safety data sheets, distribution sites and your product brochure to KTA/SET, attention undersigned.

In accordance with the study protocol, each abrasive supplier is asked to specify the proper abrasive designation for providing the 2-3 mil profile. The actual study will be performed using a 6 bag pot at 100 psi with 1/4" venturi nozzle. One variable that can be altered at the request of the abrasive manufacturer is the metering valve setting. KTA/SET is requesting that each manufacturer recommend an abrasive metering valve size diameter, such as 1/2", 7/16", 3/8", 5/16", or 1/4" diameter hole metering valve setting. The default metering orifice will be 1/2" diameter.

We are asking you to supply this information by April 19, so that we can proceed with the acquisition of the abrasive and the start of testing. The abrasive will be purchased from one of your distributors. Please, feel free to contact me at 412-788-1300, extension 213, for any question or comments. Thank you in advance for your prompt attention to this matter.

Very truly yours,
KTA/SET Environmental

Michael F. MeLampy
Project Supervisor

J95331
MFM/KAT:lsk

NIOSH Abrasive Substitutes Study Questionnaire

Abrasive Type	Nickel Slag	
Size Designation		
Nozzle Pressure	100 psi	
Nozzle Type	#4 Venturi	
Metering Valve Orifice Diameter	0.5"	Pick only one please
	0.4375"	
	0.375"	
	0.3125"	
	0.25"	
Product Data Sheets Enclosed		yes or no
Material Safety Data Sheets Enclosed		yes or no

Truck Load Distributor Closest to:

Portland OR	
Los Angeles CA	
Houston TX	
Pittsburgh PA	
Baltimore MD	
Hartford CT	

Small Quantity Distributor Closest to:

Portland OR	
Los Angeles CA	
Houston TX	
Pittsburgh PA	
Baltimore MD	
Hartford CT	

Filled out by: _____ **Print Name:** _____

Title: _____ **Date:** _____

APPENDIX 5

KTA-TATOR, Inc.
Protective Coating Consultants
115 Technology Drive
Pittsburgh, PA
412-788-1300

NIOSH Project

Blast Cleaning Inspection Report

Facility:		Time	Air T °F	RH %	DP °F	ST °F	Bar Pre
Date:	IR #: J95331-01						
KTA/SET Job Number J95331							

Generic Abrasive	TradeName
Abrasive Log Number	Size Designation Grade
Abrasive Mfg.	Supplier

Pre Blast Checkboxes :

Abrasive Riffle ❑	100g Sieve Analysis ASTM C136 ❑	Sample Envelope Microhardness ITL ❑
1 lb Sample NIOSH ❑	300ml Sample ASTM D4940 KTA Lab ❑	1 lb Sample KTA ❑

Item No: Panel No.		Surface Preparation Spec	Act.	Surface Profile (mils) Spec	Act.	Act.	Embedment Area 1	Area 2	Area 3	Area 4	Area 5	Steel Sample Area #
1		SP-10		2-3								
2		SP-10		2-3								
3		SP-10		2-3								
4		SP-10		2-3								
5		SP-10		2-3								
6		SP-10		2-3								
7		SP-10		2-3								
8		SP-10		2-3								
9		SP-10		2-3								

Consumption and Cleaning Rate			Total Blast Time
Initial Amount of Abrasive	Spec	Act.	Choke Valve Setting
Abrasive left (hose and pot)			Metering Valve Setting
Square Feet Cleaned			

S.P. QUALITY ITEMS		CAL. OK	Instrument			SERIAL NUMBER
Hose/Nozzle Number Used	1 2	❑	HYGROMETER			
Nozzle Orifice Gauge	Size: 3 4 5 6	❑	SURFACE THERMOMETER			
ASTM D-4285 Blotter Test Results	P F	❑	TESTEX TAPE Used	XC	C	N/A
Nozzle Pressure	psi	❑	SPRING MICROMETER			
Hose Flushed and dried	Y N	❑	NOZZLE ORIFICE GAGE			
		❑	BAROMETER			

Post Blast Checkboxes :

Abrasive Riffle ❑	1 lb Sample NIOSH ❑	100g Sieve Analysis ASTM C136 ❑

Technician	Signature	Project Supervisor	Signature
Date	Print	Date	Print

KTA-TATOR, Inc.
Protective Coating Consultants
115 Technology Drive
Pittsburgh, PA
412-788-1300

NIOSH Project

Facility: KTA Blast Room		Blast Cleaning Reclaim Report	Time	Air T °F	RH %	DP °F	ST °F	Bar Pre
Date:	IR #: J95331-RC							
KTA/SET Job Number : J95331								

Generic Abrasive :	Trade Name :
Abrasive Log Number :	Size Designation : Grade :
Abrasive Mfg. :	Supplier :

Weight of Abrasive to be Reclaimed :

Weight of Abrasive Reclaimed :

Weight of Fines (black bucket) :

100 gram Sample Abrasive to be reclaimed for sieve analysis - Sample collected ? : Y N

100 gram Sample Abrasive to be reclaimed for fines for ASTM C 136 - Sample collected ? : Y N

100 gram Sample Abrasive to be reclaimed for abrasive ASTM C 136 - Sample collected ? : Y N

Abrasive to be:	RE-RUN	☐	BROKEDOWN	☐

If abrasive is to be brokendown, complete the following information :

Time	Air T °F	RH %	DP °F	ST °F	Bar Pre

Initial Amount of Abrasive :	Actual :	Choke Valve Setting :
Abrasive left (hose and pot) :	Total Blast Time :	Metering Valve Setting :

S. P. QUALITY ITEMS		CAL. OK	Instrument	SERIAL NUMBER
Hose/Nozzle Number Used :	1 2	☐	HYGROMETER	118124
Nozzle Orifice Gauge :	Size: 3 4 5 6	☐	SURFACE THERMOMETER	102678
ASTM D-4285 Blotter Test Results :	P F	☐	BAROMETER	118125
Nozzle Pressure :	psi	☐	NOZZLE ORIFICE GAGE	K41052
Hose flushed and dried :	Y N			

Technician	Signature	Project Supervisor	Signature
Date	Print	Date	Print

KTA Sieve Analysis Report Form	MATF 100R.2
Revision No. 2	Issued 3/12/96

KTA-Tator, Inc.

MATS Group

Sieve Analysis

Sample Number _____ Date _____

Weight of Sample _____ Technician _____

Sample Description _____ Job _____

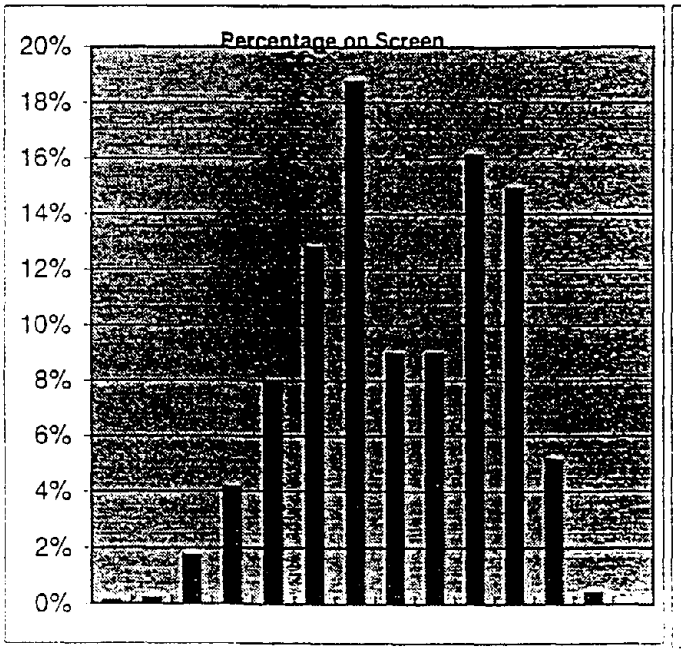
_____

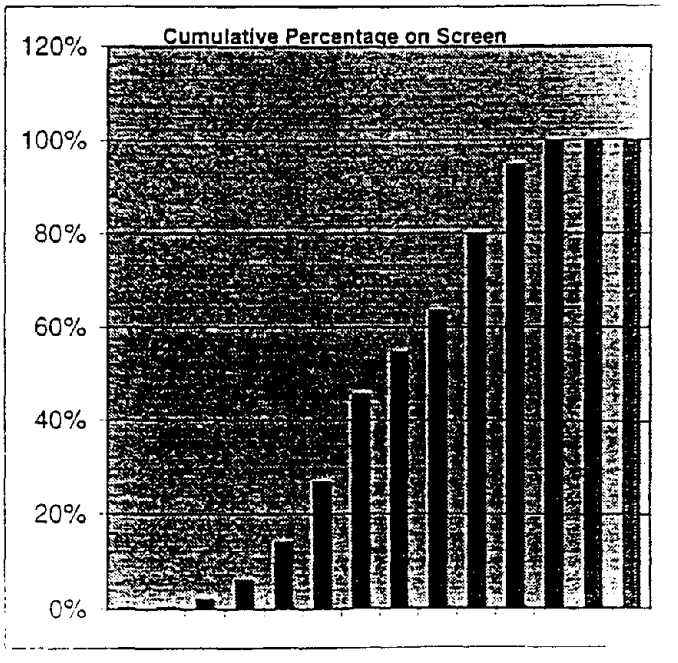
Sieve #	Cup and Grit	Cup	Grit	% of Total	Cum % of Total	S.O.S.** in mm	Particle Size Avg
10	12.7	12.6	0.1	0.10%	0.10%	2.000	0.20
12	13.1	12.9	0.2	0.20%	0.20%	1.700	0.34
16	15.2	13.5	1.7	1.71%	1.91%	1.180	2.01
20	16.8	12.7	4.1	4.13%	6.04%	0.850	3.49
30	20.6	12.8	7.8	7.85%	13.90%	0.600	4.68
40	25.4	12.7	12.7	12.79%	26.69%	0.425	5.40
50	31.5	12.9	18.6	18.73%	45.42%	0.300	5.58
60	21.7	12.8	8.9	8.96%	54.38%	0.250	2.23
70	21.8	12.9	8.9	8.96%	63.34%	0.210	1.87
100	28.9	12.9	16	16.11%	79.46%	0.150	2.40
140	27.7	12.9	14.8	14.90%	94.36%	0.110	1.63
200	17.5	12.4	5.1	5.14%	99.50%	0.075	0.38
270	13.1	12.7	0.4	0.40%	99.90%	0.053	0.02
Pan*	12.8	12.8	0	0.00%	99.90%	0.038	0.00
Total			99.3	100.00%		Sum =	30.21

* Approximated as a #400 Sieve

** S.O.S. is Screen Opening Size

Average particle size = Sum / Total Wt. (in mm) = 0.30





KTA/SET ENVIRONMENTAL

115 Technology Drive
Pittsburgh, PA
412-788-1300

Project: CDC/NIOSH	**Industrial Hygiene Report**	Facility: KTA-TATOR, INC. Pittsburgh, PA

Date:	Time:	Generic Abr. Type:
KTA/SET Project Number: J95331		Trade Name:
Abrasive Log Number:		Supplier:
Abrasive Mfg.:		Size:
Worker Properly Protected (√)		Grade:

Ventilation Assessment Complete (√)			**Ventilation Form Complete** (√)		
Abrasive Sample Collection (√)	**NI**	**KT**		**NI**	**KT**
Abrasive Sample as Received			Abrasive Sample Post Blast		
			Post Blast Steel Sample		

Cleaning Verification (√)				**Wipe Sampling (every fifth trial)**		
Hopper		Walls		Surface	Sample No.	Area (in^2)
Hose		Ceiling		Wall		
Nozzle		Floor		Ceiling		
Reclaimer		Worker		Floor		
				Chain of Custody - Wipe - Complete (√)		
Chain of Custody - Air - Complete (√)				**NIOSH Sample Submittal Form Complete** (√)		

Comments :

Technician	Project Supervisor
Print	Print
Signature	Signature
Date	Date

AIR SAMPLING DATA

Location : Make-up Air Sample Bank							
Pump ID	Hose No.	Sample No.	Media	Time On	Time Off	Elapsed Time	Volume
A	1						
A	2						
B	3						
B	4						
C	5						
D	6						
E	7						
F	8						

Location : Operator Area Sample Bank							
Pump ID	Hose No.	Sample No.	Media	Time On	Time Off	Elapsed Time	Volume
G	14						
G	15						
H	16						
H	17						
I	18						
J	19						
K	20						
L	21						
	22						
	23						
P-24	24R						
P-25	25L						

Location : Exhaust Sample Bank							
Pump ID	Hose No.	Sample No.	Media	Time On	Time Off	Elapsed Time	Volume
M	27						
M	28						
N	29						
N	30						
O	31						
P	32						
Q	33						
R	34						

Location : Operator Breathing Zone							
Pump ID	Hose No.	Sample No.	Media	Time On	Time Off	Elapsed Time	Volume
S	40						
T	41						
U	42						

KTA/SET ENVIRONMENTAL

115 Technology Drive
Pittsburgh, PA
412-788-1300

Project: CDC/NIOSH	**Pump Calibration Report**	Facility: KTA-TATOR, INC. Pittsburgh, PA
Date:	Time:	Generic Abr. Type:
KTA/SET Project Number: J95331		Trade Name:
Abrasive Log Number:		Supplier:
Abrasive Mfg.:		Size:
		Grade:

Calibration Equipment:	
Gilibrator Precision Flow Bubble Meter	SN: 001479-B
Gilibrator Standard Flow Cell	SN: 19825-S
Gilibrator High Flow Cell	SN: 19747-H

Calibration Conducted By:_____(print) _____(signature)

Comments:

Location : Make-up Air Sample Bank										
Pump ID	**Hose No.**	**Media**	**Target (l/min)**	**Actual Flow (l/min)**					**Ave Flow (l/min)**
				1	**2**	**3**	**4**	**5**	
A	1,2	PVC (Total Dust)	1.0						
B	3,4	PVC (Total Dust)	1.0						
C	5	0.8 μm MCE	2.0						
D	6	PVC (Resp. Dust)	1.7						
E	7	PVC (Total R.A.)	4.0						
F	8	PVC (Resp. R.A.)	1.7						
	9	Open							
	10	Open							
	11	Open							
	12	Open							
N/A	13	Calibration	N/A						

Location : Operator Area Sample Bank									
Pump ID	Hose No.	Media	Target (l/min)	Actual Flow (l/min)					Ave Flow (l/min)
				1	2	3	4	5	
G	14,15	PVC (Total Dust)	1.0						
H	16,17	PVC (Total Dust)	1.0						
I	18	0.8 μm MCE	2.0						
J	19	PVC (Resp.)	1.7						
K	20	PVC (Total R.A.)	4.0						
L	21	PVC (Resp. R.A.)	1.7						
	22	PVC (Background)							
	23	PVC (Background)							
P-24	24R	PVC (Resp. R.A.)	72.0						
P-25	25L	PVC (Resp. R.A.)	75.0						
N/A	26	Calibration	N/A						

Location : Exhaust Sample Bank									
Pump ID	Hose No.	Media	Target (l/min)	Actual Flow (l/min)					Ave Flow (l/min)
				1	2	3	4	5	
M	27,28	PVC (Total Dust)	1.0						
N	29,30	PVC (Total Dust)	1.0						
O	31	0.8 μm MCE	2.0						
P	32	PVC (Resp.)	1.7						
Q	33	PVC (Total R.A.)	4.0						
R	34	PVC (Resp. R.A.)	1.7						
	35	Open							
	36	Open							
	37	Open							
	38	Open							
N/A	39	Calibration	N/A						

Location : Operator Breathing Zone									
Pump ID	Hose No.	Media	Target (l/min)	Actual Flow (l/min)					Ave Flow (l/min)
				1	2	3	4	5	
S	40	0.8 μm MCE	2.0						
T	41	PVC (Total Dust)	1.0						
U	42	PVC (Resp. Dust)	1.7						

KTA/SET ENVIRONMENTAL

115 Technology Drive
Pittsburgh, PA
412-788-1300

Project: CDC/NIOSH	**Pump Flow Verification Report**	Facility: KTA-TATOR, INC. Pittsburgh, PA
Date:	Time:	Generic Abr. Type:
KTA/SET Project Number: J95331		Trade Name:
Abrasive Log Number:		Supplier:
Abrasive Mfg.:		Size:
		Grade:

Verification Equipment:	
Gilibrator Precision Flow Bubble Meter	SN: 001479-B
Gilibrator Standard Flow Cell	SN: 19825-S
Gilibrator High Flow Cell	SN: 19747-H

Verification Conducted By:_____(print) _____(signature)

Comments:

Location : Make-up Air Sample Bank										
Pump. ID	**Hose No.**	**Media**	**Target (l/min)**	**Actual Flow (l/min)**					**Ave Flow (l/min)**
				1	**2**	**3**	**4**	**5**	
A	1,2	PVC (Total Dust)	1.0						
B	3,4	PVC (Total Dust)	1.0						
C	5	0.8 μm MCE	2.0						
D	6	PVC (Resp. Dust)	1.7						
E	7	PVC (Total R.A.)	4.0						
F	8	PVC (Resp. R.A.)	1.7						
	9	Open							
	10	Open							
	11	Open							
	12	Open							
N/A	13	Calibration	N/A						

Location : Operator Area Sample Bank									
Pump ID	Hose No.	Media	Target (l/min)	Actual Flow (l/min)					Ave Flow (l/min)
				1	2	3	4	5	
G	14,15	PVC (Total Dust)	1.0						
H	16,17	PVC (Total Dust)	1.0						
I	18	0.8 μm MCE	2.0						
J	19	PVC (Resp.)	1.7						
K	20	PVC (Total R.A.)	4.0						
L	21	PVC (Resp. R.A.)	1.7						
	22	PVC (Background)							
	23	PVC (Background)							
P-24	24R	PVC (Resp. R.A.)	72.0						
P-25	25L	PVC (Resp. R.A.)	75.0						
N/A	26	Calibration	N/A						

Location : Exhaust Sample Bank									
Pump ID	Hose No.	Media	Target (l/min)	Actual Flow (l/min)					Ave Flow (l/min)
				1	2	3	4	5	
M	27,28	PVC (Total Dust)	1.0						
N	29,30	PVC (Total Dust)	1.0						
O	31	0.8 μm MCE	2.0						
P	32	PVC (Resp.)	1.7						
Q	33	PVC (Total R.A.)	4.0						
R	34	PVC (Resp. R.A.)	1.7						
	35	Open							
	36	Open							
	37	Open							
	38	Open							
N/A	39	Calibration	N/A						

Location : Operator Breathing Zone									
Pump ID	Hose No.	Media	Target (l/min)	Actual Flow (l/min)					Ave Flow (l/min)
				1	2	3	4	5	
S	40	0.8 μm MCE	2.0						
T	41	PVC (Total Dust)	1.0						
U	42	PVC (Resp. Dust)	1.7						

KTA/SET ENVIRONMENTAL
MECHANICAL VENTILATION EVALUATION FORM

Project: CDC/NIOSH
Equipment:
Air Measurement Instrument:

Evaluator:
Inspection Date:
KTA/SET No.: J95331

A. LOCATION DIAGRAM

AIR VELOCITY MEASUREMENTS
INSIDE BLAST ROOM

1	2	3	4
5	6	7	8
9	10	11	12

Measurements are made at the center of the blast room, across the cross-sectional area perpindicular to the air flow.

B. AIR VELOCITY MEASUREMENTS

MEASUREMENT RESULTS

1 _____ 7 _____
2 _____ 8 _____
3 _____ 9 _____
4 _____ 10 _____
5 _____ 11 _____
6 _____ 12 _____

Average Air Velocity (AAV) = _____ FPM

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Division of Respiratory Disease Studies
1095 Willowdale Road
Morgantown, WV 26505-2888
(304) 285-5754

SAMPLE SUBMITTAL FORM

NIOSH Investigator: Mark F. Greskevitch
Sampling Site: KTA/SET ENVIRONMENTAL, INC. ENCLOSED BLASTING BOOTH in PITTSBURGH, PA
Industrial Process: SIC 1700 CONSTRUCTION
Collection Date: 06-07-96
Shipment Date: 06-27-96

Date: July 1, 1996
Project No: DRDS 96-057
Air Temp (°C): N/A

Sequence Number	Analysis Requested	Sample Characteristics (Type*, Manuf., Lot No.)
8395	Elemental: ICP-AES (7300) and Graphite furnace method for 4 elements listed in comments	Airborne samples for elemental analysis, see attached MSDS sheets of abrasive used and spec sheets for steel blasted upon

* Specify: Solid Sorbent Tube (eg, Charcoal), Filter Type, Impinger Solution, Bulk Sample, Blood, Urine, Tissue, Other

Laboratory Sample Number	Field Sample Number	Air Vol. (liters)

CHAIN OF CUSTODY RECORD - AIR SAMPLING FORM				SHEET ____ OF ____
1. PROJECT NUMBER:	J95331	2. DATE:		
3. PROJECT NAME/LOCATION:	NIOSH/CDC - PITTSBURGH, PA			
4. NAME OF SAMPLER	Print	Signature		
	Name	Company	KTA/SET Environmental	
	City Pittsburgh	State PA	Zip Code 15275	

6. SAMPLE NUMBERS					

7. SAMPLES RELINQUISHED BY			8. SAMPLES RECEIVED BY		
NAME	DATE	TIME (note am/pm)	NAME	DATE	TIME (note am/pm)

KTA/SET ENVIRONMENTAL
115 TECHNOLOGY DRIVE
PITTSBURGH, PA 15275
PHONE: (412) 788-1300
FAX: (412) 788-1306

APPENDIX 6

Process Control Checks Summary

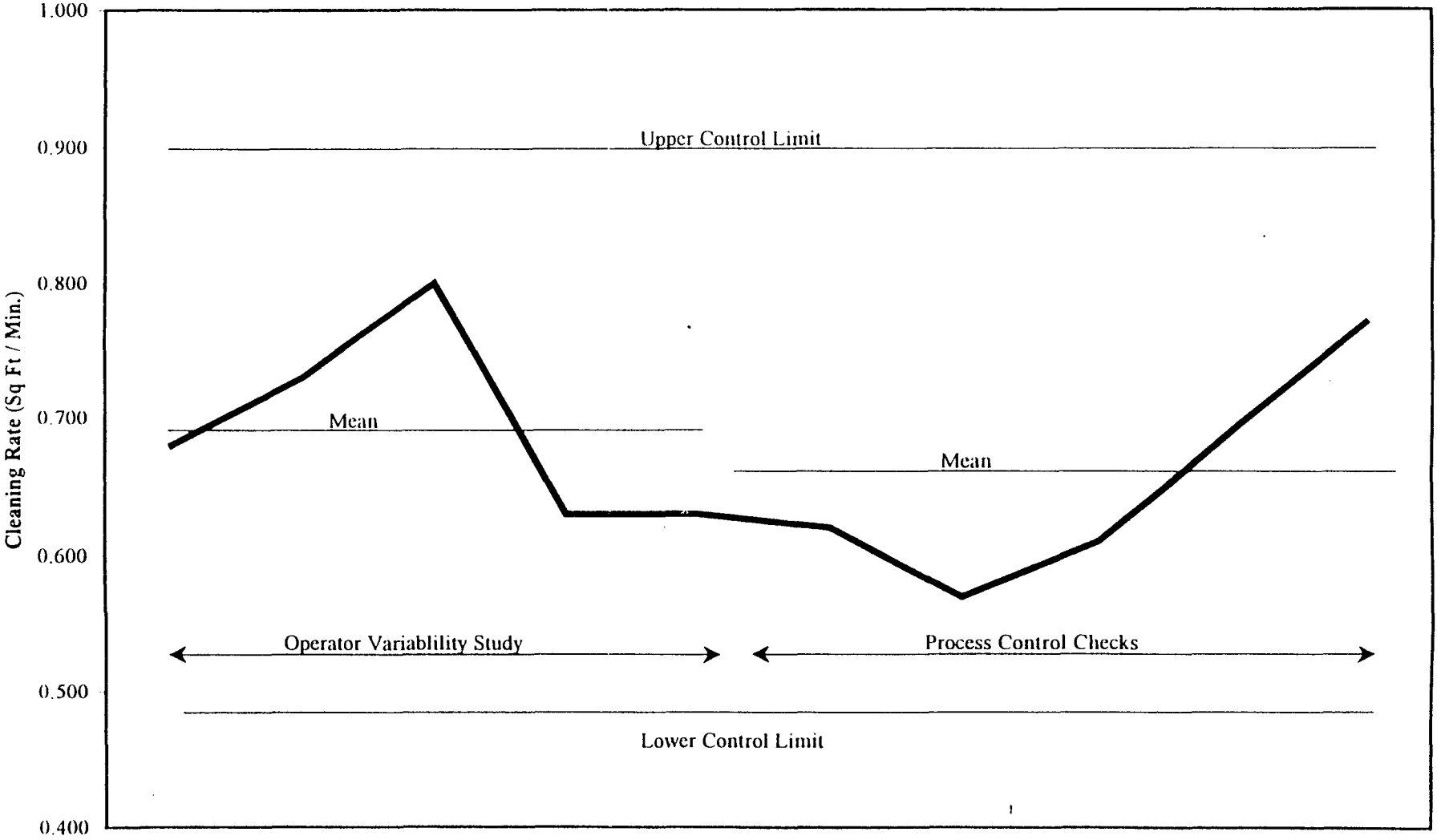
Trial Time (Minutes)	Statistical Analysis of Process Control Check Results	
80.40	Mean	74.120
78.70	Standard Error	3.127
68.50	Median	78.200
78.20	Standard Deviation	6.991
64.80	Sample Variance	48.877
	Kurtosis	-2.341
	Skewness	-0.702
	Range	15.600
	Minimum	64.800
	Maximum	80.400
	Confidence Level(95.000%)	6.128

Cleaning Rate (Square Feet / Minute)	Statistical Analysis of Process Control Check Results	
0.62	Mean	0.652
0.57	Standard Error	0.035
0.61	Median	0.620
0.69	Standard Deviation	0.079
0.77	Sample Variance	0.006
	Kurtosis	-0.073
	Skewness	0.883
	Range	0.200
	Minimum	0.570
	Maximum	0.770
	Confidence Level(95.000%)	0.069

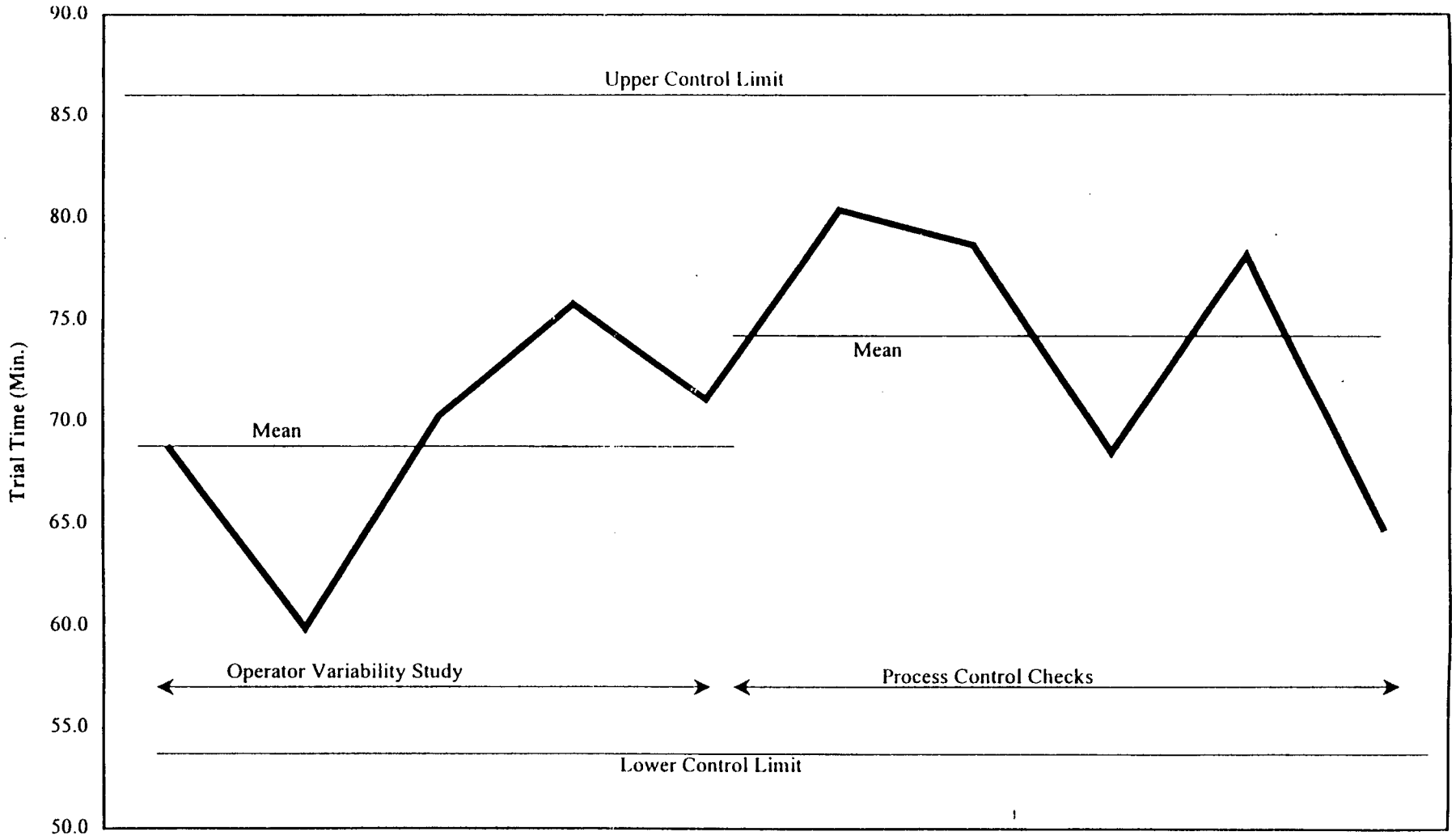
Surface Area Cleaned (Square Feet)	Statistical Analysis of Process Control Check Results	
49.80	Mean	48.140
45.10	Standard Error	2.208
41.50	Median	49.800
54.30	Standard Deviation	4.937
50.00	Sample Variance	24.373
	Kurtosis	-0.659
	Skewness	-0.264
	Range	12.800
	Minimum	41.500
	Maximum	54.300
	Confidence Level(95.000%)	4.327

Consumption Rate (Pounds / Square Foot)	Statistical Analysis of Process Control Check Results	
9.92	Mean	10.436
11.09	Standard Error	0.511
12.05	Median	10.000
9.12	Standard Deviation	1.142
10.00	Sample Variance	1.305
	Kurtosis	-0.607
	Skewness	0.555
	Range	2.930
	Minimum	9.120
	Maximum	12.050
	Confidence Level(95.000%)	1.001

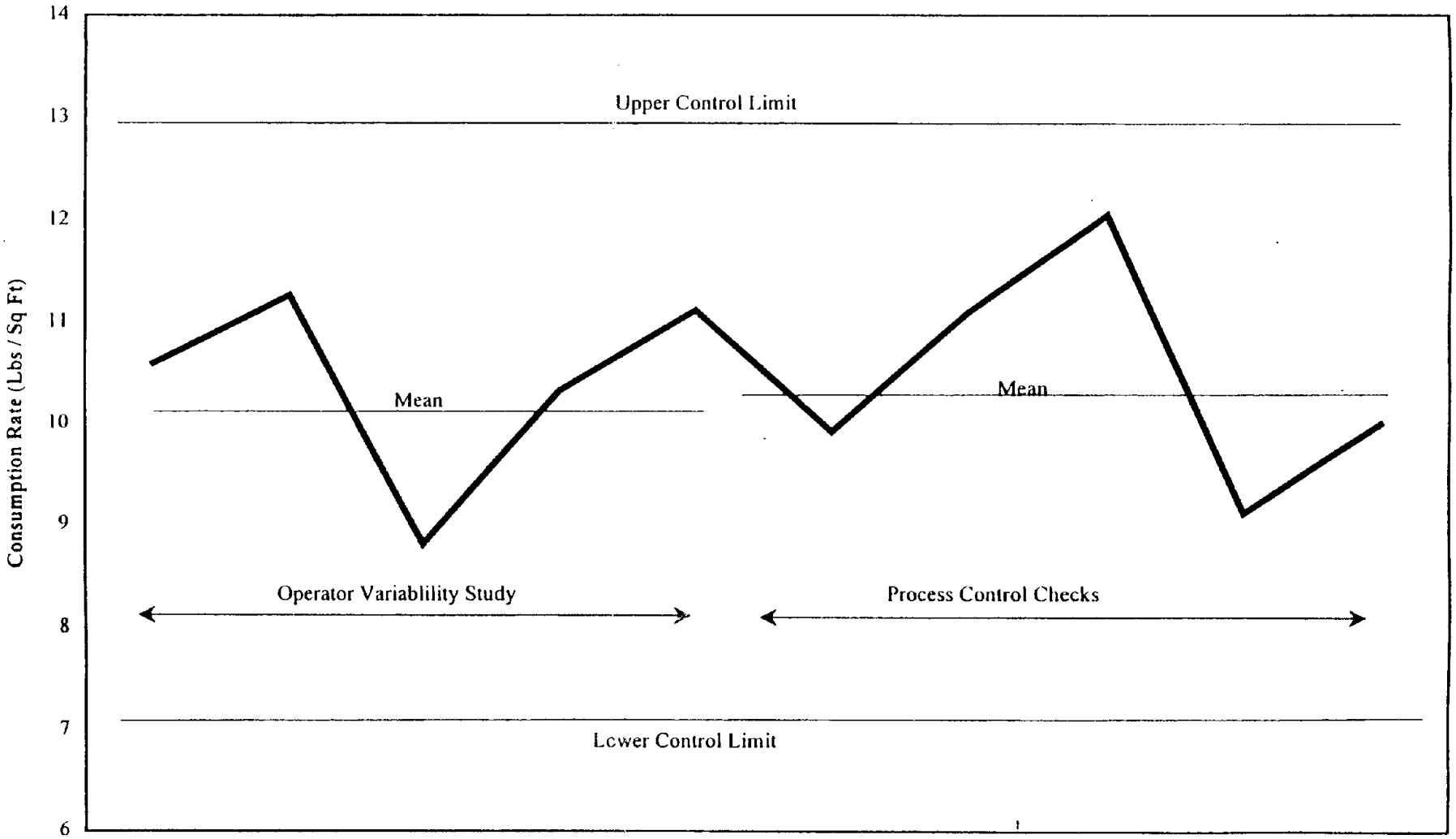
Cleaning Rate Process Control



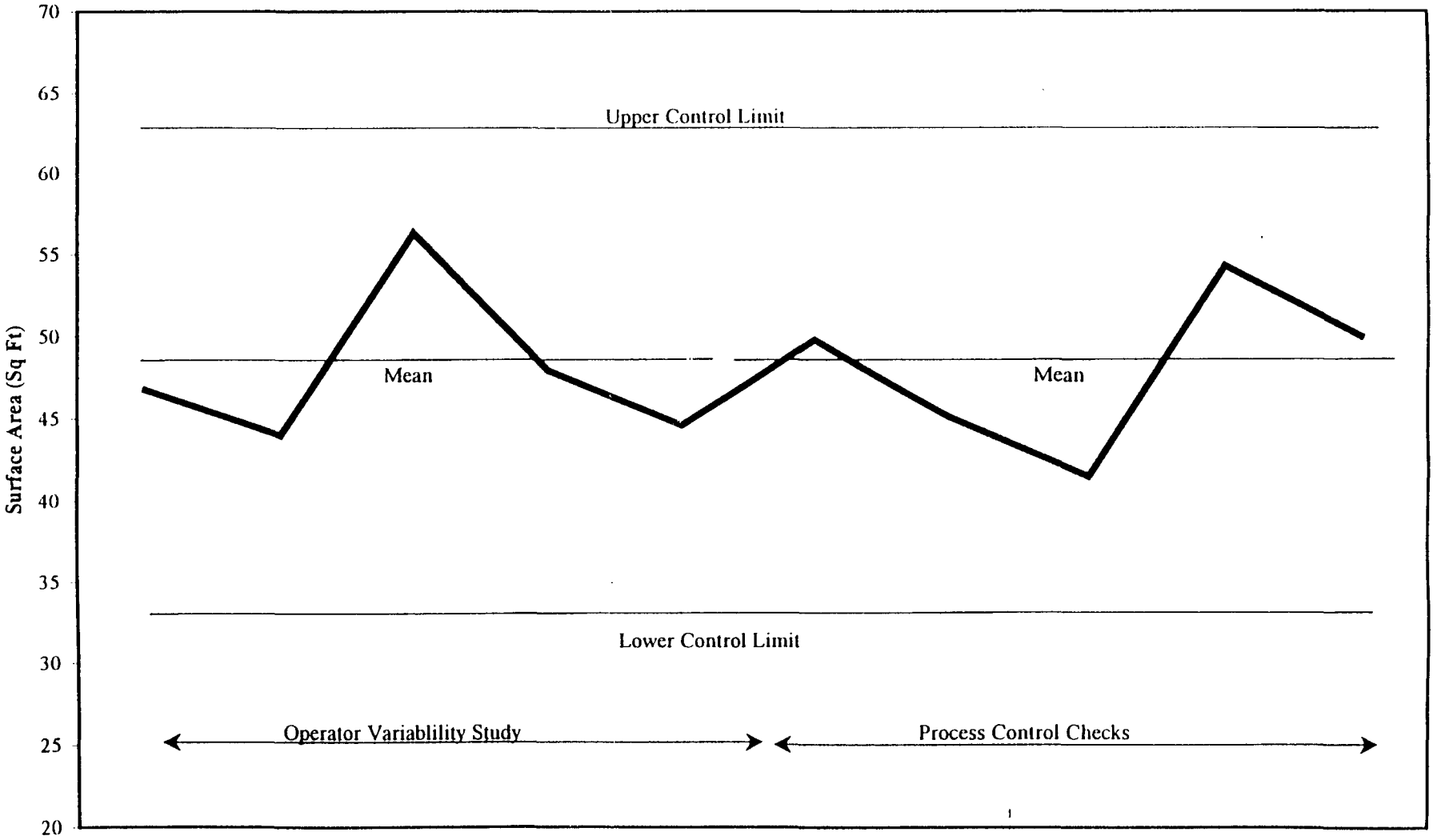
Trial Time Process Control



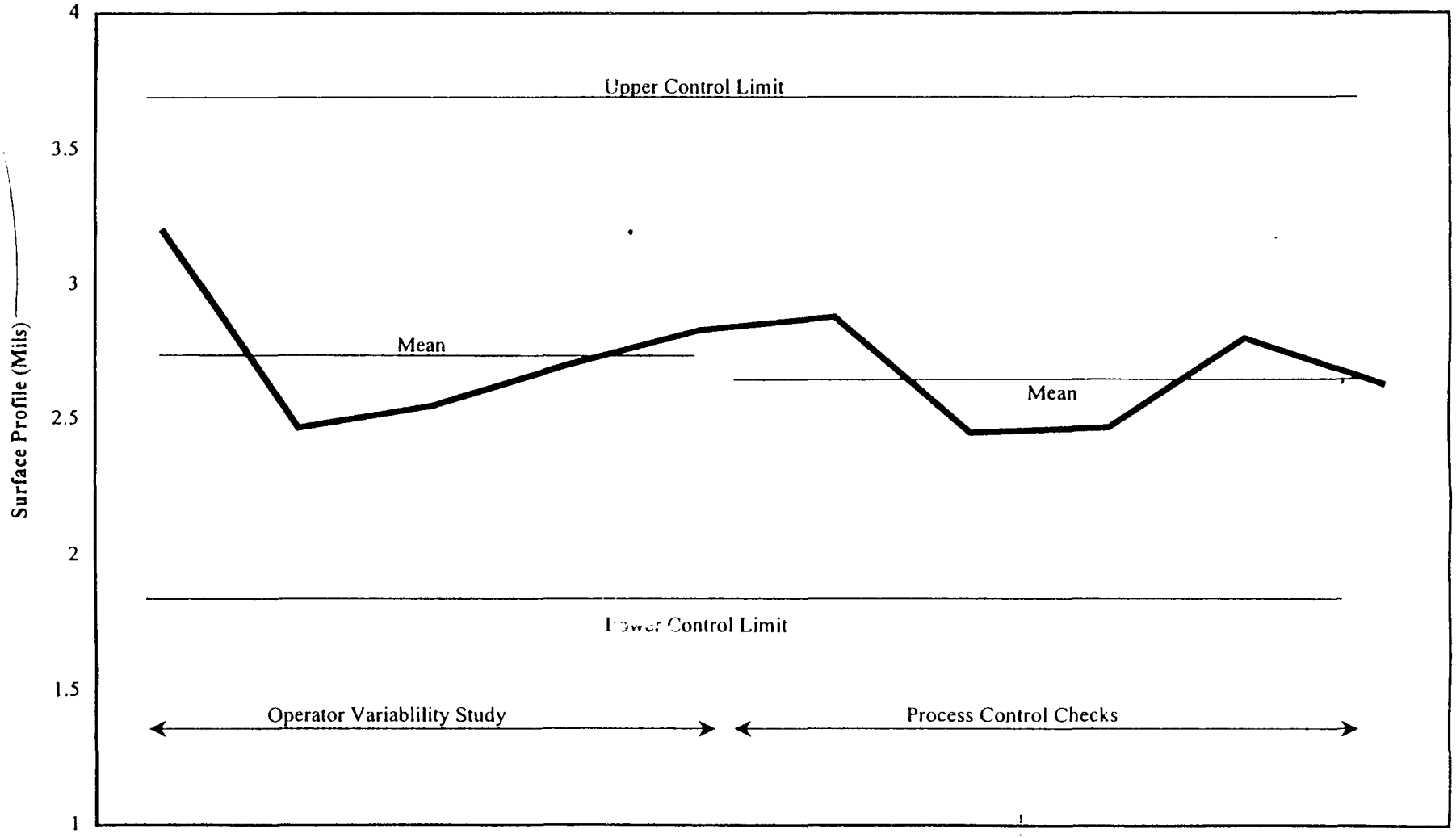
Consumption Rate Process Control



Surface Area Cleaned Process Control

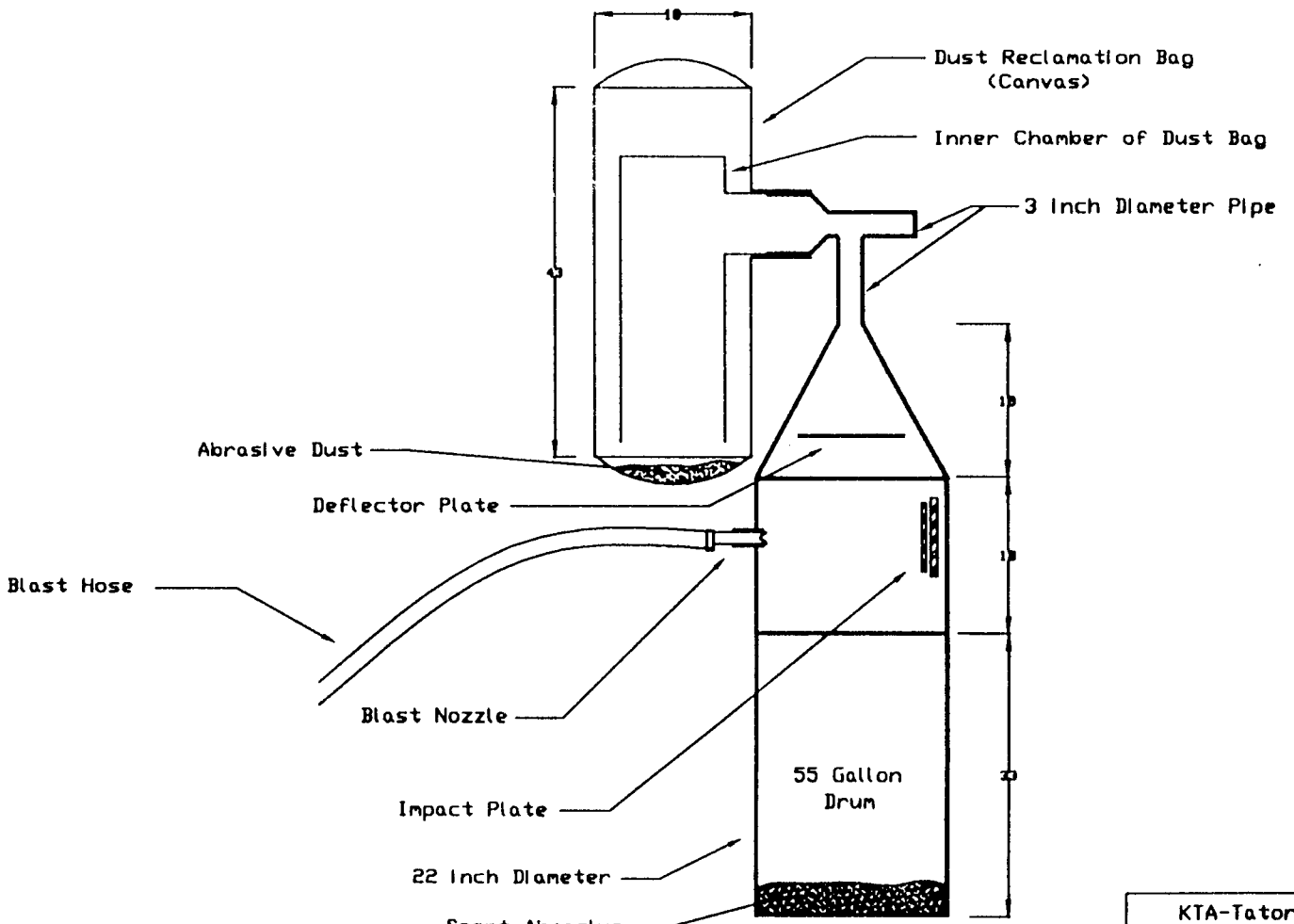


Surface Profile Process Control



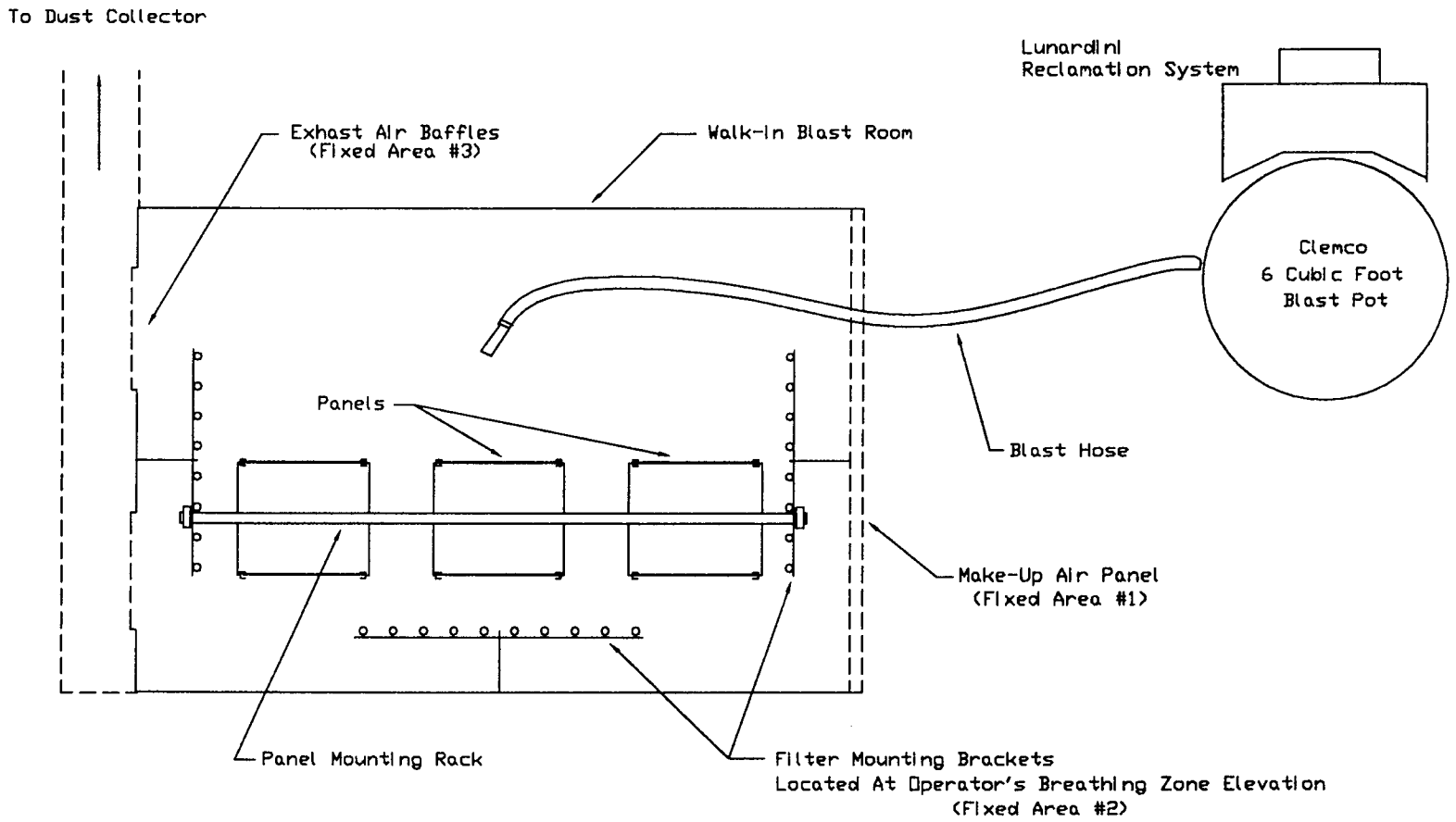
APPENDIX 7

KTA-TATOR ABRASIVE BREAKDOWN CHAMBER



KTA-Tator, Inc.
Blast Reclamation Chamber

APPENDIX 8



KTA-Tator, Inc.		
Blast Cleaning Facilities		
Drawn By: MPR	Date: 2/5/98	Chk'd By: MFM

APPENDIX 8
Blast Run Conditions
Expendable Abrasives

Abrasive Type	Log Number	Blast Date	Blast Time	Ambient Conditions					Ventilation
				Air Temp °F	RH %	DP °F	ST °F	Bar Pre	Air Flow (FPM)
CG-01	J95331-63	7/9/96	11:01am	88	37	58	80	29.53	61.92
CS-01	J95331-34	5/22/96	1:10pm	89	27	49	80	29.77	60.17
CS-02	J95331-37	5/29/96	8:48am	72	31	39	67	29.94	59
CS-03	J95331-38	5/1/96	1:08pm	82	23	40	72	30.00	55.67
CS-04	J95331-39	5/30/96	12:25pm	76	27	39	71	31.12	56.25
CS-05	J95331-57	7/1/96	9:01am	84	61	69	80	29.80	62
CS-06	J95331-70	8/1/96	8:15am	75	57	58	72	29.85	58.42
CS-07	J95331-83	8/26/96	1:18pm	83	51	63	75	29.88	62.75
CSDS-01	J95331-31	5/16/96	8:58am	71	48	50	70	29.88	63
CSDS-02	J95331-35	5/22/96	10:05am	92	29	53	84	29.8	64.92
N-01	J95331-52	6/19/96	1:28pm	89	57	71	79	29.77	66.58
N-02	J95331-81	8/21/96	2:25pm	88	48	65	80	30.03	56.33
O-01	J95331-69	7/29/96	1:30pm	84	70	73	78	30.00	58.42
S-01	J95331-28	5/14/96	12:31pm	70	20	27	66	30.21	57.66
S-02	J95331-29	5/15/96	8:02am	70	32	39	68	30.06	62.58
SH-01	J95331-36	5/28/96	7:54am	73	51	54	70	29.68	62.33
SS-01	J95331-32	5/16/96	1:08pm	86	39	57	79	29.91	67.08
SS-02	J95331-40	6/3/96	9:06am	76	61	62	71	29.97	59.33
SS-03	J95331-45	6/6/96	2:20pm	86	36	54	78	30.00	62.25
SS-04	J95331-47	6/10/96	9:00am	79	64	66	74	29.83	56.58
SS-05	J95331-53	6/20/96	10:06am	85	64	71	80	29.68	64
SS-06	J95331-76	8/15/96	8:45am	78	62	64	72	30.00	61.25
SS-07	J95331-80	8/21/96	8:45am	77	67	65	74	30.06	50.25
SSDS-01	J95331-33	5/22/96	8:38am	78	48	56	75	29.68	56.92
SSDS-02	J95331-44	6/6/96	8:53am	73	48	52	69	30.00	59.00
SSDS-03	J95331-48	6/11/96	8:47am	82	58	65	76	29.85	63.75

APPENDIX 8
Blast Run Condition
Recyclable Abrasives

Abrasive Type	Log Number	Run	Blast Date	Blast Time	Ambient Conditions					Ventilation
					Air Temp °F	RH %	DP °F	ST °F	Bar Pre	Air Flow (FPM)
CP-1A	J95331-60	1	7/3/96	1:03pm	79	46	56	73	29.56	56.58
CP-1B	J95331-62	2	7/8/96	3:12pm	92	46	68	84	29.59	63.92
CP-2A	J95331-67	1	7/24/96	7:27am	76	61	62	73	29.83	52.83
CP-2B	J95331-68	1	7/29/96	9:12am	72.5	71	67	72	30.00	55.17
CP-3A	J95331-72	1	8/5/96	1:00 pm	84	55	66	77	30.06	56.67
CP-3B	J95331-73	3	8/6/96	1:29 pm	88	53	68	83	30.06	60.83
CP-4A	J95331-78	1	8/19/96	1:02pm	84	46	60	78	30.15	56
CP-4B	J95331-79	2	8/20/96	10:58am	82	64	68	76	30.15	58.25
CPDS-1A	J95331-84	1	8/29/96	1:00pm	84	44	59	76	30.00	65.33
CPDS-1B	J95331-85	2	8/30/96	8:41am	77	48	55	71	30.03	55.25
G-1A	J95331-41	1	6/3/96	12:39pm	82	54	63	72	29.94	56.25
G-1B	J95331-46	5	6/7/96	1:05pm	89	46	65	81	29.85	58.25
G-2A	J95331-43	1	6/5/96	9:40pm	76	47	54	69	29.91	65.83
G-2B	J95331-50	4	6/14/96	9:00 am	84	58	67	76	29.83	70.67
G-3A	J95331-49	1	6/12/96	8:43am	82	55	64	76	29.77	63.45
G-4A	J95331-55	1	6/27/96	9:09 am	77	47	55	73	30.06	68.92
G-4B	J95331-56	3	6/28/96	10:41 am	87	44	61	81	30.00	60.33
G-5A	J95331-58	1	7/1/96	12:38pm	92	41	64	86	29.80	63.17
G-5B	J95331-59	4	7/3/96	9:08am	79	56	62	74	29.56	62.25
G-6A	J95331-64	1	7/10/96	9:27am	78	38	50	73	29.83	57.58
G-6B	J95331-65	3	7/11/96	10:20am	77	44	53	73	30.09	48.67
G-7A	J95331-74	1	8/12/96	9:21 am	75	74	66	70	29.91	59.67
G-7B	J95331-75	3	8/13/96	8:11 am	73	58	57	70	29.88	67.67
SG-1A	J95331-54	1	6/21/96	10:33am	84	51	63	80	29.77	62.67
SG-1B	J95331-71	25	8/2/96	8:24am	77	54	59	72	29.88	61.42
SG-2A	J95331-66	1	7/12/96	12:21 pm	84	48	62	79	30.03	67
SG-2B	J95331-82	25	8/26/96	8:31 am	76	56	59	71	29.91	62.75

APPENDIX 9

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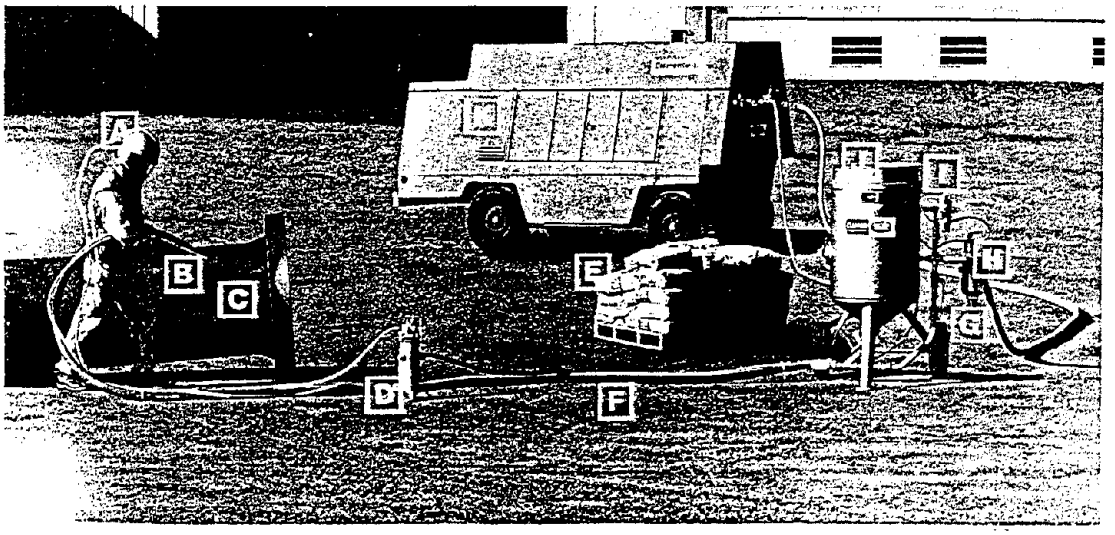
Achieving Productivity from Abrasive Blast Cleaning Systems

By Clemco Industries

Abrasive blasting of steel substrates can provide the best possible surface preparation for coatings adhesion. If done properly, abrasive blasting thoroughly cleans the surface and creates a surface profile for mechanical adhesion. To achieve the economy available through abrasive blasting, the operator must maintain the productivity and efficiency of the cleaning system through careful attention to all of its components.



■ Fig. 1
A complete abrasive blast cleaning system. Labeled parts are identified as follows.
- A Safety air-fed helmet
- B Large orifice venturi nozzle
- C High nozzle air pressure
- D Breathing air filter
- E Appropriate abrasive material
- F Large blast hose and external couplings
- G Moisture separator
- H Large air hose and coupling
- I Remote control valves
- J High production blast cleaning machines
- K Large air compressor

Courtesy of Clemco Industries

The principle of air-supported abrasive blasting is very elementary. Compressed air propels abrasive particles at high velocities to impact and clean a substrate.

All the equipment between the air compressor and the emission of abrasive particles is used to supply, convey, and accelerate the abrasive.

Three basic components are found in most abrasive blasting operations: the equipment, the abrasive, and the personnel. Careful attention to these 3 basic components is the key to the success or failure of the entire operation.

Table 1 The Effect of Nozzle Orifice Size on Air Flow (cu ft/min) and Horsepower Requirements of the Compressor[1]

Orifice Size (inches)	Nozzle Pressure (psi) 50	60	70	80	90	100
3/16	26.0	30.0	33.0	38.0	41.0	45.0 air (cfm)
	6.0	7.0	7.5	8.5	9.5	10.0 (hp)
1/4	47.0	54.0	61.0	68.0	74.0	81.0 air (cfm)
	10.5	12.0	13.5	15.5	16.5	18.0 (hp)
5/16	77.0	89.0	101.0	113.0	126.0	137.0 air (cfm)
	17.5	20.0	22.5	25.5	28.0	30.5 (hp)
3/8[2]	108.0	126.0	143.0	161.0	173.0	196.0 air (cfm)
	24.0	28.0	32.0	36.0	38.5	44.0 (hp)
7/16[2]	147.0	170.0	194.0	217.0	240.0	254.0 air (cfm)
	33.0	38.0	43.0	48.5	53.5	56.5 (hp)
1/2[2]	195.0	224.0	252.0	280.0	309.0	338.0 air (cfm)
	43.5	50.0	56.0	62.5	69.0	75.0 (hp)
5/8[3]	308.0	356.0	404.0	452.0	504.0	548.0 air (cfm)
	68.0	79.5	90.0	100.5	112.0	122.0 (hp)
3/4[3]	432.0	504.0	572.0	644.0	692.0	784.0 air (cfm)
	96.0	112.0	127.0	143.0	154.0	174.5 (hp)

[1] Air requirements were measured by a flow meter under actual blasting conditions, and are, therefore, lower than figures for air alone, with no abrasive. Horsepower requirements are based on 4.5 cfm per horsepower. Figures may vary for different working conditions.

[2] Blast machines should be equipped with 1 1/4 in. piping and valves to provide sufficient air volume.

[3] Blast machines piping, valves, and blast hose may have to be enlarged to prevent pressure loss.

Equipment

For abrasive blasting, as with any discipline, efficiency and productivity are directly affected by the appropriateness of the tools that are used.

Air Compressor

The air compressor is one of the most critical pieces of equipment in the entire operation. It is also one of the most costly, and demands proper maintenance. Because the volume and pressure of the compressed air determine the speed of the abrasive as it exits the nozzle, and thus its cleaning productivity, maintenance of air volume and pressure is critical.

The size of the blast nozzle's orifice will determine the size of compressor required to achieve a given psi of air at the nozzle. Reductions in pressure affect blast cleaning efficiency. For example, if 100 psi is taken as a standard providing highest (100 percent) productivity, then a nozzle pressure of 80 psi will result in 66 percent blasting productivity, while a nozzle pressure of 60 psi will result in 50 percent blasting productivity.

Table 1 shows the effect of nozzle orifice size on compressed air requirements. For instance, when a 3/8-inch nozzle orifice is used, 196 cfm of air is required to achieve 100 psi of air at the nozzle and a 44 hp compressor is needed.

Two factors can influence compressor size requirements, in addition to nozzle orifice size. They are pressure and air volume loss due to hoses and couplings, and the use of the blast machine compressor to supply breathing air for respirators.

Pressure and air volume are lost when undersized hoses and couplings are used to join the compressor to the blast machine. The air hose should be at least 1.5 in. inside diameter(I.D.) and preferably 2 in. or larger. Keep in mind that for every pound of pressure lost at the blast nozzle, there is approximately 1.5 percent loss in blasting production. If because of undersized air hose the air pressure is reduced by 10 psi, blasting production will be reduced by 15 percent. Pressure and volume loss can be minimized by keeping the I.D. of the air hose and couplings a minimum of 4

times the size of the blast nozzle orifice.

If blasting operators acquire breathable air for their respirators from the same compressor that is used for the blast machine, then the amount of air required by the respirators must be added to the amount of air required by the blasting nozzle(s) to calculate the size of compressor needed for the operation.

The diameter and length of blast hose that conveys the abrasive to the nozzle can also cause pressure loss, but this factor will be discussed in the next section.

Outdoor blasting usually dictates the use of a portable gasoline or diesel engine compressor, while in-plant blasting needs are best served using a stationary, electrically driven compressor. With either, it is necessary to have clean, dry air supplied at the correct volume and pressure.

Abrasive Blast Machine

The abrasive blast machine must be an ASME-coded vessel, designed to meet all safety laws. Blast machines are designed and chosen primarily for their abrasive capacity and if required, for their portability. Their overall design, however, is an essential factor in their efficiency and productivity. For proper functioning, the air pressure inside the blast machine must be equal to the air pressure flowing through the external piping. While there are relatively few moving parts, the machine should have certain features to increase its efficiency. These features include an automatic filling valve (pop-up valve) that seals when air is supplied to the machine and opens when air is turned off, a concave head for ease in filling with abrasive, and a conical bottom that permits the smooth and complete flow of abrasive into the abrasive metering valve.

The external piping on any high production blast machine should be at least 1 in. I.D. and preferably 1.25 in. I.D. One in. I.D. is suitable for those blasting operations using up to 5/16 in. orifice nozzles. For 3/8 in. or larger nozzle orifice sizes, 1.25 in. I.D. is applicable. All piping, valves, and fittings must have full air flow capabilities. The use of small, restrictive piping and valves will cause pressure loss by reducing air volume and will prevent steady, uniform abrasive flow. It is of no value to use large diameter piping and then restrict the entire system by using even 1 undersized valve or fitting.

A critical component of the blast machine is the abrasive metering valve. Its design should allow for quick, precise adjustment of abrasive flow into the compressed air stream. A 45-degree angle of abrasive feed into the air stream has been found to be very efficient because at this angle the abrasive tends to merge uniformly with the air flow.

It should have good abrasive metering capabilities because too little abrasive can give an uneven distribution of particles in the blast pattern. This causes much slower cleaning rates and can leave some surface areas untouched. Excessive abrasive interferes with the abrading action because of abrasive impacting other rebounding particles. The optimum metering adjustment gives a very fine flow of abrasive that can be seen exiting the blast nozzle in a smooth and steady flow.

In addition to smooth and easy adjustability, the metering valve should have quick clean-out capabilities when foreign materials cause plugging.

Remote controls are an absolute necessity, both for the overall productivity of the blast operation and to satisfy OSHA requirements for the safety of the operator. Remote controls allow the blast operator to start and stop the machine AT THE NOZZLE, thus keeping abrasive and air consumption to a minimum because the operator does not have to rely on a blast machine tender to turn the machine on or off.

Remote controls can, however, be a detriment to air flow if they are not properly designed or sized for the machine. Like the machine piping, remote control valves must be large enough to handle the air requirements of the system.

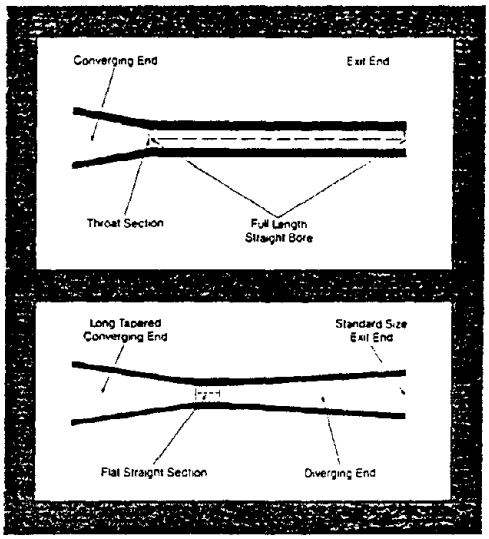
There are 2 basic types of remote controls: pneumatic and electro/pneumatic. Electro/pneumatic remotes should be used on jobs that require over 100-foot runs of blast hose because they respond much faster than pneumatic remote controls.

The sole purpose of blast hose is to convey the air-driven abrasive from the blast machine to the blast nozzle. The abrasive/air mixture should flow freely without passing through any undersized hose or fittings that could cause excessive wear and pressure loss.

If the blast hose I.D. is decreased by only 1/4 in., the pressure loss can be as great as 12 psi. The I.D. of blast hose that is used in high production operations should be at least 1 in., but preferably

Table 2 Effect on Changes in Hose I.D. on Inner Area of Hose

Hose I.D. (inches)	Area Size (inches)	Percent of Area Reduction
1.5	1.77	0
1.25	1.23	30
1.0	.79	55
0.75	.44	75



■ Fig. 2
(top) Straight bore nozzle
(bottom) Long venturi nozzle

1.25 in. When the I.D. of hose is doubled, the inner area of the hose is quadrupled. The opposite is true, of course, when the hose I.D. is reduced. Table 2 shows hose I.D. and area size and the reduction of area as the I.D. is decreased.

Any coupling that is used on a blast hose should allow a smooth transition between hose lengths of any I.D. The coupling must not interfere with the flow of air and abrasive, and the coupling should only be of the external fitting, quick disconnect style. In addition, if the coupling does not include automatic safety wire connections in its design, safety wires must be used to help prevent the accidental disengagement of the quick couplings. Hose safety cables are also available for use on both air and blast hose.

It is important to minimize the length of the blast hose, because this factor also causes pressure loss. In normal operations 4 to 5 psi of pressure is lost due to friction in each 50-foot length of blast hose.

Nozzles

Blast nozzles are designed to meet a wide variety of needs, and they are supplied in various lengths and configurations. In addition, various materials are used for both the liner and the outer jacket. Proper nozzle selection depends upon the surface to be cleaned, the size of the overall job to be done, the amount of compressed air that is available, and the type of abrasive to be used. When the air and abrasive reach the blast nozzle, the nozzle design should allow for rapid acceleration of the mixture to be evenly dispersed in a high velocity pattern.

Of the nozzle styles that are currently available, long venturi types provide the highest velocity and most uniform blast pattern. A straight barrel nozzle provides abrasive/air exit speeds of up to 318 ft/sec, while venturi nozzles provide abrasive/air exit speeds of up to 660 ft/sec (Fig.2).

Modern nozzle liner materials are usually manufactured from ceramics, tungsten carbide, boron carbide, or silicon carbide. Outer jackets can be of aluminum, zinc die metals, steel, or urethane. Common ceramic liners wear fast and unevenly, giving the operator very little control over the work being performed. Fast and uneven wear can overtax the air compressor, causing an inevitable loss of air pressure that will create a substantial drop in production rates.

Nozzles lined with tungsten carbide, boron carbide, or silicon carbide give longer hours of service with minimal wear, assuring a more consistent air and abrasive supply over long periods of nozzle use. The most popular liner materials are tungsten carbide and silicon carbide, which are suitable for use with most expendable and re-usable abrasives. Boron carbide liners are more expensive than tungsten or silicon carbide liners and are generally used only with the most aggressive abrasives, such as aluminum oxide.

While the hardness and composition of the nozzle liner can allow longer wear, these same qualities can make the liners very brittle and susceptible to premature fracture if the nozzle is misused. The use of soft urethane as a nozzle jacket material has provided an extra measure of protection against impact while reducing the overall weight of the nozzle.

The fastening end of the nozzle has traditionally had 1.25 in. fine threads, or occasionally, a flange fitting. The newest fastening form is with 50-millimeter threads that are larger, deeper, and stronger than fine threads. In addition, 50-millimeter threads help prevent thread gall, which can occur when abrasive lodges in the threads as the nozzle is put in and taken out of the nozzle holder.

Nozzle orifice size is very critical to productivity. The orifice diameter determines air volume requirements at given nozzle pressures as well as abrasive consumption and cleaning production rates. All work accomplished will be in direct proportion to the volume and pressure of air that exits the nozzle.

The best nozzle length depends upon several factors. The accessibility of the operator to the work, the type of surface to be cleaned, and the amount of surface to be cleaned are 3 considerations. Generally, a short nozzle, 3 in. long, is used when the surface area is small or when the cleaning job is very easy, such as raised and flaking paint. On hard to clean surfaces, such as rusted and pitted steel or tight mill scale, a long venturi nozzle is the most efficient.

Since the air pressure that exits an air compressor is always higher than nozzle pressure, a nozzle pressure gauge must be used to measure the actual pressure at the nozzle. Once again, the work performed is in direct proportion to the vol-

ume and pressure at the blast nozzle.

Abrasive Selection

Abrasive selection is determined by the scope of the job, the job location, and the desired surface finish, which may be determined by the coating manufacturer or the owner of the equipment or structure that is being cleaned. A wide variety of abrasives is readily available throughout the world, and any of several types may be chosen to accomplish the required surface cleaning.

In the very broadest sense, there are 2 basic types of blasting abrasives: expendable and re-usable. Sand and slag are 2 examples of expendable abrasives normally used outdoors. Steel grit and aluminum oxide are 2 re-usable abrasives normally used in a blast room or blast cabinet where there is some type of reclaim system. Generally speaking, sand and slag are used once and then disposed of; steel grit and other metallic abrasives have a very high re-use factor.

There are 4 important features that affect performance of any abrasive: hardness, shape, size, and cleanliness.

Hardness dictates the friability or breakdown rate of most abrasives; hard abrasives fracture or pulverize easily upon impact. Hard abrasives are used on surfaces where the material to be removed is tenacious or where a deep profile is required.

Abrasive shape will determine the surface etch or surface profile. Angular, sharp particles produce the greatest cutting action and the deepest profile. Round or semi-round particles will cut much more slowly and will produce a more shallow profile. This one feature has caused more problems with production rates than any other characteristic.

Size is a very critical aspect of any abrasive selection process. Properly sized abrasive has a major effect on coating coverage and coating adhesion. A coarse particle will produce a deep profile, while a finer particle will produce a more shallow profile. Excessively deep or shallow profiles can cause major coating problems and failures. When a profile is too deep for the applied coating, peaks will protrude through the coating surface allowing premature coatings failure. Shallow profiles do not provide a sufficient roughness for bonding. Achieving the specified profile depends upon selecting the right size range of abrasive.

The final prerequisite for abrasive is cleanliness. Abrasives should be washed and screened to remove any contaminants, dust, or fines. Dust and fines reduce cleaning rates and can interfere with surface profiles. In addition, contaminants, such as soluble salts, can ultimately cause premature coating failure.

Personnel

Equipment that has been properly selected for the job and the correct abrasive for the surface to be cleaned produce the necessary "power" to operate at a consistent pace. It is the operator, however, who controls the equipment and determines the ultimate productivity and job efficiency. Operators therefore must be properly trained and protected from the health and safety hazards of abrasive blasting.

In nearly all trades, the cost of labor is at least equal to if not higher than the cost of equipment and supplies. Personnel can make or break any abrasive blasting job. Properly trained, abrasive blast operators can turn an otherwise potential failure into a profitable operation. They should be trained in the use of the equipment, safety, proper blasting techniques, control of surface profile, surface cleanliness standards, and coating manufacturers' requirements for the end condition of steel for each coating used.

Operators who are well trained on the equipment will be able to tell instantly if it is functioning at full capacity. If it is not, they will be able to make appropriate adjustments in techniques or equipment set-up. Adjustments in technique might include nozzle angle, nozzle distance from the surface, and nozzle dwell time. Adjustments in equipment set-up could include changing air pressure, adjusting the abrasive metering valve, or using different diameter hose.

Every operator must be protected in his work environment, for his own safety and for the safety of those workers who may be in the same area. Abrasive blast operator safety regulations are set by local, state, and federal agencies. All abrasive blast operators must wear NIOSH- (National Institute of Occupational Safety and Health) approved, air-fed helmets or hoods. This equipment must be supplied with at least Class D breathing air.

In the case of supplied air from the blast machine compressor, a carbon monoxide alarm or converter, an overheating alarm, and a breathing air filter are essential. The filter will remove light

Table 3 Production Rates (sq ft/hr) for Blasting on Steel Surfaces with Various Degrees of Cleanliness and Different Nozzle Sizes

Nozzle Size and Degree of Cleaning (SSPC-SP)	Light Rust, Mill Scale and/or Loose Paint	Tight Mill Scale Light Rust, Partially Loose Paint	Tightly Adhering Thin Film Paint and/or Heavy Rust	Multi-Layered Coatings or Heavy Rust with Pitted Surfaces
1/4 in.				
SSPC-SP 5	100	80	60	40
SSPC-SP 10	110	90	70	50
SSPC-SP 6	220	180	130	90
SSPC-SP 7	450	450	450	450
5/16 in.				
SSPC SP 5	150	120	90	60
SSPC-SP 10	170	140	100	70
SSPC-SP 6	330	270	200	140
SSPC-SP 7	700	700	700	700
3/8 in.				
SSPC-SP 5	220	180	130	90
SSPC-SP 10	240	200	150	100
SSPC-SP 6	500	400	300	200
SSPC-SP 7	1000	1000	1000	1000
7/16 in.				
SSPC-SP 5	320	260	190	130
SSPC-SP 10	350	280	210	140
SSPC-SP 6	750	600	450	300
SSPC-SP 7	1500	1500	1500	1500
1/2 in.				
SSPC-SP 5	440	360	260	180
SSPC-SP 10	480	390	290	200
SSPC-SP 6	1000	800	600	400
SSPC-SP 7	2000	2000	2000	2000

oils and mists and some odors that are usually associated with air compressors that require oil for lubrication. The carbon monoxide alarm will alert personnel to the presence of potentially injurious levels of carbon monoxide that may be in the breathing air supply. The converter can remove dangerous levels of carbon monoxide.

Typically, air compressors will raise the air temperature above ambient. There are lightweight devices attached to the operator's belt that will cool or even raise the temperature of the compressed air that is supplied to the operator.

Complete blast suits, which are made of breathable cotton fabric that is leather-faced, and leather gloves round out the operator safety equipment. Because an operator's productivity can be greatly affected by his comfort or discomfort, it is important to select safety clothing and equipment that minimize weight, heat, and impediments to movement.

After considering the essential elements that make abrasive blasting systems productive, it is still difficult to estimate production rates. The variability of system set-ups, the operator's skill or lack thereof, the condition of the surface to be cleaned, abrasive characteristics, and environmental considerations make any calculations merely estimates. Table 3, however, provides general guidelines on production rates based upon accumulated field data. The data presume that 100 psi is maintained at the blast nozzle.

Conclusion

It is well known that correct surface preparation is essential to achieving the full life of any coating or coating system. Abrasive blasting is recognized as the most effective means of obtaining the correct surface cleanliness and surface profile. Careful attention to all the components of an abrasive blasting system, including the air supply, the abrasive blast equipment, the abrasive, and the expertise of the operator, can assure that any abrasive blasting operation obtains its maximum level of efficiency. ❑

APPENDIX A

TABLE A1
Expendable Abrasives

Cleaning and Consumption Rates

Abrasive Type	Abrasive Trial Time (seconds)	Abrasive Consumed (pounds)	Surface Area Cleaned (square feet)	Cleaning Rate (ft^2 / hour-rounded)[1]	Consumption Rate (Lbs. / ft^2)
CG-01	4984	500	45.50	33	10.99
CS-01	5619	500	43.00	28	11.63
CS-02	5967	500	51.20	31	9.77
CS-03	4299	500	40.50	34	12.35
CS-04	5053	450	43.10	31	10.44
CS-05	4896	500	46.75	34	10.70
CS-06	4694	495	54.30	41	9.12
CS-07	5681	600	66.30	42	9.05
CSDS-01	4773	500	47.00	35	10.64
CSDS-02	3926	500	41.00	38	12.20
N-01	4953	600	48.00	35	12.50
N-02	2628	550	34.75	47	15.83
O-01	5892	578	72.00	44	8.02
S-01	5930	541	72.00	44	7.51
S-02	3731	500	50.50	49	9.90
SH-01	8026	475	72.00	32	6.60
SS-01	5125	500	48.00	34	10.42
SS-02	2770	500	19.00	25	26.32
SS-03	4631	500	44.00	34	11.36
SS-04	3888	362	40.00	37	9.05
SS-05	5745	500	48.50	31	10.31
SS-06	5340	593	44.00	29	13.48
SS-07	6217	600	46.00	26	13.04
SSDS-01	4856	500	36.00	26	13.89
SSDS-02	5313	500	57.20	39	8.74
SSDS-03	3153	317	29.70	34	10.67

Note 1 - Rounded according to raw data.

TABLE A2
Expendable Abrasives

Surface Profile

Abrasive Type	Surface Profile Measurements (mils)						Average Surface Profile
CG-01	2.5	2.7	2.7	2.7	2.8	2.9	2.72
CS-01	3.3	3.8	3.8	3.8	3.8	3.8	3.72
CS-02	2.7	2.7	3.1	3.0	3.3	3.0	2.97
CS-03	3.1	3.3	3.3	3.1	3.5	3.3	3.27
CS-04	2.9	3.1	3.0	3.1	3.0	2.7	2.97
CS-05	3.2	3.1	3.0	3.2	3.2	3.1	3.13
CS-06	2.8	2.8	2.8	3.1	2.5	2.8	2.80
CS-07	2.6	2.9	2.0	2.6	2.9	3.0	2.67
CSDS-01	3.2	2.7	3.2	3.2	3.2	3.3	3.13
CSDS-02	3.0	3.2	3.5	3.4	3.7	3.7	3.42
N-01	3.5	3.4	3.2	2.9	3.2	3.3	3.25
N-02	3.9	3.8	3.5	4.0	4.1	3.9	3.87
O-01	3.3	2.9	2.6	2.8	3.4	3.2	3.03
S-01	2.0	2.0	2.2	2.2	2.0	2.1	2.08
S-02	2.0	2.1	2.0	2.2	2.0	1.8	2.02
SH-01	2.9	2.9	2.7	2.4	2.9	2.8	2.77
SS-01	3.5	3.2	3.5	3.3	3.5	3.5	3.42
SS-02	4.4	4.5	4.4	4.5	4.1	4.5	4.40
SS-03	2.8	2.8	2.7	2.7	2.7	2.7	2.73
SS-04	2.4	3.0	3.0	2.7	2.7	3.0	2.80
SS-05	3.2	3.2	3.6	3.6	3.4	3.6	3.43
SS-06	3.4	3.3	3.2	3.2	3.4	3.3	3.30
SS-07	4.3	3.5	3.8	3.4	3.8	3.6	3.73
SSDS-01	3.3	3.4	3.5	3.5	2.1	2.3	3.02
SSDS-02	2.7	2.8	2.7	2.9	2.9	3.0	2.83
SSDS-03	2.8	2.9	3.0	2.9	2.9	3.0	2.92

Table A3
Expendable Abrasives

Breakdown Rate

Abrasive Type	Pre-Blast Particle Size (mm x 100)	Post-Blast Particle Size (mm x 100)	Average Particle Size is Reduced by X%	Average Particle Size is X% of Original
CG-01	40.32	19.61	51.36	48.64
CS-01	62.94	31.42	50.08	49.92
CS-02	43.81	21.19	51.63	48.37
CS-03	48.83	24.43	49.97	50.03
CS-04	47.87	23.38	51.16	48.84
CS-05	49.08	22.23	54.71	45.29
CS-06	28.02	16.90	39.69	60.31
CS-07	40.38	24.87	38.41	61.59
CSDS-01	49.85	23.93	52.00	48.00
CSDS-02	64.91	30.21	53.46	46.54
N-01	52.25	25.50	51.20	48.80
N-02	70.89	32.68	53.90	46.10
O-01	31.83	21.14	33.58	66.42
S-01	16.56	13.57	18.06	81.94
S-02	16.40	13.18	19.63	80.37
SH-01	31.75	18.82	40.72	59.28
SS-01	64.50	48.00	25.58	74.42
SS-02	112.67	30.56	72.88	27.12
SS-03	38.80	22.99	40.75	59.25
SS-04	37.97	20.36	46.38	53.62
SS-05	66.98	24.43	63.53	36.47
SS-06	65.28	26.34	59.65	40.35
SS-07	90.45	27.01	70.14	29.86
SSDS-01	64.02	21.42	66.54	33.46
SSDS-02	43.15	22.93	46.86	53.14
SSDS-03	40.54	27.86	31.28	68.72

TABLE A4
Embedment Results

Expendable

Abrasive	Panel 1					Panel 2					Panel 3					Average
Type	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Embedment
CG-01	4	6	1	4	2	1	0	3	0	1	2	0	4	3	1	2.1
CS-01	32	29	26	27	27	24	29	23	24	24	27	24	20	16	27	25.3
CS-02	12	13	13	10	11	11	12	9	12	8	6	8	11	11	11	10.5
CS-03	8	6	14	8	9	16	12	17	13	7	13	10	9	8	9	10.6
CS-04	5	3	2	5	2	4	4	1	5	3	2	4	3	6	5	3.6
CS-05	13	11	8	11	13	17	9	7	12	14	9	11	8	9	15	11.1
CS-06	10	8	7	8	9	5	12	9	7	8	9	8	13	7	6	8.4
CS-07	16	12	17	15	12	10	18	14	15	14	20	18	22	18	14	15.7
CSDS-01	4	9	3	7	4	2	4	3	3	2	6	7	3	6	7	4.7
CSDS-02	12	12	9	12	13	10	14	9	13	17	10	6	4	7	7	10.3
N-01	1	3	2	0	2	0	2	1	0	1	2	1	0	2	1	1.2
N-02	32	36	39	28	20	18	31	22	29	31	36	28	22	20	18	27.3
O-01	10	8	17	17	13	20	16	14	18	11	18	17	17	14	16	15.1
S-01	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0.2
S-02	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
SH-01	0	0	3	0	1	2	1	0	1	1	1	0	0	0	0	0.7
SS-01	1	0	0	0	0	0	1	2	2	1	3	1	2	3	1	1.1
SS-02	5	6	0	5	4	3	5	2	4	3	7	10	4	7	5	4.7
SS-03	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0.1
SS-04	2	4	4	6	2	1	4	1	5	4	1	2	1	2	5	2.9
SS-05	9	15	6	11	8	11	11	6	5	7	11	8	7	14	9	9.2
SS-06	5	4	6	2	7	5	5	5	2	2	5	4	2	3	3	4.0
SS-07	21	12	15	12	14	9	7	8	9	18	14	8	12	16	9	12.3
SSDS-01	2	0	1	0	1	1	0	0	1	1	0	1	1	2	1	0.8
SSDS-02	3	4	4	3	2	1	1	4	1	3	6	3	1	3	2	2.7
SSDS-03	3	4	1	5	1	1	2	0	0	1	0	0	0	0	0	1.2

Note 1 - Number of squares out of 100 (within a 1/2" x 1/2" area) containing one or more particles of embedded abrasive.

TABLE A5
Expendable Abrasives

Microhardness

Abrasive Type	Microhardness (Knoop)		Maximum Microhardness Reading Obtained
CG-01	485	430	485.0
CS-01	669	669	669.0
CS-02	720	Note 1	720.0
CS-03	669	720	720.0
CS-04	611	577	611.0
CS-05	605	656	656.0
CS-06	617	511	617.0
CS-07	656	656	656.0
CSDS-01	594	511	594.0
CSDS-02	760	594	760.0
N-01	937	984	984.0
N-02	530	545	545.0
O-01	960	760	960.0
S-01	936	397	936.0
S-02	219	82	219.0
SH-01	1090	1182	1182.0
SS-01	1215	1587	1587.0
SS-02	1587	630	1587.0
SS-03	1403	1809	1809.0
SS-04	1267	315	1267.0
SS-05	2469	1840	2469.0
SS-06	1872	2008	2008.0
SS-07	1537	Note 1	1537.0
SSDS-01	1840	2008	2008.0
SSDS-02	Note 2	Note 2	Note 2
SSDS-03	643	Note 1	643.0

Microhardness tested in accordance with ASTM E384 by Industrial Testing Laboratory Services Corporation

Note 1 - Could not obtain a valid second test

Note 2 - Material was so porous that there was insufficient area to test.
KTA tested this material in accordance with SSPC-AB 1 Section 4.1.2, hardness exceeded 6 on the Mohs hardness scale (approximately 500 Knoop)

Note 3 - Microhardness values varied. Since the lower values may be attributed to porosity or other discontinuity within the specific particle tested, only the higher values are being used to avoid inappropriately lowering the results through averaging.

Note 4 - The hardness of the silica sand used in the study was typically greater than all the abrasives. This deviates from other sources of information on hardness such as Clemco Blast Off, 2nd Edition and A.B. Williams "Abrasive Blast Cleaning Handbook", Update 1991, First Edition.

TABLE A6
Expendable Abrasives

Water-Soluble Contaminants

Abrasive Type	Conductivity (microsiemens)
CG-01	112.0
CS-01	833.3
CS-02	88.3
CS-03	72.3
CS-04	96.7
CS-05	23.8
CS-06	47.0
CS-07	76.7
CSDS-01	42.0
CSDS-02	400.3
N-01	146.7
N-02	36.3
O-01	96.7
S-01	213.3
S-02	87.3
SH-01	63.3
SS-01	80.0
SS-02	18.2
SS-03	38.0
SS-04	66.0
SS-05	21.5
SS-06	708.3
SS-07	96.7
SSDS-01	99.3
SSDS-02	60.7
SSDS-03	25.0

TABLE A7
Recyclable Abrasives

Cleaning and Consumption Rates

Abrasive Type	Number of Uses	Abrasive Trial Time (seconds)	Abrasive Consumed (pounds)	Surface Area Cleaned (square feet)	Cleaning Rate[1] (ft^2 / hour-rounded)	Consumption Rate (Lbs. / ft^2)
CP-1A	1	2721	593	45.80	61.00	12.95
CP-1B	2	1380	455	35.10	92.00	12.96
CP-2A	1	3276	600	36.80	40.00	16.30
CP-2B	2	1502	347	22.58	54.00	15.37
CP-3A	1	1849	600	24.70	48.00	24.29
CP-3B	2	1389	516	20.00	52.00	25.80
CP-4A	1	4606	700	36.00	28.00	19.44
CP-4B	2	3962	557	36.00	33.00	15.47
CPDS-1A	1	4268	563	36.00	31.00	15.64
CPDS-1B	2	2224	362	24.90	40.00	14.54
G-1A	1	6587	500	47.00	26.00	10.64
G-1B	2	3912	317	37.60	35.00	8.43
G-2A	1	5810	500	38.70	24.00	12.92
G-2B	2	5655	349	49.00	31.00	7.12
G-3A	1	5752	400	53.80	34.00	7.43
G-3B	2	Note 2	Note 2	Note 2	Note 2	Note 2
G-4A	1	5537	692	48.00	31.00	14.42
G-4B	3	4482	554	72.00	58.00	7.69
G-5A	1	5856	589	72.00	44.00	8.18
G-5B	3	2282	406	42.30	67.00	9.60
G-6A	1	4162	663	72.00	62.00	9.21
G-6B	2	2879	508	60.00	75.00	8.47
G-7A	1	5362	691	64.00	43.00	10.80
G-7B	2	4089	526	64.80	57.00	8.12
SG-1A	1	2331	485	17.50	27.00	27.71
SG-1B	25	932	230	8.00	31.00	28.75
SG-2A	1	3882	900	41.80	39.00	21.53
SG-2B	25	2624	704	32.34	44.00	21.77

Note 1 - Rounded according to raw data.

Note 2 - Final abrasive trial of reclaimed material was not performed since no usable material remained.

TABLE A8
Recyclable Abrasives

Surface Profile

Abrasive Type	Number of Uses	Surface Profile Measurements (mils)						Average Surface Profile
CP-1A	1	3.8	3.9	4.0	4.0	3.8	3.3	3.80
CP-1B	2	3.0	3.1	3.0	3.0	3.1	2.7	2.98
CP-2A	1	3.6	3.6	3.8	3.6	3.7	3.8	3.68
CP-2B	2	3.7	3.5	3.3	3.4	3.4	3.3	3.43
CP-3A	1	3.8	4.0	3.9	4.0	3.9	3.9	3.92
CP-3B	2	3.2	3.3	3.2	3.3	3.1	3.0	3.18
CP-4A	1	4.2	3.8	3.8	3.5	3.5	4.0	3.80
CP-4B	2	3.1	3.1	3.0	3.0	3.6	3.1	3.15
CPDS-1A	1	3.9	4.0	3.8	4.1	3.8	4.1	3.95
CPDS-1B	2	3.0	3.0	2.7	2.8	3.0	3.1	2.93
G-1A	1	3.9	4.0	3.9	3.9	4.0	3.9	3.93
G-1B	2	2.5	2.3	2.5	2.3	2.7	3.0	2.55
G-2A	1	4.4	4.2	4.3	4.0	4.0	4.0	4.15
G-2B	2	3.0	3.5	3.6	2.9	3.4	3.5	3.32
G-3A	1	3.0	3.2	3.1	2.9	3.2	3.2	3.10
G-3B	2	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
G-4A	1	3.6	3.5	3.3	3.4	3.2	3.4	3.40
G-4B	3	2.8	3.0	3.0	3.0	2.2	2.6	2.77
G-5A	1	2.6	2.6	2.8	2.7	2.8	2.6	2.68
G-5B	3	2.1	2.1	2.0	2.0	2.1	2.1	2.07
G-6A	1	3.2	3.2	3.5	3.1	3.2	3.2	3.23
G-6B	2	2.3	2.5	2.4	2.4	2.5	2.1	2.37
G-7A	1	3.1	3.1	3.1	3.2	3.0	3.2	3.12
G-7B	2	2.7	2.8	2.8	3.0	2.4	2.4	2.68
SG-1A	1	3.0	3.2	3.5	3.2	3.1	3.0	3.17
SG-1B	25	3.0	2.8	3.1	2.6	Note 2	Note 2	2.88
SG-2A	1	3.1	3.1	3.1	3.0	3.1	3.1	3.08
SG-2B	25	3.7	3.3	3.5	3.6	3.1	3.2	3.40

Note 1 - Final abrasive trial of reclaimed material was not performed since no usable material remained.

Note 2 - Third panel not available for measurement. Only 2 panel faces (8 square feet) were cleaned using the reclaimed abrasive material.

TABLE A9
Recyclable Abrasives

Breakdown Rate

Abrasive Type	Number of Uses	Pre-Blast Particle Size (mm x 100)	Post-Blast Particle Size (mm x 100)	Average Particle Size is Reduced by X%	Average Particle Size is X% of Original
CP-1A	1	75.04	36.17	51.80	48.20
CP-1B	2	75.04	31.41	58.14	41.86
CP-2A	1	82.94	39.68	52.16	47.84
CP-2B	2	82.94	34.22	58.74	41.26
CP-3A	1	104.93	50.52	51.85	48.15
CP-3B	2	104.93	36.28	65.42	34.58
CP-4A	1	68.16	32.48	52.35	47.65
CP-4B	2	68.16	20.77	69.53	30.47
CPDS-1A	1	85.40	33.85	60.36	39.64
CPDS-1B	2	85.40	26.08	69.46	30.54
G-1A	1	52.01	27.55	47.03	52.97
G-1B	2	52.01	21.17	59.30	40.70
G-2A	1	66.75	42.39	36.49	63.51
G-2B	2	66.75	26.45	60.00	40.00
G-3A	1	37.12	21.44	42.24	57.76
G-3B	2	Note 1	Note 1	NA	NA
G-4A	1	68.66	27.43	60.05	39.95
G-4B	3[a]	68.66	16.61	75.81	24.19
G-5A	1	26.95	21.36	20.74	79.26
G-5B	3[b]	26.95	16.14	40.11	59.89
G-6A	1	41.93	24.45	41.69	58.31
G-6B	2	41.93	18.88	54.97	45.03
G-7A	1	59.65	26.29	55.93	44.07
G-7B	2	59.65	15.48	74.05	25.95
SG-1A	1	46.03	44.05	4.30	95.70
SG-1B	25	46.03	46.34	-0.67[c]	100.67
SG-2A	1	51.38	47.34	7.86	92.14
SG-2B	25	51.38	46.90	8.72	91.28

Note 1 - Final abrasive trial of reclaimed material was not performed since no usable material remained.

a - Should have only been 2 uses. Abrasive was reduced in size >50% after first run.

b - Abrasive could have gone through an additional use. Size was not reduced >50%.

c - Initial blend of abrasives was very close to working blend. Overall did not change throughout study.

TABLE A10
Embedment Results

Recyclable

Abrasive	Panel 1					Panel 2					Panel 3					Average
Type	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Embedment
CP-1A	9	11	6	10	5	15	9	14	11	13	21	16	10	22	16	12.5
CP-1B	24	10	15	21	12	19	13	17	16	17	25	21	14	17	19	17.3
CP-2A	18	16	18	15	10	16	17	20	21	19	19	13	17	22	14	17.0
CP-2B	8	6	5	12	9	8	9	7	8	9	7	5	6	12	10	8.1
CP-3A	36	29	30	29	37	33	26	33	35	27	31	30	27	34	30	31.1
CP-3B	26	24	21	21	26	33	32	24	26	24	18	25	15	15	16	23.1
CP-4A	51	39	42	49	39	47	39	34	47	36	48	40	35	39	38	41.5
CP-4B	29	23	26	21	25	21	17	24	19	12	18	27	23	18	25	21.9
CPDS-1A	27	18	21	17	24	20	23	16	14	16	17	15	21	18	18	19.0
CPDS-1B	28	18	16	21	12	25	16	21	18	19	19	19	15	27	15	19.3
G-1A	4	6	6	2	5	3	4	5	7	4	3	6	3	7	6	4.7
G-1B	6	7	4	7	2	3	3	2	1	3	3	2	1	2	2	3.2
G-2A	6	4	7	11	15	9	9	8	10	6	13	6	8	6	11	8.6
G-2B	2	2	2	3	1	1	2	1	1	0	1	1	1	2	2	1.5
G-3A	3	3	2	5	6	3	0	1	5	3	0	0	0	1	0	2.1
G-4A	10	7	12	10	15	13	11	7	13	10	7	11	5	9	5	9.7
G-4B	1	1	1	3	1	2	2	1	3	1	1	1	0	2	1	1.4
G-5A	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0.1
G-5B	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0.2
G-6A	3	5	5	7	7	9	4	3	4	6	5	4	5	7	3	5.1
G-6B	4	4	4	2	2	2	1	1	2	5	1	1	3	1	0	2.2
G-7A	44	29	47	37	34	42	29	40	35	29	36	46	45	24	34	36.7
G-7B	6	4	4	4	5	2	4	2	4	5	2	1	2	2	3	3.3
SG-1A	3	2	2	3	3	6	3	4	4	4	3	3	2	4	1	3.1
SG-1B	2	0	0	2	1	2	3	1	1	4	Note 2					1.6
SG-2A	9	7	2	4	3	5	5	3	4	3	2	3	5	4	2	4.1
SG-2B	4	2	0	3	1	3	2	1	0	3	2	3	4	4	3	2.3

Note 1 - Number of squares out of 100 (within a 1/2" x 1/2" area) containing one or more particles of embedded abrasive.

Note 2 - Only the front sides of two panels were blast cleaned during this trial. Not enough abrasive remained to blast more panels.

Note 3 - Final abrasive trial of reclaimed material for abrasive G-3B was not performed since no usable material remained.

TABLE A11
Recyclable Abrasives

Microhardness

Abrasive Type	Microhardness Measurements (Knoop)		Maximum Microhardness Reading Obtained
CP-1A	713	769	769.0
CP-2A	617	662	662.0
CP-3A	630	649	649.0
CP-4A	540	507	540.0
CPDS-1A	656	656	656.0
G-1A	1809	1749	1809.0
G-2A	1587	1537	1587.0
G-3A	1285	937	1285.0
G-4A	1323	1304	1323.0
G-5A	535	Note 1	535.0
G-6A	1323	1362	1362.0
G-7A	948	690	948.0
SG-1A	786	823	823.0
SG-2A	238	240	240.0

Microhardness tested in accordance with ASTM E384 by Industrial Testing Laboratory Services Corp.

Note 1 - Could not obtain a valid second test

Note 2 - Microhardness values varied. Since the lower values may be attributed to porosity or other discontinuity within the specific particle tested, only the higher values are being used to avoid inappropriately lowering the results through averaging.

Note 3 - The hardness of the silica sand used in the study was typically greater than all the abrasives. This deviates from other sources of information on hardness such as Clemco Blast Off, 2nd Edition and A.B. Williams "Abrasive Blast Cleaning Handbook", Update 1991, First Edition.

TABLE A12
Recyclable Abrasives

Water-Soluble Contaminants

Abrasive Type	Number of Uses	Conductivity (microsiemens)
CP-1A	1	84.3
CP-1B	2	83.3
CP-2A	1	31.8
CP-2B	2	59.3
CP-3A	1	135.0
CP-3B	2	120.0
CP-4A	1	131.7
CP-4B	2	223.3
CPDS-1A	1	26.3
CPDS-1B	2	53.3
G-1A	1	586.7
G-1B	2	250.0
G-2A	1	19.0
G-2B	2	25.0
G-3A	1	9.0
G-3B	2	Note 1
G-4A	1	95.7
G-4B	3	96.3
G-5A	1	145.0
G-5B	3	103.3
G-6A	1	21.7
G-6B	2	37.7
G-7A	1	47.0
G-7B	2	73.3
SG-1A	1	100.0
SG-1B	25	80.0
SG-2A	1	33.7
SG-2B	25	34.0

Note 1 - Could not be performed as no usable material remained.

TABLE A13
Generic Abrasive Summary

Average Results for Abrasive Type[1]

Generic Abrasive Type	Number of Products	Cleaning Rate $(ft^2/hour)^2$	Consumption Rate $(Lbs./ft^2)^2$	Surface Profile (mils)	Number of Uses	Breakdown Rate (%)	Embedment (%)	Maximum Microhardness (Knoop)	Conductivity (microsiemens)
CG	1	33.00	10.99	2.72	1	51.36	2.1	185	112.0
CS	7	34.00	10.44	3.07	1	47.95	12.2	720	176.9
CSDS	2	37.00	11.42	3.28	1	52.73	7.5	760	221.2
N	2	41.00	14.17	3.56	1	52.55	14.3	984	91.5
O	1	44.00	8.02	3.03	1	33.58	15.1	960	96.7
S	2	46.00	8.71	2.05	1	18.84	0.2	936	150.3
SH	1	32.00	6.60	2.77	1	40.72	0.7	1182	63.3
SS	7	31.00	13.43	3.40	1	54.13	4.9	2469	147.0
SSDS	3	33.00	11.10	2.92	1	48.23	1.6	2008	61.7
CP[3]	4	52	17.82	3.49	2	54.49	21.5	769	108.6
CPDS[3]	1	35	15.09	3.44	2	64.91	19.2	656	39.8
G[3]	7	44	9.46	3.03	2-3	53.61	5.6	1809	116.1
SG[3]	2	35	24.94	3.13	2-5	5.22	2.8	823	61.9

Note 1 - There was a wide variation in performance between the products within a given generic class of abrasives. Specific products should be evaluated individually.

Note 2 - The cost analysis presented in Appendix D is based on industry data rather than these values which were derived from the study.

Note 3 - Values for the recyclable abrasives represent the average of the initial and final runs.

APPENDIX B

APPENDIX B - ALUMINUM

Aluminum

Aluminum, in the form of a fine powder with particles less than 5 microns in size and exposures of concentrations greater than 5000 $\mu g/m^3$, has reportedly caused fibrosis of the lung. The NIOSH REL and OSHA PEL for aluminum are 10,000 and 15,000 micrograms/cubic meter of air, respectively.

Air Sample Results - Aluminum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Aluminum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	11.00	> LOQ 3.5	228.41	> LOQ 72.67
24412	2	47.89	S-01	28	29.00	> LOQ 3.5	605.55	> LOQ 73.08
24441	3	47.90	S-01	28	300.00	> LOQ 3.5	6263.05	> LOQ 73.07
24450	OBZ	47.93	S-01	28	50.00	> LOQ 3.5	1043.19	> LOQ 73.02
24643	1	47.98	S-02	29	14.00	> LOQ 3.5	291.79	> LOQ 72.95
24625	2	47.76	S-02	29	96.00	> LOQ 3.5	2010.05	> LOQ 73.28
24642	3	48.00	S-02	29	120.00	> LOQ 3.5	2500	> LOQ 72.92
24632	OBZ	47.89	S-02	29	39.00	> LOQ 3.5	814.37	> LOQ 73.08
24634	1	48.16	CSDS-01	31	3400.00	> LOQ 3.5	70598.01	> LOQ 72.67
24650	2	48.01	CSDS-01	31	1800.00	> LOQ 3.5	37492.19	> LOQ 72.90
24644	3	48.16	CSDS-01	31	5600.00	> LOQ 3.5	116279.07	> LOQ 72.67
24645	OBZ	48.07	CSDS-01	31	2700.00	> LOQ 3.5	56168.09	> LOQ 72.81
24640	1	48.44	SS-01	32	20.00	> LOQ 3.5	412.88	> LOQ 72.25
24641	2	47.90	SS-01	32	120.00	> LOQ 3.5	2505.22	> LOQ 73.07
24651	3	48.35	SS-01	32	120.00	> LOQ 3.5	2481.9	> LOQ 72.39
24635	OBZ	48.30	SS-01	32	120.00	> LOQ 3.5	2484.47	> LOQ 72.46
24646	1	48.58	SSDS-01	33	17.00	> LOQ 3.5	349.94	> LOQ 72.05
24626	2	47.84	SSDS-01	33	88.00	> LOQ 3.5	1839.46	> LOQ 73.16
24638	3	48.49	SSDS-01	33	140.00	> LOQ 3.5	2887.19	> LOQ 72.18
24647	OBZ	48.32	SSDS-01	33	120.00	> LOQ 3.5	2483.44	> LOQ 72.43
24628	1	48.55	CS-01	34	420.00	> LOQ 3.5	8650.88	> LOQ 72.09
24637	2	48.00	CS-01	34	1300.00	> LOQ 3.5	27083.33	> LOQ 72.92
24624	3	48.47	CS-01	34	6100.00	> LOQ 3.5	125851.04	> LOQ 72.21
24636	OBZ	47.92	CS-01	34	1300.00	> LOQ 3.5	27128.55	> LOQ 73.04
24623	1	48.53	CSDS-02	35	430.00	> LOQ 3.5	8860.5	> LOQ 72.12
24622	2	48.36	CSDS-02	35	1600.00	> LOQ 3.5	33085.19	> LOQ 72.37
24654	3	48.31	CSDS-02	35	6400.00	> LOQ 3.5	132477.75	> LOQ 72.45
24653	OBZ	47.78	CSDS-02	35	2200.00	> LOQ 3.5	46044.37	> LOQ 73.25
24629	1	47.88	SH-01	36	4.00	> LOQ 3.5	83.54	> LOQ 73.10
24633	2	47.86	SH-01	36	7.80	> LOQ 3.5	162.98	> LOQ 73.13
24627	3	48.24	SH-01	36	19.00	> LOQ 3.5	393.86	> LOQ 72.55
24648	OBZ	48.08	SH-01	36	7.10	> LOQ 3.5	147.67	> LOQ 72.80
24555	1	48.08	CS-02	37	550.00	> LOQ 3.5	11439.27	> LOQ 72.80
24552	2	47.84	CS-02	37	1600.00	> LOQ 3.5	33444.82	> LOQ 73.16
24541	3	48.01	CS-02	37	6900.00	> LOQ 3.5	143720.06	> LOQ 72.90
24529	OBZ	47.99	CS-02	37	2500.00	> LOQ 3.5	52094.19	> LOQ 72.93
24558	1	48.49	CS-03	38	470.00	> LOQ 3.5	9692.72	> LOQ 72.18
24524	2	48.29	CS-03	38	2000.00	> LOQ 3.5	41416.44	> LOQ 72.48
24561	3	48.22	CS-03	38	7400.00	> LOQ 3.5	153463.29	> LOQ 72.58
24559	OBZ	48.29	CS-03	38	2000.00	> LOQ 3.5	41416.44	> LOQ 72.48
24543	1	48.61	CS-04	39	260.00	> LOQ 3.5	5348.69	> LOQ 72.00
24532	2	47.78	CS-04	39	920.00	> LOQ 3.5	19254.92	> LOQ 73.25
24546	3	48.29	CS-04	39	2500.00	> LOQ 3.5	51770.55	> LOQ 72.48
24557	OBZ	48.58	CS-04	39	1300.00	> LOQ 3.5	26759.98	> LOQ 72.05
24560	1	48.13	SS-02	40	35.00	> LOQ 3.5	727.2	> LOQ 72.72
24565	2	47.95	SS-02	40	170.00	> LOQ 3.5	3545.36	> LOQ 72.99
24630	3	48.32	SS-02	40	160.00	> LOQ 3.5	3311.26	> LOQ 72.43
24553	OBZ	48.62	SS-02	40	170.00	> LOQ 3.5	3496.5	> LOQ 71.99
24525	1	48.13	G-1A	41	82.00	> LOQ 3.5	1703.72	> LOQ 72.72
24563	2	47.87	G-1A	41	330.00	> LOQ 3.5	6893.67	> LOQ 73.11
24547	3	48.17	G-1A	41	1100.00	> LOQ 3.5	22835.79	> LOQ 72.66
24526	OBZ	48.91	G-1A	41	840.00	> LOQ 3.5	17174.4	> LOQ 71.56
24538	1	47.45	G-2A	43	50.00	> LOQ 3.5	1053.74	> LOQ 73.76

Air Sample Results - Aluminum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Aluminum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	330.00	> LOQ 3.5	7003.4	> LOQ 74.28
24533	3	48.24	G-2A	43	500.00	> LOQ 3.5	10364.84	> LOQ 72.55
24540	OBZ	48.04	G-2A	43	210.00	> LOQ 3.5	4371.36	> LOQ 72.86
24528	1	47.99	SSDS-02	44	37.00	> LOQ 3.5	770.99	> LOQ 72.93
24544	2	48.00	SSDS-02	44	140.00	> LOQ 3.5	2916.67	> LOQ 72.92
24567	3	48.46	SSDS-02	44	340.00	> LOQ 3.5	7016.1	> LOQ 72.22
24539	OBZ	49.37	SSDS-02	44	210.00	> LOQ 3.5	4253.6	> LOQ 70.89
24571	1	48.05	SS-03	45	5.90	> LOQ 3.5	122.79	> LOQ 72.84
24536	2	47.60	SS-03	45	18.00	> LOQ 3.5	378.15	> LOQ 73.53
24534	3	48.94	SS-03	45	58.00	> LOQ 3.5	1185.12	> LOQ 71.52
24570	OBZ	49.61	SS-03	45	23.00	> LOQ 3.5	463.62	> LOQ 70.55
24568	1	48.28	G-1B	46	50.00	> LOQ 3.5	1035.63	> LOQ 72.49
24592	2	47.38	G-1B	46	460.00	> LOQ 3.5	9708.74	> LOQ 73.87
24593	3	48.17	G-1B	46	580.00	> LOQ 3.5	12040.69	> LOQ 72.66
24535	OBZ	48.22	G-1B	46	630.00	> LOQ 3.5	13065.12	> LOQ 72.58
24590	1	47.81	SS-04	47	49.00	> LOQ 3.5	1024.89	> LOQ 73.21
24605	2	47.78	SS-04	47	260.00	> LOQ 3.5	5441.61	> LOQ 73.25
24562	3	47.80	SS-04	47	370.00	> LOQ 3.5	7740.59	> LOQ 73.22
24531	OBZ	48.59	SS-04	47	240.00	> LOQ 3.5	4939.29	> LOQ 72.03
24527	1	49.48	SSDS-03	48	2.10	> LOQ 3.5	42.44	> LOQ 70.74
24569	2	50.35	SSDS-03	48	9.40	> LOQ 3.5	186.69	> LOQ 69.51
24584	3	50.24	SSDS-03	48	12.00	> LOQ 3.5	238.85	> LOQ 69.67
24579	OBZ	48.26	SSDS-03	48	11.00	> LOQ 3.5	227.93	> LOQ 72.52
24600	1	48.34	G-3A	49	150.00	> LOQ 3.5	3103.02	> LOQ 72.40
24616	2	48.11	G-3A	49	460.00	> LOQ 3.5	9561.42	> LOQ 72.75
24585	3	47.65	G-3A	49	1700.00	> LOQ 3.5	35676.81	> LOQ 73.45
24583	OBZ	47.99	G-3A	49	180.00	> LOQ 3.5	3750.78	> LOQ 72.93
24587	1	48.79	G-2B	50	73.00	> LOQ 3.5	1496.21	> LOQ 71.74
24602	2	48.17	G-2B	50	630.00	> LOQ 3.5	13078.68	> LOQ 72.66
24564	3	47.81	G-2B	50	370.00	> LOQ 3.5	7738.97	> LOQ 73.21
24621	OBZ	48.54	G-2B	50	130.00	> LOQ 3.5	2678.2	> LOQ 72.11
24618	1	49.21	N-01	52	29.00	> LOQ 3.5	589.31	> LOQ 71.12
24611	2	47.96	N-01	52	140.00	> LOQ 3.5	2919.1	> LOQ 72.98
24588	3	48.32	N-01	52	560.00	> LOQ 3.5	11589.4	> LOQ 72.43
24615	OBZ	48.80	N-01	52	290.00	> LOQ 3.5	5942.62	> LOQ 71.72
24597	1	49.78	SS-05	53	13.00	> LOQ 3.5	261.15	> LOQ 70.31
24599	2	47.68	SS-05	53	56.00	> LOQ 3.5	1174.5	> LOQ 73.41
24575	3	48.11	SS-05	53	130.00	> LOQ 3.5	2702.14	> LOQ 72.75
24617	OBZ	48.79	SS-05	53	100.00	> LOQ 3.5	2049.6	> LOQ 71.74
24609	1	48.98	SG-1A	54	4.70	> LOQ 3.5	95.96	> LOQ 71.46
24596	2	48.20	SG-1A	54	6.30	> LOQ 3.5	130.71	> LOQ 72.61
24610	3	48.18	SG-1A	54	8.70	> LOQ 3.5	180.57	> LOQ 72.64
24576	OBZ	48.47	SG-1A	54	7.10	> LOQ 3.5	146.48	> LOQ 72.21
24606	1	49.24	G-4A	55	640.00	> LOQ 3.5	12997.56	> LOQ 71.08
24620	2	48.37	G-4A	55	630.00	> LOQ 3.5	13024.6	> LOQ 72.36
24573	3	48.67	G-4A	55	4800.00	> LOQ 3.5	98623.38	> LOQ 71.91
24505	OBZ	48.16	G-4A	55	1300.00	> LOQ 3.5	26993.36	> LOQ 72.67
24340	1	48.38	G-4B	56	160.00	> LOQ 3.5	3307.15	> LOQ 72.34
24607	2	48.01	G-4B	56	1500.00	> LOQ 3.5	31243.49	> LOQ 72.90
24595	3	48.38	G-4B	56	2600.00	> LOQ 3.5	53741.22	> LOQ 72.34
24598	OBZ	48.42	G-4B	56	1300.00	> LOQ 3.5	26848.41	> LOQ 72.28
24580	1	48.44	CS-05	57	200.00	> LOQ 3.5	4128.82	> LOQ 72.25
24604	2	47.93	CS-05	57	830.00	> LOQ 3.5	17316.92	> LOQ 73.02

Air Sample Results - Aluminum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Aluminum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	2100.00	> LOQ 3.5	43951.44	> LOQ 73.25
24574	OBZ	30.41	CS-05	57	690.00	> LOQ 3.5	22689.9	> LOQ 115.09
24614	1	48.58	G-5A	58	58.00	> LOQ 3.5	1193.91	> LOQ 72.05
24577	2	48.18	G-5A	58	260.00	> LOQ 3.5	5396.43	> LOQ 72.64
24572	3	48.05	G-5A	58	950.00	> LOQ 3.5	19771.07	> LOQ 72.84
24582	OBZ	47.83	G-5A	58	1400.00	> LOQ 3.5	29270.33	> LOQ 73.18
24322	1	47.88	G-5B	59	150.00	> LOQ 3.5	3132.83	> LOQ 73.10
24354	2	48.16	G-5B	59	650.00	> LOQ 3.5	13496.68	> LOQ 72.67
24510	3	47.98	G-5B	59	2200.00	> LOQ 3.5	45852.44	> LOQ 72.95
24321	OBZ	47.99	G-5B	59	280.00	> LOQ 3.5	5834.55	> LOQ 72.93
24497	1	48.49	CP-1A	60	25.00	> LOQ 3.5	515.57	> LOQ 72.18
24333	2	48.28	CP-1A	60	120.00	> LOQ 3.5	2485.5	> LOQ 72.49
24326	3	48.19	CP-1A	60	160.00	> LOQ 3.5	3320.19	> LOQ 72.63
24329	OBZ	47.74	CP-1A	60	75.00	> LOQ 3.5	1571.01	> LOQ 73.31
24499	1	42.42	CP-1B	62	43.00	> LOQ 3.5	1013.67	> LOQ 82.51
24506	2	42.02	CP-1B	62	59.00	> LOQ 3.5	1404.09	> LOQ 83.29
24388	3	42.47	CP-1B	62	300.00	> LOQ 3.5	7063.81	> LOQ 82.41
24315	OBZ	41.77	CP-1B	62	56.00	> LOQ 3.5	1340.68	> LOQ 83.79
24318	1	48.56	CG-01	63	ND	< LOD 1.0	ND	< LOD 20.59
24308	2	48.00	CG-01	63	6.10	> LOQ 3.5	127.08	> LOQ 72.92
24330	3	48.47	CG-01	63	5.90	> LOQ 3.5	121.72	> LOQ 72.21
24230	OBZ	48.31	CG-01	63	6.50	> LOQ 3.5	134.55	> LOQ 72.45
24363	1	48.10	G-6A	64	410.00	> LOQ 3.5	8523.91	> LOQ 72.77
24398	2	47.84	G-6A	64	2000.00	> LOQ 3.5	41806.02	> LOQ 73.16
24351	3	48.06	G-6A	64	4200.00	> LOQ 3.5	87390.76	> LOQ 72.83
24594	OBZ	48.29	G-6A	64	700.00	> LOQ 3.5	14495.75	> LOQ 72.48
24312	1	48.76	G-6B	65	76.00	> LOQ 3.5	1558.65	> LOQ 71.78
24484	2	47.45	G-6B	65	930.00	> LOQ 3.5	19599.58	> LOQ 73.76
24327	3	48.92	G-6B	65	680.00	> LOQ 3.5	13900.25	> LOQ 71.55
24389	OBZ	48.46	G-6B	65	880.00	> LOQ 3.5	18159.31	> LOQ 72.22
24348	1	48.59	SG-2A	66	18.00	> LOQ 3.5	370.45	> LOQ 72.03
24314	2	47.90	SG-2A	66	19.00	> LOQ 3.5	396.66	> LOQ 73.07
24494	3	48.24	SG-2A	66	19.00	> LOQ 7.0	393.86	> LOQ 145.11
24337	OBZ	48.30	SG-2A	66	73.00	> LOQ 7.0	1511.39	> LOQ 144.93
24508	1	48.47	CP-2A	67	410.00	> LOQ 3.5	8458.84	> LOQ 72.21
24361	2	47.82	CP-2A	67	1200.00	> LOQ 3.5	25094.1	> LOQ 73.19
24359	3	48.22	CP-2A	67	7600.00	> LOQ 7.0	157610.95	> LOQ 145.17
24471	OBZ	48.14	CP-2A	67	2900.00	> LOQ 3.5	60240.96	> LOQ 72.70
24373	1	48.41	CP-2B	68	1200.00	> LOQ 3.5	24788.27	> LOQ 72.30
24468	2	47.90	CP-2B	68	670.00	> LOQ 3.5	13987.47	> LOQ 73.07
24481	3	48.26	CP-2B	68	2800.00	> LOQ 3.5	58019.06	> LOQ 72.52
24391	OBZ	47.53	CP-2B	68	520.00	> LOQ 3.5	10940.46	> LOQ 73.64
24356	1	48.56	O-1	69	13.00	> LOQ 3.5	267.71	> LOQ 72.08
24470	2	47.89	O-1	69	18.00	> LOQ 3.5	375.86	> LOQ 73.08
24467	3	48.67	O-1	69	55.00	> LOQ 3.5	1130.06	> LOQ 71.91
24313	OBZ	47.78	O-1	69	26.00	> LOQ 3.5	544.16	> LOQ 73.25
24501	1	47.96	CS-06	70	890.00	> LOQ 3.5	18557.13	> LOQ 72.98
24496	2	47.75	CS-06	70	2300.00	> LOQ 3.5	48167.54	> LOQ 73.30
24478	3	48.31	CS-06	70	2700.00	> LOQ 3.5	55889.05	> LOQ 72.45
24503	OBZ	48.04	CS-06	70	1700.00	> LOQ 3.5	35387.18	> LOQ 72.86
24474	1	26.02	SG-1B	71	1.80	< LOQ 3.5	69.18	< LOQ 134.51
24469	2	26.02	SG-1B	71	4.10	> LOQ 3.5	157.57	> LOQ 134.51
24492	3	26.10	SG-1B	71	3.60	> LOQ 3.5	137.93	> LOQ 134.10

Air Sample Results - Aluminum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Aluminum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	6.30	< LOQ 18.0	240	< LOQ 685.71
24489	1	48.42	CP-3A	72	360.00	> LOQ 3.5	7434.94	> LOQ 72.28
24491	2	47.93	CP-3A	72	960.00	> LOQ 3.5	20029.21	> LOQ 73.02
24482	3	48.35	CP-3A	72	5500.00	> LOQ 3.5	113753.88	> LOQ 72.39
24486	OBZ	48.32	CP-3A	72	4700.00	> LOQ 3.5	97268.21	> LOQ 72.43
24516	1	36.34	CP-3B	73	360.00	> LOQ 3.5	9906.44	> LOQ 96.31
24502	2	36.02	CP-3B	73	2100.00	> LOQ 3.5	58300.94	> LOQ 97.17
24515	3	36.48	CP-3B	73	3100.00	> LOQ 3.5	84978.07	> LOQ 95.94
24500	OBZ	40.27	CP-3B	73	1300.00	> LOQ 3.5	32282.1	> LOQ 86.91
24504	1	48.47	G-7A	74	180.00	> LOQ 3.5	3713.64	> LOQ 72.21
24513	2	48.22	G-7A	74	410.00	> LOQ 3.5	8502.7	> LOQ 72.58
24458	3	47.94	G-7A	74	1100.00	> LOQ 3.5	22945.35	> LOQ 73.01
24389	OBZ	47.75	G-7A	74	270.00	> LOQ 3.5	5654.45	> LOQ 73.30
24404	1	48.68	G-7B	75	130.00	> LOQ 3.5	2670.5	> LOQ 71.90
24451	2	48.06	G-7B	75	240.00	> LOQ 3.5	4993.76	> LOQ 72.83
24447	3	47.16	G-7B	75	510.00	> LOQ 3.5	10814.25	> LOQ 74.22
24423	OBZ	47.27	G-7B	75	130.00	> LOQ 3.5	2750.16	> LOQ 74.04
24456	1	49.19	SS-06	76	98.00	> LOQ 3.5	1992.27	> LOQ 71.15
24480	2	48.26	SS-06	76	240.00	> LOQ 3.5	4973.06	> LOQ 72.52
24429	3	47.68	SS-06	76	1.60	< LOQ 3.5	33.56	< LOQ 73.41
24418	OBZ	47.83	SS-06	76	130.00	> LOQ 3.5	2717.96	> LOQ 73.18
24427	1	48.54	CP-4A	78	160.00	> LOQ 3.5	3296.25	> LOQ 72.11
24435	2	47.71	CP-4A	78	740.00	> LOQ 3.5	15510.38	> LOQ 73.36
24244	3	49.01	CP-4A	78	4000.00	> LOQ 7.0	81616	> LOQ 142.83
24220	OBZ	48.74	CP-4A	78	800.00	> LOQ 3.5	16413.62	> LOQ 71.81
24460	1	50.05	CP-4B	79	160.00	> LOQ 3.5	3196.8	> LOQ 69.93
24465	2	48.47	CP-4B	79	530.00	> LOQ 3.5	10934.6	> LOQ 72.21
24207	3	48.49	CP-4B	79	2700.00	> LOQ 7.0	55681.58	> LOQ 144.36
24390	OBZ	49.02	CP-4B	79	150.00	> LOQ 3.5	3059.98	> LOQ 71.40
24259	1	48.76	SS-07	80	51.00	> LOQ 3.5	1045.94	> LOQ 71.78
24421	2	48.13	SS-07	80	120.00	> LOQ 3.5	2493.25	> LOQ 72.72
24445	3	47.87	SS-07	80	340.00	> LOQ 3.5	7102.57	> LOQ 73.11
24432	OBZ	48.49	SS-07	80	57.00	> LOQ 3.5	1175.5	> LOQ 72.18
24459	1	48.96	N-02	81	420.00	> LOQ 3.5	8578.43	> LOQ 71.49
24417	2	48.11	N-02	81	810.00	> LOQ 3.5	16836.42	> LOQ 72.75
24442	3	48.01	N-02	81	3700.00	> LOQ 3.5	77067.28	> LOQ 72.90
24386	OBZ	48.19	N-02	81	690.00	> LOQ 3.5	14318.32	> LOQ 72.63
24452	1	48.20	SG-2B	82	4.30	> LOQ 3.5	89.21	> LOQ 72.61
24453	2	48.59	SG-2B	82	9.90	> LOQ 3.5	203.75	> LOQ 72.03
24420	3	47.84	SG-2B	82	20.00	> LOQ 3.5	418.06	> LOQ 73.16
24444	OBZ	47.95	SG-2B	82	100.00	> LOQ 18.0	2085.51	> LOQ 375.39
24455	1	48.56	CS-07	83	940.00	> LOQ 3.5	19357.5	> LOQ 72.08
24433	2	47.96	CS-07	83	2400.00	> LOQ 3.5	50041.7	> LOQ 72.98
24398	3	48.06	CS-07	83	11000.00	> LOQ 3.5	228880.57	> LOQ 72.83
24511	OBZ	47.96	CS-07	83	2200.00	> LOQ 3.5	45871.56	> LOQ 72.98
24454	1	49.34	CPDS-1A	84	570.00	> LOQ 3.5	11552.49	> LOQ 70.94
24291	2	48.49	CPDS-1A	84	940.00	> LOQ 3.5	19385.44	> LOQ 72.18
24209	3	48.43	CPDS-1A	84	7000.00	> LOQ 3.5	144538.51	> LOQ 72.27
24402	OBZ	48.77	CPDS-1A	84	2600.00	> LOQ 3.5	53311.46	> LOQ 71.77
24204	1	49.46	CPDS-1B	85	680.00	> LOQ 3.5	13748.48	> LOQ 70.76
24273	2	48.35	CPDS-1B	85	1100.00	> LOQ 3.5	22750.78	> LOQ 72.39
24223	3	48.82	CPDS-1B	85	5800.00	> LOQ 3.5	118803.77	> LOQ 71.69
24466	OBZ	49.96	CPDS-1B	85	930.00	> LOQ 3.5	18614.89	> LOQ 70.06

Airborne Sample Data Analysis - Aluminum

NIOSH REL 10000.0 micrograms/cubic meter
OSHA PEL 15000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 20.59	127.08	> LOQ 72.92	121.72	> LOQ 72.21	134.55	> LOQ 72.45
CS-01	8650.88	> LOQ 72.09	27083.33	> LOQ 72.92	125851.04	> LOQ 72.21	27128.55	> LOQ 73.04
CS-02	11439.27	> LOQ 72.80	33444.82	> LOQ 73.16	143720.06	> LOQ 72.90	52094.19	> LOQ 72.93
CS-03	9692.72	> LOQ 72.18	41416.44	> LOQ 72.48	153463.29	> LOQ 72.58	41416.44	> LOQ 72.48
CS-04	5348.69	> LOQ 72.00	19254.92	> LOQ 73.25	51770.55	> LOQ 72.48	26759.98	> LOQ 72.05
CS-05	4128.82	> LOQ 72.25	17316.92	> LOQ 73.02	43951.44	> LOQ 73.25	22689.9	> LOQ 115.09
CS-06	18557.13	> LOQ 72.98	48167.54	> LOQ 73.30	55889.05	> LOQ 72.45	35387.18	> LOQ 72.86
CS-07	19357.5	> LOQ 72.08	50041.7	> LOQ 72.98	228880.57	> LOQ 72.83	45871.56	> LOQ 72.98
CSDS-01	70598.01	> LOQ 72.67	37492.19	> LOQ 72.90	116279.07	> LOQ 72.67	56168.09	> LOQ 72.81
CSDS-02	8860.5	> LOQ 72.12	33085.19	> LOQ 72.37	132477.75	> LOQ 72.45	46044.37	> LOQ 73.25
N-01	589.31	> LOQ 71.12	2919.1	> LOQ 72.98	11589.40	> LOQ 72.43	5942.62	> LOQ 71.72
N-02	8578.43	> LOQ 71.49	16836.42	> LOQ 72.75	77067.28	> LOQ 72.90	14318.32	> LOQ 72.63
O-1	267.71	> LOQ 72.08	375.86	> LOQ 73.08	1130.06	> LOQ 71.91	544.16	> LOQ 73.25
S-01	228.41	> LOQ 72.67	605.55	> LOQ 73.08	6263.05	> LOQ 73.07	1043.19	> LOQ 73.02
S-02	291.79	> LOQ 72.95	2010.05	> LOQ 73.28	2500.00	> LOQ 72.92	814.37	> LOQ 73.08
SH-01	83.54	> LOQ 73.10	162.98	> LOQ 73.13	393.86	> LOQ 72.55	147.67	> LOQ 72.80
SS-01	412.88	> LOQ 72.25	2505.22	> LOQ 73.07	2481.90	> LOQ 72.39	2484.47	> LOQ 72.46
SS-02	727.2	> LOQ 72.72	3545.36	> LOQ 72.99	3311.26	> LOQ 72.43	3496.5	> LOQ 71.99
SS-03	122.79	> LOQ 72.84	378.15	> LOQ 73.53	1185.12	> LOQ 71.52	463.62	> LOQ 70.55
SS-04	1024.89	> LOQ 73.21	5441.61	> LOQ 73.25	7740.59	> LOQ 73.22	4939.29	> LOQ 72.03
SS-05	261.15	> LOQ 70.31	1174.5	> LOQ 73.41	2702.14	> LOQ 72.75	2049.6	> LOQ 71.74
SS-06	1992.27	> LOQ 71.15	4973.06	> LOQ 72.52	33.56	< LOQ 73.41	2717.96	> LOQ 73.18
SS-07	1045.94	> LOQ 71.78	2493.25	> LOQ 72.72	7102.57	> LOQ 73.11	1175.5	> LOQ 72.18
SSDS-01	349.94	> LOQ 72.05	1339.46	> LOQ 73.16	2887.19	> LOQ 72.18	2483.44	> LOQ 72.43
SSDS-02	770.99	> LOQ 72.93	2916.67	> LOQ 72.92	7016.10	> LOQ 72.22	4253.6	> LOQ 70.89
SSDS-03	42.44	> LOQ 70.74	186.69	> LOQ 69.51	238.85	> LOQ 69.67	227.93	> LOQ 72.52
CP-1A	515.57	> LOQ 72.18	2485.5	> LOQ 72.49	3320.19	> LOQ 72.63	1571.01	> LOQ 73.31
CP-1B	1013.67	> LOQ 82.51	1404.09	> LOQ 83.29	7063.81	> LOQ 82.41	1340.68	> LOQ 83.79
CP-2A	8458.84	> LOQ 72.21	25094.1	> LOQ 73.19	157610.95	> LOQ 145.17	60240.96	> LOQ 72.70
CP-2B	24788.27	> LOQ 72.30	13987.47	> LOQ 73.07	58019.06	> LOQ 72.52	10940.46	> LOQ 73.64
CP-3A	7434.94	> LOQ 72.28	20029.21	> LOQ 73.02	113753.88	> LOQ 72.39	97268.21	> LOQ 72.43
CP-3B	9906.44	> LOQ 96.31	58300.94	> LOQ 97.17	84978.07	> LOQ 95.94	32282.1	> LOQ 86.91
CP-4A	3296.25	> LOQ 72.11	15510.38	> LOQ 73.36	81616.00	> LOQ 142.83	16413.62	> LOQ 71.81
CP-4B	3196.8	> LOQ 69.93	10934.6	> LOQ 72.21	55681.58	> LOQ 144.36	3059.98	> LOQ 71.40
CPDS-1A	11552.49	> LOQ 70.94	19385.44	> LOQ 72.18	144538.51	> LOQ 72.27	53311.46	> LOQ 71.77
CPDS-1B	13748.48	> LOQ 70.76	22750.78	> LOQ 72.39	118803.77	> LOQ 71.69	18614.89	> LOQ 70.06
G-1A	1703.72	> LOQ 72.72	6893.67	> LOQ 73.11	22835.79	> LOQ 72.66	17174.4	> LOQ 71.56
G-1B	1035.63	> LOQ 72.49	9708.74	> LOQ 73.87	12040.69	> LOQ 72.66	13065.12	> LOQ 72.58
G-2A	1053.74	> LOQ 73.76	7003.4	> LOQ 74.28	10364.84	> LOQ 72.55	4371.36	> LOQ 72.86
G-2B	1496.21	> LOQ 71.74	13078.68	> LOQ 72.66	7738.97	> LOQ 73.21	2678.2	> LOQ 72.11
G-3A	3103.02	> LOQ 72.40	9561.42	> LOQ 72.75	35676.81	> LOQ 73.45	3750.78	> LOQ 72.93
G-4A	12997.56	> LOQ 71.08	13024.6	> LOQ 72.36	98623.38	> LOQ 71.91	26993.36	> LOQ 72.67
G-4B	3307.15	> LOQ 72.34	31243.49	> LOQ 72.90	53741.22	> LOQ 72.34	26848.41	> LOQ 72.28
G-5A	1193.91	> LOQ 72.05	5396.43	> LOQ 72.64	19771.07	> LOQ 72.84	29270.33	> LOQ 73.18
G-5B	3132.83	> LOQ 73.10	13406.69	> LOQ 72.67	45852.44	> LOQ 72.95	5834.55	> LOQ 72.93
G-6A	8523.91	> LOQ 72.77	41806.02	> LOQ 73.16	87390.76	> LOQ 72.83	14495.75	> LOQ 72.48
G-6B	1558.65	> LOQ 71.78	19599.58	> LOQ 73.76	13900.25	> LOQ 71.55	18159.31	> LOQ 72.22
G-7A	3713.64	> LOQ 72.21	6502.7	> LOQ 72.58	22945.35	> LOQ 73.01	5654.45	> LOQ 73.30
G-7B	2670.5	> LOQ 71.90	4993.76	> LOQ 72.83	10814.25	> LOQ 74.22	2750.16	> LOQ 74.04
SG-1A	95.96	> LOQ 71.46	130.71	> LOQ 72.61	180.57	> LOQ 72.64	146.48	> LOQ 72.21
SG-1B	69.18	< LOQ 134.51	157.57	> LOQ 134.51	137.93	> LOQ 134.10	240	< LOQ 685.71
SG-2A	370.45	> LOQ 72.03	396.66	> LOQ 73.07	393.86	> LOQ 145.11	1511.39	> LOQ 144.93
SG-2B	89.21	> LOQ 72.61	203.75	> LOQ 72.03	418.06	> LOQ 73.16	2085.51	> LOQ 375.39

Bulk Elemental Analysis - Aluminum

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Aluminum		Sample	Aluminum	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 4.0	J95331-63 PB	ND	< LOD 4.0
CS-01	J95331-34 VB	57000.00	> LOQ 14.0	J95331-34 PB	51000.00	> LOQ 14.0
CS-02	J95331-37 VB	25000.00	> LOQ 14.0	J95331-37 PB	25000.00	> LOQ 14.0
CS-03	J95331-38 VB	47000.00	> LOQ 14.0	J95331-38 PB	59000.00	> LOQ 14.0
CS-04	J95331-39 VB	2600.00	> LOQ 14.0	J95331-39 PB	3200.00	> LOQ 14.0
CS-05	J95331-57 VB	1700.00	> LOQ 14.0	J95331-57 PB	2900.00	> LOQ 14.0
CS-06	J95331-70 VB	2200.00	> LOQ 14.0	J95331-70 PB	4500.00	> LOQ 14.0
CS-07	J95331-83 VB	5300.00	> LOQ 14.0	J95331-83 PB	13000.00	> LOQ 14.0
CSDS-01	J95331-31 VB	4500.00	> LOQ 14.0	J95331-31 PB	9400.00	> LOQ 14.0
CSDS-02	J95331-35 VB	48000.00	> LOQ 14.0	J95331-35 PB	51000.00	> LOQ 14.0
N-01	J95331-52 VB	790.00	> LOQ 14.0	J95331-52 PB	1000.00	> LOQ 14.0
N-02	J95331-81 VB	6900.00	> LOQ 14.0	J95331-81 PB	15000.00	> LOQ 70.0
O-1	J95331-69 VB	190.00	> LOQ 14.0	J95331-69 PB	350.00	> LOQ 14.0
S-01	J95331-28 VB	460.00	> LOQ 14.0	J95331-28 PB	350.00	> LOQ 14.0
S-02	J95331-29 VB	320.00	> LOQ 14.0	J95331-29 PB	440.00	> LOQ 14.0
SH-01	J95331-36 VB	72.00	> LOQ 14.0	J95331-36 PB	71.00	> LOQ 14.0
SS-01	J95331-32 VB	200.00	> LOQ 14.0	J95331-32 PB	320.00	> LOQ 14.0
SS-02	J95331-40 VB	170.00	> LOQ 14.0	J95331-40 PB	160.00	> LOQ 14.0
SS-03	J95331-45 VB	49.00	> LOQ 14.0	J95331-45 PB	100.00	> LOQ 14.0
SS-04	J95331-47 VB	1200.00	> LOQ 14.0	J95331-47 PB	3200.00	> LOQ 14.0
SS-05	J95331-53 VB	190.00	> LOQ 14.0	J95331-53 PB	140.00	> LOQ 14.0
SS-06	J95331-76 VB	870.00	> LOQ 14.0	J95331-76 PB	850.00	> LOQ 14.0
SS-07	J95331-80 VB	7400.00	> LOQ 14.0	J95331-80 PB	250.00	> LOQ 14.0
SSDS-01	J95331-33 VB	370.00	> LOQ 14.0	J95331-33 PB	320.00	> LOQ 14.0
SSDS-02	J95331-44 VB	1300.00	> LOQ 14.0	J95331-44 PB	1400.00	> LOQ 14.0
SSDS-03	J95331-48 VB	92.00	> LOQ 14.0	J95331-48 PB	98.00	> LOQ 14.0
CP-1A	J95331-60 VB	310.00	> LOQ 14.0	J95331-60 PB	1300.00	> LOQ 14.0
CP-1B	J95331-61 VB	6900.00	> LOQ 14.0	J95331-61 PB	9400.00	> LOQ 14.0
CP-2A	J95331-67 VB	29000.00	> LOQ 14.0	J95331-67 PB	39000.00	> LOQ 28.0
CP-2B	J95331-68 VB	33000.00	> LOQ 28.0	J95331-68 PB	35000.00	> LOQ 28.0
CP-3A	J95331-72 VB	23000.00	> LOQ 14.0	J95331-72 PB	25000.00	> LOQ 14.0
CP-3B	J95331-73 VB	29000.00	> LOQ 14.0	J95331-73 PB	26000.00	> LOQ 14.0
CP-4A	J95331-78 VB	3700.00	> LOQ 14.0	J95331-78 PB	7300.00	> LOQ 28.0
CP-4B	J95331-79 VB	8500.00	> LOQ 14.0	J95331-79 PB	9000.00	> LOQ 14.0
CPDS-1A	J95331-84 VB	19000.00	> LOQ 14.0	J95331-84 PB	33000.00	> LOQ 14.0
CPDS-1B	J95331-85 VB	29000.00	> LOQ 14.0	J95331-85 PB	33000.00	> LOQ 14.0
G-1A	J95331-41 VB	960.00	> LOQ 14.0	J95331-41 PB	1600.00	> LOQ 14.0
G-1B	J95331-46 VB	1500.00	> LOQ 14.0	J95331-46 PB	2000.00	> LOQ 14.0
G-2A	J95331-43 VB	690.00	> LOQ 14.0	J95331-43 PB	1800.00	> LOQ 14.0
G-2B	J95331-50 VB	1800.00	> LOQ 14.0	J95331-50 PB	1100.00	> LOQ 14.0
G-3A	J95331-49 VB	1100.00	> LOQ 14.0	J95331-49 PB	1300.00	> LOQ 14.0
G-4A	J95331-55 VB	1100.00	> LOQ 14.0	J95331-55 PB	3800.00	> LOQ 14.0
G-4B	J95331-56 VB	4000.00	> LOQ 14.0	J95331-56 PB	3500.00	> LOQ 14.0
G-5A	J95331-58 VB	1300.00	> LOQ 14.0	J95331-58 PB	1400.00	> LOQ 14.0
G-5B	J95331-59 VB	1500.00	> LOQ 14.0	J95331-59 PB	1200.00	> LOQ 14.0
G-6A	J95331-64 VB	1100.00	> LOQ 14.0	J95331-64 PB	1800.00	> LOQ 14.0
G-6B	J95331-65 VB	2500.00	> LOQ 14.0	J95331-65 PB	1700.00	> LOQ 14.0
G-7A	J95331-74 VB	1600.00	> LOQ 14.0	J95331-74 PB	1500.00	> LOQ 14.0
G-7B	J95331-75 VB	5100.00	> LOQ 14.0	J95331-75 PB	3000.00	> LOQ 14.0
SG-1A	J95331-54 VB	20.00	< LOQ 70.0	J95331-54 PB	50.00	< LOQ 70.0
SG-1B	J95331-71 VB	20.00	< LOQ 70.0	J95331-71 PB	20.00	< LOQ 70.0
SG-2A	J95331-66 VB	450.00	> LOQ 70.0	J95331-66 PB	300.00	> LOQ 70.0
SG-2B	J95331-82 VB	530.00	< LOQ 70.0	J95331-82 PB	490.00	> LOQ 70.0

Comparison of Airborne Concentrations to Bulk Concentrations - Aluminum

NIOSH REL 10000.0 micrograms/cubic meter
OSHA PEL 15000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	127.08	121.72	134.55	ND
CS-01	8650.88	27083.33	125851.04	27128.55	57000.00
CS-02	11439.27	33444.82	143720.06	52094.19	25000.00
CS-03	9692.72	41416.44	153463.29	41416.44	47000.00
CS-04	5348.69	19254.92	51770.55	26759.98	2600.00
CS-05	4128.82	17316.92	43951.44	22689.90	1700.00
CS-06	18557.13	48167.54	55889.05	35387.18	2200.00
CS-07	19357.50	50041.70	228880.57	45871.56	5300.00
CSDS-01	70598.01	37492.19	116279.07	56168.09	4500.00
CSDS-02	8860.50	33085.19	132477.75	46044.37	48000.00
N-01	589.31	2919.10	11589.40	5942.62	790.00
N-02	8578.43	16836.42	77067.28	14318.32	6900.00
O-1	267.71	375.86	1130.06	544.16	190.00
S-01	228.41	605.55	6263.05	1043.19	460.00
S-02	291.79	2010.05	2500.00	814.37	320.00
SH-01	83.54	162.98	393.86	147.67	72.00
SS-01	412.88	2505.22	2481.90	2484.47	200.00
SS-02	727.20	3545.36	3311.26	3496.50	170.00
SS-03	122.79	378.15	1185.12	463.62	49.00
SS-04	1024.89	5441.61	7740.59	4939.29	1200.00
SS-05	261.15	1174.50	2702.14	2049.60	190.00
SS-06	1992.27	4973.06	33.56	2717.96	870.00
SS-07	1045.94	2493.25	7102.57	1175.50	7400.00
SSDS-01	349.94	1839.46	2887.19	2483.44	370.00
SSDS-02	770.99	2916.67	7016.10	4253.60	1300.00
SSDS-03	42.44	186.69	238.85	227.93	92.00
CP-1A	515.57	2485.50	3320.19	1571.01	310.00
CP-2A	8458.84	25094.10	157610.95	60240.96	29000.00
CP-3A	7434.94	20029.21	113753.88	97268.21	23000.00
CP-4A	3296.25	15510.38	81616.00	16413.62	3700.00
CPDS-1A	11552.49	19385.44	144538.51	53311.46	19000.00
G-1A	1703.72	6893.67	22835.79	17174.40	960.00
G-2A	1053.74	7003.40	10364.84	4371.36	690.00
G-3A	3103.02	9561.42	35676.81	3750.78	1100.00
G-4A	12997.56	13024.60	98623.38	26993.36	1100.00
G-5A	1193.91	5396.43	19771.07	29270.33	1300.00
G-6A	8523.91	41806.02	87390.76	14495.75	1100.00
G-7A	3713.64	8502.70	22945.35	5654.45	1600.00
SG-1A	95.96	130.71	180.57	146.48	20.00
SG-2A	370.45	396.66	393.86	1511.39	450.00

APPENDIX B - ARSENIC

Arsenic

Inhalation, ingestion, or dermal exposure of workers to inorganic arsenic has reportedly caused peripheral nerve inflammation (neuritis) and degeneration (neuropathy), reduced peripheral circulation, anemia, increased mortality due to cardiovascular failure, and cancer of the skin, lungs, and lymphatic system. The OSHA PEL for arsenic is 10 micrograms/cubic meter of air.

Arsenic is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

For the past 20 plus years, NIOSH has subscribed to a carcinogen policy that was published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, which called for "no detectable exposure levels for proven carcinogenic substances [New York Academy of Sciences Annals 1976]." This was in response to a generic OSHA rulemaking on carcinogens.

Because of advances in science and in approaches to risk assessment and risk management, NIOSH has in more recent years adopted a more inclusive policy. NIOSH RELs will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will protect not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy for potential occupational carcinogens will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL. Under the old policy for potential occupational carcinogens, RELs for most carcinogens were non-quantitative values labeled "lowest feasible concentration (LFC)." In 1989, NIOSH adopted several quantitative RELs for carcinogens from OSHA's PEL update. NIOSH will also recommend the complete range of respirators (as determined by the NIOSH Respirator Decision Logic) for carcinogens with quantitative RELs. In this way, respirators will be consistently recommended regardless of whether a substance is a carcinogen or a non-carcinogen.

Air Sample Results - Arsenic

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Arsenic			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.2	ND	< LOD 4.15
24412	2	47.89	S-01	28	ND	< LOD 0.2	ND	< LOD 4.18
24441	3	47.90	S-01	28	ND	< LOD 0.2	ND	< LOD 4.18
24450	OBZ	47.93	S-01	28	ND	< LOD 0.2	ND	< LOD 4.17
24643	1	47.98	S-02	29	ND	< LOD 0.2	ND	< LOD 4.17
24625	2	47.76	S-02	29	ND	< LOD 0.2	ND	< LOD 4.19
24642	3	48.00	S-02	29	ND	< LOD 0.2	ND	< LOD 4.17
24632	OBZ	47.89	S-02	29	ND	< LOD 0.2	ND	< LOD 4.18
24634	1	48.16	CSDS-01	31	ND	< LOD 0.2	ND	< LOD 4.15
24650	2	48.01	CSDS-01	31	ND	< LOD 0.2	ND	< LOD 4.17
24644	3	48.16	CSDS-01	31	ND	< LOD 0.2	ND	< LOD 4.15
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 0.2	ND	< LOD 4.16
24640	1	48.44	SS-01	32	ND	< LOD 0.2	ND	< LOD 4.13
24641	2	47.90	SS-01	32	ND	< LOD 0.2	ND	< LOD 4.18
24651	3	48.35	SS-01	32	ND	< LOD 0.2	ND	< LOD 4.14
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.2	ND	< LOD 4.14
24646	1	48.58	SSDS-01	33	ND	< LOD 0.2	ND	< LOD 4.12
24626	2	47.84	SSDS-01	33	ND	< LOD 0.2	ND	< LOD 4.18
24638	3	48.49	SSDS-01	33	ND	< LOD 0.2	ND	< LOD 4.12
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.2	ND	< LOD 4.14
24628	1	48.55	CS-01	34	ND	< LOD 0.2	ND	< LOD 4.12
24637	2	48.00	CS-01	34	0.48	> LOQ 0.42	10	> LOQ 8.75
24624	3	48.47	CS-01	34	1.20	> LOQ 0.42	24.76	> LOQ 8.67
24636	OBZ	47.92	CS-01	34	0.44	> LOQ 0.42	9.18	> LOQ 8.76
24623	1	48.53	CSDS-02	35	ND	< LOD 0.2	ND	< LOD 4.12
24622	2	48.36	CSDS-02	35	ND	< LOD 0.2	ND	< LOD 4.14
24654	3	48.31	CSDS-02	35	0.23	< LOQ 0.42	4.76	< LOQ 8.69
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 0.2	ND	< LOD 4.19
24629	1	47.88	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.18
24633	2	47.86	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.18
24627	3	48.24	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.15
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.16
24555	1	48.08	CS-02	37	ND	< LOD 0.2	ND	< LOD 4.16
24552	2	47.84	CS-02	37	ND	< LOD 0.2	ND	< LOD 4.18
24541	3	48.01	CS-02	37	0.50	> LOQ 0.42	10.41	> LOQ 8.75
24529	OBZ	47.99	CS-02	37	ND	< LOD 0.2	ND	< LOD 4.17
24558	1	48.49	CS-03	38	ND	< LOD 0.2	ND	< LOD 4.12
24524	2	48.29	CS-03	38	ND	< LOD 0.2	ND	< LOD 4.14
24561	3	48.22	CS-03	38	ND	< LOD 0.2	ND	< LOD 4.15
24559	OBZ	48.29	CS-03	38	ND	< LOD 0.2	ND	< LOD 4.14
24543	1	48.61	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.11
24532	2	47.78	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.19
24546	3	48.29	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.14
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.12
24560	1	48.13	SS-02	40	ND	< LOD 0.2	ND	< LOD 4.16
24565	2	47.95	SS-02	40	ND	< LOD 0.2	ND	< LOD 4.17
24630	3	48.32	SS-02	40	ND	< LOD 0.2	ND	< LOD 4.14
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.2	ND	< LOD 4.11
24525	1	48.13	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.16
24563	2	47.87	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.18
24547	3	48.17	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.15
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.09
24538	1	47.45	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.21

Air Sample Results - Arsenic

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Arsenic			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.24
24533	3	48.24	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.15
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.16
24528	1	47.99	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.17
24544	2	48.00	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.17
24567	3	48.46	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.13
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.05
24571	1	48.05	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.16
24536	2	47.60	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.20
24534	3	48.94	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.09
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.03
24568	1	48.28	G-1B	46	ND	< LOD 0.2	ND	< LOD 4.14
24592	2	47.38	G-1B	46	ND	< LOD 0.2	ND	< LOD 4.22
24593	3	48.17	G-1B	46	ND	< LOD 0.2	ND	< LOD 4.15
24535	OBZ	48.22	G-1B	46	ND	< LOD 0.2	ND	< LOD 4.15
24590	1	47.81	SS-04	47	ND	< LOD 0.2	ND	< LOD 4.18
24605	2	47.78	SS-04	47	ND	< LOD 0.2	ND	< LOD 4.19
24562	3	47.80	SS-04	47	ND	< LOD 0.2	ND	< LOD 4.18
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.2	ND	< LOD 4.12
24527	1	49.48	SSDS-03	48	ND	< LOD 0.2	ND	< LOD 4.04
24569	2	50.35	SSDS-03	48	ND	< LOD 0.2	ND	< LOD 3.97
24584	3	50.24	SSDS-03	48	ND	< LOD 0.2	ND	< LOD 3.98
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.2	ND	< LOD 4.14
24600	1	48.34	G-3A	49	ND	< LOD 0.2	ND	< LOD 4.14
24616	2	48.11	G-3A	49	ND	< LOD 0.2	ND	< LOD 4.16
24585	3	47.65	G-3A	49	ND	< LOD 0.2	ND	< LOD 4.20
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.2	ND	< LOD 4.17
24587	1	48.79	G-2B	50	ND	< LOD 0.2	ND	< LOD 4.10
24602	2	48.17	G-2B	50	ND	< LOD 0.2	ND	< LOD 4.15
24564	3	47.81	G-2B	50	ND	< LOD 0.2	ND	< LOD 4.18
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.2	ND	< LOD 4.12
24618	1	49.21	N-01	52	ND	< LOD 0.2	ND	< LOD 4.06
24611	2	47.96	N-01	52	ND	< LOD 0.2	ND	< LOD 4.17
24588	3	48.32	N-01	52	ND	< LOD 0.2	ND	< LOD 4.14
24615	OBZ	48.80	N-01	52	ND	< LOD 0.2	ND	< LOD 4.10
24597	1	49.78	SS-05	53	ND	< LOD 0.2	ND	< LOD 4.02
24599	2	47.68	SS-05	53	ND	< LOD 0.2	ND	< LOD 4.19
24575	3	48.11	SS-05	53	ND	< LOD 0.2	ND	< LOD 4.16
24617	OBZ	48.79	SS-05	53	ND	< LOD 0.2	ND	< LOD 4.10
24609	1	48.98	SG-1A	54	ND	< LOD 0.2	ND	< LOD 4.08
24596	2	48.20	SG-1A	54	ND	< LOD 0.2	ND	< LOD 4.15
24610	3	48.18	SG-1A	54	0.48	> LOQ 0.42	9.96	> LOQ 8.72
24576	OBZ	48.47	SG-1A	54	1.70	> LOQ 0.42	35.07	> LOQ 8.67
24606	1	49.24	G-4A	55	ND	< LOD 0.2	ND	< LOD 4.06
24620	2	48.37	G-4A	55	ND	< LOD 0.2	ND	< LOD 4.13
24573	3	48.67	G-4A	55	ND	< LOD 0.2	ND	< LOD 4.11
24505	OBZ	48.16	G-4A	55	ND	< LOD 0.2	ND	< LOD 4.15
24340	1	48.38	G-4B	56	ND	< LOD 0.2	ND	< LOD 4.13
24607	2	48.01	G-4B	56	ND	< LOD 0.2	ND	< LOD 4.17
24595	3	48.38	G-4B	56	ND	< LOD 0.2	ND	< LOD 4.13
24598	OBZ	48.42	G-4B	56	ND	< LOD 0.2	ND	< LOD 4.13
24580	1	48.44	CS-05	57	ND	< LOD 0.2	ND	< LOD 4.13
24604	2	47.93	CS-05	57	ND	< LOD 0.2	ND	< LOD 4.17

Air Sample Results - Arsenic

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Arsenic			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 0.2	ND	< LOD 4.19
24574	OBZ	30.41	CS-05	57	ND	< LOD 0.2	ND	< LOD 6.58
24614	1	48.58	G-5A	58	ND	< LOD 0.2	ND	< LOD 4.12
24577	2	48.18	G-5A	58	ND	< LOD 0.2	ND	< LOD 4.15
24572	3	48.05	G-5A	58	ND	< LOD 0.2	ND	< LOD 4.16
24582	OBZ	47.83	G-5A	58	ND	< LOD 0.2	ND	< LOD 4.18
24322	1	47.88	G-5B	59	ND	< LOD 0.2	ND	< LOD 4.18
24354	2	48.16	G-5B	59	ND	< LOD 0.2	ND	< LOD 4.15
24510	3	47.98	G-5B	59	ND	< LOD 0.2	ND	< LOD 4.17
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.2	ND	< LOD 4.17
24497	1	48.49	CP-1A	60	0.29	< LOQ 0.42	5.98	< LOQ 8.66
24333	2	48.28	CP-1A	60	0.90	> LOQ 0.42	18.64	> LOQ 8.70
24326	3	48.19	CP-1A	60	1.40	> LOQ 0.42	29.05	> LOQ 8.72
24329	OBZ	47.74	CP-1A	60	0.82	> LOQ 0.42	17.18	> LOQ 8.80
24499	1	42.42	CP-1B	62	0.49	> LOQ 0.42	11.55	> LOQ 9.90
24506	2	42.02	CP-1B	62	0.60	> LOQ 0.42	14.28	> LOQ 10.00
24388	3	42.47	CP-1B	62	3.20	> LOQ 2.1	75.35	> LOQ 49.45
24315	OBZ	41.77	CP-1B	62	0.62	> LOQ 0.42	14.84	> LOQ 10.06
24318	1	48.56	CG-01	63	ND	< LOD 0.2	ND	< LOD 4.12
24308	2	48.00	CG-01	63	ND	< LOD 0.2	ND	< LOD 4.17
24330	3	48.47	CG-01	63	ND	< LOD 0.2	ND	< LOD 4.13
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.2	ND	< LOD 4.14
24363	1	48.10	G-6A	64	ND	< LOD 0.2	ND	< LOD 4.16
24398	2	47.84	G-6A	64	ND	< LOD 0.2	ND	< LOD 4.18
24351	3	48.06	G-6A	64	ND	< LOD 0.2	ND	< LOD 4.16
24594	OBZ	48.29	G-6A	64	ND	< LOD 0.2	ND	< LOD 4.14
24312	1	48.76	G-6B	65	ND	< LOD 0.2	ND	< LOD 4.10
24484	2	47.45	G-6B	65	ND	< LOD 0.2	ND	< LOD 4.21
24327	3	48.92	G-6B	65	ND	< LOD 0.2	ND	< LOD 4.09
24389	OBZ	48.46	G-6B	65	ND	< LOD 0.2	ND	< LOD 4.13
24348	1	48.59	SG-2A	66	0.85	> LOQ 0.42	17.49	> LOQ 8.64
24314	2	47.90	SG-2A	66	0.58	> LOQ 0.42	12.11	> LOQ 8.77
24494	3	48.24	SG-2A	66	0.86	> LOQ 0.42	17.83	> LOQ 8.71
24337	OBZ	48.30	SG-2A	66	2.00	> LOQ 0.42	41.41	> LOQ 8.70
24508	1	48.47	CP-2A	67	0.32	> LOQ 0.17	6.6	> LOQ 3.51
24361	2	47.82	CP-2A	67	0.80	> LOQ 0.58	16.73	> LOQ 12.13
24359	3	48.22	CP-2A	67	4.80	> LOQ 1.2	99.54	> LOQ 24.89
24471	OBZ	48.14	CP-2A	67	2.20	> LOQ 0.17	45.7	> LOQ 3.53
24373	1	48.41	CP-2B	68	0.72	> LOQ 0.58	14.87	> LOQ 11.98
24468	2	47.90	CP-2B	68	0.49	> LOQ 0.17	10.23	> LOQ 3.55
24481	3	48.26	CP-2B	68	3.90	> LOQ 0.34	80.81	> LOQ 7.05
24391	OBZ	47.53	CP-2B	68	0.39	< LOQ 0.42	8.21	< LOQ 8.84
24356	1	48.56	O-1	69	ND	< LOD 0.2	ND	< LOD 4.12
24470	2	47.89	O-1	69	ND	< LOD 0.05	ND	< LOD 1.04
24467	3	48.67	O-1	69	ND	< LOD 0.05	ND	< LOD 1.03
24313	OBZ	47.78	O-1	69	ND	< LOD 0.2	ND	< LOD 4.19
24501	1	47.96	CS-06	70	ND	< LOD 0.05	ND	< LOD 1.04
24496	2	47.75	CS-06	70	0.10	< LOQ 0.17	2.09	< LOQ 3.56
24478	3	48.31	CS-06	70	0.16	< LOQ 0.17	3.31	< LOQ 3.52
24503	OBZ	48.04	CS-06	70	0.10	< LOQ 0.17	2.08	< LOQ 3.54
24474	1	26.02	SG-1B	71	ND	< LOD 0.05	ND	< LOD 1.92
24469	2	26.02	SG-1B	71	ND	< LOD 0.05	ND	< LOD 1.92
24492	3	26.10	SG-1B	71	0.19	> LOQ 0.17	7.28	> LOQ 6.51

Air Sample Results - Arsenic

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Arsenic			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	1.30	> LOQ 0.17	49.52	> LOQ 6.48
24489	1	48.42	CP-3A	72	2.50	> LOQ 0.34	51.63	> LOQ 7.02
24491	2	47.93	CP-3A	72	9.40	> LOQ 1.7	196.12	> LOQ 35.47
24482	3	48.35	CP-3A	72	54.00	> LOQ 6.8	1116.86	> LOQ 140.64
24486	OBZ	48.32	CP-3A	72	43.00	> LOQ 17.0	889.9	> LOQ 351.82
24516	1	36.34	CP-3B	73	2.60	> LOQ 0.34	71.55	> LOQ 9.36
24502	2	36.02	CP-3B	73	18.00	> LOQ 8.5	499.72	> LOQ 235.98
24515	3	36.48	CP-3B	73	24.00	> LOQ 8.5	657.89	> LOQ 233.00
24500	OBZ	40.27	CP-3B	73	11.00	> LOQ 0.85	273.16	> LOQ 21.11
24504	1	48.47	G-7A	74	ND	< LOD 0.05	ND	< LOD 1.03
24513	2	48.22	G-7A	74	ND	< LOD 0.05	ND	< LOD 1.04
24458	3	47.94	G-7A	74	0.10	< LOQ 0.17	2.09	< LOQ 3.55
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.2	ND	< LOD 4.19
24404	1	48.68	G-7B	75	ND	< LOD 0.2	ND	< LOD 4.11
24451	2	48.06	G-7B	75	ND	< LOD 0.2	ND	< LOD 4.16
24447	3	47.16	G-7B	75	ND	< LOD 0.2	ND	< LOD 4.24
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.2	ND	< LOD 4.23
24456	1	49.19	SS-06	76	ND	< LOD 0.1	ND	< LOD 2.03
24480	2	48.26	SS-06	76	0.10	< LOQ 0.17	2.07	< LOQ 3.52
24429	3	47.68	SS-06	76	0.33	< LOQ 0.42	6.92	< LOQ 8.81
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.2	ND	< LOD 4.18
24427	1	48.54	CP-4A	78	4.40	> LOQ 4.2	90.65	> LOQ 86.53
24435	2	47.71	CP-4A	78	21.00	> LOQ 8.4	440.16	> LOQ 176.06
24244	3	49.01	CP-4A	78	1200.00	> LOQ 250.0	24484.8	> LOQ 5101.00
24220	OBZ	48.74	CP-4A	78	180.00	> LOQ 25.0	3693.07	> LOQ 512.93
24460	1	50.05	CP-4B	79	6.30	> LOQ 3.4	125.87	> LOQ 67.93
24465	2	48.47	CP-4B	79	17.00	> LOQ 8.5	350.73	> LOQ 175.37
24207	3	48.49	CP-4B	79	28.00	> LOQ 0.25	577.44	> LOQ 5.16
24390	OBZ	49.02	CP-4B	79	3.90	< LOQ 4.2	79.56	< LOQ 85.68
24259	1	48.76	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.64
24421	2	48.13	SS-07	80	ND	< LOD 0.2	ND	< LOD 4.16
24445	3	47.87	SS-07	80	ND	< LOD 0.2	ND	< LOD 4.18
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.2	ND	< LOD 4.12
24459	1	48.96	N-02	81	0.97	> LOQ 0.17	19.81	> LOQ 3.47
24417	2	48.11	N-02	81	1.80	> LOQ 0.42	37.41	> LOQ 8.73
24442	3	48.01	N-02	81	8.20	> LOQ 4.2	170.8	> LOQ 87.48
24386	OBZ	48.19	N-02	81	1.70	> LOQ 0.42	35.28	> LOQ 8.72
24452	1	48.20	SG-2B	82	0.39	< LOQ 0.42	8.09	< LOQ 8.71
24453	2	48.59	SG-2B	82	0.66	> LOQ 0.42	13.58	> LOQ 8.64
24420	3	47.84	SG-2B	82	0.91	> LOQ 0.42	19.02	> LOQ 8.78
24444	OBZ	47.95	SG-2B	82	9.00	> LOQ 4.2	187.7	> LOQ 87.59
24455	1	48.56	CS-07	83	ND	< LOD 0.1	ND	< LOD 2.06
24433	2	47.96	CS-07	83	ND	< LOD 0.2	ND	< LOD 4.17
24398	3	48.06	CS-07	83	1.40	> LOQ 0.42	29.13	> LOQ 8.74
24511	OBZ	47.96	CS-07	83	0.21	> LOQ 0.17	4.38	> LOQ 3.54
24454	1	49.34	CPDS-1A	84	0.47	> LOQ 0.36	9.53	> LOQ 7.30
24291	2	48.49	CPDS-1A	84	0.56	< LOQ 0.58	11.55	< LOQ 11.96
24209	3	48.43	CPDS-1A	84	5.20	> LOQ 1.3	107.37	> LOQ 26.84
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 0.2	ND	< LOD 4.10
24204	1	49.46	CPDS-1B	85	0.41	> LOQ 0.25	8.29	> LOQ 5.05
24273	2	48.35	CPDS-1B	85	0.54	> LOQ 0.25	11.17	> LOQ 5.17
24223	3	48.82	CPDS-1B	85	3.70	> LOQ 0.50	75.79	> LOQ 10.24
24466	OBZ	49.96	CPDS-1B	85	0.73	> LOQ 0.17	14.61	> LOQ 3.40

Airborne Sample Data Analysis - Arsenic
NIOSH REL 2.0 micrograms/cubic meter Ceiling Limit
OSHA PEL 10.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 4.12	ND	< LOD 4.17	ND	< LOD 4.13	ND	< LOD 4.14
CS-01	ND	< LOD 4.12	10	> LOQ 8.75	24.76	> LOQ 8.67	9.18	> LOQ 8.76
CS-02	ND	< LOD 4.16	ND	< LOD 4.18	10.41	> LOQ 8.75	ND	< LOD 4.17
CS-03	ND	< LOD 4.12	ND	< LOD 4.14	ND	< LOD 4.15	ND	< LOD 4.14
CS-04	ND	< LOD 4.11	ND	< LOD 4.19	ND	< LOD 4.14	ND	< LOD 4.12
CS-05	ND	< LOD 4.13	ND	< LOD 4.17	ND	< LOD 4.19	ND	< LOD 6.58
CS-06	ND	< LOD 1.04	2.09	< LOQ 3.56	3.31	< LOQ 3.52	2.08	< LOQ 3.54
CS-07	ND	< LOD 2.06	ND	< LOD 4.17	29.13	> LOQ 8.74	4.38	> LOQ 3.54
CSDS-01	ND	< LOD 4.15	ND	< LOD 4.17	ND	< LOD 4.15	ND	< LOD 4.16
CSDS-02	ND	< LOD 4.12	ND	< LOD 4.14	4.76	< LOQ 8.69	ND	< LOD 4.19
N-01	ND	< LOD 4.06	ND	< LOD 4.17	ND	< LOD 4.14	ND	< LOD 4.10
N-02	19.81	> LOQ 3.47	37.41	> LOQ 8.73	170.80	> LOQ 87.48	35.28	> LOQ 8.72
O-1	ND	< LOD 4.12	ND	< LOD 1.04	ND	< LOD 1.03	ND	< LOD 4.19
S-01	ND	< LOD 4.15	ND	< LOD 4.18	ND	< LOD 4.18	ND	< LOD 4.17
S-02	ND	< LOD 4.17	ND	< LOD 4.19	ND	< LOD 4.17	ND	< LOD 4.18
SH-01	ND	< LOD 4.18	ND	< LOD 4.18	ND	< LOD 4.15	ND	< LOD 4.16
SS-01	ND	< LOD 4.13	ND	< LOD 4.18	ND	< LOD 4.14	ND	< LOD 4.14
SS-02	ND	< LOD 4.16	ND	< LOD 4.17	ND	< LOD 4.14	ND	< LOD 4.11
SS-03	ND	< LOD 4.16	ND	< LOD 4.20	ND	< LOD 4.09	ND	< LOD 4.03
SS-04	ND	< LOD 4.18	ND	< LOD 4.19	ND	< LOD 4.18	ND	< LOD 4.12
SS-05	ND	< LOD 4.02	ND	< LOD 4.19	ND	< LOD 4.16	ND	< LOD 4.10
SS-06	ND	< LOD 2.03	2.07	< LOQ 3.52	6.92	< LOQ 8.81	ND	< LOD 4.18
SS-07	ND	< LOD 1.64	ND	< LOD 4.16	ND	< LOD 4.18	ND	< LOD 4.12
SSDS-01	ND	< LOD 4.12	ND	< LOD 4.18	ND	< LOD 4.12	ND	< LOD 4.14
SSDS-02	ND	< LOD 4.17	ND	< LOD 4.17	ND	< LOD 4.13	ND	< LOD 4.05
SSDS-03	ND	< LOD 4.04	ND	< LOD 3.97	ND	< LOD 3.98	ND	< LOD 4.14
CP-1A	5.98	< LOQ 8.66	18.64	> LOQ 8.70	29.05	> LOQ 8.72	17.18	> LOQ 8.80
CP-1B	11.55	> LOQ 9.90	14.28	> LOQ 10.00	75.35	> LOQ 49.45	14.84	> LOQ 10.06
CP-2A	6.6	> LOQ 3.51	16.73	> LOQ 12.13	99.54	> LOQ 24.89	45.7	> LOQ 3.53
CP-2B	14.87	> LOQ 11.98	10.23	> LOQ 3.55	80.81	> LOQ 7.05	8.21	< LOQ 8.84
CP-3A	51.63	> LOQ 7.02	196.12	> LOQ 35.47	1116.86	> LOQ 140.64	889.9	> LOQ 351.82
CP-3B	71.55	> LOQ 9.36	499.72	> LOQ 235.98	657.89	> LOQ 233.00	273.16	> LOQ 21.11
CP-4A	90.65	> LOQ 86.53	440.16	> LOQ 176.06	24484.80	> LOQ 5101.00	3693.07	> LOQ 512.93
CP-4B	125.87	> LOQ 67.93	350.73	> LOQ 175.37	577.44	> LOQ 5.16	79.56	< LOQ 85.68
CPDS-1A	9.53	> LOQ 7.30	11.55	< LOQ 11.96	107.37	> LOQ 26.84	ND	< LOD 4.10
CPDS-1B	8.29	> LOQ 5.05	11.17	> LOQ 5.17	75.79	> LOQ 10.24	14.61	> LOQ 3.40
G-1A	ND	< LOD 4.16	ND	< LOD 4.18	ND	< LOD 4.15	ND	< LOD 4.09
G-1B	ND	< LOD 4.14	ND	< LOD 4.22	ND	< LOD 4.15	ND	< LOD 4.15
G-2A	ND	< LOD 4.21	ND	< LOD 4.24	ND	< LOD 4.15	ND	< LOD 4.16
G-2B	ND	< LOD 4.10	ND	< LOD 4.15	ND	< LOD 4.18	ND	< LOD 4.12
G-3A	ND	< LOD 4.14	ND	< LOD 4.16	ND	< LOD 4.20	ND	< LOD 4.17
G-4A	ND	< LOD 4.06	ND	< LOD 4.13	ND	< LOD 4.11	ND	< LOD 4.15
G-4B	ND	< LOD 4.13	ND	< LOD 4.17	ND	< LOD 4.13	ND	< LOD 4.13
G-5A	ND	< LOD 4.12	ND	< LOD 4.15	ND	< LOD 4.16	ND	< LOD 4.18
G-5B	ND	< LOD 4.18	ND	< LOD 4.15	ND	< LOD 4.17	ND	< LOD 4.17
G-6A	ND	< LOD 4.16	ND	< LOD 4.18	ND	< LOD 4.16	ND	< LOD 4.14
G-6B	ND	< LOD 4.10	ND	< LOD 4.21	ND	< LOD 4.09	ND	< LOD 4.13
G-7A	ND	< LOD 1.03	ND	< LOD 1.04	2.09	< LOQ 3.55	ND	< LOD 4.19
G-7B	ND	< LOD 4.11	ND	< LOD 4.16	ND	< LOD 4.24	ND	< LOD 4.23
SG-1A	ND	< LOD 4.08	ND	< LOD 4.15	9.96	> LOQ 8.72	35.07	> LOQ 8.67
SG-1B	ND	< LOD 1.92	ND	< LOD 1.92	7.28	> LOQ 6.51	49.52	> LOQ 6.48
SG-2A	17.49	> LOQ 8.64	12.11	> LOQ 8.77	17.83	> LOQ 8.71	41.41	> LOQ 8.70
SG-2B	8.09	< LOQ 8.71	13.58	> LOQ 8.64	19.02	> LOQ 8.78	187.7	> LOQ 87.59

Bulk Elemental Analysis - Arsenic

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Arsenic		Sample	Arsenic	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.5	J95331-63 PB	ND	< LOD 0.5
CS-01	J95331-34 VB	1.40	< LOQ 1.7	J95331-34 PB	15.00	< LOQ 17
CS-02	J95331-37 VB	1.60	< LOQ 1.7	J95331-37 PB	2.10	> LOQ 1.7
CS-03	J95331-38 VB	0.68	> LOQ 1.7	J95331-38 PB	0.79	< LOQ 1.7
CS-04	J95331-39 VB	ND	< LOD 0.5	J95331-39 PB	0.65	< LOQ 1.7
CS-05	J95331-57 VB	ND	< LOD 0.5	J95331-57 PB	ND	< LOD 0.5
CS-06	J95331-70 VB	ND	< LOD 0.1	J95331-70 PB	0.12	< LOQ 0.47
CS-07	J95331-83 VB	2.10	> LOQ 1.4	J95331-83 PB	2.40	> LOQ 1.4
CSDS-01	J95331-31 VB	ND	< LOD 0.5	J95331-31 PB	ND	< LOD 0.5
CSDS-02	J95331-35 VB	0.80	< LOQ 1.7	J95331-35 PB	1.10	< LOQ 1.7
N-01	J95331-52 VB	ND	< LOD 0.5	J95331-52 PB	ND	< LOD 0.5
N-02	J95331-81 VB	15.00	> LOQ 2.8	J95331-81 PB	32.00	> LOQ 7.0
O-1	J95331-69 VB	0.33	< LOQ 0.47	J95331-69 PB	1.00	> LOQ 0.47
S-01	J95331-28 VB	ND	< LOD 0.5	J95331-28 PB	ND	< LOD 0.5
S-02	J95331-29 VB	ND	< LOD 0.5	J95331-29 PB	ND	< LOD 0.5
SH-01	J95331-36 VB	ND	< LOD 0.5	J95331-36 PB	ND	< LOD 0.5
SS-01	J95331-32 VB	ND	< LOD 0.5	J95331-32 PB	ND	< LOD 0.5
SS-02	J95331-40 VB	ND	< LOD 0.5	J95331-40 PB	ND	< LOD 0.5
SS-03	J95331-45 VB	ND	< LOD 0.5	J95331-45 PB	ND	< LOD 0.5
SS-04	J95331-47 VB	ND	< LOD 0.5	J95331-47 PB	0.66	< LOQ 1.7
SS-05	J95331-53 VB	0.71	< LOQ 1.7	J95331-53 PB	0.67	< LOQ 1.7
SS-06	J95331-76 VB	1.50	> LOQ 1.4	J95331-76 PB	1.70	> LOQ 1.4
SS-07	J95331-80 VB	ND	< LOD 0.4	J95331-80 PB	ND	< LOD 0.4
SSDS-01	J95331-33 VB	ND	< LOD 0.5	J95331-33 PB	ND	< LOD 0.5
SSDS-02	J95331-44 VB	ND	< LOD 0.5	J95331-44 PB	ND	< LOD 0.5
SSDS-03	J95331-48 VB	ND	< LOD 0.5	J95331-48 PB	ND	< LOD 0.5
CP-1A	J95331-60 VB	13.00	> LOQ 1.7	J95331-60 PB	21.00	> LOQ 8.5
CP-1B	J95331-61 VB	ND	< LOD 0.5	J95331-61 PB	ND	< LOD 0.5
CP-2A	J95331-67 VB	18.00	> LOQ 2.4	J95331-67 PB	22.00	> LOQ 2.4
CP-2B	J95331-68 VB	25.00	> LOQ 2.4	J95331-68 PB	25.00	> LOQ 2.4
CP-3A	J95331-72 VB	160.00	> LOQ 9.4	J95331-72 PB	110.00	> LOQ 9.4
CP-3B	J95331-73 VB	ND	< LOD 0.1	J95331-73 PB	150.00	> LOQ 9.4
CP-4A	J95331-78 VB	410.00	> LOQ 140	J95331-78 PB	340.00	> LOQ 140
CP-4B	J95331-79 VB	400.00	> LOQ 140	J95331-79 PB	370.00	> LOQ 140
CPDS-1A	J95331-84 VB	5.70	> LOQ 1.4	J95331-84 PB	8.50	< LOQ 1.4
CPDS-1B	J95331-85 VB	6.80	> LOQ 1.4	J95331-85 PB	8.00	> LOQ 1.4
G-1A	J95331-41 VB	ND	< LOD 0.5	J95331-41 PB	ND	< LOD 0.5
G-1B	J95331-46 VB	2.20	> LOQ 1.7	J95331-46 PB	1.60	< LOQ 1.7
G-2A	J95331-43 VB	0.55	< LOQ 1.7	J95331-43 PB	0.72	< LOQ 1.7
G-2B	J95331-50 VB	0.71	< LOQ 1.7	J95331-50 PB	ND	< LOD 0.5
G-3A	J95331-49 VB	0.50	< LOQ 1.7	J95331-49 PB	0.51	< LOQ 1.7
G-4A	J95331-55 VB	ND	< LOD 0.5	J95331-55 PB	ND	< LOD 0.5
G-4B	J95331-56 VB	ND	< LOD 0.5	J95331-56 PB	ND	< LOD 0.5
G-5A	J95331-58 VB	ND	< LOD 0.5	J95331-58 PB	ND	< LOD 0.5
G-5B	J95331-59 VB	ND	< LOD 0.5	J95331-59 PB	ND	< LOD 0.5
G-6A	J95331-64 VB	ND	< LOD 0.5	J95331-64 PB	0.71	< LOQ 1.7
G-6B	J95331-65 VB	0.71	< LOQ 1.7	J95331-65 PB	0.56	< LOQ 1.7
G-7A	J95331-74 VB	ND	< LOD 0.1	J95331-74 PB	0.25	< LOQ 0.47
G-7B	J95331-75 VB	ND	< LOD 0.04	J95331-75 PB	0.11	< LOQ 0.47
SG-1A	J95331-54 VB	27.00	> LOQ 8.5	J95331-54 PB	26.00	> LOQ 8.5
SG-1B	J95331-71 VB	17.00	> LOQ 0.94	J95331-71 PB	17.00	> LOQ 0.94
SG-2A	J95331-66 VB	31.00	> LOQ 8.5	J95331-66 PB	30.00	> LOQ 8.5
SG-2B	J95331-82 VB	8.10	< LOQ 1.4	J95331-82 PB	8.00	> LOQ 1.4

Comparison of Airborne Concentrations to Bulk Concentrations - Arsenic

NIOSH REL 2.0 micrograms/cubic meter Ceiling Limit
OSHA PEL 10.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	10.00	24.76	9.18	1.40
CS-02	ND	ND	10.41	ND	1.60
CS-03	ND	ND	ND	ND	0.68
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	2.09	3.31	2.08	ND
CS-07	ND	ND	29.13	4.38	2.10
CSDS-01	ND	ND	ND	ND	ND
CSDS-02	ND	ND	4.76	ND	0.80
N-01	ND	ND	ND	ND	ND
N-02	19.81	37.41	170.80	35.28	15.00
O-1	ND	ND	ND	ND	0.33
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	0.71
SS-06	ND	2.07	6.92	ND	1.50
SS-07	ND	ND	ND	ND	ND
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	5.98	18.64	29.05	17.18	13.00
CP-2A	6.60	16.73	99.54	45.70	18.00
CP-3A	51.63	196.12	1116.86	889.90	160.00
CP-4A	90.65	440.16	24484.80	3693.07	410.00
CPDS-1A	9.53	11.55	107.37	ND	5.70
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	0.55
G-3A	ND	ND	ND	ND	0.50
G-4A	ND	ND	ND	ND	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	ND	2.09	ND	ND
SG-1A	ND	ND	9.96	35.07	27.00
SG-2A	17.49	12.11	17.83	41.41	31.00

APPENDIX B - BARIUM

Barium

The toxicity of barium depends upon the solubility of its compounds. Soluble barium compounds may cause local irritation of the nose, eyes, throat, bronchial tubes, and skin. The NIOSH REL and OSHA PEL for barium are both 500 micrograms/cubic meter of air.

Air Sample Results - Barium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Barium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.053	< LOQ 0.17	1.1	< LOQ 3.53
24412	2	47.89	S-01	28	0.150	< LOQ 0.17	3.13	< LOQ 3.55
24441	3	47.90	S-01	28	0.700	> LOQ 0.17	14.61	> LOQ 3.55
24450	OBZ	47.93	S-01	28	0.240	> LOQ 0.17	5.01	> LOQ 3.55
24643	1	47.98	S-02	29	0.096	< LOQ 0.17	2	< LOQ 3.54
24625	2	47.76	S-02	29	0.510	> LOQ 0.17	10.68	> LOQ 3.56
24642	3	48.00	S-02	29	1.100	> LOQ 0.17	22.92	> LOQ 3.54
24632	OBZ	47.89	S-02	29	0.330	> LOQ 0.17	6.89	> LOQ 3.55
24634	1	48.16	CSDS-01	31	1.400	> LOQ 0.17	29.07	> LOQ 3.53
24650	2	48.01	CSDS-01	31	7.300	> LOQ 0.17	152.05	> LOQ 3.54
24644	3	48.16	CSDS-01	31	22.000	> LOQ 0.17	456.81	> LOQ 3.53
24645	OBZ	48.07	CSDS-01	31	11.000	> LOQ 0.17	228.83	> LOQ 3.54
24640	1	48.44	SS-01	32	0.060	< LOQ 0.17	1.24	< LOQ 3.51
24641	2	47.90	SS-01	32	0.240	> LOQ 0.17	5.01	> LOQ 3.55
24651	3	48.35	SS-01	32	0.310	> LOQ 0.17	6.41	> LOQ 3.52
24635	OBZ	48.30	SS-01	32	0.330	> LOQ 0.17	6.83	> LOQ 3.52
24646	1	48.58	SSDS-01	33	ND	< LOD 0.05	ND	< LOD 1.03
24626	2	47.84	SSDS-01	33	0.200	> LOQ 0.17	4.18	> LOQ 3.55
24638	3	48.49	SSDS-01	33	0.280	> LOQ 0.17	5.77	> LOQ 3.51
24647	OBZ	48.32	SSDS-01	33	0.240	> LOQ 0.17	4.97	> LOQ 3.52
24628	1	48.55	CS-01	34	2.300	> LOQ 0.17	47.37	> LOQ 3.50
24637	2	48.00	CS-01	34	6.900	> LOQ 0.17	143.75	> LOQ 3.54
24624	3	48.47	CS-01	34	30.000	> LOQ 0.17	618.94	> LOQ 3.51
24636	OBZ	47.92	CS-01	34	6.800	> LOQ 0.17	141.9	> LOQ 3.55
24623	1	48.53	CSDS-02	35	2.300	> LOQ 0.17	47.39	> LOQ 3.50
24622	2	48.36	CSDS-02	35	8.600	> LOQ 0.17	177.83	> LOQ 3.52
24654	3	48.31	CSDS-02	35	30.000	> LOQ 0.17	620.99	> LOQ 3.52
24653	OBZ	47.78	CSDS-02	35	11.000	> LOQ 0.17	230.22	> LOQ 3.56
24629	1	47.88	SH-01	36	0.068	< LOQ 0.17	1.42	< LOQ 3.55
24633	2	47.86	SH-01	36	0.160	< LOQ 0.17	3.34	< LOQ 3.55
24627	3	48.24	SH-01	36	0.790	> LOQ 0.17	16.38	> LOQ 3.52
24648	OBZ	48.08	SH-01	36	0.140	< LOQ 0.17	2.91	< LOQ 3.54
24555	1	48.08	CS-02	37	2.800	> LOQ 0.17	58.24	> LOQ 3.54
24552	2	47.84	CS-02	37	8.100	> LOQ 0.17	169.31	> LOQ 3.55
24541	3	48.01	CS-02	37	32.000	> LOQ 0.17	666.53	> LOQ 3.54
24529	OBZ	47.99	CS-02	37	12.000	> LOQ 0.17	250.05	> LOQ 3.54
24558	1	48.49	CS-03	38	14.000	> LOQ 0.17	288.72	> LOQ 3.51
24524	2	48.29	CS-03	38	61.000	> LOQ 0.17	1263.2	> LOQ 3.52
24561	3	48.22	CS-03	38	220.000	> LOQ 0.17	4562.42	> LOQ 3.53
24559	OBZ	48.29	CS-03	38	61.000	> LOQ 0.17	1263.2	> LOQ 3.52
24543	1	48.61	CS-04	39	3.000	> LOQ 0.17	61.72	> LOQ 3.50
24532	2	47.78	CS-04	39	10.000	> LOQ 0.17	209.29	> LOQ 3.56
24546	3	48.29	CS-04	39	28.000	> LOQ 0.17	579.83	> LOQ 3.52
24557	OBZ	48.58	CS-04	39	14.000	> LOQ 0.17	288.18	> LOQ 3.50
24560	1	48.13	SS-02	40	0.430	> LOQ 0.17	8.93	> LOQ 3.53
24565	2	47.95	SS-02	40	1.100	> LOQ 0.17	22.94	> LOQ 3.55
24630	3	48.32	SS-02	40	1.900	> LOQ 0.17	39.32	> LOQ 3.52
24553	OBZ	48.62	SS-02	40	1.200	> LOQ 0.17	24.68	> LOQ 3.50
24525	1	48.13	G-1A	41	0.082	< LOQ 0.17	1.7	< LOQ 3.53
24563	2	47.87	G-1A	41	0.310	> LOQ 0.17	6.48	> LOQ 3.55
24547	3	48.17	G-1A	41	0.470	> LOQ 0.17	9.76	> LOQ 3.53
24526	OBZ	48.91	G-1A	41	0.230	> LOQ 0.17	4.7	> LOQ 3.48
24538	1	47.45	G-2A	43	0.059	< LOQ 0.17	1.24	< LOQ 3.58

Air Sample Results - Barium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Barium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	0.280	> LOQ 0.17	5.94	> LOQ 3.61
24533	3	48.24	G-2A	43	0.300	> LOQ 0.17	6.22	> LOQ 3.52
24540	OBZ	48.04	G-2A	43	0.330	> LOQ 0.17	6.87	> LOQ 3.54
24528	1	47.99	SSDS-02	44	0.310	> LOQ 0.17	6.46	> LOQ 3.54
24544	2	48.00	SSDS-02	44	1.100	> LOQ 0.17	22.92	> LOQ 3.54
24567	3	48.46	SSDS-02	44	2.100	> LOQ 0.17	43.33	> LOQ 3.51
24539	OBZ	49.37	SSDS-02	44	2.200	> LOQ 0.17	44.56	> LOQ 3.44
24571	1	48.05	SS-03	45	ND	< LOD 0.05	ND	< LOD 1.04
24536	2	47.60	SS-03	45	0.070	< LOQ 0.17	1.47	< LOQ 3.57
24534	3	48.94	SS-03	45	0.100	< LOQ 0.17	2.04	< LOQ 3.47
24570	OBZ	49.61	SS-03	45	0.089	< LOQ 0.17	1.79	< LOQ 3.43
24568	1	48.28	G-1B	46	ND	< LOD 0.05	ND	< LOD 1.04
24592	2	47.38	G-1B	46	0.110	< LOQ 0.17	2.32	< LOQ 3.59
24593	3	48.17	G-1B	46	0.160	< LOQ 0.17	3.32	< LOQ 3.53
24535	OBZ	48.22	G-1B	46	0.093	< LOQ 0.17	1.93	< LOQ 3.53
24590	1	47.81	SS-04	47	0.420	> LOQ 0.05	8.78	> LOQ 1.04
24605	2	47.78	SS-04	47	1.700	> LOQ 0.17	35.58	> LOQ 3.56
24562	3	47.80	SS-04	47	2.200	> LOQ 0.17	46.03	> LOQ 3.56
24531	OBZ	48.59	SS-04	47	1.600	> LOQ 0.17	32.93	> LOQ 3.50
24527	1	49.48	SSDS-03	48	ND	< LOD 0.05	ND	< LOD 1.01
24569	2	50.35	SSDS-03	48	ND	< LOD 0.05	ND	< LOD 0.99
24584	3	50.24	SSDS-03	48	ND	< LOD 0.05	ND	< LOD 1.00
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.05	ND	< LOD 1.04
24600	1	48.34	G-3A	49	ND	< LOD 0.05	ND	< LOD 1.03
24616	2	48.11	G-3A	49	0.089	< LOQ 0.17	1.85	< LOQ 3.53
24585	3	47.65	G-3A	49	0.140	< LOQ 0.17	2.94	< LOQ 3.57
24583	OBZ	47.99	G-3A	49	0.065	< LOQ 0.17	1.35	< LOQ 3.54
24587	1	48.79	G-2B	50	ND	< LOD 0.05	ND	< LOD 1.02
24602	2	48.17	G-2B	50	0.110	< LOQ 0.17	2.28	< LOQ 3.53
24564	3	47.81	G-2B	50	0.078	< LOQ 0.17	1.63	< LOQ 3.56
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.05	ND	< LOD 1.03
24618	1	49.21	N-01	52	0.130	< LOQ 0.17	2.64	< LOQ 3.45
24611	2	47.96	N-01	52	0.570	> LOQ 0.17	11.88	> LOQ 3.54
24588	3	48.32	N-01	52	2.000	> LOQ 0.17	41.39	> LOQ 3.52
24615	OBZ	48.80	N-01	52	1.100	> LOQ 0.17	22.54	> LOQ 3.48
24597	1	49.78	SS-05	53	ND	< LOD 0.05	ND	< LOD 1.00
24599	2	47.68	SS-05	53	0.100	< LOQ 0.17	2.1	< LOQ 3.57
24575	3	48.11	SS-05	53	0.200	> LOQ 0.17	4.16	> LOQ 3.53
24617	OBZ	48.79	SS-05	53	0.190	> LOQ 0.17	3.89	> LOQ 3.48
24609	1	48.98	SG-1A	54	0.076	< LOQ 0.17	1.55	< LOQ 3.47
24596	2	48.20	SG-1A	54	0.076	< LOQ 0.17	1.58	< LOQ 3.53
24610	3	48.18	SG-1A	54	0.160	< LOQ 0.17	3.32	< LOQ 3.53
24576	OBZ	48.47	SG-1A	54	0.730	> LOQ 0.17	15.06	> LOQ 3.51
24606	1	49.24	G-4A	55	0.160	< LOQ 0.17	3.25	< LOQ 3.45
24620	2	48.37	G-4A	55	0.260	> LOQ 0.17	5.38	> LOQ 3.51
24573	3	48.67	G-4A	55	1.000	> LOQ 0.17	20.55	> LOQ 3.49
24505	OBZ	48.16	G-4A	55	0.390	> LOQ 0.17	8.1	> LOQ 3.53
24340	1	48.38	G-4B	56	0.064	< LOQ 0.17	1.32	< LOQ 3.51
24607	2	48.01	G-4B	56	0.330	> LOQ 0.17	6.87	> LOQ 3.54
24595	3	48.38	G-4B	56	0.640	> LOQ 0.17	13.23	> LOQ 3.51
24598	OBZ	48.42	G-4B	56	0.280	> LOQ 0.17	5.78	> LOQ 3.51
24580	1	48.44	CS-05	57	0.960	> LOQ 0.17	19.82	> LOQ 3.51
24604	2	47.93	CS-05	57	4.000	> LOQ 0.17	83.46	> LOQ 3.55

Air Sample Results - Barium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Barium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	10.000	> LOQ 0.17	209.29	> LOQ 3.56
24574	OBZ	30.41	CS-05	57	3.200	> LOQ 0.17	105.23	> LOQ 5.59
24614	1	48.58	G-5A	58	ND	< LOD 0.05	ND	< LOD 1.03
24577	2	48.18	G-5A	58	0.076	< LOQ 0.17	1.58	< LOQ 3.53
24572	3	48.05	G-5A	58	0.150	< LOQ 0.17	3.12	< LOQ 3.54
24582	OBZ	47.83	G-5A	58	0.100	< LOQ 0.17	2.09	< LOQ 3.55
24322	1	47.88	G-5B	59	ND	< LOD 0.05	ND	< LOD 1.04
24354	2	48.16	G-5B	59	0.050	< LOQ 0.17	1.04	< LOQ 3.53
24510	3	47.98	G-5B	59	0.110	< LOQ 0.17	2.29	< LOQ 3.54
24321	OBZ	47.99	G-5B	59	0.052	< LOQ 0.17	1.08	< LOQ 3.54
24497	1	48.49	CP-1A	60	0.250	> LOQ 0.17	5.16	> LOQ 3.51
24333	2	48.28	CP-1A	60	1.100	> LOQ 0.17	22.78	> LOQ 3.52
24326	3	48.19	CP-1A	60	1.600	> LOQ 0.17	33.2	> LOQ 3.53
24329	OBZ	47.74	CP-1A	60	0.850	> LOQ 0.17	17.8	> LOQ 3.56
24499	1	42.42	CP-1B	62	0.440	> LOQ 0.17	10.37	> LOQ 4.01
24506	2	42.02	CP-1B	62	0.630	> LOQ 0.17	14.99	> LOQ 4.05
24388	3	42.47	CP-1B	62	2.600	> LOQ 0.17	61.22	> LOQ 4.00
24315	OBZ	41.77	CP-1B	62	0.600	> LOQ 0.17	14.36	> LOQ 4.07
24318	1	48.56	CG-01	63	ND	< LOD 0.05	ND	< LOD 1.03
24308	2	48.00	CG-01	63	0.058	< LOQ 0.17	1.21	< LOQ 3.54
24330	3	48.47	CG-01	63	0.086	< LOQ 0.17	1.77	< LOQ 3.51
24230	OBZ	48.31	CG-01	63	0.062	< LOQ 0.17	1.28	< LOQ 3.52
24363	1	48.10	G-6A	64	0.370	> LOQ 0.17	7.69	> LOQ 3.53
24398	2	47.84	G-6A	64	2.200	> LOQ 0.17	45.99	> LOQ 3.55
24351	3	48.06	G-6A	64	2.100	> LOQ 0.17	43.7	> LOQ 3.54
24594	OBZ	48.29	G-6A	64	1.900	> LOQ 0.17	39.35	> LOQ 3.52
24312	1	48.76	G-6B	65	0.370	> LOQ 0.17	7.59	> LOQ 3.49
24484	2	47.45	G-6B	65	1.500	> LOQ 0.17	31.61	> LOQ 3.58
24327	3	48.92	G-6B	65	5.500	> LOQ 0.17	112.43	> LOQ 3.48
24389	OBZ	48.46	G-6B	65	0.870	> LOQ 0.17	17.95	> LOQ 3.51
24348	1	48.59	SG-2A	66	0.110	< LOQ 0.17	2.26	< LOQ 3.50
24314	2	47.90	SG-2A	66	0.120	< LOQ 0.17	2.51	< LOQ 3.55
24494	3	48.24	SG-2A	66	0.170	> LOQ 0.17	3.52	> LOQ 3.52
24337	OBZ	48.30	SG-2A	66	0.560	> LOQ 0.34	11.59	> LOQ 7.04
24508	1	48.47	CP-2A	67	5.100	> LOQ 0.17	105.22	> LOQ 3.51
24361	2	47.82	CP-2A	67	13.000	> LOQ 0.17	271.85	> LOQ 3.55
24359	3	48.22	CP-2A	67	76.000	> LOQ 0.34	1576.11	> LOQ 7.05
24471	OBZ	48.14	CP-2A	67	30.000	> LOQ 0.17	623.18	> LOQ 3.53
24373	1	48.41	CP-2B	68	13.000	> LOQ 0.17	268.54	> LOQ 3.51
24468	2	47.90	CP-2B	68	7.300	> LOQ 0.17	152.4	> LOQ 3.55
24481	3	48.26	CP-2B	68	29.000	> LOQ 0.17	600.91	> LOQ 3.52
24391	OBZ	47.53	CP-2B	68	6.200	> LOQ 0.17	130.44	> LOQ 3.58
24356	1	48.56	O-1	69	0.066	< LOQ 0.17	1.36	< LOQ 3.50
24470	2	47.89	O-1	69	0.190	> LOQ 0.17	3.97	> LOQ 3.55
24467	3	48.67	O-1	69	0.260	> LOQ 0.17	5.34	> LOQ 3.49
24313	OBZ	47.78	O-1	69	0.170	> LOQ 0.17	3.56	> LOQ 3.56
24501	1	47.96	CS-06	70	3.700	> LOQ 0.17	77.15	> LOQ 3.54
24496	2	47.75	CS-06	70	9.300	> LOQ 0.17	194.76	> LOQ 3.56
24478	3	48.31	CS-06	70	11.000	> LOQ 0.17	227.7	> LOQ 3.52
24503	OBZ	48.04	CS-06	70	7.000	> LOQ 0.17	145.71	> LOQ 3.54
24474	1	26.02	SG-1B	71	ND	< LOD 0.05	ND	< LOD 1.92
24469	2	26.02	SG-1B	71	ND	< LOD 0.05	ND	< LOD 1.92
24492	3	26.10	SG-1B	71	ND	< LOD 0.05	ND	< LOD 1.92

Air Sample Results - Barium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Barium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	0.550	< LOQ 0.85	20.95	< LOQ 32.38
24489	1	48.42	CP-3A	72	29.000	> LOQ 0.17	598.93	> LOQ 3.51
24491	2	47.93	CP-3A	72	70.000	> LOQ 0.17	1460.46	> LOQ 3.55
24482	3	48.35	CP-3A	72	420.000	> LOQ 0.17	8686.66	> LOQ 3.52
24486	OBZ	48.32	CP-3A	72	370.000	> LOQ 0.17	7657.28	> LOQ 3.52
24516	1	36.34	CP-3B	73	31.000	> LOQ 0.17	853.05	> LOQ 4.68
24502	2	36.02	CP-3B	73	170.000	> LOQ 0.17	4719.6	> LOQ 4.72
24515	3	36.48	CP-3B	73	240.000	> LOQ 0.17	6578.95	> LOQ 4.66
24500	OBZ	40.27	CP-3B	73	110.000	> LOQ 0.17	2731.56	> LOQ 4.22
24504	1	48.47	G-7A	74	0.053	< LOQ 0.17	1.09	< LOQ 3.51
24513	2	48.22	G-7A	74	0.230	> LOQ 0.17	4.77	> LOQ 3.53
24458	3	47.94	G-7A	74	0.360	> LOQ 0.17	7.51	> LOQ 3.55
24389	OBZ	47.75	G-7A	74	0.180	> LOQ 0.17	3.77	> LOQ 3.56
24404	1	48.68	G-7B	75	0.060	< LOQ 0.17	1.23	< LOQ 3.49
24451	2	48.06	G-7B	75	0.100	< LOQ 0.17	2.08	< LOQ 3.54
24447	3	47.16	G-7B	75	0.180	> LOQ 0.17	3.82	> LOQ 3.60
24423	OBZ	47.27	G-7B	75	0.180	> LOQ 0.17	3.81	> LOQ 3.60
24456	1	49.19	SS-06	76	1.000	> LOQ 0.17	20.33	> LOQ 3.46
24480	2	48.26	SS-06	76	2.400	> LOQ 0.17	49.73	> LOQ 3.52
24429	3	47.68	SS-06	76	0.420	> LOQ 0.17	8.81	> LOQ 3.57
24418	OBZ	47.83	SS-06	76	1.800	> LOQ 0.17	37.63	> LOQ 3.55
24427	1	48.54	CP-4A	78	26.000	> LOQ 0.17	535.64	> LOQ 3.50
24435	2	47.71	CP-4A	78	87.000	> LOQ 0.17	1823.52	> LOQ 3.56
24244	3	49.01	CP-4A	78	490.000	> LOQ 0.34	9997.96	> LOQ 6.94
24220	OBZ	48.74	CP-4A	78	99.000	> LOQ 0.17	2031.19	> LOQ 3.49
24460	1	50.05	CP-4B	79	22.000	> LOQ 0.17	439.56	> LOQ 3.40
24465	2	48.47	CP-4B	79	67.000	> LOQ 0.17	1382.3	> LOQ 3.51
24207	3	48.49	CP-4B	79	350.000	> LOQ 0.34	7217.98	> LOQ 7.01
24390	OBZ	49.02	CP-4B	79	18.000	> LOQ 0.17	367.2	> LOQ 3.47
24259	1	48.76	SS-07	80	1.000	> LOQ 0.17	20.51	> LOQ 3.49
24421	2	48.13	SS-07	80	2.800	> LOQ 0.17	58.18	> LOQ 3.53
24445	3	47.87	SS-07	80	4.000	> LOQ 0.17	83.56	> LOQ 3.55
24432	OBZ	48.49	SS-07	80	1.600	> LOQ 0.17	33	> LOQ 3.51
24459	1	48.96	N-02	81	4.000	> LOQ 0.17	81.7	> LOQ 3.47
24417	2	48.11	N-02	81	7.500	> LOQ 0.17	155.89	> LOQ 3.53
24442	3	48.01	N-02	81	33.000	> LOQ 0.17	687.36	> LOQ 3.54
24386	OBZ	48.19	N-02	81	6.500	> LOQ 0.17	134.88	> LOQ 3.53
24452	1	48.20	SG-2B	82	0.078	< LOQ 0.17	1.62	< LOQ 3.53
24453	2	48.59	SG-2B	82	0.130	< LOQ 0.17	2.68	< LOQ 3.50
24420	3	47.84	SG-2B	82	0.180	> LOQ 0.17	3.76	> LOQ 3.55
24444	OBZ	47.95	SG-2B	82	0.880	> LOQ 0.85	18.35	> LOQ 17.73
24455	1	48.56	CS-07	83	17.000	> LOQ 0.17	350.08	> LOQ 3.50
24433	2	47.96	CS-07	83	44.000	> LOQ 0.17	917.43	> LOQ 3.54
24398	3	48.06	CS-07	83	190.000	> LOQ 0.17	3953.39	> LOQ 3.54
24511	OBZ	47.96	CS-07	83	37.000	> LOQ 0.17	771.48	> LOQ 3.54
24454	1	49.34	CPDS-1A	84	6.200	> LOQ 0.17	125.66	> LOQ 3.45
24291	2	48.49	CPDS-1A	84	11.000	> LOQ 0.17	226.85	> LOQ 3.51
24209	3	48.43	CPDS-1A	84	70.000	> LOQ 0.17	1445.39	> LOQ 3.51
24402	OBZ	48.77	CPDS-1A	84	26.000	> LOQ 0.17	533.11	> LOQ 3.49
24204	1	49.46	CPDS-1B	85	7.400	> LOQ 0.17	149.62	> LOQ 3.44
24273	2	48.35	CPDS-1B	85	12.000	> LOQ 0.17	248.19	> LOQ 3.52
24223	3	48.82	CPDS-1B	85	60.000	> LOQ 0.17	1229	> LOQ 3.48
24466	OBZ	49.96	CPDS-1B	85	10.000	> LOQ 0.17	200.16	> LOQ 3.40

Airborne Sample Data Analysis - Barium

NIOSH REL 500.0 micrograms/cubic meter

OSHA PEL 500.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 1.03	1.21	< LOQ 3.54	1.77	< LOQ 3.51	1.28	< LOQ 3.52
CS-01	47.37	> LOQ 3.50	143.75	> LOQ 3.54	618.94	> LOQ 3.51	141.9	> LOQ 3.55
CS-02	58.24	> LOQ 3.54	169.31	> LOQ 3.55	666.53	> LOQ 3.54	250.05	> LOQ 3.54
CS-03	288.72	> LOQ 3.51	1263.2	> LOQ 3.52	4562.42	> LOQ 3.53	1263.2	> LOQ 3.52
CS-04	61.72	> LOQ 3.50	209.29	> LOQ 3.56	579.83	> LOQ 3.52	288.18	> LOQ 3.50
CS-05	19.82	> LOQ 3.51	83.46	> LOQ 3.55	209.29	> LOQ 3.56	105.23	> LOQ 5.59
CS-06	77.15	> LOQ 3.54	194.76	> LOQ 3.56	227.70	> LOQ 3.52	145.71	> LOQ 3.54
CS-07	350.08	> LOQ 3.50	917.43	> LOQ 3.54	3953.39	> LOQ 3.54	771.48	> LOQ 3.54
CSDS-01	29.07	> LOQ 3.53	152.05	> LOQ 3.54	456.81	> LOQ 3.53	228.83	> LOQ 3.54
CSDS-02	47.39	> LOQ 3.50	177.83	> LOQ 3.52	620.99	> LOQ 3.52	230.22	> LOQ 3.56
N-01	2.64	< LOQ 3.45	11.88	> LOQ 3.54	41.39	> LOQ 3.52	22.54	> LOQ 3.48
N-02	81.7	> LOQ 3.47	155.89	> LOQ 3.53	687.36	> LOQ 3.54	134.88	> LOQ 3.53
O-1	1.36	< LOQ 3.50	3.97	> LOQ 3.55	5.34	> LOQ 3.49	3.56	> LOQ 3.56
S-01	1.1	< LOQ 3.53	3.13	< LOQ 3.55	14.61	> LOQ 3.55	5.01	> LOQ 3.55
S-02	2	< LOQ 3.54	10.68	> LOQ 3.56	22.92	> LOQ 3.54	6.89	> LOQ 3.55
SH-01	1.42	< LOQ 3.55	3.34	< LOQ 3.55	16.38	> LOQ 3.52	2.91	< LOQ 3.54
SS-01	1.24	< LOQ 3.51	5.01	> LOQ 3.55	6.41	> LOQ 3.52	6.83	> LOQ 3.52
SS-02	8.93	> LOQ 3.53	22.94	> LOQ 3.55	39.32	> LOQ 3.52	24.68	> LOQ 3.50
SS-03	ND	< LOD 1.04	1.47	< LOQ 3.57	2.04	< LOQ 3.47	1.79	< LOQ 3.43
SS-04	8.78	> LOQ 1.04	35.58	> LOQ 3.56	46.03	> LOQ 3.56	32.93	> LOQ 3.50
SS-05	ND	< LOD 1.00	2.1	< LOQ 3.57	4.16	> LOQ 3.53	3.89	> LOQ 3.48
SS-06	20.33	> LOQ 3.46	49.73	> LOQ 3.52	8.81	> LOQ 3.57	37.63	> LOQ 3.55
SS-07	20.51	> LOQ 3.49	58.18	> LOQ 3.53	83.56	> LOQ 3.55	33	> LOQ 3.51
SSDS-01	ND	< LOD 1.03	4.18	> LOQ 3.55	5.77	> LOQ 3.51	4.97	> LOQ 3.52
SSDS-02	6.46	> LOQ 3.54	22.92	> LOQ 3.54	43.33	> LOQ 3.51	44.56	> LOQ 3.44
SSDS-03	ND	< LOD 1.01	ND	< LOD 0.99	ND	< LOD 1.00	ND	< LOD 1.04
CP-1A	5.16	> LOQ 3.51	22.78	> LOQ 3.52	33.20	> LOQ 3.53	17.8	> LOQ 3.56
CP-1B	10.37	> LOQ 4.01	14.99	> LOQ 4.05	61.22	> LOQ 4.00	14.36	> LOQ 4.07
CP-2A	105.22	> LOQ 3.51	271.85	> LOQ 3.55	1576.11	> LOQ 7.05	623.18	> LOQ 3.53
CP-2B	268.54	> LOQ 3.51	152.4	> LOQ 3.55	600.91	> LOQ 3.52	130.44	> LOQ 3.58
CP-3A	598.93	> LOQ 3.51	1460.46	> LOQ 3.55	8686.66	> LOQ 3.52	7657.28	> LOQ 3.52
CP-3B	853.05	> LOQ 4.68	4719.6	> LOQ 4.72	6578.95	> LOQ 4.66	2731.56	> LOQ 4.22
CP-4A	535.64	> LOQ 3.50	1823.52	> LOQ 3.56	9997.96	> LOQ 6.94	2031.19	> LOQ 3.49
CP-4B	439.56	> LOQ 3.40	1382.3	> LOQ 3.51	7217.98	> LOQ 7.01	367.2	> LOQ 3.47
CPDS-1A	125.66	> LOQ 3.45	226.85	> LOQ 3.51	1445.39	> LOQ 3.51	533.11	> LOQ 3.49
CPDS-1B	149.62	> LOQ 3.44	248.19	> LOQ 3.52	1229.00	> LOQ 3.48	200.16	> LOQ 3.40
G-1A	1.7	< LOQ 3.53	6.48	> LOQ 3.55	9.76	> LOQ 3.53	4.7	> LOQ 3.48
G-1B	ND	< LOD 1.04	2.32	< LOQ 3.59	3.32	< LOQ 3.53	1.93	< LOQ 3.53
G-2A	1.24	< LOQ 3.58	5.94	> LOQ 3.61	6.22	> LOQ 3.52	6.87	> LOQ 3.54
G-2B	ND	< LOD 1.02	2.28	< LOQ 3.53	1.63	< LOQ 3.56	ND	< LOD 1.03
G-3A	ND	< LOD 1.03	1.85	< LOQ 3.53	2.94	< LOQ 3.57	1.35	< LOQ 3.54
G-4A	3.25	< LOQ 3.45	5.38	> LOQ 3.51	20.55	> LOQ 3.49	8.1	> LOQ 3.53
G-4B	1.32	< LOQ 3.51	6.87	> LOQ 3.54	13.23	> LOQ 3.51	5.78	> LOQ 3.51
G-5A	ND	< LOD 1.03	1.58	< LOQ 3.53	3.12	< LOQ 3.54	2.09	< LOQ 3.55
G-5B	ND	< LOD 1.04	1.04	< LOQ 3.53	2.29	< LOQ 3.54	1.08	< LOQ 3.54
G-6A	7.69	> LOQ 3.53	45.99	> LOQ 3.55	43.70	> LOQ 3.54	39.35	> LOQ 3.52
G-6B	7.59	> LOQ 3.49	31.61	> LOQ 3.58	112.43	> LOQ 3.48	17.95	> LOQ 3.51
G-7A	1.09	< LOQ 3.51	4.77	> LOQ 3.53	7.51	> LOQ 3.55	3.77	> LOQ 3.56
G-7B	1.23	< LOQ 3.49	2.08	< LOQ 3.54	3.82	> LOQ 3.60	3.81	> LOQ 3.60
SG-1A	1.55	< LOQ 3.47	1.58	< LOQ 3.53	3.32	< LOQ 3.53	15.06	> LOQ 3.51
SG-1B	ND	< LOD 1.92	ND	< LOD 1.92	ND	< LOD 1.92	20.95	< LOQ 32.38
SG-2A	2.26	< LOQ 3.50	2.51	< LOQ 3.55	3.52	> LOQ 3.52	11.59	> LOQ 7.04
SG-2B	1.62	< LOQ 3.53	2.68	< LOQ 3.50	3.76	> LOQ 3.55	18.35	> LOQ 17.73

Bulk Elemental Analysis - Barium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Barium		Sample	Barium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.2	J95331-63 PB	0.25	< LOQ 0.67
CS-01	J95331-34 VB	270.00	> LOQ 0.67	J95331-34 PB	240.00	> LOQ 0.67
CS-02	J95331-37 VB	100.00	> LOQ 0.67	J95331-37 PB	100.00	> LOQ 0.67
CS-03	J95331-38 VB	1500.00	> LOQ 0.67	J95331-38 PB	1800.00	> LOQ 0.67
CS-04	J95331-39 VB	27.00	> LOQ 0.67	J95331-39 PB	37.00	> LOQ 0.67
CS-05	J95331-57 VB	11.00	> LOQ 0.67	J95331-57 PB	15.00	> LOQ 0.67
CS-06	J95331-70 VB	9.50	> LOQ 0.67	J95331-70 PB	19.00	> LOQ 0.67
CS-07	J95331-83 VB	67.00	> LOQ 0.67	J95331-83 PB	280.00	> LOQ 0.67
CSDS-01	J95331-31 VB	19.00	> LOQ 0.67	J95331-31 PB	40.00	> LOQ 0.67
CSDS-02	J95331-35 VB	220.00	> LOQ 0.67	J95331-35 PB	240.00	> LOQ 0.67
N-01	J95331-52 VB	4.30	> LOQ 0.67	J95331-52 PB	4.70	< LOQ 6.7
N-02	J95331-81 VB	66.00	> LOQ 0.67	J95331-81 PB	150.00	> LOQ 0.67
O-1	J95331-69 VB	1.40	> LOQ 0.67	J95331-69 PB	1.50	> LOQ 0.67
S-01	J95331-28 VB	3.50	> LOQ 0.67	J95331-28 PB	2.50	> LOQ 0.67
S-02	J95331-29 VB	4.00	> LOQ 0.67	J95331-29 PB	5.20	> LOQ 0.67
SH-01	J95331-36 VB	0.99	> LOQ 0.67	J95331-36 PB	2.50	> LOQ 0.67
SS-01	J95331-32 VB	0.65	< LOQ 0.67	J95331-32 PB	0.98	> LOQ 0.67
SS-02	J95331-40 VB	0.80	> LOQ 0.67	J95331-40 PB	2.20	> LOQ 0.67
SS-03	J95331-45 VB	ND	< LOD 0.2	J95331-45 PB	0.38	< LOQ 0.67
SS-04	J95331-47 VB	7.80	> LOQ 0.67	J95331-47 PB	0.63	< LOQ 0.67
SS-05	J95331-53 VB	ND	< LOD 0.2	J95331-53 PB	0.33	< LOQ 6.7
SS-06	J95331-76 VB	2.20	> LOQ 0.67	J95331-76 PB	4.10	> LOQ 0.67
SS-07	J95331-80 VB	3.20	> LOQ 0.67	J95331-80 PB	2.80	> LOQ 0.67
SSDS-01	J95331-33 VB	0.94	> LOQ 0.67	J95331-33 PB	0.85	> LOQ 0.67
SSDS-02	J95331-44 VB	6.60	> LOQ 0.67	J95331-44 PB	8.70	> LOQ 0.67
SSDS-03	J95331-48 VB	ND	< LOD 0.2	J95331-48 PB	0.36	< LOQ 0.67
CP-1A	J95331-60 VB	4.70	> LOQ 0.67	J95331-60 PB	14.00	> LOQ 0.67
CP-1B	J95331-61 VB	29.00	> LOQ 0.67	J95331-61 PB	40.00	> LOQ 0.67
CP-2A	J95331-67 VB	270.00	> LOQ 0.67	J95331-67 PB	390.00	> LOQ 1.3
CP-2B	J95331-68 VB	340.00	> LOQ 1.3	J95331-68 PB	350.00	> LOQ 1.3
CP-3A	J95331-72 VB	1700.00	> LOQ 0.67	J95331-72 PB	2000.00	> LOQ 0.67
CP-3B	J95331-73 VB	2300.00	> LOQ 0.67	J95331-73 PB	2000.00	> LOQ 0.67
CP-4A	J95331-78 VB	500.00	> LOQ 0.67	J95331-78 PB	960.00	> LOQ 1.3
CP-4B	J95331-79 VB	1000.00	> LOQ 0.67	J95331-79 PB	1100.00	> LOQ 0.67
CPDS-1A	J95331-84 VB	190.00	> LOQ 0.67	J95331-84 PB	320.00	> LOQ 0.67
CPDS-1B	J95331-85 VB	280.00	> LOQ 0.67	J95331-85 PB	320.00	> LOQ 0.67
G-1A	J95331-41 VB	15.00	> LOQ 0.67	J95331-41 PB	1.40	> LOQ 0.67
G-1B	J95331-46 VB	1.50	> LOQ 0.67	J95331-46 PB	1.00	> LOQ 0.67
G-2A	J95331-43 VB	1.40	> LOQ 0.67	J95331-43 PB	1.40	> LOQ 0.67
G-2B	J95331-50 VB	0.98	> LOQ 0.67	J95331-50 PB	0.34	< LOQ 0.67
G-3A	J95331-49 VB	0.70	> LOQ 0.67	J95331-49 PB	6.60	> LOQ 0.67
G-4A	J95331-55 VB	1.90	> LOQ 0.67	J95331-55 PB	3.30	> LOQ 0.67
G-4B	J95331-56 VB	4.40	> LOQ 0.67	J95331-56 PB	2.50	> LOQ 0.67
G-5A	J95331-58 VB	0.73	> LOQ 0.67	J95331-58 PB	0.70	> LOQ 0.67
G-5B	J95331-59 VB	0.39	< LOQ 0.67	J95331-59 PB	0.33	< LOQ 0.67
G-6A	J95331-64 VB	6.40	> LOQ 0.67	J95331-64 PB	33.00	> LOQ 0.67
G-6B	J95331-65 VB	19.00	> LOQ 0.67	J95331-65 PB	13.00	> LOQ 0.67
G-7A	J95331-74 VB	0.22	< LOQ 0.67	J95331-74 PB	0.34	< LOQ 0.67
G-7B	J95331-75 VB	0.65	< LOQ 0.67	J95331-75 PB	0.42	< LOQ 0.67
SG-1A	J95331-54 VB	4.40	> LOQ 3.4	J95331-54 PB	4.70	> LOQ 3.4
SG-1B	J95331-71 VB	3.50	> LOQ 3.4	J95331-71 PB	3.60	> LOQ 3.4
SG-2A	J95331-66 VB	3.30	< LOQ 3.4	J95331-66 PB	2.40	> LOQ 3.4
SG-2B	J95331-82 VB	4.80	> LOQ 3.4	J95331-82 PB	3.40	> LOQ 3.4

Comparison of Airborne Concentrations to Bulk Concentrations - Barium

NIOSH REL 500.0 micrograms/cubic meter
OSHA PEL 500.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	1.21	1.77	1.28	ND
CS-01	47.37	143.75	618.94	141.90	270.00
CS-02	58.24	169.31	666.53	250.05	100.00
CS-03	288.72	1263.20	4562.42	1263.20	1500.00
CS-04	61.72	209.29	579.83	288.18	27.00
CS-05	19.82	83.46	209.29	105.23	11.00
CS-06	77.15	194.76	227.70	145.71	9.50
CS-07	350.08	917.43	3953.39	771.48	67.00
CSDS-01	29.07	152.05	456.81	228.83	19.00
CSDS-02	47.39	177.83	620.99	230.22	220.00
N-01	2.64	11.88	41.39	22.54	4.30
N-02	81.70	155.89	687.36	134.88	66.00
O-1	1.36	3.97	5.34	3.56	1.40
S-01	1.10	3.13	14.61	5.01	3.50
S-02	2.00	10.68	22.92	6.89	4.00
SH-01	1.42	3.34	16.38	2.91	0.99
SS-01	1.24	5.01	6.41	6.83	0.65
SS-02	8.93	22.94	39.32	24.68	0.80
SS-03	ND	1.47	2.04	1.79	ND
SS-04	8.78	35.58	46.03	32.93	7.80
SS-05	ND	2.10	4.16	3.89	ND
SS-06	20.33	49.73	8.81	37.63	2.20
SS-07	20.51	58.18	83.56	33.00	3.20
SSDS-01	ND	4.18	5.77	4.97	0.94
SSDS-02	6.46	22.92	43.33	44.56	6.60
SSDS-03	ND	ND	ND	ND	ND
CP-1A	5.16	22.78	33.20	17.80	4.70
CP-2A	105.22	271.85	1576.11	623.18	270.00
CP-3A	598.93	1460.46	8686.66	7657.28	1700.00
CP-4A	535.64	1823.52	9997.96	2031.19	500.00
CPDS-1A	125.66	226.85	1445.39	533.11	190.00
G-1A	1.70	6.48	9.76	4.70	15.00
G-2A	1.24	5.94	6.22	6.87	1.40
G-3A	ND	1.85	2.94	1.35	0.70
G-4A	3.25	5.38	20.55	8.10	1.90
G-5A	ND	1.58	3.12	2.09	0.73
G-6A	7.69	45.99	43.70	39.35	6.40
G-7A	1.09	4.77	7.51	3.77	0.22
SG-1A	1.55	1.58	3.32	15.06	4.40
SG-2A	2.26	2.51	3.52	11.59	3.30

APPENDIX B - BERYLLIUM

Beryllium

Inhalation of beryllium may result in rhinitis, tracheobronchitis, pneumonitis, and death due to pulmonary edema or heart failure. Beryllium has been associated with damage to the kidney, liver, spleen and heart, and an increased incidence of lung cancer. The NIOSH REL and OSHA PEL for beryllium are 0.50 and 2.0 micrograms/cubic meter of air, respectively.

Beryllium is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

For the past 20 plus years, NIOSH has subscribed to a carcinogen policy that was published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, which called for "no detectable exposure levels for proven carcinogenic substances [New York Academy of Sciences Annals 1976]." This was in response to a generic OSHA rulemaking on carcinogens.

Because of advances in science and in approaches to risk assessment and risk management, NIOSH has in more recent years adopted a more inclusive policy. NIOSH RELs will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will protect not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy for potential occupational carcinogens will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL. Under the old policy for potential occupational carcinogens, RELs for most carcinogens were non-quantitative values labeled "lowest feasible concentration (LFC)." In 1989, NIOSH adopted several quantitative RELs for carcinogens from OSHA's PEL update. NIOSH will also recommend the complete range of respirators (as determined by the NIOSH Respirator Decision Logic) for carcinogens with quantitative RELs. In this way, respirators will be consistently recommended regardless of whether a substance is a carcinogen or a non-carcinogen.

Air Sample Results - Beryllium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Beryllium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.003	ND	< LOD 0.062
24412	2	47.89	S-01	28	ND	< LOD 0.003	ND	< LOD 0.063
24441	3	47.90	S-01	28	0.0140	> LOQ 0.0084	0.292	> LOQ 0.175
24450	OBZ	47.93	S-01	28	ND	< LOD 0.003	ND	< LOD 0.063
24643	1	47.98	S-02	29	ND	< LOD 0.003	ND	< LOD 0.063
24625	2	47.76	S-02	29	0.0055	< LOQ 0.0084	0.115	< LOQ 0.176
24642	3	48.00	S-02	29	0.0067	< LOQ 0.0086	0.14	< LOQ 0.179
24632	OBZ	47.89	S-02	29	ND	< LOD 0.003	ND	< LOD 0.063
24634	1	48.16	CSDS-01	31	0.0170	> LOQ 0.0084	0.353	> LOQ 0.174
24650	2	48.01	CSDS-01	31	0.1100	> LOQ 0.0086	2.291	> LOQ 0.179
24644	3	48.16	CSDS-01	31	0.3600	> LOQ 0.043	7.475	> LOQ 0.893
24645	OBZ	48.07	CSDS-01	31	0.2100	> LOQ 0.0086	4.369	> LOQ 0.179
24640	1	48.44	SS-01	32	ND	< LOD 0.003	ND	< LOD 0.062
24641	2	47.90	SS-01	32	0.0033	< LOQ 0.0086	0.069	< LOQ 0.180
24651	3	48.35	SS-01	32	ND	< LOD 0.003	ND	< LOD 0.062
24635	OBZ	48.30	SS-01	32	0.0047	< LOQ 0.0086	0.097	< LOQ 0.178
24646	1	48.58	SSDS-01	33	0.0057	< LOQ 0.0086	0.117	< LOQ 0.177
24626	2	47.84	SSDS-01	33	ND	< LOD 0.003	ND	< LOD 0.063
24638	3	48.49	SSDS-01	33	ND	< LOD 0.003	ND	< LOD 0.062
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.003	ND	< LOD 0.062
24628	1	48.55	CS-01	34	0.0300	> LOQ 0.0084	0.618	> LOQ 0.173
24637	2	48.00	CS-01	34	0.1100	> LOQ 0.0086	2.292	> LOQ 0.179
24624	3	48.47	CS-01	34	0.4900	> LOQ 0.042	10.109	> LOQ 0.867
24636	OBZ	47.92	CS-01	34	0.0920	> LOQ 0.0086	1.92	> LOQ 0.179
24623	1	48.53	CSDS-02	35	0.0320	> LOQ 0.0084	0.659	> LOQ 0.173
24622	2	48.36	CSDS-02	35	0.1200	> LOQ 0.0084	2.481	> LOQ 0.174
24654	3	48.31	CSDS-02	35	0.1900	> LOQ 0.0086	3.933	> LOQ 0.178
24653	OBZ	47.78	CSDS-02	35	0.1700	> LOQ 0.0086	3.558	> LOQ 0.180
24629	1	47.88	SH-01	36	ND	< LOD 0.003	ND	< LOD 0.063
24633	2	47.86	SH-01	36	ND	< LOD 0.003	ND	< LOD 0.063
24627	3	48.24	SH-01	36	0.0210	> LOQ 0.0084	0.435	> LOQ 0.174
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.003	ND	< LOD 0.062
24555	1	48.08	CS-02	37	0.0360	> LOQ 0.0084	0.749	> LOQ 0.175
24552	2	47.84	CS-02	37	0.1400	> LOQ 0.0084	2.926	> LOQ 0.176
24541	3	48.01	CS-02	37	0.6900	> LOQ 0.042	14.372	> LOQ 0.875
24529	OBZ	47.99	CS-02	37	0.1700	> LOQ 0.015	3.542	> LOQ 0.313
24558	1	48.49	CS-03	38	0.0170	> LOQ 0.0084	0.351	> LOQ 0.173
24524	2	48.29	CS-03	38	0.1000	> LOQ 0.015	2.071	> LOQ 0.311
24561	3	48.22	CS-03	38	0.2300	> LOQ 0.0084	4.77	> LOQ 0.174
24559	OBZ	48.29	CS-03	38	0.0880	> LOQ 0.0084	1.822	> LOQ 0.174
24543	1	48.61	CS-04	39	0.0094	> LOQ 0.0084	0.193	> LOQ 0.173
24532	2	47.78	CS-04	39	0.0460	> LOQ 0.015	0.963	> LOQ 0.314
24546	3	48.29	CS-04	39	0.1300	> LOQ 0.0084	2.692	> LOQ 0.174
24557	OBZ	48.58	CS-04	39	0.0510	> LOQ 0.0084	1.05	> LOQ 0.173
24560	1	48.13	SS-02	40	ND	< LOD 0.003	ND	< LOD 0.062
24565	2	47.95	SS-02	40	ND	< LOD 0.003	ND	< LOD 0.063
24630	3	48.32	SS-02	40	ND	< LOD 0.003	ND	< LOD 0.062
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.003	ND	< LOD 0.062
24525	1	48.13	G-1A	41	ND	< LOD 0.005	ND	< LOD 0.104
24563	2	47.87	G-1A	41	ND	< LOD 0.003	ND	< LOD 0.063
24547	3	48.17	G-1A	41	0.0032	< LOQ 0.0084	0.066	< LOQ 0.174
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.005	ND	< LOD 0.102
24538	1	47.45	G-2A	43	ND	< LOD 0.005	ND	< LOD 0.105

Air Sample Results - Beryllium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Beryllium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	0.0067	< LOQ 0.0084	0.142	< LOQ 0.178
24533	3	48.24	G-2A	43	0.0120	< LOQ 0.015	0.249	< LOQ 0.311
24540	OBZ	48.04	G-2A	43	0.0056	< LOQ 0.0084	0.117	< LOQ 0.175
24528	1	47.99	SSDS-02	44	ND	< LOD 0.005	ND	< LOD 0.104
24544	2	48.00	SSDS-02	44	0.0068	< LOQ 0.0084	0.142	< LOQ 0.175
24567	3	48.46	SSDS-02	44	0.0150	> LOQ 0.0084	0.31	> LOQ 0.173
24539	OBZ	49.37	SSDS-02	44	0.0069	< LOQ 0.0084	0.14	< LOQ 0.170
24571	1	48.05	SS-03	45	ND	< LOD 0.003	ND	< LOD 0.062
24536	2	47.60	SS-03	45	ND	< LOD 0.005	ND	< LOD 0.105
24534	3	48.94	SS-03	45	ND	< LOD 0.005	ND	< LOD 0.102
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.003	ND	< LOD 0.060
24568	1	48.28	G-1B	46	ND	< LOD 0.003	ND	< LOD 0.062
24592	2	47.38	G-1B	46	ND	< LOD 0.003	ND	< LOD 0.063
24593	3	48.17	G-1B	46	ND	< LOD 0.003	ND	< LOD 0.062
24535	OBZ	48.22	G-1B	46	ND	< LOD 0.003	ND	< LOD 0.062
24590	1	47.81	SS-04	47	0.0039	< LOQ 0.0084	0.082	< LOQ 0.176
24605	2	47.78	SS-04	47	0.0140	> LOQ 0.0084	0.293	> LOQ 0.176
24562	3	47.80	SS-04	47	0.0170	> LOQ 0.009	0.356	> LOQ 0.188
24531	OBZ	48.59	SS-04	47	0.0100	> LOQ 0.009	0.206	> LOQ 0.185
24527	1	49.48	SSDS-03	48	ND	< LOD 0.003	ND	< LOD 0.061
24569	2	50.35	SSDS-03	48	ND	< LOD 0.003	ND	< LOD 0.060
24584	3	50.24	SSDS-03	48	ND	< LOD 0.003	ND	< LOD 0.060
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.003	ND	< LOD 0.062
24600	1	48.34	G-3A	49	ND	< LOD 0.003	ND	< LOD 0.062
24616	2	48.11	G-3A	49	0.0033	< LOQ 0.0084	0.069	< LOQ 0.175
24585	3	47.65	G-3A	49	0.0042	< LOQ 0.009	0.088	< LOQ 0.189
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.003	ND	< LOD 0.063
24587	1	48.79	G-2B	50	ND	< LOD 0.003	ND	< LOD 0.061
24602	2	48.17	G-2B	50	0.0034	< LOQ 0.0084	0.071	< LOQ 0.174
24564	3	47.81	G-2B	50	ND	< LOD 0.003	ND	< LOD 0.063
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.003	ND	< LOD 0.062
24618	1	49.21	N-01	52	ND	< LOD 0.003	ND	< LOD 0.061
24611	2	47.96	N-01	52	ND	< LOD 0.003	ND	< LOD 0.063
24588	3	48.32	N-01	52	0.0051	< LOQ 0.0084	0.106	< LOQ 0.174
24615	OBZ	48.80	N-01	52	ND	< LOD 0.003	ND	< LOD 0.061
24597	1	49.78	SS-05	53	ND	< LOD 0.003	ND	< LOD 0.060
24599	2	47.68	SS-05	53	0.0063	< LOQ 0.0084	0.132	< LOQ 0.176
24575	3	48.11	SS-05	53	0.0130	> LOQ 0.009	0.27	> LOQ 0.187
24617	OBZ	48.79	SS-05	53	0.0090	> LOQ 0.0084	0.184	> LOQ 0.172
24609	1	48.98	SG-1A	54	ND	< LOD 0.003	ND	< LOD 0.061
24596	2	48.20	SG-1A	54	ND	< LOD 0.003	ND	< LOD 0.062
24610	3	48.18	SG-1A	54	ND	< LOD 0.003	ND	< LOD 0.062
24576	OBZ	48.47	SG-1A	54	ND	< LOD 0.003	ND	< LOD 0.062
24606	1	49.24	G-4A	55	0.0099	> LOQ 0.0084	0.201	> LOQ 0.171
24620	2	48.37	G-4A	55	0.0250	> LOQ 0.0084	0.517	> LOQ 0.174
24573	3	48.67	G-4A	55	0.0620	> LOQ 0.009	1.274	> LOQ 0.185
24505	OBZ	48.16	G-4A	55	0.0250	> LOQ 0.009	0.519	> LOQ 0.187
24340	1	48.38	G-4B	56	0.0130	> LOQ 0.0084	0.269	> LOQ 0.174
24607	2	48.01	G-4B	56	0.0370	> LOQ 0.010	0.771	> LOQ 0.208
24595	3	48.38	G-4B	56	0.0350	> LOQ 0.010	0.723	> LOQ 0.207
24598	OBZ	48.42	G-4B	56	0.0270	> LOQ 0.010	0.558	> LOQ 0.207
24580	1	48.44	CS-05	57	0.0150	> LOQ 0.010	0.31	> LOQ 0.206
24604	2	47.93	CS-05	57	0.0680	> LOQ 0.010	1.419	> LOQ 0.209

Air Sample Results - Beryllium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Beryllium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	0.1600	> LOQ 0.0084	3.349	> LOQ 0.176
24574	OBZ	30.41	CS-05	57	0.0570	> LOQ 0.010	1.874	> LOQ 0.329
24614	1	48.58	G-5A	58	0.0032	< LOQ 0.010	0.066	< LOQ 0.206
24577	2	48.18	G-5A	58	0.0061	< LOQ 0.010	0.127	< LOQ 0.208
24572	3	48.05	G-5A	58	ND	< LOD 0.003	ND	< LOD 0.062
24582	OBZ	47.83	G-5A	58	0.0046	< LOQ 0.010	0.096	< LOQ 0.209
24322	1	47.88	G-5B	59	ND	< LOD 0.003	ND	< LOD 0.063
24354	2	48.16	G-5B	59	0.0053	< LOQ 0.0084	0.11	< LOQ 0.174
24510	3	47.98	G-5B	59	0.0093	< LOQ 0.010	0.194	< LOQ 0.208
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.003	ND	< LOD 0.063
24497	1	48.49	CP-1A	60	0.0190	> LOQ 0.010	0.392	> LOQ 0.206
24333	2	48.28	CP-1A	60	0.0088	> LOQ 0.0084	0.182	> LOQ 0.174
24326	3	48.19	CP-1A	60	0.0110	> LOQ 0.0084	0.228	> LOQ 0.174
24329	OBZ	47.74	CP-1A	60	0.0060	< LOQ 0.0084	0.126	< LOQ 0.176
24499	1	42.42	CP-1B	62	0.0080	< LOQ 0.010	0.189	< LOQ 0.236
24506	2	42.02	CP-1B	62	0.0950	> LOQ 0.010	2.261	> LOQ 0.238
24388	3	42.47	CP-1B	62	0.0140	> LOQ 0.0084	0.33	> LOQ 0.198
24315	OBZ	41.77	CP-1B	62	ND	< LOD 0.003	ND	< LOD 0.072
24318	1	48.56	CG-01	63	ND	< LOD 0.003	ND	< LOD 0.062
24308	2	48.00	CG-01	63	0.0048	< LOQ 0.0084	0.1	< LOQ 0.175
24330	3	48.47	CG-01	63	0.0061	< LOQ 0.0084	0.126	< LOQ 0.173
24230	OBZ	48.31	CG-01	63	0.0038	< LOQ 0.0084	0.079	< LOQ 0.174
24363	1	48.10	G-6A	64	0.0046	< LOQ 0.0084	0.096	< LOQ 0.175
24398	2	47.84	G-6A	64	0.0110	> LOQ 0.010	0.23	> LOQ 0.209
24351	3	48.06	G-6A	64	0.1100	> LOQ 0.0084	2.289	> LOQ 0.175
24594	OBZ	48.29	G-6A	64	0.0870	> LOQ 0.010	1.802	> LOQ 0.207
24312	1	48.76	G-6B	65	0.0063	< LOQ 0.0084	0.129	< LOQ 0.172
24484	2	47.45	G-6B	65	0.0073	< LOQ 0.010	0.154	< LOQ 0.211
24327	3	48.92	G-6B	65	0.0087	> LOQ 0.0084	0.178	> LOQ 0.172
24389	OBZ	48.46	G-6B	65	0.0260	> LOQ 0.010	0.537	> LOQ 0.206
24348	1	48.59	SG-2A	66	0.0250	> LOQ 0.0084	0.515	> LOQ 0.173
24314	2	47.90	SG-2A	66	0.0096	> LOQ 0.0084	0.2	> LOQ 0.175
24494	3	48.24	SG-2A	66	ND	< LOD 0.003	ND	< LOD 0.062
24337	OBZ	48.30	SG-2A	66	0.0170	> LOQ 0.0084	0.352	> LOQ 0.174
24508	1	48.47	CP-2A	67	0.0080	> LOQ 0.0070	0.165	> LOQ 0.144
24361	2	47.82	CP-2A	67	0.0390	> LOQ 0.010	0.816	> LOQ 0.209
24359	3	48.22	CP-2A	67	0.1900	> LOQ 0.020	3.94	> LOQ 0.415
24471	OBZ	48.14	CP-2A	67	0.0790	> LOQ 0.0054	1.641	> LOQ 0.112
24373	1	48.41	CP-2B	68	0.0320	> LOQ 0.010	0.661	> LOQ 0.207
24468	2	47.90	CP-2B	68	0.0160	> LOQ 0.007	0.334	> LOQ 0.146
24481	3	48.26	CP-2B	68	0.0790	> LOQ 0.0054	1.637	> LOQ 0.112
24391	OBZ	47.53	CP-2B	68	0.0130	> LOQ 0.0084	0.274	> LOQ 0.177
24356	1	48.56	O-1	69	ND	< LOD 0.0003	ND	< LOD 0.006
24470	2	47.89	O-1	69	ND	< LOD 0.002	ND	< LOD 0.042
24467	3	48.67	O-1	69	0.0041	< LOQ 0.0054	0.084	< LOQ 0.111
24313	OBZ	47.78	O-1	69	0.0058	< LOQ 0.010	0.121	< LOQ 0.209
24501	1	47.96	CS-06	70	0.0540	> LOQ 0.0054	1.126	> LOQ 0.113
24496	2	47.75	CS-06	70	0.1400	> LOQ 0.0054	2.932	> LOQ 0.113
24478	3	48.31	CS-06	70	0.1800	> LOQ 0.0054	3.726	> LOQ 0.112
24503	OBZ	48.04	CS-06	70	0.0540	> LOQ 0.0070	1.124	> LOQ 0.146
24474	1	26.02	SG-1B	71	ND	< LOD 0.002	ND	< LOD 0.077
24469	2	26.02	SG-1B	71	ND	< LOD 0.002	ND	< LOD 0.077
24492	3	26.10	SG-1B	71	ND	< LOD 0.002	ND	< LOD 0.077

Air Sample Results - Beryllium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Beryllium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 0.002	ND	< LOD 0.076
24489	1	48.42	CP-3A	72	0.0240	> LOQ 0.0054	0.496	> LOQ 0.112
24491	2	47.93	CP-3A	72	0.0570	> LOQ 0.0054	1.189	> LOQ 0.113
24482	3	48.35	CP-3A	72	0.3100	> LOQ 0.11	6.412	> LOQ 2.275
24486	OBZ	48.32	CP-3A	72	0.2700	> LOQ 0.054	5.588	> LOQ 1.118
24516	1	36.34	CP-3B	73	0.0190	> LOQ 0.0054	0.523	> LOQ 0.149
24502	2	36.02	CP-3B	73	0.1200	> LOQ 0.0070	3.331	> LOQ 0.194
24515	3	36.48	CP-3B	73	0.2100	> LOQ 0.0070	5.757	> LOQ 0.192
24500	OBZ	40.27	CP-3B	73	0.1000	> LOQ 0.0054	2.483	> LOQ 0.134
24504	1	48.47	G-7A	74	ND	< LOD 0.002	ND	< LOD 0.041
24513	2	48.22	G-7A	74	ND	< LOD 0.002	ND	< LOD 0.041
24458	3	47.94	G-7A	74	ND	< LOQ 0.002	ND	< LOD 0.042
24389	OBZ	47.75	G-7A	74	0.0110	> LOQ 0.0084	0.23	> LOQ 0.176
24404	1	48.68	G-7B	75	0.0040	< LOQ 0.0084	0.082	< LOQ 0.173
24451	2	48.06	G-7B	75	ND	< LOD 0.003	ND	< LOD 0.062
24447	3	47.16	G-7B	75	ND	< LOD 0.003	ND	< LOD 0.064
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.003	ND	< LOD 0.063
24456	1	49.19	SS-06	76	0.0069	< LOQ 0.0089	0.14	< LOQ 0.181
24480	2	48.26	SS-06	76	0.0071	> LOQ 0.0054	0.147	> LOQ 0.112
24429	3	47.68	SS-06	76	0.0140	> LOQ 0.0084	0.294	> LOQ 0.176
24418	OBZ	47.83	SS-06	76	0.0066	< LOQ 0.0084	0.138	< LOQ 0.176
24427	1	48.54	CP-4A	78	0.0340	> LOQ 0.0084	0.7	> LOQ 0.173
24435	2	47.71	CP-4A	78	0.0500	> LOQ 0.0084	1.048	> LOQ 0.176
24244	3	49.01	CP-4A	78	0.3000	> LOQ 0.020	6.121	> LOQ 0.408
24220	OBZ	48.74	CP-4A	78	0.0440	> LOQ 0.017	0.903	> LOQ 0.349
24460	1	50.05	CP-4B	79	0.0130	> LOQ 0.007	0.26	> LOQ 0.140
24465	2	48.47	CP-4B	79	0.0420	> LOQ 0.007	0.867	> LOQ 0.144
24207	3	48.49	CP-4B	79	0.2000	> LOQ 0.017	4.125	> LOQ 0.351
24390	OBZ	49.02	CP-4B	79	0.0110	> LOQ 0.0084	0.224	> LOQ 0.171
24259	1	48.76	SS-07	80	0.0056	< LOQ 0.010	0.115	< LOQ 0.205
24421	2	48.13	SS-07	80	0.0067	< LOQ 0.0084	0.139	< LOQ 0.175
24445	3	47.87	SS-07	80	0.0140	> LOQ 0.0084	0.292	> LOQ 0.175
24432	OBZ	48.49	SS-07	80	0.0043	< LOQ 0.0084	0.089	< LOQ 0.173
24459	1	48.96	N-02	81	0.0085	> LOQ 0.007	0.174	> LOQ 0.143
24417	2	48.11	N-02	81	0.0170	> LOQ 0.0084	0.353	> LOQ 0.175
24442	3	48.01	N-02	81	0.0830	> LOQ 0.0084	1.729	> LOQ 0.175
24386	OBZ	48.19	N-02	81	0.0240	> LOQ 0.0084	0.498	> LOQ 0.174
24452	1	48.20	SG-2B	82	ND	< LOD 0.003	ND	< LOD 0.062
24453	2	48.59	SG-2B	82	ND	< LOD 0.003	ND	< LOD 0.062
24420	3	47.84	SG-2B	82	ND	< LOD 0.003	ND	< LOD 0.063
24444	OBZ	47.95	SG-2B	82	ND	< LOD 0.003	ND	< LOD 0.063
24455	1	48.56	CS-07	83	0.0940	> LOQ 0.0089	1.936	> LOQ 0.183
24433	2	47.96	CS-07	83	0.3000	> LOQ 0.084	6.255	> LOQ 1.751
24398	3	48.06	CS-07	83	1.2000	> LOQ 0.084	24.969	> LOQ 1.748
24511	OBZ	47.96	CS-07	83	0.1900	> LOQ 0.0070	3.962	> LOQ 0.146
24454	1	49.34	CPDS-1A	84	0.0150	> LOQ 0.0089	0.304	> LOQ 0.180
24291	2	48.49	CPDS-1A	84	0.0270	> LOQ 0.010	0.557	> LOQ 0.206
24209	3	48.43	CPDS-1A	84	0.1400	> LOQ 0.017	2.891	> LOQ 0.351
24402	OBZ	48.77	CPDS-1A	84	0.0150	> LOQ 0.0084	0.308	> LOQ 0.172
24204	1	49.46	CPDS-1B	85	0.0120	< LOQ 0.017	0.243	< LOQ 0.344
24273	2	48.35	CPDS-1B	85	0.0300	> LOQ 0.010	0.62	> LOQ 0.207
24223	3	48.82	CPDS-1B	85	0.1200	> LOQ 0.010	2.458	> LOQ 0.205
24466	OBZ	49.96	CPDS-1B	85	0.0250	> LOQ 0.007	0.5	> LOQ 0.140

Airborne Sample Data Analysis - Beryllium

NIOSH REL 0.50 micrograms/cubic meter
OSHA PEL 2.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 0.062	0.1	< LOQ 0.175	0.13	< LOQ 0.173	0.079	< LOQ 0.174
CS-01	0.618	> LOQ 0.173	2.292	> LOQ 0.179	10.11	> LOQ 0.867	1.92	> LOQ 0.179
CS-02	0.749	> LOQ 0.175	2.926	> LOQ 0.176	14.37	> LOQ 0.875	3.542	> LOQ 0.313
CS-03	0.351	> LOQ 0.173	2.071	> LOQ 0.311	4.77	> LOQ 0.174	1.822	> LOQ 0.174
CS-04	0.193	> LOQ 0.173	0.963	> LOQ 0.314	2.69	> LOQ 0.174	1.05	> LOQ 0.173
CS-05	0.31	> LOQ 0.206	1.419	> LOQ 0.209	3.35	> LOQ 0.176	1.874	> LOQ 0.329
CS-06	1.126	> LOQ 0.113	2.932	> LOQ 0.113	3.73	> LOQ 0.112	1.124	> LOQ 0.146
CS-07	1.936	> LOQ 0.183	6.255	> LOQ 1.751	24.97	> LOQ 1.748	3.962	> LOQ 0.146
CSDS-01	0.353	> LOQ 0.174	2.291	> LOQ 0.179	7.48	> LOQ 0.893	4.369	> LOQ 0.179
CSDS-02	0.659	> LOQ 0.173	2.481	> LOQ 0.174	3.93	> LOQ 0.178	3.558	> LOQ 0.180
N-01	ND	< LOD 0.061	ND	< LOD 0.063	0.11	< LOQ 0.174	ND	< LOD 0.061
N-02	0.174	> LOQ 0.143	0.353	> LOQ 0.175	1.73	> LOQ 0.175	0.498	> LOQ 0.174
O-1	ND	< LOD 0.006	ND	< LOD 0.042	0.08	< LOQ 0.111	0.121	< LOQ 0.209
S-01	ND	< LOD 0.062	ND	< LOD 0.063	0.29	> LOQ 0.175	ND	< LOD 0.063
S-02	ND	< LOD 0.063	0.115	< LOQ 0.176	0.14	< LOQ 0.179	ND	< LOD 0.063
SH-01	ND	< LOD 0.063	ND	< LOD 0.063	0.44	> LOQ 0.174	ND	< LOD 0.062
SS-01	ND	< LOD 0.062	0.069	< LOQ 0.180	ND	< LOD 0.062	0.097	< LOQ 0.178
SS-02	ND	< LOD 0.062	ND	< LOD 0.063	ND	< LOD 0.062	ND	< LOD 0.062
SS-03	ND	< LOD 0.062	ND	< LOD 0.105	ND	< LOD 0.102	ND	< LOD 0.060
SS-04	0.082	< LOQ 0.176	0.293	> LOQ 0.176	0.36	> LOQ 0.188	0.206	> LOQ 0.185
SS-05	ND	< LOD 0.060	0.132	< LOQ 0.176	0.27	> LOQ 0.187	0.184	> LOQ 0.172
SS-06	0.14	< LOQ 0.181	0.147	> LOQ 0.112	0.29	> LOQ 0.176	0.138	< LOQ 0.176
SS-07	0.115	< LOQ 0.205	0.139	< LOQ 0.175	0.29	> LOQ 0.175	0.089	< LOQ 0.173
SSDS-01	0.117	< LOQ 0.177	ND	< LOD 0.063	ND	< LOD 0.062	ND	< LOD 0.062
SSDS-02	ND	< LOD 0.104	0.142	< LOQ 0.175	0.31	> LOQ 0.173	0.14	< LOQ 0.170
SSDS-03	ND	< LOD 0.061	ND	< LOD 0.060	ND	< LOD 0.060	ND	< LOD 0.062
CP-1A	0.392	> LOQ 0.206	0.182	> LOQ 0.174	0.23	> LOQ 0.174	0.126	< LOQ 0.176
CP-1B	0.189	< LOQ 0.236	2.261	> LOQ 0.238	0.33	> LOQ 0.198	ND	< LOD 0.072
CP-2A	0.165	> LOQ 0.144	0.816	> LOQ 0.209	3.94	> LOQ 0.415	1.641	> LOQ 0.112
CP-2B	0.661	> LOQ 0.207	0.334	> LOQ 0.146	1.64	> LOQ 0.112	0.274	> LOQ 0.177
CP-3A	0.496	> LOQ 0.112	1.189	> LOQ 0.113	6.41	> LOQ 2.275	5.588	> LOQ 1.118
CP-3B	0.523	> LOQ 0.149	3.331	> LOQ 0.194	5.76	> LOQ 0.192	2.483	> LOQ 0.134
CP-4A	0.7	> LOQ 0.173	1.048	> LOQ 0.176	6.12	> LOQ 0.408	0.903	> LOQ 0.349
CP-4B	0.26	> LOQ 0.140	0.867	> LOQ 0.144	4.13	> LOQ 0.351	0.224	> LOQ 0.171
CPDS-1A	0.304	> LOQ 0.180	0.557	> LOQ 0.206	2.89	> LOQ 0.351	0.308	> LOQ 0.172
CPDS-1B	0.243	< LOQ 0.344	0.62	> LOQ 0.207	2.46	> LOQ 0.205	0.5	> LOQ 0.140
G-1A	ND	< LOD 0.104	ND	< LOD 0.063	0.07	< LOQ 0.174	ND	< LOD 0.102
G-1B	ND	< LOD 0.062	ND	< LOD 0.063	ND	< LOD 0.062	ND	< LOD 0.062
G-2A	ND	< LOD 0.105	0.142	< LOQ 0.178	0.25	< LOQ 0.311	0.117	< LOQ 0.175
G-2B	ND	< LOD 0.061	0.071	< LOQ 0.174	ND	< LOD 0.063	ND	< LOD 0.062
G-3A	ND	< LOD 0.062	0.069	< LOQ 0.175	0.09	< LOQ 0.189	ND	< LOD 0.063
G-4A	0.201	> LOQ 0.171	0.517	> LOQ 0.174	1.27	> LOQ 0.185	0.519	> LOQ 0.187
G-4B	0.269	> LOQ 0.174	0.771	> LOQ 0.208	0.72	> LOQ 0.207	0.558	> LOQ 0.207
G-5A	0.066	< LOQ 0.206	0.127	< LOQ 0.208	ND	< LOD 0.062	0.096	< LOQ 0.209
G-5B	ND	< LOD 0.063	0.11	< LOQ 0.174	0.19	< LOQ 0.208	ND	< LOD 0.063
G-6A	0.096	< LOQ 0.175	0.23	> LOQ 0.209	2.29	> LOQ 0.175	1.802	> LOQ 0.207
G-6B	0.129	< LOQ 0.172	0.154	< LOQ 0.211	0.18	> LOQ 0.172	0.537	> LOQ 0.206
G-7A	ND	< LOD 0.041	ND	< LOD 0.041	ND	< LOD 0.042	0.23	> LOQ 0.176
G-7B	0.082	< LOQ 0.173	ND	< LOD 0.062	ND	< LOD 0.064	ND	< LOD 0.063
SG-1A	ND	< LOD 0.061	ND	< LOD 0.062	ND	< LOD 0.062	ND	< LOD 0.062
SG-1B	ND	< LOD 0.077	ND	< LOD 0.077	ND	< LOD 0.077	ND	< LOD 0.076
SG-2A	0.515	> LOQ 0.173	0.2	> LOQ 0.175	ND	< LOD 0.062	0.352	> LOQ 0.174
SG-2B	ND	< LOD 0.062	ND	< LOD 0.062	ND	< LOD 0.063	ND	< LOD 0.063

Bulk Elemental Analysis - Beryllium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Beryllium		Sample	Beryllium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.03	J95331-63 PB	ND	< LOD 0.03
CS-01	J95331-34 VB	5.70	> LOQ 0.86	J95331-34 PB	5.20	> LOQ 0.86
CS-02	J95331-37 VB	3.70	> LOQ 0.86	J95331-37 PB	4.40	> LOQ 0.043
CS-03	J95331-38 VB	3.20	> LOQ 0.043	J95331-38 PB	3.20	> LOQ 0.043
CS-04	J95331-39 VB	0.33	> LOQ 0.043	J95331-39 PB	0.37	> LOQ 0.043
CS-05	J95331-57 VB	0.28	> LOQ 0.071	J95331-57 PB	0.57	> LOQ 0.071
CS-06	J95331-70 VB	0.58	> LOQ 0.069	J95331-70 PB	0.93	> LOQ 0.069
CS-07	J95331-83 VB	6.30	> LOQ 0.023	J95331-83 PB	3.70	> LOQ 0.12
CSDS-01	J95331-31 VB	0.78	> LOQ .043	J95331-31 PB	1.50	> LOQ 0.22
CSDS-02	J95331-35 VB	3.90	> LOQ .043	J95331-35 PB	4.70	> LOQ .043
N-01	J95331-52 VB	0.05	> LOQ 0.034	J95331-52 PB	0.04	> LOQ 0.034
N-02	J95331-81 VB	0.28	> LOQ 0.023	J95331-81 PB	0.46	> LOQ 0.023
O-1	J95331-69 VB	ND	< LOD 0.02	J95331-69 PB	ND	< LOD 0.02
S-01	J95331-28 VB	0.01	< LOQ 0.034	J95331-28 PB	0.02	< LOQ 0.034
S-02	J95331-29 VB	ND	< LOD 0.02	J95331-29 PB	0.01	< LOQ 0.034
SH-01	J95331-36 VB	0.16	> LOQ 0.043	J95331-36 PB	0.15	> LOQ 0.043
SS-01	J95331-32 VB	ND	< LOD 0.02	J95331-32 PB	ND	< LOD 0.02
SS-02	J95331-40 VB	ND	< LOD 0.02	J95331-40 PB	ND	< LOD 0.02
SS-03	J95331-45 VB	ND	< LOD 0.02	J95331-45 PB	ND	< LOD 0.02
SS-04	J95331-47 VB	0.03	< LOQ 1.7	J95331-47 PB	0.08	> LOQ 0.034
SS-05	J95331-53 VB	0.06	> LOQ 0.034	J95331-53 PB	0.05	> LOQ 0.034
SS-06	J95331-76 VB	0.05	< LOQ 0.069	J95331-76 PB	0.06	< LOQ 0.069
SS-07	J95331-80 VB	0.07	> LOQ 0.023	J95331-80 PB	0.04	> LOQ 0.023
SSDS-01	J95331-33 VB	ND	< LOD 0.02	J95331-33 PB	ND	< LOD 0.02
SSDS-02	J95331-44 VB	0.08	> LOQ 0.043	J95331-44 PB	0.09	> LOQ 0.043
SSDS-03	J95331-48 VB	ND	< LOD 0.01	J95331-48 PB	ND	< LOD 0.01
CP-1A	J95331-60 VB	0.04	< LOQ 0.071	J95331-60 PB	0.09	> LOQ 0.071
CP-1B	J95331-61 VB	0.86	> LOQ 0.071	J95331-61 PB	1.00	> LOQ 0.36
CP-2A	J95331-67 VB	0.77	> LOQ 0.069	J95331-67 PB	0.86	> LOQ 0.069
CP-2B	J95331-68 VB	0.90	> LOQ 0.069	J95331-68 PB	0.88	> LOQ 0.069
CP-3A	J95331-72 VB	1.40	> LOQ 0.14	J95331-72 PB	1.60	> LOQ 0.14
CP-3B	J95331-73 VB	1.50	> LOQ 0.14	J95331-73 PB	1.60	> LOQ 0.14
CP-4A	J95331-78 VB	1.00	> LOQ 0.046	J95331-78 PB	0.79	> LOQ 0.023
CP-4B	J95331-79 VB	0.91	> LOQ 0.046	J95331-79 PB	0.73	> LOQ 0.023
CPDS-1A	J95331-84 VB	0.47	> LOQ 0.023	J95331-84 PB	0.92	> LOQ 0.023
CPDS-1B	J95331-85 VB	0.81	> LOQ 0.023	J95331-85 PB	1.00	> LOQ 0.046
G-1A	J95331-41 VB	ND	< LOD 0.02	J95331-41 PB	ND	< LOD 0.02
G-1B	J95331-46 VB	ND	< LOD 0.01	J95331-46 PB	ND	< LOD 0.01
G-2A	J95331-43 VB	0.06	> LOQ 0.043	J95331-43 PB	0.06	> LOQ 0.043
G-2B	J95331-50 VB	0.05	> LOQ 0.034	J95331-50 PB	ND	< LOD 0.01
G-3A	J95331-49 VB	0.04	> LOQ 0.034	J95331-49 PB	0.10	> LOQ 0.034
G-4A	J95331-55 VB	0.05	> LOQ 0.034	J95331-55 PB	0.11	> LOQ 0.034
G-4B	J95331-56 VB	0.18	> LOQ 0.071	J95331-56 PB	0.12	> LOQ 0.071
G-5A	J95331-58 VB	0.07	< LOQ 0.71	J95331-58 PB	ND	< LOD 0.03
G-5B	J95331-59 VB	0.11	> LOQ 0.071	J95331-59 PB	ND	< LOD 0.03
G-6A	J95331-64 VB	0.07	< LOQ 0.071	J95331-64 PB	0.05	< LOQ 0.071
G-6B	J95331-65 VB	0.05	< LOQ 0.071	J95331-65 PB	0.04	< LOQ 0.071
G-7A	J95331-74 VB	ND	< LOD 0.02	J95331-74 PB	ND	< LOD 0.02
G-7B	J95331-75 VB	ND	< LOD 0.02	J95331-75 PB	ND	< LOD 0.02
SG-1A	J95331-54 VB	ND	< LOD 0.01	J95331-54 PB	ND	< LOD 0.01
SG-1B	J95331-71 VB	ND	< LOD 0.02	J95331-71 PB	ND	< LOD 0.02
SG-2A	J95331-66 VB	ND	< LOD 0.03	J95331-66 PB	ND	< LOD 0.03
SG-2B	J95331-82 VB	0.02	< LOQ 0.023	J95331-82 PB	0.01	< LOQ 0.023

Comparison of Airborne Concentrations to Bulk Concentrations - Beryllium

NIOSH REL 0.50 micrograms/cubic meter
OSHA PEL 2.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	0.10	0.13	0.08	ND
CS-01	0.62	2.29	10.11	1.92	5.70
CS-02	0.75	2.93	14.37	3.54	3.70
CS-03	0.35	2.07	4.77	1.82	3.20
CS-04	0.19	0.96	2.69	1.05	0.33
CS-05	0.31	1.42	3.35	1.87	0.28
CS-06	1.13	2.93	3.73	1.12	0.58
CS-07	1.94	6.26	24.97	3.96	6.30
CSDS-01	0.35	2.29	7.48	4.37	0.78
CSDS-02	0.66	2.48	3.93	3.56	3.90
N-01	ND	ND	0.11	ND	0.05
N-02	0.17	0.35	1.73	0.50	0.28
O-1	ND	ND	0.08	0.12	ND
S-01	ND	ND	0.29	ND	0.01
S-02	ND	0.12	0.14	ND	ND
SH-01	ND	ND	0.44	ND	0.16
SS-01	ND	0.07	ND	0.10	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	0.08	0.29	0.36	0.21	0.03
SS-05	ND	0.13	0.27	0.18	0.06
SS-06	0.14	0.15	0.29	0.14	0.05
SS-07	0.12	0.14	0.29	0.09	0.07
SSDS-01	0.12	ND	ND	ND	ND
SSDS-02	ND	0.14	0.31	0.14	0.08
SSDS-03	ND	ND	ND	ND	ND
CP-1A	0.39	0.18	0.23	0.13	0.04
CP-2A	0.17	0.82	3.94	1.64	0.77
CP-3A	0.50	1.19	6.41	5.59	1.40
CP-4A	0.70	1.05	6.12	0.90	1.00
CPDS-1A	0.30	0.56	2.89	0.31	0.47
G-1A	ND	ND	0.07	ND	ND
G-2A	ND	0.14	0.25	0.12	0.06
G-3A	ND	0.07	0.09	ND	0.04
G-4A	0.20	0.52	1.27	0.52	0.05
G-5A	0.07	0.13	ND	0.10	0.07
G-6A	0.10	0.23	2.29	1.80	0.07
G-7A	ND	ND	ND	0.23	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	0.52	0.20	ND	0.35	ND

APPENDIX B - CADMIUM

Cadmium

Cadmium dust may cause irritation of the nose and throat, cough, chest pain, sweating, chills, shortness of breath, and weakness. Repeated exposure may cause loss of the sense of smell, ulceration of the nose, shortness of breath, kidney damage, and mild anemia. An increased incidence of prostrate cancer in men has been reported. The OSHA PEL for cadmium is 5.0 micrograms/cubic meter of air. NIOSH does not currently have a recommended exposure limit (REL) for cadmium.

Cadmium is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

For the past 20 plus years, NIOSH has subscribed to a carcinogen policy that was published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, which called for "no detectable exposure levels for proven carcinogenic substances [New York Academy of Sciences Annals 1976]." This was in response to a generic OSHA rulemaking on carcinogens.

Because of advances in science and in approaches to risk assessment and risk management, NIOSH has in more recent years adopted a more inclusive policy. NIOSH RELs will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will protect not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy for potential occupational carcinogens will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL. Under the old policy for potential occupational carcinogens, RELs for most carcinogens were non-quantitative values labeled "lowest feasible concentration (LFC)." In 1989, NIOSH adopted several quantitative RELs for carcinogens from OSHA's PEL update. NIOSH will also recommend the complete range of respirators (as determined by the NIOSH Respirator Decision Logic) for carcinogens with quantitative RELs. In this way, respirators will be consistently recommended regardless of whether a substance is a carcinogen or a non-carcinogen.

Air Sample Results - Cadmium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cadmium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.007	ND	< LOD 0.15
24412	2	47.89	S-01	28	ND	< LOD 0.007	ND	< LOD 0.15
24441	3	47.90	S-01	28	ND	< LOD 0.007	ND	< LOD 0.15
24450	OBZ	47.93	S-01	28	0.0110	< LOQ 0.025	0.23	< LOQ 0.52
24643	1	47.98	S-02	29	ND	< LOD 0.007	ND	< LOD 0.15
24625	2	47.76	S-02	29	ND	< LOD 0.007	ND	< LOD 0.15
24642	3	48.00	S-02	29	ND	< LOD 0.007	ND	< LOD 0.15
24632	OBZ	47.89	S-02	29	ND	< LOD 0.007	ND	< LOD 0.15
24634	1	48.16	CSDS-01	31	ND	< LOD 0.007	ND	< LOD 0.15
24650	2	48.01	CSDS-01	31	ND	< LOD 0.007	ND	< LOD 0.15
24644	3	48.16	CSDS-01	31	ND	< LOD 0.007	ND	< LOD 0.15
24645	OBZ	48.07	CSDS-01	31	0.0100	< LOQ 0.025	0.21	< LOQ 0.52
24640	1	48.44	SS-01	32	ND	< LOD 0.007	ND	< LOD 0.14
24641	2	47.90	SS-01	32	ND	< LOD 0.007	ND	< LOD 0.15
24651	3	48.35	SS-01	32	ND	< LOD 0.007	ND	< LOD 0.14
24635	OBZ	48.30	SS-01	32	0.0960	> LOQ 0.025	1.99	> LOQ 0.52
24646	1	48.58	SSDS-01	33	ND	< LOD 0.007	ND	< LOD 0.14
24626	2	47.84	SSDS-01	33	0.0110	< LOQ 0.025	0.23	< LOQ 0.52
24638	3	48.49	SSDS-01	33	ND	< LOD 0.007	ND	< LOD 0.14
24647	OBZ	48.32	SSDS-01	33	0.0720	> LOQ 0.025	1.49	> LOQ 0.52
24628	1	48.55	CS-01	34	ND	< LOD 0.007	ND	< LOD 0.14
24637	2	48.00	CS-01	34	ND	< LOD 0.007	ND	< LOD 0.15
24624	3	48.47	CS-01	34	ND	< LOD 0.007	ND	< LOD 0.14
24636	OBZ	47.92	CS-01	34	0.0120	< LOQ 0.025	0.25	< LOQ 0.52
24623	1	48.53	CSDS-02	35	ND	< LOD 0.007	ND	< LOD 0.14
24622	2	48.36	CSDS-02	35	ND	< LOD 0.007	ND	< LOD 0.14
24654	3	48.31	CSDS-02	35	ND	< LOD 0.007	ND	< LOD 0.14
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 0.007	ND	< LOD 0.15
24629	1	47.88	SH-01	36	ND	< LOD 0.007	ND	< LOD 0.15
24633	2	47.86	SH-01	36	ND	< LOD 0.007	ND	< LOD 0.15
24627	3	48.24	SH-01	36	ND	< LOD 0.007	ND	< LOD 0.15
24648	OBZ	48.08	SH-01	36	0.0120	< LOQ 0.024	0.25	< LOQ 0.50
24555	1	48.08	CS-02	37	ND	< LOD 0.007	ND	< LOD 0.15
24552	2	47.84	CS-02	37	ND	< LOD 0.008	ND	< LOD 0.17
24541	3	48.01	CS-02	37	ND	< LOD 0.008	ND	< LOD 0.17
24529	OBZ	47.99	CS-02	37	0.0097	< LOQ 0.028	0.2	< LOQ 0.58
24558	1	48.49	CS-03	38	ND	< LOD 0.007	ND	< LOD 0.14
24524	2	48.29	CS-03	38	ND	< LOD 0.008	ND	< LOD 0.17
24561	3	48.22	CS-03	38	0.0120	< LOQ 0.024	0.25	< LOQ 0.50
24559	OBZ	48.29	CS-03	38	0.0180	< LOQ 0.024	0.37	< LOQ 0.50
24543	1	48.61	CS-04	39	ND	< LOD 0.008	ND	< LOD 0.16
24532	2	47.78	CS-04	39	ND	< LOD 0.008	ND	< LOD 0.17
24546	3	48.29	CS-04	39	ND	< LOD 0.008	ND	< LOD 0.17
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.007	ND	< LOD 0.14
24560	1	48.13	SS-02	40	ND	< LOD 0.007	ND	< LOD 0.15
24565	2	47.95	SS-02	40	ND	< LOD 0.007	ND	< LOD 0.15
24630	3	48.32	SS-02	40	ND	< LOD 0.007	ND	< LOD 0.14
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.008	ND	< LOD 0.16
24525	1	48.13	G-1A	41	ND	< LOD 0.008	ND	< LOD 0.17
24563	2	47.87	G-1A	41	ND	< LOD 0.007	ND	< LOD 0.15
24547	3	48.17	G-1A	41	ND	< LOD 0.008	ND	< LOD 0.17
24526	OBZ	48.91	G-1A	41	0.0340	> LOQ 0.028	0.7	> LOQ 0.57
24538	1	47.45	G-2A	43	ND	< LOD 0.008	ND	< LOD 0.17

Air Sample Results - Cadmium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cadmium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.008	ND	< LOD 0.17
24533	3	48.24	G-2A	43	0.0140	< LOQ 0.028	0.29	< LOQ 0.58
24540	OBZ	48.04	G-2A	43	0.0350	> LOQ 0.028	0.73	> LOQ 0.58
24528	1	47.99	SSDS-02	44	ND	< LOD 0.008	ND	< LOD 0.17
24544	2	48.00	SSDS-02	44	ND	< LOD 0.008	ND	< LOD 0.17
24567	3	48.46	SSDS-02	44	ND	< LOD 0.007	ND	< LOD 0.14
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.008	ND	< LOD 0.16
24571	1	48.05	SS-03	45	ND	< LOD 0.007	ND	< LOD 0.15
24536	2	47.60	SS-03	45	ND	< LOD 0.008	ND	< LOD 0.17
24534	3	48.94	SS-03	45	ND	< LOD 0.008	ND	< LOD 0.16
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.007	ND	< LOD 0.14
24568	1	48.28	G-1B	46	ND	< LOD 0.006	ND	< LOD 0.12
24592	2	47.38	G-1B	46	0.0240	> LOQ 0.013	0.51	> LOQ 0.27
24593	3	48.17	G-1B	46	0.0120	< LOQ 0.013	0.25	< LOQ 0.27
24535	OBZ	48.22	G-1B	46	0.0500	> LOQ 0.018	1.04	> LOQ 0.37
24590	1	47.81	SS-04	47	0.0050	< LOQ 0.013	0.1	< LOQ 0.27
24605	2	47.78	SS-04	47	ND	< LOD 0.004	ND	< LOD 0.08
24562	3	47.80	SS-04	47	0.0065	< LOQ 0.018	0.14	< LOQ 0.38
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.006	ND	< LOD 0.12
24527	1	49.48	SSDS-03	48	ND	< LOD 0.006	ND	< LOD 0.12
24569	2	50.35	SSDS-03	48	ND	< LOD 0.006	ND	< LOD 0.12
24584	3	50.24	SSDS-03	48	ND	< LOD 0.006	ND	< LOD 0.12
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.006	ND	< LOD 0.12
24600	1	48.34	G-3A	49	ND	< LOD 0.004	ND	< LOD 0.08
24616	2	48.11	G-3A	49	0.0068	< LOQ 0.013	0.14	< LOQ 0.27
24585	3	47.65	G-3A	49	0.0230	> LOQ 0.018	0.48	> LOQ 0.38
24583	OBZ	47.99	G-3A	49	0.0790	> LOQ 0.018	1.65	> LOQ 0.38
24587	1	48.79	G-2B	50	ND	< LOD 0.004	ND	< LOD 0.08
24602	2	48.17	G-2B	50	0.0080	< LOQ 0.013	0.17	< LOQ 0.27
24564	3	47.81	G-2B	50	ND	< LOD 0.006	ND	< LOD 0.13
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.004	ND	< LOD 0.08
24618	1	49.21	N-01	52	ND	< LOD 0.004	ND	< LOD 0.08
24611	2	47.96	N-01	52	ND	< LOD 0.004	ND	< LOD 0.08
24588	3	48.32	N-01	52	ND	< LOD 0.004	ND	< LOD 0.08
24615	OBZ	48.80	N-01	52	ND	< LOD 0.004	ND	< LOD 0.08
24597	1	49.78	SS-05	53	ND	< LOD 0.004	ND	< LOD 0.08
24599	2	47.68	SS-05	53	ND	< LOD 0.004	ND	< LOD 0.08
24575	3	48.11	SS-05	53	ND	< LOD 0.006	ND	< LOD 0.12
24617	OBZ	48.79	SS-05	53	0.0060	< LOQ 0.013	0.12	< LOQ 0.27
24609	1	48.98	SG-1A	54	ND	< LOD 0.004	ND	< LOD 0.08
24596	2	48.20	SG-1A	54	ND	< LOD 0.004	ND	< LOD 0.08
24610	3	48.18	SG-1A	54	ND	< LOD 0.004	ND	< LOD 0.08
24576	OBZ	48.47	SG-1A	54	0.0270	> LOQ 0.018	0.56	> LOQ 0.37
24606	1	49.24	G-4A	55	ND	< LOD 0.004	ND	< LOD 0.08
24620	2	48.37	G-4A	55	ND	< LOD 0.004	ND	< LOD 0.08
24573	3	48.67	G-4A	55	0.0220	> LOQ 0.018	0.45	> LOQ 0.37
24505	OBZ	48.16	G-4A	55	0.0093	< LOQ 0.018	0.19	< LOQ 0.37
24340	1	48.38	G-4B	56	ND	< LOD 0.005	ND	< LOD 0.10
24607	2	48.01	G-4B	56	0.0055	< LOQ 0.017	0.11	< LOQ 0.35
24595	3	48.38	G-4B	56	0.0085	< LOQ 0.017	0.18	< LOQ 0.35
24598	OBZ	48.42	G-4B	56	0.0060	< LOQ 0.017	0.12	< LOQ 0.35
24580	1	48.44	CS-05	57	ND	< LOD 0.005	ND	< LOD 0.10
24604	2	47.93	CS-05	57	0.0075	< LOQ 0.017	0.16	< LOQ 0.35

Air Sample Results - Cadmium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cadmium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 0.005	ND	< LOD 0.10
24574	OBZ	30.41	CS-05	57	0.0410	> LOQ 0.017	1.35	> LOQ 0.56
24614	1	48.58	G-5A	58	ND	< LOD 0.005	ND	< LOD 0.10
24577	2	48.18	G-5A	58	ND	< LOD 0.005	ND	< LOD 0.10
24572	3	48.05	G-5A	58	ND	< LOD 0.0050	ND	< LOD 0.10
24582	OBZ	47.83	G-5A	58	0.0470	> LOQ 0.017	0.98	> LOQ 0.36
24322	1	47.88	G-5B	59	ND	< LOD 0.005	ND	< LOD 0.10
24354	2	48.16	G-5B	59	ND	< LOD 0.005	ND	< LOD 0.10
24510	3	47.98	G-5B	59	0.0073	< LOQ 0.017	0.15	< LOQ 0.35
24321	OBZ	47.99	G-5B	59	0.0078	< LOQ 0.015	0.16	< LOQ 0.31
24497	1	48.49	CP-1A	60	0.0130	< LOQ 0.017	0.27	< LOQ 0.35
24333	2	48.28	CP-1A	60	0.0380	> LOQ 0.015	0.79	> LOQ 0.31
24326	3	48.19	CP-1A	60	0.1200	> LOQ 0.015	2.49	> LOQ 0.31
24329	OBZ	47.74	CP-1A	60	0.0370	> LOQ 0.015	0.78	> LOQ 0.31
24499	1	42.42	CP-1B	62	0.0130	< LOQ 0.017	0.31	< LOQ 0.40
24506	2	42.02	CP-1B	62	0.0380	> LOQ 0.017	0.9	> LOQ 0.40
24388	3	42.47	CP-1B	62	0.1600	> LOQ 0.015	3.77	> LOQ 0.35
24315	OBZ	41.77	CP-1B	62	0.0330	> LOQ 0.015	0.79	> LOQ 0.36
24318	1	48.56	CG-01	63	ND	< LOD 0.005	ND	< LOD 0.10
24308	2	48.00	CG-01	63	ND	< LOD 0.005	ND	< LOD 0.10
24330	3	48.47	CG-01	63	ND	< LOD 0.005	ND	< LOD 0.10
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.005	ND	< LOD 0.10
24363	1	48.10	G-6A	64	ND	< LOD 0.005	ND	< LOD 0.10
24398	2	47.84	G-6A	64	0.0120	< LOQ 0.017	0.25	< LOQ 0.36
24351	3	48.06	G-6A	64	0.0210	> LOQ 0.015	0.44	> LOQ 0.31
24594	OBZ	48.29	G-6A	64	0.1300	> LOQ 0.017	2.69	> LOQ 0.35
24312	1	48.76	G-6B	65	ND	< LOD 0.005	ND	< LOD 0.10
24484	2	47.45	G-6B	65	0.0055	< LOQ 0.017	0.12	< LOQ 0.36
24327	3	48.92	G-6B	65	0.0068	< LOQ 0.015	0.14	< LOQ 0.31
24389	OBZ	48.46	G-6B	65	ND	< LOD 0.005	ND	< LOD 0.10
24348	1	48.59	SG-2A	66	ND	< LOD 0.005	ND	< LOD 0.10
24314	2	47.90	SG-2A	66	ND	< LOD 0.005	ND	< LOD 0.10
24494	3	48.24	SG-2A	66	ND	< LOD 0.005	ND	< LOD 0.10
24337	OBZ	48.30	SG-2A	66	ND	< LOD 0.005	ND	< LOD 0.10
24508	1	48.47	CP-2A	67	ND	< LOD 0.005	ND	< LOD 0.10
24361	2	47.82	CP-2A	67	ND	< LOD 0.004	ND	< LOD 0.08
24359	3	48.22	CP-2A	67	0.0048	< LOQ 0.013	0.1	< LOQ 0.27
24471	OBZ	48.14	CP-2A	67	0.0070	< LOQ 0.017	0.15	< LOQ 0.35
24373	1	48.41	CP-2B	68	ND	< LOD 0.004	ND	< LOD 0.08
24468	2	47.90	CP-2B	68	ND	< LOD 0.005	ND	< LOD 0.10
24481	3	48.26	CP-2B	68	ND	< LOD 0.005	ND	< LOD 0.10
24391	OBZ	47.53	CP-2B	68	0.0240	> LOQ 0.019	0.5	> LOQ 0.40
24356	1	48.56	O-1	69	ND	< LOD 0.004	ND	< LOD 0.08
24470	2	47.89	O-1	69	ND	< LOD 0.005	ND	< LOD 0.10
24467	3	48.67	O-1	69	ND	< LOD 0.005	ND	< LOD 0.10
24313	OBZ	47.78	O-1	69	ND	< LOD 0.004	ND	< LOD 0.08
24501	1	47.96	CS-06	70	0.0270	> LOQ 0.017	0.56	> LOQ 0.35
24496	2	47.75	CS-06	70	ND	< LOD 0.005	ND	< LOD 0.10
24478	3	48.31	CS-06	70	ND	< LOD 0.005	ND	< LOD 0.10
24503	OBZ	48.04	CS-06	70	ND	< LOD 0.005	ND	< LOD 0.10
24474	1	26.02	SG-1B	71	ND	< LOD 0.005	ND	< LOD 0.19
24469	2	26.02	SG-1B	71	ND	< LOD 0.005	ND	< LOD 0.19
24492	3	26.10	SG-1B	71	ND	< LOD 0.005	ND	< LOD 0.19

Air Sample Results - Cadmium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cadmium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 0.005	ND	< LOD 0.19
24489	1	48.42	CP-3A	72	0.0170	= LOQ	0.35	> LOQ 0.00
24491	2	47.93	CP-3A	72	0.0470	> LOQ 0.017	0.98	> LOQ 0.35
24482	3	48.35	CP-3A	72	0.1900	> LOQ 0.017	3.93	> LOQ 0.35
24486	OBZ	48.32	CP-3A	72	0.1300	> LOQ 0.017	2.69	> LOQ 0.35
24516	1	36.34	CP-3B	73	0.0170	> LOQ 0.017	0.47	> LOQ 0.47
24502	2	36.02	CP-3B	73	0.1100	> LOQ 0.017	3.05	> LOQ 0.47
24515	3	36.48	CP-3B	73	0.0940	> LOQ 0.017	2.58	> LOQ 0.47
24500	OBZ	40.27	CP-3B	73	0.1800	> LOQ 0.017	4.47	> LOQ 0.42
24504	1	48.47	G-7A	74	ND	< LOD 0.005	ND	< LOD 0.10
24513	2	48.22	G-7A	74	0.0053	< LOQ 0.017	0.11	< LOQ 0.35
24458	3	47.94	G-7A	74	ND	< LOD 0.005	ND	< LOD 0.10
24389	OBZ	47.75	G-7A	74	0.0280	> LOQ 0.019	0.59	> LOQ 0.40
24404	1	48.68	G-7B	75	ND	< LOD 0.006	ND	< LOD 0.12
24451	2	48.06	G-7B	75	ND	< LOD 0.006	ND	< LOD 0.12
24447	3	47.16	G-7B	75	ND	< LOD 0.006	ND	< LOD 0.13
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.006	ND	< LOD 0.13
24456	1	49.19	SS-06	76	ND	< LOD 0.005	ND	< LOD 0.10
24480	2	48.26	SS-06	76	ND	< LOD 0.005	ND	< LOD 0.10
24429	3	47.68	SS-06	76	0.0063	< LOQ 0.019	0.13	< LOQ 0.40
24418	OBZ	47.83	SS-06	76	0.0063	< LOQ 0.019	0.13	< LOQ 0.40
24427	1	48.54	CP-4A	78	0.1000	> LOQ 0.019	2.06	> LOQ 0.39
24435	2	47.71	CP-4A	78	0.7700	> LOQ 0.019	16.14	> LOQ 0.40
24244	3	49.01	CP-4A	78	3.5000	> LOQ 0.26	71.41	> LOQ 5.31
24220	OBZ	48.74	CP-4A	78	0.6400	> LOQ 0.13	13.13	> LOQ 2.67
24460	1	50.05	CP-4B	79	0.1300	> LOQ 0.017	2.6	> LOQ 0.34
24465	2	48.47	CP-4B	79	0.5300	> LOQ 0.085	10.93	> LOQ 1.75
24207	3	48.49	CP-4B	79	2.1000	> LOQ 0.033	43.31	> LOQ 0.68
24390	OBZ	49.02	CP-4B	79	0.1500	> LOQ 0.019	3.06	> LOQ 0.39
24259	1	48.76	SS-07	80	ND	< LOD 0.01	ND	< LOD 0.21
24421	2	48.13	SS-07	80	ND	< LOD 0.006	ND	< LOD 0.12
24445	3	47.87	SS-07	80	0.0080	< LOQ 0.019	0.17	< LOQ 0.40
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.006	ND	< LOD 0.12
24459	1	48.96	N-02	81	0.5000	> LOQ 0.085	10.21	> LOQ 1.74
24417	2	48.11	N-02	81	0.0250	> LOQ 0.019	0.52	> LOQ 0.39
24442	3	48.01	N-02	81	0.0750	> LOQ 0.019	1.56	> LOQ 0.40
24386	OBZ	48.19	N-02	81	0.0310	> LOQ 0.019	0.64	> LOQ 0.39
24452	1	48.20	SG-2B	82	ND	< LOD 0.006	ND	< LOD 0.12
24453	2	48.59	SG-2B	82	ND	< LOD 0.006	ND	< LOD 0.12
24420	3	47.84	SG-2B	82	ND	< LOD 0.006	ND	< LOD 0.13
24444	OBZ	47.95	SG-2B	82	0.0850	> LOQ 0.019	1.77	> LOQ 0.40
24455	1	48.56	CS-07	83	ND	< LOD 0.005	ND	< LOD 0.10
24433	2	47.96	CS-07	83	0.0120	< LOQ 0.019	0.25	< LOQ 0.40
24398	3	48.06	CS-07	83	0.0580	> LOQ 0.019	1.21	> LOQ 0.40
24511	OBZ	47.96	CS-07	83	0.1300	> LOQ 0.017	2.71	> LOQ 0.35
24454	1	49.34	CPDS-1A	84	ND	< LOD 0.005	ND	< LOD 0.10
24291	2	48.49	CPDS-1A	84	ND	< LOD 0.004	ND	< LOD 0.08
24209	3	48.43	CPDS-1A	84	ND	< LOD 0.01	ND	< LOD 0.21
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 0.005	ND	< LOD 0.10
24204	1	49.46	CPDS-1B	85	ND	< LOD 0.01	ND	< LOD 0.20
24273	2	48.35	CPDS-1B	85	ND	< LOD 0.004	ND	< LOD 0.08
24223	3	48.82	CPDS-1B	85	0.0048	< LOQ 0.033	0.1	< LOQ 0.68
24466	OBZ	49.96	CPDS-1B	85	0.0180	> LOQ 0.017	0.36	> LOQ 0.34

Airborne Sample Data Analysis - Cadmium

NIOSH REL - Limit of Quantification (Lowest Feasible Concentration)
OSHA PEL 5.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.10
CS-01	ND	< LOD 0.14	ND	< LOD 0.15	ND	< LOD 0.14	0.25	< LOQ 0.52
CS-02	ND	< LOD 0.15	ND	< LOD 0.17	ND	< LOD 0.17	0.2	< LOQ 0.58
CS-03	ND	< LOD 0.14	ND	< LOD 0.17	0.25	< LOQ 0.50	0.37	< LOQ 0.50
CS-04	ND	< LOD 0.16	ND	< LOD 0.17	ND	< LOD 0.17	ND	< LOD 0.14
CS-05	ND	< LOD 0.10	0.16	< LOQ 0.35	ND	< LOD 0.10	1.35	> LOQ 0.56
CS-06	0.56	> LOQ 0.35	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.10
CS-07	ND	< LOD 0.10	0.25	< LOQ 0.40	1.21	> LOQ 0.40	2.71	> LOQ 0.35
CSDS-01	ND	< LOD 0.15	ND	< LOD 0.15	ND	< LOD 0.15	0.21	< LOQ 0.52
CSDS-02	ND	< LOD 0.14	ND	< LOD 0.14	ND	< LOD 0.14	ND	< LOD 0.15
N-01	ND	< LOD 0.08	ND	< LOD 0.08	ND	< LOD 0.08	ND	< LOD 0.08
N-02	10.21	> LOQ 1.74	0.52	> LOQ 0.39	1.56	> LOQ 0.40	0.64	> LOQ 0.39
O-1	ND	< LOD 0.08	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.08
S-01	ND	< LOD 0.15	ND	< LOD 0.15	ND	< LOD 0.15	0.23	< LOQ 0.52
S-02	ND	< LOD 0.15	ND	< LOD 0.15	ND	< LOD 0.15	ND	< LOD 0.15
SH-01	ND	< LOD 0.15	ND	< LOD 0.15	ND	< LOD 0.15	0.25	< LOQ 0.50
SS-01	ND	< LOD 0.14	ND	< LOD 0.15	ND	< LOD 0.14	1.99	> LOQ 0.52
SS-02	ND	< LOD 0.15	ND	< LOD 0.15	ND	< LOD 0.14	ND	< LOD 0.16
SS-03	ND	< LOD 0.15	ND	< LOD 0.17	ND	< LOD 0.16	ND	< LOD 0.14
SS-04	0.1	< LOQ 0.27	ND	< LOD 0.08	0.14	< LOQ 0.38	ND	< LOD 0.12
SS-05	ND	< LOD 0.08	ND	< LOD 0.08	ND	< LOD 0.12	0.12	< LOQ 0.27
SS-06	ND	< LOD 0.10	ND	< LOD 0.10	0.13	< LOQ 0.40	0.13	< LOQ 0.40
SS-07	ND	< LOD 0.21	ND	< LOD 0.12	0.17	< LOQ 0.40	ND	< LOD 0.12
SSDS-01	ND	< LOD 0.14	0.23	< LOQ 0.52	ND	< LOD 0.14	1.49	> LOQ 0.52
SSDS-02	ND	< LOD 0.17	ND	< LOD 0.17	ND	< LOD 0.14	ND	< LOD 0.16
SSDS-03	ND	< LOD 0.12	ND	< LOD 0.12	ND	< LOD 0.12	ND	< LOD 0.12
CP-1A	0.27	< LOQ 0.35	0.79	> LOQ 0.31	2.49	> LOQ 0.31	0.78	> LOQ 0.31
CP-1B	0.31	< LOQ 0.40	0.9	> LOQ 0.40	3.77	> LOQ 0.35	0.79	> LOQ 0.36
CP-2A	ND	< LOD 0.10	ND	< LOD 0.08	0.10	< LOQ 0.27	0.15	< LOQ 0.35
CP-2B	ND	< LOD 0.08	ND	< LOD 0.10	ND	< LOD 0.10	0.5	> LOQ 0.40
CP-3A	0.35	> LOQ 0.00	0.98	> LOQ 0.35	3.93	> LOQ 0.35	2.69	> LOQ 0.35
CP-3B	0.47	> LOQ 0.47	3.05	> LOQ 0.47	2.58	> LOQ 0.47	4.47	> LOQ 0.42
CP-4A	2.06	> LOQ 0.39	16.14	> LOQ 0.40	71.41	> LOQ 5.31	13.13	> LOQ 2.67
CP-4B	2.6	> LOQ 0.34	10.93	> LOQ 1.75	43.31	> LOQ 0.68	3.06	> LOQ 0.39
CPDS-1A	ND	< LOD 0.10	ND	< LOD 0.08	ND	< LOD 0.21	ND	< LOD 0.10
CPDS-1B	ND	< LOD 0.20	ND	< LOD 0.08	0.10	< LOQ 0.68	0.36	> LOQ 0.34
G-1A	ND	< LOD 0.17	ND	< LOD 0.15	ND	< LOD 0.17	0.7	> LOQ 0.57
G-1B	ND	< LOD 0.12	0.51	> LOQ 0.27	0.25	< LOQ 0.27	1.04	> LOQ 0.37
G-2A	ND	< LOD 0.17	ND	< LOD 0.17	0.29	< LOQ 0.58	0.73	> LOQ 0.58
G-2B	ND	< LOD 0.08	0.17	< LOQ 0.27	ND	< LOD 0.13	ND	< LOD 0.08
G-3A	ND	< LOD 0.08	0.14	< LOQ 0.27	0.48	> LOQ 0.38	1.65	> LOQ 0.38
G-4A	ND	< LOD 0.08	ND	< LOD 0.08	0.45	> LOQ 0.37	0.19	< LOQ 0.37
G-4B	ND	< LOD 0.10	0.11	< LOQ 0.35	0.18	< LOQ 0.35	0.12	< LOQ 0.35
G-5A	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.10	0.98	> LOQ 0.36
G-5B	ND	< LOD 0.10	ND	< LOD 0.10	0.15	< LOQ 0.35	0.16	< LOQ 0.31
G-6A	ND	< LOD 0.10	0.25	< LOQ 0.36	0.44	> LOQ 0.31	2.69	> LOQ 0.35
G-6B	ND	< LOD 0.10	0.12	< LOQ 0.36	0.14	< LOQ 0.31	ND	< LOD 0.10
G-7A	ND	< LOD 0.10	0.11	< LOQ 0.35	ND	< LOD 0.10	0.59	> LOQ 0.40
G-7B	ND	< LOD 0.12	ND	< LOD 0.12	ND	< LOD 0.13	ND	< LOD 0.13
SG-1A	ND	< LOD 0.08	ND	< LOD 0.08	ND	< LOD 0.08	0.56	> LOQ 0.37
SG-1B	ND	< LOD 0.19	ND	< LOD 0.19	ND	< LOD 0.19	ND	< LOD 0.19
SG-2A	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.10	ND	< LOD 0.10
SG-2B	ND	< LOD 0.12	ND	< LOD 0.12	ND	< LOD 0.13	1.77	> LOQ 0.40

Bulk Elemental Analysis - Cadmium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Cadmium		Sample	Cadmium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.02	J95331-63 PB	0.03	< LOQ 0.062
CS-01	J95331-34 VB	ND	< LOD 0.04	J95331-34 PB	ND	< LOD 0.04
CS-02	J95331-37 VB	ND	< LOD 0.04	J95331-37 PB	ND	< LOD 0.04
CS-03	J95331-38 VB	0.06	< LOQ 0.14	J95331-38 PB	0.07	< LOQ 0.14
CS-04	J95331-39 VB	ND	< LOD 0.04	J95331-39 PB	ND	< LOD 0.04
CS-05	J95331-57 VB	ND	< LOD 0.02	J95331-57 PB	ND	< LOD 0.02
CS-06	J95331-70 VB	ND	< LOD 0.7	J95331-70 PB	ND	< LOD 0.7
CS-07	J95331-83 VB	ND	< LOD 0.7	J95331-83 PB	ND	< LOD 0.7
CSDS-01	J95331-31 VB	ND	< LOD 0.04	J95331-31 PB	ND	< LOD 0.04
CSDS-02	J95331-35 VB	ND	< LOD 0.04	J95331-35 PB	ND	< LOD 0.04
N-01	J95331-52 VB	ND	< LOD 0.04	J95331-52 PB	ND	< LOD 0.04
N-02	J95331-81 VB	ND	< LOD 0.7	J95331-81 PB	ND	< LOD 0.7
O-1	J95331-69 VB	ND	< LOD 0.7	J95331-69 PB	ND	< LOD 0.7
S-01	J95331-28 VB	ND	< LOD 0.04	J95331-28 PB	ND	< LOD 0.4
S-02	J95331-29 VB	ND	< LOD 0.04	J95331-29 PB	ND	< LOD 0.07
SH-01	J95331-36 VB	ND	< LOD 0.04	J95331-36 PB	ND	< LOD 0.04
SS-01	J95331-32 VB	ND	< LOD 0.04	J95331-32 PB	ND	< LOD 0.04
SS-02	J95331-40 VB	ND	< LOD 0.04	J95331-40 PB	ND	< LOD 0.04
SS-03	J95331-45 VB	ND	< LOD 0.04	J95331-45 PB	ND	< LOD 0.04
SS-04	J95331-47 VB	ND	< LOD 0.04	J95331-47 PB	ND	< LOD 0.04
SS-05	J95331-53 VB	ND	< LOD 0.04	J95331-53 PB	ND	< LOD 0.04
SS-06	J95331-76 VB	ND	< LOD 0.7	J95331-76 PB	ND	< LOD 0.7
SS-07	J95331-80 VB	ND	< LOD 0.7	J95331-80 PB	ND	< LOD 0.7
SSDS-01	J95331-33 VB	ND	< LOD 0.04	J95331-33 PB	ND	< LOD 0.04
SSDS-02	J95331-44 VB	ND	< LOD 0.04	J95331-44 PB	ND	< LOD 0.04
SSDS-03	J95331-48 VB	ND	< LOD 0.04	J95331-48 PB	ND	< LOD 0.04
CP-1A	J95331-60 VB	0.48	> LOQ .062	J95331-60 PB	1.10	> LOQ 0.31
CP-1B	J95331-61 VB	ND	< LOD 0.02	J95331-61 PB	ND	< LOD 0.02
CP-2A	J95331-67 VB	ND	< LOD 0.7	J95331-67 PB	ND	< LOD 0.7
CP-2B	J95331-68 VB	ND	< LOD 0.7	J95331-68 PB	ND	< LOD 0.7
CP-3A	J95331-72 VB	ND	< LOD 0.7	J95331-72 PB	ND	< LOD 0.7
CP-3B	J95331-73 VB	ND	< LOD 0.7	J95331-73 PB	ND	< LOD 0.7
CP-4A	J95331-78 VB	8.30	< LOQ 12.0	J95331-78 PB	7.80	< LOQ 12.0
CP-4B	J95331-79 VB	8.30	< LOQ 12.0	J95331-79 PB	7.60	< LOQ 12.0
CPDS-1A	J95331-84 VB	ND	< LOD 0.7	J95331-84 PB	ND	< LOD 0.7
CPDS-1B	J95331-85 VB	ND	< LOD 0.7	J95331-85 PB	ND	< LOD 0.7
G-1A	J95331-41 VB	ND	< LOD 0.04	J95331-41 PB	ND	< LOD 0.04
G-1B	J95331-46 VB	ND	< LOD 0.04	J95331-46 PB	ND	< LOD 0.04
G-2A	J95331-43 VB	ND	< LOD 0.04	J95331-43 PB	ND	< LOD 0.04
G-2B	J95331-50 VB	ND	< LOD 0.04	J95331-50 PB	ND	< LOD 0.04
G-3A	J95331-49 VB	ND	< LOD 0.04	J95331-49 PB	ND	< LOD 0.04
G-4A	J95331-55 VB	ND	< LOD 0.04	J95331-55 PB	ND	< LOD 0.04
G-4B	J95331-56 VB	ND	< LOD 0.02	J95331-56 PB	ND	< LOD 0.02
G-5A	J95331-58 VB	ND	< LOD 0.02	J95331-58 PB	ND	< LOD 0.02
G-5B	J95331-59 VB	ND	< LOD 0.02	J95331-59 PB	ND	< LOD 0.02
G-6A	J95331-64 VB	ND	< LOD 0.02	J95331-64 PB	0.03	< LOQ 0.062
G-6B	J95331-65 VB	0.03	< LOQ 0.062	J95331-65 PB	ND	< LOD 0.02
G-7A	J95331-74 VB	ND	< LOD 0.7	J95331-74 PB	ND	< LOD 0.7
G-7B	J95331-75 VB	ND	< LOD 0.7	J95331-75 PB	ND	< LOD 0.7
SG-1A	J95331-54 VB	ND	< LOD 0.04	J95331-54 PB	ND	< LOD 0.04
SG-1B	J95331-71 VB	ND	< LOD 0.7	J95331-71 PB	ND	< LOD 0.7
SG-2A	J95331-66 VB	ND	< LOD 0.02	J95331-66 PB	ND	< LOD 0.02
SG-2B	J95331-82 VB	ND	< LOD 0.7	J95331-82 PB	ND	< LOD 0.7

Comparison of Airborne Concentrations to Bulk Concentrations - Cadmium

NIOSH REL - Limit of Quantification (Lowest Feasible Concentration)
OSHA PEL 5.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	0.25	ND
CS-02	ND	ND	ND	0.20	ND
CS-03	ND	ND	0.25	0.37	0.06
CS-04	ND	ND	ND	ND	ND
CS-05	ND	0.16	ND	1.35	ND
CS-06	0.56	ND	ND	ND	ND
CS-07	ND	0.25	1.21	2.71	ND
CSDS-01	ND	ND	ND	0.21	ND
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	ND
N-02	10.21	0.52	1.56	0.64	ND
O-1	ND	ND	ND	ND	ND
S-01	ND	ND	ND	0.23	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	0.25	ND
SS-01	ND	ND	ND	1.99	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	0.10	ND	0.14	ND	ND
SS-05	ND	ND	ND	0.12	ND
SS-06	ND	ND	0.13	0.13	ND
SS-07	ND	ND	0.17	ND	ND
SSDS-01	ND	0.23	ND	1.49	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	0.27	0.79	2.49	0.78	0.48
CP-2A	ND	ND	0.10	0.15	ND
CP-3A	0.35	0.98	3.93	2.69	ND
CP-4A	2.06	16.14	71.41	13.13	8.30
CPDS-1A	ND	ND	ND	ND	ND
G-1A	ND	ND	ND	0.70	ND
G-2A	ND	ND	0.29	0.73	ND
G-3A	ND	0.14	0.48	1.65	ND
G-4A	ND	ND	0.45	0.19	ND
G-5A	ND	ND	ND	0.98	ND
G-6A	ND	0.25	0.44	2.69	ND
G-7A	ND	0.11	ND	0.59	ND
SG-1A	ND	ND	ND	0.56	ND
SG-2A	ND	ND	ND	ND	ND

APPENDIX B - CALCIUM

Calcium

Calcium oxide reportedly causes irritation of the eyes, nose, throat and skin and may also cause bronchitis and pneumonitis. Ulceration and perforation of the nasal septum is possible in repeated or prolonged exposure. The NIOSH REL and OSHA PEL for calcium are 10,000 and 15,000 micrograms/cubic meter of air, respectively.

Air Sample Results - Calcium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Calcium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	7.50	> LOQ 7.5	155.73	> LOQ 155.73
24412	2	47.89	S-01	28	9.80	> LOQ 7.5	204.64	> LOQ 156.61
24441	3	47.90	S-01	28	22.00	> LOQ 7.5	459.29	> LOQ 156.58
24450	OBZ	47.93	S-01	28	14.00	> LOQ 7.5	292.09	> LOQ 156.48
24643	1	47.98	S-02	29	4.60	< LOQ 7.5	95.87	< LOQ 156.32
24625	2	47.76	S-02	29	14.00	> LOQ 7.5	293.13	> LOQ 157.04
24642	3	48.00	S-02	29	18.00	> LOQ 7.5	375	> LOQ 156.25
24632	OBZ	47.89	S-02	29	12.00	> LOQ 7.5	250.57	> LOQ 156.61
24634	1	48.16	CSDS-01	31	97.00	> LOQ 7.5	2014.12	> LOQ 155.73
24650	2	48.01	CSDS-01	31	520.00	> LOQ 7.5	10831.08	> LOQ 156.22
24644	3	48.16	CSDS-01	31	1600.00	> LOQ 7.5	33222.59	> LOQ 155.73
24645	OBZ	48.07	CSDS-01	31	760.00	> LOQ 7.5	15810.28	> LOQ 156.02
24640	1	48.44	SS-01	32	3.10	< LOQ 7.5	64	< LOQ 154.83
24641	2	47.90	SS-01	32	5.90	< LOQ 7.5	123.17	< LOQ 156.58
24651	3	48.35	SS-01	32	6.10	< LOQ 7.5	126.16	< LOQ 155.12
24635	OBZ	48.30	SS-01	32	13.00	> LOQ 7.5	269.15	> LOQ 155.28
24646	1	48.58	SSDS-01	33	4.20	< LOQ 7.5	86.46	< LOQ 154.38
24626	2	47.84	SSDS-01	33	8.40	> LOQ 7.5	175.59	> LOQ 156.77
24638	3	48.49	SSDS-01	33	9.80	> LOQ 7.5	202.1	> LOQ 154.67
24647	OBZ	48.32	SSDS-01	33	8.70	> LOQ 7.5	180.05	> LOQ 155.22
24628	1	48.55	CS-01	34	890.00	> LOQ 7.5	18331.62	> LOQ 154.48
24637	2	48.00	CS-01	34	2600.00	> LOQ 7.5	54166.67	> LOQ 156.25
24624	3	48.47	CS-01	34	12000.00	> LOQ 7.5	247575.82	> LOQ 154.73
24636	OBZ	47.92	CS-01	34	2600.00	> LOQ 7.5	54257.1	> LOQ 156.51
24623	1	48.53	CSDS-02	35	930.00	> LOQ 7.5	19163.4	> LOQ 154.54
24622	2	48.36	CSDS-02	35	3600.00	> LOQ 7.5	74441.69	> LOQ 155.09
24654	3	48.31	CSDS-02	35	14000.00	> LOQ 7.5	289795.07	> LOQ 155.25
24653	OBZ	47.78	CSDS-02	35	5000.00	> LOQ 7.5	104646.3	> LOQ 156.97
24629	1	47.88	SH-01	36	6.40	< LOQ 7.5	133.67	< LOQ 156.64
24633	2	47.86	SH-01	36	10.00	> LOQ 7.5	208.94	> LOQ 156.71
24627	3	48.24	SH-01	36	0.79	> LOQ 7.5	16.38	> LOQ 155.47
24648	OBZ	48.08	SH-01	36	8.60	> LOQ 7.5	178.87	> LOQ 155.99
24555	1	48.08	CS-02	37	300.00	> LOQ 7.5	6239.6	> LOQ 155.99
24552	2	47.84	CS-02	37	1100.00	> LOQ 7.5	22993.31	> LOQ 156.77
24541	3	48.01	CS-02	37	5100.00	> LOQ 7.5	106227.87	> LOQ 156.22
24529	OBZ	47.99	CS-02	37	1700.00	> LOQ 7.5	35424.05	> LOQ 156.28
24558	1	48.49	CS-03	38	530.00	> LOQ 7.5	10930.09	> LOQ 154.67
24524	2	48.29	CS-03	38	2300.00	> LOQ 7.5	47628.91	> LOQ 155.31
24561	3	48.22	CS-03	38	8400.00	> LOQ 15.0	174201.58	> LOQ 311.07
24559	OBZ	48.29	CS-03	38	2300.00	> LOQ 7.5	47628.91	> LOQ 155.31
24543	1	48.61	CS-04	39	220.00	> LOQ 7.5	4525.82	> LOQ 154.29
24532	2	47.78	CS-04	39	760.00	> LOQ 7.5	15906.24	> LOQ 156.97
24546	3	48.29	CS-04	39	2100.00	> LOQ 7.5	43487.26	> LOQ 155.31
24557	OBZ	48.58	CS-04	39	1000.00	> LOQ 7.5	20584.6	> LOQ 154.38
24560	1	48.13	SS-02	40	12.00	> LOQ 7.5	249.32	> LOQ 155.83
24565	2	47.95	SS-02	40	22.00	> LOQ 7.5	458.81	> LOQ 156.41
24630	3	48.32	SS-02	40	23.00	> LOQ 7.5	475.99	> LOQ 155.22
24553	OBZ	48.62	SS-02	40	32.00	> LOQ 7.5	658.17	> LOQ 154.26
24525	1	48.13	G-1A	41	19.00	> LOQ 7.5	394.76	> LOQ 155.83
24563	2	47.87	G-1A	41	80.00	> LOQ 7.5	1671.19	> LOQ 156.67
24547	3	48.17	G-1A	41	330.00	> LOQ 7.5	6850.74	> LOQ 155.70
24526	OBZ	48.91	G-1A	41	120.00	> LOQ 7.5	2453.49	> LOQ 153.34
24538	1	47.45	G-2A	43	9.10	> LOQ 7.5	191.78	> LOQ 158.06

Air Sample Results - Calcium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Calcium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	44.00	> LOQ 7.5	933.79	> LOQ 159.17
24533	3	48.24	G-2A	43	71.00	> LOQ 7.5	1471.81	> LOQ 155.47
24540	OBZ	48.04	G-2A	43	37.00	> LOQ 7.5	770.19	> LOQ 156.12
24528	1	47.99	SSDS-02	44	81.00	> LOQ 7.5	1687.85	> LOQ 156.28
24544	2	48.00	SSDS-02	44	310.00	> LOQ 7.5	6458.33	> LOQ 156.25
24567	3	48.46	SSDS-02	44	840.00	> LOQ 7.5	17333.88	> LOQ 154.77
24539	OBZ	49.37	SSDS-02	44	270.00	> LOQ 7.5	5468.91	> LOQ 151.91
24571	1	48.05	SS-03	45	ND	< LOD 3.0	ND	< LOD 62.43
24536	2	47.60	SS-03	45	9.00	> LOQ 7.5	189.08	> LOQ 157.56
24534	3	48.94	SS-03	45	9.80	> LOQ 7.5	200.25	> LOQ 153.25
24570	OBZ	49.61	SS-03	45	11.00	> LOQ 7.5	221.73	> LOQ 151.18
24568	1	48.28	G-1B	46	9.70	> LOQ 7.5	200.91	> LOQ 155.34
24592	2	47.38	G-1B	46	59.00	> LOQ 7.5	1245.25	> LOQ 158.29
24593	3	48.17	G-1B	46	88.00	> LOQ 7.5	1826.86	> LOQ 155.70
24535	OBZ	48.22	G-1B	46	71.00	> LOQ 7.5	1472.42	> LOQ 155.54
24590	1	47.81	SS-04	47	74.00	> LOQ 7.5	1547.79	> LOQ 156.87
24605	2	47.78	SS-04	47	470.00	> LOQ 7.5	9836.75	> LOQ 156.97
24562	3	47.80	SS-04	47	560.00	> LOQ 7.5	11715.48	> LOQ 156.90
24531	OBZ	48.59	SS-04	47	440.00	> LOQ 7.5	9055.36	> LOQ 154.35
24527	1	49.48	SSDS-03	48	3.40	< LOQ 7.5	68.71	< LOQ 151.58
24569	2	50.35	SSDS-03	48	6.00	< LOQ 7.5	119.17	< LOQ 148.96
24584	3	50.24	SSDS-03	48	7.60	> LOQ 7.5	151.27	> LOQ 149.28
24579	OBZ	48.26	SSDS-03	48	7.10	< LOQ 7.5	147.12	< LOQ 155.41
24600	1	48.34	G-3A	49	17.00	> LOQ 7.5	351.68	> LOQ 155.15
24616	2	48.11	G-3A	49	47.00	> LOQ 7.5	976.93	> LOQ 155.89
24585	3	47.65	G-3A	49	160.00	> LOQ 7.5	3357.82	> LOQ 157.40
24583	OBZ	47.99	G-3A	49	24.00	> LOQ 7.5	500.1	> LOQ 156.28
24587	1	48.79	G-2B	50	9.80	> LOQ 7.5	200.86	> LOQ 153.72
24602	2	48.17	G-2B	50	69.00	> LOQ 7.5	1432.43	> LOQ 155.70
24564	3	47.81	G-2B	50	52.00	> LOQ 7.5	1087.64	> LOQ 156.87
24621	OBZ	48.54	G-2B	50	17.00	> LOQ 7.5	350.23	> LOQ 154.51
24618	1	49.21	N-01	52	22.00	> LOQ 7.5	447.06	> LOQ 152.41
24611	2	47.96	N-01	52	95.00	> LOQ 7.5	1980.82	> LOQ 156.38
24588	3	48.32	N-01	52	320.00	> LOQ 7.5	6622.52	> LOQ 155.22
24615	OBZ	48.80	N-01	52	180.00	> LOQ 7.5	3688.52	> LOQ 153.69
24597	1	49.78	SS-05	53	ND	< LOD 3.0	ND	< LOD 60.27
24599	2	47.68	SS-05	53	3.30	< LOQ 7.5	69.21	< LOQ 157.30
24575	3	48.11	SS-05	53	8.10	> LOQ 7.5	168.36	> LOQ 155.89
24617	OBZ	48.79	SS-05	53	6.50	< LOQ 7.5	133.22	< LOQ 153.72
24609	1	48.98	SG-1A	54	5.70	< LOQ 7.5	116.37	< LOQ 153.12
24596	2	48.20	SG-1A	54	19.00	> LOQ 7.5	394.19	> LOQ 155.60
24610	3	48.18	SG-1A	54	33.00	> LOQ 7.5	684.93	> LOQ 155.67
24576	OBZ	48.47	SG-1A	54	19.00	> LOQ 7.5	392	> LOQ 154.73
24606	1	49.24	G-4A	55	140.00	> LOQ 7.5	2843.22	> LOQ 152.32
24620	2	48.37	G-4A	55	150.00	> LOQ 7.5	3101.1	> LOQ 155.05
24573	3	48.67	G-4A	55	1000.00	> LOQ 7.5	20546.54	> LOQ 154.10
24505	OBZ	48.16	G-4A	55	280.00	> LOQ 7.5	5813.95	> LOQ 155.73
24340	1	48.38	G-4B	56	39.00	> LOQ 7.5	806.12	> LOQ 155.02
24607	2	48.01	G-4B	56	330.00	> LOQ 7.5	6873.57	> LOQ 156.22
24595	3	48.38	G-4B	56	590.00	> LOQ 7.5	12195.12	> LOQ 155.02
24598	OBZ	48.42	G-4B	56	280.00	> LOQ 7.5	5782.73	> LOQ 154.89
24580	1	48.44	CS-05	57	59.00	> LOQ 7.5	1218	> LOQ 154.83
24604	2	47.93	CS-05	57	210.00	> LOQ 7.5	4381.39	> LOQ 156.48

Air Sample Results - Calcium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Calcium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	510.00	> LOQ 7.5	10673.92	> LOQ 156.97
24574	OBZ	30.41	CS-05	57	180.00	> LOQ 7.5	5919.11	> LOQ 246.63
24614	1	48.58	G-5A	58	36.00	> LOQ 7.5	741.05	> LOQ 154.38
24577	2	48.18	G-5A	58	97.00	> LOQ 7.5	2013.28	> LOQ 155.67
24572	3	48.05	G-5A	58	320.00	> LOQ 7.5	6659.73	> LOQ 156.09
24582	OBZ	47.83	G-5A	58	210.00	> LOQ 7.5	4390.55	> LOQ 156.81
24322	1	47.88	G-5B	59	26.00	> LOQ 7.5	543.02	> LOQ 156.64
24354	2	48.16	G-5B	59	120.00	> LOQ 7.5	2491.69	> LOQ 155.73
24510	3	47.98	G-5B	59	300.00	> LOQ 7.5	6252.61	> LOQ 156.32
24321	OBZ	47.99	G-5B	59	73.00	> LOQ 7.5	1521.15	> LOQ 156.28
24497	1	48.49	CP-1A	60	61.00	> LOQ 7.5	1257.99	> LOQ 154.67
24333	2	48.28	CP-1A	60	320.00	> LOQ 7.5	6628	> LOQ 155.34
24326	3	48.19	CP-1A	60	390.00	> LOQ 7.5	8092.97	> LOQ 155.63
24329	OBZ	47.74	CP-1A	60	170.00	> LOQ 7.5	3560.96	> LOQ 157.10
24499	1	42.42	CP-1B	62	110.00	> LOQ 7.5	2593.12	> LOQ 176.80
24506	2	42.02	CP-1B	62	120.00	> LOQ 7.5	2855.78	> LOQ 178.49
24388	3	42.47	CP-1B	62	760.00	> LOQ 7.5	17894.98	> LOQ 176.60
24315	OBZ	41.77	CP-1B	62	110.00	> LOQ 7.5	2633.47	> LOQ 179.55
24318	1	48.56	CG-01	63	14.00	> LOQ 7.5	288.3	> LOQ 154.45
24308	2	48.00	CG-01	63	150.00	> LOQ 7.5	3125	> LOQ 156.25
24330	3	48.47	CG-01	63	240.00	> LOQ 7.5	4951.52	> LOQ 154.73
24230	OBZ	48.31	CG-01	63	80.00	> LOQ 7.5	1655.97	> LOQ 155.25
24363	1	48.10	G-6A	64	160.00	> LOQ 7.5	3326.4	> LOQ 155.93
24398	2	47.84	G-6A	64	800.00	> LOQ 7.5	16722.41	> LOQ 156.77
24351	3	48.06	G-6A	64	1500.00	> LOQ 7.5	31210.99	> LOQ 156.05
24594	OBZ	48.29	G-6A	64	300.00	> LOQ 7.5	6212.47	> LOQ 155.31
24312	1	48.76	G-6B	65	36.00	> LOQ 7.5	738.31	> LOQ 153.81
24484	2	47.45	G-6B	65	350.00	> LOQ 7.5	7376.19	> LOQ 158.06
24327	3	48.92	G-6B	65	290.00	> LOQ 7.5	5928.05	> LOQ 153.31
24389	OBZ	48.46	G-6B	65	330.00	> LOQ 7.5	6809.74	> LOQ 154.77
24348	1	48.59	SG-2A	66	3.00	< LOQ 7.5	61.74	< LOQ 154.35
24314	2	47.90	SG-2A	66	5.80	< LOQ 7.5	121.09	< LOQ 156.58
24494	3	48.24	SG-2A	66	5.60	< LOQ 7.5	116.09	< LOQ 155.47
24337	OBZ	48.30	SG-2A	66	6.00	< LOQ 15.0	124.22	< LOQ 310.56
24508	1	48.47	CP-2A	67	1600.00	> LOQ 7.5	33010.11	> LOQ 154.73
24361	2	47.82	CP-2A	67	4900.00	> LOQ 7.5	102467.59	> LOQ 156.84
24359	3	48.22	CP-2A	67	31000.00	> LOQ 15.0	642886.77	> LOQ 311.07
24471	OBZ	48.14	CP-2A	67	12000.00	> LOQ 7.5	249272.95	> LOQ 155.80
24373	1	48.41	CP-2B	68	4800.00	> LOQ 7.5	99153.07	> LOQ 154.93
24468	2	47.90	CP-2B	68	2700.00	> LOQ 7.5	56367.43	> LOQ 156.58
24481	3	48.26	CP-2B	68	10000.00	> LOQ 7.5	207210.94	> LOQ 155.41
24391	OBZ	47.53	CP-2B	68	2100.00	> LOQ 7.5	44182.62	> LOQ 157.80
24356	1	48.56	O-1	69	7.40	< LOQ 7.5	152.39	< LOQ 154.45
24470	2	47.89	O-1	69	18.00	> LOQ 7.5	375.86	> LOQ 156.61
24467	3	48.67	O-1	69	24.00	> LOQ 7.5	493.12	> LOQ 154.10
24313	OBZ	47.78	O-1	69	25.00	> LOQ 7.5	523.23	> LOQ 156.97
24501	1	47.96	CS-06	70	270.00	> LOQ 7.5	5629.69	> LOQ 156.38
24496	2	47.75	CS-06	70	660.00	> LOQ 7.5	13821.99	> LOQ 157.07
24478	3	48.31	CS-06	70	820.00	> LOQ 7.5	16973.71	> LOQ 155.25
24503	OBZ	48.04	CS-06	70	490.00	> LOQ 7.5	10199.83	> LOQ 156.12
24474	1	26.02	SG-1B	71	3.80	< LOQ 7.5	146.04	< LOQ 288.24
24469	2	26.02	SG-1B	71	4.90	< LOQ 7.5	188.32	< LOQ 288.24
24492	3	26.10	SG-1B	71	3.40	< LOQ 7.5	130.27	< LOQ 287.36

Air Sample Results - Calcium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Calcium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	15.00	< LOQ 38.0	571.43	< LOQ 1447.62
24489	1	48.42	CP-3A	72	1100.00	> LOQ 7.5	22717.89	> LOQ 154.89
24491	2	47.93	CP-3A	72	3500.00	> LOQ 7.5	73023.16	> LOQ 156.48
24482	3	48.35	CP-3A	72	15000.00	> LOQ 7.5	310237.85	> LOQ 155.12
24486	OBZ	48.32	CP-3A	72	15000.00	> LOQ 7.5	310430.46	> LOQ 155.22
24516	1	36.34	CP-3B	73	1300.00	> LOQ 7.5	35773.25	> LOQ 206.38
24502	2	36.02	CP-3B	73	6600.00	> LOQ 7.5	183231.54	> LOQ 208.22
24515	3	36.48	CP-3B	73	10000.00	> LOQ 7.5	274122.81	> LOQ 205.59
24500	OBZ	40.27	CP-3B	73	4300.00	> LOQ 7.5	106779.24	> LOQ 186.24
24504	1	48.47	G-7A	74	3400.00	> LOQ 7.5	70146.48	> LOQ 154.73
24513	2	48.22	G-7A	74	7900.00	> LOQ 7.5	163832.43	> LOQ 155.54
24458	3	47.94	G-7A	74	21000.00	> LOQ 7.5	438047.56	> LOQ 156.45
24389	OBZ	47.75	G-7A	74	6000.00	> LOQ 7.5	125654.45	> LOQ 157.07
24404	1	48.68	G-7B	75	2500.00	> LOQ 7.5	51355.79	> LOQ 154.07
24451	2	48.06	G-7B	75	5400.00	> LOQ 7.5	112359.55	> LOQ 156.05
24447	3	47.16	G-7B	75	12000.00	> LOQ 7.5	254452.93	> LOQ 159.03
24423	OBZ	47.27	G-7B	75	2600.00	> LOQ 7.5	55003.17	> LOQ 158.66
24456	1	49.19	SS-06	76	28.00	> LOQ 7.5	569.22	> LOQ 152.47
24480	2	48.26	SS-06	76	66.00	> LOQ 7.5	1367.59	> LOQ 155.41
24429	3	47.68	SS-06	76	23.00	> LOQ 7.5	482.38	> LOQ 157.30
24418	OBZ	47.83	SS-06	76	43.00	> LOQ 7.5	899.02	> LOQ 156.81
24427	1	48.54	CP-4A	78	420.00	> LOQ 7.5	8652.66	> LOQ 154.51
24435	2	47.71	CP-4A	78	1900.00	> LOQ 7.5	39823.94	> LOQ 157.20
24244	3	49.01	CP-4A	78	10000.00	> LOQ 15.0	204039.99	> LOQ 306.06
24220	OBZ	48.74	CP-4A	78	2000.00	> LOQ 7.5	41034.06	> LOQ 153.88
24460	1	50.05	CP-4B	79	390.00	> LOQ 7.5	7792.21	> LOQ 149.85
24465	2	48.47	CP-4B	79	1400.00	> LOQ 7.5	28883.85	> LOQ 154.73
24207	3	48.49	CP-4B	79	6900.00	> LOQ 15.0	142297.38	> LOQ 309.34
24390	OBZ	49.02	CP-4B	79	410.00	> LOQ 7.5	8363.93	> LOQ 153.00
24259	1	48.76	SS-07	80	23.00	> LOQ 7.5	471.7	> LOQ 153.81
24421	2	48.13	SS-07	80	84.00	> LOQ 7.5	1745.27	> LOQ 155.83
24445	3	47.87	SS-07	80	230.00	> LOQ 7.5	4804.68	> LOQ 156.67
24432	OBZ	48.49	SS-07	80	63.00	> LOQ 7.5	1299.24	> LOQ 154.67
24459	1	48.96	N-02	81	230.00	> LOQ 7.5	4697.71	> LOQ 153.19
24417	2	48.11	N-02	81	460.00	> LOQ 7.5	9561.42	> LOQ 155.89
24442	3	48.01	N-02	81	2100.00	> LOQ 7.5	43740.89	> LOQ 156.22
24386	OBZ	48.19	N-02	81	440.00	> LOQ 7.5	9130.53	> LOQ 155.63
24452	1	48.20	SG-2B	82	39.00	> LOQ 7.5	809.13	> LOQ 155.60
24453	2	48.59	SG-2B	82	40.00	> LOQ 7.5	823.21	> LOQ 154.35
24420	3	47.84	SG-2B	82	31.00	> LOQ 7.5	647.99	> LOQ 156.77
24444	OBZ	47.95	SG-2B	82	37.00	< LOQ 38.0	771.64	< LOQ 792.49
24455	1	48.56	CS-07	83	360.00	> LOQ 7.5	7413.51	> LOQ 154.45
24433	2	47.96	CS-07	83	1100.00	> LOQ 7.5	22935.78	> LOQ 156.38
24398	3	48.06	CS-07	83	4800.00	> LOQ 7.5	99875.16	> LOQ 156.05
24511	OBZ	47.96	CS-07	83	850.00	> LOQ 7.5	17723.1	> LOQ 156.38
24454	1	49.34	CPDS-1A	84	2300.00	> LOQ 7.5	46615.32	> LOQ 152.01
24291	2	48.49	CPDS-1A	84	3900.00	> LOQ 7.5	80428.95	> LOQ 154.67
24209	3	48.43	CPDS-1A	84	29000.00	> LOQ 7.5	598802.4	> LOQ 154.86
24402	OBZ	48.77	CPDS-1A	84	11000.00	> LOQ 7.5	225548.49	> LOQ 153.78
24204	1	49.46	CPDS-1B	85	2900.00	> LOQ 7.5	58633.24	> LOQ 151.64
24273	2	48.35	CPDS-1B	85	4800.00	> LOQ 7.5	99276.11	> LOQ 155.12
24223	3	48.82	CPDS-1B	85	23000.00	> LOQ 7.5	471118.39	> LOQ 153.63
24466	OBZ	49.96	CPDS-1B	85	3700.00	> LOQ 7.5	74059.25	> LOQ 150.12

Airborne Sample Data Analysis - Calcium

NIOSH REL 10000.0 micrograms/cubic meter
OSHA PEL 15000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	288.3	> LOQ 154.45	3125	> LOQ 156.25	4951.52	> LOQ 154.73	1655.97	> LOQ 155.25
CS-01	18331.62	> LOQ 154.48	54166.67	> LOQ 156.25	247575.82	> LOQ 154.73	54257.1	> LOQ 156.51
CS-02	6239.6	> LOQ 155.99	22993.31	> LOQ 156.77	106227.87	> LOQ 156.22	35424.05	> LOQ 156.28
CS-03	10930.09	> LOQ 154.67	47628.91	> LOQ 155.31	174201.58	> LOQ 311.07	47628.91	> LOQ 155.31
CS-04	4525.82	> LOQ 154.29	15906.24	> LOQ 156.97	43487.26	> LOQ 155.31	20584.6	> LOQ 154.38
CS-05	1218	> LOQ 154.83	4381.39	> LOQ 156.48	10673.92	> LOQ 156.97	5919.11	> LOQ 246.63
CS-06	5629.69	> LOQ 156.38	13821.99	> LOQ 157.07	16973.71	> LOQ 155.25	10199.83	> LOQ 156.12
CS-07	7413.51	> LOQ 154.45	22935.78	> LOQ 156.38	99875.16	> LOQ 156.05	17723.1	> LOQ 156.38
CSDS-01	2014.12	> LOQ 155.73	10831.08	> LOQ 156.22	33222.59	> LOQ 155.73	15810.28	> LOQ 156.02
CSDS-02	19163.4	> LOQ 154.54	74441.69	> LOQ 155.09	289795.07	> LOQ 155.25	104646.3	> LOQ 156.97
N-01	447.06	> LOQ 152.41	1980.82	> LOQ 156.38	6622.52	> LOQ 155.22	3688.52	> LOQ 153.69
N-02	4697.71	> LOQ 153.19	9561.42	> LOQ 155.89	43740.89	> LOQ 156.22	9130.53	> LOQ 155.63
O-1	152.39	< LOQ 154.45	375.86	> LOQ 156.61	493.12	> LOQ 154.10	523.23	> LOQ 156.97
S-01	155.73	> LOQ 155.73	204.64	> LOQ 156.61	459.29	> LOQ 156.58	292.09	> LOQ 156.48
S-02	95.87	< LOQ 156.32	293.13	> LOQ 157.04	375.00	> LOQ 156.25	250.57	> LOQ 156.61
SH-01	133.67	< LOQ 156.64	208.94	> LOQ 156.71	16.38	> LOQ 155.47	178.87	> LOQ 155.99
SS-01	64	< LOQ 154.83	123.17	< LOQ 156.58	126.16	< LOQ 155.12	269.15	> LOQ 155.28
SS-02	249.32	> LOQ 155.83	458.81	> LOQ 156.41	475.99	> LOQ 155.22	658.17	> LOQ 154.26
SS-03	ND	< LOD 62.43	189.08	> LOQ 157.56	200.25	> LOQ 153.25	221.73	> LOQ 151.18
SS-04	1547.79	> LOQ 156.87	9836.75	> LOQ 156.97	11715.48	> LOQ 156.90	9055.36	> LOQ 154.35
SS-05	ND	< LOD 60.27	69.21	< LOQ 157.30	168.36	> LOQ 155.89	133.22	< LOQ 153.72
SS-06	569.22	> LOQ 152.47	1367.59	> LOQ 155.41	482.38	> LOQ 157.30	899.02	> LOQ 156.81
SS-07	471.7	> LOQ 153.81	1745.27	> LOQ 155.83	4804.68	> LOQ 156.67	1299.24	> LOQ 154.67
SSDS-01	86.46	< LOQ 154.38	175.59	> LOQ 156.77	202.10	> LOQ 154.67	180.05	> LOQ 155.22
SSDS-02	1687.85	> LOQ 156.28	6458.33	> LOQ 156.25	17333.88	> LOQ 154.77	5468.91	> LOQ 151.91
SSDS-03	68.71	< LOQ 151.58	119.17	< LOQ 148.96	151.27	> LOQ 149.28	147.12	< LOQ 155.41
CP-1A	1257.99	> LOQ 154.67	6628	> LOQ 155.34	8092.97	> LOQ 155.63	3560.96	> LOQ 157.10
CP-1B	2593.12	> LOQ 176.80	2855.78	> LOQ 178.49	17894.98	> LOQ 176.60	2633.47	> LOQ 179.55
CP-2A	33010.11	> LOQ 154.73	102467.59	> LOQ 156.84	642886.77	> LOQ 311.07	249272.95	> LOQ 155.80
CP-2B	99153.07	> LOQ 154.93	56367.43	> LOQ 156.58	207210.94	> LOQ 155.41	44182.62	> LOQ 157.80
CP-3A	22717.89	> LOQ 154.89	73023.16	> LOQ 156.48	310237.85	> LOQ 155.12	310430.46	> LOQ 155.22
CP-3B	35773.25	> LOQ 206.38	183231.54	> LOQ 208.22	274122.81	> LOQ 205.59	106779.24	> LOQ 186.24
CP-4A	8652.66	> LOQ 154.51	39823.94	> LOQ 157.20	204039.99	> LOQ 306.06	41034.06	> LOQ 153.88
CP-4B	7792.21	> LOQ 149.85	28883.85	> LOQ 154.73	142297.38	> LOQ 309.34	8363.93	> LOQ 153.00
CPDS-1A	46615.32	> LOQ 152.01	80428.95	> LOQ 154.67	598802.40	> LOQ 154.86	225548.49	> LOQ 153.78
CPDS-1B	58633.24	> LOQ 151.64	99276.11	> LOQ 155.12	471118.39	> LOQ 153.63	74059.25	> LOQ 150.12
G-1A	394.76	> LOQ 155.83	1671.19	> LOQ 156.67	6850.74	> LOQ 155.70	2453.49	> LOQ 153.34
G-1B	200.91	> LOQ 155.34	1245.25	> LOQ 158.29	1826.86	> LOQ 155.70	1472.42	> LOQ 155.54
G-2A	191.78	> LOQ 158.06	933.79	> LOQ 159.17	1471.81	> LOQ 155.47	770.19	> LOQ 156.12
G-2B	200.86	> LOQ 153.72	1432.43	> LOQ 155.70	1087.64	> LOQ 156.87	350.23	> LOQ 154.51
G-3A	351.68	> LOQ 155.15	976.93	> LOQ 155.89	3357.82	> LOQ 157.40	500.1	> LOQ 156.28
G-4A	2843.22	> LOQ 152.32	3101.1	> LOQ 155.05	20546.54	> LOQ 154.10	5813.95	> LOQ 155.73
G-4B	806.12	> LOQ 155.02	6873.57	> LOQ 156.22	12195.12	> LOQ 155.02	5782.73	> LOQ 154.89
G-5A	741.05	> LOQ 154.38	2013.28	> LOQ 155.67	6659.73	> LOQ 156.09	4390.55	> LOQ 156.81
G-5B	543.02	> LOQ 156.64	2491.69	> LOQ 155.73	6252.61	> LOQ 156.32	1521.15	> LOQ 156.28
G-6A	3326.4	> LOQ 155.93	16722.41	> LOQ 156.77	31210.99	> LOQ 156.05	6212.47	> LOQ 155.31
G-6B	738.31	> LOQ 153.81	7376.19	> LOQ 158.06	5928.05	> LOQ 153.31	6809.74	> LOQ 154.77
G-7A	70146.48	> LOQ 154.73	163832.43	> LOQ 155.54	438047.56	> LOQ 156.45	125654.45	> LOQ 157.07
G-7B	51355.79	> LOQ 154.07	112359.55	> LOQ 156.05	254452.93	> LOQ 159.03	55003.17	> LOQ 158.66
SG-1A	116.37	< LOQ 153.12	394.19	> LOQ 155.60	684.93	> LOQ 155.67	392	> LOQ 154.73
SG-1B	146.04	< LOQ 288.24	198.32	< LOQ 288.24	130.27	< LOQ 287.36	571.43	< LOQ 1447.62
SG-2A	61.74	< LOQ 154.35	121.09	< LOQ 156.58	116.09	< LOQ 155.47	124.22	< LOQ 310.56
SG-2B	809.13	> LOQ 155.60	823.21	> LOQ 154.35	647.99	> LOQ 156.77	771.64	< LOQ 792.49

Bulk Elemental Analysis - Calcium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Calcium		Sample	Calcium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	55.00	> LOQ 30.0	J95331-63 PB	110.00	> LOQ 30.0
CS-01	J95331-34 VB	130000.00	> LOQ 30.0	J95331-34 PB	100000.00	> LOQ 30.0
CS-02	J95331-37 VB	30000.00	> LOQ 30.0	J95331-37 PB	29000.00	> LOQ 30.0
CS-03	J95331-38 VB	58000.00	> LOQ 30.0	J95331-38 PB	66000.00	> LOQ 30.0
CS-04	J95331-39 VB	2500.00	> LOQ 30.0	J95331-39 PB	3100.00	> LOQ 30.0
CS-05	J95331-57 VB	540.00	> LOQ 30.0	J95331-57 PB	750.00	> LOQ 30.0
CS-06	J95331-70 VB	760.00	> LOQ 30.0	J95331-70 PB	1500.00	> LOQ 30.0
CS-07	J95331-83 VB	3100.00	> LOQ 30.0	J95331-83 PB	6400.00	> LOQ 30.0
CSDS-01	J95331-31 VB	1500.00	> LOQ 30.0	J95331-31 PB	2700.00	> LOQ 30.0
CSDS-02	J95331-35 VB	110000.00	> LOQ 30.0	J95331-35 PB	110000.00	> LOQ 30.0
N-01	J95331-52 VB	610.00	> LOQ 30.0	J95331-52 PB	730.00	> LOQ 30.0
N-02	J95331-81 VB	4000.00	> LOQ 30.0	J95331-81 PB	9000.00	> LOQ 30.0
O-1	J95331-69 VB	130.00	> LOQ 30.0	J95331-69 PB	99.00	> LOQ 30.0
S-01	J95331-28 VB	79.00	> LOQ 30.0	J95331-28 PB	77.00	> LOQ 30.0
S-02	J95331-29 VB	53.00	> LOQ 30.0	J95331-29 PB	91.00	> LOQ 30.0
SH-01	J95331-36 VB	46.00	> LOQ 30.0	J95331-36 PB	64.00	> LOQ 30.0
SS-01	J95331-32 VB	11.00	< LOQ 30.0	J95331-32 PB	19.00	< LOQ 30.0
SS-02	J95331-40 VB	23.00	< LOQ 30.0	J95331-40 PB	50.00	> LOQ 30.0
SS-03	J95331-45 VB	140.00	> LOQ 30.0	J95331-45 PB	43.00	> LOQ 30.0
SS-04	J95331-47 VB	2800.00	> LOQ 30.0	J95331-47 PB	510.00	> LOQ 30.0
SS-05	J95331-53 VB	ND	< LOD 9.0	J95331-53 PB	9.50	< LOQ 30.0
SS-06	J95331-76 VB	290.00	> LOQ 30.0	J95331-76 PB	430.00	> LOQ 30.0
SS-07	J95331-80 VB	600.00	> LOQ 30.0	J95331-80 PB	230.00	> LOQ 30.0
SSDS-01	J95331-33 VB	23.00	< LOQ 30.0	J95331-33 PB	23.00	< LOQ 30.0
SSDS-02	J95331-44 VB	3600.00	> LOQ 30.0	J95331-44 PB	4000.00	> LOQ 30.0
SSDS-03	J95331-48 VB	13.00	< LOQ 30.0	J95331-48 PB	46.00	> LOQ 30.0
CP-1A	J95331-60 VB	730.00	> LOQ 30.0	J95331-60 PB	3000.00	> LOQ 30.0
CP-1B	J95331-61 VB	2100.00	> LOQ 30.0	J95331-61 PB	2800.00	> LOQ 30.0
CP-2A	J95331-67 VB	120000.00	> LOQ 30.0	J95331-67 PB	160000.00	> LOQ 60.0
CP-2B	J95331-68 VB	140000.00	> LOQ 60.0	J95331-68 PB	150000.00	> LOQ 60.0
CP-3A	J95331-72 VB	91000.00	> LOQ 30.0	J95331-72 PB	84000.00	> LOQ 30.0
CP-3B	J95331-73 VB	84000.00	> LOQ 60.0	J95331-73 PB	83000.00	< LOQ 60.0
CP-4A	J95331-78 VB	12000.00	> LOQ 30.0	J95331-78 PB	22000.00	> LOQ 60.0
CP-4B	J95331-79 VB	24000.00	> LOQ 30.0	J95331-79 PB	24000.00	> LOQ 30.0
CPDS-1A	J95331-84 VB	90000.00	> LOQ 30.0	J95331-84 PB	130000.00	> LOQ 30.0
CPDS-1B	J95331-85 VB	120000.00	> LOQ 30.0	J95331-85 PB	140000.00	> LOQ 60.0
G-1A	J95331-41 VB	900.00	> LOQ 30.0	J95331-41 PB	930.00	> LOQ 30.0
G-1B	J95331-46 VB	770.00	> LOQ 30.0	J95331-46 PB	530.00	> LOQ 30.0
G-2A	J95331-43 VB	180.00	> LOQ 30.0	J95331-43 PB	360.00	> LOQ 30.0
G-2B	J95331-50 VB	450.00	> LOQ 30.0	J95331-50 PB	290.00	> LOQ 30.0
G-3A	J95331-49 VB	250.00	> LOQ 30.0	J95331-49 PB	3400.00	> LOQ 30.0
G-4A	J95331-55 VB	510.00	> LOQ 30.0	J95331-55 PB	1100.00	> LOQ 30.0
G-4B	J95331-56 VB	1100.00	> LOQ 30.0	J95331-56 PB	960.00	> LOQ 30.0
G-5A	J95331-58 VB	1800.00	> LOQ 30.0	J95331-58 PB	1500.00	> LOQ 30.0
G-5B	J95331-59 VB	640.00	> LOQ 30.0	J95331-59 PB	450.00	> LOQ 30.0
G-6A	J95331-64 VB	600.00	> LOQ 30.0	J95331-64 PB	1100.00	> LOQ 30.0
G-6B	J95331-65 VB	1300.00	> LOQ 30.0	J95331-65 PB	830.00	> LOQ 30.0
G-7A	J95331-74 VB	37000.00	> LOQ 30.0	J95331-74 PB	36000.00	> LOQ 30.0
G-7B	J95331-75 VB	110000.00	> LOQ 30.0	J95331-75 PB	70000.00	> LOQ 30.0
SG-1A	J95331-54 VB	76.00	< LOQ 150.0	J95331-54 PB	130.00	< LOQ 150.0
SG-1B	J95331-71 VB	ND	< LOD 45.0	J95331-71 PB	67.00	< LOQ 150.0
SG-2A	J95331-66 VB	ND	< LOD 45.0	J95331-66 PB	ND	< LOD 150.0
SG-2B	J95331-82 VB	45.00	< LOQ 150.0	J95331-82 PB	ND	< LOD 45.0

Comparison of Airborne Concentrations to Bulk Concentrations - Calcium

NIOSH REL 10000.0 micrograms/cubic meter
OSHA PEL 15000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	288.30	3125.00	4951.52	1655.97	55.00
CS-01	18331.62	54166.67	247575.82	54257.10	130000.00
CS-02	6239.60	22993.31	106227.87	35424.05	30000.00
CS-03	10930.09	47628.91	174201.58	47628.91	58000.00
CS-04	4525.82	15906.24	43487.26	20584.60	2500.00
CS-05	1218.00	4381.39	10673.92	5919.11	540.00
CS-06	5629.69	13821.99	16973.71	10199.83	760.00
CS-07	7413.51	22935.78	99875.16	17723.10	3100.00
CSDS-01	2014.12	10831.08	33222.59	15810.28	1500.00
CSDS-02	19163.40	74441.69	289795.07	104646.30	110000.00
N-01	447.06	1980.82	6622.52	3688.52	610.00
N-02	4697.71	9561.42	43740.89	9130.53	4000.00
O-1	152.39	375.86	493.12	523.23	130.00
S-01	155.73	204.64	459.29	292.09	79.00
S-02	95.87	293.13	375.00	250.57	53.00
SH-01	133.67	208.94	16.38	178.87	46.00
SS-01	64.00	123.17	126.16	269.15	11.00
SS-02	249.32	458.81	475.99	658.17	23.00
SS-03	ND	189.08	200.25	221.73	140.00
SS-04	1547.79	9836.75	11715.48	9055.36	2800.00
SS-05	ND	69.21	168.36	133.22	ND
SS-06	569.22	1367.59	482.38	899.02	290.00
SS-07	471.70	1745.27	4804.68	1299.24	600.00
SSDS-01	86.46	175.59	202.10	180.05	23.00
SSDS-02	1687.85	6458.33	17333.88	5468.91	3600.00
SSDS-03	68.71	119.17	151.27	147.12	13.00
CP-1A	1257.99	6628.00	8092.97	3560.96	730.00
CP-2A	33010.11	102467.59	642886.77	249272.95	120000.00
CP-3A	22717.89	73023.16	310237.85	310430.46	91000.00
CP-4A	8652.66	39823.94	204039.99	41034.06	12000.00
CPDS-1A	46615.32	80428.95	598802.40	225548.49	90000.00
G-1A	394.76	1671.19	6850.74	2453.49	900.00
G-2A	191.78	933.79	1471.81	770.19	180.00
G-3A	351.68	976.93	3357.82	500.10	250.00
G-4A	2843.22	3101.10	20546.54	5813.95	510.00
G-5A	741.05	2013.28	6659.73	4390.55	1800.00
G-6A	3326.40	16722.41	31210.99	6212.47	600.00
G-7A	70146.48	163832.43	438047.56	125654.45	37000.00
SG-1A	116.37	394.19	684.93	392.00	76.00
SG-2A	61.74	121.09	116.09	124.22	ND

APPENDIX B - CHROMIUM

Chromium

Chromium metal and divalent and trivalent compounds have been associated with dermatitis and allergic skin reaction. The compounds may cause skin ulceration, ulceration in the mucus membranes, and perforations of the nasal septum. Adverse effects on pulmonary functions, including hypersensitivity, have been reported. The NIOSH REL for chromium are both 500 micrograms/cubic meter of air.

Per the "NIOSH Pocket Guide to Chemical Hazards" the OSHA PEL for chromium depends on the valence. The OSHA PEL for chromium metal and insoluble salts is 100 $\mu g/m^3$. The OSHA PEL for chromium (II) and (III) compounds is 500 $\mu g/m^3$. The NIOSH REL for all valences of chromium is 500 $\mu g/m^3$, with the exception of the REL of 1 $\mu g/m^3$ for the hexavelent chromium, which is based on a 10 hour TWA.

Air Sample Results - Chromium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Chromium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.5	ND	< LOD 10.38
24412	2	47.89	S-01	28	ND	< LOD 0.5	ND	< LOD 10.44
24441	3	47.90	S-01	28	1.60	< LOQ 1.7	33.4	< LOQ 35.49
24450	OBZ	47.93	S-01	28	ND	< LOD 0.5	ND	< LOD 10.43
24643	1	47.98	S-02	29	ND	< LOD 0.5	ND	< LOD 10.42
24625	2	47.76	S-02	29	0.69	< LOQ 1.7	14.45	< LOQ 35.59
24642	3	48.00	S-02	29	0.79	< LOQ 1.7	16.46	< LOQ 35.42
24632	OBZ	47.89	S-02	29	ND	< LOD 0.5	ND	< LOD 10.44
24634	1	48.16	CSDS-01	31	ND	< LOD 0.5	ND	< LOD 10.38
24650	2	48.01	CSDS-01	31	2.10	> LOQ 1.7	43.74	> LOQ 35.41
24644	3	48.16	CSDS-01	31	5.70	> LOQ 1.7	118.36	> LOQ 35.30
24645	OBZ	48.07	CSDS-01	31	2.90	> LOQ 1.7	60.33	> LOQ 35.37
24640	1	48.44	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.32
24641	2	47.90	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.44
24651	3	48.35	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.34
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.35
24646	1	48.58	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.29
24626	2	47.84	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.45
24638	3	48.49	SSDS-01	33	0.52	< LOQ 1.7	10.72	< LOQ 35.06
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.35
24628	1	48.55	CS-01	34	0.57	< LOQ 1.7	11.74	< LOQ 35.02
24637	2	48.00	CS-01	34	1.70	< LOQ 1.7	35.42	< LOQ 35.42
24624	3	48.47	CS-01	34	6.30	> LOQ 1.7	129.98	> LOQ 35.07
24636	OBZ	47.92	CS-01	34	1.50	< LOQ 1.7	31.3	< LOQ 35.48
24623	1	48.53	CSDS-02	35	0.58	< LOQ 1.7	11.95	< LOQ 35.03
24622	2	48.36	CSDS-02	35	2.00	> LOQ 1.7	41.36	> LOQ 35.15
24654	3	48.31	CSDS-02	35	6.60	> LOQ 1.7	136.62	> LOQ 35.19
24653	OBZ	47.78	CSDS-02	35	2.60	> LOQ 1.7	54.42	> LOQ 35.58
24629	1	47.88	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.44
24633	2	47.86	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.45
24627	3	48.24	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.36
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.40
24555	1	48.08	CS-02	37	0.93	< LOQ 1.7	19.34	< LOQ 35.36
24552	2	47.84	CS-02	37	2.60	> LOQ 1.7	54.35	> LOQ 35.54
24541	3	48.01	CS-02	37	11.00	> LOQ 1.7	229.12	> LOQ 35.41
24529	OBZ	47.99	CS-02	37	4.10	> LOQ 1.7	85.43	> LOQ 35.42
24558	1	48.49	CS-03	38	0.52	< LOQ 1.7	10.72	< LOQ 35.06
24524	2	48.29	CS-03	38	2.10	> LOQ 1.7	43.49	> LOQ 35.20
24561	3	48.22	CS-03	38	6.60	> LOQ 1.7	136.87	> LOQ 35.26
24559	OBZ	48.29	CS-03	38	1.80	> LOQ 1.7	37.27	> LOQ 35.20
24543	1	48.61	CS-04	39	ND	< LOD 0.5	ND	< LOD 10.29
24532	2	47.78	CS-04	39	0.82	< LOQ 1.7	17.16	< LOQ 35.58
24546	3	48.29	CS-04	39	1.90	> LOQ 1.7	39.35	> LOQ 35.20
24557	OBZ	48.58	CS-04	39	1.00	< LOQ 1.7	20.58	< LOQ 34.99
24560	1	48.13	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.39
24565	2	47.95	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.43
24630	3	48.32	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.35
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.28
24525	1	48.13	G-1A	41	ND	< LOD 0.5	ND	< LOD 10.39
24563	2	47.87	G-1A	41	0.98	< LOQ 1.7	20.47	< LOQ 35.51
24547	3	48.17	G-1A	41	3.00	> LOQ 1.7	62.28	> LOQ 35.29
24526	OBZ	48.91	G-1A	41	2.30	> LOQ 1.7	47.03	> LOQ 34.76
24538	1	47.45	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.54

Air Sample Results - Chromium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Chromium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.61
24533	3	48.24	G-2A	43	0.56	< LOQ 1.7	11.61	< LOQ 35.24
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.41
24528	1	47.99	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.42
24544	2	48.00	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.42
24567	3	48.46	SSDS-02	44	0.74	< LOQ 1.7	15.27	< LOQ 35.08
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.13
24571	1	48.05	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.41
24536	2	47.60	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.50
24534	3	48.94	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.22
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.08
24568	1	48.28	G-1B	46	ND	< LOD 0.5	ND	< LOD 10.36
24592	2	47.38	G-1B	46	1.50	< LOQ 1.7	31.66	< LOQ 35.88
24593	3	48.17	G-1B	46	2.50	> LOQ 1.7	51.9	> LOQ 35.29
24535	OBZ	48.22	G-1B	46	4.50	> LOQ 1.7	93.32	> LOQ 35.26
24590	1	47.81	SS-04	47	ND	< LOD 0.5	ND	< LOD 10.46
24605	2	47.78	SS-04	47	0.60	< LOQ 1.7	12.56	< LOQ 35.58
24562	3	47.80	SS-04	47	0.70	< LOQ 1.7	14.64	< LOQ 35.56
24531	OBZ	48.59	SS-04	47	0.53	< LOQ 1.7	10.91	< LOQ 34.99
24527	1	49.48	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 10.11
24569	2	50.35	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 9.93
24584	3	50.24	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 9.95
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 10.36
24600	1	48.34	G-3A	49	ND	< LOD 0.5	ND	< LOD 10.34
24616	2	48.11	G-3A	49	1.30	< LOQ 1.7	27.02	< LOQ 35.34
24585	3	47.65	G-3A	49	1.20	< LOQ 1.7	25.18	< LOQ 35.68
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.5	ND	< LOD 10.42
24587	1	48.79	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.25
24602	2	48.17	G-2B	50	0.66	< LOQ 1.7	13.7	< LOQ 35.29
24564	3	47.81	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.46
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.30
24618	1	49.21	N-01	52	17.00	> LOQ 1.7	345.46	> LOQ 34.55
24611	2	47.96	N-01	52	85.00	> LOQ 1.7	1772.31	> LOQ 35.45
24588	3	48.32	N-01	52	340.00	> LOQ 1.7	7036.42	> LOQ 35.18
24615	OBZ	48.80	N-01	52	180.00	> LOQ 1.7	3688.52	> LOQ 34.84
24597	1	49.78	SS-05	53	ND	< LOD 0.5	ND	< LOD 10.04
24599	2	47.68	SS-05	53	0.61	< LOQ 1.7	12.79	< LOQ 35.65
24575	3	48.11	SS-05	53	1.20	< LOQ 1.7	24.94	< LOQ 35.34
24617	OBZ	48.79	SS-05	53	0.88	< LOQ 1.7	18.04	< LOQ 34.84
24609	1	48.98	SG-1A	54	0.60	< LOQ 1.7	12.25	< LOQ 34.71
24596	2	48.20	SG-1A	54	0.88	< LOQ 1.7	18.26	< LOQ 35.27
24610	3	48.18	SG-1A	54	3.50	> LOQ 1.7	72.64	> LOQ 35.28
24576	OBZ	48.47	SG-1A	54	11.00	> LOQ 8.5	226.94	> LOQ 175.37
24606	1	49.24	G-4A	55	0.89	< LOQ 1.7	18.07	< LOQ 34.52
24620	2	48.37	G-4A	55	0.82	< LOQ 1.7	16.95	< LOQ 35.15
24573	3	48.67	G-4A	55	4.80	> LOQ 1.7	98.62	> LOQ 34.93
24505	OBZ	48.16	G-4A	55	1.40	<LOQ 1.7	1.4	<LOQ 1.7
24340	1	48.38	G-4B	56	ND	< LOD 0.5	ND	< LOD 10.33
24607	2	48.01	G-4B	56	1.60	< LOQ 1.7	33.33	< LOQ 35.41
24595	3	48.38	G-4B	56	2.70	> LOQ 1.7	55.81	> LOQ 35.14
24598	OBZ	48.42	G-4B	56	1.70	> LOQ 1.7	35.11	> LOQ 35.11
24580	1	48.44	CS-05	57	ND	< LOD 0.5	ND	< LOD 10.32
24604	2	47.93	CS-05	57	1.00	< LOQ 1.7	20.86	< LOQ 35.47

Air Sample Results - Chromium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Chromium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	2.20	> LOQ 1.7	46.04	> LOQ 35.58
24574	OBZ	30.41	CS-05	57	0.83	< LOQ 1.7	27.29	< LOQ 55.90
24614	1	48.58	G-5A	58	ND	< LOD 0.5	ND	< LOD 10.29
24577	2	48.18	G-5A	58	0.72	< LOQ 1.7	14.94	< LOQ 35.28
24572	3	48.05	G-5A	58	2.00	> LOQ 1.7	41.62	> LOQ 35.38
24582	OBZ	47.83	G-5A	58	2.90	> LOQ 1.7	60.63	> LOQ 35.54
24322	1	47.88	G-5B	59	ND	< LOD 0.5	ND	< LOD 10.44
24354	2	48.16	G-5B	59	1.50	< LOQ 1.7	31.15	< LOQ 35.30
24510	3	47.98	G-5B	59	4.90	> LOQ 1.7	102.13	> LOQ 35.43
24321	OBZ	47.99	G-5B	59	0.81	< LOQ 1.7	16.88	< LOQ 35.42
24497	1	48.49	CP-1A	60	0.63	< LOQ 1.7	12.99	< LOQ 35.06
24333	2	48.28	CP-1A	60	3.40	> LOQ 1.7	70.42	> LOQ 35.21
24326	3	48.19	CP-1A	60	6.30	> LOQ 1.7	130.73	> LOQ 35.28
24329	OBZ	47.74	CP-1A	60	2.30	> LOQ 1.7	48.18	> LOQ 35.61
24499	1	42.42	CP-1B	62	1.00	< LOQ 1.7	23.57	< LOQ 40.08
24506	2	42.02	CP-1B	62	2.50	> LOQ 1.7	59.5	> LOQ 40.46
24388	3	42.47	CP-1B	62	10.00	> LOQ 1.7	235.46	> LOQ 40.03
24315	OBZ	41.77	CP-1B	62	2.00	> LOQ 1.7	47.88	> LOQ 40.70
24318	1	48.56	CG-01	63	ND	< LOD 0.5	ND	< LOD 10.30
24308	2	48.00	CG-01	63	0.80	< LOQ 1.7	16.67	< LOQ 35.42
24330	3	48.47	CG-01	63	1.10	< LOQ 1.7	22.69	< LOQ 35.07
24230	OBZ	48.31	CG-01	63	0.61	< LOQ 1.7	12.63	< LOQ 35.19
24363	1	48.10	G-6A	64	1.20	< LOQ 1.7	24.95	< LOQ 35.34
24398	2	47.84	G-6A	64	5.20	> LOQ 1.7	108.7	> LOQ 35.54
24351	3	48.06	G-6A	64	9.90	> LOQ 1.7	205.99	> LOQ 35.37
24594	OBZ	48.29	G-6A	64	2.10	> LOQ 1.7	43.49	> LOQ 35.20
24312	1	48.76	G-6B	65	0.64	< LOQ 1.7	13.13	< LOQ 34.86
24484	2	47.45	G-6B	65	2.50	> LOQ 1.7	52.69	> LOQ 35.83
24327	3	48.92	G-6B	65	2.00	> LOQ 1.7	40.88	> LOQ 34.75
24389	OBZ	48.46	G-6B	65	2.50	> LOQ 1.7	51.59	> LOQ 35.08
24348	1	48.59	SG-2A	66	49.00	> LOQ 1.7	1008.44	> LOQ 34.99
24314	2	47.90	SG-2A	66	45.00	> LOQ 1.7	939.46	> LOQ 35.49
24494	3	48.24	SG-2A	66	61.00	> LOQ 3.4	1264.51	> LOQ 70.48
24337	OBZ	48.30	SG-2A	66	250.00	> LOQ 3.4	5175.98	> LOQ 70.39
24508	1	48.47	CP-2A	67	0.97	< LOQ 1.7	20.01	< LOQ 35.07
24361	2	47.82	CP-2A	67	2.50	> LOQ 1.7	52.28	> LOQ 35.55
24359	3	48.22	CP-2A	67	14.00	> LOQ 3.4	290.34	> LOQ 70.51
24471	OBZ	48.14	CP-2A	67	5.10	> LOQ 1.7	105.94	> LOQ 35.31
24373	1	48.41	CP-2B	68	2.10	> LOQ 1.7	43.38	> LOQ 35.12
24468	2	47.90	CP-2B	68	1.50	< LOQ 1.7	31.32	< LOQ 35.49
24481	3	48.26	CP-2B	68	4.60	> LOQ 1.7	95.32	> LOQ 35.23
24391	OBZ	47.53	CP-2B	68	1.10	< LOQ 1.7	23.14	< LOQ 35.77
24356	1	48.56	O-1	69	3.20	> LOQ 1.7	65.9	> LOQ 35.01
24470	2	47.89	O-1	69	4.60	> LOQ 1.7	96.05	> LOQ 35.50
24467	3	48.67	O-1	69	12.00	> LOQ 1.7	246.56	> LOQ 34.93
24313	OBZ	47.78	O-1	69	5.70	> LOQ 1.7	119.3	> LOQ 35.58
24501	1	47.96	CS-06	70	1.10	< LOQ 1.7	22.94	< LOQ 35.45
24496	2	47.75	CS-06	70	2.50	> LOQ 1.7	52.36	> LOQ 35.60
24478	3	48.31	CS-06	70	5.40	> LOQ 1.7	111.78	> LOQ 35.19
24503	OBZ	48.04	CS-06	70	2.00	> LOQ 1.7	41.63	> LOQ 35.39
24474	1	26.02	SG-1B	71	ND	< LOD 0.5	ND	< LOD 19.22
24469	2	26.02	SG-1B	71	ND	< LOD 0.5	ND	< LOD 19.22
24492	3	26.10	SG-1B	71	1.60	< LOQ 1.7	61.3	< LOQ 65.13

Air Sample Results - Chromium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Chromium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	5.70	< LOQ 8.5	217.14	< LOQ 323.81
24489	1	48.42	CP-3A	72	0.53	< LOQ 1.7	10.95	< LOQ 35.11
24491	2	47.93	CP-3A	72	1.10	< LOQ 1.7	22.95	< LOQ 35.47
24482	3	48.35	CP-3A	72	4.90	> LOQ 1.7	101.34	> LOQ 35.16
24486	OBZ	48.32	CP-3A	72	4.50	> LOQ 1.7	93.13	> LOQ 35.18
24516	1	36.34	CP-3B	73	0.65	< LOQ 1.7	17.89	< LOQ 46.78
24502	2	36.02	CP-3B	73	2.20	> LOQ 1.7	61.08	> LOQ 47.20
24515	3	36.48	CP-3B	73	2.70	> LOQ 1.7	74.01	> LOQ 46.60
24500	OBZ	40.27	CP-3B	73	1.60	< LOQ 1.7	39.73	< LOQ 42.22
24504	1	48.47	G-7A	74	ND	< LOD 0.5	ND	< LOD 10.32
24513	2	48.22	G-7A	74	0.64	< LOQ 1.7	13.27	< LOQ 35.26
24458	3	47.94	G-7A	74	1.50	< LOQ 1.7	31.29	< LOQ 35.46
24389	OBZ	47.75	G-7A	74	0.61	< LOQ 1.7	12.77	< LOQ 35.60
24404	1	48.68	G-7B	75	ND	< LOD 0.5	ND	< LOD 10.27
24451	2	48.06	G-7B	75	0.73	< LOQ 1.7	15.19	< LOQ 35.37
24447	3	47.16	G-7B	75	1.90	> LOQ 1.7	40.29	> LOQ 36.05
24423	OBZ	47.27	G-7B	75	0.53	< LOQ 1.7	11.21	< LOQ 35.96
24456	1	49.19	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.16
24480	2	48.26	SS-06	76	0.63	< LOQ 1.7	13.05	< LOQ 35.23
24429	3	47.68	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.49
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.45
24427	1	48.54	CP-4A	78	5.10	> LOQ 1.7	105.07	> LOQ 35.02
24435	2	47.71	CP-4A	78	20.00	> LOQ 1.7	419.2	> LOQ 35.63
24244	3	49.01	CP-4A	78	110.00	> LOQ 3.4	2244.44	> LOQ 69.37
24220	OBZ	48.74	CP-4A	78	23.00	> LOQ 1.7	471.89	> LOQ 34.88
24460	1	50.05	CP-4B	79	5.20	> LOQ 1.7	103.9	> LOQ 33.97
24465	2	48.47	CP-4B	79	16.00	> LOQ 1.7	330.1	> LOQ 35.07
24207	3	48.49	CP-4B	79	80.00	> LOQ 3.4	1649.82	> LOQ 70.12
24390	OBZ	49.02	CP-4B	79	5.30	> LOQ 1.7	108.12	> LOQ 34.68
24259	1	48.76	SS-07	80	ND	< LOD 0.5	ND	< LOD 10.25
24421	2	48.13	SS-07	80	ND	< LOD 0.5	ND	< LOD 10.39
24445	3	47.87	SS-07	80	1.30	< LOQ 1.7	27.16	< LOQ 35.51
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.5	ND	< LOD 10.31
24459	1	48.96	N-02	81	6.80	> LOQ 1.7	138.89	> LOQ 34.72
24417	2	48.11	N-02	81	13.00	> LOQ 1.7	270.21	> LOQ 35.34
24442	3	48.01	N-02	81	61.00	> LOQ 1.7	1270.57	> LOQ 35.41
24386	OBZ	48.19	N-02	81	12.00	> LOQ 1.7	249.01	> LOQ 35.28
24452	1	48.20	SG-2B	82	15.00	> LOQ 1.7	311.2	> LOQ 35.27
24453	2	48.59	SG-2B	82	29.00	> LOQ 1.7	596.83	> LOQ 34.99
24420	3	47.84	SG-2B	82	71.00	> LOQ 1.7	1484.11	> LOQ 35.54
24444	OBZ	47.95	SG-2B	82	410.00	> LOQ 8.5	8550.57	> LOQ 177.27
24455	1	48.56	CS-07	83	1.60	< LOQ 1.7	32.95	< LOQ 35.01
24433	2	47.96	CS-07	83	3.90	> LOQ 1.7	81.32	> LOQ 35.45
24398	3	48.06	CS-07	83	16.00	> LOQ 1.7	332.92	> LOQ 35.37
24511	OBZ	47.96	CS-07	83	3.50	> LOQ 1.7	72.98	> LOQ 35.45
24454	1	49.34	CPDS-1A	84	1.20	< LOQ 1.7	24.32	< LOQ 34.45
24291	2	48.49	CPDS-1A	84	1.80	> LOQ 1.7	37.12	> LOQ 35.06
24209	3	48.43	CPDS-1A	84	11.00	> LOQ 1.7	227.13	> LOQ 35.10
24402	OBZ	48.77	CPDS-1A	84	4.70	> LOQ 1.7	96.37	> LOQ 34.86
24204	1	49.46	CPDS-1B	85	1.40	< LOQ 1.7	28.31	< LOQ 34.37
24273	2	48.35	CPDS-1B	85	2.60	> LOQ 1.7	53.77	> LOQ 35.16
24223	3	48.82	CPDS-1B	85	9.40	> LOQ 1.7	192.54	> LOQ 34.82
24466	OBZ	49.96	CPDS-1B	85	3.40	> LOQ 1.7	68.05	> LOQ 34.03

Airborne Sample Data Analysis - Chromium

NIOSH REL 500.0 micrograms/cubic meter
OSHA PEL 500.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 10.30	16.67	< LOQ 35.42	22.69	< LOQ 35.07	12.63	< LOQ 35.19
CS-01	11.74	< LOQ 35.02	35.42	< LOQ 35.42	129.98	> LOQ 35.07	31.3	< LOQ 35.48
CS-02	19.34	< LOQ 35.36	54.35	> LOQ 35.54	229.12	> LOQ 35.41	85.43	> LOQ 35.42
CS-03	10.72	< LOQ 35.06	43.49	> LOQ 35.20	136.87	> LOQ 35.26	37.27	> LOQ 35.20
CS-04	ND	< LOD 10.29	17.16	< LOQ 35.58	39.35	> LOQ 35.20	20.58	< LOQ 34.99
CS-05	ND	< LOD 10.32	20.86	< LOQ 35.47	46.04	> LOQ 35.58	27.29	< LOQ 55.90
CS-06	22.94	< LOQ 35.45	52.36	> LOQ 35.60	111.78	> LOQ 35.19	41.63	> LOQ 35.39
CS-07	32.95	< LOQ 35.01	81.32	> LOQ 35.45	332.92	> LOQ 35.37	72.98	> LOQ 35.45
CSDS-01	ND	< LOD 10.38	43.74	> LOQ 35.41	118.36	> LOQ 35.30	60.33	> LOQ 35.37
CSDS-02	11.95	< LOQ 35.03	41.36	> LOQ 35.15	136.62	> LOQ 35.19	54.42	> LOQ 35.58
N-01	345.46	> LOQ 34.55	1772.31	> LOQ 35.45	7036.42	> LOQ 35.18	3688.52	> LOQ 34.84
N-02	138.89	> LOQ 34.72	270.21	> LOQ 35.34	1270.57	> LOQ 35.41	249.01	> LOQ 35.28
O-1	65.9	> LOQ 35.01	96.05	> LOQ 35.50	246.56	> LOQ 34.93	119.3	> LOQ 35.58
S-01	ND	< LOD 10.38	ND	< LOD 10.44	33.40	< LOQ 35.49	ND	< LOD 10.43
S-02	ND	< LOD 10.42	14.45	< LOQ 35.59	16.46	< LOQ 35.42	ND	< LOD 10.44
SH-01	ND	< LOD 10.44	ND	< LOD 10.45	ND	< LOD 10.36	ND	< LOD 10.40
SS-01	ND	< LOD 10.32	ND	< LOD 10.44	ND	< LOD 10.34	ND	< LOD 10.35
SS-02	ND	< LOD 10.39	ND	< LOD 10.43	ND	< LOD 10.35	ND	< LOD 10.28
SS-03	ND	< LOD 10.41	ND	< LOD 10.50	ND	< LOD 10.22	ND	< LOD 10.08
SS-04	ND	< LOD 10.46	12.56	< LOQ 35.58	14.64	< LOQ 35.56	10.91	< LOQ 34.99
SS-05	ND	< LOD 10.04	12.79	< LOQ 35.65	24.94	< LOQ 35.34	18.04	< LOQ 34.84
SS-06	ND	< LOD 10.16	13.05	< LOQ 35.23	ND	< LOD 10.49	ND	< LOD 10.45
SS-07	ND	< LOD 10.25	ND	< LOD 10.39	27.16	< LOQ 35.51	ND	< LOD 10.31
SSDS-01	ND	< LOD 10.29	ND	< LOD 10.45	10.72	< LOQ 35.06	ND	< LOD 10.35
SSDS-02	ND	< LOD 10.42	ND	< LOD 10.42	15.27	< LOQ 35.08	ND	< LOD 10.13
SSDS-03	ND	< LOD 10.11	ND	< LOD 9.93	ND	< LOD 9.95	ND	< LOD 10.36
CP-1A	12.99	< LOQ 35.06	70.42	> LOQ 35.21	130.73	> LOQ 35.28	48.18	> LOQ 35.61
CP-1B	23.57	< LOQ 40.08	59.5	> LOQ 40.46	235.46	> LOQ 40.03	47.88	> LOQ 40.70
CP-2A	20.01	< LOQ 35.07	52.28	> LOQ 35.55	290.34	> LOQ 70.51	105.94	> LOQ 35.31
CP-2B	43.38	> LOQ 35.12	31.32	< LOQ 35.49	95.32	> LOQ 35.23	23.14	< LOQ 35.77
CP-3A	10.95	< LOQ 35.11	22.95	< LOQ 35.47	101.34	> LOQ 35.16	93.13	> LOQ 35.18
CP-3B	17.89	< LOQ 46.78	61.08	> LOQ 47.20	74.01	> LOQ 46.60	39.73	< LOQ 42.22
CP-4A	105.07	> LOQ 35.02	419.2	> LOQ 35.63	2244.44	> LOQ 69.37	471.89	> LOQ 34.88
CP-4B	103.9	> LOQ 33.97	330.1	> LOQ 35.07	1649.82	> LOQ 70.12	108.12	> LOQ 34.68
CPDS-1A	24.32	< LOQ 34.45	37.12	> LOQ 35.06	227.13	> LOQ 35.10	96.37	> LOQ 34.86
CPDS-1B	28.31	< LOQ 34.37	53.77	> LOQ 35.16	192.54	> LOQ 34.82	68.05	> LOQ 34.03
G-1A	ND	< LOD 10.39	20.47	< LOQ 35.51	62.28	> LOQ 35.29	47.03	> LOQ 34.76
G-1B	ND	< LOD 10.36	31.66	< LOQ 35.88	51.90	> LOQ 35.29	93.32	> LOQ 35.26
G-2A	ND	< LOD 10.54	ND	< LOD 10.61	11.61	< LOQ 35.24	ND	< LOD 10.41
G-2B	ND	< LOD 10.25	13.7	< LOQ 35.29	ND	< LOD 10.46	ND	< LOD 10.30
G-3A	ND	< LOD 10.34	27.02	< LOQ 35.34	25.18	< LOQ 35.68	ND	< LOD 10.42
G-4A	18.07	< LOQ 34.52	16.95	< LOQ 35.15	98.62	> LOQ 34.93	1.4	<LOQ 1.7
G-4B	ND	< LOD 10.33	33.33	< LOQ 35.41	55.81	> LOQ 35.14	35.11	> LOQ 35.11
G-5A	ND	< LOD 10.29	14.94	< LOQ 35.28	41.62	> LOQ 35.38	60.63	> LOQ 35.54
G-5B	ND	< LOD 10.44	31.15	< LOQ 35.30	102.13	> LOQ 35.43	16.88	< LOQ 35.42
G-6A	24.95	< LOQ 35.34	108.7	> LOQ 35.54	205.99	> LOQ 35.37	43.49	> LOQ 35.20
G-6B	13.13	< LOQ 34.86	52.69	> LOQ 35.83	40.88	> LOQ 34.75	51.59	> LOQ 35.08
G-7A	ND	< LOD 10.32	13.27	< LOQ 35.26	31.29	< LOQ 35.46	12.77	< LOQ 35.60
G-7B	ND	< LOD 10.27	15.19	< LOQ 35.37	40.29	> LOQ 36.05	11.21	< LOQ 35.96
SG-1A	12.25	< LOQ 34.71	18.26	< LOQ 35.27	72.64	> LOQ 35.28	226.94	> LOQ 175.37
SG-1B	ND	< LOD 19.22	ND	< LOD 19.22	61.30	< LOQ 65.13	217.14	< LOQ 323.81
SG-2A	1008.44	> LOQ 34.99	939.46	> LOQ 35.49	1264.51	> LOQ 70.48	5175.98	> LOQ 70.39
SG-2B	311.2	> LOQ 35.27	596.83	> LOQ 34.99	1484.11	> LOQ 35.54	8550.57	> LOQ 177.27

Bulk Elemental Analysis - Chromium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Chromium		Sample	Chromium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 2.0	J95331-63 PB	ND	< LOD 2.0
CS-01	J95331-34 VB	55.00	> LOQ 6.7	J95331-34 PB	48.00	> LOQ 6.7
CS-02	J95331-37 VB	38.00	> LOQ 6.7	J95331-37 PB	37.00	> LOQ 6.7
CS-03	J95331-38 VB	37.00	> LOQ 6.7	J95331-38 PB	46.00	> LOQ 6.7
CS-04	J95331-39 VB	ND	< LOD 2.0	J95331-39 PB	2.70	< LOQ 6.7
CS-05	J95331-57 VB	ND	< LOD 2.0	J95331-57 PB	3.30	< LOQ 6.7
CS-06	J95331-70 VB	2.40	< LOQ 6.7	J95331-70 PB	5.40	< LOQ 6.7
CS-07	J95331-83 VB	7.70	> LOQ 6.7	J95331-83 PB	20.00	> LOQ 6.7
CSDS-01	J95331-31 VB	4.60	< LOQ 6.7	J95331-31 PB	9.70	> LOQ 6.7
CSDS-02	J95331-35 VB	47.00	> LOQ 6.7	J95331-35 PB	49.00	> LOQ 6.7
N-01	J95331-52 VB	400.00	> LOQ 6.7	J95331-52 PB	610.00	> LOQ 6.7
N-02	J95331-81 VB	120.00	> LOQ 6.7	J95331-81 PB	270.00	> LOQ 6.7
O-1	J95331-69 VB	49.00	> LOQ 6.7	J95331-69 PB	71.00	> LOQ 6.7
S-01	J95331-28 VB	3.20	< LOQ 6.7	J95331-28 PB	2.70	< LOQ 6.7
S-02	J95331-29 VB	2.10	< LOQ 6.7	J95331-29 PB	3.70	0.00
SH-01	J95331-36 VB	ND	< LOD 2.0	J95331-36 PB	ND	< LOD 2.0
SS-01	J95331-32 VB	ND	< LOD 2.0	J95331-32 PB	ND	< LOD 2.0
SS-02	J95331-40 VB	ND	< LOD 2.0	J95331-40 PB	ND	< LOD 2.0
SS-03	J95331-45 VB	ND	< LOD 2.0	J95331-45 PB	ND	< LOD 2.0
SS-04	J95331-47 VB	2.70	< LOQ 6.7	J95331-47 PB	3.20	< LOQ 6.7
SS-05	J95331-53 VB	3.70	< LOQ 6.7	J95331-53 PB	2.60	< LOQ 6.7
SS-06	J95331-76 VB	2.80	< LOQ 6.7	J95331-76 PB	2.50	< LOQ 6.7
SS-07	J95331-80 VB	ND	< LOD 2.0	J95331-80 PB	ND	< LOD 2.0
SSDS-01	J95331-33 VB	ND	< LOD 2.0	J95331-33 PB	ND	< LOD 2.0
SSDS-02	J95331-44 VB	2.80	< LOQ 6.7	J95331-44 PB	2.90	< LOQ 6.7
SSDS-03	J95331-48 VB	ND	< LOD 2.0	J95331-48 PB	ND	< LOD 2.0
CP-1A	J95331-60 VB	7.60	> LOQ 6.7	J95331-60 PB	46.00	> LOQ 6.7
CP-1B	J95331-61 VB	6.60	< LOQ 6.7	J95331-61 PB	9.30	> LOQ 6.7
CP-2A	J95331-67 VB	46.00	> LOQ 6.7	J95331-67 PB	62.00	> LOQ 13.0
CP-2B	J95331-68 VB	54.00	> LOQ 13.0	J95331-68 PB	59.00	> LOQ 13.0
CP-3A	J95331-72 VB	17.00	> LOQ 6.7	J95331-72 PB	16.00	> LOQ 6.7
CP-3B	J95331-73 VB	19.00	> LOQ 6.7	J95331-73 PB	20.00	> LOQ 6.7
CP-4A	J95331-78 VB	96.00	> LOQ 6.7	J95331-78 PB	200.00	> LOQ 13.0
CP-4B	J95331-79 VB	220.00	> LOQ 6.7	J95331-79 PB	240.00	> LOQ 6.7
CPDS-1A	J95331-84 VB	28.00	> LOQ 6.7	J95331-84 PB	51.00	> LOQ 6.7
CPDS-1B	J95331-85 VB	73.00	> LOQ 6.7	J95331-85 PB	55.00	> LOQ 6.7
G-1A	J95331-41 VB	4.00	< LOQ 6.7	J95331-41 PB	5.10	< LOQ 6.7
G-1B	J95331-46 VB	64.00	> LOQ 6.7	J95331-46 PB	44.00	> LOQ 6.7
G-2A	J95331-43 VB	ND	< LOD 2.0	J95331-43 PB	2.90	< LOQ 6.7
G-2B	J95331-50 VB	5.00	< LOQ 6.7	J95331-50 PB	2.90	< LOQ 6.7
G-3A	J95331-49 VB	3.70	< LOQ 6.7	J95331-49 PB	3.00	< LOQ 6.7
G-4A	J95331-55 VB	ND	< LOD 2.0	J95331-55 PB	4.50	< LOQ 6.7
G-4B	J95331-56 VB	9.10	> LOQ 6.7	J95331-56 PB	8.10	> LOQ 6.7
G-5A	J95331-58 VB	3.50	< LOQ 6.7	J95331-58 PB	3.30	< LOQ 6.7
G-5B	J95331-59 VB	3.60	< LOQ 6.7	J95331-59 PB	3.80	< LOQ 6.7
G-6A	J95331-64 VB	3.00	< LOQ 6.7	J95331-64 PB	4.90	< LOQ 6.7
G-6B	J95331-65 VB	7.50	> LOQ 6.7	J95331-65 PB	6.50	< LOQ 6.7
G-7A	J95331-74 VB	ND	< LOD 2.0	J95331-74 PB	ND	< LOD 2.0
G-7B	J95331-75 VB	2.10	< LOQ 6.7	J95331-75 PB	2.30	< LOQ 6.7
SG-1A	J95331-54 VB	48.00	> LOQ 34.0	J95331-54 PB	46.00	> LOQ 34.0
SG-1B	J95331-71 VB	34.00	> LOQ 34.0	J95331-71 PB	40.00	> LOQ 34.0
SG-2A	J95331-66 VB	1700.00	> LOQ 34.0	J95331-66 PB	1200.00	> LOQ 34.0
SG-2B	J95331-82 VB	1900.00	> LOQ 34.0	J95331-82 PB	1900.00	> LOQ 34.0

Comparison of Airborne Concentrations to Bulk Concentrations - Chromium

NIOSH REL 500.0 micrograms/cubic meter
OSHA PEL 500.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	16.67	22.69	12.63	ND
CS-01	11.74	35.42	129.98	31.30	55.00
CS-02	19.34	54.35	229.12	85.43	38.00
CS-03	10.72	43.49	136.87	37.27	37.00
CS-04	ND	17.16	39.35	20.58	ND
CS-05	ND	20.86	46.04	27.29	ND
CS-06	22.94	52.36	111.78	41.63	2.40
CS-07	32.95	81.32	332.92	72.98	7.70
CSDS-01	ND	43.74	118.36	60.33	4.60
CSDS-02	11.95	41.36	136.62	54.42	47.00
N-01	345.46	1772.31	7036.42	3688.52	400.00
N-02	138.89	270.21	1270.57	249.01	120.00
O-1	65.90	96.05	246.56	119.30	49.00
S-01	ND	ND	33.40	ND	3.20
S-02	ND	14.45	16.46	ND	2.10
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	12.56	14.64	10.91	2.70
SS-05	ND	12.79	24.94	18.04	3.70
SS-06	ND	13.05	ND	ND	2.80
SS-07	ND	ND	27.16	ND	ND
SSDS-01	ND	ND	10.72	ND	ND
SSDS-02	ND	ND	15.27	ND	2.80
SSDS-03	ND	ND	ND	ND	ND
CP-1A	12.99	70.42	130.73	48.18	7.60
CP-2A	20.01	52.28	290.34	105.94	46.00
CP-3A	10.95	22.95	101.34	93.13	17.00
CP-4A	105.07	419.20	2244.44	471.89	96.00
CPDS-1A	24.32	37.12	227.13	96.37	28.00
G-1A	ND	20.47	62.28	47.03	4.00
G-2A	ND	ND	11.61	ND	ND
G-3A	ND	27.02	25.18	ND	3.70
G-4A	18.07	16.95	98.62	1.40	ND
G-5A	ND	14.94	41.62	60.63	3.50
G-6A	24.95	108.70	205.99	43.49	3.00
G-7A	ND	13.27	31.29	12.77	ND
SG-1A	12.25	18.26	72.64	226.94	48.00
SG-2A	1008.44	939.46	1264.51	5175.98	1700.00

APPENDIX B - COBALT

Cobalt

Cobalt metal dust may cause irritation of the nose and throat. Respiratory disease symptoms range from cough and shortness of breath to permanent disability. Exposure to cobalt may cause an allergic skin rash. The NIOSH REL and OSHA PEL for cobalt are 50 and 100 micrograms/cubic meter of air, respectively.

Air Sample Results - Cobalt

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cobalt			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.20	ND	< LOD 4.15
24412	2	47.89	S-01	28	ND	< LOD 0.20	ND	< LOD 4.18
24441	3	47.90	S-01	28	ND	< LOD 0.20	ND	< LOD 4.18
24450	OBZ	47.93	S-01	28	ND	< LOD 0.20	ND	< LOD 4.17
24643	1	47.98	S-02	29	ND	< LOD 0.20	ND	< LOD 4.17
24625	2	47.76	S-02	29	ND	< LOD 0.20	ND	< LOD 4.19
24642	3	48.00	S-02	29	ND	< LOD 0.20	ND	< LOD 4.17
24632	OBZ	47.89	S-02	29	ND	< LOD 0.20	ND	< LOD 4.18
24634	1	48.16	CSDS-01	31	ND	< LOD 0.20	ND	< LOD 4.15
24650	2	48.01	CSDS-01	31	0.26	< LOQ 0.43	5.42	< LOQ 8.96
24644	3	48.16	CSDS-01	31	1.10	> LOQ 0.43	22.84	> LOQ 8.93
24645	OBZ	48.07	CSDS-01	31	0.56	> LOQ 0.43	11.65	> LOQ 8.95
24640	1	48.44	SS-01	32	ND	< LOD 0.20	ND	< LOD 4.13
24641	2	47.90	SS-01	32	ND	< LOD 0.20	ND	< LOD 4.18
24651	3	48.35	SS-01	32	ND	< LOD 0.20	ND	< LOD 4.14
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.20	ND	< LOD 4.14
24646	1	48.58	SSDS-01	33	ND	< LOD 0.20	ND	< LOD 4.12
24626	2	47.84	SSDS-01	33	ND	< LOD 0.20	ND	< LOD 4.18
24638	3	48.49	SSDS-01	33	ND	< LOD 0.20	ND	< LOD 4.12
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.20	ND	< LOD 4.14
24628	1	48.55	CS-01	34	ND	< LOD 0.20	ND	< LOD 4.12
24637	2	48.00	CS-01	34	ND	< LOD 0.20	ND	< LOD 4.17
24624	3	48.47	CS-01	34	1.20	> LOQ 0.43	24.76	> LOQ 8.87
24636	OBZ	47.92	CS-01	34	ND	< LOD 0.20	ND	< LOD 4.17
24623	1	48.53	CSDS-02	35	ND	< LOD 0.20	ND	< LOD 4.12
24622	2	48.36	CSDS-02	35	0.32	< LOQ 0.43	6.62	< LOQ 8.89
24654	3	48.31	CSDS-02	35	0.95	> LOQ 0.43	19.66	> LOQ 8.90
24653	OBZ	47.78	CSDS-02	35	0.26	< LOQ 0.43	5.44	< LOQ 9.00
24629	1	47.88	SH-01	36	ND	< LOD 0.20	ND	< LOD 4.18
24633	2	47.86	SH-01	36	ND	< LOD 0.20	ND	< LOD 4.18
24627	3	48.24	SH-01	36	ND	< LOD 0.20	ND	< LOD 4.15
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.20	ND	< LOD 4.16
24555	1	48.08	CS-02	37	ND	< LOD 0.20	ND	< LOD 4.16
24552	2	47.84	CS-02	37	0.52	> LOQ 0.43	10.87	> LOQ 8.99
24541	3	48.01	CS-02	37	2.40	> LOQ 0.43	49.99	> LOQ 8.96
24529	OBZ	47.99	CS-02	37	0.77	> LOQ 0.43	16.05	> LOQ 8.96
24558	1	48.49	CS-03	38	ND	< LOD 0.20	ND	< LOD 4.12
24524	2	48.29	CS-03	38	0.60	> LOQ 0.43	12.42	> LOQ 8.90
24561	3	48.22	CS-03	38	2.40	> LOQ 0.43	49.77	> LOQ 8.92
24559	OBZ	48.29	CS-03	38	0.62	> LOQ 0.43	12.84	> LOQ 8.90
24543	1	48.61	CS-04	39	ND	< LOD 0.20	ND	< LOD 4.11
24532	2	47.78	CS-04	39	ND	< LOD 0.20	ND	< LOD 4.19
24546	3	48.29	CS-04	39	0.44	> LOQ 0.43	9.11	> LOQ 8.90
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.20	ND	< LOD 4.12
24560	1	48.13	SS-02	40	ND	< LOD 0.20	ND	< LOD 4.16
24565	2	47.95	SS-02	40	ND	< LOD 0.20	ND	< LOD 4.17
24630	3	48.32	SS-02	40	ND	< LOD 0.20	ND	< LOD 4.14
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.20	ND	< LOD 4.11
24525	1	48.13	G-1A	41	ND	< LOD 0.20	ND	< LOD 4.16
24563	2	47.87	G-1A	41	ND	< LOD 0.20	ND	< LOD 4.18
24547	3	48.17	G-1A	41	0.32	< LOQ 0.43	6.64	< LOQ 8.93
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.20	ND	< LOD 4.09
24538	1	47.45	G-2A	43	ND	< LOD 0.20	ND	< LOD 4.21

Air Sample Results - Cobalt

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cobalt			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	1.10	> LOQ 0.43	23.34	> LOQ 9.13
24533	3	48.24	G-2A	43	ND	< LOD 0.20	ND	< LOD 4.15
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.20	ND	< LOD 4.16
24528	1	47.99	SSDS-02	44	ND	< LOD 0.20	ND	< LOD 4.17
24544	2	48.00	SSDS-02	44	ND	< LOD 0.20	ND	< LOD 4.17
24567	3	48.46	SSDS-02	44	ND	< LOD 0.20	ND	< LOD 4.13
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.20	ND	< LOD 4.05
24571	1	48.05	SS-03	45	ND	< LOD 0.20	ND	< LOD 4.16
24536	2	47.60	SS-03	45	ND	< LOD 0.20	ND	< LOD 4.20
24534	3	48.94	SS-03	45	ND	< LOD 0.20	ND	< LOD 4.09
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.20	ND	< LOD 4.03
24568	1	48.28	G-1B	46	ND	< LOD 0.20	ND	< LOD 4.14
24592	2	47.38	G-1B	46	0.28	< LOQ 0.43	5.91	< LOQ 9.08
24593	3	48.17	G-1B	46	0.37	< LOQ 0.43	7.68	< LOQ 8.93
24535	OBZ	48.22	G-1B	46	0.46	> LOQ 0.43	9.54	> LOQ 8.92
24590	1	47.81	SS-04	47	ND	< LOD 0.20	ND	< LOD 4.18
24605	2	47.78	SS-04	47	ND	< LOD 0.20	ND	< LOD 4.19
24562	3	47.80	SS-04	47	ND	< LOD 0.20	ND	< LOD 4.18
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.20	ND	< LOD 4.12
24527	1	49.48	SSDS-03	48	ND	< LOD 0.20	ND	< LOD 4.04
24569	2	50.35	SSDS-03	48	ND	< LOD 0.20	ND	< LOD 3.97
24584	3	50.24	SSDS-03	48	ND	< LOD 0.20	ND	< LOD 3.98
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.20	ND	< LOD 4.14
24600	1	48.34	G-3A	49	ND	< LOD 0.20	ND	< LOD 4.14
24616	2	48.11	G-3A	49	ND	< LOD 0.20	ND	< LOD 4.16
24585	3	47.65	G-3A	49	ND	< LOD 0.20	ND	< LOD 4.20
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.20	ND	< LOD 4.17
24587	1	48.79	G-2B	50	ND	< LOD 0.20	ND	< LOD 4.10
24602	2	48.17	G-2B	50	ND	< LOD 0.20	ND	< LOD 4.15
24564	3	47.81	G-2B	50	ND	< LOD 0.20	ND	< LOD 4.18
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.20	ND	< LOD 4.12
24618	1	49.21	N-01	52	0.31	< LOQ 0.43	6.3	< LOQ 8.74
24611	2	47.96	N-01	52	0.95	> LOQ 0.43	19.81	> LOQ 8.97
24588	3	48.32	N-01	52	4.60	> LOQ 0.43	95.2	> LOQ 8.90
24615	OBZ	48.80	N-01	52	2.40	> LOQ 0.43	49.18	> LOQ 8.81
24597	1	49.78	SS-05	53	ND	< LOD 0.20	ND	< LOD 4.02
24599	2	47.68	SS-05	53	ND	< LOD 0.20	ND	< LOD 4.19
24575	3	48.11	SS-05	53	0.26	< LOQ 0.43	5.4	< LOQ 8.94
24617	OBZ	48.79	SS-05	53	0.24	< LOQ 0.43	4.92	< LOQ 8.81
24609	1	48.98	SG-1A	54	0.31	< LOQ 0.43	6.33	< LOQ 8.78
24596	2	48.20	SG-1A	54	ND	< LOD 0.20	ND	< LOD 4.15
24610	3	48.18	SG-1A	54	0.86	> LOQ 0.43	17.85	> LOQ 8.92
24576	OBZ	48.47	SG-1A	54	6.10	> LOQ 2.20	125.85	> LOQ 45.39
24606	1	49.24	G-4A	55	ND	< LOD 0.20	ND	< LOD 4.06
24620	2	48.37	G-4A	55	0.24	< LOQ 0.43	4.96	< LOQ 8.89
24573	3	48.67	G-4A	55	1.40	> LOQ 0.43	28.77	> LOQ 8.84
24505	OBZ	48.16	G-4A	55	0.35	< LOQ 0.43	7.27	< LOQ 8.93
24340	1	48.38	G-4B	56	0.22	< LOQ 0.43	4.55	< LOQ 8.89
24607	2	48.01	G-4B	56	0.47	> LOQ 0.43	9.79	> LOQ 8.96
24595	3	48.38	G-4B	56	0.77	> LOQ 0.43	15.92	> LOQ 8.89
24598	OBZ	48.42	G-4B	56	0.50	> LOQ 0.43	10.33	> LOQ 8.88
24580	1	48.44	CS-05	57	ND	< LOD 0.20	ND	< LOD 4.13
24604	2	47.93	CS-05	57	0.22	< LOQ 0.43	4.59	< LOQ 8.97

Air Sample Results - Cobalt

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cobalt			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	0.61	> LOQ 0.43	12.77	> LOQ 9.00
24574	OBZ	30.41	CS-05	57	ND	< LOD 0.20	ND	< LOD 6.58
24614	1	48.58	G-5A	58	ND	< LOD 0.20	ND	< LOD 4.12
24577	2	48.18	G-5A	58	ND	< LOD 0.20	ND	< LOD 4.15
24572	3	48.05	G-5A	58	0.37	< LOQ 0.43	7.7	< LOQ 8.95
24582	OBZ	47.83	G-5A	58	0.56	> LOQ 0.43	11.71	> LOQ 8.99
24322	1	47.88	G-5B	59	ND	< LOD 0.20	ND	< LOD 4.18
24354	2	48.16	G-5B	59	ND	< LOD 0.20	ND	< LOD 4.15
24510	3	47.98	G-5B	59	0.87	> LOQ 0.43	18.13	> LOQ 8.96
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.20	ND	< LOD 4.17
24497	1	48.49	CP-1A	60	0.44	> LOQ 0.43	9.07	> LOQ 8.87
24333	2	48.28	CP-1A	60	1.40	> LOQ 0.43	29	> LOQ 8.91
24326	3	48.19	CP-1A	60	4.80	> LOQ 0.43	99.61	> LOQ 8.92
24329	OBZ	47.74	CP-1A	60	1.60	> LOQ 0.43	33.51	> LOQ 9.01
24499	1	42.42	CP-1B	62	0.69	> LOQ 0.43	16.27	> LOQ 10.14
24506	2	42.02	CP-1B	62	1.50	> LOQ 0.43	35.7	> LOQ 10.23
24388	3	42.47	CP-1B	62	5.80	> LOQ 0.43	136.57	> LOQ 10.12
24315	OBZ	41.77	CP-1B	62	1.50	> LOQ 0.43	35.91	> LOQ 10.29
24318	1	48.56	CG-01	63	ND	< LOD 0.20	ND	< LOD 4.12
24308	2	48.00	CG-01	63	0.46	> LOQ 0.43	9.58	> LOQ 8.96
24330	3	48.47	CG-01	63	0.30	< LOQ 0.43	6.19	< LOQ 8.87
24230	OBZ	48.31	CG-01	63	0.21	< LOQ 0.43	4.35	< LOQ 8.90
24363	1	48.10	G-6A	64	0.21	< LOQ 0.43	4.37	< LOQ 8.94
24398	2	47.84	G-6A	64	1.00	> LOQ 0.43	20.9	> LOQ 8.99
24351	3	48.06	G-6A	64	1.80	> LOQ 0.43	37.45	> LOQ 8.95
24594	OBZ	48.29	G-6A	64	0.58	> LOQ 0.43	12.01	> LOQ 8.90
24312	1	48.76	G-6B	65	0.20	< LOQ 0.43	4.1	< LOQ 8.82
24484	2	47.45	G-6B	65	0.57	> LOQ 0.43	12.01	> LOQ 9.06
24327	3	48.92	G-6B	65	0.67	> LOQ 0.43	13.7	> LOQ 8.79
24389	OBZ	48.46	G-6B	65	0.32	< LOQ 0.43	6.6	< LOQ 8.87
24348	1	48.59	SG-2A	66	1.60	> LOQ 0.43	32.93	> LOQ 8.85
24314	2	47.90	SG-2A	66	1.70	> LOQ 0.43	35.49	> LOQ 8.98
24494	3	48.24	SG-2A	66	2.30	> LOQ 0.43	47.68	> LOQ 8.91
24337	OBZ	48.30	SG-2A	66	9.50	> LOQ 0.86	196.69	> LOQ 17.81
24508	1	48.47	CP-2A	67	0.39	< LOQ 0.43	8.05	< LOQ 8.87
24361	2	47.82	CP-2A	67	1.30	> LOQ 0.43	27.19	> LOQ 8.99
24359	3	48.22	CP-2A	67	7.50	> LOQ 0.86	155.54	> LOQ 17.83
24471	OBZ	48.14	CP-2A	67	2.90	> LOQ 0.43	60.24	> LOQ 8.93
24373	1	48.41	CP-2B	68	1.40	> LOQ 0.43	28.92	> LOQ 8.88
24468	2	47.90	CP-2B	68	0.72	> LOQ 0.43	15.03	> LOQ 8.98
24481	3	48.26	CP-2B	68	2.70	> LOQ 0.43	55.95	> LOQ 8.91
24391	OBZ	47.53	CP-2B	68	0.57	> LOQ 0.43	11.99	> LOQ 9.05
24356	1	48.56	O-1	69	1.80	> LOQ 0.43	37.07	> LOQ 8.86
24470	2	47.89	O-1	69	3.60	> LOQ 0.43	75.17	> LOQ 8.98
24467	3	48.67	O-1	69	9.40	> LOQ 0.43	193.14	> LOQ 8.84
24313	OBZ	47.78	O-1	69	1.60	> LOQ 0.43	33.49	> LOQ 9.00
24501	1	47.96	CS-06	70	ND	< LOD 0.20	ND	< LOD 4.17
24496	2	47.75	CS-06	70	0.41	< LOQ 0.43	8.59	< LOQ 9.01
24478	3	48.31	CS-06	70	0.77	> LOQ 0.43	15.94	> LOQ 8.90
24503	OBZ	48.04	CS-06	70	0.32	< LOQ 0.43	6.66	< LOQ 8.95
24474	1	26.02	SG-1B	71	ND	< LOD 0.20	ND	< LOD 7.69
24469	2	26.02	SG-1B	71	ND	< LOD 0.20	ND	< LOD 7.69
24492	3	26.10	SG-1B	71	ND	< LOD 0.20	ND	< LOD 7.66

Air Sample Results - Cobalt

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Cobalt			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	4.60	> LOQ 2.20	175.24	> LOQ 83.81
24489	1	48.42	CP-3A	72	0.35	< LOQ 0.43	7.23	< LOQ 8.88
24491	2	47.93	CP-3A	72	0.91	> LOQ 0.43	18.99	> LOQ 8.97
24482	3	48.35	CP-3A	72	3.40	> LOQ 0.43	70.32	> LOQ 8.89
24486	OBZ	48.32	CP-3A	72	3.30	> LOQ 0.43	68.29	> LOQ 8.90
24516	1	36.34	CP-3B	73	0.22	< LOQ 0.43	6.05	< LOQ 11.83
24502	2	36.02	CP-3B	73	1.60	> LOQ 0.43	44.42	> LOQ 11.94
24515	3	36.48	CP-3B	73	2.30	> LOQ 0.43	63.05	> LOQ 11.79
24500	OBZ	40.27	CP-3B	73	1.00	> LOQ 0.43	24.83	> LOQ 10.68
24504	1	48.47	G-7A	74	ND	< LOD 0.20	ND	< LOD 4.13
24513	2	48.22	G-7A	74	ND	< LOD 0.20	ND	< LOD 4.15
24458	3	47.94	G-7A	74	ND	< LOD 0.20	ND	< LOD 4.17
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.20	ND	< LOD 4.19
24404	1	48.68	G-7B	75	ND	< LOD 0.20	ND	< LOD 4.11
24451	2	48.06	G-7B	75	ND	< LOD 0.20	ND	< LOD 4.16
24447	3	47.16	G-7B	75	ND	< LOD 0.20	ND	< LOD 4.24
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.20	ND	< LOD 4.23
24456	1	49.19	SS-06	76	ND	< LOD 0.20	ND	< LOD 4.07
24480	2	48.26	SS-06	76	ND	< LOD 0.20	ND	< LOD 4.14
24429	3	47.68	SS-06	76	ND	< LOD 0.20	ND	< LOD 4.19
24418	OBZ	47.83	SS-06	76	ND	> LOQ 0.43	ND	< LOD 8.99
24427	1	48.54	CP-4A	78	1.00	> LOQ 0.43	20.6	> LOQ 8.86
24435	2	47.71	CP-4A	78	4.80	> LOQ 0.43	100.61	> LOQ 9.01
24244	3	49.01	CP-4A	78	27.00	> LOQ 0.86	550.91	> LOQ 17.55
24220	OBZ	48.74	CP-4A	78	6.10	> LOQ 0.43	125.15	> LOQ 8.82
24460	1	50.05	CP-4B	79	1.20	> LOQ 0.43	23.98	> LOQ 8.59
24465	2	48.47	CP-4B	79	3.70	> LOQ 0.43	76.34	> LOQ 8.87
24207	3	48.49	CP-4B	79	19.00	> LOQ 0.86	391.83	> LOQ 17.74
24390	OBZ	49.02	CP-4B	79	1.20	> LOQ 0.43	24.48	> LOQ 8.77
24259	1	48.76	SS-07	80	ND	< LOD 0.20	ND	< LOD 4.10
24421	2	48.13	SS-07	80	ND	< LOD 0.20	ND	< LOD 4.16
24445	3	47.87	SS-07	80	0.34	< LOQ 0.43	7.1	< LOQ 8.98
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.20	ND	< LOD 4.12
24459	1	48.96	N-02	81	12.00	> LOQ 0.43	245.1	> LOQ 8.78
24417	2	48.11	N-02	81	25.00	> LOQ 0.43	519.64	> LOQ 8.94
24442	3	48.01	N-02	81	110.00	> LOQ 0.43	2291.19	> LOQ 8.96
24386	OBZ	48.19	N-02	81	21.00	> LOQ 0.43	435.78	> LOQ 8.92
24452	1	48.20	SG-2B	82	0.69	> LOQ 0.43	14.32	> LOQ 8.92
24453	2	48.59	SG-2B	82	0.95	> LOQ 0.43	19.55	> LOQ 8.85
24420	3	47.84	SG-2B	82	2.30	> LOQ 0.43	48.08	> LOQ 8.99
24444	OBZ	47.95	SG-2B	82	13.00	> LOQ 2.20	271.12	> LOQ 45.88
24455	1	48.56	CS-07	83	0.30	< LOQ 0.43	6.18	< LOQ 8.86
24433	2	47.96	CS-07	83	1.20	> LOQ 0.43	25.02	> LOQ 8.97
24398	3	48.06	CS-07	83	6.30	> LOQ 0.43	131.09	> LOQ 8.95
24511	OBZ	47.96	CS-07	83	0.96	> LOQ 0.43	20.02	> LOQ 8.97
24454	1	49.34	CPDS-1A	84	0.66	> LOQ 0.43	13.38	> LOQ 8.72
24291	2	48.49	CPDS-1A	84	1.10	> LOQ 0.43	22.69	> LOQ 8.87
24209	3	48.43	CPDS-1A	84	7.00	> LOQ 0.43	144.54	> LOQ 8.88
24402	OBZ	48.77	CPDS-1A	84	2.40	> LOQ 0.43	49.21	> LOQ 8.82
24204	1	49.46	CPDS-1B	85	0.81	> LOQ 0.43	16.38	> LOQ 8.69
24273	2	48.35	CPDS-1B	85	1.20	> LOQ 0.43	24.82	> LOQ 8.89
24223	3	48.82	CPDS-1B	85	5.50	> LOQ 0.43	112.66	> LOQ 8.81
24466	OBZ	49.96	CPDS-1B	85	1.10	> LOQ 0.43	22.02	> LOQ 8.61

Airborne Sample Data Analysis - Cobalt

NIOSH REL 50.0 micrograms/cubic meter

OSHA PEL 100.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 4.12	9.58	> LOQ 8.96	6.19	< LOQ 8.87	4.35	< LOQ 8.90
CS-01	ND	< LOD 4.12	ND	< LOD 4.17	24.76	> LOQ 8.87	ND	< LOD 4.17
CS-02	ND	< LOD 4.16	10.87	> LOQ 8.99	49.99	> LOQ 8.96	16.05	> LOQ 8.96
CS-03	ND	< LOD 4.12	12.42	> LOQ 8.90	49.77	> LOQ 8.92	12.84	> LOQ 8.90
CS-04	ND	< LOD 4.11	ND	< LOD 4.19	9.11	> LOQ 8.90	ND	< LOD 4.12
CS-05	ND	< LOD 4.13	4.59	< LOQ 8.97	12.77	> LOQ 9.00	ND	< LOD 6.58
CS-06	ND	< LOD 4.17	8.59	< LOQ 9.01	15.94	> LOQ 8.90	6.66	< LOQ 8.95
CS-07	6.18	< LOQ 8.86	25.02	> LOQ 8.97	131.09	> LOQ 8.95	20.02	> LOQ 8.97
CSDS-01	ND	< LOD 4.15	5.42	< LOQ 8.96	22.84	> LOQ 8.93	11.65	> LOQ 8.95
CSDS-02	ND	< LOD 4.12	6.62	< LOQ 8.89	19.66	> LOQ 8.90	5.44	< LOQ 9.00
N-01	6.3	< LOQ 8.74	19.81	> LOQ 8.97	95.20	> LOQ 8.90	49.18	> LOQ 8.81
N-02	245.1	> LOQ 8.78	519.64	> LOQ 8.94	2291.19	> LOQ 8.96	435.78	> LOQ 8.92
O-1	37.07	> LOQ 8.86	75.17	> LOQ 8.98	193.14	> LOQ 8.84	33.49	> LOQ 9.00
S-01	ND	< LOD 4.15	ND	< LOD 4.18	ND	< LOD 4.18	ND	< LOD 4.17
S-02	ND	< LOD 4.17	ND	< LOD 4.19	ND	< LOD 4.17	ND	< LOD 4.18
SH-01	ND	< LOD 4.18	ND	< LOD 4.18	ND	< LOD 4.15	ND	< LOD 4.16
SS-01	ND	< LOD 4.13	ND	< LOD 4.18	ND	< LOD 4.14	ND	< LOD 4.14
SS-02	ND	< LOD 4.16	ND	< LOD 4.17	ND	< LOD 4.14	ND	< LOD 4.11
SS-03	ND	< LOD 4.16	ND	< LOD 4.20	ND	< LOD 4.09	ND	< LOD 4.03
SS-04	ND	< LOD 4.18	ND	< LOD 4.19	ND	< LOD 4.18	ND	< LOD 4.12
SS-05	ND	< LOD 4.02	ND	< LOD 4.19	5.40	< LOQ 8.94	4.92	< LOQ 8.81
SS-06	ND	< LOD 4.07	ND	< LOD 4.14	ND	< LOD 4.19	ND	< LOD 8.99
SS-07	ND	< LOD 4.10	ND	< LOD 4.16	7.10	< LOQ 8.98	ND	< LOD 4.12
SSDS-01	ND	< LOD 4.12	ND	< LOD 4.18	ND	< LOD 4.12	ND	< LOD 4.14
SSDS-02	ND	< LOD 4.17	ND	< LOD 4.17	ND	< LOD 4.13	ND	< LOD 4.05
SSDS-03	ND	< LOD 4.04	ND	< LOD 3.97	ND	< LOD 3.98	ND	< LOD 4.14
CP-1A	9.07	> LOQ 8.87	29	> LOQ 8.91	99.61	> LOQ 8.92	33.51	> LOQ 9.01
CP-1B	16.27	> LOQ 10.14	35.7	> LOQ 10.23	136.57	> LOQ 10.12	35.91	> LOQ 10.29
CP-2A	8.05	< LOQ 8.87	27.19	> LOQ 8.99	155.54	> LOQ 17.83	60.24	> LOQ 8.93
CP-2B	28.92	> LOQ 8.88	15.03	> LOQ 8.98	55.95	> LOQ 8.91	11.99	> LOQ 9.05
CP-3A	7.23	< LOQ 8.88	18.99	> LOQ 8.97	70.32	> LOQ 8.89	68.29	> LOQ 8.90
CP-3B	6.05	< LOQ 11.83	44.42	> LOQ 11.94	63.05	> LOQ 11.79	24.83	> LOQ 10.68
CP-4A	20.6	> LOQ 8.86	100.61	> LOQ 9.01	550.91	> LOQ 17.55	125.15	> LOQ 8.82
CP-4B	23.98	> LOQ 8.59	76.34	> LOQ 8.87	391.83	> LOQ 17.74	24.48	> LOQ 8.77
CPDS-1A	13.38	> LOQ 8.72	22.69	> LOQ 8.87	144.54	> LOQ 8.88	49.21	> LOQ 8.82
CPDS-1B	16.38	> LOQ 8.69	24.82	> LOQ 8.89	112.66	> LOQ 8.81	22.02	> LOQ 8.61
G-1A	ND	< LOD 4.16	ND	< LOD 4.18	6.64	< LOQ 8.93	ND	< LOD 4.09
G-1B	ND	< LOD 4.14	5.91	< LOQ 9.08	7.68	< LOQ 8.93	9.54	> LOQ 8.92
G-2A	ND	< LOD 4.21	23.34	> LOQ 9.13	ND	< LOD 4.15	ND	< LOD 4.16
G-2B	ND	< LOD 4.10	ND	< LOD 4.15	ND	< LOD 4.18	ND	< LOD 4.12
G-3A	ND	< LOD 4.14	ND	< LOD 4.16	ND	< LOD 4.20	ND	< LOD 4.17
G-4A	ND	< LOD 4.06	4.96	< LOQ 8.89	28.77	> LOQ 8.84	7.27	< LOQ 8.93
G-4B	4.55	< LOQ 8.89	9.79	> LOQ 8.96	15.92	> LOQ 8.89	10.33	> LOQ 8.88
G-5A	ND	< LOD 4.12	ND	< LOD 4.15	7.70	< LOQ 8.95	11.71	> LOQ 8.99
G-5B	ND	< LOD 4.18	ND	< LOD 4.15	18.13	> LOQ 8.96	ND	< LOD 4.17
G-6A	4.37	< LOQ 8.94	20.9	> LOQ 8.99	37.45	> LOQ 8.95	12.01	> LOQ 8.90
G-6B	4.1	< LOQ 8.82	12.01	> LOQ 9.06	13.70	> LOQ 8.79	6.6	< LOQ 8.87
G-7A	ND	< LOD 4.13	ND	< LOD 4.15	ND	< LOD 4.17	ND	< LOD 4.19
G-7B	ND	< LOD 4.11	ND	< LOD 4.16	ND	< LOD 4.24	ND	< LOD 4.23
SG-1A	6.33	< LOQ 8.78	ND	< LOD 4.15	17.85	> LOQ 8.92	125.85	> LOQ 45.39
SG-1B	ND	< LOD 7.69	ND	< LOD 7.69	ND	< LOD 7.66	175.24	> LOQ 83.81
SG-2A	32.93	> LOQ 8.85	35.49	> LOQ 8.98	47.68	> LOQ 8.91	196.69	> LOQ 17.81
SG-2B	14.32	> LOQ 8.92	19.55	> LOQ 8.85	48.08	> LOQ 8.99	271.12	> LOQ 45.88

Bulk Elemental Analysis - Cobalt

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Cobalt		Sample	Cobalt	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	1.10	< LOQ 1.7	J95331-63 PB	1.40	< LOQ 1.7
CS-01	J95331-34 VB	9.10	> LOQ 1.7	J95331-34 PB	9.50	> LOQ 1.7
CS-02	J95331-37 VB	8.20	> LOQ 1.7	J95331-37 PB	7.80	> LOQ 1.7
CS-03	J95331-38 VB	15.00	> LOQ 1.7	J95331-38 PB	18.00	> LOQ 1.7
CS-04	J95331-39 VB	0.55	< LOQ 1.7	J95331-39 PB	0.64	< LOQ 1.7
CS-05	J95331-57 VB	0.83	< LOQ 1.7	J95331-57 PB	0.67	< LOQ 1.7
CS-06	J95331-70 VB	ND	< LOD 0.5	J95331-70 PB	0.72	< LOQ 1.7
CS-07	J95331-83 VB	2.80	> LOQ 1.7	J95331-83 PB	1.40	< LOQ 1.7
CSDS-01	J95331-31 VB	0.97	< LOQ 1.7	J95331-31 PB	1.50	< LOQ 1.7
CSDS-02	J95331-35 VB	7.00	> LOQ 1.7	J95331-35 PB	7.70	> LOQ 1.7
N-01	J95331-52 VB	11.00	> LOQ 1.7	J95331-52 PB	12.00	> LOQ 1.7
N-02	J95331-81 VB	250.00	> LOQ 1.7	J95331-81 PB	510.00	> LOQ 1.7
O-1	J95331-69 VB	74.00	> LOQ 1.7	J95331-69 PB	79.00	> LOQ 1.7
S-01	J95331-28 VB	ND	< LOD 0.5	J95331-28 PB	ND	< LOD 0.5
S-02	J95331-29 VB	ND	< LOD 0.5	J95331-29 PB	ND	< LOD 0.5
SH-01	J95331-36 VB	ND	< LOD 0.5	J95331-36 PB	ND	< LOD 0.5
SS-01	J95331-32 VB	ND	< LOD 0.5	J95331-32 PB	ND	< LOD 0.5
SS-02	J95331-40 VB	ND	< LOD 0.5	J95331-40 PB	ND	< LOD 0.5
SS-03	J95331-45 VB	ND	< LOD 0.5	J95331-45 PB	ND	< LOD 0.5
SS-04	J95331-47 VB	0.73	< LOQ 1.7	J95331-47 PB	ND	< LOD 0.5
SS-05	J95331-53 VB	0.95	< LOQ 1.7	J95331-53 PB	ND	< LOD 0.5
SS-06	J95331-76 VB	ND	< LOD 0.5	J95331-76 PB	ND	< LOD 0.5
SS-07	J95331-80 VB	ND	< LOD 0.5	J95331-80 PB	ND	< LOD 0.5
SSDS-01	J95331-33 VB	ND	< LOD 0.5	J95331-33 PB	ND	< LOD 0.5
SSDS-02	J95331-44 VB	0.97	< LOQ 1.7	J95331-44 PB	0.66	< LOQ 1.7
SSDS-03	J95331-48 VB	ND	< LOD 0.5	J95331-48 PB	ND	< LOD 0.5
CP-1A	J95331-60 VB	8.50	> LOQ 1.7	J95331-60 PB	36.00	> LOQ 1.7
CP-1B	J95331-61 VB	1.10	< LOQ 1.7	J95331-61 PB	2.10	> LOQ 1.7
CP-2A	J95331-67 VB	30.00	> LOQ 1.7	J95331-67 PB	38.00	> LOQ 3.4
CP-2B	J95331-68 VB	36.00	> LOQ 3.4	J95331-68 PB	37.00	> LOQ 3.4
CP-3A	J95331-72 VB	17.00	> LOQ 1.7	J95331-72 PB	14.00	> LOQ 1.7
CP-3B	J95331-73 VB	14.00	> LOQ 1.7	J95331-73 PB	15.00	> LOQ 1.7
CP-4A	J95331-78 VB	35.00	> LOQ 1.7	J95331-78 PB	60.00	> LOQ 3.4
CP-4B	J95331-79 VB	61.00	> LOQ 1.7	J95331-79 PB	61.00	> LOQ 1.7
CPDS-1A	J95331-84 VB	26.00	> LOQ 1.7	J95331-84 PB	34.00	> LOQ 1.7
CPDS-1B	J95331-85 VB	33.00	> LOQ 1.7	J95331-85 PB	34.00	> LOQ 1.7
G-1A	J95331-41 VB	ND	< LOD 0.5	J95331-41 PB	ND	< LOD 0.5
G-1B	J95331-46 VB	3.50	> LOQ 1.7	J95331-46 PB	0.67	< LOQ 1.7
G-2A	J95331-43 VB	ND	< LOD 0.5	J95331-43 PB	ND	< LOD 0.5
G-2B	J95331-50 VB	0.58	< LOQ 1.7	J95331-50 PB	0.53	< LOQ 1.7
G-3A	J95331-49 VB	ND	< LOD 0.5	J95331-49 PB	0.78	< LOQ 1.7
G-4A	J95331-55 VB	1.80	> LOQ 1.7	J95331-55 PB	1.70	> LOQ 1.7
G-4B	J95331-56 VB	3.10	> LOQ 1.7	J95331-56 PB	1.90	> LOQ 1.7
G-5A	J95331-58 VB	ND	< LOD 0.5	J95331-58 PB	0.62	< LOQ 1.7
G-5B	J95331-59 VB	ND	< LOD 0.5	J95331-59 PB	ND	< LOD 0.5
G-6A	J95331-64 VB	1.40	< LOQ 1.7	J95331-64 PB	2.90	> LOQ 1.7
G-6B	J95331-65 VB	3.60	> LOQ 1.7	J95331-65 PB	2.80	> LOQ 1.7
G-7A	J95331-74 VB	ND	< LOD 0.5	J95331-74 PB	ND	< LOD 0.5
G-7B	J95331-75 VB	ND	< LOD 0.5	J95331-75 PB	ND	< LOD 0.5
SG-1A	J95331-54 VB	31.00	> LOQ 8.5	J95331-54 PB	26.00	> LOQ 8.5
SG-1B	J95331-71 VB	35.00	> LOQ 8.5	J95331-71 PB	27.00	> LOQ 8.5
SG-2A	J95331-66 VB	56.00	> LOQ 8.5	J95331-66 PB	39.00	> LOQ 8.5
SG-2B	J95331-82 VB	64.00	> LOQ 8.5	J95331-82 PB	64.00	> LOQ 8.5

Comparison of Airborne Concentrations to Bulk Concentrations - Cobalt

NIOSH REL 50.0 micrograms/cubic meter
OSHA PEL 100.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	9.58	6.19	4.35	1.10
CS-01	ND	ND	24.76	ND	9.10
CS-02	ND	10.87	49.99	16.05	8.20
CS-03	ND	12.42	49.77	12.84	15.00
CS-04	ND	ND	9.11	ND	0.55
CS-05	ND	4.59	12.77	ND	0.83
CS-06	ND	8.59	15.94	6.66	ND
CS-07	6.18	25.02	131.09	20.02	2.80
CSDS-01	ND	5.42	22.84	11.65	0.97
CSDS-02	ND	6.62	19.66	5.44	7.00
N-01	6.30	19.81	95.20	49.18	11.00
N-02	245.10	519.64	2291.19	435.78	250.00
O-1	37.07	75.17	193.14	33.49	74.00
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	0.73
SS-05	ND	ND	5.40	4.92	0.95
SS-06	ND	ND	ND	ND	ND
SS-07	ND	ND	7.10	ND	ND
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	0.97
SSDS-03	ND	ND	ND	ND	ND
CP-1A	9.07	29.00	99.61	33.51	8.50
CP-2A	8.05	27.19	155.54	60.24	30.00
CP-3A	7.23	18.99	70.32	68.29	17.00
CP-4A	20.60	100.61	550.91	125.15	35.00
CPDS-1A	13.38	22.69	144.54	49.21	26.00
G-1A	ND	ND	6.64	ND	ND
G-2A	ND	23.34	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	4.96	28.77	7.27	1.80
G-5A	ND	ND	7.70	11.71	ND
G-6A	4.37	20.90	37.45	12.01	1.40
G-7A	ND	ND	ND	ND	ND
SG-1A	6.33	ND	17.85	125.85	31.00
SG-2A	32.93	35.49	47.68	196.69	56.00

APPENDIX B - COPPER

Copper

Copper dust may cause sensations of chills and stuffiness of the head. Small copper particles may enter the eye and cause irritation, discoloration, and damage. Repeated or prolonged exposure may cause skin irritation or discoloration of the skin or hair. The NIOSH REL and OSHA PEL for copper are both 1,000 micrograms/cubic meter of air.

Air Sample Results - Copper

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Copper			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.08	ND	< LOD 1.66
24412	2	47.89	S-01	28	0.120	< LOQ 0.25	2.51	< LOQ 5.22
24441	3	47.90	S-01	28	0.470	> LOQ 0.25	9.81	> LOQ 5.22
24450	OBZ	47.93	S-01	28	0.095	< LOQ 0.25	1.98	< LOQ 5.22
24643	1	47.98	S-02	29	ND	< LOD 0.08	ND	< LOD 1.67
24625	2	47.76	S-02	29	0.130	< LOQ 0.25	2.72	< LOQ 5.23
24642	3	48.00	S-02	29	0.170	< LOQ 0.25	3.54	< LOQ 5.21
24632	OBZ	47.89	S-02	29	0.100	< LOQ 0.25	2.09	< LOQ 5.22
24634	1	48.16	CSDS-01	31	0.110	< LOQ 0.25	2.28	< LOQ 5.19
24650	2	48.01	CSDS-01	31	0.610	> LOQ 0.25	12.71	> LOQ 5.21
24644	3	48.16	CSDS-01	31	8.800	> LOQ 0.25	182.72	> LOQ 5.19
24645	OBZ	48.07	CSDS-01	31	0.830	> LOQ 0.25	17.27	> LOQ 5.20
24640	1	48.44	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24641	2	47.90	SS-01	32	0.093	< LOQ 0.25	1.94	< LOQ 5.22
24651	3	48.35	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24635	OBZ	48.30	SS-01	32	0.120	< LOQ 0.25	2.48	< LOQ 5.18
24646	1	48.58	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.65
24626	2	47.84	SSDS-01	33	0.180	< LOQ 0.25	3.76	< LOQ 5.23
24638	3	48.49	SSDS-01	33	0.420	> LOQ 0.25	8.66	> LOQ 5.16
24647	OBZ	48.32	SSDS-01	33	0.280	> LOQ 0.25	5.79	> LOQ 5.17
24628	1	48.55	CS-01	34	0.150	< LOQ 0.25	3.09	< LOQ 5.15
24637	2	48.00	CS-01	34	0.510	> LOQ 0.25	10.63	> LOQ 5.21
24624	3	48.47	CS-01	34	1.900	> LOQ 0.25	39.2	> LOQ 5.16
24636	OBZ	47.92	CS-01	34	0.450	> LOQ 0.25	9.39	> LOQ 5.22
24623	1	48.53	CSDS-02	35	0.180	< LOQ 0.25	3.71	< LOQ 5.15
24622	2	48.36	CSDS-02	35	0.470	> LOQ 0.25	9.72	> LOQ 5.17
24654	3	48.31	CSDS-02	35	1.300	> LOQ 0.25	26.91	> LOQ 5.17
24653	OBZ	47.78	CSDS-02	35	0.600	> LOQ 0.25	12.56	> LOQ 5.23
24629	1	47.88	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24633	2	47.86	SH-01	36	0.130	< LOQ 0.25	2.72	< LOQ 5.22
24627	3	48.24	SH-01	36	0.450	> LOQ 0.25	9.33	> LOQ 5.18
24648	OBZ	48.08	SH-01	36	0.290	> LOQ 0.25	6.03	> LOQ 5.20
24555	1	48.08	CS-02	37	0.310	> LOQ 0.25	6.45	> LOQ 5.20
24552	2	47.84	CS-02	37	1.100	> LOQ 0.25	22.99	> LOQ 5.23
24541	3	48.01	CS-02	37	4.400	> LOQ 0.25	91.65	> LOQ 5.21
24529	OBZ	47.99	CS-02	37	1.700	> LOQ 0.25	35.42	> LOQ 5.21
24558	1	48.49	CS-03	38	0.310	> LOQ 0.25	6.39	> LOQ 5.16
24524	2	48.29	CS-03	38	1.300	> LOQ 0.25	26.92	> LOQ 5.18
24561	3	48.22	CS-03	38	4.600	> LOQ 0.25	95.4	> LOQ 5.18
24559	OBZ	48.29	CS-03	38	1.300	> LOQ 0.25	26.92	> LOQ 5.18
24543	1	48.61	CS-04	39	0.560	> LOQ 0.25	11.52	> LOQ 5.14
24532	2	47.78	CS-04	39	1.000	> LOQ 0.25	20.93	> LOQ 5.23
24546	3	48.29	CS-04	39	2.500	> LOQ 0.25	51.77	> LOQ 5.18
24557	OBZ	48.58	CS-04	39	1.300	> LOQ 0.25	26.76	> LOQ 5.15
24560	1	48.13	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.66
24565	2	47.95	SS-02	40	0.130	< LOQ 0.25	2.71	< LOQ 5.21
24630	3	48.32	SS-02	40	0.110	< LOQ 0.25	2.28	< LOQ 5.17
24553	OBZ	48.62	SS-02	40	0.190	< LOQ 0.25	3.91	< LOQ 5.14
24525	1	48.13	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.66
24563	2	47.87	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.67
24547	3	48.17	G-1A	41	0.110	< LOQ 0.25	2.28	< LOQ 5.19
24526	OBZ	48.91	G-1A	41	0.110	< LOQ 0.25	2.25	< LOQ 5.11
24538	1	47.45	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.69

Air Sample Results - Copper

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Copper			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	0.210	< LOQ 0.25	4.46	< LOQ 5.31
24533	3	48.24	G-2A	43	0.240	< LOQ 0.25	4.98	< LOQ 5.18
24540	OBZ	48.04	G-2A	43	0.180	< LOQ 0.25	3.75	< LOQ 5.20
24528	1	47.99	SSDS-02	44	ND	< LOD 0.08	ND	< LOD 1.67
24544	2	48.00	SSDS-02	44	0.620	> LOQ 0.25	12.92	> LOQ 5.21
24567	3	48.46	SSDS-02	44	0.770	> LOQ 0.25	15.89	> LOQ 5.16
24539	OBZ	49.37	SSDS-02	44	0.240	< LOQ 0.25	4.86	< LOQ 5.06
24571	1	48.05	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.66
24536	2	47.60	SS-03	45	0.093	< LOQ 0.25	1.95	< LOQ 5.25
24534	3	48.94	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.63
24570	OBZ	49.61	SS-03	45	0.150	< LOQ 0.25	3.02	< LOQ 5.04
24568	1	48.28	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.66
24592	2	47.38	G-1B	46	0.420	> LOQ 0.25	8.86	> LOQ 5.28
24593	3	48.17	G-1B	46	0.910	> LOQ 0.25	18.89	> LOQ 5.19
24535	OBZ	48.22	G-1B	46	2.800	> LOQ 0.25	58.07	> LOQ 5.18
24590	1	47.81	SS-04	47	0.081	< LOQ 0.25	1.69	< LOQ 5.23
24605	2	47.78	SS-04	47	0.470	> LOQ 0.25	9.84	> LOQ 5.23
24562	3	47.80	SS-04	47	0.850	> LOQ 0.25	17.78	> LOQ 5.23
24531	OBZ	48.59	SS-04	47	0.510	> LOQ 0.25	10.5	> LOQ 5.15
24527	1	49.48	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.62
24569	2	50.35	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.59
24584	3	50.24	SSDS-03	48	0.190	< LOQ 0.25	3.78	< LOQ 4.98
24579	OBZ	48.26	SSDS-03	48	0.100	< LOQ 0.25	2.07	< LOQ 5.18
24600	1	48.34	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.65
24616	2	48.11	G-3A	49	0.087	< LOQ 0.25	1.81	< LOQ 5.20
24585	3	47.65	G-3A	49	0.180	< LOQ 0.25	3.78	< LOQ 5.25
24583	OBZ	47.99	G-3A	49	0.380	> LOQ 0.25	7.92	> LOQ 5.21
24587	1	48.79	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.64
24602	2	48.17	G-2B	50	0.140	< LOQ 0.25	2.91	< LOQ 5.19
24564	3	47.81	G-2B	50	0.290	> LOQ 0.25	6.07	> LOQ 5.23
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.65
24618	1	49.21	N-01	52	0.110	< LOQ 0.25	2.24	< LOQ 5.08
24611	2	47.96	N-01	52	0.440	> LOQ 0.25	9.17	> LOQ 5.21
24588	3	48.32	N-01	52	1.900	> LOQ 0.25	39.32	> LOQ 5.17
24615	OBZ	48.80	N-01	52	0.950	> LOQ 0.25	19.47	> LOQ 5.12
24597	1	49.78	SS-05	53	0.082	< LOQ 0.25	1.65	< LOQ 5.02
24599	2	47.68	SS-05	53	0.280	> LOQ 0.25	5.87	> LOQ 5.24
24575	3	48.11	SS-05	53	0.660	> LOQ 0.25	13.72	> LOQ 5.20
24617	OBZ	48.79	SS-05	53	0.340	> LOQ 0.25	6.97	> LOQ 5.12
24609	1	48.98	SG-1A	54	1.300	> LOQ 0.25	26.54	> LOQ 5.10
24596	2	48.20	SG-1A	54	0.850	> LOQ 0.25	17.63	> LOQ 5.19
24610	3	48.18	SG-1A	54	4.100	> LOQ 0.25	85.1	> LOQ 5.19
24576	OBZ	48.47	SG-1A	54	26.000	> LOQ 1.3	536.41	> LOQ 26.82
24606	1	49.24	G-4A	55	0.420	> LOQ 0.25	8.53	> LOQ 5.08
24620	2	48.37	G-4A	55	0.870	> LOQ 0.25	17.99	> LOQ 5.17
24573	3	48.67	G-4A	55	2.700	> LOQ 0.25	55.48	> LOQ 5.14
24505	OBZ	48.16	G-4A	55	1.200	> LOQ 0.25	24.92	> LOQ 5.19
24340	1	48.38	G-4B	56	0.240	< LOQ 0.25	4.96	< LOQ 5.17
24607	2	48.01	G-4B	56	1.100	> LOQ 0.25	22.91	> LOQ 5.21
24595	3	48.38	G-4B	56	1.800	> LOQ 0.25	37.21	> LOQ 5.17
24598	OBZ	48.42	G-4B	56	1.100	> LOQ 0.25	22.72	> LOQ 5.16
24580	1	48.44	CS-05	57	0.180	< LOQ 0.25	3.72	< LOQ 5.16
24604	2	47.93	CS-05	57	0.450	> LOQ 0.25	9.39	> LOQ 5.22

Air Sample Results - Copper

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Copper			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	4.000	> LOQ 0.25	83.72	> LOQ 5.23
24574	OBZ	30.41	CS-05	57	0.440	> LOQ 0.25	14.47	> LOQ 8.22
24614	1	48.58	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.65
24577	2	48.18	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.66
24572	3	48.05	G-5A	58	0.150	< LOQ 0.25	3.12	< LOQ 5.20
24582	OBZ	47.83	G-5A	58	0.083	< LOQ 0.25	1.74	< LOQ 5.23
24322	1	47.88	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.67
24354	2	48.16	G-5B	59	0.970	> LOQ 0.25	20.14	> LOQ 5.19
24510	3	47.98	G-5B	59	0.770	> LOQ 0.25	16.05	> LOQ 5.21
24321	OBZ	47.99	G-5B	59	0.250	> LOQ 0.25	5.21	> LOQ 5.21
24497	1	48.49	CP-1A	60	47.000	> LOQ 0.25	969.27	> LOQ 5.16
24333	2	48.28	CP-1A	60	130.000	> LOQ 0.25	2692.63	> LOQ 5.18
24326	3	48.19	CP-1A	60	410.000	> LOQ 0.25	8507.99	> LOQ 5.19
24329	OBZ	47.74	CP-1A	60	150.000	> LOQ 0.25	3142.02	> LOQ 5.24
24499	1	42.42	CP-1B	62	46.000	> LOQ 0.25	1084.39	> LOQ 5.89
24506	2	42.02	CP-1B	62	140.000	> LOQ 0.25	3331.75	> LOQ 5.95
24388	3	42.47	CP-1B	62	470.000	> LOQ 0.25	11066.64	> LOQ 5.89
24315	OBZ	41.77	CP-1B	62	160.000	> LOQ 0.25	3830.5	> LOQ 5.99
24318	1	48.56	CG-01	63	0.120	< LOQ 0.25	2.47	< LOQ 5.15
24308	2	48.00	CG-01	63	0.630	> LOQ 0.25	13.13	> LOQ 5.21
24330	3	48.47	CG-01	63	0.540	> LOQ 0.25	11.14	> LOQ 5.16
24230	OBZ	48.31	CG-01	63	1.600	> LOQ 0.25	33.12	> LOQ 5.17
24363	1	48.10	G-6A	64	0.220	< LOQ 0.25	4.57	< LOQ 5.20
24398	2	47.84	G-6A	64	1.100	> LOQ 0.25	22.99	> LOQ 5.23
24351	3	48.06	G-6A	64	2.000	> LOQ 0.25	41.61	> LOQ 5.20
24594	OBZ	48.29	G-6A	64	1.200	> LOQ 0.25	24.85	> LOQ 5.18
24312	1	48.76	G-6B	65	0.190	< LOQ 0.25	3.9	< LOQ 5.13
24484	2	47.45	G-6B	65	0.780	> LOQ 0.25	16.44	> LOQ 5.27
24327	3	48.92	G-6B	65	1.300	> LOQ 0.25	26.57	> LOQ 5.11
24389	OBZ	48.46	G-6B	65	0.550	> LOQ 0.25	11.35	> LOQ 5.16
24348	1	48.59	SG-2A	66	33.000	> LOQ 0.25	679.15	> LOQ 5.15
24314	2	47.90	SG-2A	66	30.000	> LOQ 0.25	626.3	> LOQ 5.22
24494	3	48.24	SG-2A	66	47.000	> LOQ 0.25	974.3	> LOQ 5.18
24337	OBZ	48.30	SG-2A	66	190.000	> LOQ 0.50	3933.75	> LOQ 10.35
24508	1	48.47	CP-2A	67	21.000	> LOQ 0.25	433.26	> LOQ 5.16
24361	2	47.82	CP-2A	67	64.000	> LOQ 0.25	1338.35	> LOQ 5.23
24359	3	48.22	CP-2A	67	360.000	> LOQ 0.50	7465.78	> LOQ 10.37
24471	OBZ	48.14	CP-2A	67	150.000	> LOQ 0.25	3115.91	> LOQ 5.19
24373	1	48.41	CP-2B	68	63.000	> LOQ 0.25	1301.38	> LOQ 5.16
24468	2	47.90	CP-2B	68	38.000	> LOQ 0.25	793.32	> LOQ 5.22
24481	3	48.26	CP-2B	68	160.000	> LOQ 0.25	3315.38	> LOQ 5.18
24391	OBZ	47.53	CP-2B	68	32.000	> LOQ 0.25	673.26	> LOQ 5.26
24356	1	48.56	O-1	69	0.160	< LOQ 0.25	3.29	< LOQ 5.15
24470	2	47.89	O-1	69	0.530	> LOQ 0.25	11.07	> LOQ 5.22
24467	3	48.67	O-1	69	0.660	> LOQ 0.25	13.56	> LOQ 5.14
24313	OBZ	47.78	O-1	69	0.860	> LOQ 0.25	18	> LOQ 5.23
24501	1	47.96	CS-06	70	0.510	> LOQ 0.25	10.63	> LOQ 5.21
24496	2	47.75	CS-06	70	0.780	> LOQ 0.25	16.34	> LOQ 5.24
24478	3	48.31	CS-06	70	3.300	> LOQ 0.25	68.31	> LOQ 5.17
24503	OBZ	48.04	CS-06	70	0.670	> LOQ 0.25	13.95	> LOQ 5.20
24474	1	26.02	SG-1B	71	0.240	< LOQ 0.25	9.22	< LOQ 9.61
24469	2	26.02	SG-1B	71	0.280	> LOQ 0.25	10.76	> LOQ 9.61
24492	3	26.10	SG-1B	71	1.700	> LOQ 0.25	65.13	> LOQ 9.58

Air Sample Results - Copper

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Copper			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	31.000	> LOQ 1.30	1180.95	> LOQ 49.52
24489	1	48.42	CP-3A	72	49.000	> LOQ 0.25	1011.98	> LOQ 5.16
24491	2	47.93	CP-3A	72	200.000	> LOQ 0.25	4172.75	> LOQ 5.22
24482	3	48.35	CP-3A	72	780.000	> LOQ 0.25	16132.37	> LOQ 5.17
24486	OBZ	48.32	CP-3A	72	590.000	> LOQ 0.25	12210.26	> LOQ 5.17
24516	1	36.34	CP-3B	73	46.000	> LOQ 0.25	1265.82	> LOQ 6.88
24502	2	36.02	CP-3B	73	280.000	> LOQ 0.25	7773.46	> LOQ 6.94
24515	3	36.48	CP-3B	73	470.000	> LOQ 0.25	12883.77	> LOQ 6.85
24500	OBZ	40.27	CP-3B	73	190.000	> LOQ 0.25	4718.15	> LOQ 6.21
24504	1	48.47	G-7A	74	0.086	< LOQ 0.25	1.77	< LOQ 5.16
24513	2	48.22	G-7A	74	0.830	> LOQ 0.25	17.21	> LOQ 5.18
24458	3	47.94	G-7A	74	1.900	> LOQ 0.25	39.63	> LOQ 5.21
24389	OBZ	47.75	G-7A	74	0.490	> LOQ 0.25	10.26	> LOQ 5.24
24404	1	48.68	G-7B	75	0.120	< LOQ 0.25	2.47	< LOQ 5.14
24451	2	48.06	G-7B	75	0.250	> LOQ 0.25	5.2	> LOQ 5.20
24447	3	47.16	G-7B	75	0.920	> LOQ 0.25	19.51	> LOQ 5.30
24423	OBZ	47.27	G-7B	75	0.860	> LOQ 0.25	18.19	> LOQ 5.29
24456	1	49.19	SS-06	76	0.110	< LOQ 0.25	2.24	< LOQ 5.08
24480	2	48.26	SS-06	76	0.250	< LOQ 0.25	5.18	< LOQ 5.18
24429	3	47.68	SS-06	76	2.400	> LOQ 0.25	50.34	> LOQ 5.24
24418	OBZ	47.83	SS-06	76	0.180	< LOQ 0.25	3.76	< LOQ 5.23
24427	1	48.54	CP-4A	78	130.000	> LOQ 0.25	2678.2	> LOQ 5.15
24435	2	47.71	CP-4A	78	950.000	> LOQ 0.25	19911.97	> LOQ 5.24
24244	3	49.01	CP-4A	78	3500.000	> LOQ 0.50	71414	> LOQ 10.20
24220	OBZ	48.74	CP-4A	78	630.000	> LOQ 0.25	12925.73	> LOQ 5.13
24460	1	50.05	CP-4B	79	120.000	> LOQ 0.25	2397.6	> LOQ 5.00
24465	2	48.47	CP-4B	79	670.000	> LOQ 0.25	13822.98	> LOQ 5.16
24207	3	48.49	CP-4B	79	2100.000	> LOQ 0.50	43307.9	> LOQ 10.31
24390	OBZ	49.02	CP-4B	79	260.000	> LOQ 0.25	5303.96	> LOQ 5.10
24259	1	48.76	SS-07	80	0.270	> LOQ 0.25	5.54	> LOQ 5.13
24421	2	48.13	SS-07	80	1.400	> LOQ 0.25	29.09	> LOQ 5.19
24445	3	47.87	SS-07	80	2.100	> LOQ 0.25	43.87	> LOQ 5.22
24432	OBZ	48.49	SS-07	80	1.800	> LOQ 0.25	37.12	> LOQ 5.16
24459	1	48.96	N-02	81	5.400	> LOQ 0.25	110.29	> LOQ 5.11
24417	2	48.11	N-02	81	13.000	> LOQ 0.25	270.21	> LOQ 5.20
24442	3	48.01	N-02	81	50.000	> LOQ 0.25	1041.45	> LOQ 5.21
24386	OBZ	48.19	N-02	81	13.000	> LOQ 0.25	269.77	> LOQ 5.19
24452	1	48.20	SG-2B	82	11.000	> LOQ 0.25	228.22	> LOQ 5.19
24453	2	48.59	SG-2B	82	20.000	> LOQ 0.25	411.61	> LOQ 5.15
24420	3	47.84	SG-2B	82	36.000	> LOQ 0.25	752.51	> LOQ 5.23
24444	OBZ	47.95	SG-2B	82	260.000	> LOQ 1.3	5422.31	> LOQ 27.11
24455	1	48.56	CS-07	83	0.870	> LOQ 0.25	17.92	> LOQ 5.15
24433	2	47.96	CS-07	83	2.400	> LOQ 0.25	50.04	> LOQ 5.21
24398	3	48.06	CS-07	83	11.000	> LOQ 0.25	228.88	> LOQ 5.20
24511	OBZ	47.96	CS-07	83	3.000	> LOQ 0.25	62.55	> LOQ 5.21
24454	1	49.34	CPDS-1A	84	29.000	> LOQ 0.25	587.76	> LOQ 5.07
24291	2	48.49	CPDS-1A	84	45.000	> LOQ .25	928.03	> LOQ 5.16
24209	3	48.43	CPDS-1A	84	360.000	> LOQ 0.25	7433.41	> LOQ 5.16
24402	OBZ	48.77	CPDS-1A	84	130.000	> LOQ 0.25	2665.57	> LOQ 5.13
24204	1	49.46	CPDS-1B	85	33.000	> LOQ 0.25	667.21	> LOQ 5.05
24273	2	48.35	CPDS-1B	85	60.000	> LOQ 0.25	1240.95	> LOQ 5.17
24223	3	48.82	CPDS-1B	85	300.000	> LOQ 0.25	6145.02	> LOQ 5.12
24466	OBZ	49.96	CPDS-1B	85	60.000	> LOQ 0.25	1200.96	> LOQ 5.00

Airborne Sample Data Analysis - Copper

NIOSH REL 1000.0 micrograms/cubic meter
OSHA PEL 1000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	2.47	< LOQ 5.15	13.13	> LOQ 5.21	11.14	> LOQ 5.16	33.12	> LOQ 5.17
CS-01	3.09	< LOQ 5.15	10.63	> LOQ 5.21	39.20	> LOQ 5.16	9.39	> LOQ 5.22
CS-02	6.45	> LOQ 5.20	22.99	> LOQ 5.23	91.65	> LOQ 5.21	35.42	> LOQ 5.21
CS-03	6.39	> LOQ 5.16	26.92	> LOQ 5.18	95.40	> LOQ 5.18	26.92	> LOQ 5.18
CS-04	11.52	> LOQ 5.14	20.93	> LOQ 5.23	51.77	> LOQ 5.18	26.76	> LOQ 5.15
CS-05	3.72	< LOQ 5.16	9.39	> LOQ 5.22	83.72	> LOQ 5.23	14.47	> LOQ 8.22
CS-06	10.63	> LOQ 5.21	16.34	> LOQ 5.24	68.31	> LOQ 5.17	13.95	> LOQ 5.20
CS-07	17.92	> LOQ 5.15	50.04	> LOQ 5.21	228.88	> LOQ 5.20	62.55	> LOQ 5.21
CSDS-01	2.28	< LOQ 5.19	12.71	> LOQ 5.21	182.72	> LOQ 5.19	17.27	> LOQ 5.20
CSDS-02	3.71	< LOQ 5.15	9.72	> LOQ 5.17	26.91	> LOQ 5.17	12.56	> LOQ 5.23
N-01	2.24	< LOQ 5.08	9.17	> LOQ 5.21	39.32	> LOQ 5.17	19.47	> LOQ 5.12
N-02	110.29	> LOQ 5.11	270.21	> LOQ 5.20	1041.45	> LOQ 5.21	269.77	> LOQ 5.19
O-1	3.29	< LOQ 5.15	11.07	> LOQ 5.22	13.56	> LOQ 5.14	18	> LOQ 5.23
S-01	ND	< LOD 1.66	2.51	< LOQ 5.22	9.81	> LOQ 5.22	1.98	< LOQ 5.22
S-02	ND	< LOD 1.67	2.72	< LOQ 5.23	3.54	< LOQ 5.21	2.09	< LOQ 5.22
SH-01	ND	< LOD 1.67	2.72	< LOQ 5.22	9.33	> LOQ 5.18	6.03	> LOQ 5.20
SS-01	ND	< LOD 1.65	1.94	< LOQ 5.22	ND	< LOD 1.65	2.48	< LOQ 5.18
SS-02	ND	< LOD 1.66	2.71	< LOQ 5.21	2.28	< LOQ 5.17	3.91	< LOQ 5.14
SS-03	ND	< LOD 1.66	1.95	< LOQ 5.25	ND	< LOD 1.63	3.02	< LOQ 5.04
SS-04	1.69	< LOQ 5.23	9.84	> LOQ 5.23	17.78	> LOQ 5.23	10.5	> LOQ 5.15
SS-05	1.65	< LOQ 5.02	5.87	> LOQ 5.24	13.72	> LOQ 5.20	6.97	> LOQ 5.12
SS-06	2.24	< LOQ 5.08	5.18	< LOQ 5.18	50.34	> LOQ 5.24	3.76	< LOQ 5.23
SS-07	5.54	> LOQ 5.13	29.09	> LOQ 5.19	43.87	> LOQ 5.22	37.12	> LOQ 5.16
SSDS-01	ND	< LOD 1.65	3.76	< LOQ 5.23	8.66	> LOQ 5.16	5.79	> LOQ 5.17
SSDS-02	ND	< LOD 1.67	12.92	> LOQ 5.21	15.89	> LOQ 5.16	4.86	< LOQ 5.06
SSDS-03	ND	< LOD 1.62	ND	< LOD 1.59	3.78	< LOQ 4.98	2.07	< LOQ 5.18
CP-1A	969.27	> LOQ 5.16	2692.63	> LOQ 5.18	8507.99	> LOQ 5.19	3142.02	> LOQ 5.24
CP-1B	1084.39	> LOQ 5.89	3331.75	> LOQ 5.95	11066.64	> LOQ 5.89	3830.5	> LOQ 5.99
CP-2A	433.26	> LOQ 5.16	1338.35	> LOQ 5.23	7465.78	> LOQ 10.37	3115.91	> LOQ 5.19
CP-2B	1301.38	> LOQ 5.16	793.32	> LOQ 5.22	3315.38	> LOQ 5.18	673.26	> LOQ 5.26
CP-3A	1011.98	> LOQ 5.16	4172.75	> LOQ 5.22	16132.37	> LOQ 5.17	12210.26	> LOQ 5.17
CP-3B	1265.82	> LOQ 6.88	7773.46	> LOQ 6.94	12883.77	> LOQ 6.85	4718.15	> LOQ 6.21
CP-4A	2678.2	> LOQ 5.15	19911.97	> LOQ 5.24	71414.00	> LOQ 10.20	12925.73	> LOQ 5.13
CP-4B	2397.6	> LOQ 5.00	13822.98	> LOQ 5.16	43307.90	> LOQ 10.31	5303.96	> LOQ 5.10
CPDS-1A	587.76	> LOQ 5.07	928.03	> LOQ 5.16	7433.41	> LOQ 5.16	2665.57	> LOQ 5.13
CPDS-1B	667.21	> LOQ 5.05	1240.95	> LOQ 5.17	6145.02	> LOQ 5.12	1200.96	> LOQ 5.00
G-1A	ND	< LOD 1.66	ND	< LOD 1.67	2.28	< LOQ 5.19	2.25	< LOQ 5.11
G-1B	ND	< LOD 1.66	8.86	> LOQ 5.28	18.89	> LOQ 5.19	58.07	> LOQ 5.18
G-2A	ND	< LOD 1.69	4.46	< LOQ 5.31	4.98	< LOQ 5.18	3.75	< LOQ 5.20
G-2B	ND	< LOD 1.64	2.91	< LOQ 5.19	6.07	> LOQ 5.23	ND	< LOD 1.65
G-3A	ND	< LOD 1.65	1.81	< LOQ 5.20	3.78	< LOQ 5.25	7.92	> LOQ 5.21
G-4A	8.53	> LOQ 5.08	17.99	> LOQ 5.17	55.48	> LOQ 5.14	24.92	> LOQ 5.19
G-4B	4.96	< LOQ 5.17	22.91	> LOQ 5.21	37.21	> LOQ 5.17	22.72	> LOQ 5.16
G-5A	ND	< LOD 1.65	ND	< LOD 1.66	3.12	< LOQ 5.20	1.74	< LOQ 5.23
G-5B	ND	< LOD 1.67	20.14	> LOQ 5.19	16.05	> LOQ 5.21	5.21	> LOQ 5.21
G-6A	4.57	< LOQ 5.20	22.99	> LOQ 5.23	41.61	> LOQ 5.20	24.85	> LOQ 5.18
G-6B	3.9	< LOQ 5.13	16.44	> LOQ 5.27	26.57	> LOQ 5.11	11.35	> LOQ 5.16
G-7A	1.77	< LOQ 5.16	17.21	> LOQ 5.18	39.63	> LOQ 5.21	10.26	> LOQ 5.24
G-7B	2.47	< LOQ 5.14	5.2	> LOQ 5.20	19.51	> LOQ 5.30	18.19	> LOQ 5.29
SG-1A	26.54	> LOQ 5.10	17.63	> LOQ 5.19	85.10	> LOQ 5.19	536.41	> LOQ 26.82
SG-1B	9.22	< LOQ 9.61	10.76	> LOQ 9.61	65.13	> LOQ 9.58	1180.95	> LOQ 49.52
SG-2A	679.15	> LOQ 5.15	626.3	> LOQ 5.22	974.30	> LOQ 5.18	3933.75	> LOQ 10.35
SG-2B	228.22	> LOQ 5.19	411.61	> LOQ 5.15	752.51	> LOQ 5.23	5422.31	> LOQ 27.11

Bulk Elemental Analysis - Copper

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Copper		Sample	Copper	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.3	J95331-63 PB	0.70	< LOQ 1.0
CS-01	J95331-34 VB	11.00	> LOQ 1.0	J95331-34 PB	12.00	> LOQ 1.0
CS-02	J95331-37 VB	13.00	> LOQ 1.0	J95331-37 PB	14.00	> LOQ 1.0
CS-03	J95331-38 VB	31.00	> LOQ 1.0	J95331-38 PB	36.00	> LOQ 1.0
CS-04	J95331-39 VB	9.40	> LOQ 1.0	J95331-39 PB	7.80	> LOQ 1.0
CS-05	J95331-57 VB	1.10	> LOQ 1.0	J95331-57 PB	2.50	> LOQ 1.0
CS-06	J95331-70 VB	0.98	< LOQ 1.0	J95331-70 PB	2.90	> LOQ 1.0
CS-07	J95331-83 VB	7.00	> LOQ 1.0	J95331-83 PB	12.00	> LOQ 1.0
CSDS-01	J95331-31 VB	1.30	> LOQ 1.0	J95331-31 PB	2.80	> LOQ 1.0
CSDS-02	J95331-35 VB	8.30	> LOQ 1.0	J95331-35 PB	9.40	> LOQ 1.0
N-01	J95331-52 VB	5.10	> LOQ 1.0	J95331-52 PB	4.90	> LOQ 1.0
N-02	J95331-81 VB	170.00	> LOQ 1.0	J95331-81 PB	340.00	> LOQ 1.0
O-1	J95331-69 VB	3.90	> LOQ 1.0	J95331-69 PB	5.20	> LOQ 1.0
S-01	J95331-28 VB	0.52	< LOQ 1.0	J95331-28 PB	0.70	< LOQ 1.0
S-02	J95331-29 VB	0.36	< LOQ 1.0	J95331-29 PB	1.40	> LOQ 1.0
SH-01	J95331-36 VB	0.60	< LOQ 1.0	J95331-36 PB	4.10	> LOQ 1.0
SS-01	J95331-32 VB	ND	< LOD 0.3	J95331-32 PB	0.66	< LOQ 1.0
SS-02	J95331-40 VB	ND	< LOD 0.3	J95331-40 PB	0.61	< LOQ 1.0
SS-03	J95331-45 VB	ND	< LOD 0.3	J95331-45 PB	ND	< LOD 0.3
SS-04	J95331-47 VB	3.60	> LOQ 1.0	J95331-47 PB	1.40	> LOQ 1.0
SS-05	J95331-53 VB	1.90	> LOQ 1.0	J95331-53 PB	2.10	> LOQ 1.0
SS-06	J95331-76 VB	0.91	< LOQD 0.3	J95331-76 PB	0.81	< LOD 0.3
SS-07	J95331-80 VB	0.45	< LOQ 1.0	J95331-80 PB	0.41	< LOQ 1.0
SSDS-01	J95331-33 VB	0.33	< LOQ 1.0	J95331-33 PB	0.37	< LOQ 1.0
SSDS-02	J95331-44 VB	2.90	> LOQ 1.0	J95331-44 PB	3.10	> LOQ 1.0
SSDS-03	J95331-48 VB	ND	< LOD 0.3	J95331-48 PB	ND	< LOD 0.3
CP-1A	J95331-60 VB	1400.00	> LOQ 1.0	J95331-60 PB	4200.00	> LOQ 1.0
CP-1B	J95331-61 VB	1.90	> LOQ 1.0	J95331-61 PB	3.00	> LOQ 1.0
CP-2A	J95331-67 VB	1500.00	> LOQ 1.0	J95331-67 PB	1900.00	> LOQ 5.0
CP-2B	J95331-68 VB	2100.00	> LOQ 2.0	J95331-68 PB	1800.00	> LOQ 2.0
CP-3A	J95331-72 VB	3200.00	> LOQ 1.0	J95331-72 PB	2200.00	> LOQ 1.0
CP-3B	J95331-73 VB	2000.00	> LOQ 1.0	J95331-73 PB	2500.00	> LOQ 1.0
CP-4A	J95331-78 VB	8300.00	> LOQ 1.0	J95331-78 PB	9600.00	> LOQ 2.0
CP-4B	J95331-79 VB	11000.00	> LOQ 1.0	J95331-79 PB	9200.00	> LOQ 1.0
CPDS-1A	J95331-84 VB	1000.00	> LOQ 1.0	J95331-84 PB	1700.00	> LOQ 1.0
CPDS-1B	J95331-85 VB	1600.00	> LOQ 1.0	J95331-85 PB	1600.00	> LOQ 1.0
G-1A	J95331-41 VB	0.54	< LOQ 1.0	J95331-41 PB	0.95	< LOQ 1.0
G-1B	J95331-46 VB	56.00	> LOQ 1.0	J95331-46 PB	35.00	> LOQ 1.0
G-2A	J95331-43 VB	0.49	< LOQ 1.0	J95331-43 PB	1.30	> LOQ 1.0
G-2B	J95331-50 VB	6.40	> LOQ 1.0	J95331-50 PB	2.40	> LOQ 1.0
G-3A	J95331-49 VB	0.88	< LOQ 1.0	J95331-49 PB	3.30	> LOQ 1.0
G-4A	J95331-55 VB	3.90	> LOQ 1.0	J95331-55 PB	15.00	> LOQ 1.0
G-4B	J95331-56 VB	22.00	> LOQ 1.0	J95331-56 PB	8.30	> LOQ 1.0
G-5A	J95331-58 VB	ND	< LOD 0.3	J95331-58 PB	0.80	< LOQ 1.0
G-5B	J95331-59 VB	1.80	> LOQ 1.0	J95331-59 PB	2.00	> LOQ 1.0
G-6A	J95331-64 VB	5.00	> LOQ 1.0	J95331-64 PB	8.50	> LOQ 1.0
G-6B	J95331-65 VB	7.50	> LOQ 1.0	J95331-65 PB	6.70	> LOQ 1.0
G-7A	J95331-74 VB	0.53	< LOQ 1.0	J95331-74 PB	0.41	< LOQ 1.0
G-7B	J95331-75 VB	ND	< LOD 0.3	J95331-75 PB	1.50	> LOQ 1.0
SG-1A	J95331-54 VB	170.00	> LOQ 5.0	J95331-54 PB	220.00	> LOQ 5.0
SG-1B	J95331-71 VB	190.00	> LOQ 5.0	J95331-71 PB	170.00	> LOQ 5.0
SG-2A	J95331-66 VB	1200.00	> LOQ 5.0	J95331-66 PB	870.00	> LOQ 5.0
SG-2B	J95331-82 VB	1300.00	> LOQ 5.0	J95331-82 PB	1300.00	> LOQ 5.0

Comparison of Airborne Concentrations to Bulk Concentrations - Copper

NIOSH REL 1000.0 micrograms/cubic meter
OSHA PEL 1000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	2.47	13.13	11.14	33.12	ND
CS-01	3.09	10.63	39.20	9.39	11.00
CS-02	6.45	22.99	91.65	35.42	13.00
CS-03	6.39	26.92	95.40	26.92	31.00
CS-04	11.52	20.93	51.77	26.76	9.40
CS-05	3.72	9.39	83.72	14.47	1.10
CS-06	10.63	16.34	68.31	13.95	0.98
CS-07	17.92	50.04	228.88	62.55	7.00
CSDS-01	2.28	12.71	182.72	17.27	1.30
CSDS-02	3.71	9.72	26.91	12.56	8.30
N-01	2.24	9.17	39.32	19.47	5.10
N-02	110.29	270.21	1041.45	269.77	170.00
O-1	3.29	11.07	13.56	18.00	3.90
S-01	ND	2.51	9.81	1.98	0.52
S-02	ND	2.72	3.54	2.09	0.36
SH-01	ND	2.72	9.33	6.03	0.60
SS-01	ND	1.94	ND	2.48	ND
SS-02	ND	2.71	2.28	3.91	ND
SS-03	ND	1.95	ND	3.02	ND
SS-04	1.69	9.84	17.78	10.50	3.60
SS-05	1.65	5.87	13.72	6.97	1.90
SS-06	2.24	5.18	50.34	3.76	0.91
SS-07	5.54	29.09	43.87	37.12	0.45
SSDS-01	ND	3.76	8.66	5.79	0.33
SSDS-02	ND	12.92	15.89	4.86	2.90
SSDS-03	ND	ND	3.78	2.07	ND
CP-1A	969.27	2692.63	8507.99	3142.02	1400.00
CP-2A	433.26	1338.35	7465.78	3115.91	1500.00
CP-3A	1011.98	4172.75	16132.37	12210.26	3200.00
CP-4A	2678.20	19911.97	71414.00	12925.73	8300.00
CPDS-1A	587.76	928.03	7433.41	2665.57	1000.00
G-1A	ND	ND	2.28	2.25	0.54
G-2A	ND	4.46	4.98	3.75	0.49
G-3A	ND	1.81	3.78	7.92	0.88
G-4A	8.53	17.99	55.48	24.92	3.90
G-5A	ND	ND	3.12	1.74	ND
G-6A	4.57	22.99	41.61	24.85	5.00
G-7A	1.77	17.21	39.63	10.26	0.53
SG-1A	26.54	17.63	85.10	536.41	170.00
SG-2A	679.15	626.30	974.30	3933.75	1200.00

APPENDIX B - IRON

Iron

Changes attributed to the inhalation of iron dust generally involve a benign pneumoconiosis (siderosis) not suspected of progression to true fibrosis. The NIOSH REL and OSHA PEL for iron are 5,000 and 10,000 micrograms/cubic meter of air, respectively.

Air Sample Results - Iron

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Iron			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	61.0	> LOQ 2.5	1266.61	> LOQ 51.91
24412	2	47.89	S-01	28	240.0	> LOQ 2.5	5011.48	> LOQ 52.20
24441	3	47.90	S-01	28	690.0	> LOQ 2.5	14405.01	> LOQ 52.19
24450	OBZ	47.93	S-01	28	290.0	> LOQ 2.5	6050.49	> LOQ 52.16
24643	1	47.98	S-02	29	69.0	> LOQ 2.5	1438.1	> LOQ 52.11
24625	2	47.76	S-02	29	370.0	> LOQ 2.5	7747.07	> LOQ 52.35
24642	3	48.00	S-02	29	500.0	> LOQ 2.5	10416.67	> LOQ 52.08
24632	OBZ	47.89	S-02	29	320.0	> LOQ 2.5	6681.98	> LOQ 52.20
24634	1	48.16	CSDS-01	31	580.0	> LOQ 2.5	12043.19	> LOQ 51.91
24650	2	48.01	CSDS-01	31	3100.0	> LOQ 2.5	64569.88	> LOQ 52.07
24644	3	48.16	CSDS-01	31	8300.0	> LOQ 2.5	172342.19	> LOQ 51.91
24645	OBZ	48.07	CSDS-01	31	4200.0	> LOQ 2.5	87372.58	> LOQ 52.01
24640	1	48.44	SS-01	32	52.0	> LOQ 2.5	1073.49	> LOQ 51.61
24641	2	47.90	SS-01	32	210.0	> LOQ 2.5	4384.13	> LOQ 52.19
24651	3	48.35	SS-01	32	280.0	> LOQ 2.5	5791.11	> LOQ 51.71
24635	OBZ	48.30	SS-01	32	290.0	> LOQ 2.5	6004.14	> LOQ 51.76
24646	1	48.58	SSDS-01	33	44.0	> LOQ 2.5	905.72	> LOQ 51.46
24626	2	47.84	SSDS-01	33	240.0	> LOQ 2.5	5016.72	> LOQ 52.26
24638	3	48.49	SSDS-01	33	430.0	> LOQ 2.5	8867.81	> LOQ 51.56
24647	OBZ	48.32	SSDS-01	33	380.0	> LOQ 2.5	7864.24	> LOQ 51.74
24628	1	48.55	CS-01	34	460.0	> LOQ 2.5	9474.77	> LOQ 51.49
24637	2	48.00	CS-01	34	1600.0	> LOQ 2.5	33333.33	> LOQ 52.08
24624	3	48.47	CS-01	34	5700.0	> LOQ 2.5	117598.51	> LOQ 51.58
24636	OBZ	47.92	CS-01	34	1400.0	> LOQ 2.5	29215.36	> LOQ 52.17
24623	1	48.53	CSDS-02	35	350.0	> LOQ 2.5	7212.03	> LOQ 51.51
24622	2	48.36	CSDS-02	35	1600.0	> LOQ 2.5	33085.19	> LOQ 51.70
24654	3	48.31	CSDS-02	35	4300.0	> LOQ 2.5	89008.49	> LOQ 51.75
24653	OBZ	47.78	CSDS-02	35	1800.0	> LOQ 2.5	37672.67	> LOQ 52.32
24629	1	47.88	SH-01	36	360.0	> LOQ 2.5	7518.8	> LOQ 52.21
24633	2	47.86	SH-01	36	990.0	> LOQ 2.5	20685.33	> LOQ 52.24
24627	3	48.24	SH-01	36	4600.0	> LOQ 2.5	95356.55	> LOQ 51.82
24648	OBZ	48.08	SH-01	36	670.0	> LOQ 2.5	13935.11	> LOQ 52.00
24555	1	48.08	CS-02	37	480.0	> LOQ 2.5	9983.36	> LOQ 52.00
24552	2	47.84	CS-02	37	1500.0	> LOQ 2.5	31354.52	> LOQ 52.26
24541	3	48.01	CS-02	37	5400.0	> LOQ 2.5	112476.57	> LOQ 52.07
24529	OBZ	47.99	CS-02	37	2200.0	> LOQ 2.5	45842.88	> LOQ 52.09
24558	1	48.49	CS-03	38	520.0	> LOQ 2.5	10723.86	> LOQ 51.56
24524	2	48.29	CS-03	38	2100.0	> LOQ 2.5	43487.26	> LOQ 51.77
24561	3	48.22	CS-03	38	6700.0	> LOQ 2.5	138946.5	> LOQ 51.85
24559	OBZ	48.29	CS-03	38	2200.0	> LOQ 2.5	45558.09	> LOQ 51.77
24543	1	48.61	CS-04	39	160.0	> LOQ 2.5	3291.5	> LOQ 51.43
24532	2	47.78	CS-04	39	660.0	> LOQ 2.5	13813.31	> LOQ 52.32
24546	3	48.29	CS-04	39	1400.0	> LOQ 2.5	28991.51	> LOQ 51.77
24557	OBZ	48.58	CS-04	39	730.0	> LOQ 2.5	15026.76	> LOQ 51.46
24560	1	48.13	SS-02	40	62.0	> LOQ 2.5	1288.18	> LOQ 51.94
24565	2	47.95	SS-02	40	270.0	> LOQ 2.5	5630.87	> LOQ 52.14
24630	3	48.32	SS-02	40	250.0	> LOQ 2.5	5173.84	> LOQ 51.74
24553	OBZ	48.62	SS-02	40	310.0	> LOQ 2.5	6375.98	> LOQ 51.42
24525	1	48.13	G-1A	41	200.0	> LOQ 2.5	4155.41	> LOQ 51.94
24563	2	47.87	G-1A	41	810.0	> LOQ 2.5	16920.83	> LOQ 52.22
24547	3	48.17	G-1A	41	2500.0	> LOQ 2.5	51899.52	> LOQ 51.90
24526	OBZ	48.91	G-1A	41	1900.0	> LOQ 2.5	38846.86	> LOQ 51.11
24538	1	47.45	G-2A	43	150.0	> LOQ 2.5	3161.22	> LOQ 52.69

Air Sample Results - Iron

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Iron			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	1000.0	> LOQ 2.5	21222.41	> LOQ 53.06
24533	3	48.24	G-2A	43	1500.0	> LOQ 2.5	31094.53	> LOQ 51.82
24540	OBZ	48.04	G-2A	43	720.0	> LOQ 2.5	14987.51	> LOQ 52.04
24528	1	47.99	SSDS-02	44	93.0	> LOQ 2.5	1937.9	> LOQ 52.09
24544	2	48.00	SSDS-02	44	440.0	> LOQ 2.5	9166.67	> LOQ 52.08
24567	3	48.46	SSDS-02	44	1000.0	> LOQ 2.5	20635.58	> LOQ 51.59
24539	OBZ	49.37	SSDS-02	44	490.0	> LOQ 2.5	9925.06	> LOQ 50.64
24571	1	48.05	SS-03	45	37.0	> LOQ 2.5	770.03	> LOQ 52.03
24536	2	47.60	SS-03	45	200.0	> LOQ 2.5	4201.68	> LOQ 52.52
24534	3	48.94	SS-03	45	230.0	> LOQ 2.5	4699.63	> LOQ 51.08
24570	OBZ	49.61	SS-03	45	210.0	> LOQ 2.5	4233.02	> LOQ 50.39
24568	1	48.28	G-1B	46	180.0	> LOQ 2.5	3728.25	> LOQ 51.78
24592	2	47.38	G-1B	46	1300.0	> LOQ 2.5	27437.74	> LOQ 52.76
24593	3	48.17	G-1B	46	2100.0	> LOQ 2.5	43595.6	> LOQ 51.90
24535	OBZ	48.22	G-1B	46	3800.0	> LOQ 2.5	78805.47	> LOQ 51.85
24590	1	47.81	SS-04	47	99.0	> LOQ 2.5	2070.7	> LOQ 52.29
24605	2	47.78	SS-04	47	650.0	> LOQ 2.5	13604.02	> LOQ 52.32
24562	3	47.80	SS-04	47	870.0	> LOQ 2.5	18200.84	> LOQ 52.30
24531	OBZ	48.59	SS-04	47	650.0	> LOQ 2.5	13377.24	> LOQ 51.45
24527	1	49.48	SSDS-03	48	34.0	> LOQ 2.5	687.15	> LOQ 50.53
24569	2	50.35	SSDS-03	48	120.0	> LOQ 2.5	2383.32	> LOQ 49.65
24584	3	50.24	SSDS-03	48	250.0	> LOQ 2.5	4976.11	> LOQ 49.76
24579	OBZ	48.26	SSDS-03	48	180.0	> LOQ 2.5	3729.8	> LOQ 51.80
24600	1	48.34	G-3A	49	440.0	> LOQ 2.5	9102.19	> LOQ 51.72
24616	2	48.11	G-3A	49	1400.0	> LOQ 2.5	29099.98	> LOQ 51.96
24585	3	47.65	G-3A	49	4600.0	> LOQ 2.5	96537.25	> LOQ 52.47
24583	OBZ	47.99	G-3A	49	640.0	> LOQ 2.5	13336.11	> LOQ 52.09
24587	1	48.79	G-2B	50	230.0	> LOQ 2.5	4714.08	> LOQ 51.24
24602	2	48.17	G-2B	50	1800.0	> LOQ 2.5	37367.66	> LOQ 51.90
24564	3	47.81	G-2B	50	1300.0	> LOQ 2.5	27190.96	> LOQ 52.29
24621	OBZ	48.54	G-2B	50	440.0	> LOQ 2.5	9064.69	> LOQ 51.50
24618	1	49.21	N-01	52	350.0	> LOQ 2.5	7112.38	> LOQ 50.80
24611	2	47.96	N-01	52	1800.0	> LOQ 2.5	37531.28	> LOQ 52.13
24588	3	48.32	N-01	52	6500.0	> LOQ 2.5	134519.87	> LOQ 51.74
24615	OBZ	48.80	N-01	52	3400.0	> LOQ 2.5	69672.13	> LOQ 51.23
24597	1	49.78	SS-05	53	120.0	> LOQ 2.5	2410.61	> LOQ 50.22
24599	2	47.68	SS-05	53	400.0	> LOQ 2.5	8389.26	> LOQ 52.43
24575	3	48.11	SS-05	53	940.0	> LOQ 2.5	19538.56	> LOQ 51.96
24617	OBZ	48.79	SS-05	53	600.0	> LOQ 2.5	12297.6	> LOQ 51.24
24609	1	48.98	SG-1A	54	7000.0	> LOQ 2.5	142915.48	> LOQ 51.04
24596	2	48.20	SG-1A	54	5400.0	> LOQ 2.5	112033.2	> LOQ 51.87
24610	3	48.18	SG-1A	54	25000.0	> LOQ 5.0	518887.51	> LOQ 103.78
24576	OBZ	48.47	SG-1A	54	170000.0	> LOQ 50.0	3507324.12	> LOQ 1031.57
24606	1	49.24	G-4A	55	1700.0	> LOQ 2.5	34524.78	> LOQ 50.77
24620	2	48.37	G-4A	55	1700.0	> LOQ 2.5	35145.75	> LOQ 51.68
24573	3	48.67	G-4A	55	11000.0	> LOQ 2.5	226011.92	> LOQ 51.37
24505	OBZ	48.16	G-4A	55	3300.0	> LOQ 2.5	68521.59	> LOQ 51.91
24340	1	48.38	G-4B	56	510.0	> LOQ 2.5	10541.55	> LOQ 51.67
24607	2	48.01	G-4B	56	4200.0	> LOQ 2.5	87481.77	> LOQ 52.07
24595	3	48.38	G-4B	56	6900.0	> LOQ 2.5	142620.92	> LOQ 51.67
24598	OBZ	48.42	G-4B	56	3600.0	> LOQ 2.5	74349.44	> LOQ 51.63
24580	1	48.44	CS-05	57	320.0	> LOQ 2.5	6606.11	> LOQ 51.61
24604	2	47.93	CS-05	57	1400.0	> LOQ 2.5	29209.26	> LOQ 52.16

Air Sample Results - Iron

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Iron			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	3200.0	> LOQ 2.5	66973.63	> LOQ 52.32
24574	OBZ	30.41	CS-05	57	1100.0	> LOQ 2.5	36172.31	> LOQ 82.21
24614	1	48.58	G-5A	58	170.0	> LOQ 2.5	3499.38	> LOQ 51.46
24577	2	48.18	G-5A	58	720.0	> LOQ 2.5	14943.96	> LOQ 51.89
24572	3	48.05	G-5A	58	2400.0	> LOQ 2.5	49947.97	> LOQ 52.03
24582	OBZ	47.83	G-5A	58	3200.0	> LOQ 2.5	66903.62	> LOQ 52.27
24322	1	47.88	G-5B	59	400.0	> LOQ 2.5	8354.22	> LOQ 52.21
24354	2	48.16	G-5B	59	2000.0	> LOQ 2.5	41528.24	> LOQ 51.91
24510	3	47.98	G-5B	59	5600.0	> LOQ 2.5	116715.3	> LOQ 52.11
24321	OBZ	47.99	G-5B	59	1000.0	> LOQ 2.5	20837.67	> LOQ 52.09
24497	1	48.49	CP-1A	60	1500.0	> LOQ 2.5	30934.21	> LOQ 51.56
24333	2	48.28	CP-1A	60	5700.0	> LOQ 2.5	118061.31	> LOQ 51.78
24326	3	48.19	CP-1A	60	16000.0	> LOQ 2.5	332019.09	> LOQ 51.88
24329	OBZ	47.74	CP-1A	60	5600.0	> LOQ 2.5	117302.05	> LOQ 52.37
24499	1	42.42	CP-1B	62	2000.0	> LOQ 2.5	47147.57	> LOQ 58.93
24506	2	42.02	CP-1B	62	5300.0	> LOQ 2.5	126130.41	> LOQ 59.50
24388	3	42.47	CP-1B	62	22000.0	> LOQ 5.0	518012.71	> LOQ 117.73
24315	OBZ	41.77	CP-1B	62	5500.0	> LOQ 2.5	131673.45	> LOQ 59.85
24318	1	48.56	CG-01	63	60.0	> LOQ 2.5	1235.58	> LOQ 51.48
24308	2	48.00	CG-01	63	380.0	> LOQ 2.5	7916.67	> LOQ 52.08
24330	3	48.47	CG-01	63	390.0	> LOQ 2.5	8046.21	> LOQ 51.58
24230	OBZ	48.31	CG-01	63	370.0	> LOQ 2.5	7658.87	> LOQ 51.75
24363	1	48.10	G-6A	64	920.0	> LOQ 2.5	19126.82	> LOQ 51.98
24398	2	47.84	G-6A	64	4500.0	> LOQ 2.5	94063.55	> LOQ 52.26
24351	3	48.06	G-6A	64	8700.0	> LOQ 2.5	181023.72	> LOQ 52.02
24594	OBZ	48.29	G-6A	64	2000.0	> LOQ 2.5	41416.44	> LOQ 51.77
24312	1	48.76	G-6B	65	240.0	> LOQ 2.5	4922.07	> LOQ 51.27
24484	2	47.45	G-6B	65	2500.0	> LOQ 2.5	52687.04	> LOQ 52.69
24327	3	48.92	G-6B	65	2200.0	> LOQ 2.5	44971.38	> LOQ 51.10
24389	OBZ	48.46	G-6B	65	2200.0	> LOQ 2.5	45398.27	> LOQ 51.59
24348	1	48.59	SG-2A	66	21000.0	> LOQ 2.5	432187.69	> LOQ 51.45
24314	2	47.90	SG-2A	66	20000.0	> LOQ 5.0	417536.53	> LOQ 104.38
24494	3	48.24	SG-2A	66	29000.0	> LOQ 2.5	601160.86	> LOQ 51.82
24337	OBZ	48.30	SG-2A	66	120000.0	> LOQ 13.0	2484472.05	> LOQ 269.15
24508	1	48.47	CP-2A	67	1500.0	> LOQ 2.5	30946.98	> LOQ 51.58
24361	2	47.82	CP-2A	67	4300.0	> LOQ 2.5	89920.54	> LOQ 52.28
24359	3	48.22	CP-2A	67	23000.0	> LOQ 5.0	476980.51	> LOQ 103.69
24471	OBZ	48.14	CP-2A	67	8800.0	> LOQ 2.5	182800.17	> LOQ 51.93
24373	1	48.41	CP-2B	68	3800.0	> LOQ 2.5	78496.18	> LOQ 51.64
24468	2	47.90	CP-2B	68	2500.0	> LOQ 2.5	52192.07	> LOQ 52.19
24481	3	48.26	CP-2B	68	8400.0	> LOQ 2.5	174057.19	> LOQ 51.80
24391	OBZ	47.53	CP-2B	68	2100.0	> LOQ 2.5	44182.62	> LOQ 52.60
24356	1	48.56	O-1	69	830.0	> LOQ 2.5	17092.26	> LOQ 51.48
24470	2	47.89	O-1	69	1800.0	> LOQ 2.5	37586.13	> LOQ 52.20
24467	3	48.67	O-1	69	4400.0	> LOQ 2.5	90404.77	> LOQ 51.37
24313	OBZ	47.78	O-1	69	1000.0	> LOQ 2.5	20929.26	> LOQ 52.32
24501	1	47.96	CS-06	70	1400.0	> LOQ 2.5	29190.99	> LOQ 52.13
24496	2	47.75	CS-06	70	3500.0	> LOQ 2.5	73298.43	> LOQ 52.36
24478	3	48.31	CS-06	70	5900.0	> LOQ 2.5	122127.92	> LOQ 51.75
24503	OBZ	48.04	CS-06	70	2700.0	> LOQ 2.5	56203.16	> LOQ 52.04
24474	1	26.02	SG-1B	71	550.0	> LOQ 2.5	21137.59	> LOQ 96.08
24469	2	26.02	SG-1B	71	670.0	> LOQ 2.5	25749.42	> LOQ 96.08
24492	3	26.10	SG-1B	71	5300.0	> LOQ 2.5	203065.13	> LOQ 95.79

Air Sample Results - Iron

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Iron			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24495	OBZ	26.25	SG-1B	71	110000.0	> LOQ 25.0	4190476.19	> LOQ 952.38
24489	1	48.42	CP-3A	72	2400.0	> LOQ 2.5	49566.29	> LOQ 51.63
24491	2	47.93	CP-3A	72	6900.0	> LOQ 2.5	143959.94	> LOQ 52.16
24482	3	48.35	CP-3A	72	28000.0	> LOQ 5.0	579110.65	> LOQ 103.41
24486	OBZ	48.32	CP-3A	72	27000.0	> LOQ 5.0	558774.83	> LOQ 103.48
24516	1	36.34	CP-3B	73	2500.0	> LOQ 2.5	68794.72	> LOQ 68.79
24502	2	36.02	CP-3B	73	12000.0	> LOQ 2.5	333148.25	> LOQ 69.41
24515	3	36.48	CP-3B	73	20000.0	> LOQ 5.0	548245.61	> LOQ 137.06
24500	OBZ	40.27	CP-3B	73	8700.0	> LOQ 2.5	216041.72	> LOQ 62.08
24504	1	48.47	G-7A	74	2800.0	> LOQ 2.5	57767.69	> LOQ 51.58
24513	2	48.22	G-7A	74	6300.0	> LOQ 2.5	130651.18	> LOQ 51.85
24458	3	47.94	G-7A	74	15000.0	> LOQ 2.5	312891.11	> LOQ 52.15
24389	OBZ	47.75	G-7A	74	4700.0	> LOQ 2.5	98429.32	> LOQ 52.36
24404	1	48.68	G-7B	75	2100.0	> LOQ 2.5	43138.87	> LOQ 51.36
24451	2	48.06	G-7B	75	4400.0	> LOQ 2.5	91552.23	> LOQ 52.02
24447	3	47.16	G-7B	75	9000.0	> LOQ 2.5	190839.69	> LOQ 53.01
24423	OBZ	47.27	G-7B	75	2300.0	> LOQ 2.5	48656.65	> LOQ 52.89
24456	1	49.19	SS-06	76	100.0	> LOQ 2.5	2032.93	> LOQ 50.82
24480	2	48.26	SS-06	76	350.0	> LOQ 2.5	7252.38	> LOQ 51.80
24429	3	47.68	SS-06	76	90.0	> LOQ 2.5	1887.58	> LOQ 52.43
24418	OBZ	47.83	SS-06	76	280.0	> LOQ 2.5	5854.07	> LOQ 52.27
24427	1	48.54	CP-4A	78	3200.0	> LOQ 2.5	65925.01	> LOQ 51.50
24435	2	47.71	CP-4A	78	16000.0	> LOQ 5.0	335359.46	> LOQ 104.80
24244	3	49.01	CP-4A	78	86000.0	> LOQ 25.0	1754743.93	> LOQ 510.10
24220	OBZ	48.74	CP-4A	78	17000.0	> LOQ 5.0	348789.5	> LOQ 102.59
24460	1	50.05	CP-4B	79	3700.0	> LOQ 2.5	73926.07	> LOQ 49.95
24465	2	48.47	CP-4B	79	11000.0	> LOQ 2.5	226944.5	> LOQ 51.58
24207	3	48.49	CP-4B	79	58000.0	> LOQ 13.0	1196122.91	> LOQ 268.10
24390	OBZ	49.02	CP-4B	79	3500.0	> LOQ 2.5	71399.43	> LOQ 51.00
24259	1	48.76	SS-07	80	72.0	> LOQ 2.5	1476.62	> LOQ 51.27
24421	2	48.13	SS-07	80	270.0	> LOQ 2.5	5609.81	> LOQ 51.94
24445	3	47.87	SS-07	80	830.0	> LOQ 2.5	17338.63	> LOQ 52.22
24432	OBZ	48.49	SS-07	80	210.0	> LOQ 2.5	4330.79	> LOQ 51.56
24459	1	48.96	N-02	81	4600.0	> LOQ 2.5	93954.25	> LOQ 51.06
24417	2	48.11	N-02	81	8600.0	> LOQ 2.5	178757.02	> LOQ 51.96
24442	3	48.01	N-02	81	40000.0	> LOQ 13	833159.76	> LOQ 270.78
24386	OBZ	48.19	N-02	81	7800.0	> LOQ 2.5	161859.31	> LOQ 51.88
24452	1	48.20	SG-2B	82	7200.0	> LOQ 2.5	149377.59	> LOQ 51.87
24453	2	48.59	SG-2B	82	13000.0	> LOQ 2.5	267544.76	> LOQ 51.45
24420	3	47.84	SG-2B	82	28000.0	> LOQ 13.0	585284.28	> LOQ 271.74
24444	OBZ	47.95	SG-2B	82	190000.0	> LOQ 50	3962460.9	> LOQ 1042.75
24455	1	48.56	CS-07	83	1000.0	> LOQ 2.5	20593.08	> LOQ 51.48
24433	2	47.96	CS-07	83	2700.0	> LOQ 2.5	56296.91	> LOQ 52.13
24398	3	48.06	CS-07	83	11000.0	> LOQ 2.5	228880.57	> LOQ 52.02
24511	OBZ	47.96	CS-07	83	2600.0	> LOQ 2.5	54211.84	> LOQ 52.13
24454	1	49.34	CPDS-1A	84	2000.0	> LOQ 2.5	40535.06	> LOQ 50.67
24291	2	48.49	CPDS-1A	84	3200.0	> LOQ 2.5	65992.99	> LOQ 51.56
24209	3	48.43	CPDS-1A	84	21000.0	> LOQ 5.0	433615.53	> LOQ 103.24
24402	OBZ	48.77	CPDS-1A	84	7700.0	> LOQ 2.5	157883.95	> LOQ 51.26
24204	1	49.46	CPDS-1B	85	2400.0	> LOQ 2.5	48524.06	> LOQ 50.55
24273	2	48.35	CPDS-1B	85	4300.0	> LOQ 2.5	88934.85	> LOQ 51.71
24223	3	48.82	CPDS-1B	85	18000.0	> LOQ 5.0	368701.35	> LOQ 102.42
24466	OBZ	49.96	CPDS-1B	85	4200.0	> LOQ 2.5	84067.25	> LOQ 50.04

Airborne Sample Data Analysis - Iron

NIOSH REL 5000.0 micrograms/cubic meter
OSHA PEL 10000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	1235.58	> LOQ 51.48	7916.67	> LOQ 52.08	8046.21	> LOQ 51.58	7658.87	> LOQ 51.75
CS-01	9474.77	> LOQ 51.49	33333.33	> LOQ 52.08	117598.51	> LOQ 51.58	29215.36	> LOQ 52.17
CS-02	9983.36	> LOQ 52.00	31354.52	> LOQ 52.26	112476.57	> LOQ 52.07	45842.88	> LOQ 52.09
CS-03	10723.86	> LOQ 51.56	43487.26	> LOQ 51.77	138946.50	> LOQ 51.85	45558.09	> LOQ 51.77
CS-04	3291.5	> LOQ 51.43	13813.31	> LOQ 52.32	28991.51	> LOQ 51.77	15026.76	> LOQ 51.46
CS-05	6606.11	> LOQ 51.61	29209.26	> LOQ 52.16	66973.63	> LOQ 52.32	36172.31	> LOQ 82.21
CS-06	29190.99	> LOQ 52.13	73298.43	> LOQ 52.36	122127.92	> LOQ 51.75	56203.16	> LOQ 52.04
CS-07	20593.08	> LOQ 51.48	56296.91	> LOQ 52.13	228880.57	> LOQ 52.02	54211.84	> LOQ 52.13
CSDS-01	12043.19	> LOQ 51.91	64569.88	> LOQ 52.07	172342.19	> LOQ 51.91	87372.58	> LOQ 52.01
CSDS-02	7212.03	> LOQ 51.51	33085.19	> LOQ 51.70	89008.49	> LOQ 51.75	37672.67	> LOQ 52.32
N-01	7112.38	> LOQ 50.80	37531.28	> LOQ 52.13	134519.87	> LOQ 51.74	69672.13	> LOQ 51.23
N-02	93954.25	> LOQ 51.06	178757.02	> LOQ 51.96	833159.76	> LOQ 270.78	161859.31	> LOQ 51.88
O-1	17092.26	> LOQ 51.48	37586.13	> LOQ 52.20	90404.77	> LOQ 51.37	20929.26	> LOQ 52.32
S-01	1266.61	> LOQ 51.91	5011.48	> LOQ 52.20	14405.01	> LOQ 52.19	6050.49	> LOQ 52.16
S-02	1438.1	> LOQ 52.11	7747.07	> LOQ 52.35	10416.67	> LOQ 52.08	6681.98	> LOQ 52.20
SH-01	7518.8	> LOQ 52.21	20685.33	> LOQ 52.24	95356.55	> LOQ 51.82	13935.11	> LOQ 52.00
SS-01	1073.49	> LOQ 51.61	4384.13	> LOQ 52.19	5791.11	> LOQ 51.71	6004.14	> LOQ 51.76
SS-02	1288.18	> LOQ 51.94	5630.87	> LOQ 52.14	5173.84	> LOQ 51.74	6375.98	> LOQ 51.42
SS-03	770.03	> LOQ 52.03	4201.68	> LOQ 52.52	4699.63	> LOQ 51.08	4233.02	> LOQ 50.39
SS-04	2070.7	> LOQ 52.29	13604.02	> LOQ 52.32	18200.84	> LOQ 52.30	13377.24	> LOQ 51.45
SS-05	2410.61	> LOQ 50.22	8389.26	> LOQ 52.43	19538.56	> LOQ 51.96	12297.6	> LOQ 51.24
SS-06	2032.93	> LOQ 50.82	7252.38	> LOQ 51.80	1887.58	> LOQ 52.43	5854.07	> LOQ 52.27
SS-07	1476.62	> LOQ 51.27	5609.81	> LOQ 51.94	17338.63	> LOQ 52.22	4330.79	> LOQ 51.56
SSDS-01	905.72	> LOQ 51.46	5016.72	> LOQ 52.26	8867.81	> LOQ 51.56	7864.24	> LOQ 51.74
SSDS-02	1937.9	> LOQ 52.09	9166.67	> LOQ 52.08	20635.58	> LOQ 51.59	9925.06	> LOQ 50.64
SSDS-03	687.15	> LOQ 50.53	2383.32	> LOQ 49.65	4976.11	> LOQ 49.76	3729.8	> LOQ 51.80
CP-1A	30934.21	> LOQ 51.56	118061.31	> LOQ 51.78	332019.09	> LOQ 51.88	117302.05	> LOQ 52.37
CP-1B	47147.57	> LOQ 58.93	126130.41	> LOQ 59.50	518012.71	> LOQ 117.73	131673.45	> LOQ 59.85
CP-2A	30946.98	> LOQ 51.58	89920.54	> LOQ 52.28	476980.51	> LOQ 103.69	182800.17	> LOQ 51.93
CP-2B	78496.18	> LOQ 51.64	52192.07	> LOQ 52.19	174057.19	> LOQ 51.80	44182.62	> LOQ 52.60
CP-3A	49566.29	> LOQ 51.63	143959.94	> LOQ 52.16	579110.65	> LOQ 103.41	558774.83	> LOQ 103.48
CP-3B	68794.72	> LOQ 68.79	333148.25	> LOQ 69.41	548245.61	> LOQ 137.06	216041.72	> LOQ 62.08
CP-4A	65925.01	> LOQ 51.50	335359.46	> LOQ 104.80	1754743.93	> LOQ 510.10	348789.5	> LOQ 102.59
CP-4B	73926.07	> LOQ 49.95	226944.5	> LOQ 51.58	1196122.91	> LOQ 268.10	71399.43	> LOQ 51.00
CPDS-1A	40535.06	> LOQ 50.67	65992.99	> LOQ 51.56	433615.53	> LOQ 103.24	157883.95	> LOQ 51.26
CPDS-1B	48524.06	> LOQ 50.55	88934.85	> LOQ 51.71	368701.35	> LOQ 102.42	84067.25	> LOQ 50.04
G-1A	4155.41	> LOQ 51.94	16920.83	> LOQ 52.22	51899.52	> LOQ 51.90	38846.86	> LOQ 51.11
G-1B	3728.25	> LOQ 51.78	27437.74	> LOQ 52.76	43595.60	> LOQ 51.90	78805.47	> LOQ 51.85
G-2A	3161.22	> LOQ 52.69	21222.41	> LOQ 53.06	31094.53	> LOQ 51.82	14987.51	> LOQ 52.04
G-2B	4714.08	> LOQ 51.24	37367.66	> LOQ 51.90	27190.96	> LOQ 52.29	9064.69	> LOQ 51.50
G-3A	9102.19	> LOQ 51.72	29099.98	> LOQ 51.96	96537.25	> LOQ 52.47	13336.11	> LOQ 52.09
G-4A	34524.78	> LOQ 50.77	35145.75	> LOQ 51.68	226011.92	> LOQ 51.37	68521.59	> LOQ 51.91
G-4B	10541.55	> LOQ 51.67	87481.77	> LOQ 52.07	142620.92	> LOQ 51.67	74349.44	> LOQ 51.63
G-5A	3499.38	> LOQ 51.46	14943.96	> LOQ 51.89	49947.97	> LOQ 52.03	66903.62	> LOQ 52.27
G-5B	8354.22	> LOQ 52.21	41528.24	> LOQ 51.91	116715.30	> LOQ 52.11	20837.67	> LOQ 52.09
G-6A	19126.82	> LOQ 51.98	94063.55	> LOQ 52.26	181023.72	> LOQ 52.02	41416.44	> LOQ 51.77
G-6B	4922.07	> LOQ 51.27	52687.04	> LOQ 52.69	44971.38	> LOQ 51.10	45398.27	> LOQ 51.59
G-7A	57767.69	> LOQ 51.58	130651.18	> LOQ 51.85	312891.11	> LOQ 52.15	98429.32	> LOQ 52.36
G-7B	43138.87	> LOQ 51.36	91552.23	> LOQ 52.02	190839.69	> LOQ 53.01	48656.65	> LOQ 52.89
SG-1A	142915.48	> LOQ 51.04	112033.2	> LOQ 51.87	518887.51	> LOQ 103.78	3507324.12	> LOQ 1031.57
SG-1B	21137.59	> LOQ 96.08	25749.42	> LOQ 96.08	203065.13	> LOQ 95.79	4190476.19	> LOQ 952.38
SG-2A	432187.69	> LOQ 51.45	417536.53	> LOQ 104.38	601160.86	> LOQ 51.82	2484472.05	> LOQ 269.15
SG-2B	149377.59	> LOQ 51.87	267544.76	> LOQ 51.45	585284.28	> LOQ 271.74	3962460.9	> LOQ 1042.75

Bulk Elemental Analysis - Iron

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Iron		Sample	Iron	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	23.00	> LOQ 10.0	J95331-63 PB	800.00	> LOQ 10.0
CS-01	J95331-34 VB	36000.00	> LOQ 10.0	J95331-34 PB	44000.00	> LOQ 10.0
CS-02	J95331-37 VB	17000.00	> LOQ 10.0	J95331-37 PB	18000.00	> LOQ 10.0
CS-03	J95331-38 VB	39000.00	> LOQ 10.0	J95331-38 PB	48000.00	> LOQ 10.0
CS-04	J95331-39 VB	1500.00	> LOQ 10.0	J95331-39 PB	3100.00	> LOQ 10.0
CS-05	J95331-57 VB	3300.00	> LOQ 10.0	J95331-57 PB	6300.00	> LOQ 10.0
CS-06	J95331-70 VB	3500.00	> LOQ 10.0	J95331-70 PB	10000.00	> LOQ 10.0
CS-07	J95331-83 VB	6500.00	> LOQ 10.0	J95331-83 PB	14000.00	> LOQ 10.0
CSDS-01	J95331-31 VB	7200.00	> LOQ 10.0	J95331-31 PB	15000.00	> LOQ 10.0
CSDS-02	J95331-35 VB	25000.00	> LOQ 10.0	J95331-35 PB	30000.00	> LOQ 10.0
N-01	J95331-52 VB	9000.00	> LOQ 10.0	J95331-52 PB	13000.00	> LOQ 10.0
N-02	J95331-81 VB	84000.00	> LOQ 20.0	J95331-81 PB	170000.00	> LOQ 50.0
O-1	J95331-69 VB	37000.00	> LOQ 10.0	J95331-69 PB	49000.00	> LOQ 50.0
S-01	J95331-28 VB	230.00	> LOQ 10.0	J95331-28 PB	510.00	> LOQ 10.0
S-02	J95331-29 VB	96.00	> LOQ 10.0	J95331-29 PB	710.00	> LOQ 10.0
SH-01	J95331-36 VB	23000.00	> LOQ 10.0	J95331-36 PB	20000.00	> LOQ 10.0
SS-01	J95331-32 VB	59.00	> LOQ 10.0	J95331-32 PB	530.00	> LOQ 10.0
SS-02	J95331-40 VB	190.00	> LOQ 10.0	J95331-40 PB	650.00	> LOQ 10.0
SS-03	J95331-45 VB	58.00	> LOQ 10.0	J95331-45 PB	260.00	> LOQ 10.0
SS-04	J95331-47 VB	2900.00	> LOQ 10.0	J95331-47 PB	9000.00	> LOQ 10.0
SS-05	J95331-53 VB	2800.00	> LOQ 10.0	J95331-53 PB	2400.00	> LOQ 10.0
SS-06	J95331-76 VB	1800.00	> LOQ 10.0	J95331-76 PB	2000.00	> LOQ 10.0
SS-07	J95331-80 VB	1100.00	> LOQ 10.0	J95331-80 PB	510.00	> LOQ 10.0
SSDS-01	J95331-33 VB	190.00	> LOQ 10.0	J95331-33 PB	600.00	> LOQ 10.0
SSDS-02	J95331-44 VB	2800.00	> LOQ 10.0	J95331-44 PB	3400.00	> LOQ 10.0
SSDS-03	J95331-48 VB	110.00	> LOQ 10.0	J95331-48 PB	380.00	> LOQ 10.0
CP-1A	J95331-60 VB	35000.00	> LOQ 10.0	J95331-60 PB	140000.00	> LOQ 10.0
CP-1B	J95331-61 VB	11000.00	> LOQ 10.0	J95331-61 PB	15000.00	> LOQ 10.0
CP-2A	J95331-67 VB	85000.00	> LOQ 20.0	J95331-67 PB	110000.00	> LOQ 10.0
CP-2B	J95331-68 VB	130000.00	> LOQ 50.0	J95331-68 PB	140000.00	> LOQ 10.0
CP-3A	J95331-72 VB	160000.00	> LOQ 200.0	J95331-72 PB	110000.00	> LOQ 200.0
CP-3B	J95331-73 VB	100000.00	> LOQ 20.0	J95331-73 PB	120000.00	> LOQ 20.0
CP-4A	J95331-78 VB	94000.00	> LOQ 50.0	J95331-78 PB	150000.00	> LOQ 20.0
CP-4B	J95331-79 VB	180000.00	> LOQ 50.0	J95331-79 PB	200000.00	> LOQ 50.0
CPDS-1A	J95331-84 VB	56000.00	> LOQ 10.0	J95331-84 PB	96000.00	> LOQ 20.0
CPDS-1B	J95331-85 VB	100000.00	> LOQ 20.0	J95331-85 PB	98000.00	> LOQ 20.0
G-1A	J95331-41 VB	2200.00	> LOQ 10.0	J95331-41 PB	3900.00	> LOQ 10.0
G-1B	J95331-46 VB	43000.00	> LOQ 10.0	J95331-46 PB	29000.00	> LOQ 10.0
G-2A	J95331-43 VB	2500.00	> LOQ 10.0	J95331-43 PB	5900.00	> LOQ 10.0
G-2B	J95331-50 VB	7500.00	> LOQ 10.0	J95331-50 PB	4600.00	> LOQ 10.0
G-3A	J95331-49 VB	3500.00	> LOQ 10.0	J95331-49 PB	3300.00	> LOQ 10.0
G-4A	J95331-55 VB	3400.00	> LOQ 10.0	J95331-55 PB	9800.00	> LOQ 10.0
G-4B	J95331-56 VB	14000.00	> LOQ 10.0	J95331-56 PB	12000.00	> LOQ 10.0
G-5A	J95331-58 VB	3000.00	> LOQ 10.0	J95331-58 PB	3900.00	> LOQ 10.0
G-5B	J95331-59 VB	3900.00	> LOQ 10.0	J95331-59 PB	4500.00	> LOQ 10.0
G-6A	J95331-64 VB	3600.00	> LOQ 10.0	J95331-64 PB	6500.00	> LOQ 10.0
G-6B	J95331-65 VB	8400.00	> LOQ 10.0	J95331-65 PB	7000.00	> LOQ 10.0
G-7A	J95331-74 VB	27000.00	> LOQ 10.0	J95331-74 PB	26000.00	> LOQ 10.0
G-7B	J95331-75 VB	84000.00	> LOQ 20.0	J95331-75 PB	50000.00	> LOQ 10.0
SG-1A	J95331-54 VB	890000.00	> LOQ 200.0	J95331-54 PB	890000.00	> LOQ 200.0
SG-1B	J95331-71 VB	920000.00	> LOQ 200.0	J95331-71 PB	870000.00	> LOQ 200.0
SG-2A	J95331-66 VB	800000.00	> LOQ 100.0	J95331-66 PB	560000.00	> LOQ 100.0
SG-2B	J95331-82 VB	900000.00	> LOQ 200.0	J95331-82 PB	890000.00	> LOQ 200.0

Comparison of Airborne Concentrations to Bulk Concentrations - Iron

NIOSH REL 5000.0 micrograms/cubic meter
OSHA PEL 10000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	1235.58	7916.67	8046.21	7658.87	23.00
CS-01	9474.77	33333.33	117598.51	29215.36	36000.00
CS-02	9983.36	31354.52	112476.57	45842.88	17000.00
CS-03	10723.86	43487.26	138946.50	45558.09	39000.00
CS-04	3291.50	13813.31	28991.51	15026.76	1500.00
CS-05	6606.11	29209.26	66973.63	36172.31	3300.00
CS-06	29190.99	73298.43	122127.92	56203.16	3500.00
CS-07	20593.08	56296.91	228880.57	54211.84	6500.00
CSDS-01	12043.19	64569.88	172342.19	87372.58	7200.00
CSDS-02	7212.03	33085.19	89008.49	37672.67	25000.00
N-01	7112.38	37531.28	134519.87	69672.13	9000.00
N-02	93954.25	178757.02	833159.76	161859.31	84000.00
O-1	17092.26	37586.13	90404.77	20929.26	37000.00
S-01	1266.61	5011.48	14405.01	6050.49	230.00
S-02	1438.10	7747.07	10416.67	6681.98	96.00
SH-01	7518.80	20685.33	95356.55	13935.11	23000.00
SS-01	1073.49	4384.13	5791.11	6004.14	59.00
SS-02	1288.18	5630.87	5173.84	6375.98	190.00
SS-03	770.03	4201.68	4699.63	4233.02	58.00
SS-04	2070.70	13604.02	18200.84	13377.24	2900.00
SS-05	2410.61	8389.26	19538.56	12297.60	2800.00
SS-06	2032.93	7252.38	1887.58	5854.07	1800.00
SS-07	1476.62	5609.81	17338.63	4330.79	1100.00
SSDS-01	905.72	5016.72	8867.81	7864.24	190.00
SSDS-02	1937.90	9166.67	20635.58	9925.06	2800.00
SSDS-03	687.15	2383.32	4976.11	3729.80	110.00
CP-1A	30934.21	118061.31	332019.09	117302.05	35000.00
CP-2A	30946.98	89920.54	476980.51	182800.17	85000.00
CP-3A	49566.29	143959.94	579110.65	558774.83	160000.00
CP-4A	65925.01	335359.46	1754743.93	348789.50	94000.00
CPDS-1A	40535.06	65992.99	433615.53	157883.95	56000.00
G-1A	4155.41	16920.83	51899.52	38846.86	2200.00
G-2A	3161.22	21222.41	31094.53	14987.51	2500.00
G-3A	9102.19	29099.98	96537.25	13336.11	3500.00
G-4A	34524.78	35145.75	226011.92	68521.59	3400.00
G-5A	3499.38	14943.96	49947.97	66903.62	3000.00
G-6A	19126.82	94063.55	181023.72	41416.44	3600.00
G-7A	57767.69	130651.18	312891.11	98429.32	27000.00
SG-1A	142915.48	112033.20	518887.51	3507324.12	890000.00
SG-2A	432187.69	417536.53	601160.86	2484472.05	800000.00

APPENDIX B - LEAD

Lead

Inhalation or ingestion of inorganic lead has reportedly caused peripheral neuropathy with paralysis of the muscles of the wrists and ankles, encephalopathy, anemia due to decreased red blood cell life and impaired heme synthesis, kidney damage and adverse effects on the reproductive systems of males and females. The NIOSH REL and OSHA PEL for lead are 100 and 50 micrograms/cubic meter of air, respectively.

Air Sample Results - Lead

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lead			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.08	ND	< LOD 1.66
24412	2	47.89	S-01	28	0.230	< LOQ 0.25	4.8	< LOQ 5.22
24441	3	47.90	S-01	28	1.200	> LOQ 0.25	25.05	> LOQ 5.22
24450	OBZ	47.93	S-01	28	0.450	> LOQ 0.25	9.39	> LOQ 5.22
24643	1	47.98	S-02	29	0.140	< LOQ 0.25	2.92	< LOQ 5.21
24625	2	47.76	S-02	29	0.720	> LOQ 0.25	15.08	> LOQ 5.23
24642	3	48.00	S-02	29	1.600	> LOQ 0.25	33.33	> LOQ 5.21
24632	OBZ	47.89	S-02	29	0.410	> LOQ 0.25	8.56	> LOQ 5.22
24634	1	48.16	CSDS-01	31	ND	< LOD 0.08	ND	< LOD 1.66
24650	2	48.01	CSDS-01	31	0.150	< LOQ 0.25	3.12	< LOQ 5.21
24644	3	48.16	CSDS-01	31	0.610	> LOQ 0.25	12.67	> LOQ 5.19
24645	OBZ	48.07	CSDS-01	31	0.150	< LOQ 0.25	3.12	< LOQ 5.20
24640	1	48.44	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24641	2	47.90	SS-01	32	0.180	< LOQ 0.25	3.76	< LOQ 5.22
24651	3	48.35	SS-01	32	0.230	< LOQ 0.25	4.76	< LOQ 5.17
24635	OBZ	48.30	SS-01	32	0.200	< LOQ 0.25	4.14	< LOQ 5.18
24646	1	48.58	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.65
24626	2	47.84	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.67
24638	3	48.49	SSDS-01	33	0.100	< LOQ 0.25	2.06	< LOQ 5.16
24647	OBZ	48.32	SSDS-01	33	0.094	< LOQ 0.25	1.95	< LOQ 5.17
24628	1	48.55	CS-01	34	0.110	< LOQ 0.25	2.27	< LOQ 5.15
24637	2	48.00	CS-01	34	0.260	> LOQ 0.25	5.42	> LOQ 5.21
24624	3	48.47	CS-01	34	0.510	> LOQ 0.25	10.52	> LOQ 5.16
24636	OBZ	47.92	CS-01	34	0.190	< LOQ 0.25	3.96	< LOQ 5.22
24623	1	48.53	CSDS-02	35	ND	< LOD 0.08	ND	< LOD 1.65
24622	2	48.36	CSDS-02	35	4.300	> LOQ 0.25	88.92	> LOQ 5.17
24654	3	48.31	CSDS-02	35	0.200	< LOQ 0.25	4.14	< LOQ 5.17
24653	OBZ	47.78	CSDS-02	35	0.110	< LOQ 0.25	2.3	< LOQ 5.23
24629	1	47.88	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.18
24633	2	47.86	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.18
24627	3	48.24	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.15
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.2	ND	< LOD 4.16
24555	1	48.08	CS-02	37	ND	< LOD 0.2	ND	< LOD 4.16
24552	2	47.84	CS-02	37	0.360	< LOQ 0.42	7.53	< LOQ 8.78
24541	3	48.01	CS-02	37	1.600	> LOQ 0.42	33.33	> LOQ 8.75
24529	OBZ	47.99	CS-02	37	0.550	> LOQ 0.42	11.46	> LOQ 8.75
24558	1	48.49	CS-03	38	ND	< LOD 0.2	ND	< LOD 4.12
24524	2	48.29	CS-03	38	ND	< LOD 0.2	ND	< LOD 4.14
24561	3	48.22	CS-03	38	0.550	> LOQ 0.42	11.41	> LOQ 8.71
24559	OBZ	48.29	CS-03	38	0.240	< LOQ 0.42	4.97	< LOQ 8.70
24543	1	48.61	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.11
24532	2	47.78	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.19
24546	3	48.29	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.14
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.2	ND	< LOD 4.12
24560	1	48.13	SS-02	40	0.400	< LOQ 0.42	8.31	< LOQ 8.73
24565	2	47.95	SS-02	40	ND	< LOD 0.2	ND	< LOD 4.17
24630	3	48.32	SS-02	40	0.500	> LOQ 0.42	10.35	> LOQ 8.69
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.2	ND	< LOD 4.11
24525	1	48.13	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.16
24563	2	47.87	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.18
24547	3	48.17	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.15
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.2	ND	< LOD 4.09
24538	1	47.45	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.21

Air Sample Results - Lead

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lead			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.24
24533	3	48.24	G-2A	43	0.420	= LOQ	8.71	> LOQ 0.00
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.2	ND	< LOD 4.16
24528	1	47.99	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.17
24544	2	48.00	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.17
24567	3	48.46	SSDS-02	44	0.240	< LOQ 0.42	4.95	< LOQ 8.67
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.2	ND	< LOD 4.05
24571	1	48.05	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.16
24536	2	47.60	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.20
24534	3	48.94	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.09
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.2	ND	< LOD 4.03
24568	1	48.28	G-1B	46	ND	< LOD 0.09	ND	< LOD 1.86
24592	2	47.38	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.69
24593	3	48.17	G-1B	46	0.082	< LOQ 0.25	1.7	< LOQ 5.19
24535	OBZ	48.22	G-1B	46	ND	< LOD 0.09	ND	< LOD 1.87
24590	1	47.81	SS-04	47	ND	< LOD 0.08	ND	< LOD 1.67
24605	2	47.78	SS-04	47	0.160	< LOQ 0.25	3.35	< LOQ 5.23
24562	3	47.80	SS-04	47	0.250	< LOQ 0.29	5.23	< LOQ 6.07
24531	OBZ	48.59	SS-04	47	0.150	< LOQ 0.29	3.09	< LOQ 5.97
24527	1	49.48	SSDS-03	48	ND	< LOD 0.09	ND	< LOD 1.82
24569	2	50.35	SSDS-03	48	0.009	< LOQ 0.29	0.18	< LOQ 5.76
24584	3	50.24	SSDS-03	48	ND	< LOD 0.09	ND	< LOD 1.79
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.09	ND	< LOD 1.86
24600	1	48.34	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.65
24616	2	48.11	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.66
24585	3	47.65	G-3A	49	0.100	< LOQ 0.29	2.1	< LOQ 6.09
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.09	ND	< LOD 1.88
24587	1	48.79	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.64
24602	2	48.17	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.66
24564	3	47.81	G-2B	50	ND	< LOD 0.09	ND	< LOD 1.88
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.65
24618	1	49.21	N-01	52	ND	< LOD 0.08	ND	< LOD 1.63
24611	2	47.96	N-01	52	ND	< LOD 0.08	ND	< LOD 1.67
24588	3	48.32	N-01	52	0.110	< LOQ 0.25	2.28	< LOQ 5.17
24615	OBZ	48.80	N-01	52	0.089	< LOQ 0.25	1.82	< LOQ 5.12
24597	1	49.78	SS-05	53	ND	< LOD 0.08	ND	< LOD 1.61
24599	2	47.68	SS-05	53	0.110	< LOQ 0.25	2.31	< LOQ 5.24
24575	3	48.11	SS-05	53	0.210	< LOQ 0.29	4.36	< LOQ 6.03
24617	OBZ	48.79	SS-05	53	0.290	> LOQ 0.25	5.94	> LOQ 5.12
24609	1	48.98	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.63
24596	2	48.20	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.66
24610	3	48.18	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.66
24576	OBZ	48.47	SG-1A	54	ND	< LOD 0.09	ND	< LOD 1.86
24606	1	49.24	G-4A	55	ND	< LOD 0.08	ND	< LOD 1.62
24620	2	48.37	G-4A	55	0.160	< LOQ 0.25	3.31	< LOQ 5.17
24573	3	48.67	G-4A	55	0.350	> LOQ 0.29	7.19	> LOQ 5.96
24505	OBZ	48.16	G-4A	55	0.150	< LOQ 0.29	3.11	< LOQ 6.02
24340	1	48.38	G-4B	56	ND	< LOD 0.08	ND	< LOD 1.65
24607	2	48.01	G-4B	56	0.130	< LOQ 0.25	2.71	< LOQ 5.21
24595	3	48.38	G-4B	56	0.250	> LOQ 0.25	5.17	> LOQ 5.17
24598	OBZ	48.42	G-4B	56	0.120	< LOQ 0.25	2.48	< LOQ 5.16
24580	1	48.44	CS-05	57	ND	< LOD 0.08	ND	< LOD 1.65
24604	2	47.93	CS-05	57	0.093	< LOQ 0.25	1.94	< LOQ 5.22

Air Sample Results - Lead

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lead			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	0.240	< LOQ 0.25	5.02	< LOQ 5.23
24574	OBZ	30.41	CS-05	57	ND	< LOD 0.08	ND	< LOD 2.63
24614	1	48.58	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.65
24577	2	48.18	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.66
24572	3	48.05	G-5A	58	0.210	< LOQ 0.25	4.37	< LOQ 5.20
24582	OBZ	47.83	G-5A	58	0.087	< LOQ 0.25	1.82	< LOQ 5.23
24322	1	47.88	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.67
24354	2	48.16	G-5B	59	0.120	< LOQ 0.25	2.49	< LOQ 5.19
24510	3	47.98	G-5B	59	0.017	< LOQ 0.25	0.35	< LOQ 5.21
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.67
24497	1	48.49	CP-1A	60	0.380	> LOQ 0.25	7.84	> LOQ 5.16
24333	2	48.28	CP-1A	60	1.000	> LOQ 0.25	20.71	> LOQ 5.18
24326	3	48.19	CP-1A	60	2.700	> LOQ 1.3	56.03	> LOQ 26.98
24329	OBZ	47.74	CP-1A	60	1.100	> LOQ 0.25	23.04	> LOQ 5.24
24499	1	42.42	CP-1B	62	0.380	> LOQ 0.25	8.96	> LOQ 5.89
24506	2	42.02	CP-1B	62	0.970	> LOQ 0.25	23.08	> LOQ 5.95
24388	3	42.47	CP-1B	62	3.700	> LOQ 1.3	87.12	> LOQ 30.61
24315	OBZ	41.77	CP-1B	62	0.900	> LOQ 0.25	21.55	> LOQ 5.99
24318	1	48.56	CG-01	63	0.190	< LOQ 0.25	3.91	< LOQ 5.15
24308	2	48.00	CG-01	63	0.720	> LOQ 0.25	15	> LOQ 5.21
24330	3	48.47	CG-01	63	1.300	> LOQ 0.25	26.82	> LOQ 5.16
24230	OBZ	48.31	CG-01	63	0.670	> LOQ 0.25	13.87	> LOQ 5.17
24363	1	48.10	G-6A	64	0.098	< LOQ 0.25	2.04	< LOQ 5.20
24398	2	47.84	G-6A	64	0.370	> LOQ 0.25	7.73	> LOQ 5.23
24351	3	48.06	G-6A	64	0.640	> LOQ 0.25	13.32	> LOQ 5.20
24594	OBZ	48.29	G-6A	64	0.340	> LOQ 0.25	7.04	> LOQ 5.18
24312	1	48.76	G-6B	65	ND	< LOD 0.08	ND	< LOD 1.64
24484	2	47.45	G-6B	65	0.390	> LOQ 0.25	8.22	> LOQ 5.27
24327	3	48.92	G-6B	65	0.540	> LOQ 0.25	11.04	> LOQ 5.11
24389	OBZ	48.46	G-6B	65	0.190	< LOQ 0.25	3.92	< LOQ 5.16
24348	1	48.59	SG-2A	66	0.250	= LOQ	5.15	> LOQ 0.00
24314	2	47.90	SG-2A	66	0.210	< LOQ 0.25	4.38	< LOQ 5.22
24494	3	48.24	SG-2A	66	0.430	> LOQ 0.25	8.91	> LOQ 5.18
24337	OBZ	48.30	SG-2A	66	1.400	> LOQ 0.25	28.99	> LOQ 5.18
24508	1	48.47	CP-2A	67	ND	< LOD 0.08	ND	< LOD 1.65
24361	2	47.82	CP-2A	67	ND	< LOD 0.2	ND	< LOD 4.18
24359	3	48.22	CP-2A	67	0.470	< LOQ 0.53	9.75	< LOQ 10.99
24471	OBZ	48.14	CP-2A	67	0.180	< LOQ 0.26	3.74	< LOQ 5.40
24373	1	48.41	CP-2B	68	0.085	< LOQ 0.19	1.76	< LOQ 3.92
24468	2	47.90	CP-2B	68	ND	< LOD 0.08	ND	< LOD 1.67
24481	3	48.26	CP-2B	68	0.170	< LOQ 0.26	3.52	< LOQ 5.39
24391	OBZ	47.53	CP-2B	68	0.095	< LOQ 0.25	2	< LOQ 5.26
24356	1	48.56	O-1	69	ND	< LOD 0.2	ND	< LOD 4.12
24470	2	47.89	O-1	69	0.096	< LOQ 0.26	2	< LOQ 5.43
24467	3	48.67	O-1	69	ND	< LOD 0.08	ND	< LOD 1.64
24313	OBZ	47.78	O-1	69	ND	< LOD 0.2	ND	< LOD 4.19
24501	1	47.96	CS-06	70	ND	< LOD 0.08	ND	< LOD 1.67
24496	2	47.75	CS-06	70	0.120	< LOQ 0.26	2.51	< LOQ 5.45
24478	3	48.31	CS-06	70	0.210	< LOQ 0.26	4.35	< LOQ 5.38
24503	OBZ	48.04	CS-06	70	0.110	< LOQ 0.26	2.29	< LOQ 5.41
24474	1	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24469	2	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24492	3	26.10	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07

Air Sample Results - Lead

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lead			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.05
24489	1	48.42	CP-3A	72	6.800	> LOQ 2.6	140.44	> LOQ 53.70
24491	2	47.93	CP-3A	72	22.000	> LOQ 2.6	459	> LOQ 54.25
24482	3	48.35	CP-3A	72	110.000	> LOQ 26.0	2275.08	> LOQ 537.75
24486	OBZ	48.32	CP-3A	72	77.000	> LOQ 10.0	1593.54	> LOQ 206.95
24516	1	36.34	CP-3B	73	6.000	> LOQ 2.6	165.11	> LOQ 71.55
24502	2	36.02	CP-3B	73	35.000	> LOQ 5.2	971.68	> LOQ 144.36
24515	3	36.48	CP-3B	73	58.000	> LOQ 10.0	1589.91	> LOQ 274.12
24500	OBZ	40.27	CP-3B	73	25.000	> LOQ 2.6	620.81	> LOQ 64.56
24504	1	48.47	G-7A	74	ND	< LOD 0.08	ND	< LOD 1.65
24513	2	48.22	G-7A	74	ND	< LOD 0.08	ND	< LOD 1.66
24458	3	47.94	G-7A	74	0.120	< LOQ 0.26	2.5	< LOQ 5.42
24389	OBZ	47.75	G-7A	74	0.110	< LOQ 0.25	2.3	< LOQ 5.24
24404	1	48.68	G-7B	75	ND	< LOD 0.08	ND	< LOD 1.64
24451	2	48.06	G-7B	75	ND	< LOD 0.08	ND	< LOD 1.66
24447	3	47.16	G-7B	75	0.140	< LOQ 0.25	2.97	< LOQ 5.30
24423	OBZ	47.27	G-7B	75	0.120	< LOQ 0.25	2.54	< LOQ 5.29
24456	1	49.19	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.63
24480	2	48.26	SS-06	76	0.091	< LOQ 0.26	1.89	< LOQ 5.39
24429	3	47.68	SS-06	76	0.190	< LOQ 0.25	3.98	< LOQ 5.24
24418	OBZ	47.83	SS-06	76	0.082	< LOQ 0.25	1.71	< LOQ 5.23
24427	1	48.54	CP-4A	78	19.000	> LOQ 5.0	391.43	> LOQ 103.01
24435	2	47.71	CP-4A	78	120.000	> LOQ 100.0	2515.2	> LOQ 2096.00
24244	3	49.01	CP-4A	78	5900.000	> LOQ 5300.0	120383.6	> LOQ 108141.20
24220	OBZ	48.74	CP-4A	78	120.000	> LOQ 53.0	2462.04	> LOQ 1087.40
24460	1	50.05	CP-4B	79	25.000	> LOQ 5.2	499.5	> LOQ 103.90
24465	2	48.47	CP-4B	79	85.000	> LOQ 13.0	1753.66	> LOQ 268.21
24207	3	48.49	CP-4B	79	120.000	> LOQ 0.53	2474.74	> LOQ 10.93
24390	OBZ	49.02	CP-4B	79	27.000	> LOQ 5.0	550.8	> LOQ 102.00
24259	1	48.76	SS-07	80	ND	< LOD 0.2	ND	< LOD 4.10
24421	2	48.13	SS-07	80	0.200	< LOQ 0.25	4.16	< LOQ 5.19
24445	3	47.87	SS-07	80	0.370	> LOQ 0.25	7.73	> LOQ 5.22
24432	OBZ	48.49	SS-07	80	0.150	< LOQ 0.25	3.09	< LOQ 5.16
24459	1	48.96	N-02	81	0.250	< LOQ 0.26	5.11	< LOQ 5.31
24417	2	48.11	N-02	81	0.660	> LOQ 0.25	13.72	> LOQ 5.20
24442	3	48.01	N-02	81	2.400	> LOQ 0.25	49.99	> LOQ 5.21
24386	OBZ	48.19	N-02	81	0.680	> LOQ 0.25	14.11	> LOQ 5.19
24452	1	48.20	SG-2B	82	0.095	< LOQ 0.25	1.97	< LOQ 5.19
24453	2	48.59	SG-2B	82	0.019	< LOQ 0.25	0.39	< LOQ 5.15
24420	3	47.84	SG-2B	82	0.430	> LOQ 0.25	8.99	> LOQ 5.23
24444	OBZ	47.95	SG-2B	82	2.200	> LOQ 0.25	45.88	> LOQ 5.21
24455	1	48.56	CS-07	83	0.180	< LOQ 0.26	3.71	< LOQ 5.35
24433	2	47.96	CS-07	83	0.380	> LOQ 0.25	7.92	> LOQ 5.21
24398	3	48.06	CS-07	83	1.700	> LOQ 0.25	35.37	> LOQ 5.20
24511	OBZ	47.96	CS-07	83	0.490	> LOQ 0.26	10.22	> LOQ 5.42
24454	1	49.34	CPDS-1A	84	0.460	> LOQ 0.26	9.32	> LOQ 5.27
24291	2	48.49	CPDS-1A	84	ND	< LOD 0.2	ND	< LOD 4.12
24209	3	48.43	CPDS-1A	84	0.730	> LOQ 0.53	15.07	> LOQ 10.94
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 0.08	ND	< LOD 1.64
24204	1	49.46	CPDS-1B	85	ND	< LOD 0.2	ND	< LOD 4.04
24273	2	48.35	CPDS-1B	85	0.320	< LOQ 0.53	6.62	< LOQ 10.96
24223	3	48.82	CPDS-1B	85	0.690	> LOQ 0.53	14.13	> LOQ 10.86
24466	OBZ	49.96	CPDS-1B	85	0.520	> LOQ 0.26	10.41	> LOQ 5.20

Airborne Sample Data Analysis - Lead

NIOSH REL 100.0 micrograms/cubic meter

OSHA PEL 50.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	3.91	< LOQ 5.15	15	> LOQ 5.21	26.82	> LOQ 5.16	13.87	> LOQ 5.17
CS-01	2.27	< LOQ 5.15	5.42	> LOQ 5.21	10.52	> LOQ 5.16	3.96	< LOQ 5.22
CS-02	ND	< LOD 4.16	7.53	< LOQ 8.78	33.33	> LOQ 8.75	11.46	> LOQ 8.75
CS-03	ND	< LOD 4.12	ND	< LOD 4.14	11.41	> LOQ 8.71	4.97	< LOQ 8.70
CS-04	ND	< LOD 4.11	ND	< LOD 4.19	ND	< LOD 4.14	ND	< LOD 4.12
CS-05	ND	< LOD 1.65	1.94	< LOQ 5.22	5.02	< LOQ 5.23	ND	< LOD 2.63
CS-06	ND	< LOD 1.67	2.51	< LOQ 5.45	4.35	< LOQ 5.38	2.29	< LOQ 5.41
CS-07	3.71	< LOQ 5.35	7.92	> LOQ 5.21	35.37	> LOQ 5.20	10.22	> LOQ 5.42
CSDS-01	ND	< LOD 1.66	3.12	< LOQ 5.21	12.67	> LOQ 5.19	3.12	< LOQ 5.20
CSDS-02	ND	< LOD 1.65	88.92	> LOQ 5.17	4.14	< LOQ 5.17	2.3	< LOQ 5.23
N-01	ND	< LOD 1.63	ND	< LOD 1.67	2.28	< LOQ 5.17	1.82	< LOQ 5.12
N-02	5.11	< LOQ 5.31	13.72	> LOQ 5.20	49.99	> LOQ 5.21	14.11	> LOQ 5.19
O-1	ND	< LOD 4.12	2	< LOQ 5.43	ND	< LOD 1.64	ND	< LOD 4.19
S-01	ND	< LOD 1.66	4.8	< LOQ 5.22	25.05	> LOQ 5.22	9.39	> LOQ 5.22
S-02	2.92	< LOQ 5.21	15.08	> LOQ 5.23	33.33	> LOQ 5.21	8.56	> LOQ 5.22
SH-01	ND	< LOD 4.18	ND	< LOD 4.18	ND	< LOD 4.15	ND	< LOD 4.16
SS-01	ND	< LOD 1.65	3.76	< LOQ 5.22	4.76	< LOQ 5.17	4.14	< LOQ 5.18
SS-02	8.31	< LOQ 8.73	ND	< LOD 4.17	10.35	> LOQ 8.69	ND	< LOD 4.11
SS-03	ND	< LOD 4.16	ND	< LOD 4.20	ND	< LOD 4.09	ND	< LOD 4.03
SS-04	ND	< LOD 1.67	3.35	< LOQ 5.23	5.23	< LOQ 6.07	3.09	< LOQ 5.97
SS-05	ND	< LOD 1.61	2.31	< LOQ 5.24	4.36	< LOQ 6.03	5.94	> LOQ 5.12
SS-06	ND	< LOD 1.63	1.89	< LOQ 5.39	3.98	< LOQ 5.24	1.71	< LOQ 5.23
SS-07	ND	< LOD 4.10	4.16	< LOQ 5.19	7.73	> LOQ 5.22	3.09	< LOQ 5.16
SSDS-01	ND	< LOD 1.65	ND	< LOD 1.67	2.06	< LOQ 5.16	1.95	< LOQ 5.17
SSDS-02	ND	< LOD 4.17	ND	< LOD 4.17	4.95	< LOQ 8.67	ND	< LOD 4.05
SSDS-03	ND	< LOD 1.82	0.18	< LOQ 5.76	ND	< LOD 1.79	ND	< LOD 1.86
CP-1A	7.84	> LOQ 5.16	20.71	> LOQ 5.18	56.03	> LOQ 26.98	23.04	> LOQ 5.24
CP-1B	8.96	> LOQ 5.89	23.08	> LOQ 5.95	87.12	> LOQ 30.61	21.55	> LOQ 5.99
CP-2A	ND	< LOD 1.65	ND	< LOD 4.18	9.75	< LOQ 10.99	3.74	< LOQ 5.40
CP-2B	1.76	< LOQ 3.92	ND	< LOD 1.67	3.52	< LOQ 5.39	2	< LOQ 5.26
CP-3A	140.44	> LOQ 53.70	459	> LOQ 54.25	2275.08	> LOQ 537.75	1593.54	> LOQ 206.95
CP-3B	165.11	> LOQ 71.55	971.68	> LOQ 144.36	1589.91	> LOQ 274.12	620.81	> LOQ 64.56
CP-4A	391.43	> LOQ 103.01	2515.[illegible]	> LOQ 2096.00	120383.60	> LOQ 108141.20	2462.04	> LOQ 1087.40
CP-4B	499.5	> LOQ 103.90	1753.66	> LOQ 268.21	2474.74	> LOQ 10.93	550.8	> LOQ 102.00
CPDS-1A	9.32	> LOQ 5.27	ND	< LOD 4.12	15.07	> LOQ 10.94	ND	< LOD 1.64
CPDS-1B	ND	< LOD 4.04	6.62	< LOQ 10.96	14.13	> LOQ 10.86	10.41	> LOQ 5.20
G-1A	ND	< LOD 4.16	ND	< LOD 4.18	ND	< LOD 4.15	ND	< LOD 4.09
G-1B	ND	< LOD 1.86	ND	< LOD 1.69	1.70	< LOQ 5.19	ND	< LOD 1.87
G-2A	ND	< LOD 4.21	ND	< LOD 4.24	8.71	> LOQ 0.00	ND	< LOD 4.16
G-2B	ND	< LOD 1.64	ND	< LOD 1.66	ND	< LOD 1.88	ND	< LOD 1.65
G-3A	ND	< LOD 1.65	ND	< LOD 1.66	2.10	< LOQ 6.09	ND	< LOD 1.88
G-4A	ND	< LOD 1.62	3.31	< LOQ 5.17	7.19	> LOQ 5.96	3.11	< LOQ 6.02
G-4B	ND	< LOD 1.65	2.71	< LOQ 5.21	5.17	> LOQ 5.17	2.48	< LOQ 5.16
G-5A	ND	< LOD 1.65	ND	< LOD 1.66	4.37	< LOQ 5.20	1.82	< LOQ 5.23
G-5B	ND	< LOD 1.67	2.49	< LOQ 5.19	0.35	< LOQ 5.21	ND	< LOD 1.67
G-6A	2.04	< LOQ 5.20	7.73	> LOQ 5.23	13.32	> LOQ 5.20	7.04	> LOQ 5.18
G-6B	ND	< LOD 1.64	8.22	> LOQ 5.27	11.04	> LOQ 5.11	3.92	< LOQ 5.16
G-7A	ND	< LOD 1.65	ND	< LOD 1.66	2.50	< LOQ 5.42	2.3	< LOQ 5.24
G-7B	ND	< LOD 1.64	ND	< LOD 1.66	2.97	< LOQ 5.30	2.54	< LOQ 5.29
SG-1A	ND	< LOD 1.63	ND	< LOD 1.66	ND	< LOD 1.66	ND	< LOD 1.86
SG-1B	ND	< LOD 3.07	ND	< LOD 3.07	ND	< LOD 3.07	ND	< LOD 3.05
SG-2A	5.15	> LOQ 0.00	4.38	< LOQ 5.22	8.91	> LOQ 5.18	28.99	> LOQ 5.18
SG-2B	1.97	< LOQ 5.19	[illegible]39	< LOQ 5.15	8.99	> LOQ 5.23	45.88	> LOQ 5.21

Bulk Elemental Analysis - Lead

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Lead		Sample	Lead	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	6.30	> LOQ 1.0	J95331-63 PB	13.00	> LOQ 5.0
CS-01	J95331-34 VB	2.20	> LOQ 1.0	J95331-34 PB	7.20	> LOQ 1.0
CS-02	J95331-37 VB	6.20	> LOQ 1.0	J95331-37 PB	7.80	> LOQ 1.0
CS-03	J95331-38 VB	3.00	> LOQ 1.0	J95331-38 PB	3.30	> LOQ 1.0
CS-04	J95331-39 VB	0.95	< LOQ 1.0	J95331-39 PB	1.10	> LOQ 1.0
CS-05	J95331-57 VB	0.53	< LOQ 1.0	J95331-57 PB	0.79	< LOQ 1.0
CS-06	J95331-70 VB	0.63	> LOQ 0.24	J95331-70 PB	0.82	> LOQ 0.24
CS-07	J95331-83 VB	6.80	> LOQ 0.64	J95331-83 PB	6.10	> LOQ 0.64
CSDS-01	J95331-31 VB	0.79	< LOQ 1.0	J95331-31 PB	1.30	> LOQ 1.0
CSDS-02	J95331-35 VB	0.96	< LOQ 1.0	J95331-35 PB	1.10	> LOQ 1.0
N-01	J95331-52 VB	0.62	< LOQ 1.0	J95331-52 PB	0.57	< LOQ 1.0
N-02	J95331-81 VB	7.50	> LOQ 0.64	J95331-81 PB	8.40	> LOQ 0.45
O-1	J95331-69 VB	0.49	> LOQ 0.24	J95331-69 PB	0.34	> LOQ 0.24
S-01	J95331-28 VB	8.40	> LOQ 1.0	J95331-28 PB	5.80	> LOQ 1.0
S-02	J95331-29 VB	6.00	> LOQ 1.0	J95331-29 PB	8.20	> LOQ 1.0
SH-01	J95331-36 VB	0.30	< LOQ 1.0	J95331-36 PB	0.61	< LOQ 1.0
SS-01	J95331-32 VB	0.89	< LOQ 1.0	J95331-32 PB	0.84	< LOQ 1.0
SS-02	J95331-40 VB	0.39	< LOQ 1.0	J95331-40 PB	0.57	< LOQ 1.0
SS-03	J95331-45 VB	0.33	< LOQ 1.0	J95331-45 PB	0.54	< LOQ 1.0
SS-04	J95331-47 VB	0.47	< LOQ 1.0	J95331-47 PB	1.00	> LOQ 1.0
SS-05	J95331-53 VB	0.62	< LOQ 1.0	J95331-53 PB	0.67	< LOQ 1.0
SS-06	J95331-76 VB	0.64	> LOQ 0.24	J95331-76 PB	0.60	> LOQ 0.24
SS-07	J95331-80 VB	0.20	< LOQ 0.45	J95331-80 PB	0.25	< LOQ 0.64
SSDS-01	J95331-33 VB	0.41	< LOQ 1.0	J95331-33 PB	0.38	< LOQ 1.0
SSDS-02	J95331-44 VB	1.30	> LOQ 1.0	J95331-44 PB	1.20	> LOQ 1.0
SSDS-03	J95331-48 VB	0.42	< LOQ 1.0	J95331-48 PB	0.45	< LOQ 1.0
CP-1A	J95331-60 VB	12.00	> LOQ 5.0	J95331-60 PB	30.00	> LOQ 5.0
CP-1B	J95331-61 VB	0.88	< LOQ 1.0	J95331-61 PB	1.00	> LOQ 1.0
CP-2A	J95331-67 VB	1.90	> LOQ 0.24	J95331-67 PB	2.00	> LOQ 0.24
CP-2B	J95331-68 VB	2.10	> LOQ 0.24	J95331-68 PB	2.10	> LOQ 0.24
CP-3A	J95331-72 VB	330.00	> LOQ 12.0	J95331-72 PB	250.00	> LOQ 12.0
CP-3B	J95331-73 VB	240.00	> LOQ 12.0	J95331-73 PB	350.00	> LOQ 12.0
CP-4A	J95331-78 VB	810.00	> LOQ 90.0	J95331-78 PB	790.00	> LOQ 90.0
CP-4B	J95331-79 VB	890.00	> LOQ 90.0	J95331-79 PB	710.00	> LOQ 90.0
CPDS-1A	J95331-84 VB	1.30	> LOQ 0.64	J95331-84 PB	3.50	> LOQ 0.64
CPDS-1B	J95331-85 VB	2.60	> LOQ 0.64	J95331-85 PB	2.20	> LOQ 0.64
G-1A	J95331-41 VB	0.83	< LOQ 1.0	J95331-41 PB	0.79	< LOQ 1.0
G-1B	J95331-46 VB	1.80	> LOQ 1.0	J95331-46 PB	1.20	> LOQ 1.0
G-2A	J95331-43 VB	ND	< LOD 0.3	J95331-43 PB	0.62	< LOQ 1.0
G-2B	J95331-50 VB	0.82	< LOQ 1.7	J95331-50 PB	0.31	< LOQ 1.0
G-3A	J95331-49 VB	0.36	< LOQ 1.0	J95331-49 PB	1.10	> LOQ 1.0
G-4A	J95331-55 VB	1.00	> LOQ 1.0	J95331-55 PB	1.30	> LOQ 1.0
G-4B	J95331-56 VB	1.00	> LOQ 1.0	J95331-56 PB	0.76	< LOQ 1.0
G-5A	J95331-58 VB	0.84	< LOQ 1.0	J95331-58 PB	1.20	> LOQ 1.0
G-5B	J95331-59 VB	0.70	< LOQ 1.0	J95331-59 PB	0.48	< LOQ 1.0
G-6A	J95331-64 VB	2.40	> LOQ 1.0	J95331-64 PB	3.90	> LOQ 1.0
G-6B	J95331-65 VB	3.80	> LOQ 1.0	J95331-65 PB	2.10	> LOQ 1.0
G-7A	J95331-74 VB	0.13	< LOQ 0.24	J95331-74 PB	0.12	< LOQ 0.24
G-7B	J95331-75 VB	0.22	< LOQ 0.24	J95331-75 PB	0.23	< LOQ 0.24
SG-1A	J95331-54 VB	ND	< LOD 0.3	J95331-54 PB	ND	< LOD 0.3
SG-1B	J95331-71 VB	ND	< LOD 0.07	J95331-71 PB	0.08	< LOQ 0.24
SG-2A	J95331-66 VB	9.20	> LOQ 1.0	J95331-66 PB	7.00	> LOQ 1.0
SG-2B	J95331-82 VB	11.00	> LOQ 1.3	J95331-82 PB	11.00	> LOQ 1.3

Comparison of Airborne Concentrations to Bulk Concentrations - Lead

NIOSH REL 100.0 micrograms/cubic meter
OSHA PEL 50.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	3.91	15.00	26.82	13.87	6.30
CS-01	2.27	5.42	10.52	3.96	2.20
CS-02	ND	7.53	33.33	11.46	6.20
CS-03	ND	ND	11.41	4.97	3.00
CS-04	ND	ND	ND	ND	0.95
CS-05	ND	1.94	5.02	ND	0.53
CS-06	ND	2.51	4.35	2.29	0.63
CS-07	3.71	7.92	35.37	10.22	6.80
CSDS-01	ND	3.12	12.67	3.12	0.79
CSDS-02	ND	88.92	4.14	2.30	0.96
N-01	ND	ND	2.28	1.82	0.62
N-02	5.11	13.72	49.99	14.11	7.50
O-1	ND	2.00	ND	ND	0.49
S-01	ND	4.80	25.05	9.39	8.40
S-02	2.92	15.08	33.33	8.56	6.00
SH-01	ND	ND	ND	ND	0.30
SS-01	ND	3.76	4.76	4.14	0.89
SS-02	8.31	ND	10.35	ND	0.39
SS-03	ND	ND	ND	ND	0.33
SS-04	ND	3.35	5.23	3.09	0.47
SS-05	ND	2.31	4.36	5.94	0.62
SS-06	ND	1.89	3.98	1.71	0.64
SS-07	ND	4.16	7.73	3.09	0.20
SSDS-01	ND	ND	2.06	1.95	0.41
SSDS-02	ND	ND	4.95	ND	1.30
SSDS-03	ND	0.18	ND	ND	0.42
CP-1A	7.84	20.71	56.03	23.04	12.00
CP-2A	ND	ND	9.75	3.74	1.90
CP-3A	140.44	459.00	2275.08	1593.54	330.00
CP-4A	391.43	2515.20	120383.60	2462.04	810.00
CPDS-1A	9.32	ND	15.07	ND	1.30
G-1A	ND	ND	ND	ND	0.83
G-2A	ND	ND	8.71	ND	ND
G-3A	ND	ND	2.10	ND	0.36
G-4A	ND	3.31	7.19	3.11	1.00
G-5A	ND	ND	4.37	1.82	0.84
G-6A	2.04	7.73	13.32	7.04	2.40
G-7A	ND	ND	2.50	2.30	0.13
SG-1A	ND	ND	ND	ND	ND
SG-2A	5.15	4.38	8.91	28.99	9.20

APPENDIX B - LITHIUM

Lithium

Lithium hydride causes sneezing, coughing, and severe irritation of the nose and throat. Ingestion may cause nausea, muscle twitches, mental confusion and blurring of vision. Nervous system damages have been reported for high short-term exposure periods. The NIOSH REL and OSHA PEL for lithium are both 25 micrograms/cubic meter of air.

Air Sample Results - Lithium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lithium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.030	ND	< LOD 0.623
24412	2	47.89	S-01	28	ND	< LOD 0.030	ND	< LOD 0.626
24441	3	47.90	S-01	28	0.980	> LOQ 0.075	20.459	> LOQ 1.566
24450	OBZ	47.93	S-01	28	0.120	> LOQ 0.075	2.504	> LOQ 1.565
24643	1	47.98	S-02	29	ND	< LOD 0.030	ND	< LOD 0.625
24625	2	47.76	S-02	29	0.250	> LOQ 0.075	5.235	> LOQ 1.570
24642	3	48.00	S-02	29	0.190	> LOQ 0.075	3.958	> LOQ 1.563
24632	OBZ	47.89	S-02	29	0.065	< LOQ 0.075	1.357	< LOQ 1.566
24634	1	48.16	CSDS-01	31	0.290	> LOQ 0.075	6.022	> LOQ 1.557
24650	2	48.01	CSDS-01	31	1.500	> LOQ 0.075	31.243	> LOQ 1.562
24644	3	48.16	CSDS-01	31	4.700	> LOQ 0.075	97.591	> LOQ 1.557
24645	OBZ	48.07	CSDS-01	31	2.300	> LOQ 0.075	47.847	> LOQ 1.560
24640	1	48.44	SS-01	32	ND	< LOD 0.030	ND	< LOD 0.619
24641	2	47.90	SS-01	32	ND	< LOD 0.030	ND	< LOD 0.626
24651	3	48.35	SS-01	32	ND	< LOD 0.030	ND	< LOD 0.620
24635	OBZ	48.30	SS-01	32	0.032	< LOQ 0.075	0.663	< LOQ 1.553
24646	1	48.58	SSDS-01	33	ND	< LOD 0.030	ND	< LOD 0.618
24626	2	47.84	SSDS-01	33	0.032	< LOQ 0.075	0.669	< LOQ 1.568
24638	3	48.49	SSDS-01	33	0.054	< LOQ 0.075	1.114	< LOQ 1.547
24647	OBZ	48.32	SSDS-01	33	0.058	< LOQ 0.075	1.2	< LOQ 1.552
24628	1	48.55	CS-01	34	0.330	> LOQ 0.075	6.797	> LOQ 1.545
24637	2	48.00	CS-01	34	1.100	> LOQ 0.075	22.917	> LOQ 1.563
24624	3	48.47	CS-01	34	4.800	> LOQ 0.075	99.03	> LOQ 1.547
24636	OBZ	47.92	CS-01	34	1.000	> LOQ 0.075	20.868	> LOQ 1.565
24623	1	48.53	CSDS-02	35	0.340	> LOQ 0.075	7.006	> LOQ 1.545
24622	2	48.36	CSDS-02	35	1.300	> LOQ 0.075	26.882	> LOQ 1.551
24654	3	48.31	CSDS-02	35	5.000	> LOQ 0.075	103.498	> LOQ 1.552
24653	OBZ	47.78	CSDS-02	35	1.800	> LOQ 0.075	37.673	> LOQ 1.570
24629	1	47.88	SH-01	36	ND	< LOD 0.030	ND	< LOD 0.627
24633	2	47.86	SH-01	36	ND	< LOD 0.030	ND	< LOD 0.627
24627	3	48.24	SH-01	36	ND	< LOD 0.030	ND	< LOD 0.622
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.030	ND	< LOD 0.624
24555	1	48.08	CS-02	37	0.560	> LOQ 0.075	11.647	> LOQ 1.560
24552	2	47.84	CS-02	37	1.500	> LOQ 0.075	31.355	> LOQ 1.568
24541	3	48.01	CS-02	37	6.300	> LOQ 0.075	131.223	> LOQ 1.562
24529	OBZ	47.99	CS-02	37	2.300	> LOQ 0.075	47.927	> LOQ 1.563
24558	1	48.49	CS-03	38	0.290	> LOQ 0.075	5.981	> LOQ 1.547
24524	2	48.29	CS-03	38	1.200	> LOQ 0.075	24.85	> LOQ 1.553
24561	3	48.22	CS-03	38	4.400	> LOQ 0.075	91.248	> LOQ 1.555
24559	OBZ	48.29	CS-03	38	1.200	> LOQ 0.075	24.85	> LOQ 1.553
24543	1	48.61	CS-04	39	0.250	> LOQ 0.075	5.143	> LOQ 1.543
24532	2	47.78	CS-04	39	0.880	> LOQ 0.075	18.418	> LOQ 1.570
24546	3	48.29	CS-04	39	2.400	> LOQ 0.075	49.7	> LOQ 1.553
24557	OBZ	48.58	CS-04	39	1.200	> LOQ 0.075	24.702	> LOQ 1.544
24560	1	48.13	SS-02	40	ND	< LOD 0.030	ND	< LOD 0.623
24565	2	47.95	SS-02	40	ND	< LOD 0.030	ND	< LOD 0.626
24630	3	48.32	SS-02	40	0.031	< LOQ 0.075	0.642	< LOQ 1.552
24553	OBZ	48.62	SS-02	40	0.049	< LOQ 0.075	1.008	< LOQ 1.543
24525	1	48.13	G-1A	41	ND	< LOD 0.030	ND	< LOD 0.623
24563	2	47.87	G-1A	41	0.030	< LOQ 0.075	0.627	< LOQ 1.567
24547	3	48.17	G-1A	41	0.100	> LOQ 0.075	2.076	> LOQ 1.557
24526	OBZ	48.91	G-1A	41	0.054	< LOQ 0.075	1.104	< LOQ 1.533
24538	1	47.45	G-2A	43	ND	< LOD 0.030	ND	< LOD 0.632

Air Sample Results - Lithium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lithium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	0.120	> LOQ 0.075	2.547	> LOQ 1.592
24533	3	48.24	G-2A	43	0.140	> LOQ 0.075	2.902	> LOQ 1.555
24540	OBZ	48.04	G-2A	43	0.087	> LOQ 0.075	1.811	> LOQ 1.561
24528	1	47.99	SSDS-02	44	ND	< LOD 0.030	ND	< LOD 0.625
24544	2	48.00	SSDS-02	44	0.130	> LOQ 0.075	2.708	> LOQ 1.563
24567	3	48.46	SSDS-02	44	0.480	> LOQ 0.075	9.905	> LOQ 1.548
24539	OBZ	49.37	SSDS-02	44	0.140	> LOQ 0.075	2.836	> LOQ 1.519
24571	1	48.05	SS-03	45	ND	< LOD 0.030	ND	< LOD 0.624
24536	2	47.60	SS-03	45	ND	< LOD 0.030	ND	< LOD 0.630
24534	3	48.94	SS-03	45	0.050	< LOQ 0.075	1.022	< LOQ 1.532
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.030	ND	< LOD 0.605
24568	1	48.28	G-1B	46	ND	< LOD 0.030	ND	< LOD 0.621
24592	2	47.38	G-1B	46	0.044	< LOQ 0.075	0.929	< LOQ 1.583
24593	3	48.17	G-1B	46	0.068	< LOQ 0.075	1.412	< LOQ 1.557
24535	OBZ	48.22	G-1B	46	0.058	> LOQ 0.075	1.203	> LOQ 1.555
24590	1	47.81	SS-04	47	0.056	< LOQ 0.075	1.171	< LOQ 1.569
24605	2	47.78	SS-04	47	0.280	> LOQ 0.075	5.86	> LOQ 1.570
24562	3	47.80	SS-04	47	0.430	> LOQ 0.075	8.996	> LOQ 1.569
24531	OBZ	48.59	SS-04	47	0.270	> LOQ 0.075	5.557	> LOQ 1.544
24527	1	49.48	SSDS-03	48	ND	< LOD 0.030	ND	< LOD 0.606
24569	2	50.35	SSDS-03	48	ND	< LOD 0.030	ND	< LOD 0.596
24584	3	50.24	SSDS-03	48	ND	< LOD 0.030	ND	< LOD 0.597
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.030	ND	< LOD 0.622
24600	1	48.34	G-3A	49	0.066	< LOQ 0.075	1.365	< LOQ 1.552
24616	2	48.11	G-3A	49	0.140	> LOQ 0.075	2.91	> LOQ 1.559
24585	3	47.65	G-3A	49	0.410	> LOQ 0.075	8.604	> LOQ 1.574
24583	OBZ	47.99	G-3A	49	0.070	< LOQ 0.075	1.459	< LOQ 1.563
24587	1	48.79	G-2B	50	0.031	< LOQ 0.075	0.635	< LOQ 1.537
24602	2	48.17	G-2B	50	0.150	> LOQ 0.075	3.114	> LOQ 1.557
24564	3	47.81	G-2B	50	0.120	> LOQ 0.075	2.51	> LOQ 1.569
24621	OBZ	48.54	G-2B	50	0.059	< LOQ 0.075	1.215	< LOQ 1.545
24618	1	49.21	N-01	52	ND	< LOD 0.030	ND	< LOD 0.610
24611	2	47.96	N-01	52	0.063	< LOQ 0.075	1.314	< LOQ 1.564
24588	3	48.32	N-01	52	0.210	> LOQ 0.075	4.346	> LOQ 1.552
24615	OBZ	48.80	N-01	52	0.100	> LOQ 0.075	2.049	> LOQ 1.537
24597	1	49.78	SS-05	53	ND	< LOD 0.030	ND	< LOD 0.603
24599	2	47.68	SS-05	53	ND	< LOD 0.030	ND	< LOD 0.629
24575	3	48.11	SS-05	53	0.035	< LOQ 0.075	0.727	< LOQ 1.559
24617	OBZ	48.79	SS-05	53	0.031	< LOQ 0.075	0.635	< LOQ 1.537
24609	1	48.98	SG-1A	54	ND	< LOD 0.030	ND	< LOD 0.612
24596	2	48.20	SG-1A	54	ND	< LOD 0.030	ND	< LOD 0.622
24610	3	48.18	SG-1A	54	ND	< LOD 0.030	ND	< LOD 0.623
24576	OBZ	48.47	SG-1A	54	ND	< LOD 0.030	ND	< LOD 0.619
24606	1	49.24	G-4A	55	0.260	> LOQ 0.075	5.28	> LOQ 1.523
24620	2	48.37	G-4A	55	0.350	> LOQ 0.075	7.236	> LOQ 1.551
24573	3	48.67	G-4A	55	2.000	> LOQ 0.075	41.093	> LOQ 1.541
24505	OBZ	48.16	G-4A	55	0.610	> LOQ 0.075	12.666	> LOQ 1.557
24340	1	48.38	G-4B	56	0.095	> LOQ 0.075	1.964	> LOQ 1.550
24607	2	48.01	G-4B	56	0.680	> LOQ 0.075	14.164	> LOQ 1.562
24595	3	48.38	G-4B	56	1.200	> LOQ 0.075	24.804	> LOQ 1.550
24598	OBZ	48.42	G-4B	56	0.580	> LOQ 0.075	11.979	> LOQ 1.549
24580	1	48.44	CS-05	57	0.190	> LOQ 0.075	3.922	> LOQ 1.548
24604	2	47.93	CS-05	57	0.680	> LOQ 0.075	14.187	> LOQ 1.565

Air Sample Results - Lithium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lithium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	1.800	> LOQ 0.075	37.673	> LOQ 1.570
24574	OBZ	30.41	CS-05	57	0.560	> LOQ 0.075	18.415	> LOQ 2.466
24614	1	48.58	G-5A	58	ND	< LOD 0.030	ND	< LOD 0.618
24577	2	48.18	G-5A	58	0.050	< LOQ 0.075	1.038	< LOQ 1.557
24572	3	48.05	G-5A	58	0.110	> LOQ 0.075	2.289	> LOQ 1.561
24582	OBZ	47.83	G-5A	58	0.120	> LOQ 0.075	2.509	> LOQ 1.568
24322	1	47.88	G-5B	59	ND	< LOD 0.030	ND	< LOD 0.627
24354	2	48.16	G-5B	59	0.081	> LOQ 0.075	1.682	> LOQ 1.557
24510	3	47.98	G-5B	59	0.210	> LOQ 0.075	4.377	> LOQ 1.563
24321	OBZ	47.99	G-5B	59	0.050	< LOQ 0.075	1.042	< LOQ 1.563
24497	1	48.49	CP-1A	60	0.039	< LOQ 0.075	0.804	< LOQ 1.547
24333	2	48.28	CP-1A	60	0.140	> LOQ 0.075	2.9	> LOQ 1.553
24326	3	48.19	CP-1A	60	0.290	> LOQ 0.075	6.018	> LOQ 1.556
24329	OBZ	47.74	CP-1A	60	0.130	> LOQ 0.075	2.723	> LOQ 1.571
24499	1	42.42	CP-1B	62	0.059	< LOQ 0.075	1.391	< LOQ 1.768
24506	2	42.02	CP-1B	62	0.140	> LOQ 0.075	3.332	> LOQ 1.785
24388	3	42.47	CP-1B	62	0.420	> LOQ 0.075	9.889	> LOQ 1.766
24315	OBZ	41.77	CP-1B	62	0.130	> LOQ 0.075	3.112	> LOQ 1.796
24318	1	48.56	CG-01	63	ND	< LOD 0.030	ND	< LOD 0.618
24308	2	48.00	CG-01	63	ND	< LOD 0.030	ND	< LOD 0.625
24330	3	48.47	CG-01	63	ND	< LOD 0.030	ND	< LOD 0.619
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.030	ND	< LOD 0.621
24363	1	48.10	G-6A	64	0.061	< LOQ 0.075	1.268	< LOQ 1.559
24398	2	47.84	G-6A	64	0.230	> LOQ 0.075	4.808	> LOQ 1.568
24351	3	48.06	G-6A	64	0.360	> LOQ 0.075	7.491	> LOQ 1.561
24594	OBZ	48.29	G-6A	64	0.150	> LOQ 0.075	3.106	> LOQ 1.553
24312	1	48.76	G-6B	65	0.032	< LOQ 0.075	0.656	< LOQ 1.538
24484	2	47.45	G-6B	65	0.110	> LOQ 0.075	2.318	> LOQ 1.581
24327	3	48.92	G-6B	65	0.140	> LOQ 0.075	2.862	> LOQ 1.533
24389	OBZ	48.46	G-6B	65	0.092	> LOQ 0.075	1.898	> LOQ 1.548
24348	1	48.59	SG-2A	66	ND	< LOD 0.030	ND	< LOD 0.617
24314	2	47.90	SG-2A	66	ND	< LOD 0.030	ND	< LOD 0.626
24494	3	48.24	SG-2A	66	0.410	> LOQ 0.075	8.499	> LOQ 1.555
24337	OBZ	48.30	SG-2A	66	ND	< LOD 0.060	ND	< LOD 1.242
24508	1	48.47	CP-2A	67	0.360	> LOQ 0.075	7.427	> LOQ 1.547
24361	2	47.82	CP-2A	67	0.910	> LOQ 0.075	19.03	> LOQ 1.568
24359	3	48.22	CP-2A	67	5.500	> LOQ 0.150	114.061	> LOQ 3.111
24471	OBZ	48.14	CP-2A	67	2.100	> LOQ 0.075	43.623	> LOQ 1.558
24373	1	48.41	CP-2B	68	0.900	> LOQ 0.075	18.591	> LOQ 1.549
24468	2	47.90	CP-2B	68	0.550	> LOQ 0.075	11.482	> LOQ 1.566
24481	3	48.26	CP-2B	68	2.200	> LOQ 0.075	45.586	> LOQ 1.554
24391	OBZ	47.53	CP-2B	68	0.450	> LOQ 0.075	9.468	> LOQ 1.578
24356	1	48.56	O-1	69	0.031	< LOQ 0.075	0.638	< LOQ 1.544
24470	2	47.89	O-1	69	0.072	< LOQ 0.075	1.503	< LOQ 1.566
24467	3	48.67	O-1	69	0.190	> LOQ 0.075	3.904	> LOQ 1.541
24313	OBZ	47.78	O-1	69	ND	< LOD 0.030	ND	< LOD 0.628
24501	1	47.96	CS-06	70	0.770	> LOQ 0.075	16.055	> LOQ 1.564
24496	2	47.75	CS-06	70	1.900	> LOQ 0.075	39.791	> LOQ 1.571
24478	3	48.31	CS-06	70	2.100	> LOQ 0.075	43.469	> LOQ 1.552
24503	OBZ	48.04	CS-06	70	1.400	> LOQ 0.075	29.142	> LOQ 1.561
24474	1	26.02	SG-1B	71	ND	< LOD 0.030	ND	< LOD 1.153
24469	2	26.02	SG-1B	71	ND	< LOD 0.030	ND	< LOD 1.153
24492	3	26.10	SG-1B	71	ND	< LOD 0.030	ND	< LOD 1.149

Air Sample Results - Lithium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Lithium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 0.150	ND	< LOD 5.714
24489	1	48.42	CP-3A	72	0.250	> LOQ 0.075	5.163	> LOQ 1.549
24491	2	47.93	CP-3A	72	0.620	> LOQ 0.075	12.936	> LOQ 1.565
24482	3	48.35	CP-3A	72	3.100	> LOQ 0.075	64.116	> LOQ 1.551
24486	OBZ	48.32	CP-3A	72	2.400	> LOQ 0.075	49.669	> LOQ 1.552
24516	1	36.34	CP-3B	73	0.220	> LOQ 0.075	6.054	> LOQ 2.064
24502	2	36.02	CP-3B	73	1.200	> LOQ 0.075	33.315	> LOQ 2.082
24515	3	36.48	CP-3B	73	1.800	> LOQ 0.075	49.342	> LOQ 2.056
24500	OBZ	40.27	CP-3B	73	0.780	> LOQ 0.075	19.369	> LOQ 1.862
24504	1	48.47	G-7A	74	ND	< LOD 0.030	ND	< LOD 0.619
24513	2	48.22	G-7A	74	ND	< LOD 0.030	ND	< LOD 0.622
24458	3	47.94	G-7A	74	ND	< LOD 0.030	ND	< LOD 0.626
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.030	ND	< LOD 0.628
24404	1	48.68	G-7B	75	ND	< LOD 0.030	ND	< LOD 0.616
24451	2	48.06	G-7B	75	ND	< LOD 0.030	ND	< LOD 0.624
24447	3	47.16	G-7B	75	ND	< LOD 0.030	ND	< LOD 0.636
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.030	ND	< LOD 0.635
24456	1	49.19	SS-06	76	0.067	< LOQ 0.075	1.362	< LOQ 1.525
24480	2	48.26	SS-06	76	0.180	> LOQ 0.075	3.73	> LOQ 1.554
24429	3	47.68	SS-06	76	ND	< LOD 0.030	ND	< LOD 0.629
24418	OBZ	47.83	SS-06	76	0.050	< LOQ 0.075	1.045	< LOQ 1.568
24427	1	48.54	CP-4A	78	0.088	> LOQ 0.075	1.813	> LOQ 1.545
24435	2	47.71	CP-4A	78	0.570	> LOQ 0.075	11.947	> LOQ 1.572
24244	3	49.01	CP-4A	78	2.700	> LOQ 0.150	55.091	> LOQ 3.061
24220	OBZ	48.74	CP-4A	78	0.570	> LOQ 0.075	11.695	> LOQ 1.539
24460	1	50.05	CP-4B	79	0.130	> LOQ 0.075	2.597	> LOQ 1.499
24465	2	48.47	CP-4B	79	0.380	> LOQ 0.075	7.84	> LOQ 1.547
24207	3	48.49	CP-4B	79	1.900	> LOQ 0.150	39.183	> LOQ 3.093
24390	OBZ	49.02	CP-4B	79	0.110	> LOQ 0.075	2.244	> LOQ 1.530
24259	1	48.76	SS-07	80	ND	< LOD 0.030	ND	< LOD 0.615
24421	2	48.13	SS-07	80	0.056	< LOQ 0.075	1.164	< LOQ 1.558
24445	3	47.87	SS-07	80	0.190	> LOQ 0.075	3.969	> LOQ 1.567
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.030	ND	< LOD 0.619
24459	1	48.96	N-02	81	0.190	> LOQ 0.075	3.881	> LOQ 1.532
24417	2	48.11	N-02	81	0.370	> LOQ 0.075	7.691	> LOQ 1.559
24442	3	48.01	N-02	81	1.600	> LOQ 0.075	33.326	> LOQ 1.562
24386	OBZ	48.19	N-02	81	0.300	> LOQ 0.075	6.225	> LOQ 1.556
24452	1	48.20	SG-2B	82	ND	< LOD 0.030	ND	< LOD 0.622
24453	2	48.59	SG-2B	82	ND	< LOD 0.030	ND	< LOD 0.617
24420	3	47.84	SG-2B	82	ND	< LOD 0.030	ND	< LOD 0.627
24444	OBZ	47.95	SG-2B	82	ND	< LOD 0.150	ND	< LOD 3.128
24455	1	48.56	CS-07	83	0.790	> LOQ 0.075	16.269	> LOQ 1.544
24433	2	47.96	CS-07	83	2.000	> LOQ 0.075	41.701	> LOQ 1.564
24398	3	48.06	CS-07	83	9.000	> LOQ 0.075	187.266	> LOQ 1.561
24511	OBZ	47.96	CS-07	83	2.000	> LOQ 0.075	41.701	> LOQ 1.564
24454	1	49.34	CPDS-1A	84	0.450	> LOQ 0.075	9.12	> LOQ 1.520
24291	2	48.49	CPDS-1A	84	0.750	> LOQ 0.075	15.467	> LOQ 1.547
24209	3	48.43	CPDS-1A	84	4.800	> LOQ 0.075	99.112	> LOQ 1.549
24402	OBZ	48.77	CPDS-1A	84	2.100	> LOQ 0.075	43.059	> LOQ 1.538
24204	1	49.46	CPDS-1B	85	0.530	> LOQ 0.075	10.716	> LOQ 1.516
24273	2	48.35	CPDS-1B	85	0.820	> LOQ 0.075	16.96	> LOQ 1.551
24223	3	48.82	CPDS-1B	85	4.400	> LOQ 0.075	90.127	> LOQ 1.536
24466	OBZ	49.96	CPDS-1B	85	0.750	> LOQ 0.075	15.012	> LOQ 1.501

Airborne Sample Data Analysis - Lithium

NIOSH REL 25.0 micrograms/cubic meter

OSHA PEL 25.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 0.618	ND	< LOD 0.625	ND	< LOD 0.619	ND	< LOD 0.621
CS-01	6.797	> LOQ 1.545	22.917	> LOQ 1.563	99.03	> LOQ 1.547	20.868	> LOQ 1.565
CS-02	11.647	> LOQ 1.560	31.355	> LOQ 1.568	131.22	> LOQ 1.562	47.927	> LOQ 1.563
CS-03	5.981	> LOQ 1.547	24.85	> LOQ 1.553	91.25	> LOQ 1.555	24.85	> LOQ 1.553
CS-04	5.143	> LOQ 1.543	18.418	> LOQ 1.570	49.70	> LOQ 1.553	24.702	> LOQ 1.544
CS-05	3.922	> LOQ 1.548	14.187	> LOQ 1.565	37.67	> LOQ 1.570	18.415	> LOQ 2.466
CS-06	16.055	> LOQ 1.564	39.791	> LOQ 1.571	43.47	> LOQ 1.552	29.142	> LOQ 1.561
CS-07	16.269	> LOQ 1.544	41.701	> LOQ 1.564	187.27	> LOQ 1.561	41.701	> LOQ 1.564
CSDS-01	6.022	> LOQ 1.557	31.243	> LOQ 1.562	97.59	> LOQ 1.557	47.847	> LOQ 1.560
CSDS-02	7.006	> LOQ 1.545	26.882	> LOQ 1.551	103.50	> LOQ 1.552	37.673	> LOQ 1.570
N-01	ND	< LOD 0.610	1.314	< LOQ 1.564	4.35	> LOQ 1.552	2.049	> LOQ 1.537
N-02	3.881	> LOQ 1.532	7.691	> LOQ 1.559	33.33	> LOQ 1.562	6.225	> LOQ 1.556
O-1	0.638	< LOQ 1.544	1.503	< LOQ 1.566	3.90	> LOQ 1.541	ND	< LOD 0.628
S-01	ND	< LOD 0.623	ND	< LOD 0.626	20.46	> LOQ 1.566	2.504	> LOQ 1.565
S-02	ND	< LOD 0.625	5.235	> LOQ 1.570	3.96	> LOQ 1.563	1.357	< LOQ 1.566
SH-01	ND	< LOD 0.627	ND	< LOD 0.627	ND	< LOD 0.622	ND	< LOD 0.624
SS-01	ND	< LOD 0.619	ND	< LOD 0.626	ND	< LOD 0.620	0.663	< LOQ 1.553
SS-02	ND	< LOD 0.623	ND	< LOD 0.626	0.64	< LOQ 1.552	1.008	< LOQ 1.543
SS-03	ND	< LOD 0.624	ND	< LOD 0.630	1.02	< LOQ 1.532	ND	< LOD 0.605
SS-04	1.171	< LOQ 1.569	5.86	> LOQ 1.570	9.00	> LOQ 1.569	5.557	> LOQ 1.544
SS-05	ND	< LOD 0.603	ND	< LOD 0.629	0.73	< LOQ 1.559	0.635	< LOQ 1.537
SS-06	1.362	< LOQ 1.525	3.73	> LOQ 1.554	ND	< LOD 0.629	1.045	< LOQ 1.568
SS-07	ND	< LOD 0.615	1.164	< LOQ 1.558	3.97	> LOQ 1.567	ND	< LOD 0.619
SSDS-01	ND	< LOD 0.618	0.669	< LOQ 1.568	1.11	< LOQ 1.547	1.2	< LOQ 1.552
SSDS-02	ND	< LOD 0.625	2.708	> LOQ 1.563	9.91	> LOQ 1.548	2.836	> LOQ 1.519
SSDS-03	ND	< LOD 0.606	ND	< LOD 0.596	ND	< LOD 0.597	ND	< LOD 0.622
CP-1A	0.804	< LOQ 1.547	2.9	> LOQ 1.553	6.02	> LOQ 1.556	2.723	> LOQ 1.571
CP-1B	1.391	< LOQ 1.768	3.332	> LOQ 1.785	9.89	> LOQ 1.766	3.112	> LOQ 1.796
CP-2A	7.427	> LOQ 1.547	19.03	> LOQ 1.568	114.06	> LOQ 3.111	43.623	> LOQ 1.558
CP-2B	18.591	> LOQ 1.549	11.482	> LOQ 1.566	45.59	> LOQ 1.554	9.468	> LOQ 1.578
CP-3A	5.163	> LOQ 1.549	12.936	> LOQ 1.565	64.12	> LOQ 1.551	49.669	> LOQ 1.552
CP-3B	6.054	> LOQ 2.064	33.315	> LOQ 2.082	49.34	> LOQ 2.056	19.369	> LOQ 1.862
CP-4A	1.813	> LOQ 1.545	11.947	> LOQ 1.572	55.09	> LOQ 3.061	11.695	> LOQ 1.539
CP-4B	2.597	> LOQ 1.499	7.84	> LOQ 1.547	39.18	> LOQ 3.093	2.244	> LOQ 1.530
CPDS-1A	9.12	> LOQ 1.520	15.467	> LOQ 1.547	99.11	> LOQ 1.549	43.059	> LOQ 1.538
CPDS-1B	10.716	> LOQ 1.516	16.96	> LOQ 1.551	90.13	> LOQ 1.536	15.012	> LOQ 1.501
G-1A	ND	< LOD 0.623	0.627	< LOQ 1.567	2.08	> LOQ 1.557	1.104	< LOQ 1.533
G-1B	ND	< LOD 0.621	0.929	< LOQ 1.583	1.41	< LOQ 1.557	1.203	> LOQ 1.555
G-2A	ND	< LOD 0.632	2.547	> LOQ 1.592	2.90	> LOQ 1.555	1.811	> LOQ 1.561
G-2B	0.635	< LOQ 1.537	3.114	> LOQ 1.557	2.51	> LOQ 1.569	1.215	< LOQ 1.545
G-3A	1.365	< LOQ 1.552	2.91	> LOQ 1.559	8.60	> LOQ 1.574	1.459	< LOQ 1.563
G-4A	5.28	> LOQ 1.523	7.236	> LOQ 1.551	41.09	> LOQ 1.541	12.666	> LOQ 1.557
G-4B	1.964	> LOQ 1.550	14.164	> LOQ 1.562	24.80	> LOQ 1.550	11.979	> LOQ 1.549
G-5A	ND	< LOD 0.618	1.038	< LOQ 1.557	2.29	> LOQ 1.561	2.509	> LOQ 1.568
G-5B	ND	< LOD 0.627	1.682	> LOQ 1.557	4.38	> LOQ 1.563	1.042	< LOQ 1.563
G-6A	1.268	< LOQ 1.559	4.808	> LOQ 1.568	7.49	> LOQ 1.561	3.106	> LOQ 1.553
G-6B	0.656	< LOQ 1.538	2.318	> LOQ 1.581	2.86	> LOQ 1.533	1.898	> LOQ 1.548
G-7A	ND	< LOD 0.619	ND	< LOD 0.622	ND	< LOD 0.626	ND	< LOD 0.628
G-7B	ND	< LOD 0.616	ND	< LOD 0.624	ND	< LOD 0.636	ND	< LOD 0.635
SG-1A	ND	< LOD 0.612	ND	< LOD 0.622	ND	< LOD 0.623	ND	< LOD 0.619
SG-1B	ND	< LOD 1.153	ND	< LOD 1.153	ND	< LOD 1.149	ND	< LOD 5.714
SG-2A	ND	< LOD 0.617	ND	< LOD 0.626	8.50	> LOQ 1.555	ND	< LOD 1.242
SG-2B	ND	< LOD 0.622	ND	< LOD 0.617	ND	< LOD 0.627	ND	< LOD 3.128

Bulk Elemental Analysis - Lithium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Lithium		Sample	Lithium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.09	J95331-63 PB	ND	< LOD 0.09
CS-01	J95331-34 VB	44.00	> LOQ 0.30	J95331-34 PB	39.00	> LOQ 0.30
CS-02	J95331-37 VB	26.00	> LOQ 0.30	J95331-37 PB	26.00	> LOQ 0.30
CS-03	J95331-38 VB	33.00	> LOQ 0.30	J95331-38 PB	38.00	> LOQ 0.30
CS-04	J95331-39 VB	2.80	> LOQ 0.30	J95331-39 PB	3.50	> LOQ 0.30
CS-05	J95331-57 VB	1.60	> LOQ 30.0	J95331-57 PB	2.50	> LOQ 30.0
CS-06	J95331-70 VB	1.70	> LOQ 0.30	J95331-70 PB	3.40	> LOQ 0.30
CS-07	J95331-83 VB	6.10	> LOQ 0.30	J95331-83 PB	12.00	> LOQ 0.30
CSDS-01	J95331-31 VB	4.30	> LOQ 0.30	J95331-31 PB	8.50	> LOQ 0.30
CSDS-02	J95331-35 VB	36.00	> LOQ 0.30	J95331-35 PB	39.00	> LOQ 0.30
N-01	J95331-52 VB	0.27	< LOQ 0.30	J95331-52 PB	0.27	< LOQ 0.30
N-02	J95331-81 VB	3.10	> LOQ 0.30	J95331-81 PB	6.40	> LOQ 0.30
O-1	J95331-69 VB	1.30	> LOQ 0.30	J95331-69 PB	1.40	> LOQ 0.30
S-01	J95331-28 VB	0.13	< LOQ 0.30	J95331-28 PB	0.29	< LOQ 0.30
S-02	J95331-29 VB	0.17	< LOQ 0.30	J95331-29 PB	0.36	> LOQ 0.30
SH-01	J95331-36 VB	ND	< LOD 0.09	J95331-36 PB	0.16	< LOQ 0.30
SS-01	J95331-32 VB	ND	< LOD 0.09	J95331-32 PB	ND	< LOD 0.09
SS-02	J95331-40 VB	ND	< LOD 0.09	J95331-40 PB	ND	< LOD 0.09
SS-03	J95331-45 VB	ND	< LOD 0.09	J95331-45 PB	ND	< LOD 0.09
SS-04	J95331-47 VB	1.80	> LOQ 30.0	J95331-47 PB	0.80	> LOQ 30.0
SS-05	J95331-53 VB	ND	< LOD 0.09	J95331-53 PB	ND	< LOD 0.09
SS-06	J95331-76 VB	1.50	> LOQ 0.30	J95331-76 PB	1.30	> LOQ 0.30
SS-07	J95331-80 VB	1.00	> LOQ 0.30	J95331-80 PB	0.24	< LOQ 0.30
SSDS-01	J95331-33 VB	0.20	< LOQ 0.30	J95331-33 PB	0.13	< LOQ 0.30
SSDS-02	J95331-44 VB	2.60	> LOQ 0.30	J95331-44 PB	2.30	> LOQ 0.30
SSDS-03	J95331-48 VB	ND	< LOD 0.09	J95331-48 PB	ND	< LOD 0.09
CP-1A	J95331-60 VB	0.84	> LOQ 30.0	J95331-60 PB	2.50	> LOQ 30.0
CP-1B	J95331-61 VB	5.20	> LOQ 30.0	J95331-61 PB	7.40	> LOQ 30.0
CP-2A	J95331-67 VB	19.00	> LOQ 0.30	J95331-67 PB	26.00	> LOQ 0.60
CP-2B	J95331-68 VB	23.00	> LOQ 0.60	J95331-68 PB	24.00	> LOQ 0.60
CP-3A	J95331-72 VB	11.00	> LOQ 0.30	J95331-72 PB	11.00	> LOQ 0.30
CP-3B	J95331-73 VB	12.00	> LOQ 0.30	J95331-73 PB	11.00	> LOQ 0.30
CP-4A	J95331-78 VB	3.40	> LOQ 0.30	J95331-78 PB	5.30	> LOQ 0.30
CP-4B	J95331-79 VB	6.00	> LOQ 0.30	J95331-79 PB	5.80	> LOQ 0.30
CPDS-1A	J95331-84 VB	13.00	> LOQ 0.30	J95331-84 PB	21.00	> LOQ 0.30
CPDS-1B	J95331-85 VB	19.00	> LOQ 0.30	J95331-85 PB	23.00	> LOQ 0.30
G-1A	J95331-41 VB	0.36	> LOQ 0.30	J95331-41 PB	0.24	< LOQ 3.0
G-1B	J95331-46 VB	0.16	< LOQ 3.0	J95331-46 PB	0.20	< LOQ 3.0
G-2A	J95331-43 VB	0.39	> LOQ 0.30	J95331-43 PB	0.73	> LOQ 0.30
G-2B	J95331-50 VB	0.42	< LOQ 0.30	J95331-50 PB	0.18	< LOQ 0.30
G-3A	J95331-49 VB	0.27	< LOQ 0.30	J95331-49 PB	2.20	> LOQ 30.0
G-4A	J95331-55 VB	1.80	> LOQ 0.30	J95331-55 PB	3.10	> LOQ 30.0
G-4B	J95331-56 VB	3.30	> LOQ 30.0	J95331-56 PB	2.40	> LOQ 30.0
G-5A	J95331-58 VB	0.33	> LOQ 30.0	J95331-58 PB	0.27	< LOQ 30.0
G-5B	J95331-59 VB	0.18	< LOQ 30.0	J95331-59 PB	0.16	< LOQ 30.0
G-6A	J95331-64 VB	0.82	> LOQ 30.0	J95331-64 PB	0.93	> LOQ 30.0
G-6B	J95331-65 VB	0.81	> LOQ 30.0	J95331-65 PB	0.59	> LOQ 30.0
G-7A	J95331-74 VB	ND	< LOD 0.09	J95331-74 PB	ND	< LOD 0.09
G-7B	J95331-75 VB	0.10	< LOQ 0.30	J95331-75 PB	0.10	< LOQ 0.30
SG-1A	J95331-54 VB	ND	< LOD 0.45	J95331-54 PB	ND	< LOD 0.45
SG-1B	J95331-71 VB	ND	< LOD 0.45	J95331-71 PB	ND	< LOD 0.45
SG-2A	J95331-66 VB	ND	< LOD 0.45	J95331-66 PB	ND	< LOD 0.45
SG-2B	J95331-82 VB	ND	< LOD 0.45	J95331-82 PB	0.45	< LOQ 1.5

Comparison of Airborne Concentrations to Bulk Concentrations - Lithium

NIOSH REL 25.0 micrograms/cubic meter
OSHA PEL 25.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	6.80	22.92	99.03	20.87	44.00
CS-02	11.65	31.36	131.22	47.93	26.00
CS-03	5.98	24.85	91.25	24.85	33.00
CS-04	5.14	18.42	49.70	24.70	2.80
CS-05	3.92	14.19	37.67	18.42	1.60
CS-06	16.06	39.79	43.47	29.14	1.70
CS-07	16.27	41.70	187.27	41.70	6.10
CSDS-01	6.02	31.24	97.59	47.85	4.30
CSDS-02	7.01	26.88	103.50	37.67	36.00
N-01	ND	1.31	4.35	2.05	0.27
N-02	3.88	7.69	33.33	6.23	3.10
O-1	0.64	1.50	3.90	ND	1.30
S-01	ND	ND	20.46	2.50	0.13
S-02	ND	5.24	3.96	1.36	0.17
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	0.66	ND
SS-02	ND	ND	0.64	1.01	ND
SS-03	ND	ND	1.02	ND	ND
SS-04	1.17	5.86	9.00	5.56	1.80
SS-05	ND	ND	0.73	0.64	ND
SS-06	1.36	3.73	ND	1.05	1.50
SS-07	ND	1.16	3.97	ND	1.00
SSDS-01	ND	0.67	1.11	1.20	0.20
SSDS-02	ND	2.71	9.91	2.84	2.60
SSDS-03	ND	ND	ND	ND	ND
CP-1A	0.80	2.90	6.02	2.72	0.84
CP-2A	7.43	19.03	114.06	43.62	19.00
CP-3A	5.16	12.94	64.12	49.67	11.00
CP-4A	1.81	11.95	55.09	11.70	3.40
CPDS-1A	9.12	15.47	99.11	43.06	13.00
G-1A	ND	0.63	2.08	1.10	0.36
G-2A	ND	2.55	2.90	1.81	0.39
G-3A	1.37	2.91	8.60	1.46	0.27
G-4A	5.28	7.24	41.09	12.67	1.80
G-5A	ND	1.04	2.29	2.51	0.33
G-6A	1.27	4.81	7.49	3.11	0.82
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	8.50	ND	ND

APPENDIX B - MAGNESIUM

Magnesium

Magnesium may cause irritation of the eyes, nose, and throat. Magnesium oxide fume may cause metal fume fever. However, the dust is generally considered a nuisance particulate, which will not produce significant toxic effects when exposures are kept under reasonable control. For the purpose of this study, the NIOSH REL is 10,000 micrograms/cubic meter of air based on the discussion in APPENDIX D to NIOSH POCKET GUIDE TO CHEMICAL HAZARDS[1] concerning magnesium oxide fume, as there is no NIOSH REL listed for magnesium. The OSHA PEL for magnesium oxide fume is 15,000 micrograms/cubic meter of air.

[1] *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Fourth Printing, June 1994

Air Sample Results - Magnesium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Magnesium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.94	< LOQ 1.7	19.52	< LOQ 35.30
24412	2	47.89	S-01	28	1.20	< LOQ 1.7	25.06	< LOQ 35.50
24441	3	47.90	S-01	28	12.00	> LOQ 1.7	250.52	> LOQ 35.49
24450	OBZ	47.93	S-01	28	2.60	> LOQ 1.7	54.25	> LOQ 35.47
24643	1	47.98	S-02	29	0.66	< LOQ 1.7	13.76	< LOQ 35.43
24625	2	47.76	S-02	29	4.10	> LOQ 1.7	85.85	> LOQ 35.59
24642	3	48.00	S-02	29	3.40	> LOQ 1.7	70.83	> LOQ 35.42
24632	OBZ	47.89	S-02	29	1.10	< LOQ 1.7	22.97	< LOQ 35.50
24634	1	48.16	CSDS-01	31	15.00	> LOQ 1.7	311.46	> LOQ 35.30
24650	2	48.01	CSDS-01	31	83.00	> LOQ 1.7	1728.81	> LOQ 35.41
24644	3	48.16	CSDS-01	31	250.00	> LOQ 1.7	5191.03	> LOQ 35.30
24645	OBZ	48.07	CSDS-01	31	120.00	> LOQ 1.7	2496.36	> LOQ 35.37
24640	1	48.44	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.32
24641	2	47.90	SS-01	32	0.91	< LOQ 1.7	19	< LOQ 35.49
24651	3	48.35	SS-01	32	1.30	< LOQ 1.7	26.89	< LOQ 35.16
24635	OBZ	48.30	SS-01	32	1.70	> LOQ 1.7	35.2	> LOQ 35.20
24646	1	48.58	SSDS-01	33	0.72	< LOQ 1.7	14.82	< LOQ 34.99
24626	2	47.84	SSDS-01	33	2.80	> LOQ 1.7	58.53	> LOQ 35.54
24638	3	48.49	SSDS-01	33	4.30	> LOQ 1.7	88.68	> LOQ 35.06
24647	OBZ	48.32	SSDS-01	33	3.30	> LOQ 1.7	68.29	> LOQ 35.18
24628	1	48.55	CS-01	34	58.00	> LOQ 1.7	1194.64	> LOQ 35.02
24637	2	48.00	CS-01	34	170.00	> LOQ 1.7	3541.67	> LOQ 35.42
24624	3	48.47	CS-01	34	820.00	> LOQ 1.7	16917.68	> LOQ 35.07
24636	OBZ	47.92	CS-01	34	170.00	> LOQ 1.7	3547.58	> LOQ 35.48
24623	1	48.53	CSDS-02	35	61.00	> LOQ 1.7	1256.95	> LOQ 35.03
24622	2	48.36	CSDS-02	35	240.00	> LOQ 1.7	4962.78	> LOQ 35.15
24654	3	48.31	CSDS-02	35	930.00	> LOQ 1.7	19250.67	> LOQ 35.19
24653	OBZ	47.78	CSDS-02	35	320.00	> LOQ 1.7	6697.36	> LOQ 35.58
24629	1	47.88	SH-01	36	1.40	< LOQ 1.7	29.24	< LOQ 35.51
24633	2	47.86	SH-01	36	1.70	> LOQ 1.7	35.52	> LOQ 35.52
24627	3	48.24	SH-01	36	4.90	> LOQ 1.7	101.58	> LOQ 35.24
24648	OBZ	48.08	SH-01	36	1.60	< LOQ 1.7	33.28	< LOQ 35.36
24555	1	48.08	CS-02	37	27.00	> LOQ 1.7	561.56	> LOQ 35.36
24552	2	47.84	CS-02	37	85.00	> LOQ 1.7	1776.76	> LOQ 35.54
24541	3	48.01	CS-02	37	360.00	> LOQ 1.7	7498.44	> LOQ 35.41
24529	OBZ	47.99	CS-02	37	130.00	> LOQ 1.7	2708.9	> LOQ 35.42
24558	1	48.49	CS-03	38	78.00	> LOQ 1.7	1608.58	> LOQ 35.06
24524	2	48.29	CS-03	38	330.00	> LOQ 1.7	6833.71	> LOQ 35.20
24561	3	48.22	CS-03	38	1200.00	> LOQ 1.7	24885.94	> LOQ 35.26
24559	OBZ	48.29	CS-03	38	330.00	> LOQ 1.7	6833.71	> LOQ 35.20
24543	1	48.61	CS-04	39	28.00	> LOQ 1.7	576.01	> LOQ 34.97
24532	2	47.78	CS-04	39	100.00	> LOQ 1.7	2092.93	> LOQ 35.58
24546	3	48.29	CS-04	39	270.00	> LOQ 1.7	5591.22	> LOQ 35.20
24557	OBZ	48.58	CS-04	39	140.00	> LOQ 1.7	2881.84	> LOQ 34.99
24560	1	48.13	SS-02	40	2.60	> LOQ 1.7	54.02	> LOQ 35.32
24565	2	47.95	SS-02	40	4.30	> LOQ 1.7	89.68	> LOQ 35.45
24630	3	48.32	SS-02	40	4.30	> LOQ 1.7	88.99	> LOQ 35.18
24553	OBZ	48.62	SS-02	40	5.30	> LOQ 1.7	109.01	> LOQ 34.97
24525	1	48.13	G-1A	41	34.00	> LOQ 1.7	706.42	> LOQ 35.32
24563	2	47.87	G-1A	41	140.00	> LOQ 1.7	2924.59	> LOQ 35.51
24547	3	48.17	G-1A	41	470.00	> LOQ 1.7	9757.11	> LOQ 35.29
24526	OBZ	48.91	G-1A	41	360.00	> LOQ 1.7	7360.46	> LOQ 34.76
24538	1	47.45	G-2A	43	7.70	> LOQ 1.7	162.28	> LOQ 35.83

Air Sample Results - Magnesium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Magnesium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	49.00	> LOQ 1.7	1039.9	> LOQ 36.08
24533	3	48.24	G-2A	43	74.00	> LOQ 1.7	1534	> LOQ 35.24
24540	OBZ	48.04	G-2A	43	31.00	> LOQ 1.7	645.3	> LOQ 35.39
24528	1	47.99	SSDS-02	44	46.00	> LOQ 1.7	958.53	> LOQ 35.42
24544	2	48.00	SSDS-02	44	180.00	> LOQ 1.7	3750	> LOQ 35.42
24567	3	48.46	SSDS-02	44	530.00	> LOQ 1.7	10936.86	> LOQ 35.08
24539	OBZ	49.37	SSDS-02	44	150.00	> LOQ 1.7	3038.28	> LOQ 34.43
24571	1	48.05	SS-03	45	1.00	< LOQ 1.7	20.81	< LOQ 35.38
24536	2	47.60	SS-03	45	2.80	> LOQ 1.7	58.82	> LOQ 35.71
24534	3	48.94	SS-03	45	3.30	> LOQ 1.7	67.43	> LOQ 34.74
24570	OBZ	49.61	SS-03	45	4.00	> LOQ 1.7	80.63	> LOQ 34.27
24568	1	48.28	G-1B	46	21.00	> LOQ 1.7	434.96	> LOQ 35.21
24592	2	47.38	G-1B	46	200.00	> LOQ 1.7	4221.19	> LOQ 35.88
24593	3	48.17	G-1B	46	250.00	> LOQ 1.7	5189.95	> LOQ 35.29
24535	OBZ	48.22	G-1B	46	260.00	> LOQ 1.7	5391.95	> LOQ 35.26
24590	1	47.81	SS-04	47	45.00	> LOQ 1.7	941.23	> LOQ 35.56
24605	2	47.78	SS-04	47	290.00	> LOQ 1.7	6069.49	> LOQ 35.58
24562	3	47.80	SS-04	47	360.00	> LOQ 1.7	7531.38	> LOQ 35.56
24531	OBZ	48.59	SS-04	47	270.00	> LOQ 1.7	5556.7	> LOQ 34.99
24527	1	49.48	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 10.11
24569	2	50.35	SSDS-03	48	1.10	< LOQ 1.7	21.85	< LOQ 33.76
24584	3	50.24	SSDS-03	48	3.00	> LOQ 1.7	59.71	> LOQ 33.84
24579	OBZ	48.26	SSDS-03	48	2.90	> LOQ 1.7	60.09	> LOQ 35.23
24600	1	48.34	G-3A	49	21.00	> LOQ 1.7	434.42	> LOQ 35.17
24616	2	48.11	G-3A	49	86.00	> LOQ 1.7	1787.57	> LOQ 35.34
24585	3	47.65	G-3A	49	240.00	> LOQ 1.7	5036.73	> LOQ 35.68
24583	OBZ	47.99	G-3A	49	26.00	> LOQ 1.7	541.78	> LOQ 35.42
24587	1	48.79	G-2B	50	15.00	> LOQ 1.7	307.44	> LOQ 34.84
24602	2	48.17	G-2B	50	91.00	> LOQ 1.7	1889.14	> LOQ 35.29
24564	3	47.81	G-2B	50	54.00	> LOQ 1.7	1129.47	> LOQ 35.56
24621	OBZ	48.54	G-2B	50	19.00	> LOQ 1.7	391.43	> LOQ 35.02
24618	1	49.21	N-01	52	550.00	> LOQ 1.7	11176.59	> LOQ 34.55
24611	2	47.96	N-01	52	2700.00	> LOQ 1.7	56296.91	> LOQ 35.45
24588	3	48.32	N-01	52	13000.00	> LOQ 1.7	269039.74	> LOQ 35.18
24615	OBZ	48.80	N-01	52	6100.00	> LOQ 1.7	125000	> LOQ 34.84
24597	1	49.78	SS-05	53	1.20	< LOQ 1.7	24.11	< LOQ 34.15
24599	2	47.68	SS-05	53	3.00	> LOQ 1.7	62.92	> LOQ 35.65
24575	3	48.11	SS-05	53	5.90	> LOQ 1.7	122.64	> LOQ 35.34
24617	OBZ	48.79	SS-05	53	7.30	> LOQ 1.7	149.62	> LOQ 34.84
24609	1	48.98	SG-1A	54	2.50	> LOQ 1.7	51.04	> LOQ 34.71
24596	2	48.20	SG-1A	54	2.70	> LOQ 1.7	56.02	> LOQ 35.27
24610	3	48.18	SG-1A	54	6.70	> LOQ 1.7	139.06	> LOQ 35.28
24576	OBZ	48.47	SG-1A	54	12.00	> LOQ 8.5	247.58	> LOQ 175.37
24606	1	49.24	G-4A	55	72.00	> LOQ 1.7	1462.23	> LOQ 34.52
24620	2	48.37	G-4A	55	86.00	> LOQ 1.7	1777.96	> LOQ 35.15
24573	3	48.67	G-4A	55	560.00	> LOQ 1.7	11506.06	> LOQ 34.93
24505	OBZ	48.16	G-4A	55	160.00	> LOQ 1.7	3322.26	> LOQ 35.30
24340	1	48.38	G-4B	56	21.00	> LOQ 1.7	434.06	> LOQ 35.14
24607	2	48.01	G-4B	56	180.00	> LOQ 1.7	3749.22	> LOQ 35.41
24595	3	48.38	G-4B	56	320.00	> LOQ 1.7	6614.3	> LOQ 35.14
24598	OBZ	48.42	G-4B	56	150.00	> LOQ 1.7	3097.89	> LOQ 35.11
24580	1	48.44	CS-05	57	12.00	> LOQ 1.7	247.73	> LOQ 35.09
24604	2	47.93	CS-05	57	44.00	> LOQ 1.7	918.01	> LOQ 35.47

Air Sample Results - Magnesium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Magnesium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	110.00	> LOQ 1.7	2302.22	> LOQ 35.58
24574	OBZ	30.41	CS-05	57	37.00	> LOQ 1.7	1216.71	> LOQ 55.90
24614	1	48.58	G-5A	58	22.00	> LOQ 1.7	452.86	> LOQ 34.99
24577	2	48.18	G-5A	58	94.00	> LOQ 1.7	1951.02	> LOQ 35.28
24572	3	48.05	G-5A	58	340.00	> LOQ 1.7	7075.96	> LOQ 35.38
24582	OBZ	47.83	G-5A	58	480.00	> LOQ 1.7	10035.54	> LOQ 35.54
24322	1	47.88	G-5B	59	51.00	> LOQ 1.7	1065.16	> LOQ 35.51
24354	2	48.16	G-5B	59	230.00	> LOQ 1.7	4775.75	> LOQ 35.30
24510	3	47.98	G-5B	59	740.00	> LOQ 1.7	15423.09	> LOQ 35.43
24321	OBZ	47.99	G-5B	59	99.00	> LOQ 1.7	2062.93	> LOQ 35.42
24497	1	48.49	CP-1A	60	17.00	> LOQ 1.7	350.59	> LOQ 35.06
24333	2	48.28	CP-1A	60	63.00	> LOQ 1.7	1304.89	> LOQ 35.21
24326	3	48.19	CP-1A	60	190.00	> LOQ 1.7	3942.73	> LOQ 35.28
24329	OBZ	47.74	CP-1A	60	64.00	> LOQ 1.7	1340.59	> LOQ 35.61
24499	1	42.42	CP-1B	62	23.00	> LOQ 1.7	542.2	> LOQ 40.08
24506	2	42.02	CP-1B	62	55.00	> LOQ 1.7	1308.9	> LOQ 40.46
24388	3	42.47	CP-1B	62	250.00	> LOQ 1.7	5886.51	> LOQ 40.03
24315	OBZ	41.77	CP-1B	62	60.00	> LOQ 1.7	1436.44	> LOQ 40.70
24318	1	48.56	CG-01	63	4.00	> LOQ 1.7	82.37	> LOQ 35.01
24308	2	48.00	CG-01	63	46.00	> LOQ 1.7	958.33	> LOQ 35.42
24330	3	48.47	CG-01	63	73.00	> LOQ 1.7	1506.09	> LOQ 35.07
24230	OBZ	48.31	CG-01	63	23.00	> LOQ 1.7	476.09	> LOQ 35.19
24363	1	48.10	G-6A	64	140.00	> LOQ 1.7	2910.6	> LOQ 35.34
24398	2	47.84	G-6A	64	690.00	> LOQ 1.7	14423.08	> LOQ 35.54
24351	3	48.06	G-6A	64	1300.00	> LOQ 1.7	27049.52	> LOQ 35.37
24594	OBZ	48.29	G-6A	64	250.00	> LOQ 1.7	5177.06	> LOQ 35.20
24312	1	48.76	G-6B	65	30.00	> LOQ 1.7	615.26	> LOQ 34.86
24484	2	47.45	G-6B	65	320.00	> LOQ 1.7	6743.94	> LOQ 35.83
24327	3	48.92	G-6B	65	260.00	> LOQ 1.7	5314.8	> LOQ 34.75
24389	OBZ	48.46	G-6B	65	310.00	> LOQ 1.7	6397.03	> LOQ 35.08
24348	1	48.59	SG-2A	66	2.70	> LOQ 1.7	55.57	> LOQ 34.99
24314	2	47.90	SG-2A	66	3.20	> LOQ 1.7	66.81	> LOQ 35.49
24494	3	48.24	SG-2A	66	2.30	< LOQ 3.4	47.68	< LOQ 70.48
24337	OBZ	48.30	SG-2A	66	10.00	> LOQ 8.5	207.04	> LOQ 175.98
24508	1	48.47	CP-2A	67	250.00	> LOQ 1.7	5157.83	> LOQ 35.07
24361	2	47.82	CP-2A	67	710.00	> LOQ 1.7	14847.34	> LOQ 35.55
24359	3	48.22	CP-2A	67	4500.00	> LOQ 3.4	93322.27	> LOQ 70.51
24471	OBZ	48.14	CP-2A	67	1800.00	> LOQ 1.7	37390.94	> LOQ 35.31
24373	1	48.41	CP-2B	68	710.00	> LOQ 1.7	14666.39	> LOQ 35.12
24468	2	47.90	CP-2B	68	440.00	> LOQ 1.7	9185.8	> LOQ 35.49
24481	3	48.26	CP-2B	68	1600.00	> LOQ 1.7	33153.75	> LOQ 35.23
24391	OBZ	47.53	CP-2B	68	320.00	> LOQ 1.7	6732.59	> LOQ 35.77
24356	1	48.56	O-1	69	4200.00	> LOQ 1.7	86490.94	> LOQ 35.01
24470	2	47.89	O-1	69	8800.00	> LOQ 1.7	183754.44	> LOQ 35.50
24467	3	48.67	O-1	69	24000.00	> LOQ 1.7	493116.91	> LOQ 34.93
24313	OBZ	47.78	O-1	69	4100.00	> LOQ 1.7	85809.96	> LOQ 35.58
24501	1	47.96	CS-06	70	41.00	> LOQ 1.7	854.88	> LOQ 35.45
24496	2	47.75	CS-06	70	100.00	> LOQ 1.7	2094.24	> LOQ 35.60
24478	3	48.31	CS-06	70	120.00	> LOQ 1.7	2483.96	> LOQ 35.19
24503	OBZ	48.04	CS-06	70	83.00	> LOQ 1.7	1727.73	> LOQ 35.39
24474	1	26.02	SG-1B	71	1.40	< LOQ 1.7	53.8	< LOQ 65.33
24469	2	26.02	SG-1B	71	3.00	> LOQ 1.7	115.3	> LOQ 65.33
24492	3	26.10	SG-1B	71	2.00	> LOQ 1.7	76.63	> LOQ 65.13

Air Sample Results - Magnesium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Magnesium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	6.70	< LOQ 8.5	255.24	< LOQ 323.81
24489	1	48.42	CP-3A	72	130.00	> LOQ 1.7	2684.84	> LOQ 35.11
24491	2	47.93	CP-3A	72	310.00	> LOQ 1.7	6467.77	> LOQ 35.47
24482	3	48.35	CP-3A	72	1800.00	> LOQ 1.7	37228.54	> LOQ 35.16
24486	OBZ	48.32	CP-3A	72	1700.00	> LOQ 1.7	35182.12	> LOQ 35.18
24516	1	36.34	CP-3B	73	130.00	> LOQ 1.7	3577.33	> LOQ 46.78
24502	2	36.02	CP-3B	73	770.00	> LOQ 1.7	21377.01	> LOQ 47.20
24515	3	36.48	CP-3B	73	1000.00	> LOQ 1.7	27412.28	> LOQ 46.60
24500	OBZ	40.27	CP-3B	73	490.00	> LOQ 1.7	12167.87	> LOQ 42.22
24504	1	48.47	G-7A	74	7.30	> LOQ 1.7	150.61	> LOQ 35.07
24513	2	48.22	G-7A	74	18.00	> LOQ 1.7	373.29	> LOQ 35.26
24458	3	47.94	G-7A	74	36.00	> LOQ 1.7	750.94	> LOQ 35.46
24389	OBZ	47.75	G-7A	74	23.00	> LOQ 1.7	481.68	> LOQ 35.60
24404	1	48.68	G-7B	75	6.30	> LOQ 1.7	129.42	> LOQ 34.92
24451	2	48.06	G-7B	75	22.00	> LOQ 1.7	457.76	> LOQ 35.37
24447	3	47.16	G-7B	75	32.00	> LOQ 1.7	678.54	> LOQ 36.05
24423	OBZ	47.27	G-7B	75	17.00	> LOQ 1.7	359.64	> LOQ 35.96
24456	1	49.19	SS-06	76	15.00	> LOQ 1.7	304.94	> LOQ 34.56
24480	2	48.26	SS-06	76	35.00	> LOQ 1.7	725.24	> LOQ 35.23
24429	3	47.68	SS-06	76	2.00	> LOQ 1.7	41.95	> LOQ 35.65
24418	OBZ	47.83	SS-06	76	23.00	> LOQ 1.7	480.87	> LOQ 35.54
24427	1	48.54	CP-4A	78	94.00	> LOQ 1.7	1936.55	> LOQ 35.02
24435	2	47.71	CP-4A	78	410.00	> LOQ 1.7	8593.59	> LOQ 35.63
24244	3	49.01	CP-4A	78	2100.00	> LOQ 3.4	42848.4	> LOQ 69.37
24220	OBZ	48.74	CP-4A	78	420.00	> LOQ 1.7	8617.15	> LOQ 34.88
24460	1	50.05	CP-4B	79	89.00	> LOQ 1.7	1778.22	> LOQ 33.97
24465	2	48.47	CP-4B	79	290.00	> LOQ 1.7	5983.08	> LOQ 35.07
24207	3	48.49	CP-4B	79	1500.00	> LOQ 3.4	30934.21	> LOQ 70.12
24390	OBZ	49.02	CP-4B	79	95.00	> LOQ 1.7	1937.98	> LOQ 34.68
24259	1	48.76	SS-07	80	6.50	> LOQ 1.7	133.31	> LOQ 34.86
24421	2	48.13	SS-07	80	24.00	> LOQ 1.7	498.65	> LOQ 35.32
24445	3	47.87	SS-07	80	60.00	> LOQ 1.7	1253.39	> LOQ 35.51
24432	OBZ	48.49	SS-07	80	17.00	> LOQ 1.7	350.59	> LOQ 35.06
24459	1	48.96	N-02	81	260.00	> LOQ 1.7	5310.46	> LOQ 34.72
24417	2	48.11	N-02	81	530.00	> LOQ 1.7	11016.42	> LOQ 35.34
24442	3	48.01	N-02	81	2400.00	> LOQ 1.7	49989.59	> LOQ 35.41
24386	OBZ	48.19	N-02	81	450.00	> LOQ 1.7	9338.04	> LOQ 35.28
24452	1	48.20	SG-2B	82	11.00	> LOQ 1.7	228.22	> LOQ 35.27
24453	2	48.59	SG-2B	82	12.00	> LOQ 1.7	246.96	> LOQ 34.99
24420	3	47.84	SG-2B	82	10.00	> LOQ 1.7	209.03	> LOQ 35.54
24444	OBZ	47.95	SG-2B	82	20.00	> LOQ 8.5	417.1	> LOQ 177.27
24455	1	48.56	CS-07	83	68.00	> LOQ 1.7	1400.33	> LOQ 35.01
24433	2	47.96	CS-07	83	190.00	> LOQ 1.7	3961.63	> LOQ 35.45
24398	3	48.06	CS-07	83	850.00	> LOQ 1.7	17686.23	> LOQ 35.37
24511	OBZ	47.96	CS-07	83	160.00	> LOQ 1.7	3336.11	> LOQ 35.45
24454	1	49.34	CPDS-1A	84	350.00	> LOQ 1.7	7093.64	> LOQ 34.45
24291	2	48.49	CPDS-1A	84	580.00	> LOQ 1.7	11961.23	> LOQ 35.06
24209	3	48.43	CPDS-1A	84	4100.00	> LOQ 1.7	84658.27	> LOQ 35.10
24402	OBZ	48.77	CPDS-1A	84	1600.00	> LOQ 1.7	32807.05	> LOQ 34.86
24204	1	49.46	CPDS-1B	85	420.00	> LOQ 1.7	8491.71	> LOQ 34.37
24273	2	48.35	CPDS-1B	85	700.00	> LOQ 1.7	14477.77	> LOQ 35.16
24223	3	48.82	CPDS-1B	85	3400.00	> LOQ 1.7	69643.59	> LOQ 34.82
24466	OBZ	49.96	CPDS-1B	85	570.00	> LOQ 1.7	11409.13	> LOQ 34.03

Airborne Sample Data Analysis - Magnesium

NIOSH REL 10000.0 micrograms/cubic meter (nuisance)

OSHA PEL 15000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	82.37	> LOQ 35.01	958.33	> LOQ 35.42	1506.09	> LOQ 35.07	476.09	> LOQ 35.19
CS-01	1194.64	> LOQ 35.02	3541.67	> LOQ 35.42	16917.68	> LOQ 35.07	3547.58	> LOQ 35.48
CS-02	561.56	> LOQ 35.36	1776.76	> LOQ 35.54	7498.44	> LOQ 35.41	2708.9	> LOQ 35.42
CS-03	1608.58	> LOQ 35.06	6833.71	> LOQ 35.20	24885.94	> LOQ 35.26	6833.71	> LOQ 35.20
CS-04	576.01	> LOQ 34.97	2092.93	> LOQ 35.58	5591.22	> LOQ 35.20	2881.84	> LOQ 34.99
CS-05	247.73	> LOQ 35.09	918.01	> LOQ 35.47	2302.22	> LOQ 35.58	1216.71	> LOQ 55.90
CS-06	854.88	> LOQ 35.45	2094.24	> LOQ 35.60	2483.96	> LOQ 35.19	1727.73	> LOQ 35.39
CS-07	1400.33	> LOQ 35.01	3961.63	> LOQ 35.45	17686.23	> LOQ 35.37	3336.11	> LOQ 35.45
CSDS-01	311.46	> LOQ 35.30	1728.81	> LOQ 35.41	5191.03	> LOQ 35.30	2496.36	> LOQ 35.37
CSDS-02	1256.95	> LOQ 35.03	4962.78	> LOQ 35.15	19250.67	> LOQ 35.19	6697.36	> LOQ 35.58
N-01	11176.59	> LOQ 34.55	56296.91	> LOQ 35.45	269039.74	> LOQ 35.18	125000	> LOQ 34.84
N-02	5310.46	> LOQ 34.72	11016.42	> LOQ 35.34	49989.59	> LOQ 35.41	9338.04	> LOQ 35.28
O-1	86490.94	> LOQ 35.01	183754.44	> LOQ 35.50	493116.91	> LOQ 34.93	85809.96	> LOQ 35.58
S-01	19.52	< LOQ 35.30	25.06	< LOQ 35.50	250.52	> LOQ 35.49	54.25	> LOQ 35.47
S-02	13.76	< LOQ 35.43	85.85	> LOQ 35.59	70.83	> LOQ 35.42	22.97	< LOQ 35.50
SH-01	29.24	< LOQ 35.51	35.52	> LOQ 35.52	101.58	> LOQ 35.24	33.28	< LOQ 35.36
SS-01	ND	< LOD 10.32	19	< LOQ 35.49	26.89	< LOQ 35.16	35.2	> LOQ 35.20
SS-02	54.02	> LOQ 35.32	89.68	> LOQ 35.45	88.99	> LOQ 35.18	109.01	> LOQ 34.97
SS-03	20.81	< LOQ 35.38	58.82	> LOQ 35.71	67.43	> LOQ 34.74	80.63	> LOQ 34.27
SS-04	941.23	> LOQ 35.56	6069.49	> LOQ 35.58	7531.38	> LOQ 35.56	5556.7	> LOQ 34.99
SS-05	24.11	< LOQ 34.15	62.92	> LOQ 35.65	122.64	> LOQ 35.34	149.62	> LOQ 34.84
SS-06	304.94	> LOQ 34.56	725.24	> LOQ 35.23	41.95	> LOQ 35.65	480.87	> LOQ 35.54
SS-07	133.31	> LOQ 34.86	498.65	> LOQ 35.32	1253.39	> LOQ 35.51	350.59	> LOQ 35.06
SSDS-01	14.82	< LOQ 34.99	58.53	> LOQ 35.54	88.68	> LOQ 35.06	68.29	> LOQ 35.18
SSDS-02	958.53	> LOQ 35.42	3750	> LOQ 35.42	10936.86	> LOQ 35.08	3038.28	> LOQ 34.43
SSDS-03	ND	< LOD 10.11	21.85	< LOQ 33.76	59.71	> LOQ 33.84	60.09	> LOQ 35.23
CP-1A	350.59	> LOQ 35.06	1304.89	> LOQ 35.21	3942.73	> LOQ 35.28	1340.59	> LOQ 35.61
CP-1B	542.2	> LOQ 40.08	1308.9	> LOQ 40.46	5886.51	> LOQ 40.03	1436.44	> LOQ 40.70
CP-2A	5157.83	> LOQ 35.07	14847.34	> LOQ 35.55	93322.27	> LOQ 70.51	37390.94	> LOQ 35.31
CP-2B	14666.39	> LOQ 35.12	9185.8	> LOQ 35.49	33153.75	> LOQ 35.23	6732.59	> LOQ 35.77
CP-3A	2684.84	> LOQ 35.11	6467.77	> LOQ 35.47	37228.54	> LOQ 35.16	35182.12	> LOQ 35.18
CP-3B	3577.33	> LOQ 46.78	21377.01	> LOQ 47.20	27412.28	> LOQ 46.60	12167.87	> LOQ 42.22
CP-4A	1936.55	> LOQ 35.02	8593.59	> LOQ 35.63	42848.40	> LOQ 69.37	8617.15	> LOQ 34.88
CP-4B	1778.22	> LOQ 33.97	5983.08	> LOQ 35.07	30934.21	> LOQ 70.12	1937.98	> LOQ 34.68
CPDS-1A	7093.64	> LOQ 34.45	11961.23	> LOQ 35.06	84658.27	> LOQ 35.10	32807.05	> LOQ 34.86
CPDS-1B	8491.71	> LOQ 34.37	14477.77	> LOQ 35.16	69643.59	> LOQ 34.82	11409.13	> LOQ 34.03
G-1A	706.42	> LOQ 35.32	2924.59	> LOQ 35.51	9757.11	> LOQ 35.29	7360.46	> LOQ 34.76
G-1B	434.96	> LOQ 35.21	4221.19	> LOQ 35.88	5189.95	> LOQ 35.29	5391.95	> LOQ 35.26
G-2A	162.28	> LOQ 35.83	1039.9	> LOQ 36.08	1534.00	> LOQ 35.24	645.3	> LOQ 35.39
G-2B	307.44	> LOQ 34.84	1889.14	> LOQ 35.29	1129.47	> LOQ 35.56	391.43	> LOQ 35.02
G-3A	434.42	> LOQ 35.17	1787.57	> LOQ 35.34	5036.73	> LOQ 35.68	541.78	> LOQ 35.42
G-4A	1462.23	> LOQ 34.52	1777.96	> LOQ 35.15	11506.06	> LOQ 34.93	3322.26	> LOQ 35.30
G-4B	434.06	> LOQ 35.14	3749.22	> LOQ 35.41	6614.30	> LOQ 35.14	3097.89	> LOQ 35.11
G-5A	452.86	> LOQ 34.99	1951.02	> LOQ 35.28	7075.96	> LOQ 35.38	10035.54	> LOQ 35.54
G-5B	1065.16	> LOQ 35.51	4775.75	> LOQ 35.30	15423.09	> LOQ 35.43	2062.93	> LOQ 35.42
G-6A	2910.6	> LOQ 35.34	14423.08	> LOQ 35.54	27049.52	> LOQ 35.37	5177.06	> LOQ 35.20
G-6B	615.26	> LOQ 34.86	6743.94	> LOQ 35.83	5314.80	> LOQ 34.75	6397.03	> LOQ 35.08
G-7A	150.61	> LOQ 35.07	373.29	> LOQ 35.26	750.94	> LOQ 35.46	481.68	> LOQ 35.60
G-7B	129.42	> LOQ 34.92	457.76	> LOQ 35.37	678.54	> LOQ 36.05	359.64	> LOQ 35.96
SG-1A	51.04	> LOQ 34.71	56.02	> LOQ 35.27	139.06	> LOQ 35.28	247.58	> LOQ 175.37
SG-1B	53.8	< LOQ 65.33	115.3	> LOQ 65.33	76.63	> LOQ 65.13	255.24	< LOQ 323.81
SG-2A	55.57	> LOQ 34.99	66.81	> LOQ 35.49	47.68	< LOQ 70.48	207.04	> LOQ 175.98
SG-2B	228.22	> LOQ 35.27	246.96	> LOQ 34.99	209.03	> LOQ 35.54	417.1	> LOQ 177.27

Bulk Elemental Analysis - Magnesium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Magnesium		Sample	Magnesium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	17.00	> LOQ 6.7	J95331-63 PB	35.00	> LOQ 6.7
CS-01	J95331-34 VB	7900.00	> LOQ 6.7	J95331-34 PB	6500.00	> LOQ 6.7
CS-02	J95331-37 VB	1500.00	> LOQ 6.7	J95331-37 PB	1500.00	> LOQ 6.7
CS-03	J95331-38 VB	8500.00	> LOQ 6.7	J95331-38 PB	9700.00	> LOQ 6.7
CS-04	J95331-39 VB	290.00	> LOQ 6.7	J95331-39 PB	380.00	> LOQ 6.7
CS-05	J95331-57 VB	110.00	> LOQ 6.7	J95331-57 PB	150.00	> LOQ 6.7
CS-06	J95331-70 VB	100.00	> LOQ 6.7	J95331-70 PB	210.00	> LOQ 6.7
CS-07	J95331-83 VB	420.00	> LOQ 6.7	J95331-83 PB	1000.00	> LOQ 6.7
CSDS-01	J95331-31 VB	210.00	> LOQ 6.7	J95331-31 PB	430.00	> LOQ 6.7
CSDS-02	J95331-35 VB	7000.00	> LOQ 6.7	J95331-35 PB	7400.00	> LOQ 6.7
N-01	J95331-52 VB	18000.00	> LOQ 6.7	J95331-52 PB	30000.00	> LOQ 6.7
N-02	J95331-81 VB	4600.00	> LOQ 6.7	J95331-81 PB	10000.00	> LOQ 6.7
O-1	J95331-69 VB	180000.00	> LOQ 6.7	J95331-69 PB	190000.00	> LOQ 6.7
S-01	J95331-28 VB	6.00	< LOQ 6.7	J95331-28 PB	5.20	< LOQ 6.7
S-02	J95331-29 VB	2.70	< LOQ 6.7	J95331-29 PB	5.70	< LOQ 6.7
SH-01	J95331-36 VB	20.00	> LOQ 6.7	J95331-36 PB	18.00	> LOQ 6.7
SS-01	J95331-32 VB	ND	< LOD 2.0	J95331-32 PB	3.90	< LOQ 6.7
SS-02	J95331-40 VB	2.30	< LOQ 6.7	J95331-40 PB	5.10	< LOQ 6.7
SS-03	J95331-45 VB	2.00	< LOQ 6.7	J95331-45 PB	8.50	> LOQ 6.7
SS-04	J95331-47 VB	1900.00	> LOQ 6.7	J95331-47 PB	460.00	> LOQ 6.7
SS-05	J95331-53 VB	4.60	< LOQ 6.7	J95331-53 PB	5.80	< LOQ 6.7
SS-06	J95331-76 VB	470.00	> LOQ 6.7	J95331-76 PB	430.00	> LOQ 6.7
SS-07	J95331-80 VB	240.00	> LOQ 6.7	J95331-80 PB	69.00	> LOQ 6.7
SSDS-01	J95331-33 VB	9.90	> LOQ 6.7	J95331-33 PB	6.70	> LOQ 6.7
SSDS-02	J95331-44 VB	2400.00	> LOQ 6.7	J95331-44 PB	2600.00	> LOQ 6.7
SSDS-03	J95331-48 VB	4.90	< LOQ 6.7	J95331-48 PB	16.00	> LOQ 6.7
CP-1A	J95331-60 VB	400.00	> LOQ 6.7	J95331-60 PB	1600.00	> LOQ 6.7
CP-1B	J95331-61 VB	320.00	> LOQ 6.7	J95331-61 PB	420.00	> LOQ 6.7
CP-2A	J95331-67 VB	16000.00	> LOQ 6.7	J95331-67 PB	22000.00	> LOQ 13.0
CP-2B	J95331-68 VB	19000.00	> LOQ 13.0	J95331-68 PB	20000.00	> LOQ 13.0
CP-3A	J95331-72 VB	7500.00	> LOQ 6.7	J95331-72 PB	9100.00	> LOQ 6.7
CP-3B	J95331-73 VB	11000.00	> LOQ 6.7	J95331-73 PB	9200.00	> LOQ 6.7
CP-4A	J95331-78 VB	2300.00	> LOQ 6.7	J95331-78 PB	4200.00	> LOQ 13.0
CP-4B	J95331-79 VB	4500.00	> LOQ 6.7	J95331-79 PB	4600.00	> LOQ 6.7
CPDS-1A	J95331-84 VB	13000.00	> LOQ 6.7	J95331-84 PB	19000.00	> LOQ 6.7
CPDS-1B	J95331-85 VB	17000.00	> LOQ 6.7	J95331-85 PB	19000.00	> LOQ 6.7
G-1A	J95331-41 VB	560.00	> LOQ 6.7	J95331-41 PB	840.00	> LOQ 6.7
G-1B	J95331-46 VB	730.00	> LOQ 6.7	J95331-46 PB	900.00	> LOQ 6.7
G-2A	J95331-43 VB	130.00	> LOQ 6.7	J95331-43 PB	280.00	> LOQ 6.7
G-2B	J95331-50 VB	290.00	> LOQ 6.7	J95331-50 PB	170.00	> LOQ 6.7
G-3A	J95331-49 VB	200.00	> LOQ 6.7	J95331-49 PB	2200.00	> LOQ 6.7
G-4A	J95331-55 VB	390.00	> LOQ 6.7	J95331-55 PB	740.00	> LOQ 6.7
G-4B	J95331-56 VB	850.00	> LOQ 6.7	J95331-56 PB	610.00	> LOQ 6.7
G-5A	J95331-58 VB	590.00	> LOQ 6.7	J95331-58 PB	590.00	> LOQ 6.7
G-5B	J95331-59 VB	550.00	> LOQ 6.7	J95331-59 PB	460.00	> LOQ 6.7
G-6A	J95331-64 VB	600.00	> LOQ 6.7	J95331-64 PB	830.00	> LOQ 6.7
G-6B	J95331-65 VB	1000.00	> LOQ 6.7	J95331-65 PB	730.00	> LOQ 6.7
G-7A	J95331-74 VB	64.00	> LOQ 6.7	J95331-74 PB	65.00	> LOQ 6.7
G-7B	J95331-75 VB	180.00	> LOQ 6.7	J95331-75 PB	140.00	> LOQ 6.7
SG-1A	J95331-54 VB	110.00	> LOQ 34.0	J95331-54 PB	130.00	> LOQ 34.0
SG-1B	J95331-71 VB	29.00	< LOQ 67.0	J95331-71 PB	38.00	< LOQ 67.0
SG-2A	J95331-66 VB	37.00	> LOQ 34.0	J95331-66 PB	21.00	< LOQ 34.0
SG-2B	J95331-82 VB	51.00	> LOQ 34.0	J95331-82 PB	54.00	> LOQ 34.0

Comparison of Airborne Concentrations to Bulk Concentrations - Magnesium

NIOSH REL 10000.0 micrograms/cubic meter (nuisance)
OSHA PEL 15000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	82.37	958.33	1506.09	476.09	17.00
CS-01	1194.64	3541.67	16917.68	3547.58	7900.00
CS-02	561.56	1776.76	7498.44	2708.90	1500.00
CS-03	1608.58	6833.71	24885.94	6833.71	8500.00
CS-04	576.01	2092.93	5591.22	2881.84	290.00
CS-05	247.73	918.01	2302.22	1216.71	110.00
CS-06	854.88	2094.24	2483.96	1727.73	100.00
CS-07	1400.33	3961.63	17686.23	3336.11	420.00
CSDS-01	311.46	1728.81	5191.03	2496.36	210.00
CSDS-02	1256.95	4962.78	19250.67	6697.36	7000.00
N-01	11176.59	56296.91	269039.74	125000.00	18000.00
N-02	5310.46	11016.42	49989.59	9338.04	4600.00
O-1	86490.94	183754.44	493116.91	85809.96	180000.00
S-01	19.52	25.06	250.52	54.25	6.00
S-02	13.76	85.85	70.83	22.97	2.70
SH-01	29.24	35.52	101.58	33.28	20.00
SS-01	ND	19.00	26.89	35.20	ND
SS-02	54.02	89.68	88.99	109.01	2.30
SS-03	20.81	58.82	67.43	80.63	2.00
SS-04	941.23	6069.49	7531.38	5556.70	1900.00
SS-05	24.11	62.92	122.64	149.62	4.60
SS-06	304.94	725.24	41.95	480.87	470.00
SS-07	133.31	498.65	1253.39	350.59	240.00
SSDS-01	14.82	58.53	88.68	68.29	9.90
SSDS-02	958.53	3750.00	10936.86	3038.28	2400.00
SSDS-03	ND	21.85	59.71	60.09	4.90
CP-1A	350.59	1304.89	3942.73	1340.59	400.00
CP-2A	5157.83	14847.34	93322.27	37390.94	16000.00
CP-3A	2684.84	6467.77	37228.54	35182.12	7500.00
CP-4A	1936.55	8593.59	42848.40	8617.15	2300.00
CPDS-1A	7093.64	11961.23	84658.27	32807.05	13000.00
G-1A	706.42	2924.59	9757.11	7360.46	560.00
G-2A	162.28	1039.90	1534.00	645.30	130.00
G-3A	434.42	1787.57	5036.73	541.78	200.00
G-4A	1462.23	1777.96	11506.06	3322.26	390.00
G-5A	452.86	1951.02	7075.96	10035.54	590.00
G-6A	2910.60	14423.08	27049.52	5177.06	600.00
G-7A	150.61	373.29	750.94	481.68	64.00
SG-1A	51.04	56.02	139.06	247.58	110.00
SG-2A	55.57	66.81	47.68	207.04	37.00

APPENDIX B - MANGANESE

Manganese

Prolonged or repeated exposure to manganese may effect the nervous system with difficulty in walking, weakness, memory lapse, and unstable emotions. Chronic exposure may effect the respiratory system resulting in pneumonitis and bronchitis. The NIOSH REL for manganese metal, fumes, and compounds is 1,000 micrograms/cubic meter of air. The OSHA PEL for manganese is 5,000 micrograms/cubic meter of air as a ceiling limit.

Air Sample Results - Manganese

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Manganese			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.940	> LOQ 0.035	19.518	> LOQ 0.727
24412	2	47.89	S-01	28	3.800	> LOQ 0.035	79.349	> LOQ 0.731
24441	3	47.90	S-01	28	25.000	> LOQ 0.035	521.921	> LOQ 0.731
24450	OBZ	47.93	S-01	28	7.700	> LOQ 0.035	160.651	> LOQ 0.730
24643	1	47.98	S-02	29	2.500	> LOQ 0.035	52.105	> LOQ 0.729
24625	2	47.76	S-02	29	11.000	> LOQ 0.035	230.318	> LOQ 0.733
24642	3	48.00	S-02	29	13.000	> LOQ 0.035	270.833	> LOQ 0.729
24632	OBZ	47.89	S-02	29	5.200	> LOQ 0.035	108.582	> LOQ 0.731
24634	1	48.16	CSDS-01	31	1.500	> LOQ 0.035	31.146	> LOQ 0.727
24650	2	48.01	CSDS-01	31	8.300	> LOQ 0.035	172.881	> LOQ 0.729
24644	3	48.16	CSDS-01	31	22.000	> LOQ 0.035	456.811	> LOQ 0.727
24645	OBZ	48.07	CSDS-01	31	9.700	> LOQ 0.035	201.789	> LOQ 0.728
24640	1	48.44	SS-01	32	0.530	> LOQ 0.035	10.941	> LOQ 0.723
24641	2	47.90	SS-01	32	2.300	> LOQ 0.035	48.017	> LOQ 0.731
24651	3	48.35	SS-01	32	2.900	> LOQ 0.035	59.979	> LOQ 0.724
24635	OBZ	48.30	SS-01	32	2.700	> LOQ 0.035	55.901	> LOQ 0.725
24646	1	48.58	SSDS-01	33	0.490	> LOQ 0.035	10.086	> LOQ 0.720
24626	2	47.84	SSDS-01	33	2.600	> LOQ 0.035	54.348	> LOQ 0.732
24638	3	48.49	SSDS-01	33	4.500	> LOQ 0.035	92.803	> LOQ 0.722
24647	OBZ	48.32	SSDS-01	33	3.900	> LOQ 0.035	80.712	> LOQ 0.724
24628	1	48.55	CS-01	34	1.400	> LOQ 0.035	28.836	> LOQ 0.721
24637	2	48.00	CS-01	34	5.900	> LOQ 0.035	122.917	> LOQ 0.729
24624	3	48.47	CS-01	34	15.000	> LOQ 0.035	309.47	> LOQ 0.722
24636	OBZ	47.92	CS-01	34	5.200	> LOQ 0.035	108.514	> LOQ 0.730
24623	1	48.53	CSDS-02	35	1.300	> LOQ 0.035	26.788	> LOQ 0.721
24622	2	48.36	CSDS-02	35	8.100	> LOQ 0.035	167.494	> LOQ 0.724
24654	3	48.31	CSDS-02	35	14.000	> LOQ 0.035	289.795	> LOQ 0.724
24653	OBZ	47.78	CSDS-02	35	7.100	> LOQ 0.035	148.598	> LOQ 0.733
24629	1	47.88	SH-01	36	0.760	> LOQ 0.035	15.873	> LOQ 0.731
24633	2	47.86	SH-01	36	3.500	> LOQ 0.035	73.13	> LOQ 0.731
24627	3	48.24	SH-01	36	12.000	> LOQ 0.035	248.756	> LOQ 0.726
24648	OBZ	48.08	SH-01	36	2.300	> LOQ 0.035	47.837	> LOQ 0.728
24555	1	48.08	CS-02	37	1.300	> LOQ 0.035	27.038	> LOQ 0.728
24552	2	47.84	CS-02	37	5.100	> LOQ 0.035	106.605	> LOQ 0.732
24541	3	48.01	CS-02	37	13.000	> LOQ 0.035	270.777	> LOQ 0.729
24529	OBZ	47.99	CS-02	37	6.300	> LOQ 0.035	131.277	> LOQ 0.729
24558	1	48.49	CS-03	38	3.000	> LOQ 0.035	61.868	> LOQ 0.722
24524	2	48.29	CS-03	38	13.000	> LOQ 0.035	269.207	> LOQ 0.725
24561	3	48.22	CS-03	38	40.000	> LOQ 0.035	829.531	> LOQ 0.726
24559	OBZ	48.29	CS-03	38	14.000	> LOQ 0.035	289.915	> LOQ 0.725
24543	1	48.61	CS-04	39	1.800	> LOQ 0.035	37.029	> LOQ 0.720
24532	2	47.78	CS-04	39	8.100	> LOQ 0.035	169.527	> LOQ 0.733
24546	3	48.29	CS-04	39	17.000	> LOQ 0.035	352.04	> LOQ 0.725
24557	OBZ	48.58	CS-04	39	8.800	> LOQ 0.035	181.145	> LOQ 0.720
24560	1	48.13	SS-02	40	0.550	> LOQ 0.035	11.427	> LOQ 0.727
24565	2	47.95	SS-02	40	2.500	> LOQ 0.035	52.138	> LOQ 0.730
24630	3	48.32	SS-02	40	2.300	> LOQ 0.035	47.599	> LOQ 0.724
24553	OBZ	48.62	SS-02	40	2.900	> LOQ 0.035	59.646	> LOQ 0.720
24525	1	48.13	G-1A	41	3.300	> LOQ 0.035	68.564	> LOQ 0.727
24563	2	47.87	G-1A	41	13.000	> LOQ 0.035	271.569	> LOQ 0.731
24547	3	48.17	G-1A	41	42.000	> LOQ 0.035	871.912	> LOQ 0.727
24526	OBZ	48.91	G-1A	41	33.000	> LOQ 0.035	674.709	> LOQ 0.716
24538	1	47.45	G-2A	43	5.500	> LOQ 0.035	115.911	> LOQ 0.738

Air Sample Results - Manganese

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Manganese			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	41.000	> LOQ 0.035	870.119	> LOQ 0.743
24533	3	48.24	G-2A	43	62.000	> LOQ 0.035	1285.24	> LOQ 0.726
24540	OBZ	48.04	G-2A	43	22.000	> LOQ 0.035	457.952	> LOQ 0.729
24528	1	47.99	SSDS-02	44	1.600	> LOQ 0.035	33.34	> LOQ 0.729
24544	2	48.00	SSDS-02	44	7.100	> LOQ 0.035	147.917	> LOQ 0.729
24567	3	48.46	SSDS-02	44	17.000	> LOQ 0.035	350.805	> LOQ 0.722
24539	OBZ	49.37	SSDS-02	44	7.600	> LOQ 0.035	153.94	> LOQ 0.709
24571	1	48.05	SS-03	45	0.390	> LOQ 0.035	8.117	> LOQ 0.728
24536	2	47.60	SS-03	45	2.200	> LOQ 0.035	46.218	> LOQ 0.735
24534	3	48.94	SS-03	45	2.600	> LOQ 0.035	53.126	> LOQ 0.715
24570	OBZ	49.61	SS-03	45	2.500	> LOQ 0.035	50.393	> LOQ 0.706
24568	1	48.28	G-1B	46	2.800	> LOQ 0.035	57.995	> LOQ 0.725
24592	2	47.38	G-1B	46	21.000	> LOQ 0.035	443.225	> LOQ 0.739
24593	3	48.17	G-1B	46	29.000	> LOQ 0.035	602.034	> LOQ 0.727
24535	OBZ	48.22	G-1B	46	46.000	> LOQ 0.035	953.961	> LOQ 0.726
24590	1	47.81	SS-04	47	1.800	> LOQ 0.035	37.649	> LOQ 0.732
24605	2	47.78	SS-04	47	13.000	> LOQ 0.035	272.08	> LOQ 0.733
24562	3	47.80	SS-04	47	17.000	> LOQ 0.035	355.649	> LOQ 0.732
24531	OBZ	48.59	SS-04	47	13.000	> LOQ 0.035	267.545	> LOQ 0.720
24527	1	49.48	SSDS-03	48	0.370	> LOQ 0.035	7.478	> LOQ 0.707
24569	2	50.35	SSDS-03	48	1.600	> LOQ 0.035	31.778	> LOQ 0.695
24584	3	50.24	SSDS-03	48	3.100	> LOQ 0.035	61.704	> LOQ 0.697
24579	OBZ	48.26	SSDS-03	48	2.000	> LOQ 0.035	41.442	> LOQ 0.725
24600	1	48.34	G-3A	49	25.000	> LOQ 0.035	517.17	> LOQ 0.724
24616	2	48.11	G-3A	49	63.000	> LOQ 0.035	1309.499	> LOQ 0.727
24585	3	47.65	G-3A	49	240.000	> LOQ 0.035	5036.726	> LOQ 0.735
24583	OBZ	47.99	G-3A	49	26.000	> LOQ 0.035	541.78	> LOQ 0.729
24587	1	48.79	G-2B	50	9.900	> LOQ 0.035	202.91	> LOQ 0.717
24602	2	48.17	G-2B	50	87.000	> LOQ 0.035	1806.103	> LOQ 0.727
24564	3	47.81	G-2B	50	51.000	> LOQ 0.035	1066.722	> LOQ 0.732
24621	OBZ	48.54	G-2B	50	18.000	> LOQ 0.035	370.828	> LOQ 0.721
24618	1	49.21	N-01	52	5.800	> LOQ 0.035	117.862	> LOQ 0.711
24611	2	47.96	N-01	52	30.000	> LOQ 0.035	625.521	> LOQ 0.730
24588	3	48.32	N-01	52	120.000	> LOQ 0.035	2483.444	> LOQ 0.724
24615	OBZ	48.80	N-01	52	59.000	> LOQ 0.035	1209.016	> LOQ 0.717
24597	1	49.78	SS-05	53	0.550	> LOQ 0.035	11.049	> LOQ 0.703
24599	2	47.68	SS-05	53	1.700	> LOQ 0.035	35.654	> LOQ 0.734
24575	3	48.11	SS-05	53	6.500	> LOQ 0.035	135.107	> LOQ 0.727
24617	OBZ	48.79	SS-05	53	2.900	> LOQ 0.035	59.438	> LOQ 0.717
24609	1	48.98	SG-1A	54	14.000	> LOQ 0.035	285.831	> LOQ 0.715
24596	2	48.20	SG-1A	54	29.000	> LOQ 0.035	601.66	> LOQ 0.726
24610	3	48.18	SG-1A	54	96.000	> LOQ 0.035	1992.528	> LOQ 0.726
24576	OBZ	48.47	SG-1A	54	190.000	> LOQ 0.180	3919.95	> LOQ 3.714
24606	1	49.24	G-4A	55	120.000	> LOQ 0.035	2437.043	> LOQ 0.711
24620	2	48.37	G-4A	55	110.000	> LOQ 0.035	2274.137	> LOQ 0.724
24573	3	48.67	G-4A	55	860.000	> LOQ 0.035	17670.023	> LOQ 0.719
24505	OBZ	48.16	G-4A	55	230.000	> LOQ 0.035	4775.748	> LOQ 0.727
24340	1	48.38	G-4B	56	28.000	> LOQ 0.035	578.752	> LOQ 0.723
24607	2	48.01	G-4B	56	280.000	> LOQ 0.035	5832.118	> LOQ 0.729
24595	3	48.38	G-4B	56	480.000	> LOQ 0.035	9921.455	> LOQ 0.723
24598	OBZ	48.42	G-4B	56	230.000	> LOQ 0.035	4750.103	> LOQ 0.723
24580	1	48.44	CS-05	57	1.300	> LOQ 0.035	26.837	> LOQ 0.723
24604	2	47.93	CS-05	57	5.400	> LOQ 0.035	112.664	> LOQ 0.730

Air Sample Results - Manganese

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Manganese			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	11.000	> LOQ 0.035	230.222	> LOQ 0.733
24574	OBZ	30.41	CS-05	57	4.100	> LOQ 0.035	134.824	> LOQ 1.151
24614	1	48.58	G-5A	58	4.500	> LOQ 0.035	92.631	> LOQ 0.720
24577	2	48.18	G-5A	58	19.000	> LOQ 0.035	394.355	> LOQ 0.726
24572	3	48.05	G-5A	58	67.000	> LOQ 0.035	1394.381	> LOQ 0.728
24582	OBZ	47.83	G-5A	58	98.000	> LOQ 0.035	2048.923	> LOQ 0.732
24322	1	47.88	G-5B	59	11.000	> LOQ 0.035	229.741	> LOQ 0.731
24354	2	48.16	G-5B	59	51.000	> LOQ 0.035	1058.97	> LOQ 0.727
24510	3	47.98	G-5B	59	160.000	> LOQ 0.035	3334.723	> LOQ 0.729
24321	OBZ	47.99	G-5B	59	24.000	> LOQ 0.035	500.104	> LOQ 0.729
24497	1	48.49	CP-1A	60	1.700	> LOQ 0.035	35.059	> LOQ 0.722
24333	2	48.28	CP-1A	60	6.100	> LOQ 0.035	126.346	> LOQ 0.725
24326	3	48.19	CP-1A	60	14.000	> LOQ 0.035	290.517	> LOQ 0.726
24329	OBZ	47.74	CP-1A	60	6.300	> LOQ 0.035	131.965	> LOQ 0.733
24499	1	42.42	CP-1B	62	1.500	> LOQ 0.035	35.361	> LOQ 0.825
24506	2	42.02	CP-1B	62	7.800	> LOQ 0.035	185.626	> LOQ 0.833
24388	3	42.47	CP-1B	62	19.000	> LOQ 0.035	447.375	> LOQ 0.824
24315	OBZ	41.77	CP-1B	62	7.800	> LOQ 0.035	186.737	> LOQ 0.838
24318	1	48.56	CG-01	63	0.650	> LOQ 0.035	13.386	> LOQ 0.721
24308	2	48.00	CG-01	63	4.500	> LOQ 0.035	93.75	> LOQ 0.729
24330	3	48.47	CG-01	63	4.900	> LOQ 0.035	101.093	> LOQ 0.722
24230	OBZ	48.31	CG-01	63	4.000	> LOQ 0.035	82.799	> LOQ 0.724
24363	1	48.10	G-6A	64	27.000	> LOQ 0.035	561.331	> LOQ 0.728
24398	2	47.84	G-6A	64	130.000	> LOQ 0.035	2717.391	> LOQ 0.732
24351	3	48.06	G-6A	64	290.000	> LOQ 0.035	6034.124	> LOQ 0.728
24594	OBZ	48.29	G-6A	64	53.000	> LOQ 0.035	1097.536	> LOQ 0.725
24312	1	48.76	G-6B	65	7.100	> LOQ 0.035	145.611	> LOQ 0.718
24484	2	47.45	G-6B	65	71.000	> LOQ 0.035	1496.312	> LOQ 0.738
24327	3	48.92	G-6B	65	73.000	> LOQ 0.035	1492.232	> LOQ 0.715
24389	OBZ	48.46	G-6B	65	64.000	> LOQ 0.035	1320.677	> LOQ 0.722
24348	1	48.59	SG-2A	66	230.000	> LOQ 0.035	4733.484	> LOQ 0.720
24314	2	47.90	SG-2A	66	230.000	> LOQ 0.035	4801.67	> LOQ 0.731
24494	3	48.24	SG-2A	66	370.000	> LOQ 0.035	7669.983	> LOQ 0.726
24337	OBZ	48.30	SG-2A	66	1300.000	> LOQ 0.070	26915.114	> LOQ 1.449
24508	1	48.47	CP-2A	67	34.000	> LOQ 0.035	701.465	> LOQ 0.722
24361	2	47.82	CP-2A	67	100.000	> LOQ 0.035	2091.175	> LOQ 0.732
24359	3	48.22	CP-2A	67	610.000	> LOQ 0.070	12650.353	> LOQ 1.452
24471	OBZ	48.14	CP-2A	67	230.000	> LOQ 0.035	4777.732	> LOQ 0.727
24373	1	48.41	CP-2B	68	96.000	> LOQ 0.035	1983.061	> LOQ 0.723
24468	2	47.90	CP-2B	68	58.000	> LOQ 0.035	1210.856	> LOQ 0.731
24481	3	48.26	CP-2B	68	210.000	> LOQ 0.035	4351.43	> LOQ 0.725
24391	OBZ	47.53	CP-2B	68	47.000	> LOQ 0.035	988.849	> LOQ 0.736
24356	1	48.56	O-1	69	12.000	> LOQ 0.035	247.117	> LOQ 0.721
24470	2	47.89	O-1	69	28.000	> LOQ 0.035	584.673	> LOQ 0.731
24467	3	48.67	O-1	69	67.000	> LOQ 0.035	1376.618	> LOQ 0.719
24313	OBZ	47.78	O-1	69	15.000	> LOQ 0.035	313.939	> LOQ 0.733
24501	1	47.96	CS-06	70	3.100	> LOQ 0.035	64.637	> LOQ 0.730
24496	2	47.75	CS-06	70	8.900	> LOQ 0.035	186.387	> LOQ 0.733
24478	3	48.31	CS-06	70	26.000	> LOQ 0.035	538.191	> LOQ 0.724
24503	OBZ	48.04	CS-06	70	6.900	> LOQ 0.035	143.63	> LOQ 0.729
24474	1	26.02	SG-1B	71	0.380	> LOQ 0.035	14.604	> LOQ 1.345
24469	2	26.02	SG-1B	71	1.700	> LOQ 0.035	65.334	> LOQ 1.345
24492	3	26.10	SG-1B	71	13.000	> LOQ 0.035	498.084	> LOQ 1.341

Air Sample Results - Manganese

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Manganese			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	79.000	> LOQ 0.180	3009.524	> LOQ 6.857
24489	1	48.42	CP-3A	72	9.800	> LOQ 0.035	202.396	> LOQ 0.723
24491	2	47.93	CP-3A	72	38.000	> LOQ 0.035	792.823	> LOQ 0.730
24482	3	48.35	CP-3A	72	140.000	> LOQ 0.035	2895.553	> LOQ 0.724
24486	OBZ	48.32	CP-3A	72	130.000	> LOQ 0.035	2690.397	> LOQ 0.724
24516	1	36.34	CP-3B	73	12.000	> LOQ 0.035	330.215	> LOQ 0.963
24502	2	36.02	CP-3B	73	61.000	> LOQ 0.035	1693.504	> LOQ 0.972
24515	3	36.48	CP-3B	73	89.000	> LOQ 0.035	2439.693	> LOQ 0.959
24500	OBZ	40.27	CP-3B	73	50.000	> LOQ 0.035	1241.619	> LOQ 0.869
24504	1	48.47	G-7A	74	11.000	> LOQ 0.035	226.945	> LOQ 0.722
24513	2	48.22	G-7A	74	26.000	> LOQ 0.035	539.195	> LOQ 0.726
24458	3	47.94	G-7A	74	68.000	> LOQ 0.035	1418.44	> LOQ 0.730
24389	OBZ	47.75	G-7A	74	20.000	> LOQ 0.035	418.848	> LOQ 0.733
24404	1	48.68	G-7B	75	8.200	> LOQ 0.035	168.447	> LOQ 0.719
24451	2	48.06	G-7B	75	19.000	> LOQ 0.035	395.339	> LOQ 0.728
24447	3	47.16	G-7B	75	71.000	> LOQ 0.035	1505.513	> LOQ 0.742
24423	OBZ	47.27	G-7B	75	11.000	> LOQ 0.035	232.706	> LOQ 0.740
24456	1	49.19	SS-06	76	1.000	> LOQ 0.035	20.329	> LOQ 0.712
24480	2	48.26	SS-06	76	3.800	> LOQ 0.035	78.74	> LOQ 0.725
24429	3	47.68	SS-06	76	0.220	> LOQ 0.035	4.614	> LOQ 0.734
24418	OBZ	47.83	SS-06	76	3.000	> LOQ 0.035	62.722	> LOQ 0.732
24427	1	48.54	CP-4A	78	6.900	> LOQ 0.035	142.151	> LOQ 0.721
24435	2	47.71	CP-4A	78	30.000	> LOQ 0.035	628.799	> LOQ 0.734
24244	3	49.01	CP-4A	78	160.000	> LOQ 0.070	3264.64	> LOQ 1.428
24220	OBZ	48.74	CP-4A	78	36.000	> LOQ 0.035	738.613	> LOQ 0.718
24460	1	50.05	CP-4B	79	7.000	> LOQ 0.035	139.86	> LOQ 0.699
24465	2	48.47	CP-4B	79	25.000	> LOQ 0.035	515.783	> LOQ 0.722
24207	3	48.49	CP-4B	79	120.000	> LOQ 0.070	2474.737	> LOQ 1.444
24390	OBZ	49.02	CP-4B	79	8.300	> LOQ 0.035	169.319	> LOQ 0.714
24259	1	48.76	SS-07	80	0.730	> LOQ 0.035	14.971	> LOQ 0.718
24421	2	48.13	SS-07	80	2.900	> LOQ 0.035	60.253	> LOQ 0.727
24445	3	47.87	SS-07	80	8.700	> LOQ 0.035	181.742	> LOQ 0.731
24432	OBZ	48.49	SS-07	80	2.100	> LOQ 0.035	43.308	> LOQ 0.722
24459	1	48.96	N-02	81	6.000	> LOQ 0.035	122.549	> LOQ 0.715
24417	2	48.11	N-02	81	13.000	> LOQ 0.035	270.214	> LOQ 0.727
24442	3	48.01	N-02	81	52.000	> LOQ 0.035	1083.108	> LOQ 0.729
24386	OBZ	48.19	N-02	81	12.000	> LOQ 0.035	249.014	> LOQ 0.726
24452	1	48.20	SG-2B	82	79.000	> LOQ 0.035	1639.004	> LOQ 0.726
24453	2	48.59	SG-2B	82	150.000	> LOQ 0.035	3087.055	> LOQ 0.720
24420	3	47.84	SG-2B	82	350.000	> LOQ 0.035	7316.054	> LOQ 0.732
24444	OBZ	47.95	SG-2B	82	2000.000	> LOQ 0.18	41710.115	> LOQ 3.754
24455	1	48.56	CS-07	83	3.800	> LOQ 0.035	78.254	> LOQ 0.721
24433	2	47.96	CS-07	83	12.000	> LOQ 0.035	250.209	> LOQ 0.730
24398	3	48.06	CS-07	83	42.000	> LOQ 0.035	873.908	> LOQ 0.728
24511	OBZ	47.96	CS-07	83	11.000	> LOQ 0.035	229.358	> LOQ 0.730
24454	1	49.34	CPDS-1A	84	46.000	> LOQ 0.035	932.306	> LOQ 0.709
24291	2	48.49	CPDS-1A	84	79.000	> LOQ 0.035	1629.202	> LOQ 0.722
24209	3	48.43	CPDS-1A	84	550.000	> LOQ 0.035	11356.597	> LOQ 0.723
24402	OBZ	48.77	CPDS-1A	84	210.000	> LOQ 0.035	4305.926	> LOQ 0.718
24204	1	49.46	CPDS-1B	85	59.000	> LOQ 0.035	1192.883	> LOQ 0.708
24273	2	48.35	CPDS-1B	85	100.000	> LOQ 0.035	2068.252	> LOQ 0.724
24223	3	48.82	CPDS-1B	85	450.000	> LOQ 0.035	9217.534	> LOQ 0.717
24466	OBZ	49.96	CPDS-1B	85	88.000	> LOQ 0.035	1761.409	> LOQ 0.701

Airborne Sample Data Analysis - Manganese

NIOSH REL 1000.0 micrograms/cubic meter

OSHA PEL 5000.0 micrograms/cubic meter Ceiling Limit

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	13.386	> LOQ 0.721	93.75	> LOQ 0.729	101.09	> LOQ 0.722	82.799	> LOQ 0.724
CS-01	28.836	> LOQ 0.721	122.917	> LOQ 0.729	309.47	> LOQ 0.722	108.514	> LOQ 0.730
CS-02	27.038	> LOQ 0.728	106.605	> LOQ 0.732	270.78	> LOQ 0.729	131.277	> LOQ 0.729
CS-03	61.868	> LOQ 0.722	269.207	> LOQ 0.725	829.53	> LOQ 0.726	289.915	> LOQ 0.725
CS-04	37.029	> LOQ 0.720	169.527	> LOQ 0.733	352.04	> LOQ 0.725	181.145	> LOQ 0.720
CS-05	26.837	> LOQ 0.723	112.664	> LOQ 0.730	230.22	> LOQ 0.733	134.824	> LOQ 1.151
CS-06	64.637	> LOQ 0.730	186.387	> LOQ 0.733	538.19	> LOQ 0.724	143.63	> LOQ 0.729
CS-07	78.254	> LOQ 0.721	250.209	> LOQ 0.730	873.91	> LOQ 0.728	229.358	> LOQ 0.730
CSDS-01	31.146	> LOQ 0.727	172.881	> LOQ 0.729	456.81	> LOQ 0.727	201.789	> LOQ 0.728
CSDS-02	26.788	> LOQ 0.721	167.494	> LOQ 0.724	289.80	> LOQ 0.724	148.598	> LOQ 0.733
N-01	117.862	> LOQ 0.711	625.521	> LOQ 0.730	2483.44	> LOQ 0.724	1209.016	> LOQ 0.717
N-02	122.549	> LOQ 0.715	270.214	> LOQ 0.727	1083.11	> LOQ 0.729	249.014	> LOQ 0.726
O-1	247.117	> LOQ 0.721	584.673	> LOQ 0.731	1376.62	> LOQ 0.719	313.939	> LOQ 0.733
S-01	19.518	> LOQ 0.727	79.349	> LOQ 0.731	521.92	> LOQ 0.731	160.651	> LOQ 0.730
S-02	52.105	> LOQ 0.729	230.318	> LOQ 0.733	270.83	> LOQ 0.729	108.582	> LOQ 0.731
SH-01	15.873	> LOQ 0.731	73.13	> LOQ 0.731	248.76	> LOQ 0.726	47.837	> LOQ 0.728
SS-01	10.941	> LOQ 0.723	48.017	> LOQ 0.731	59.98	> LOQ 0.724	55.901	> LOQ 0.725
SS-02	11.427	> LOQ 0.727	52.138	> LOQ 0.730	47.60	> LOQ 0.724	59.646	> LOQ 0.720
SS-03	8.117	> LOQ 0.728	46.218	> LOQ 0.735	53.13	> LOQ 0.715	50.393	> LOQ 0.706
SS-04	37.649	> LOQ 0.732	272.08	> LOQ 0.733	355.65	> LOQ 0.732	267.545	> LOQ 0.720
SS-05	11.049	> LOQ 0.703	35.654	> LOQ 0.734	135.11	> LOQ 0.727	59.438	> LOQ 0.717
SS-06	20.329	> LOQ 0.712	78.74	> LOQ 0.725	4.61	> LOQ 0.734	62.722	> LOQ 0.732
SS-07	14.971	> LOQ 0.718	60.253	> LOQ 0.727	181.74	> LOQ 0.731	43.308	> LOQ 0.722
SSDS-01	10.086	> LOQ 0.720	54.348	> LOQ 0.732	92.80	> LOQ 0.722	80.712	> LOQ 0.724
SSDS-02	33.34	> LOQ 0.729	147.917	> LOQ 0.729	350.81	> LOQ 0.722	153.94	> LOQ 0.709
SSDS-03	7.478	> LOQ 0.707	31.778	> LOQ 0.695	61.70	> LOQ 0.697	41.442	> LOQ 0.725
CP-1A	35.059	> LOQ 0.722	126.346	> LOQ 0.725	290.52	> LOQ 0.726	131.965	> LOQ 0.733
CP-1B	35.361	> LOQ 0.825	185.626	> LOQ 0.833	447.38	> LOQ 0.824	186.737	> LOQ 0.838
CP-2A	701.465	> LOQ 0.722	2091.175	> LOQ 0.732	12650.35	> LOQ 1.452	4777.732	> LOQ 0.727
CP-2B	1983.061	> LOQ 0.723	1210.856	> LOQ 0.731	4351.43	> LOQ 0.725	988.849	> LOQ 0.736
CP-3A	202.396	> LOQ 0.723	792.823	> LOQ 0.730	2895.55	> LOQ 0.724	2690.397	> LOQ 0.724
CP-3B	330.215	> LOQ 0.963	1693.504	> LOQ 0.972	2439.69	> LOQ 0.959	1241.619	> LOQ 0.869
CP-4A	142.151	> LOQ 0.721	628.799	> LOQ 0.734	3264.64	> LOQ 1.428	738.613	> LOQ 0.718
CP-4B	139.86	> LOQ 0.699	515.783	> LOQ 0.722	2474.74	> LOQ 1.444	169.319	> LOQ 0.714
CPDS-1A	932.306	> LOQ 0.709	1629.202	> LOQ 0.722	11356.60	> LOQ 0.723	4305.926	> LOQ 0.718
CPDS-1B	1192.883	> LOQ 0.708	2068.252	> LOQ 0.724	9217.53	> LOQ 0.717	1761.409	> LOQ 0.701
G-1A	68.564	> LOQ 0.727	271.569	> LOQ 0.731	871.91	> LOQ 0.727	674.709	> LOQ 0.716
G-1B	57.995	> LOQ 0.725	443.225	> LOQ 0.739	602.03	> LOQ 0.727	953.961	> LOQ 0.726
G-2A	115.911	> LOQ 0.738	870.119	> LOQ 0.743	1285.24	> LOQ 0.726	457.952	> LOQ 0.729
G-2B	202.91	> LOQ 0.717	1806.103	> LOQ 0.727	1066.72	> LOQ 0.732	370.828	> LOQ 0.721
G-3A	517.17	> LOQ 0.724	1309.499	> LOQ 0.727	5036.73	> LOQ 0.735	541.78	> LOQ 0.729
G-4A	2437.043	> LOQ 0.711	2274.137	> LOQ 0.724	17670.02	> LOQ 0.719	4775.748	> LOQ 0.727
G-4B	578.752	> LOQ 0.723	5832.118	> LOQ 0.729	9921.46	> LOQ 0.723	4750.103	> LOQ 0.723
G-5A	92.631	> LOQ 0.720	394.355	> LOQ 0.726	1394.38	> LOQ 0.728	2048.923	> LOQ 0.732
G-5B	229.741	> LOQ 0.731	1058.97	> LOQ 0.727	3334.72	> LOQ 0.729	500.104	> LOQ 0.729
G-6A	561.331	> LOQ 0.728	2717.391	> LOQ 0.732	6034.12	> LOQ 0.728	1097.536	> LOQ 0.725
G-6B	145.611	> LOQ 0.718	1496.312	> LOQ 0.738	1492.23	> LOQ 0.715	1320.677	> LOQ 0.722
G-7A	226.945	> LOQ 0.722	539.195	> LOQ 0.726	1418.44	> LOQ 0.730	418.848	> LOQ 0.733
G-7B	168.447	> LOQ 0.719	395.339	> LOQ 0.728	1505.51	> LOQ 0.742	232.706	> LOQ 0.740
SG-1A	285.831	> LOQ 0.715	601.66	> LOQ 0.726	1992.53	> LOQ 0.726	3919.95	> LOQ 3.714
SG-1B	14.604	> LOQ 1.345	65.334	> LOQ 1.345	498.08	> LOQ 1.341	3009.524	> LOQ 6.857
SG-2A	4733.484	> LOQ 0.720	4801.67	> LOQ 0.731	7669.98	> LOQ 0.726	26915.114	> LOQ 1.449
SG-2B	1639.004	> LOQ 0.726	3087.055	> LOQ 0.720	7316.05	> LOQ 0.732	41710.115	> LOQ 3.754

Bulk Elemental Analysis - Manganese

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Manganese		Sample	Manganese	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	0.66	> LOQ 0.14	J95331-63 PB	7.90	> LOQ 0.14
CS-01	J95331-34 VB	94.00	> LOQ 0.14	J95331-34 PB	100.00	> LOQ 0.14
CS-02	J95331-37 VB	36.00	> LOQ 0.14	J95331-37 PB	42.00	> LOQ 0.14
CS-03	J95331-38 VB	240.00	> LOQ 0.14	J95331-38 PB	290.00	> LOQ 0.14
CS-04	J95331-39 VB	14.00	> LOQ 0.14	J95331-39 PB	29.00	> LOQ 0.14
CS-05	J95331-57 VB	6.00	> LOQ 0.14	J95331-57 PB	20.00	> LOQ 0.14
CS-06	J95331-70 VB	6.30	> LOQ 0.14	J95331-70 PB	18.00	> LOQ 0.14
CS-07	J95331-83 VB	31.00	> LOQ 0.14	J95331-83 PB	57.00	> LOQ 0.14
CSDS-01	J95331-31 VB	12.00	> LOQ 0.14	J95331-31 PB	33.00	> LOQ 0.14
CSDS-02	J95331-35 VB	68.00	> LOQ 0.14	J95331-35 PB	83.00	> LOQ 0.14
N-01	J95331-52 VB	150.00	> LOQ 0.14	J95331-52 PB	220.00	> LOQ 0.14
N-02	J95331-81 VB	97.00	> LOQ 0.14	J95331-81 PB	220.00	> LOQ 0.14
O-1	J95331-69 VB	510.00	> LOQ 0.14	J95331-69 PB	540.00	> LOQ 0.14
S-01	J95331-28 VB	13.00	> LOQ 0.14	J95331-28 PB	13.00	> LOQ 0.14
S-02	J95331-29 VB	8.90	> LOQ 0.14	J95331-29 PB	27.00	> LOQ 0.14
SH-01	J95331-36 VB	42.00	> LOQ 0.14	J95331-36 PB	59.00	> LOQ 0.14
SS-01	J95331-32 VB	0.13	< LOQ 0.14	J95331-32 PB	5.00	> LOQ 0.14
SS-02	J95331-40 VB	0.61	> LOQ 0.14	J95331-40 PB	4.40	> LOQ 0.14
SS-03	J95331-45 VB	0.31	> LOQ 0.14	J95331-45 PB	2.40	> LOQ 0.14
SS-04	J95331-47 VB	88.00	> LOQ 0.14	J95331-47 PB	440.00	> LOQ 0.14
SS-05	J95331-53 VB	2.10	> LOQ 0.14	J95331-53 PB	5.00	> LOQ 0.14
SS-06	J95331-76 VB	16.00	> LOQ 0.14	J95331-76 PB	20.00	> LOQ 0.14
SS-07	J95331-80 VB	14.00	> LOQ 0.14	J95331-80 PB	5.80	> LOQ 0.14
SSDS-01	J95331-33 VB	2.00	> LOQ 0.14	J95331-33 PB	6.00	> LOQ 0.14
SSDS-02	J95331-44 VB	80.00	> LOQ 0.14	J95331-44 PB	57.00	> LOQ 0.14
SSDS-03	J95331-48 VB	0.38	> LOQ 0.14	J95331-48 PB	3.60	> LOQ 0.14
CP-1A	J95331-60 VB	17.00	> LOQ 0.14	J95331-60 PB	83.00	> LOQ 0.14
CP-1B	J95331-61 VB	24.00	> LOQ 0.14	J95331-61 PB	35.00	> LOQ 0.14
CP-2A	J95331-67 VB	2200.00	> LOQ 0.14	J95331-67 PB	3000.00	> LOQ 0.28
CP-2B	J95331-68 VB	2600.00	> LOQ 0.28	J95331-68 PB	2800.00	> LOQ 0.28
CP-3A	J95331-72 VB	590.00	> LOQ 0.14	J95331-72 PB	500.00	> LOQ 0.14
CP-3B	J95331-73 VB	530.00	> LOQ 0.14	J95331-73 PB	650.00	> LOQ 0.14
CP-4A	J95331-78 VB	190.00	> LOQ 0.14	J95331-78 PB	310.00	> LOQ 0.28
CP-4B	J95331-79 VB	340.00	> LOQ 0.14	J95331-79 PB	340.00	> LOQ 0.14
CPDS-1A	J95331-84 VB	1600.00	> LOQ 0.14	J95331-84 PB	2500.00	> LOQ 0.14
CPDS-1B	J95331-85 VB	2300.00	> LOQ 0.14	J95331-85 PB	2500.00	> LOQ 0.14
G-1A	J95331-41 VB	31.00	> LOQ 0.14	J95331-41 PB	60.00	> LOQ 0.14
G-1B	J95331-46 VB	420.00	> LOQ 0.14	J95331-46 PB	300.00	> LOQ 0.14
G-2A	J95331-43 VB	55.00	> LOQ 0.14	J95331-43 PB	210.00	> LOQ 0.14
G-2B	J95331-50 VB	250.00	> LOQ 0.14	J95331-50 PB	160.00	> LOQ 0.14
G-3A	J95331-49 VB	130.00	> LOQ 0.14	J95331-49 PB	61.00	> LOQ 0.14
G-4A	J95331-55 VB	100.00	> LOQ 0.14	J95331-55 PB	630.00	> LOQ 0.14
G-4B	J95331-56 VB	670.00	> LOQ 0.14	J95331-56 PB	640.00	> LOQ 0.14
G-5A	J95331-58 VB	89.00	> LOQ 0.14	J95331-58 PB	100.00	> LOQ 0.14
G-5B	J95331-59 VB	110.00	> LOQ 0.14	J95331-59 PB	100.00	> LOQ 0.14
G-6A	J95331-64 VB	61.00	> LOQ 0.14	J95331-64 PB	200.00	> LOQ 0.14
G-6B	J95331-65 VB	220.00	> LOQ 0.14	J95331-65 PB	170.00	> LOQ 0.14
G-7A	J95331-74 VB	100.00	> LOQ 0.14	J95331-74 PB	100.00	> LOQ 0.14
G-7B	J95331-75 VB	310.00	> LOQ 0.14	J95331-75 PB	200.00	> LOQ 0.14
SG-1A	J95331-54 VB	1200.00	> LOQ 0.7	J95331-54 PB	1300.00	> LOQ 0.7
SG-1B	J95331-71 VB	640.00	> LOQ 0.7	J95331-71 PB	680.00	> LOQ 0.7
SG-2A	J95331-66 VB	8900.00	> LOQ 0.7	J95331-66 PB	6400.00	> LOQ 0.7
SG-2B	J95331-82 VB	9200.00	> LOQ 0.7	J95331-82 PB	9600.00	> LOQ 0.7

Comparison of Airborne Concentrations to Bulk Concentrations - Manganese

NIOSH REL 1000.0 micrograms/cubic meter
OSHA PEL 5000.0 micrograms/cubic meter Ceiling Limit

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	13.39	93.75	101.09	82.80	0.66
CS-01	28.84	122.92	309.47	108.51	94.00
CS-02	27.04	106.61	270.78	131.28	36.00
CS-03	61.87	269.21	829.53	289.92	240.00
CS-04	37.03	169.53	352.04	181.15	14.00
CS-05	26.84	112.66	230.22	134.82	6.00
CS-06	64.64	186.39	538.19	143.63	6.30
CS-07	78.25	250.21	873.91	229.36	31.00
CSDS-01	31.15	172.88	456.81	201.79	12.00
CSDS-02	26.79	167.49	289.80	148.60	68.00
N-01	117.86	625.52	2483.44	1209.02	150.00
N-02	122.55	270.21	1083.11	249.01	97.00
O-1	247.12	584.67	1376.62	313.94	510.00
S-01	19.52	79.35	521.92	160.65	13.00
S-02	52.11	230.32	270.83	108.58	8.90
SH-01	15.87	73.13	248.76	47.84	42.00
SS-01	10.94	48.02	59.98	55.90	0.13
SS-02	11.43	52.14	47.60	59.65	0.61
SS-03	8.12	46.22	53.13	50.39	0.31
SS-04	37.65	272.08	355.65	267.55	88.00
SS-05	11.05	35.65	135.11	59.44	2.10
SS-06	20.33	78.74	4.61	62.72	16.00
SS-07	14.97	60.25	181.74	43.31	14.00
SSDS-01	10.09	54.35	92.80	80.71	2.00
SSDS-02	33.34	147.92	350.81	153.94	80.00
SSDS-03	7.48	31.78	61.70	41.44	0.38
CP-1A	35.06	126.35	290.52	131.97	17.00
CP-2A	701.47	2091.18	12650.35	4777.73	2200.00
CP-3A	202.40	792.82	2895.55	2690.40	590.00
CP-4A	142.15	628.80	3264.64	738.61	190.00
CPDS-1A	932.31	1629.20	11356.60	4305.93	1600.00
G-1A	68.56	271.57	871.91	674.71	31.00
G-2A	115.91	870.12	1285.24	457.95	55.00
G-3A	517.17	1309.50	5036.73	541.78	130.00
G-4A	2437.04	2274.14	17670.02	4775.75	100.00
G-5A	92.63	394.36	1394.38	2048.92	89.00
G-6A	561.33	2717.39	6034.12	1097.54	61.00
G-7A	226.95	539.20	1418.44	418.85	100.00
SG-1A	285.83	601.66	1992.53	3919.95	1200.00
SG-2A	4733.48	4801.67	7669.98	26915.11	8900.00

APPENDIX B - MOLYBDENUM

Molybdenum

Molybdenum exposures include symptoms of anemia, gastrointestinal disturbances, bone disorders, and growth retardation. A few cases of pneumoconiosis have been reported with workers exposed to metallic molybdenum. For the purpose of this study, the NIOSH REL is 10,000 micrograms/cubic meter of air based on the discussion in APPENDIX D to NIOSH POCKET GUIDE TO CHEMICAL HAZARDS[2] concerning molybdenum (insoluble compounds as Mo), as there is no NIOSH REL listed for molybdenum. The OSHA PEL for molybdenum is 15,000 micrograms/cubic meter of air.

[2] Ibid.

Air Sample Results - Molybdenum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Molybdenum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.32	< LOQ 0.85	6.64	< LOQ 17.65
24412	2	47.89	S-01	28	ND	< LOD 0.30	ND	< LOD 6.26
24441	3	47.90	S-01	28	ND	< LOD 0.30	ND	< LOD 6.26
24450	OBZ	47.93	S-01	28	ND	< LOD 0.30	ND	< LOD 6.26
24643	1	47.98	S-02	29	ND	< LOD 0.30	ND	< LOD 6.25
24625	2	47.76	S-02	29	ND	< LOD 0.30	ND	< LOD 6.28
24642	3	48.00	S-02	29	0.33	< LOQ 0.85	6.88	< LOQ 17.71
24632	OBZ	47.89	S-02	29	ND	< LOD 0.30	ND	< LOD 6.26
24634	1	48.16	CSDS-01	31	ND	< LOD 0.30	ND	< LOD 6.23
24650	2	48.01	CSDS-01	31	ND	< LOD 0.30	ND	< LOD 6.25
24644	3	48.16	CSDS-01	31	0.57	< LOQ 0.85	11.84	< LOQ 17.65
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 0.30	ND	< LOD 6.24
24640	1	48.44	SS-01	32	ND	< LOD 0.30	ND	< LOD 6.19
24641	2	47.90	SS-01	32	ND	< LOD 0.30	ND	< LOD 6.26
24651	3	48.35	SS-01	32	ND	< LOD 0.30	ND	< LOD 6.20
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.30	ND	< LOD 6.21
24646	1	48.58	SSDS-01	33	ND	< LOD 0.30	ND	< LOD 6.18
24626	2	47.84	SSDS-01	33	ND	< LOD 0.30	ND	< LOD 6.27
24638	3	48.49	SSDS-01	33	ND	< LOD 0.30	ND	< LOD 6.19
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.30	ND	< LOD 6.21
24628	1	48.55	CS-01	34	ND	< LOD 0.30	ND	< LOD 6.18
24637	2	48.00	CS-01	34	ND	< LOD 0.30	ND	< LOD 6.25
24624	3	48.47	CS-01	34	0.60	< LOQ 0.85	12.38	< LOQ 17.54
24636	OBZ	47.92	CS-01	34	ND	< LOD 0.30	ND	< LOD 6.26
24623	1	48.53	CSDS-02	35	ND	< LOD 0.30	ND	< LOD 6.18
24622	2	48.36	CSDS-02	35	ND	< LOD 0.30	ND	< LOD 6.20
24654	3	48.31	CSDS-02	35	0.41	< LOQ 0.85	8.49	< LOQ 17.59
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 0.30	ND	< LOD 6.28
24629	1	47.88	SH-01	36	ND	< LOD 0.30	ND	< LOD 6.27
24633	2	47.86	SH-01	36	ND	< LOD 0.30	ND	< LOD 6.27
24627	3	48.24	SH-01	36	ND	< LOD 0.30	ND	< LOD 6.22
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.30	ND	< LOD 6.24
24555	1	48.08	CS-02	37	ND	< LOD 0.30	ND	< LOD 6.24
24552	2	47.84	CS-02	37	ND	< LOD 0.30	ND	< LOD 6.27
24541	3	48.01	CS-02	37	ND	< LOD 0.30	ND	< LOD 6.25
24529	OBZ	47.99	CS-02	37	0.62	< LOQ 0.85	12.92	< LOQ 17.71
24558	1	48.49	CS-03	38	ND	< LOD 0.30	ND	< LOD 6.19
24524	2	48.29	CS-03	38	ND	< LOD 0.30	ND	< LOD 6.21
24561	3	48.22	CS-03	38	0.31	< LOQ 0.85	6.43	< LOQ 17.63
24559	OBZ	48.29	CS-03	38	ND	< LOD 0.30	ND	< LOD 6.21
24543	1	48.61	CS-04	39	ND	< LOD 0.30	ND	< LOD 6.17
24532	2	47.78	CS-04	39	ND	< LOD 0.30	ND	< LOD 6.28
24546	3	48.29	CS-04	39	ND	< LOD 0.30	ND	< LOD 6.21
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.30	ND	< LOD 6.18
24560	1	48.13	SS-02	40	ND	< LOD 0.30	ND	< LOD 6.23
24565	2	47.95	SS-02	40	ND	< LOD 0.30	ND	< LOD 6.26
24630	3	48.32	SS-02	40	ND	< LOD 0.30	ND	< LOD 6.21
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.30	ND	< LOD 6.17
24525	1	48.13	G-1A	41	ND	< LOD 0.30	ND	< LOD 6.23
24563	2	47.87	G-1A	41	ND	< LOD 0.30	ND	< LOD 6.27
24547	3	48.17	G-1A	41	ND	< LOD 0.30	ND	< LOD 6.23
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.30	ND	< LOD 6.13
24538	1	47.45	G-2A	43	ND	< LOD 0.30	ND	< LOD 6.32

Air Sample Results - Molybdenum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Molybdenum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.30	ND	< LOD 6.37
24533	3	48.24	G-2A	43	ND	< LOD 0.30	ND	< LOD 6.22
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.30	ND	< LOD 6.24
24528	1	47.99	SSDS-02	44	ND	< LOD 0.30	ND	< LOD 6.25
24544	2	48.00	SSDS-02	44	ND	< LOD 0.30	ND	< LOD 6.25
24567	3	48.46	SSDS-02	44	ND	< LOD 0.30	ND	< LOD 6.19
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.30	ND	< LOD 6.08
24571	1	48.05	SS-03	45	ND	< LOD 0.30	ND	< LOD 6.24
24536	2	47.60	SS-03	45	ND	< LOD 0.30	ND	< LOD 6.30
24534	3	48.94	SS-03	45	ND	< LOD 0.30	ND	< LOD 6.13
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.30	ND	< LOD 6.05
24568	1	48.28	G-1B	46	ND	< LOD 0.30	ND	< LOD 6.21
24592	2	47.38	G-1B	46	0.36	< LOQ 0.85	7.6	< LOQ 17.94
24593	3	48.17	G-1B	46	0.45	< LOQ 0.85	9.34	< LOQ 17.65
24535	OBZ	48.22	G-1B	46	0.74	< LOQ 0.85	15.35	< LOQ 17.63
24590	1	47.81	SS-04	47	ND	< LOD 0.30	ND	< LOD 6.27
24605	2	47.78	SS-04	47	ND	< LOD 0.30	ND	< LOD 6.28
24562	3	47.80	SS-04	47	ND	< LOD 0.30	ND	< LOD 6.28
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.30	ND	< LOD 6.17
24527	1	49.48	SSDS-03	48	0.33	< LOQ 0.85	6.67	< LOQ 17.18
24569	2	50.35	SSDS-03	48	ND	< LOD 0.30	ND	< LOD 5.96
24584	3	50.24	SSDS-03	48	ND	< LOD 0.30	ND	< LOD 5.97
24579	OBZ	48.26	SSDS-03	48	0.33	< LOQ 0.85	6.84	< LOQ 17.61
24600	1	48.34	G-3A	49	0.34	< LOQ 0.85	7.03	< LOQ 17.58
24616	2	48.11	G-3A	49	ND	< LOD 0.30	ND	< LOD 6.24
24585	3	47.65	G-3A	49	ND	< LOD 0.30	ND	< LOD 6.30
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.30	ND	< LOD 6.25
24587	1	48.79	G-2B	50	ND	< LOD 0.30	ND	< LOD 6.15
24602	2	48.17	G-2B	50	0.62	< LOQ 0.85	12.87	< LOQ 17.65
24564	3	47.81	G-2B	50	0.36	< LOQ 0.85	7.53	< LOQ 17.78
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.30	ND	< LOD 6.18
24618	1	49.21	N-01	52	ND	< LOD 0.30	ND	< LOD 6.10
24611	2	47.96	N-01	52	ND	< LOD 0.30	ND	< LOD 6.26
24588	3	48.32	N-01	52	ND	< LOD 0.30	ND	< LOD 6.21
24615	OBZ	48.80	N-01	52	0.34	< LOQ 0.85	6.97	< LOQ 17.42
24597	1	49.78	SS-05	53	ND	< LOD 0.30	ND	< LOD 6.03
24599	2	47.68	SS-05	53	ND	< LOD 0.30	ND	< LOD 6.29
24575	3	48.11	SS-05	53	ND	< LOD 0.30	ND	< LOD 6.24
24617	OBZ	48.79	SS-05	53	0.42	< LOQ 0.85	8.61	< LOQ 17.42
24609	1	48.98	SG-1A	54	ND	< LOD 0.30	ND	< LOD 6.12
24596	2	48.20	SG-1A	54	0.36	< LOQ 0.85	7.47	< LOQ 17.63
24610	3	48.18	SG-1A	54	0.56	< LOQ 0.85	11.62	< LOQ 17.64
24576	OBZ	48.47	SG-1A	54	ND	< LOD 1.50	ND	< LOD 30.95
24606	1	49.24	G-4A	55	ND	< LOD 0.30	ND	< LOD 6.09
24620	2	48.37	G-4A	55	0.63	< LOQ 0.85	13.02	< LOQ 17.57
24573	3	48.67	G-4A	55	0.39	< LOQ 0.85	8.01	< LOQ 17.46
24505	OBZ	48.16	G-4A	55	0.35	> LOQ 0.85	7.27	> LOQ 17.65
24340	1	48.38	G-4B	56	ND	< LOD 0.30	ND	< LOD 6.20
24607	2	48.01	G-4B	56	ND	< LOD 0.30	ND	< LOD 6.25
24595	3	48.38	G-4B	56	ND	< LOD 0.30	ND	< LOD 6.20
24598	OBZ	48.42	G-4B	56	ND	< LOD 0.30	ND	< LOD 6.20
24580	1	48.44	CS-05	57	ND	< LOD 0.30	ND	< LOD 6.19
24604	2	47.93	CS-05	57	ND	< LOD 0.30	ND	< LOD 6.26

Air Sample Results - Molybdenum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Molybdenum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 0.30	ND	< LOD 6.28
24574	OBZ	30.41	CS-05	57	ND	< LOD 0.30	ND	< LOD 9.87
24614	1	48.58	G-5A	58	ND	< LOD 0.30	ND	< LOD 6.18
24577	2	48.18	G-5A	58	ND	< LOD 0.30	ND	< LOD 6.23
24572	3	48.05	G-5A	58	ND	< LOD 0.30	ND	< LOD 6.24
24582	OBZ	47.83	G-5A	58	ND	< LOD 0.30	ND	< LOD 6.27
24322	1	47.88	G-5B	59	ND	< LOD 0.30	ND	< LOD 6.27
24354	2	48.16	G-5B	59	ND	< LOD 0.30	ND	< LOD 6.23
24510	3	47.98	G-5B	59	0.39	< LOQ 0.85	8.13	< LOQ 17.72
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.30	ND	< LOD 6.25
24497	1	48.49	CP-1A	60	3.60	> LOQ 0.85	74.24	> LOQ 17.53
24333	2	48.28	CP-1A	60	15.00	> LOQ 0.85	310.69	> LOQ 17.61
24326	3	48.19	CP-1A	60	37.00	> LOQ 0.85	767.79	> LOQ 17.64
24329	OBZ	47.74	CP-1A	60	13.00	> LOQ 0.85	272.31	> LOQ 17.80
24499	1	42.42	CP-1B	62	6.10	> LOQ 0.85	143.8	> LOQ 20.04
24506	2	42.02	CP-1B	62	12.00	> LOQ 0.85	285.58	> LOQ 20.23
24388	3	42.47	CP-1B	62	55.00	> LOQ 0.85	1295.03	> LOQ 20.01
24315	OBZ	41.77	CP-1B	62	12.00	> LOQ 0.85	287.29	> LOQ 20.35
24318	1	48.56	CG-01	63	ND	< LOD 0.30	ND	< LOD 6.18
24308	2	48.00	CG-01	63	ND	< LOD 0.30	ND	< LOD 6.25
24330	3	48.47	CG-01	63	ND	< LOD 0.30	ND	< LOD 6.19
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.30	ND	< LOD 6.21
24363	1	48.10	G-6A	64	ND	< LOD 0.30	ND	< LOD 6.24
24398	2	47.84	G-6A	64	ND	< LOD 0.30	ND	< LOD 6.27
24351	3	48.06	G-6A	64	0.73	< LOQ 0.85	15.19	< LOQ 17.69
24594	OBZ	48.29	G-6A	64	ND	< LOD 0.30	ND	< LOD 6.21
24312	1	48.76	G-6B	65	ND	< LOD 0.30	ND	< LOD 6.15
24484	2	47.45	G-6B	65	ND	< LOD 0.30	ND	< LOD 6.32
24327	3	48.92	G-6B	65	ND	< LOD 0.30	ND	< LOD 6.13
24389	OBZ	48.46	G-6B	65	ND	< LOD 0.30	ND	< LOD 6.19
24348	1	48.59	SG-2A	66	12.00	> LOQ 0.85	246.96	> LOQ 17.49
24314	2	47.90	SG-2A	66	11.00	> LOQ 0.85	229.65	> LOQ 17.75
24494	3	48.24	SG-2A	66	16.00	> LOQ 0.85	331.67	> LOQ 17.62
24337	OBZ	48.30	SG-2A	66	61.00	> LOQ 1.70	1262.94	> LOQ 35.20
24508	1	48.47	CP-2A	67	0.65	< LOQ 0.85	13.41	< LOQ 17.54
24361	2	47.82	CP-2A	67	ND	< LOD 0.30	ND	< LOD 6.27
24359	3	48.22	CP-2A	67	1.30	< LOQ 1.70	26.96	< LOQ 35.26
24471	OBZ	48.14	CP-2A	67	0.82	< LOQ 0.85	17.03	< LOQ 17.66
24373	1	48.41	CP-2B	68	ND	< LOD 0.30	ND	< LOD 6.20
24468	2	47.90	CP-2B	68	0.34	< LOQ 0.85	7.1	< LOQ 17.75
24481	3	48.26	CP-2B	68	1.40	> LOQ 0.85	29.01	> LOQ 17.61
24391	OBZ	47.53	CP-2B	68	ND	< LOD 0.30	ND	< LOD 6.31
24356	1	48.56	O-1	69	ND	< LOD 0.30	ND	< LOD 6.18
24470	2	47.89	O-1	69	0.67	< LOQ 0.85	13.99	< LOQ 17.75
24467	3	48.67	O-1	69	0.54	< LOQ 0.85	11.1	< LOQ 17.46
24313	OBZ	47.78	O-1	69	ND	< LOD 0.30	ND	< LOD 6.28
24501	1	47.96	CS-06	70	0.45	< LOQ 0.85	9.38	< LOQ 17.72
24496	2	47.75	CS-06	70	0.48	< LOQ 0.85	10.05	< LOQ 17.80
24478	3	48.31	CS-06	70	0.71	< LOQ 0.85	14.7	< LOQ 17.59
24503	OBZ	48.04	CS-06	70	0.52	< LOQ 0.85	10.82	< LOQ 17.69
24474	1	26.02	SG-1B	71	0.50	< LOQ 0.85	19.22	< LOQ 32.67
24469	2	26.02	SG-1B	71	0.41	< LOQ 0.85	15.76	< LOQ 32.67
24492	3	26.10	SG-1B	71	1.10	> LOQ 0.85	42.15	> LOQ 32.57

Air Sample Results - Molybdenum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Molybdenum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	5.20	> LOQ 4.30	198.1	> LOQ 163.81
24489	1	48.42	CP-3A	72	0.42	< LOQ 0.85	8.67	< LOQ 17.55
24491	2	47.93	CP-3A	72	1.50	> LOQ 0.85	31.3	> LOQ 17.73
24482	3	48.35	CP-3A	72	4.40	> LOQ 0.85	91	> LOQ 17.58
24486	OBZ	48.32	CP-3A	72	3.20	> LOQ 0.85	66.23	> LOQ 17.59
24516	1	36.34	CP-3B	73	ND	< LOD 0.30	ND	< LOD 8.26
24502	2	36.02	CP-3B	73	1.90	> LOQ 0.85	52.75	> LOQ 23.60
24515	3	36.48	CP-3B	73	3.10	> LOQ 0.85	84.98	> LOQ 23.30
24500	OBZ	40.27	CP-3B	73	1.20	> LOQ 0.85	29.8	> LOQ 21.11
24504	1	48.47	G-7A	74	ND	< LOD 0.30	ND	< LOD 6.19
24513	2	48.22	G-7A	74	0.92	> LOQ 0.85	19.08	> LOQ 17.63
24458	3	47.94	G-7A	74	0.70	< LOQ 0.85	14.6	< LOQ 17.73
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.30	ND	< LOD 6.28
24404	1	48.68	G-7B	75	ND	< LOD 0.30	ND	< LOD 6.16
24451	2	48.06	G-7B	75	ND	< LOD 0.30	ND	< LOD 6.24
24447	3	47.16	G-7B	75	0.45	< LOQ 0.85	9.54	< LOQ 18.02
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.30	ND	< LOD 6.35
24456	1	49.19	SS-06	76	ND	< LOD 0.30	ND	< LOD 6.10
24480	2	48.26	SS-06	76	0.58	< LOQ 0.85	12.02	< LOQ 17.61
24429	3	47.68	SS-06	76	0.60	< LOQ 0.85	12.58	< LOQ 17.83
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.30	ND	< LOD 6.27
24427	1	48.54	CP-4A	78	17.00	> LOQ 0.85	350.23	> LOQ 17.51
24435	2	47.71	CP-4A	78	73.00	> LOQ 0.85	1530.08	> LOQ 17.82
24244	3	49.01	CP-4A	78	420.00	> LOQ 4.30	8569.68	> LOQ 87.74
24220	OBZ	48.74	CP-4A	78	77.00	> LOQ 0.85	1579.81	> LOQ 17.44
24460	1	50.05	CP-4B	79	19.00	> LOQ 0.85	379.62	> LOQ 16.98
24465	2	48.47	CP-4B	79	53.00	> LOQ 0.85	1093.46	> LOQ 17.54
24207	3	48.49	CP-4B	79	260.00	> LOQ 1.70	5361.93	> LOQ 35.06
24390	OBZ	49.02	CP-4B	79	14.00	> LOQ 0.85	285.6	> LOQ 17.34
24259	1	48.76	SS-07	80	ND	< LOD 0.30	ND	< LOD 6.15
24421	2	48.13	SS-07	80	ND	< LOD 0.30	ND	< LOD 6.23
24445	3	47.87	SS-07	80	0.53	< LOQ 0.85	11.07	< LOQ 17.76
24432	OBZ	48.49	SS-07	80	0.35	< LOQ 0.85	7.22	< LOQ 17.53
24459	1	48.96	N-02	81	1.20	> LOQ 0.85	24.51	> LOQ 17.36
24417	2	48.11	N-02	81	1.10	> LOQ 0.85	22.86	> LOQ 17.67
24442	3	48.01	N-02	81	3.40	> LOQ 0.85	70.82	> LOQ 17.70
24386	OBZ	48.19	N-02	81	0.68	< LOQ 0.85	14.11	< LOQ 17.64
24452	1	48.20	SG-2B	82	3.90	> LOQ 0.85	80.91	> LOQ 17.63
24453	2	48.59	SG-2B	82	8.10	> LOQ 0.85	166.7	> LOQ 17.49
24420	3	47.84	SG-2B	82	17.00	> LOQ 0.85	355.35	> LOQ 17.77
24444	OBZ	47.95	SG-2B	82	100.00	> LOQ 4.30	2085.51	> LOQ 89.68
24455	1	48.56	CS-07	83	0.99	> LOQ 0.85	20.39	> LOQ 17.50
24433	2	47.96	CS-07	83	0.57	< LOQ 0.85	11.88	< LOQ 17.72
24398	3	48.06	CS-07	83	2.80	> LOQ 0.85	58.26	> LOQ 17.69
24511	OBZ	47.96	CS-07	83	1.10	> LOQ 0.85	22.94	> LOQ 17.72
24454	1	49.34	CPDS-1A	84	0.49	< LOQ 0.85	9.93	< LOQ 17.23
24291	2	48.49	CPDS-1A	84	ND	< LOD 0.30	ND	< LOD 6.19
24209	3	48.43	CPDS-1A	84	ND	< LOD 0.30	ND	< LOD 6.19
24402	OBZ	48.77	CPDS-1A	84	0.54	< LOQ 0.85	11.07	< LOQ 17.43
24204	1	49.46	CPDS-1B	85	0.72	< LOQ 0.85	14.56	< LOQ 17.19
24273	2	48.35	CPDS-1B	85	0.48	< LOQ 0.85	9.93	< LOQ 17.58
24223	3	48.82	CPDS-1B	85	2.10	> LOQ 0.85	43.02	> LOQ 17.41

Air Sample Results - Molybdenum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Molybdenum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24466	OBZ	49.96	CPDS-1B	85	1.10	> LOQ 0.85	22.02	> LOQ 17.01

Airborne Sample Data Analysis - Molybdenum

NIOSH REL 10000.0 micrograms/cubic meter (nuisance)
OSHA PEL 15000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 6.18	ND	< LOD 6.25	ND	< LOD 6.19	ND	< LOD 6.21
CS-01	ND	< LOD 6.18	ND	< LOD 6.25	12.38	< LOQ 17.54	ND	< LOD 6.26
CS-02	ND	< LOD 6.24	ND	< LOD 6.27	ND	< LOD 6.25	12.92	< LOQ 17.71
CS-03	ND	< LOD 6.19	ND	< LOD 6.21	6.43	< LOQ 17.63	ND	< LOD 6.21
CS-04	ND	< LOD 6.17	ND	< LOD 6.28	ND	< LOD 6.21	ND	< LOD 6.18
CS-05	ND	< LOD 6.19	ND	< LOD 6.26	ND	< LOD 6.28	ND	< LOD 9.87
CS-06	9.38	< LOQ 17.72	10.05	< LOQ 17.80	14.70	< LOQ 17.59	10.82	< LOQ 17.69
CS-07	20.39	> LOQ 17.50	11.88	< LOQ 17.72	58.26	> LOQ 17.69	22.94	> LOQ 17.72
CSDS-01	ND	< LOD 6.23	ND	< LOD 6.25	11.84	< LOQ 17.65	ND	< LOD 6.24
CSDS-02	ND	< LOD 6.18	ND	< LOD 6.20	8.49	< LOQ 17.59	ND	< LOD 6.28
N-01	ND	< LOD 6.10	ND	< LOD 6.26	ND	< LOD 6.21	6.97	< LOQ 17.42
N-02	24.51	> LOQ 17.36	22.86	> LOQ 17.67	70.82	> LOQ 17.70	14.11	< LOQ 17.64
O-1	ND	< LOD 6.18	13.99	< LOQ 17.75	11.10	< LOQ 17.46	ND	< LOD 6.28
S-01	6.64	< LOQ 17.65	ND	< LOD 6.26	ND	< LOD 6.26	ND	< LOD 6.26
S-02	ND	< LOD 6.25	ND	< LOD 6.28	6.88	< LOQ 17.71	ND	< LOD 6.26
SH-01	ND	< LOD 6.27	ND	< LOD 6.27	ND	< LOD 6.22	ND	< LOD 6.24
SS-01	ND	< LOD 6.19	ND	< LOD 6.26	ND	< LOD 6.20	ND	< LOD 6.21
SS-02	ND	< LOD 6.23	ND	< LOD 6.26	ND	< LOD 6.21	ND	< LOD 6.17
SS-03	ND	< LOD 6.24	ND	< LOD 6.30	ND	< LOD 6.13	ND	< LOD 6.05
SS-04	ND	< LOD 6.27	ND	< LOD 6.28	ND	< LOD 6.28	ND	< LOD 6.17
SS-05	ND	< LOD 6.03	ND	< LOD 6.29	ND	< LOD 6.24	8.61	< LOQ 17.42
SS-06	ND	< LOD 6.10	12.02	< LOQ 17.61	12.58	< LOQ 17.83	ND	< LOD 6.27
SS-07	ND	< LOD 6.15	ND	< LOD 6.23	11.07	< LOQ 17.76	7.22	< LOQ 17.53
SSDS-01	ND	< LOD 6.18	ND	< LOD 6.27	ND	< LOD 6.19	ND	< LOD 6.21
SSDS-02	ND	< LOD 6.25	ND	< LOD 6.25	ND	< LOD 6.19	ND	< LOD 6.08
SSDS-03	6.67	< LOQ 17.18	ND	< LOD 5.96	ND	< LOD 5.97	6.84	< LOQ 17.61
CP-1A	74.24	> LOQ 17.53	310.69	> LOQ 17.61	767.79	> LOQ 17.64	272.31	> LOQ 17.80
CP-1B	143.8	> LOQ 20.04	285.58	> LOQ 20.23	1295.03	> LOQ 20.01	287.29	> LOQ 20.35
CP-2A	13.41	< LOQ 17.54	ND	< LOD 6.27	26.96	< LOQ 35.26	17.03	< LOQ 17.66
CP-2B	ND	< LOD 6.20	7.1	< LOQ 17.75	29.01	> LOQ 17.61	ND	< LOD 6.31
CP-3A	8.67	< LOQ 17.55	31.3	> LOQ 17.73	91.00	> LOQ 17.58	66.23	> LOQ 17.59
CP-3B	ND	< LOD 8.26	52.75	> LOQ 23.60	84.98	> LOQ 23.30	29.8	> LOQ 21.11
CP-4A	350.23	> LOQ 17.51	1530.08	> LOQ 17.82	8569.68	> LOQ 87.74	1579.81	> LOQ 17.44
CP-4B	379.62	> LOQ 16.98	1093.46	> LOQ 17.54	5361.93	> LOQ 35.06	285.6	> LOQ 17.34
CPDS-1A	9.93	< LOQ 17.23	ND	< LOD 6.19	ND	< LOD 6.19	11.07	< LOQ 17.43
CPDS-1B	14.56	< LOQ 17.19	9.93	< LOQ 17.58	43.02	> LOQ 17.41	22.02	> LOQ 17.01
G-1A	ND	< LOD 6.23	ND	< LOD 6.27	ND	< LOD 6.23	ND	< LOD 6.13
G-1B	ND	< LOD 6.21	7.6	< LOQ 17.94	9.34	< LOQ 17.65	15.35	< LOQ 17.63
G-2A	ND	< LOD 6.32	ND	< LOD 6.37	ND	< LOD 6.22	ND	< LOD 6.24
G-2B	ND	< LOD 6.15	12.87	< LOQ 17.65	7.53	< LOQ 17.78	ND	< LOD 6.18
G-3A	7.03	< LOQ 17.58	ND	< LOD 6.24	ND	< LOD 6.30	ND	< LOD 6.25
G-4A	ND	< LOD 6.09	13.02	< LOQ 17.57	8.01	< LOQ 17.46	7.27	> LOQ 17.65
G-4B	ND	< LOD 6.20	ND	< LOD 6.25	ND	< LOD 6.20	ND	< LOD 6.20
G-5A	ND	< LOD 6.18	ND	< LOD 6.23	ND	< LOD 6.24	ND	< LOD 6.27
G-5B	ND	< LOD 6.27	ND	< LOD 6.23	8.13	< LOQ 17.72	ND	< LOD 6.25
G-6A	ND	< LOD 6.24	ND	< LOD 6.27	15.19	< LOQ 17.69	ND	< LOD 6.21
G-6B	ND	< LOD 6.15	ND	< LOD 6.32	ND	< LOD 6.13	ND	< LOD 6.19
G-7A	ND	< LOD 6.19	19.08	> LOQ 17.63	14.60	< LOQ 17.73	ND	< LOD 6.28
G-7B	ND	< LOD 6.16	ND	< LOD 6.24	9.54	< LOQ 18.02	ND	< LOD 6.35
SG-1A	ND	< LOD 6.12	7.47	< LOQ 17.63	11.62	< LOQ 17.64	ND	< LOD 30.95
SG-1B	19.22	< LOQ 32.67	15.76	< LOQ 32.67	42.15	> LOQ 32.57	198.1	> LOQ 163.81
SG-2A	246.96	> LOQ 17.49	229.65	> LOQ 17.75	331.67	> LOQ 17.62	1262.94	> LOQ 35.20
SG-2B	80.91	> LOQ 17.63	166.7	> LOQ 17.49	355.35	> LOQ 17.77	2085.51	> LOQ 89.68

Bulk Elemental Analysis - Molybdenum

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Molybdenum		Sample	Molybdenum	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 1.0	J95331-63 PB	ND	< LOD 1.0
CS-01	J95331-34 VB	1.40	< LOQ 3.4	J95331-34 PB	1.50	< LOQ 3.4
CS-02	J95331-37 VB	1.60	< LOQ 3.4	J95331-37 PB	2.90	< LOQ 3.4
CS-03	J95331-38 VB	3.40	> LOQ 3.4	J95331-38 PB	4.20	> LOQ 3.4
CS-04	J95331-39 VB	ND	< LOD 1.0	J95331-39 PB	ND	< LOD 1.0
CS-05	J95331-57 VB	ND	< LOD 1.0	J95331-57 PB	1.20	< LOQ 3.4
CS-06	J95331-70 VB	1.40	< LOQ 3.4	J95331-70 PB	1.10	< LOQ 3.4
CS-07	J95331-83 VB	1.00	< LOQ 3.4	J95331-83 PB	3.40	> LOQ 3.4
CSDS-01	J95331-31 VB	ND	< LOD 1.0	J95331-31 PB	ND	< LOD 1.0
CSDS-02	J95331-35 VB	ND	< LOD 1.0	J95331-35 PB	2.20	< LOQ 3.4
N-01	J95331-52 VB	ND	< LOD 1.0	J95331-52 PB	ND	< LOD 1.0
N-02	J95331-81 VB	9.60	> LOQ 3.4	J95331-81 PB	18.00	> LOQ 3.4
O-1	J95331-69 VB	ND	< LOD 1.0	J95331-69 PB	1.70	< LOQ 3.4
S-01	J95331-28 VB	ND	< LOD 1.0	J95331-28 PB	ND	< LOD 1.0
S-02	J95331-29 VB	ND	< LOD 1.0	J95331-29 PB	ND	< LOD 1.0
SH-01	J95331-36 VB	ND	< LOD 1.0	J95331-36 PB	ND	< LOD 1.0
SS-01	J95331-32 VB	ND	< LOD 1.0	J95331-32 PB	ND	< LOD 1.0
SS-02	J95331-40 VB	ND	< LOD 1.0	J95331-40 PB	ND	< LOD 1.0
SS-03	J95331-45 VB	ND	< LOD 1.0	J95331-45 PB	ND	< LOD 1.0
SS-04	J95331-47 VB	ND	< LOD 1.0	J95331-47 PB	1.60	< LOQ 3.4
SS-05	J95331-53 VB	1.80	< LOQ 3.4	J95331-53 PB	ND	< LOD 1.0
SS-06	J95331-76 VB	ND	< LOD 1.0	J95331-76 PB	2.70	< LOQ 3.4
SS-07	J95331-80 VB	1.30	< LOQ 3.4	J95331-80 PB	ND	< LOD 1.0
SSDS-01	J95331-33 VB	ND	< LOD 1.0	J95331-33 PB	ND	< LOD 1.0
SSDS-02	J95331-44 VB	ND	< LOD 1.0	J95331-44 PB	ND	< LOD 1.0
SSDS-03	J95331-48 VB	ND	< LOD 1.0	J95331-48 PB	ND	< LOD 1.0
CP-1A	J95331-60 VB	95.00	> LOQ 3.4	J95331-60 PB	320.00	> LOQ 3.4
CP-1B	J95331-61 VB	ND	< LOD 1.0	J95331-61 PB	ND	< LOD 1.0
CP-2A	J95331-67 VB	2.60	< LOQ 3.4	J95331-67 PB	5.70	> LOQ 6.8
CP-2B	J95331-68 VB	7.40	> LOQ 6.8	J95331-68 PB	3.40	< LOQ 6.8
CP-3A	J95331-72 VB	5.20	< LOQ 6.8	J95331-72 PB	6.70	> LOQ 3.4
CP-3B	J95331-73 VB	8.90	> LOQ 3.4	J95331-73 PB	12.00	> LOQ 3.4
CP-4A	J95331-78 VB	380.00	> LOQ 3.4	J95331-78 PB	700.00	> LOQ 6.8
CP-4B	J95331-79 VB	760.00	> LOQ 3.4	J95331-79 PB	750.00	> LOQ 3.4
CPDS-1A	J95331-84 VB	2.50	< LOQ 3.4	J95331-84 PB	5.50	> LOQ 3.4
CPDS-1B	J95331-85 VB	ND	< LOD 2.0	J95331-85 PB	5.10	> LOQ 3.4
G-1A	J95331-41 VB	ND	< LOD 1.0	J95331-41 PB	ND	< LOD 1.0
G-1B	J95331-46 VB	12.00	> LOQ 3.4	J95331-46 PB	7.80	> LOQ 3.4
G-2A	J95331-43 VB	ND	< LOD 1.0	J95331-43 PB	ND	< LOD 1.0
G-2B	J95331-50 VB	1.10	< LOQ 3.4	J95331-50 PB	2.40	< LOQ 3.4
G-3A	J95331-49 VB	ND	< LOD 1.0	J95331-49 PB	ND	< LOD 1.0
G-4A	J95331-55 VB	1.40	< LOQ 3.4	J95331-55 PB	2.50	< LOQ 3.4
G-4B	J95331-56 VB	2.80	< LOQ 3.4	J95331-56 PB	2.80	< LOQ 3.4
G-5A	J95331-58 VB	ND	< LOD 1.0	J95331-58 PB	ND	< LOD 1.0
G-5B	J95331-59 VB	ND	< LOD 1.0	J95331-59 PB	ND	< LOD 1.0
G-6A	J95331-64 VB	ND	< LOD 1.0	J95331-64 PB	1.20	< LOQ 3.4
G-6B	J95331-65 VB	ND	< LOD 1.0	J95331-65 PB	ND	< LOD 1.0
G-7A	J95331-74 VB	ND	< LOD 1.0	J95331-74 PB	1.00	< LOQ 3.4
G-7B	J95331-75 VB	ND	< LOD 2.0	J95331-75 PB	1.20	< LOQ 3.4
SG-1A	J95331-54 VB	20.00	> LOQ 17	J95331-54 PB	11.00	> LOQ 3.4
SG-1B	J95331-71 VB	ND	< LOD 5.0	J95331-71 PB	12.00	> LOQ 17.0
SG-2A	J95331-66 VB	460.00	> LOQ 17.0	J95331-66 PB	300.00	> LOQ 17.0
SG-2B	J95331-82 VB	450.00	> LOQ 17.0	J95331-82 PB	460.00	> LOQ 17.0

Comparison of Airborne Concentrations to Bulk Concentrations - Molybdenum

NIOSH REL 10000.0 micrograms/cubic meter (nuisance)
OSHA PEL 15000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	12.38	ND	1.40
CS-02	ND	ND	ND	12.92	1.60
CS-03	ND	ND	6.43	ND	3.40
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	9.38	10.05	14.70	10.82	1.40
CS-07	20.39	11.88	58.26	22.94	1.00
CSDS-01	ND	ND	11.84	ND	ND
CSDS-02	ND	ND	8.49	ND	ND
N-01	ND	ND	ND	6.97	ND
N-02	24.51	22.86	70.82	14.11	9.60
O-1	ND	13.99	11.10	ND	ND
S-01	6.64	ND	ND	ND	ND
S-02	ND	ND	6.88	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	8.61	1.80
SS-06	ND	12.02	12.58	ND	ND
SS-07	ND	ND	11.07	7.22	1.30
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	6.67	ND	ND	6.84	ND
CP-1A	74.24	310.69	767.79	272.31	95.00
CP-2A	13.41	ND	26.96	17.03	2.60
CP-3A	8.67	31.30	91.00	66.23	5.20
CP-4A	350.23	1530.08	8569.68	1579.81	380.00
CPDS-1A	9.93	ND	ND	11.07	2.50
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	7.03	ND	ND	ND	ND
G-4A	ND	13.02	8.01	7.27	1.40
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	15.19	ND	ND
G-7A	ND	19.08	14.60	ND	ND
SG-1A	ND	7.47	11.62	ND	20.00
SG-2A	246.96	229.65	331.67	1262.94	460.00

APPENDIX B - NICKEL

Nickel

Systemic affects from ingestion or inhalation of low solubility nickel compounds have not been reported. Absorption from the lungs depends on the solubility of the compounds. Occupational exposure to nickel compounds with low solubility, particularly the oxide, has reportedly caused lung cancer. Evidence suggests that soluble nickel compounds may cause respiratory or gastric cancer. Metallic nickel or nickel compounds are sensitizing. Lung reactions in the form of asthma have been attributed to nickel sensitization. Pneumoconiosis has also been reported. The NIOSH REL and OSHA PEL for nickel are 15 and 1,000 micrograms/cubic meter of air, respectively.

Nickel is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

For the past 20 plus years, NIOSH has subscribed to a carcinogen policy that was published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, which called for "no detectable exposure levels for proven carcinogenic substances [New York Academy of Sciences Annals 1976]." This was in response to a generic OSHA rulemaking on carcinogens.

Because of advances in science and in approaches to risk assessment and risk management, NIOSH has in more recent years adopted a more inclusive policy. NIOSH RELs will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will protect not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy for potential occupational carcinogens will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL. Under the old policy for potential occupational carcinogens, RELs for most carcinogens were non-quantitative values labeled "lowest feasible concentration (LFC)." In 1989, NIOSH adopted several quantitative RELs for carcinogens from OSHA's PEL update. NIOSH will also recommend the complete range of respirators (as determined by the NIOSH Respirator Decision Logic) for carcinogens with quantitative RELs. In this way, respirators will be consistently recommended regardless of whether a substance is a carcinogen or a non-carcinogen.

Air Sample Results - Nickel

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Nickel			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.5	ND	< LOD 10.38
24412	2	47.89	S-01	28	ND	< LOD 0.5	ND	< LOD 10.44
24441	3	47.90	S-01	28	ND	< LOD 0.5	ND	< LOD 10.44
24450	OBZ	47.93	S-01	28	ND	< LOD 0.5	ND	< LOD 10.43
24643	1	47.98	S-02	29	ND	< LOD 0.5	ND	< LOD 10.42
24625	2	47.76	S-02	29	ND	< LOD 0.5	ND	< LOD 10.47
24642	3	48.00	S-02	29	ND	< LOD 0.5	ND	< LOD 10.42
24632	OBZ	47.89	S-02	29	ND	< LOD 0.5	ND	< LOD 10.44
24634	1	48.16	CSDS-01	31	ND	< LOD 0.5	ND	< LOD 10.38
24650	2	48.01	CSDS-01	31	2.20	> LOQ 1.0	45.82	> LOQ 20.83
24644	3	48.16	CSDS-01	31	4.00	> LOQ 1.0	83.06	> LOQ 20.76
24645	OBZ	48.07	CSDS-01	31	1.50	> LOQ 1.0	31.2	> LOQ 20.80
24640	1	48.44	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.32
24641	2	47.90	SS-01	32	0.58	< LOQ 1.0	12.11	< LOQ 20.88
24651	3	48.35	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.34
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.35
24646	1	48.58	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.29
24626	2	47.84	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.45
24638	3	48.49	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.31
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.35
24628	1	48.55	CS-01	34	ND	< LOD 0.5	ND	< LOD 10.30
24637	2	48.00	CS-01	34	1.60	> LOQ 1.0	33.33	> LOQ 20.83
24624	3	48.47	CS-01	34	4.00	> LOQ 1.0	82.53	> LOQ 20.63
24636	OBZ	47.92	CS-01	34	1.10	> LOQ 1.0	22.95	> LOQ 20.87
24623	1	48.53	CSDS-02	35	ND	< LOD 0.5	ND	< LOD 10.30
24622	2	48.36	CSDS-02	35	1.20	> LOQ 1.0	24.81	> LOQ 20.68
24654	3	48.31	CSDS-02	35	3.20	> LOQ 1.0	66.24	> LOQ 20.70
24653	OBZ	47.78	CSDS-02	35	1.50	> LOQ 1.0	31.39	> LOQ 20.93
24629	1	47.88	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.44
24633	2	47.86	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.45
24627	3	48.24	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.36
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.5	ND	< LOD 10.40
24555	1	48.08	CS-02	37	0.52	< LOQ 1.0	10.82	< LOQ 20.80
24552	2	47.84	CS-02	37	1.60	> LOQ 1.0	33.44	> LOQ 20.90
24541	3	48.01	CS-02	37	7.70	> LOQ 1.0	160.38	> LOQ 20.83
24529	OBZ	47.99	CS-02	37	2.70	> LOQ 1.0	56.26	> LOQ 20.84
24558	1	48.49	CS-03	38	ND	< LOD 0.5	ND	< LOD 10.31
24524	2	48.29	CS-03	38	1.60	> LOQ 1.0	33.13	> LOQ 20.71
24561	3	48.22	CS-03	38	6.50	> LOQ 1.0	134.8	> LOQ 20.74
24559	OBZ	48.29	CS-03	38	1.60	> LOQ 1.0	33.13	> LOQ 20.71
24543	1	48.61	CS-04	39	ND	< LOD 0.5	ND	< LOD 10.29
24532	2	47.78	CS-04	39	0.94	< LOQ 1.0	19.67	< LOQ 20.93
24546	3	48.29	CS-04	39	1.10	> LOQ 1.0	22.78	> LOQ 20.71
24557	OBZ	48.58	CS-04	39	0.61	< LOQ 1.0	12.56	< LOQ 20.58
24560	1	48.13	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.39
24565	2	47.95	SS-02	40	0.71	< LOQ 1.0	14.81	< LOQ 20.86
24630	3	48.32	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.35
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.5	ND	< LOD 10.28
24525	1	48.13	G-1A	41	ND	< LOD 0.5	ND	< LOD 10.39
24563	2	47.87	G-1A	41	ND	< LOD 0.5	ND	< LOD 10.44
24547	3	48.17	G-1A	41	ND	< LOD 0.5	ND	< LOD 10.38
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.5	ND	< LOD 10.22
24538	1	47.45	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.54

Air Sample Results - Nickel

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Nickel			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.61
24533	3	48.24	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.36
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.5	ND	< LOD 10.41
24528	1	47.99	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.42
24544	2	48.00	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.42
24567	3	48.46	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.32
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.5	ND	< LOD 10.13
24571	1	48.05	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.41
24536	2	47.60	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.50
24534	3	48.94	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.22
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.5	ND	< LOD 10.08
24568	1	48.28	G-1B	46	ND	< LOD 0.5	ND	< LOD 10.36
24592	2	47.38	G-1B	46	ND	< LOD 0.5	ND	< LOD 10.55
24593	3	48.17	G-1B	46	0.57	< LOQ 1.0	11.83	< LOQ 20.76
24535	OBZ	48.22	G-1B	46	1.60	> LOQ 1.0	33.18	> LOQ 20.74
24590	1	47.81	SS-04	47	ND	< LOD 0.5	ND	< LOD 10.46
24605	2	47.78	SS-04	47	ND	< LOD 0.5	ND	< LOD 10.46
24562	3	47.80	SS-04	47	0.78	< LOQ 1.0	16.32	< LOQ 20.92
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.5	ND	< LOD 10.29
24527	1	49.48	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 10.11
24569	2	50.35	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 9.93
24584	3	50.24	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 9.95
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.5	ND	< LOD 10.36
24600	1	48.34	G-3A	49	ND	< LOD 0.5	ND	< LOD 10.34
24616	2	48.11	G-3A	49	ND	< LOD 0.5	ND	< LOD 10.39
24585	3	47.65	G-3A	49	ND	< LOD 0.5	ND	< LOD 10.49
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.5	ND	< LOD 10.42
24587	1	48.79	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.25
24602	2	48.17	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.38
24564	3	47.81	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.46
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.5	ND	< LOD 10.30
24618	1	49.21	N-01	52	4.40	> LOQ 1.0	89.41	> LOQ 20.32
24611	2	47.96	N-01	52	19.00	> LOQ 1.0	396.16	> LOQ 20.85
24588	3	48.32	N-01	52	140.00	> LOQ 1.0	2897.35	> LOQ 20.70
24615	OBZ	48.80	N-01	52	64.00	> LOQ 1.0	1311.48	> LOQ 20.49
24597	1	49.78	SS-05	53	ND	< LOD 0.5	ND	< LOD 10.04
24599	2	47.68	SS-05	53	ND	< LOD 0.5	ND	< LOD 10.49
24575	3	48.11	SS-05	53	ND	< LOD 0.5	ND	< LOD 10.39
24617	OBZ	48.79	SS-05	53	ND	< LOD 0.5	ND	< LOD 10.25
24609	1	48.98	SG-1A	54	1.40	> LOQ 1.0	28.58	> LOQ 20.42
24596	2	48.20	SG-1A	54	0.93	< LOQ 1.0	19.29	< LOQ 20.75
24610	3	48.18	SG-1A	54	3.40	> LOQ 1.0	70.57	> LOQ 20.76
24576	OBZ	48.47	SG-1A	54	23.00	> LOQ 1.0	474.52	> LOQ 20.63
24606	1	49.24	G-4A	55	ND	< LOD 0.5	ND	< LOD 10.15
24620	2	48.37	G-4A	55	0.62	< LOQ 1.0	12.82	< LOQ 20.67
24573	3	48.67	G-4A	55	1.70	> LOQ 1.0	34.93	> LOQ 20.55
24505	OBZ	48.16	G-4A	55	0.57	< LOQ 1.0	11.84	< LOQ 20.76
24340	1	48.38	G-4B	56	ND	< LOD 0.5	ND	< LOD 10.33
24607	2	48.01	G-4B	56	ND	< LOD 0.5	ND	< LOD 10.41
24595	3	48.38	G-4B	56	0.84	< LOQ 1.0	17.36	< LOQ 20.67
24598	OBZ	48.42	G-4B	56	ND	< LOD 0.5	ND	< LOD 10.33
24580	1	48.44	CS-05	57	ND	< LOD 0.5	ND	< LOD 10.32
24604	2	47.93	CS-05	57	1.10	> LOQ 1.0	22.95	> LOQ 20.86

Air Sample Results - Nickel

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Nickel			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	1.60	> LOQ 1.0	33.49	> LOQ 20.93
24574	OBZ	30.41	CS-05	57	0.79	< LOQ 1.0	25.98	< LOQ 32.88
24614	1	48.58	G-5A	58	ND	< LOD 0.5	ND	< LOD 10.29
24577	2	48.18	G-5A	58	ND	< LOD 0.5	ND	< LOD 10.38
24572	3	48.05	G-5A	58	ND	< LOD 0.5	ND	< LOD 10.41
24582	OBZ	47.83	G-5A	58	ND	< LOD 0.5	ND	< LOD 10.45
24322	1	47.88	G-5B	59	ND	< LOD 0.5	ND	< LOD 10.44
24354	2	48.16	G-5B	59	ND	< LOD 0.5	ND	< LOD 10.38
24510	3	47.98	G-5B	59	ND	< LOD 0.5	ND	< LOD 10.42
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.5	ND	< LOD 10.42
24497	1	48.49	CP-1A	60	0.74	< LOQ 1.0	15.26	< LOQ 20.62
24333	2	48.28	CP-1A	60	ND	< LOD 0.5	ND	< LOD 10.36
24326	3	48.19	CP-1A	60	0.63	< LOQ 1.0	13.07	< LOQ 20.75
24329	OBZ	47.74	CP-1A	60	ND	< LOD 0.5	ND	< LOD 10.47
24499	1	42.42	CP-1B	62	0.90	< LOQ 1.0	21.22	< LOQ 23.57
24506	2	42.02	CP-1B	62	ND	< LOD 0.5	ND	< LOD 11.90
24388	3	42.47	CP-1B	62	ND	< LOD 0.5	ND	< LOD 11.77
24315	OBZ	41.77	CP-1B	62	ND	< LOD 0.5	ND	< LOD 11.97
24318	1	48.56	CG-01	63	ND	< LOD 0.5	ND	< LOD 10.30
24308	2	48.00	CG-01	63	ND	< LOD 0.5	ND	< LOD 10.42
24330	3	48.47	CG-01	63	ND	< LOD 0.5	ND	< LOD 10.32
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.5	ND	< LOD 10.35
24363	1	48.10	G-6A	64	ND	< LOD 0.5	ND	< LOD 10.40
24398	2	47.84	G-6A	64	1.00	> LOQ 1.0	20.9	> LOQ 20.90
24351	3	48.06	G-6A	64	1.10	> LOQ 1.0	22.89	> LOQ 20.81
24594	OBZ	48.29	G-6A	64	0.90	< LOQ 1.0	18.64	< LOQ 20.71
24312	1	48.76	G-6B	65	ND	< LOD 0.5	ND	< LOD 10.25
24484	2	47.45	G-6B	65	0.58	< LOQ 1.0	12.22	< LOQ 21.07
24327	3	48.92	G-6B	65	1.10	> LOQ 1.0	22.49	> LOQ 20.44
24389	OBZ	48.46	G-6B	65	0.74	< LOQ 1.0	15.27	< LOQ 20.64
24348	1	48.59	SG-2A	66	24.00	> LOQ 1.0	493.93	> LOQ 20.58
24314	2	47.90	SG-2A	66	25.00	> LOQ 1.0	521.92	> LOQ 20.88
24494	3	48.24	SG-2A	66	34.00	> LOQ 2.0	704.81	> LOQ 41.46
24337	OBZ	48.30	SG-2A	66	130.00	> LOQ 2.0	2691.51	> LOQ 41.41
24508	1	48.47	CP-2A	67	ND	< LOD 0.5	ND	< LOD 10.32
24361	2	47.82	CP-2A	67	1.40	> LOQ 1.0	29.28	> LOQ 20.91
24359	3	48.22	CP-2A	67	6.10	> LOQ 2.0	126.5	> LOQ 41.48
24471	OBZ	48.14	CP-2A	67	2.40	> LOQ 1.0	49.85	> LOQ 20.77
24373	1	48.41	CP-2B	68	0.76	< LOQ 1.0	15.7	< LOQ 20.66
24468	2	47.90	CP-2B	68	0.85	< LOQ 1.0	17.75	< LOQ 20.88
24481	3	48.26	CP-2B	68	2.30	> LOQ 1.0	47.66	> LOQ 20.72
24391	OBZ	47.53	CP-2B	68	ND	< LOD 0.5	ND	< LOD 10.52
24356	1	48.56	O-1	69	42.00	> LOQ 1.0	864.91	> LOQ 20.59
24470	2	47.89	O-1	69	84.00	> LOQ 1.0	1754.02	> LOQ 20.88
24467	3	48.67	O-1	69	220.00	> LOQ 1.0	4520.24	> LOQ 20.55
24313	OBZ	47.78	O-1	69	49.00	> LOQ 1.0	1025.53	> LOQ 20.93
24501	1	47.96	CS-06	70	ND	< LOD 0.5	ND	< LOD 10.43
24496	2	47.75	CS-06	70	7.70	> LOQ 1.0	161.26	> LOQ 20.94
24478	3	48.31	CS-06	70	2.60	> LOQ 1.0	53.82	> LOQ 20.70
24503	OBZ	48.04	CS-06	70	0.97	< LOQ 1.0	20.19	< LOQ 20.82
24474	1	26.02	SG-1B	71	ND	< LOD 0.5	ND	< LOD 19.22
24469	2	26.02	SG-1B	71	ND	< LOD 0.5	ND	< LOD 19.22
24492	3	26.10	SG-1B	71	1.20	> LOQ 1.0	45.98	> LOQ 38.31

Air Sample Results - Nickel

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Nickel			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	19.00	> LOQ 5.0	723.81	> LOQ 190.48
24489	1	48.42	CP-3A	72	ND	< LOD 0.5	ND	< LOD 10.33
24491	2	47.93	CP-3A	72	ND	< LOD 0.5	ND	< LOD 10.43
24482	3	48.35	CP-3A	72	1.40	> LOQ 1.0	28.96	> LOQ 20.68
24486	OBZ	48.32	CP-3A	72	1.70	> LOQ 1.0	35.18	> LOQ 20.70
24516	1	36.34	CP-3B	73	ND	< LOD 0.5	ND	< LOD 13.76
24502	2	36.02	CP-3B	73	0.97	< LOQ 1.0	26.93	< LOQ 27.76
24515	3	36.48	CP-3B	73	1.30	> LOQ 1.0	35.64	> LOQ 27.41
24500	OBZ	40.27	CP-3B	73	ND	< LOD 0.5	ND	< LOD 12.42
24504	1	48.47	G-7A	74	ND	< LOD 0.5	ND	< LOD 10.32
24513	2	48.22	G-7A	74	2.70	> LOQ 1.0	55.99	> LOQ 20.74
24458	3	47.94	G-7A	74	ND	< LOD 0.5	ND	< LOD 10.43
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.5	ND	< LOD 10.47
24404	1	48.68	G-7B	75	ND	< LOD 0.5	ND	< LOD 10.27
24451	2	48.06	G-7B	75	ND	< LOD 0.5	ND	< LOD 10.40
24447	3	47.16	G-7B	75	0.63	< LOQ 1.0	13.36	< LOQ 21.20
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.5	ND	< LOD 10.58
24456	1	49.19	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.16
24480	2	48.26	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.36
24429	3	47.68	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.49
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.5	ND	< LOD 10.45
24427	1	48.54	CP-4A	78	0.79	< LOQ 1.0	16.28	< LOQ 20.60
24435	2	47.71	CP-4A	78	2.90	> LOQ 1.0	60.78	> LOQ 20.96
24244	3	49.01	CP-4A	78	15.00	> LOQ 2.0	306.06	> LOQ 40.81
24220	OBZ	48.74	CP-4A	78	3.30	> LOQ 1.0	67.71	> LOQ 20.52
24460	1	50.05	CP-4B	79	0.69	< LOQ 1.0	13.79	< LOQ 19.98
24465	2	48.47	CP-4B	79	2.50	> LOQ 1.0	51.58	> LOQ 20.63
24207	3	48.49	CP-4B	79	11.00	> LOQ 2.0	226.85	> LOQ 41.25
24390	OBZ	49.02	CP-4B	79	1.00	> LOQ 1.0	20.4	> LOQ 20.40
24259	1	48.76	SS-07	80	ND	< LOD 0.5	ND	< LOD 10.25
24421	2	48.13	SS-07	80	ND	< LOD 0.5	ND	< LOD 10.39
24445	3	47.87	SS-07	80	0.73	< LOQ 1.0	15.25	< LOQ 20.89
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.5	ND	< LOD 10.31
24459	1	48.96	N-02	81	30.00	> LOQ 1.0	612.75	> LOQ 20.42
24417	2	48.11	N-02	81	70.00	> LOQ 1.0	1455	> LOQ 20.79
24442	3	48.01	N-02	81	290.00	> LOQ 1.0	6040.41	> LOQ 20.83
24386	OBZ	48.19	N-02	81	60.00	> LOQ 1.0	1245.07	> LOQ 20.75
24452	1	48.20	SG-2B	82	7.80	> LOQ 1.0	161.83	> LOQ 20.75
24453	2	48.59	SG-2B	82	17.00	> LOQ 1.0	349.87	> LOQ 20.58
24420	3	47.84	SG-2B	82	33.00	> LOQ 1.0	689.8	> LOQ 20.90
24444	OBZ	47.95	SG-2B	82	210.00	> LOQ 5.0	4379.56	> LOQ 104.28
24455	1	48.56	CS-07	83	0.85	< LOQ 1.0	17.5	< LOQ 20.59
24433	2	47.96	CS-07	83	2.90	> LOQ 1.0	60.47	> LOQ 20.85
24398	3	48.06	CS-07	83	17.00	> LOQ 1.0	353.72	> LOQ 20.81
24511	OBZ	47.96	CS-07	83	2.60	> LOQ 1.0	54.21	> LOQ 20.85
24454	1	49.34	CPDS-1A	84	ND	< LOD 0.5	ND	< LOD 10.13
24291	2	48.49	CPDS-1A	84	1.80	> LOQ 1.0	37.12	> LOQ 20.62
24209	3	48.43	CPDS-1A	84	5.60	> LOQ 1.0	115.63	> LOQ 20.65
24402	OBZ	48.77	CPDS-1A	84	4.70	> LOQ 1.0	96.37	> LOQ 20.50
24204	1	49.46	CPDS-1B	85	ND	< LOD 0.5	ND	< LOD 10.11
24273	2	48.35	CPDS-1B	85	0.99	< LOQ 1.0	20.48	< LOQ 20.68
24223	3	48.82	CPDS-1B	85	4.60	> LOQ 1.0	94.22	> LOQ 20.48
24466	OBZ	49.96	CPDS-1B	85	1.70	> LOQ 1.0	34.03	> LOQ 20.02

Airborne Sample Data Analysis - Nickel

NIOSH REL 15.0 micrograms/cubic meter

OSHA PEL 1000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 10.30	ND	< LOD 10.42	ND	< LOD 10.32	ND	< LOD 10.35
CS-01	ND	< LOD 10.30	33.33	> LOQ 20.83	82.53	> LOQ 20.63	22.95	> LOQ 20.87
CS-02	10.82	< LOQ 20.80	33.44	> LOQ 20.90	160.38	> LOQ 20.83	56.26	> LOQ 20.84
CS-03	ND	< LOD 10.31	33.13	> LOQ 20.71	134.80	> LOQ 20.74	33.13	> LOQ 20.71
CS-04	ND	< LOD 10.29	19.67	< LOQ 20.93	22.78	> LOQ 20.71	12.56	< LOQ 20.58
CS-05	ND	< LOD 10.32	22.95	> LOQ 20.86	33.49	> LOQ 20.93	25.98	< LOQ 32.88
CS-06	ND	< LOD 10.43	161.26	> LOQ 20.94	53.82	> LOQ 20.70	20.19	< LOQ 20.82
CS-07	17.5	< LOQ 20.59	60.47	> LOQ 20.85	353.72	> LOQ 20.81	54.21	> LOQ 20.85
CSDS-01	ND	< LOD 10.38	45.82	> LOQ 20.83	83.06	> LOQ 20.76	31.2	> LOQ 20.80
CSDS-02	ND	< LOD 10.30	24.81	> LOQ 20.68	66.24	> LOQ 20.70	31.39	> LOQ 20.93
N-01	89.41	> LOQ 20.32	396.16	> LOQ 20.85	2897.35	> LOQ 20.70	1311.48	> LOQ 20.49
N-02	612.75	> LOQ 20.42	1455	> LOQ 20.79	6040.41	> LOQ 20.83	1245.07	> LOQ 20.75
O-1	864.91	> LOQ 20.59	1754.02	> LOQ 20.88	4520.24	> LOQ 20.55	1025.53	> LOQ 20.93
S-01	ND	< LOD 10.38	ND	< LOD 10.44	ND	< LOD 10.44	ND	< LOD 10.43
S-02	ND	< LOD 10.42	ND	< LOD 10.47	ND	< LOD 10.42	ND	< LOD 10.44
SH-01	ND	< LOD 10.44	ND	< LOD 10.45	ND	< LOD 10.36	ND	< LOD 10.40
SS-01	ND	< LOD 10.32	12.11	< LOQ 20.88	ND	< LOD 10.34	ND	< LOD 10.35
SS-02	ND	< LOD 10.39	14.81	< LOQ 20.86	ND	< LOD 10.35	ND	< LOD 10.28
SS-03	ND	< LOD 10.41	ND	< LOD 10.50	ND	< LOD 10.22	ND	< LOD 10.08
SS-04	ND	< LOD 10.46	ND	< LOD 10.46	16.32	< LOQ 20.92	ND	< LOD 10.29
SS-05	ND	< LOD 10.04	ND	< LOD 10.49	ND	< LOD 10.39	ND	< LOD 10.25
SS-06	ND	< LOD 10.16	ND	< LOD 10.36	ND	< LOD 10.49	ND	< LOD 10.45
SS-07	ND	< LOD 10.25	ND	< LOD 10.39	15.25	< LOQ 20.89	ND	< LOD 10.31
SSDS-01	ND	< LOD 10.29	ND	< LOD 10.45	ND	< LOD 10.31	ND	< LOD 10.35
SSDS-02	ND	< LOD 10.42	ND	< LOD 10.42	ND	< LOD 10.32	ND	< LOD 10.13
SSDS-03	ND	< LOD 10.11	ND	< LOD 9.93	ND	< LOD 9.95	ND	< LOD 10.36
CP-1A	15.26	< LOQ 20.62	ND	< LOD 10.36	13.07	< LOQ 20.75	ND	< LOD 10.47
CP-1B	21.22	< LOQ 23.57	ND	< LOD 11.90	ND	< LOD 11.77	ND	< LOD 11.97
CP-2A	ND	< LOD 10.32	29.28	> LOQ 20.91	126.50	> LOQ 41.48	49.85	> LOQ 20.77
CP-2B	15.7	< LOQ 20.66	17.75	< LOQ 20.88	47.66	> LOQ 20.72	ND	< LOD 10.52
CP-3A	ND	< LOD 10.33	ND	< LOD 10.43	28.96	> LOQ 20.68	35.18	> LOQ 20.70
CP-3B	ND	< LOD 13.76	26.93	< LOQ 27.76	35.64	> LOQ 27.41	ND	< LOD 12.42
CP-4A	16.28	< LOQ 20.60	60.78	> LOQ 20.96	306.06	> LOQ 40.81	67.71	> LOQ 20.52
CP-4B	13.79	< LOQ 19.98	51.58	> LOQ 20.63	226.85	> LOQ 41.25	20.4	> LOQ 20.40
CPDS-1A	ND	< LOD 10.13	37.12	> LOQ 20.62	115.63	> LOQ 20.65	96.37	> LOQ 20.50
CPDS-1B	ND	< LOD 10.11	20.48	< LOQ 20.68	94.22	> LOQ 20.48	34.03	> LOQ 20.02
G-1A	ND	< LOD 10.39	ND	< LOD 10.44	ND	< LOD 10.38	ND	< LOD 10.22
G-1B	ND	< LOD 10.36	ND	< LOD 10.55	11.83	< LOQ 20.76	33.18	> LOQ 20.74
G-2A	ND	< LOD 10.54	ND	< LOD 10.61	ND	< LOD 10.36	ND	< LOD 10.41
G-2B	ND	< LOD 10.25	ND	< LOD 10.38	ND	< LOD 10.46	ND	< LOD 10.30
G-3A	ND	< LOD 10.34	ND	< LOD 10.39	ND	< LOD 10.49	ND	< LOD 10.42
G-4A	ND	< LOD 10.15	12.82	< LOQ 20.67	34.93	> LOQ 20.55	11.84	< LOQ 20.76
G-4B	ND	< LOD 10.33	ND	< LOD 10.41	17.36	< LOQ 20.67	ND	< LOD 10.33
G-5A	ND	< LOD 10.29	ND	< LOD 10.38	ND	< LOD 10.41	ND	< LOD 10.45
G-5B	ND	< LOD 10.44	ND	< LOD 10.38	ND	< LOD 10.42	ND	< LOD 10.42
G-6A	ND	< LOD 10.40	20.9	> LOQ 20.90	22.89	> LOQ 20.81	18.64	< LOQ 20.71
G-6B	ND	< LOD 10.25	12.22	< LOQ 21.07	22.49	> LOQ 20.44	15.27	< LOQ 20.64
G-7A	ND	< LOD 10.32	55.99	> LOQ 20.74	ND	< LOD 10.43	ND	< LOD 10.47
G-7B	ND	< LOD 10.27	ND	< LOD 10.40	13.36	< LOQ 21.20	ND	< LOD 10.58
SG-1A	28.58	> LOQ 20.42	19.29	< LOQ 20.75	70.57	> LOQ 20.76	474.52	> LOQ 20.63
SG-1B	ND	< LOD 19.22	ND	< LOD 19.22	45.98	> LOQ 38.31	723.81	> LOQ 190.48
SG-2A	493.93	> LOQ 20.58	521.92	> LOQ 20.88	704.81	> LOQ 41.46	2691.51	> LOQ 41.41
SG-2B	161.83	> LOQ 20.75	349.87	> LOQ 20.58	689.80	> LOQ 20.90	4379.56	> LOQ 104.28

Bulk Elemental Analysis - Nickel

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Nickel		Sample	Nickel	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 2.0	J95331-63 PB	ND	< LOD 2.0
CS-01	J95331-34 VB	28.00	> LOQ 4.0	J95331-34 PB	30.00	> LOQ 4.0
CS-02	J95331-37 VB	25.00	> LOQ 4.0	J95331-37 PB	28.00	> LOQ 4.0
CS-03	J95331-38 VB	44.00	> LOQ 4.0	J95331-38 PB	53.00	> LOQ 4.0
CS-04	J95331-39 VB	5.00	> LOQ 4.0	J95331-39 PB	5.00	> LOQ 4.0
CS-05	J95331-57 VB	2.80	< LOQ 4.0	J95331-57 PB	3.70	< LOQ 4.0
CS-06	J95331-70 VB	ND	< LOD 2.0	J95331-70 PB	4.30	> LOQ 4.0
CS-07	J95331-83 VB	20.00	> LOQ 4.0	J95331-83 PB	13.00	> LOQ 4.0
CSDS-01	J95331-31 VB	2.90	< LOQ 4.0	J95331-31 PB	5.00	> LOQ 4.0
CSDS-02	J95331-35 VB	22.00	> LOQ 4.0	J95331-35 PB	23.00	> LOQ 4.0
N-01	J95331-52 VB	660.00	> LOQ 4.0	J95331-52 PB	520.00	> LOQ 4.0
N-02	J95331-81 VB	640.00	> LOQ 4.0	J95331-81 PB	1200.00	> LOQ 4.0
O-1	J95331-69 VB	1700.00	> LOQ 4.0	J95331-69 PB	1800.00	> LOQ 4.0
S-01	J95331-28 VB	ND	< LOD 2.0	J95331-28 PB	ND	< LOD 2.0
S-02	J95331-29 VB	ND	< LOD 2.0	J95331-29 PB	2.70	< LOQ 4.0
SH-01	J95331-36 VB	ND	< LOD 2.0	J95331-36 PB	ND	< LOD 2.0
SS-01	J95331-32 VB	ND	< LOD 2.0	J95331-32 PB	ND	< LOD 2.0
SS-02	J95331-40 VB	ND	< LOD 2.0	J95331-40 PB	ND	< LOD 2.0
SS-03	J95331-45 VB	ND	< LOD 2.0	J95331-45 PB	ND	< LOD 2.0
SS-04	J95331-47 VB	ND	< LOD 2.0	J95331-47 PB	ND	< LOD 2.0
SS-05	J95331-53 VB	ND	< LOD 2.0	J95331-53 PB	ND	< LOD 2.0
SS-06	J95331-76 VB	3.00	< LOQ 4.0	J95331-76 PB	ND	< LOD 2.0
SS-07	J95331-80 VB	ND	< LOD 2.0	J95331-80 PB	ND	< LOD 2.0
SSDS-01	J95331-33 VB	ND	< LOD 2.0	J95331-33 PB	ND	< LOD 2.0
SSDS-02	J95331-44 VB	2.50	< LOQ 4.0	J95331-44 PB	3.30	< LOQ 4.0
SSDS-03	J95331-48 VB	ND	< LOD 2.0	J95331-48 PB	ND	< LOD 2.0
CP-1A	J95331-60 VB	ND	< LOD 2.0	J95331-60 PB	2.80	< LOQ 4.0
CP-1B	J95331-61 VB	2.60	< LOQ 4.0	J95331-61 PB	5.50	> LOQ 4.0
CP-2A	J95331-67 VB	24.00	> LOQ 4.0	J95331-67 PB	27.00	> LOQ 8.0
CP-2B	J95331-68 VB	33.00	> LOQ 8.0	J95331-68 PB	35.00	> LOQ 8.0
CP-3A	J95331-72 VB	6.40	> LOQ 4.0	J95331-72 PB	6.10	> LOQ 4.0
CP-3B	J95331-73 VB	6.60	> LOQ 8.0	J95331-73 PB	8.60	> LOQ 4.0
CP-4A	J95331-78 VB	17.00	> LOQ 4.0	J95331-78 PB	28.00	> LOQ 8.0
CP-4B	J95331-79 VB	33.00	> LOQ 4.0	J95331-79 PB	33.00	> LOQ 4.0
CPDS-1A	J95331-84 VB	20.00	> LOQ 4.0	J95331-84 PB	26.00	> LOQ 4.0
CPDS-1B	J95331-85 VB	38.00	> LOQ 4.0	J95331-85 PB	28.00	> LOQ 4.0
G-1A	J95331-41 VB	ND	< LOD 2.0	J95331-41 PB	2.50	< LOQ 4.0
G-1B	J95331-46 VB	31.00	> LOQ 4.0	J95331-46 PB	21.00	> LOQ 4.0
G-2A	J95331-43 VB	ND	< LOD 2.0	J95331-43 PB	ND	< LOD 2.0
G-2B	J95331-50 VB	2.10	< LOQ 4.0	J95331-50 PB	ND	< LOD 2.0
G-3A	J95331-49 VB	ND	< LOD 2.0	J95331-49 PB	ND	< LOD 2.0
G-4A	J95331-55 VB	5.70	> LOQ 4.0	J95331-55 PB	6.10	> LOQ 4.0
G-4B	J95331-56 VB	11.00	> LOQ 4.0	J95331-56 PB	6.10	> LOQ 4.0
G-5A	J95331-58 VB	ND	< LOD 2.0	J95331-58 PB	ND	< LOD 2.0
G-5B	J95331-59 VB	ND	< LOD 2.0	J95331-59 PB	ND	< LOD 2.0
G-6A	J95331-64 VB	4.60	> LOQ 4.0	J95331-64 PB	7.00	> LOQ 4.0
G-6B	J95331-65 VB	5.90	> LOQ 4.0	J95331-65 PB	5.70	> LOQ 4.0
G-7A	J95331-74 VB	ND	< LOD 2.0	J95331-74 PB	ND	< LOD 2.0
G-7B	J95331-75 VB	ND	< LOD 2.0	J95331-75 PB	ND	< LOD 2.0
SG-1A	J95331-54 VB	140.00	> LOQ 4.0	J95331-54 PB	130.00	> LOQ 20.0
SG-1B	J95331-71 VB	130.00	> LOQ 20.0	J95331-71 PB	150.00	> LOQ 20.0
SG-2A	J95331-66 VB	980.00	> LOQ 20.0	J95331-66 PB	700.00	> LOQ 20.0
SG-2B	J95331-82 VB	990.00	> LOQ 20.0	J95331-82 PB	980.00	> LOQ 20.0

Comparison of Airborne Concentrations to Bulk Concentrations - Nickel

NIOSH REL 15.0 micrograms/cubic meter
OSHA PEL 1000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	33.33	82.53	22.95	28.00
CS-02	10.82	33.44	160.38	56.26	25.00
CS-03	ND	33.13	134.80	33.13	44.00
CS-04	ND	19.67	22.78	12.56	5.00
CS-05	ND	22.95	33.49	25.98	2.80
CS-06	ND	161.26	53.82	20.19	ND
CS-07	17.50	60.47	353.72	54.21	20.00
CSDS-01	ND	45.82	83.06	31.20	2.90
CSDS-02	ND	24.81	66.24	31.39	22.00
N-01	89.41	396.16	2897.35	1311.48	660.00
N-02	612.75	1455.00	6040.41	1245.07	640.00
O-1	864.91	1754.02	4520.24	1025.53	1700.00
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	12.11	ND	ND	ND
SS-02	ND	14.81	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	16.32	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	3.00
SS-07	ND	ND	15.25	ND	ND
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	2.50
SSDS-03	ND	ND	ND	ND	ND
CP-1A	15.26	ND	13.07	ND	ND
CP-2A	ND	29.28	126.50	49.85	24.00
CP-3A	ND	ND	28.96	35.18	6.40
CP-4A	16.28	60.78	306.06	67.71	17.00
CPDS-1A	ND	37.12	115.63	96.37	20.00
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	12.82	34.93	11.84	5.70
G-5A	ND	ND	ND	ND	ND
G-6A	ND	20.90	22.89	18.64	4.60
G-7A	ND	55.99	ND	ND	ND
SG-1A	28.58	19.29	70.57	474.52	140.00
SG-2A	493.93	521.92	704.81	2691.51	980.00

APPENDIX B - PHOSPHOROUS

Phosphorus

Repeated or prolonged exposure to phosphorus can cause "phossy jaw" with pain and swelling of the jaw, tooth aches, loosening of the teeth and deterioration of the jawbone. Chronic exposure can also cause weakness, anemia, loss of appetite, stomach complaints, cough and paleness. Chronic exposure may also cause bones to become brittle and break. The NIOSH REL and OSHA PEL for phosphorus are both 100 micrograms/cubic meter of air.

Air Sample Results - Phosphorus

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Phosphorus			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	3.40	< LOQ 4.3	70.6	< LOQ 89.29
24412	2	47.89	S-01	28	6.40	> LOQ 4.3	133.64	> LOQ 89.79
24441	3	47.90	S-01	28	15.00	> LOQ 4.3	313.15	> LOQ 89.77
24450	OBZ	47.93	S-01	28	5.60	> LOQ 4.3	116.84	> LOQ 89.71
24643	1	47.98	S-02	29	3.30	< LOQ 4.3	68.78	< LOQ 89.62
24625	2	47.76	S-02	29	13.00	> LOQ 4.3	272.19	> LOQ 90.03
24642	3	48.00	S-02	29	30.00	> LOQ 4.3	625	> LOQ 89.58
24632	OBZ	47.89	S-02	29	11.00	> LOQ 4.3	229.69	> LOQ 89.79
24634	1	48.16	CSDS-01	31	3.10	< LOQ 4.3	64.37	< LOQ 89.29
24650	2	48.01	CSDS-01	31	13.00	> LOQ 4.3	270.78	> LOQ 89.56
24644	3	48.16	CSDS-01	31	34.00	> LOQ 4.3	705.98	> LOQ 89.29
24645	OBZ	48.07	CSDS-01	31	17.00	> LOQ 4.3	353.65	> LOQ 89.45
24640	1	48.44	SS-01	32	ND	< LOD 2.0	ND	< LOD 41.29
24641	2	47.90	SS-01	32	2.90	< LOQ 4.3	60.54	< LOQ 89.77
24651	3	48.35	SS-01	32	4.70	> LOQ 4.3	97.21	> LOQ 88.93
24635	OBZ	48.30	SS-01	32	2.40	< LOQ 4.3	49.69	< LOQ 89.03
24646	1	48.58	SSDS-01	33	ND	< LOD 2.0	ND	< LOD 41.17
24626	2	47.84	SSDS-01	33	3.10	< LOQ 4.3	64.8	< LOQ 89.88
24638	3	48.49	SSDS-01	33	7.30	> LOQ 4.3	150.55	> LOQ 88.68
24647	OBZ	48.32	SSDS-01	33	5.80	> LOQ 4.3	120.03	> LOQ 88.99
24628	1	48.55	CS-01	34	6.10	> LOQ 4.3	125.64	> LOQ 88.57
24637	2	48.00	CS-01	34	18.00	> LOQ 4.3	375	> LOQ 89.58
24624	3	48.47	CS-01	34	73.00	> LOQ 4.3	1506.09	> LOQ 88.71
24636	OBZ	47.92	CS-01	34	18.00	> LOQ 4.3	375.63	> LOQ 89.73
24623	1	48.53	CSDS-02	35	6.60	> LOQ 4.3	136	> LOQ 88.60
24622	2	48.36	CSDS-02	35	24.00	> LOQ 4.3	496.28	> LOQ 88.92
24654	3	48.31	CSDS-02	35	84.00	> LOQ 4.3	1738.77	> LOQ 89.01
24653	OBZ	47.78	CSDS-02	35	30.00	> LOQ 4.3	627.88	> LOQ 90.00
24629	1	47.88	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.77
24633	2	47.86	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.79
24627	3	48.24	SH-01	36	4.20	< LOQ 4.3	87.06	< LOQ 89.14
24648	OBZ	48.08	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.60
24555	1	48.08	CS-02	37	4.80	> LOQ 4.3	99.83	> LOQ 89.43
24552	2	47.84	CS-02	37	15.00	> LOQ 4.3	313.55	> LOQ 89.88
24541	3	48.01	CS-02	37	61.00	> LOQ 4.3	1270.57	> LOQ 89.56
24529	OBZ	47.99	CS-02	37	23.00	> LOQ 4.3	479.27	> LOQ 89.60
24558	1	48.49	CS-03	38	11.00	> LOQ 4.3	226.85	> LOQ 88.68
24524	2	48.29	CS-03	38	45.00	> LOQ 4.3	931.87	> LOQ 89.05
24561	3	48.22	CS-03	38	160.00	> LOQ 4.3	3318.13	> LOQ 89.17
24559	OBZ	48.29	CS-03	38	44.00	> LOQ 4.3	911.16	> LOQ 89.05
24543	1	48.61	CS-04	39	ND	< LOD 2.0	ND	< LOD 41.14
24532	2	47.78	CS-04	39	4.30	> LOQ 4.3	90	> LOQ 90.00
24546	3	48.29	CS-04	39	11.00	> LOQ 4.3	227.79	> LOQ 89.05
24557	OBZ	48.58	CS-04	39	6.20	> LOQ 4.3	127.62	> LOQ 88.51
24560	1	48.13	SS-02	40	ND	< LOD 2.0	ND	< LOD 41.55
24565	2	47.95	SS-02	40	2.80	< LOQ 4.3	58.39	< LOQ 89.68
24630	3	48.32	SS-02	40	4.20	< LOQ 4.3	86.92	< LOQ 88.99
24553	OBZ	48.62	SS-02	40	3.00	< LOQ 4.3	61.7	< LOQ 88.44
24525	1	48.13	G-1A	41	ND	< LOD 2.0	ND	< LOD 41.55
24563	2	47.87	G-1A	41	2.10	< LOQ 4.3	43.87	< LOQ 89.83
24547	3	48.17	G-1A	41	9.40	> LOQ 4.3	195.14	> LOQ 89.27
24526	OBZ	48.91	G-1A	41	ND	< LOD 2.0	ND	< LOD 40.89
24538	1	47.45	G-2A	43	ND	< LOD 2.0	ND	< LOD 42.15

Air Sample Results - Phosphorus

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Phosphorus			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24545	2	47.12	G-2A	43	9.20	> LOQ 4.3	195.25	> LOQ 91.26
24533	3	48.24	G-2A	43	15.00	> LOQ 4.3	310.95	> LOQ 89.14
24540	OBZ	48.04	G-2A	43	8.80	> LOQ 4.3	183.18	> LOQ 89.51
24528	1	47.99	SSDS-02	44	ND	< LOD 2.0	ND	< LOD 41.68
24544	2	48.00	SSDS-02	44	5.60	> LOQ 4.3	116.67	> LOQ 89.58
24567	3	48.46	SSDS-02	44	13.00	> LOQ 4.3	268.26	> LOQ 88.73
24539	OBZ	49.37	SSDS-02	44	3.50	< LOQ 4.3	70.89	< LOQ 87.10
24571	1	48.05	SS-03	45	ND	< LOD 2.0	ND	< LOD 41.62
24536	2	47.60	SS-03	45	ND	< LOD 2.0	ND	< LOD 42.02
24534	3	48.94	SS-03	45	ND	< LOD 2.0	ND	< LOD 40.87
24570	OBZ	49.61	SS-03	45	ND	< LOD 2.0	ND	< LOD 40.31
24568	1	48.28	G-1B	46	ND	< LOD 2.0	ND	< LOD 41.43
24592	2	47.38	G-1B	46	ND	< LOD 2.0	ND	< LOD 42.21
24593	3	48.17	G-1B	46	3.80	< LOQ 4.3	78.89	< LOQ 89.27
24535	OBZ	48.22	G-1B	46	2.50	< LOQ 4.3	51.85	< LOQ 89.17
24590	1	47.81	SS-04	47	ND	< LOD 2.0	ND	< LOD 41.83
24605	2	47.78	SS-04	47	7.80	< LOD 2.0	7.8	< LOD 2.0
24562	3	47.80	SS-04	47	12.00	> LOQ 4.3	251.05	> LOQ 89.96
24531	OBZ	48.59	SS-04	47	8.50	> LOQ 4.3	174.93	> LOQ 88.50
24527	1	49.48	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 40.42
24569	2	50.35	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 39.72
24584	3	50.24	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 39.81
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 41.44
24600	1	48.34	G-3A	49	2.10	< LOQ 4.3	43.44	< LOQ 88.95
24616	2	48.11	G-3A	49	3.30	< LOQ 4.3	68.59	< LOQ 89.38
24585	3	47.65	G-3A	49	14.00	> LOQ 4.3	293.81	> LOQ 90.24
24583	OBZ	47.99	G-3A	49	6.10	> LOQ 4.3	127.11	> LOQ 89.60
24587	1	48.79	G-2B	50	ND	< LOD 2.0	ND	< LOD 40.99
24602	2	48.17	G-2B	50	5.20	> LOQ 4.3	107.95	> LOQ 89.27
24564	3	47.81	G-2B	50	9.20	> LOQ 4.3	192.43	> LOQ 89.94
24621	OBZ	48.54	G-2B	50	ND	< LOD 2.0	ND	< LOD 41.20
24618	1	49.21	N-01	52	ND	< LOD 2.0	ND	< LOD 40.64
24611	2	47.96	N-01	52	ND	< LOD 2.0	ND	< LOD 41.70
24588	3	48.32	N-01	52	ND	< LOD 2.0	ND	< LOD 41.39
24615	OBZ	48.80	N-01	52	ND	< LOD 2.0	ND	< LOD 40.98
24597	1	49.78	SS-05	53	ND	< LOD 2.0	ND	< LOD 40.18
24599	2	47.68	SS-05	53	ND	< LOD 2.0	ND	< LOD 41.95
24575	3	48.11	SS-05	53	3.10	< LOQ 4.3	64.44	< LOQ 89.38
24617	OBZ	48.79	SS-05	53	3.40	< LOQ 4.3	69.69	< LOQ 88.13
24609	1	48.98	SG-1A	54	ND	< LOD 2.0	ND	< LOD 40.83
24596	2	48.20	SG-1A	54	ND	< LOD 2.0	ND	< LOD 41.49
24610	3	48.18	SG-1A	54	7.00	> LOQ 4.3	145.29	> LOQ 89.25
24576	OBZ	48.47	SG-1A	54	20.00	< LOQ 4.3	412.63	< LOQ 88.71
24606	1	49.24	G-4A	55	2.50	< LOQ 4.3	50.77	< LOQ 87.33
24620	2	48.37	G-4A	55	11.00	> LOQ 4.3	227.41	> LOQ 88.90
24573	3	48.67	G-4A	55	61.00	> LOQ 4.3	1253.34	> LOQ 88.35
24505	OBZ	48.16	G-4A	55	15.00	> LOQ 4.3	311.46	> LOQ 89.29
24340	1	48.38	G-4B	56	3.30	< LOQ 4.3	68.21	< LOQ 88.88
24607	2	48.01	G-4B	56	16.00	> LOQ 4.3	333.26	> LOQ 89.56
24595	3	48.38	G-4B	56	45.00	> LOQ 4.3	930.14	> LOQ 88.88
24598	OBZ	48.42	G-4B	56	17.00	> LOQ 4.3	351.09	> LOQ 88.81
24580	1	48.44	CS-05	57	3.20	< LOQ 4.3	66.06	< LOQ 88.77
24604	2	47.93	CS-05	57	5.20	> LOQ 4.3	108.49	> LOQ 89.71

Air Sample Results - Phosphorus

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Phosphorus			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	12.00	> LOQ 4.3	251.15	> LOQ 90.00
24574	OBZ	30.41	CS-05	57	5.00	> LOQ 4.3	164.42	> LOQ 141.40
24614	1	48.58	G-5A	58	ND	< LOD 2.0	ND	< LOD 41.17
24577	2	48.18	G-5A	58	2.70	< LOQ 4.3	56.04	< LOQ 89.25
24572	3	48.05	G-5A	58	7.40	> LOQ 4.3	154.01	> LOQ 89.49
24582	OBZ	47.83	G-5A	58	4.70	> LOQ 4.3	98.26	> LOQ 89.90
24322	1	47.88	G-5B	59	ND	< LOD 2.0	ND	< LOD 41.77
24354	2	48.16	G-5B	59	4.10	< LOQ 4.3	85.13	< LOQ 89.29
24510	3	47.98	G-5B	59	10.00	> LOQ 4.3	208.42	> LOQ 89.62
24321	OBZ	47.99	G-5B	59	ND	< LOD 2.0	ND	< LOD 41.68
24497	1	48.49	CP-1A	60	2.50	< LOQ 4.3	51.56	< LOQ 88.68
24333	2	48.28	CP-1A	60	3.60	< LOQ 4.3	74.57	< LOQ 89.06
24326	3	48.19	CP-1A	60	8.60	> LOQ 4.3	178.46	> LOQ 89.23
24329	OBZ	47.74	CP-1A	60	3.00	< LOQ 4.3	62.84	< LOQ 90.07
24499	1	42.42	CP-1B	62	ND	< LOD 2.0	ND	< LOD 47.15
24506	2	42.02	CP-1B	62	ND	< LOD 2.0	ND	< LOD 47.60
24388	3	42.47	CP-1B	62	13.00	> LOQ 4.3	306.1	> LOQ 101.25
24315	OBZ	41.77	CP-1B	62	4.90	> LOQ 4.3	117.31	> LOQ 102.94
24318	1	48.56	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.19
24308	2	48.00	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.67
24330	3	48.47	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.26
24230	OBZ	48.31	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.40
24363	1	48.10	G-6A	64	5.50	> LOQ 4.3	114.35	> LOQ 89.40
24398	2	47.84	G-6A	64	21.00	> LOQ 4.3	438.96	> LOQ 89.88
24351	3	48.06	G-6A	64	38.00	> LOQ 4.3	790.68	> LOQ 89.47
24594	OBZ	48.29	G-6A	64	22.00	> LOQ 4.3	455.58	> LOQ 89.05
24312	1	48.76	G-6B	65	4.20	< LOQ 4.3	86.14	< LOQ 88.19
24484	2	47.45	G-6B	65	16.00	> LOQ 4.3	337.2	> LOQ 90.62
24327	3	48.92	G-6B	65	28.00	> LOQ 4.3	572.36	> LOQ 87.90
24389	OBZ	48.46	G-6B	65	8.50	> LOQ 4.3	175.4	> LOQ 88.73
24348	1	48.59	SG-2A	66	4.00	< LOQ 8.6	82.32	< LOQ 176.99
24314	2	47.90	SG-2A	66	4.00	< LOQ 4.3	83.51	< LOQ 89.77
24494	3	48.24	SG-2A	66	7.70	< LOQ 8.6	159.62	< LOQ 178.28
24337	OBZ	48.30	SG-2A	66	46.00	> LOQ 8.6	952.38	> LOQ 178.05
24508	1	48.47	CP-2A	67	19.00	> LOQ 4.3	392	> LOQ 88.71
24361	2	47.82	CP-2A	67	48.00	> LOQ 4.3	1003.76	> LOQ 89.92
24359	3	48.22	CP-2A	67	300.00	> LOQ 8.6	6221.48	> LOQ 178.35
24471	OBZ	48.14	CP-2A	67	120.00	> LOQ 4.3	2492.73	> LOQ 89.32
24373	1	48.41	CP-2B	68	48.00	> LOQ 4.3	991.53	> LOQ 88.82
24468	2	47.90	CP-2B	68	26.00	> LOQ 4.3	542.8	> LOQ 89.77
24481	3	48.26	CP-2B	68	110.00	> LOQ 4.3	2279.32	> LOQ 89.10
24391	OBZ	47.53	CP-2B	68	21.00	> LOQ 4.3	441.83	> LOQ 90.47
24356	1	48.56	O-1	69	2.90	< LOQ 4.3	59.72	< LOQ 88.55
24470	2	47.89	O-1	69	2.40	< LOQ 4.3	50.11	< LOQ 89.79
24467	3	48.67	O-1	69	ND	< LOD 2.0	ND	< LOD 41.09
24313	OBZ	47.78	O-1	69	ND	< LOD 2.0	ND	< LOD 41.86
24501	1	47.96	CS-06	70	7.90	> LOQ 4.3	164.72	> LOQ 89.66
24496	2	47.75	CS-06	70	16.00	> LOQ 4.3	335.08	> LOQ 90.05
24478	3	48.31	CS-06	70	18.00	> LOQ 4.3	372.59	> LOQ 89.01
24503	OBZ	48.04	CS-06	70	13.00	> LOQ 4.3	270.61	> LOQ 89.51
24474	1	26.02	SG-1B	71	ND	< LOD 2.0	ND	< LOD 76.86
24469	2	26.02	SG-1B	71	2.50	< LOQ 4.3	96.08	< LOQ 165.26
24492	3	26.10	SG-1B	71	ND	< LOD 2.0	ND	< LOD 76.63

Air Sample Results - Phosphorus

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Phosphorus			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	38.00	> LOQ 22.0	1447.62	> LOQ 838.10
24489	1	48.42	CP-3A	72	6.40	> LOQ 4.3	132.18	> LOQ 88.81
24491	2	47.93	CP-3A	72	21.00	> LOQ 4.3	438.14	> LOQ 89.71
24482	3	48.35	CP-3A	72	100.00	> LOQ 4.3	2068.25	> LOQ 88.93
24486	OBZ	48.32	CP-3A	72	100.00	> LOQ 4.3	2069.54	> LOQ 88.99
24516	1	36.34	CP-3B	73	9.70	> LOQ 4.3	266.92	> LOQ 118.33
24502	2	36.02	CP-3B	73	43.00	> LOQ 4.3	1193.78	> LOQ 119.38
24515	3	36.48	CP-3B	73	65.00	> LOQ 4.3	1781.8	> LOQ 117.87
24500	OBZ	40.27	CP-3B	73	26.00	> LOQ 4.3	645.64	> LOQ 106.78
24504	1	48.47	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.26
24513	2	48.22	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.48
24458	3	47.94	G-7A	74	3.80	< LOQ 4.3	79.27	< LOQ 89.70
24389	OBZ	47.75	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.88
24404	1	48.68	G-7B	75	ND	< LOD 2.0	ND	< LOD 41.08
24451	2	48.06	G-7B	75	2.50	< LOQ 4.3	52.02	< LOQ 89.47
24447	3	47.16	G-7B	75	ND	< LOD 2.0	ND	< LOD 42.41
24423	OBZ	47.27	G-7B	75	ND	< LOD 2.0	ND	< LOD 42.31
24456	1	49.19	SS-06	76	2.80	< LOQ 4.3	56.92	< LOQ 87.42
24480	2	48.26	SS-06	76	5.80	> LOQ 4.3	120.18	> LOQ 89.10
24429	3	47.68	SS-06	76	ND	< LOD 2.0	ND	< LOD 41.95
24418	OBZ	47.83	SS-06	76	4.90	> LOQ 4.3	102.45	> LOQ 89.90
24427	1	48.54	CP-4A	78	8.00	> LOQ 4.3	164.81	> LOQ 88.59
24435	2	47.71	CP-4A	78	33.00	> LOQ 4.3	691.68	> LOQ 90.13
24244	3	49.01	CP-4A	78	160.00	> LOQ 8.6	3264.64	> LOQ 175.47
24220	OBZ	48.74	CP-4A	78	33.00	> LOQ 4.3	677.06	> LOQ 88.22
24460	1	50.05	CP-4B	79	6.40	> LOQ 4.3	127.87	> LOQ 85.91
24465	2	48.47	CP-4B	79	20.00	> LOQ 4.3	412.63	> LOQ 88.71
24207	3	48.49	CP-4B	79	110.00	> LOQ 8.6	2268.51	> LOQ 177.36
24390	OBZ	49.02	CP-4B	79	5.20	> LOQ 4.3	106.08	> LOQ 87.72
24259	1	48.76	SS-07	80	3.60	< LOQ 4.3	73.83	< LOQ 88.19
24421	2	48.13	SS-07	80	2.30	< LOQ 4.3	47.79	< LOQ 89.34
24445	3	47.87	SS-07	80	10.00	> LOQ 4.3	208.9	> LOQ 89.83
24432	OBZ	48.49	SS-07	80	ND	< LOD 2.0	ND	< LOD 41.25
24459	1	48.96	N-02	81	3.40	< LOQ 4.3	69.44	< LOQ 87.83
24417	2	48.11	N-02	81	7.10	> LOQ 4.3	147.58	> LOQ 89.38
24442	3	48.01	N-02	81	30.00	> LOQ 4.3	624.87	> LOQ 89.56
24386	OBZ	48.19	N-02	81	3.30	< LOQ 4.3	68.48	< LOQ 89.23
24452	1	48.20	SG-2B	82	ND	< LOD 2.0	ND	< LOD 41.49
24453	2	48.59	SG-2B	82	2.20	< LOQ 4.3	45.28	< LOQ 88.50
24420	3	47.84	SG-2B	82	6.90	> LOQ 4.3	144.23	> LOQ 89.88
24444	OBZ	47.95	SG-2B	82	23.00	< LOQ 43.0	479.67	< LOQ 896.77
24455	1	48.56	CS-07	83	30.00	> LOQ 4.3	617.79	> LOQ 88.55
24433	2	47.96	CS-07	83	75.00	> LOQ 4.3	1563.8	> LOQ 89.66
24398	3	48.06	CS-07	83	380.00	> LOQ 4.3	7906.78	> LOQ 89.47
24511	OBZ	47.96	CS-07	83	61.00	> LOQ 4.3	1271.89	> LOQ 89.66
24454	1	49.34	CPDS-1A	84	23.00	> LOQ 4.3	466.15	> LOQ 87.15
24291	2	48.49	CPDS-1A	84	42.00	> LOQ 4.3	866.16	> LOQ 88.68
24209	3	48.43	CPDS-1A	84	290.00	> LOQ 4.3	5988.02	> LOQ 88.79
24402	OBZ	48.77	CPDS-1A	84	110.00	> LOQ 4.3	2255.48	> LOQ 88.17
24204	1	49.46	CPDS-1B	85	29.00	> LOQ 4.3	586.33	> LOQ 86.94
24273	2	48.35	CPDS-1B	85	49.00	> LOQ 4.3	1013.44	> LOQ 88.93
24223	3	48.82	CPDS-1B	85	240.00	> LOQ 4.3	4916.02	> LOQ 88.08
24466	OBZ	49.96	CPDS-1B	85	39.00	> LOQ 4.3	780.62	> LOQ 86.07

Airborne Sample Data Analysis - Phosphorus

NIOSH REL 100.0 micrograms/cubic meter
OSHA PEL 100.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 41.19	ND	< LOD 41.67	ND	< LOD 41.26	ND	< LOD 41.40
CS-01	125.64	> LOQ 88.57	375	> LOQ 89.58	1506.09	> LOQ 88.71	375.63	> LOQ 89.73
CS-02	99.83	> LOQ 89.43	313.55	> LOQ 89.88	1270.57	> LOQ 89.56	479.27	> LOQ 89.60
CS-03	226.85	> LOQ 88.68	931.87	> LOQ 89.05	3318.13	> LOQ 89.17	911.16	> LOQ 89.05
CS-04	ND	< LOD 41.14	90	> LOQ 90.00	227.79	> LOQ 89.05	127.62	> LOQ 88.51
CS-05	66.06	< LOQ 88.77	108.49	> LOQ 89.71	251.15	> LOQ 90.00	164.42	> LOQ 141.40
CS-06	164.72	> LOQ 89.66	335.08	> LOQ 90.05	372.59	> LOQ 89.01	270.61	> LOQ 89.51
CS-07	617.79	> LOQ 88.55	1563.8	> LOQ 89.66	7906.78	> LOQ 89.47	1271.89	> LOQ 89.66
CSDS-01	64.37	< LOQ 89.29	270.78	> LOQ 89.56	705.98	> LOQ 89.29	353.65	> LOQ 89.45
CSDS-02	136	> LOQ 88.60	496.28	> LOQ 88.92	1738.77	> LOQ 89.01	627.88	> LOQ 90.00
N-01	ND	< LOD 40.64	ND	< LOD 41.70	ND	< LOD 41.39	ND	< LOD 40.98
N-02	69.44	< LOQ 87.83	147.58	> LOQ 89.38	624.87	> LOQ 89.56	68.48	< LOQ 89.23
O-1	59.72	< LOQ 88.55	50.11	< LOQ 89.79	ND	< LOD 41.09	ND	< LOD 41.86
S-01	70.6	< LOQ 89.29	133.64	> LOQ 89.79	313.15	> LOQ 89.77	116.84	> LOQ 89.71
S-02	68.78	< LOQ 89.62	272.19	> LOQ 90.03	625.00	> LOQ 89.58	229.69	> LOQ 89.79
SH-01	ND	< LOD 41.77	ND	< LOD 41.79	87.06	< LOQ 89.14	ND	< LOD 41.60
SS-01	ND	< LOD 41.29	60.54	< LOQ 89.77	97.21	> LOQ 88.93	49.69	< LOQ 89.03
SS-02	ND	< LOD 41.55	58.39	< LOQ 89.68	86.92	< LOQ 88.99	61.7	< LOQ 88.44
SS-03	ND	< LOD 41.62	ND	< LOD 42.02	ND	< LOD 40.87	ND	< LOD 40.31
SS-04	ND	< LOD 41.83	7.8	< LOD 2.0	251.05	> LOQ 89.96	174.93	> LOQ 88.50
SS-05	ND	< LOD 40.18	ND	< LOD 41.95	64.44	< LOQ 89.38	69.69	< LOQ 88.13
SS-06	56.92	< LOQ 87.42	120.18	> LOQ 89.10	ND	< LOD 41.95	102.45	> LOQ 89.90
SS-07	73.83	< LOQ 88.19	47.79	< LOQ 89.34	208.90	> LOQ 89.83	ND	< LOD 41.25
SSDS-01	ND	< LOD 41.17	64.8	< LOQ 89.88	150.55	> LOQ 88.68	120.03	> LOQ 88.99
SSDS-02	ND	< LOD 41.68	116.67	> LOQ 89.58	268.26	> LOQ 88.73	70.89	< LOQ 87.10
SSDS-03	ND	< LOD 40.42	ND	< LOD 39.72	ND	< LOD 39.81	ND	< LOD 41.44
CP-1A	51.56	< LOQ 88.68	74.57	< LOQ 89.06	178.46	> LOQ 89.23	62.84	< LOQ 90.07
CP-1B	ND	< LOD 47.15	ND	< LOD 47.60	306.10	> LOQ 101.25	117.31	> LOQ 102.94
CP-2A	392	> LOQ 88.71	1003.76	> LOQ 89.92	6221.48	> LOQ 178.35	2492.73	> LOQ 89.32
CP-2B	991.53	> LOQ 88.82	542.8	> LOQ 89.77	2279.32	> LOQ 89.10	441.83	> LOQ 90.47
CP-3A	132.18	> LOQ 88.81	438.14	> LOQ 89.71	2068.25	> LOQ 88.93	2069.54	> LOQ 88.99
CP-3B	266.92	> LOQ 118.33	1193.78	> LOQ 119.38	1781.80	> LOQ 117.87	645.64	> LOQ 106.78
CP-4A	164.81	> LOQ 88.59	691.68	> LOQ 90.13	3264.64	> LOQ 175.47	677.06	> LOQ 88.22
CP-4B	127.87	> LOQ 85.91	412.63	> LOQ 88.71	2268.51	> LOQ 177.36	106.08	> LOQ 87.72
CPDS-1A	466.15	> LOQ 87.15	866.16	> LOQ 88.68	5988.02	> LOQ 88.79	2255.48	> LOQ 88.17
CPDS-1B	586.33	> LOQ 86.94	1013.44	> LOQ 88.93	4916.02	> LOQ 88.08	780.62	> LOQ 86.07
G-1A	ND	< LOD 41.55	43.87	< LOQ 89.83	195.14	> LOQ 89.27	ND	< LOD 40.89
G-1B	ND	< LOD 41.43	ND	< LOD 42.21	78.89	< LOQ 89.27	51.85	< LOQ 89.17
G-2A	ND	< LOD 42.15	195.25	> LOQ 91.26	310.95	> LOQ 89.14	183.18	> LOQ 89.51
G-2B	ND	< LOD 40.99	107.95	> LOQ 89.27	192.43	> LOQ 89.94	ND	< LOD 41.20
G-3A	43.44	< LOQ 88.95	68.59	< LOQ 89.38	293.81	> LOQ 90.24	127.11	> LOQ 89.60
G-4A	50.77	< LOQ 87.33	227.41	> LOQ 88.90	1253.34	> LOQ 88.35	311.46	> LOQ 89.29
G-4B	68.21	< LOQ 88.88	333.26	> LOQ 89.56	930.14	> LOQ 88.88	351.09	> LOQ 88.81
G-5A	ND	< LOD 41.17	56.04	< LOQ 89.25	154.01	> LOQ 89.49	98.26	> LOQ 89.90
G-5B	ND	< LOD 41.77	85.13	< LOQ 89.29	208.42	> LOQ 89.62	ND	< LOD 41.68
G-6A	114.35	> LOQ 89.40	438.96	> LOQ 89.88	790.68	> LOQ 89.47	455.58	> LOQ 89.05
G-6B	86.14	< LOQ 88.19	337.2	> LOQ 90.62	572.36	> LOQ 87.90	175.4	> LOQ 88.73
G-7A	ND	< LOD 41.26	ND	< LOD 41.48	79.27	< LOQ 89.70	ND	< LOD 41.88
G-7B	ND	< LOD 41.08	52.02	< LOQ 89.47	ND	< LOD 42.41	ND	< LOD 42.31
SG-1A	ND	< LOD 40.83	ND	< LOD 41.49	145.29	> LOQ 89.25	412.63	< LOQ 88.71
SG-1B	ND	< LOD 76.86	96.08	< LOQ 165.26	ND	< LOD 76.63	1447.62	> LOQ 838.10
SG-2A	82.32	< LOQ 176.99	83.51	< LOQ 89.77	159.62	< LOQ 178.28	952.38	> LOQ 178.05
SG-2B	ND	< LOD 41.49	45.28	< LOQ 88.50	144.23	> LOQ 89.88	479.67	< LOQ 896.77

Bulk Elemental Analysis - Phosphorus

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Phosphorus		Sample	Phosphorus	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 5.0	J95331-63 PB	ND	< LOD 5.0
CS-01	J95331-34 VB	1600.00	> LOQ 17.0	J95331-34 PB	1500.00	> LOQ 17.0
CS-02	J95331-37 VB	230.00	> LOQ 17.0	J95331-37 PB	220.00	> LOQ 17.0
CS-03	J95331-38 VB	1100.00	> LOQ 17.0	J95331-38 PB	1300.00	> LOQ 17.0
CS-04	J95331-39 VB	20.00	> LOQ 17.0	J95331-39 PB	42.00	> LOQ 17.0
CS-05	J95331-57 VB	ND	< LOD 5.0	J95331-57 PB	21.00	> LOQ 17.0
CS-06	J95331-70 VB	7.10	< LOQ 17.0	J95331-70 PB	31.00	> LOQ 17.0
CS-07	J95331-83 VB	97.00	> LOQ 17.0	J95331-83 PB	450.00	> LOQ 17.0
CSDS-01	J95331-31 VB	34.00	> LOQ 17.0	J95331-31 PB	59.00	> LOQ 17.0
CSDS-02	J95331-35 VB	1600.00	> LOQ 17.0	J95331-35 PB	1600.00	> LOQ 17.0
N-01	J95331-52 VB	5.80	< LOQ 17.0	J95331-52 PB	ND	< LOD 5.0
N-02	J95331-81 VB	51.00	> LOQ 17.0	J95331-81 PB	150.00	> LOQ 17.0
O-1	J95331-69 VB	7.80	< LOQ 17.0	J95331-69 PB	14.00	< LOQ 17.0
S-01	J95331-28 VB	36.00	> LOQ 17.0	J95331-28 PB	38.00	> LOQ 17.0
S-02	J95331-29 VB	37.00	> LOQ 17.0	J95331-29 PB	130.00	> LOQ 17.0
SH-01	J95331-36 VB	30.00	> LOQ 17.0	J95331-36 PB	33.00	> LOQ 17.0
SS-01	J95331-32 VB	14.00	< LOQ 17.0	J95331-32 PB	14.00	< LOQ 17.0
SS-02	J95331-40 VB	21.00	> LOQ 17.0	J95331-40 PB	16.00	< LOQ 17.0
SS-03	J95331-45 VB	6.90	< LOQ 17.0	J95331-45 PB	13.00	< LOQ 17.0
SS-04	J95331-47 VB	85.00	> LOQ 17.0	J95331-47 PB	140.00	> LOQ 17.0
SS-05	J95331-53 VB	23.00	> LOQ 17.0	J95331-53 PB	25.00	> LOQ 17.0
SS-06	J95331-76 VB	53.00	> LOQ 17.0	J95331-76 PB	67.00	> LOQ 17.0
SS-07	J95331-80 VB	ND	< LOD 5.0	J95331-80 PB	9.70	< LOQ 17.0
SSDS-01	J95331-33 VB	31.00	> LOQ 17.0	J95331-33 PB	30.00	> LOQ 17.0
SSDS-02	J95331-44 VB	86.00	> LOQ 17.0	J95331-44 PB	83.00	> LOQ 17.0
SSDS-03	J95331-48 VB	ND	< LOD 5.0	J95331-48 PB	ND	< LOD 5.0
CP-1A	J95331-60 VB	10.00	< LOQ 17.0	J95331-60 PB	77.00	> LOQ 17.0
CP-1B	J95331-61 VB	45.00	> LOQ 17.0	J95331-61 PB	58.00	> LOQ 17.0
CP-2A	J95331-67 VB	1100.00	> LOQ 17.0	J95331-67 PB	1500.00	> LOQ 34.0
CP-2B	J95331-68 VB	1300.00	> LOQ 34.0	J95331-68 PB	1400.00	> LOQ 34.0
CP-3A	J95331-72 VB	520.00	> LOQ 17.0	J95331-72 PB	500.00	> LOQ 17.0
CP-3B	J95331-73 VB	510.00	> LOQ 34.0	J95331-73 PB	500.00	> LOQ 17.0
CP-4A	J95331-78 VB	220.00	> LOQ 34.0	J95331-78 PB	290.00	> LOQ 34.0
CP-4B	J95331-79 VB	330.00	> LOQ 17.0	J95331-79 PB	360.00	> LOQ 17.0
CPDS-1A	J95331-84 VB	730.00	> LOQ 17.0	J95331-84 PB	1300.00	> LOQ 34.0
CPDS-1B	J95331-85 VB	1200.00	> LOQ 17.0	J95331-85 PB	1300.00	> LOQ 17.0
G-1A	J95331-41 VB	34.00	> LOQ 17.0	J95331-41 PB	47.00	> LOQ 17.0
G-1B	J95331-46 VB	31.00	> LOQ 17.0	J95331-46 PB	30.00	> LOQ 17.0
G-2A	J95331-43 VB	100.00	> LOQ 17.0	J95331-43 PB	130.00	> LOQ 17.0
G-2B	J95331-50 VB	150.00	> LOQ 17.0	J95331-50 PB	97.00	> LOQ 17.0
G-3A	J95331-49 VB	99.00	> LOQ 17.0	J95331-49 PB	93.00	> LOQ 17.0
G-4A	J95331-55 VB	140.00	> LOQ 17.0	J95331-55 PB	180.00	> LOQ 17.0
G-4B	J95331-56 VB	230.00	> LOQ 17.0	J95331-56 PB	180.00	> LOQ 17.0
G-5A	J95331-58 VB	25.00	> LOQ 17.0	J95331-58 PB	38.00	> LOQ 17.0
G-5B	J95331-59 VB	19.00	> LOQ 17.0	J95331-59 PB	25.00	> LOQ 17.0
G-6A	J95331-64 VB	160.00	> LOQ 17.0	J95331-64 PB	270.00	> LOQ 17.0
G-6B	J95331-65 VB	240.00	> LOQ 17.0	J95331-65 PB	150.00	> LOQ 17.0
G-7A	J95331-74 VB	5.70	< LOQ 17.0	J95331-74 PB	ND	< LOD 5.0
G-7B	J95331-75 VB	8.50	< LOQ 17.0	J95331-75 PB	ND	< LOD 5.0
SG-1A	J95331-54 VB	220.00	> LOQ 85.0	J95331-54 PB	250.00	> LOQ 85.0
SG-1B	J95331-71 VB	180.00	> LOQ 170.0	J95331-71 PB	310.00	> LOQ 85.0
SG-2A	J95331-66 VB	200.00	> LOQ 85.0	J95331-66 PB	130.00	> LOQ 85.0
SG-2B	J95331-82 VB	200.00	> LOQ 170	J95331-82 PB	190.00	> LOQ 170

Comparison of Airborne Concentrations to Bulk Concentrations - Phosphorus

NIOSH REL 100.0 micrograms/cubic meter
OSHA PEL 100.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	125.64	375.00	1506.09	375.63	1600.00
CS-02	99.83	313.55	1270.57	479.27	230.00
CS-03	226.85	931.87	3318.13	911.16	1100.00
CS-04	ND	90.00	227.79	127.62	20.00
CS-05	66.06	108.49	251.15	164.42	ND
CS-06	164.72	335.08	372.59	270.61	7.10
CS-07	617.79	1563.80	7906.78	1271.89	97.00
CSDS-01	64.37	270.78	705.98	353.65	34.00
CSDS-02	136.00	496.28	1738.77	627.88	1600.00
N-01	ND	ND	ND	ND	5.80
N-02	69.44	147.58	624.87	68.48	51.00
O-1	59.72	50.11	ND	ND	7.80
S-01	70.60	133.64	313.15	116.84	36.00
S-02	68.78	272.19	625.00	229.69	37.00
SH-01	ND	ND	87.06	ND	30.00
SS-01	ND	60.54	97.21	49.69	14.00
SS-02	ND	58.39	86.92	61.70	21.00
SS-03	ND	ND	ND	ND	6.90
SS-04	ND	7.80	251.05	174.93	85.00
SS-05	ND	ND	64.44	69.69	23.00
SS-06	56.92	120.18	ND	102.45	53.00
SS-07	73.83	47.79	208.90	ND	ND
SSDS-01	ND	64.80	150.55	120.03	31.00
SSDS-02	ND	116.67	268.26	70.89	86.00
SSDS-03	ND	ND	ND	ND	ND
CP-1A	51.56	74.57	178.46	62.84	10.00
CP-2A	392.00	1003.76	6221.48	2492.73	1100.00
CP-3A	132.18	438.14	2068.25	2069.54	520.00
CP-4A	164.81	691.68	3264.64	677.06	220.00
CPDS-1A	466.15	866.16	5988.02	2255.48	730.00
G-1A	ND	43.87	195.14	ND	34.00
G-2A	ND	195.25	310.95	183.18	100.00
G-3A	43.44	68.59	293.81	127.11	99.00
G-4A	50.77	227.41	1253.34	311.46	140.00
G-5A	ND	56.04	154.01	98.26	25.00
G-6A	114.35	438.96	790.68	455.58	160.00
G-7A	ND	ND	79.27	ND	5.70
SG-1A	ND	ND	145.29	412.63	220.00
SG-2A	82.32	83.51	159.62	952.38	200.00

APPENDIX B - PLATINUM

Platinum

Repeated exposure to soluble platinum salts may cause both respiratory and skin allergies. The effects may be followed by chest tightness, shortness of breath, and a blue discoloration of the skin and wheezing. A skin reaction consists of an itchy, red rash. Exposures to pure metallic platinum causes no intoxication. The NIOSH REL for platinum is 1,000 micrograms/cubic meter of air. For purposes of this study, the vacated OSHA PEL for platinum, which was 1,000 micrograms/cubic meter of air, is used, as there is no OSHA PEL listed for platinum.

Air Sample Results - Platinum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Platinum			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 3.0	ND	< LOD 62.29
24412	2	47.89	S-01	28	ND	< LOD 3.0	ND	< LOD 62.64
24441	3	47.90	S-01	28	ND	< LOD 3.0	ND	< LOD 62.63
24450	OBZ	47.93	S-01	28	ND	< LOD 3.0	ND	< LOD 62.59
24643	1	47.98	S-02	29	ND	< LOD 3.0	ND	< LOD 62.53
24625	2	47.76	S-02	29	ND	< LOD 3.0	ND	< LOD 62.81
24642	3	48.00	S-02	29	ND	< LOD 3.0	ND	< LOD 62.50
24632	OBZ	47.89	S-02	29	ND	< LOD 3.0	ND	< LOD 62.64
24634	1	48.16	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.29
24650	2	48.01	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.49
24644	3	48.16	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.29
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.41
24640	1	48.44	SS-01	32	ND	< LOD 3.0	ND	< LOD 61.93
24641	2	47.90	SS-01	32	ND	< LOD 3.0	ND	< LOD 62.63
24651	3	48.35	SS-01	32	ND	< LOD 3.0	ND	< LOD 62.05
24635	OBZ	48.30	SS-01	32	ND	< LOD 3.0	ND	< LOD 62.11
24646	1	48.58	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 61.75
24626	2	47.84	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 62.71
24638	3	48.49	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 61.87
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 62.09
24628	1	48.55	CS-01	34	ND	< LOD 3.0	ND	< LOD 61.79
24637	2	48.00	CS-01	34	ND	< LOD 3.0	ND	< LOD 62.50
24624	3	48.47	CS-01	34	ND	< LOD 3.0	ND	< LOD 61.89
24636	OBZ	47.92	CS-01	34	ND	< LOD 3.0	ND	< LOD 62.60
24623	1	48.53	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 61.82
24622	2	48.36	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 62.03
24654	3	48.31	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 62.10
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 62.79
24629	1	47.88	SH-01	36	ND	< LOD 3.0	ND	< LOD 62.66
24633	2	47.86	SH-01	36	ND	< LOD 3.0	ND	< LOD 62.68
24627	3	48.24	SH-01	36	ND	< LOD 3.0	ND	< LOD 62.19
24648	OBZ	48.08	SH-01	36	ND	< LOD 3.0	ND	< LOD 62.40
24555	1	48.08	CS-02	37	ND	< LOD 3.0	ND	< LOD 62.40
24552	2	47.84	CS-02	37	ND	< LOD 3.0	ND	< LOD 62.71
24541	3	48.01	CS-02	37	ND	< LOD 3.0	ND	< LOD 62.49
24529	OBZ	47.99	CS-02	37	ND	< LOD 3.0	ND	< LOD 62.51
24558	1	48.49	CS-03	38	ND	< LOD 3.0	ND	< LOD 61.87
24524	2	48.29	CS-03	38	ND	< LOD 3.0	ND	< LOD 62.12
24561	3	48.22	CS-03	38	ND	< LOD 3.0	ND	< LOD 62.21
24559	OBZ	48.29	CS-03	38	ND	< LOD 3.0	ND	< LOD 62.12
24543	1	48.61	CS-04	39	ND	< LOD 3.0	ND	< LOD 61.72
24532	2	47.78	CS-04	39	ND	< LOD 3.0	ND	< LOD 62.79
24546	3	48.29	CS-04	39	ND	< LOD 3.0	ND	< LOD 62.12
24557	OBZ	48.58	CS-04	39	ND	< LOD 3.0	ND	< LOD 61.75
24560	1	48.13	SS-02	40	ND	< LOD 3.0	ND	< LOD 62.33
24565	2	47.95	SS-02	40	ND	< LOD 3.0	ND	< LOD 62.57
24630	3	48.32	SS-02	40	ND	< LOD 3.0	ND	< LOD 62.09
24553	OBZ	48.62	SS-02	40	ND	< LOD 3.0	ND	< LOD 61.70
24525	1	48.13	G-1A	41	ND	< LOD 3.0	ND	< LOD 62.33
24563	2	47.87	G-1A	41	ND	< LOD 3.0	ND	< LOD 62.67
24547	3	48.17	G-1A	41	ND	< LOD 3.0	ND	< LOD 62.28
24526	OBZ	48.91	G-1A	41	ND	< LOD 3.0	ND	< LOD 61.34
24538	1	47.45	G-2A	43	ND	< LOD 3.0	ND	< LOD 63.22

Air Sample Results - Platinum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Platinum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 3.0	ND	< LOD 63.67
24533	3	48.24	G-2A	43	ND	< LOD 3.0	ND	< LOD 62.19
24540	OBZ	48.04	G-2A	43	ND	< LOD 3.0	ND	< LOD 62.45
24528	1	47.99	SSDS-02	44	ND	< LOD 3.0	ND	< LOD 62.51
24544	2	48.00	SSDS-02	44	ND	< LOD 3.0	ND	< LOD 62.50
24567	3	48.46	SSDS-02	44	ND	< LOD 3.0	ND	< LOD 61.91
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 3.0	ND	< LOD 60.77
24571	1	48.05	SS-03	45	ND	< LOD 7.5	ND	< LOD 156.09
24536	2	47.60	SS-03	45	ND	< LOD 3.0	ND	< LOD 63.03
24534	3	48.94	SS-03	45	ND	< LOD 3.0	ND	< LOD 61.30
24570	OBZ	49.61	SS-03	45	ND	< LOD 3.0	ND	< LOD 60.47
24568	1	48.28	G-1B	46	ND	< LOD 3.0	ND	< LOD 62.14
24592	2	47.38	G-1B	46	ND	< LOD 3.0	ND	< LOD 63.32
24593	3	48.17	G-1B	46	ND	< LOD 3.0	ND	< LOD 62.28
24535	OBZ	48.22	G-1B	46	ND	< LOD 3.0	ND	< LOD 62.21
24590	1	47.81	SS-04	47	ND	< LOD 3.0	ND	< LOD 62.75
24605	2	47.78	SS-04	47	ND	< LOD 3.0	ND	< LOD 62.79
24562	3	47.80	SS-04	47	ND	< LOD 3.0	ND	< LOD 62.76
24531	OBZ	48.59	SS-04	47	ND	< LOD 3.0	ND	< LOD 61.74
24527	1	49.48	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 60.63
24569	2	50.35	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 59.58
24584	3	50.24	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 59.71
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 62.16
24600	1	48.34	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.06
24616	2	48.11	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.36
24585	3	47.65	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.96
24583	OBZ	47.99	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.51
24587	1	48.79	G-2B	50	ND	< LOD 3.0	ND	< LOD 61.49
24602	2	48.17	G-2B	50	ND	< LOD 3.0	ND	< LOD 62.28
24564	3	47.81	G-2B	50	ND	< LOD 3.0	ND	< LOD 62.75
24621	OBZ	48.54	G-2B	50	ND	< LOD 3.0	ND	< LOD 61.80
24618	1	49.21	N-01	52	ND	< LOD 3.0	ND	< LOD 60.96
24611	2	47.96	N-01	52	ND	< LOD 3.0	ND	< LOD 62.55
24588	3	48.32	N-01	52	ND	< LOD 3.0	ND	< LOD 62.09
24615	OBZ	48.80	N-01	52	ND	< LOD 3.0	ND	< LOD 61.48
24597	1	49.78	SS-05	53	ND	< LOD 3.0	ND	< LOD 60.27
24599	2	47.68	SS-05	53	ND	< LOD 3.0	ND	< LOD 62.92
24575	3	48.11	SS-05	53	ND	< LOD 3.0	ND	< LOD 62.36
24617	OBZ	48.79	SS-05	53	ND	< LOD 3.0	ND	< LOD 61.49
24609	1	48.98	SG-1A	54	ND	< LOD 3.0	ND	< LOD 61.25
24596	2	48.20	SG-1A	54	ND	< LOD 3.0	ND	< LOD 62.24
24610	3	48.18	SG-1A	54	ND	< LOD 6.0	ND	< LOD 124.53
24576	OBZ	48.47	SG-1A	54	30.00	< LOQ 75.0	618.94	< LOQ 1547.35
24606	1	49.24	G-4A	55	ND	< LOD 3.0	ND	< LOD 60.93
24620	2	48.37	G-4A	55	ND	< LOD 3.0	ND	< LOD 62.02
24573	3	48.67	G-4A	55	ND	< LOD 3.0	ND	< LOD 61.64
24505	OBZ	48.16	G-4A	55	ND	< LOD 3.0	ND	< LOD 62.29
24340	1	48.38	G-4B	56	ND	< LOD 3.0	ND	< LOD 62.01
24607	2	48.01	G-4B	56	ND	< LOD 3.0	ND	< LOD 62.49
24595	3	48.38	G-4B	56	ND	< LOD 3.0	ND	< LOD 62.01
24598	OBZ	48.42	G-4B	56	ND	< LOD 3.0	ND	< LOD 61.96
24580	1	48.44	CS-05	57	ND	< LOD 3.0	ND	< LOD 61.93
24604	2	47.93	CS-05	57	ND	< LOD 3.0	ND	< LOD 62.59

Air Sample Results - Platinum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Platinum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 3.0	ND	< LOD 62.79
24574	OBZ	30.41	CS-05	57	ND	< LOD 3.0	ND	< LOD 98.65
24614	1	48.58	G-5A	58	ND	< LOD 3.0	ND	< LOD 61.75
24577	2	48.18	G-5A	58	ND	< LOD 3.0	ND	< LOD 62.27
24572	3	48.05	G-5A	58	ND	< LOD 3.0	ND	< LOD 62.43
24582	OBZ	47.83	G-5A	58	ND	< LOD 3.0	ND	< LOD 62.72
24322	1	47.88	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.66
24354	2	48.16	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.29
24510	3	47.98	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.53
24321	OBZ	47.99	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.51
24497	1	48.49	CP-1A	60	ND	< LOD 3.0	ND	< LOD 61.87
24333	2	48.28	CP-1A	60	ND	< LOD 3.0	ND	< LOD 62.14
24326	3	48.19	CP-1A	60	ND	< LOD 3.0	ND	< LOD 62.25
24329	OBZ	47.74	CP-1A	60	ND	< LOD 3.0	ND	< LOD 62.84
24499	1	42.42	CP-1B	62	ND	< LOD 3.0	ND	< LOD 70.72
24506	2	42.02	CP-1B	62	ND	< LOD 3.0	ND	< LOD 71.39
24388	3	42.47	CP-1B	62	4.40	< LOQ 7.5	103.6	< LOQ 176.60
24315	OBZ	41.77	CP-1B	62	ND	< LOD 3.0	ND	< LOD 71.82
24318	1	48.56	CG-01	63	ND	< LOD 3.0	ND	< LOD 61.78
24308	2	48.00	CG-01	63	ND	< LOD 3.0	ND	< LOD 62.50
24330	3	48.47	CG-01	63	ND	< LOD 3.0	ND	< LOD 61.89
24230	OBZ	48.31	CG-01	63	ND	< LOD 3.0	ND	< LOD 62.10
24363	1	48.10	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.37
24398	2	47.84	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.71
24351	3	48.06	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.42
24594	OBZ	48.29	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.12
24312	1	48.76	G-6B	65	ND	< LOD 3.0	ND	< LOD 61.53
24484	2	47.45	G-6B	65	ND	< LOD 3.0	ND	< LOD 63.22
24327	3	48.92	G-6B	65	ND	< LOD 3.0	ND	< LOD 61.32
24389	OBZ	48.46	G-6B	65	ND	< LOD 3.0	ND	< LOD 61.91
24348	1	48.59	SG-2A	66	ND	< LOD 6.0	ND	< LOD 123.48
24314	2	47.90	SG-2A	66	5.70	< LOQ 7.5	119	< LOQ 156.58
24494	3	48.24	SG-2A	66	ND	< LOD 6.0	ND	< LOD 124.38
24337	OBZ	48.30	SG-2A	66	30.00	< LOQ 75.0	621.12	< LOQ 1552.80
24508	1	48.47	CP-2A	67	ND	< LOD 3.0	ND	< LOD 61.89
24361	2	47.82	CP-2A	67	ND	< LOD 3.0	ND	< LOD 62.74
24359	3	48.22	CP-2A	67	ND	< LOD 6.0	ND	< LOD 124.43
24471	OBZ	48.14	CP-2A	67	ND	< LOD 3.0	ND	< LOD 62.32
24373	1	48.41	CP-2B	68	ND	< LOD 3.0	ND	< LOD 61.97
24468	2	47.90	CP-2B	68	ND	< LOD 3.0	ND	< LOD 62.63
24481	3	48.26	CP-2B	68	ND	< LOD 3.0	ND	< LOD 62.16
24391	OBZ	47.53	CP-2B	68	ND	< LOD 3.0	ND	< LOD 63.12
24356	1	48.56	O-1	69	4.00	< LOQ 7.5	82.37	< LOQ 154.45
24470	2	47.89	O-1	69	ND	< LOD 3.0	ND	< LOD 62.64
24467	3	48.67	O-1	69	ND	< LOD 3.0	ND	< LOD 61.64
24313	OBZ	47.78	O-1	69	3.30	< LOQ 7.5	69.07	< LOQ 156.97
24501	1	47.96	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.55
24496	2	47.75	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.83
24478	3	48.31	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.10
24503	OBZ	48.04	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.45
24474	1	26.02	SG-1B	71	ND	< LOD 3.0	ND	< LOD 115.30
24469	2	26.02	SG-1B	71	ND	< LOD 3.0	ND	< LOD 115.30
24492	3	26.10	SG-1B	71	ND	< LOD 3.0	ND	< LOD 114.94

Air Sample Results - Platinum

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Platinum			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 15.0	ND	< LOD 571.43
24489	1	48.42	CP-3A	72	ND	< LOD 3.0	ND	< LOD 61.96
24491	2	47.93	CP-3A	72	ND	< LOD 3.0	ND	< LOD 62.59
24482	3	48.35	CP-3A	72	ND	< LOD 6.0	ND	< LOD 124.10
24486	OBZ	48.32	CP-3A	72	ND	< LOD 6.0	ND	< LOD 124.17
24516	1	36.34	CP-3B	73	ND	< LOD 3.0	ND	< LOD 82.55
24502	2	36.02	CP-3B	73	ND	< LOD 3.0	ND	< LOD 83.29
24515	3	36.48	CP-3B	73	ND	< LOD 3.0	ND	< LOD 82.24
24500	OBZ	40.27	CP-3B	73	ND	< LOD 3.0	ND	< LOD 74.50
24504	1	48.47	G-7A	74	ND	< LOD 3.0	ND	< LOD 61.89
24513	2	48.22	G-7A	74	ND	< LOD 3.0	ND	< LOD 62.21
24458	3	47.94	G-7A	74	ND	< LOD 3.0	ND	< LOD 62.58
24389	OBZ	47.75	G-7A	74	ND	< LOD 3.0	ND	< LOD 62.83
24404	1	48.68	G-7B	75	ND	< LOD 3.0	ND	< LOD 61.63
24451	2	48.06	G-7B	75	ND	< LOD 3.0	ND	< LOD 62.42
24447	3	47.16	G-7B	75	ND	< LOD 3.0	ND	< LOD 63.61
24423	OBZ	47.27	G-7B	75	ND	< LOD 3.0	ND	< LOD 63.47
24456	1	49.19	SS-06	76	ND	< LOD 3.0	ND	< LOD 60.99
24480	2	48.26	SS-06	76	ND	< LOD 3.0	ND	< LOD 62.16
24429	3	47.68	SS-06	76	ND	< LOD 3.0	ND	< LOD 62.92
24418	OBZ	47.83	SS-06	76	ND	< LOD 3.0	ND	< LOD 62.72
24427	1	48.54	CP-4A	78	ND	< LOD 3.0	ND	< LOD 61.80
24435	2	47.71	CP-4A	78	ND	< LOD 3.0	ND	< LOD 62.88
24244	3	49.01	CP-4A	78	15.00	< LOQ 38	306.06	< LOQ 775.35
24220	OBZ	48.74	CP-4A	78	ND	< LOD 3.0	ND	< LOD 61.55
24460	1	50.05	CP-4B	79	ND	< LOD 3.0	ND	< LOD 59.94
24465	2	48.47	CP-4B	79	ND	< LOD 6.0	ND	< LOD 123.79
24207	3	48.49	CP-4B	79	ND	< LOD 15.0	ND	< LOD 309.34
24390	OBZ	49.02	CP-4B	79	ND	< LOD 3.0	ND	< LOD 61.20
24259	1	48.76	SS-07	80	3.40	< LOQ 7.5	69.73	< LOQ 153.81
24421	2	48.13	SS-07	80	ND	< LOD 3.0	ND	< LOD 62.33
24445	3	47.87	SS-07	80	ND	< LOD 3.0	ND	< LOD 62.67
24432	OBZ	48.49	SS-07	80	ND	< LOD 3.0	ND	< LOD 61.87
24459	1	48.96	N-02	81	ND	< LOD 3.0	ND	< LOD 61.27
24417	2	48.11	N-02	81	ND	< LOD 3.0	ND	< LOD 62.36
24442	3	48.01	N-02	81	ND	< LOD 15.0	ND	< LOD 312.43
24386	OBZ	48.19	N-02	81	ND	< LOD 3.0	ND	< LOD 62.25
24452	1	48.20	SG-2B	82	ND	< LOD 3.0	ND	< LOD 62.24
24453	2	48.59	SG-2B	82	ND	< LOD 3.0	ND	< LOD 61.74
24420	3	47.84	SG-2B	82	ND	< LOD 15.0	ND	< LOD 313.55
24444	OBZ	47.95	SG-2B	82	ND	< LOD 30.0	ND	< LOD 625.65
24455	1	48.56	CS-07	83	ND	< LOD 3.0	ND	< LOD 61.78
24433	2	47.96	CS-07	83	ND	< LOD 3.0	ND	< LOD 62.55
24398	3	48.06	CS-07	83	ND	< LOD 3.0	ND	< LOD 62.42
24511	OBZ	47.96	CS-07	83	ND	< LOD 3.0	ND	< LOD 62.55
24454	1	49.34	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 60.80
24291	2	48.49	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 61.87
24209	3	48.43	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 61.95
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 61.51
24204	1	49.46	CPDS-1B	85	ND	< LOD 3.0	ND	< LOD 60.66
24273	2	48.35	CPDS-1B	85	ND	< LOD 3.0	ND	< LOD 62.05
24223	3	48.82	CPDS-1B	85	ND	< LOD 3.0	ND	< LOD 61.45
24466	OBZ	49.96	CPDS-1B	85	ND	< LOD 3.0	ND	< LOD 60.05

Airborne Sample Data Analysis - Platinum

NIOSH REL 1000.0 micrograms/cubic meter

OSHA PEL 1000.0 micrograms/cubic meter (Proposed)

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 61.78	ND	< LOD 62.50	ND	< LOD 61.89	ND	< LOD 62.10
CS-01	ND	< LOD 61.79	ND	< LOD 62.50	ND	< LOD 61.89	ND	< LOD 62.60
CS-02	ND	< LOD 62.40	ND	< LOD 62.71	ND	< LOD 62.49	ND	< LOD 62.51
CS-03	ND	< LOD 61.87	ND	< LOD 62.12	ND	< LOD 62.21	ND	< LOD 62.12
CS-04	ND	< LOD 61.72	ND	< LOD 62.79	ND	< LOD 62.12	ND	< LOD 61.75
CS-05	ND	< LOD 61.93	ND	< LOD 62.59	ND	< LOD 62.79	ND	< LOD 98.65
CS-06	ND	< LOD 62.55	ND	< LOD 62.83	ND	< LOD 62.10	ND	< LOD 62.45
CS-07	ND	< LOD 61.78	ND	< LOD 62.55	ND	< LOD 62.42	ND	< LOD 62.55
CSDS-01	ND	< LOD 62.29	ND	< LOD 62.49	ND	< LOD 62.29	ND	< LOD 62.41
CSDS-02	ND	< LOD 61.82	ND	< LOD 62.03	ND	< LOD 62.10	ND	< LOD 62.79
N-01	ND	< LOD 60.96	ND	< LOD 62.55	ND	< LOD 62.09	ND	< LOD 61.48
N-02	ND	< LOD 61.27	ND	< LOD 62.36	ND	< LOD 312.43	ND	< LOD 62.25
O-1	82.37	< LOQ 154.45	ND	< LOD 62.64	ND	< LOD 61.64	69.07	< LOQ 156.97
S-01	ND	< LOD 62.29	ND	< LOD 62.64	ND	< LOD 62.63	ND	< LOD 62.59
S-02	ND	< LOD 62.53	ND	< LOD 62.81	ND	< LOD 62.50	ND	< LOD 62.64
SH-01	ND	< LOD 62.66	ND	< LOD 62.68	ND	< LOD 62.19	ND	< LOD 62.40
SS-01	ND	< LOD 61.93	ND	< LOD 62.63	ND	< LOD 62.05	ND	< LOD 62.11
SS-02	ND	< LOD 62.33	ND	< LOD 62.57	ND	< LOD 62.09	ND	< LOD 61.70
SS-03	ND	< LOD 156.09	ND	< LOD 63.03	ND	< LOD 61.30	ND	< LOD 60.47
SS-04	ND	< LOD 62.75	ND	< LOD 62.79	ND	< LOD 62.76	ND	< LOD 61.74
SS-05	ND	< LOD 60.27	ND	< LOD 62.92	ND	< LOD 62.36	ND	< LOD 61.49
SS-06	ND	< LOD 60.99	ND	< LOD 62.16	ND	< LOD 62.92	ND	< LOD 62.72
SS-07	69.73	< LOQ 153.81	ND	< LOD 62.33	ND	< LOD 62.67	ND	< LOD 61.87
SSDS-01	ND	< LOD 61.75	ND	< LOD 62.71	ND	< LOD 61.87	ND	< LOD 62.09
SSDS-02	ND	< LOD 62.51	ND	< LOD 62.50	ND	< LOD 61.91	ND	< LOD 60.77
SSDS-03	ND	< LOD 60.63	ND	< LOD 59.58	ND	< LOD 59.71	ND	< LOD 62.16
CP-1A	ND	< LOD 61.87	ND	< LOD 62.14	ND	< LOD 62.25	ND	< LOD 62.84
CP-1B	ND	< LOD 70.72	ND	< LOD 71.39	103.60	< LOQ 176.60	ND	< LOD 71.82
CP-2A	ND	< LOD 61.89	ND	< LOD 62.74	ND	< LOD 124.43	ND	< LOD 62.32
CP-2B	ND	< LOD 61.97	ND	< LOD 62.63	ND	< LOD 62.16	ND	< LOD 63.12
CP-3A	ND	< LOD 61.96	ND	< LOD 62.59	ND	< LOD 124.10	ND	< LOD 124.17
CP-3B	ND	< LOD 82.55	ND	< LOD 83.29	ND	< LOD 82.24	ND	< LOD 74.50
CP-4A	ND	< LOD 61.80	ND	< LOD 62.88	306.06	< LOQ 775.35	ND	< LOD 61.55
CP-4B	ND	< LOD 59.94	ND	< LOD 123.79	ND	< LOD 309.34	ND	< LOD 61.20
CPDS-1A	ND	< LOD 60.80	ND	< LOD 61.87	ND	< LOD 61.95	ND	< LOD 61.51
CPDS-1B	ND	< LOD 60.66	ND	< LOD 62.05	ND	< LOD 61.45	ND	< LOD 60.05
G-1A	ND	< LOD 62.33	ND	< LOD 62.67	ND	< LOD 62.28	ND	< LOD 61.34
G-1B	ND	< LOD 62.14	ND	< LOD 63.32	ND	< LOD 62.28	ND	< LOD 62.21
G-2A	ND	< LOD 63.22	ND	< LOD 63.67	ND	< LOD 62.19	ND	< LOD 62.45
G-2B	ND	< LOD 61.49	ND	< LOD 62.28	ND	< LOD 62.75	ND	< LOD 61.80
G-3A	ND	< LOD 62.06	ND	< LOD 62.36	ND	< LOD 62.96	ND	< LOD 62.51
G-4A	ND	< LOD 60.93	ND	< LOD 62.02	ND	< LOD 61.64	ND	< LOD 62.29
G-4B	ND	< LOD 62.01	ND	< LOD 62.49	ND	< LOD 62.01	ND	< LOD 61.96
G-5A	ND	< LOD 61.75	ND	< LOD 62.27	ND	< LOD 62.43	ND	< LOD 62.72
G-5B	ND	< LOD 62.66	ND	< LOD 62.29	ND	< LOD 62.53	ND	< LOD 62.51
G-6A	ND	< LOD 62.37	ND	< LOD 62.71	ND	< LOD 62.42	ND	< LOD 62.12
G-6B	ND	< LOD 61.53	ND	< LOD 63.22	ND	< LOD 61.32	ND	< LOD 61.91
G-7A	ND	< LOD 61.89	ND	< LOD 62.21	ND	< LOD 62.58	ND	< LOD 62.83
G-7B	ND	< LOD 61.63	ND	< LOD 62.42	ND	< LOD 63.61	ND	< LOD 63.47
SG-1A	ND	< LOD 61.25	ND	< LOD 62.24	ND	< LOD 124.53	618.94	< LOQ 1547.35
SG-1B	ND	< LOD 115.30	ND	< LOD 115.30	ND	< LOD 114.94	ND	< LOD 571.43
SG-2A	ND	< LOD 123.48	119	< LOQ 156.58	ND	< LOD 124.38	621.12	< LOQ 1552.80
SG-2B	ND	< LOD 62.24	ND	< LOD 61.74	ND	< LOD 313.55	ND	< LOD 625.65

Bulk Elemental Analysis - Platinum

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Platinum		Sample	Platinum	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 9.0	J95331-63 PB	ND	< LOD 9.0
CS-01	J95331-34 VB	ND	< LOD 9.0	J95331-34 PB	ND	< LOD 9.0
CS-02	J95331-37 VB	ND	< LOD 9.0	J95331-37 PB	ND	< LOD 9.0
CS-03	J95331-38 VB	ND	< LOD 9.0	J95331-38 PB	12.00	< LOQ 30.0
CS-04	J95331-39 VB	ND	< LOD 9.0	J95331-39 PB	ND	< LOD 9.0
CS-05	J95331-57 VB	ND	< LOD 9.0	J95331-57 PB	ND	< LOD 9.0
CS-06	J95331-70 VB	ND	< LOD 9.0	J95331-70 PB	ND	< LOD 9.0
CS-07	J95331-83 VB	ND	< LOD 9.0	J95331-83 PB	ND	< LOD 9.0
CSDS-01	J95331-31 VB	ND	< LOD 9.0	J95331-31 PB	ND	< LOD 9.0
CSDS-02	J95331-35 VB	ND	< LOD 9.0	J95331-35 PB	ND	< LOD 9.0
N-01	J95331-52 VB	ND	< LOD 9.0	J95331-52 PB	ND	< LOD 9.0
N-02	J95331-81 VB	ND	< LOD 18.0	J95331-81 PB	45.00	< LOQ 150.0
O-1	J95331-69 VB	12.00	< LOQ 30.0	J95331-69 PB	14.00	< LOQ 30.0
S-01	J95331-28 VB	ND	< LOD 9.0	J95331-28 PB	ND	< LOD 9.0
S-02	J95331-29 VB	ND	< LOD 9.0	J95331-29 PB	ND	< LOD 9.0
SH-01	J95331-36 VB	ND	< LOD 9.0	J95331-36 PB	ND	< LOD 9.0
SS-01	J95331-32 VB	ND	< LOD 9.0	J95331-32 PB	ND	< LOD 9.0
SS-02	J95331-40 VB	ND	< LOD 9.0	J95331-40 PB	ND	< LOD 9.0
SS-03	J95331-45 VB	ND	< LOD 9.0	J95331-45 PB	ND	< LOD 9.0
SS-04	J95331-47 VB	ND	< LOD 9.0	J95331-47 PB	ND	< LOD 9.0
SS-05	J95331-53 VB	ND	< LOD 9.0	J95331-53 PB	ND	< LOD 9.0
SS-06	J95331-76 VB	ND	< LOD 9.0	J95331-76 PB	15.00	< LOQ 30.0
SS-07	J95331-80 VB	ND	< LOD 9.0	J95331-80 PB	ND	< LOD 9.0
SSDS-01	J95331-33 VB	ND	< LOD 9.0	J95331-33 PB	ND	< LOD 9.0
SSDS-02	J95331-44 VB	ND	< LOD 9.0	J95331-44 PB	ND	< LOD 9.0
SSDS-03	J95331-48 VB	ND	< LOD 9.0	J95331-48 PB	ND	< LOD 9.0
CP-1A	J95331-60 VB	ND	< LOD 9.0	J95331-60 PB	ND	< LOD 9.0
CP-1B	J95331-61 VB	ND	< LOD 9.0	J95331-61 PB	ND	< LOD 9.0
CP-2A	J95331-67 VB	ND	< LOD 18.0	J95331-67 PB	34.00	> LOQ 60.0
CP-2B	J95331-68 VB	ND	< LOD 45.0	J95331-68 PB	ND	< LOD 45.0
CP-3A	J95331-72 VB	ND	< LOD 45.0	J95331-72 PB	ND	< LOD 18.0
CP-3B	J95331-73 VB	20.00	< LOQ 60.0	J95331-73 PB	ND	< LOD 18.0
CP-4A	J95331-78 VB	ND	< LOD 9.0	J95331-78 PB	27.00	< LOQ 60.0
CP-4B	J95331-79 VB	ND	< LOD 45.0	J95331-79 PB	ND	< LOD 45.0
CPDS-1A	J95331-84 VB	ND	< LOD 18	J95331-84 PB	ND	< LOD 18
CPDS-1B	J95331-85 VB	16.00	< LOQ 60.0	J95331-85 PB	24.00	< LOQ 60.0
G-1A	J95331-41 VB	ND	< LOD 9.0	J95331-41 PB	ND	< LOD 9.0
G-1B	J95331-46 VB	ND	< LOD 9.0	J95331-46 PB	ND	< LOD 9.0
G-2A	J95331-43 VB	ND	< LOD 9.0	J95331-43 PB	ND	< LOD 9.0
G-2B	J95331-50 VB	ND	< LOD 9.0	J95331-50 PB	ND	< LOD 9.0
G-3A	J95331-49 VB	ND	< LOD 9.0	J95331-49 PB	ND	< LOD 9.0
G-4A	J95331-55 VB	ND	< LOD 9.0	J95331-55 PB	ND	< LOD 9.0
G-4B	J95331-56 VB	ND	< LOD 9.0	J95331-56 PB	ND	< LOD 9.0
G-5A	J95331-58 VB	ND	< LOD 9.0	J95331-58 PB	ND	< LOD 9.0
G-5B	J95331-59 VB	ND	< LOD 9.0	J95331-59 PB	ND	< LOD 9.0
G-6A	J95331-64 VB	ND	< LOD 9.0	J95331-64 PB	ND	< LOD 9.0
G-6B	J95331-65 VB	ND	< LOD 9.0	J95331-65 PB	ND	< LOD 9.0
G-7A	J95331-74 VB	ND	< LOD 9.0	J95331-74 PB	ND	< LOD 9.0
G-7B	J95331-75 VB	ND	< LOD 9.0	J95331-75 PB	23.00	< LOQ 30.0
SG-1A	J95331-54 VB	ND	< LOD 180.0	J95331-54 PB	ND	< LOD 180.0
SG-1B	J95331-71 VB	ND	< LOD 180.0	J95331-71 PB	ND	< LOD 180.0
SG-2A	J95331-66 VB	180.00	< LOQ 300.0	J95331-66 PB	92.00	< LOQ 150.0
SG-2B	J95331-82 VB	ND	< LOD 180.0	J95331-82 PB	ND	< LOD 180.0

Comparison of Airborne Concentrations to Bulk Concentrations - Platinum

NIOSH REL 1000.0 micrograms/cubic meter
OSHA PEL 1000.0 micrograms/cubic meter (Proposed)

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	ND	ND
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	ND
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	ND	ND	ND	ND
CS-07	ND	ND	ND	ND	ND
CSDS-01	ND	ND	ND	ND	ND
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	ND
N-02	ND	ND	ND	ND	ND
O-1	82.37	ND	ND	69.07	12.00
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	ND
SS-07	69.73	ND	ND	ND	ND
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	ND	ND	ND	ND	ND
CP-2A	ND	ND	ND	ND	ND
CP-3A	ND	ND	ND	ND	ND
CP-4A	ND	ND	306.06	ND	ND
CPDS-1A	ND	ND	ND	ND	ND
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	ND	ND	ND	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	618.94	ND
SG-2A	ND	119.00	ND	621.12	180.00

APPENDIX B - SELENIUM

Selenium

Prolonged exposure to selenium may cause paleness, coated tongue, stomach disorders, metallic taste of the breath; damage to the spleen and liver, and anemia are possible. The NIOSH REL and OSHA PEL for selenium are both 200 micrograms/cubic meter of air.

Air Sample Results - Selenium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Selenium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 2.0	ND	< LOD 41.53
24412	2	47.89	S-01	28	ND	< LOD 2.0	ND	< LOD 41.76
24441	3	47.90	S-01	28	ND	< LOD 2.0	ND	< LOD 41.75
24450	OBZ	47.93	S-01	28	ND	< LOD 2.0	ND	< LOD 41.73
24643	1	47.98	S-02	29	ND	< LOD 2.0	ND	< LOD 41.68
24625	2	47.76	S-02	29	ND	< LOD 2.0	ND	< LOD 41.88
24642	3	48.00	S-02	29	ND	< LOD 2.0	ND	< LOD 41.67
24632	OBZ	47.89	S-02	29	ND	< LOD 2.0	ND	< LOD 41.76
24634	1	48.16	CSDS-01	31	ND	< LOD 2.0	ND	< LOD 41.53
24650	2	48.01	CSDS-01	31	ND	< LOD 2.0	ND	< LOD 41.66
24644	3	48.16	CSDS-01	31	ND	< LOD 2.0	ND	< LOD 41.53
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 2.0	ND	< LOD 41.61
24640	1	48.44	SS-01	32	ND	< LOD 2.0	ND	< LOD 41.29
24641	2	47.90	SS-01	32	ND	< LOD 2.0	ND	< LOD 41.75
24651	3	48.35	SS-01	32	ND	< LOD 2.0	ND	< LOD 41.37
24635	OBZ	48.30	SS-01	32	ND	< LOD 2.0	ND	< LOD 41.41
24646	1	48.58	SSDS-01	33	ND	< LOD 2.0	ND	< LOD 41.17
24626	2	47.84	SSDS-01	33	ND	< LOD 2.0	ND	< LOD 41.81
24638	3	48.49	SSDS-01	33	ND	< LOD 2.0	ND	< LOD 41.25
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 2.0	ND	< LOD 41.39
24628	1	48.55	CS-01	34	ND	< LOD 2.0	ND	< LOD 41.19
24637	2	48.00	CS-01	34	ND	< LOD 2.0	ND	< LOD 41.67
24624	3	48.47	CS-01	34	ND	< LOD 2.0	ND	< LOD 41.26
24636	OBZ	47.92	CS-01	34	ND	< LOD 2.0	ND	< LOD 41.74
24623	1	48.53	CSDS-02	35	ND	< LOD 2.0	ND	< LOD 41.21
24622	2	48.36	CSDS-02	35	ND	< LOD 2.0	ND	< LOD 41.36
24654	3	48.31	CSDS-02	35	ND	< LOD 2.0	ND	< LOD 41.40
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 2.0	ND	< LOD 41.86
24629	1	47.88	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.77
24633	2	47.86	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.79
24627	3	48.24	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.46
24648	OBZ	48.08	SH-01	36	ND	< LOD 2.0	ND	< LOD 41.60
24555	1	48.08	CS-02	37	ND	< LOD 2.0	ND	< LOD 41.60
24552	2	47.84	CS-02	37	ND	< LOD 2.0	ND	< LOD 41.81
24541	3	48.01	CS-02	37	ND	< LOD 2.0	ND	< LOD 41.66
24529	OBZ	47.99	CS-02	37	ND	< LOD 2.0	ND	< LOD 41.68
24558	1	48.49	CS-03	38	ND	< LOD 2.0	ND	< LOD 41.25
24524	2	48.29	CS-03	38	ND	< LOD 2.0	ND	< LOD 41.42
24561	3	48.22	CS-03	38	ND	< LOD 2.0	ND	< LOD 41.48
24559	OBZ	48.29	CS-03	38	ND	< LOD 2.0	ND	< LOD 41.42
24543	1	48.61	CS-04	39	ND	< LOD 2.0	ND	< LOD 41.14
24532	2	47.78	CS-04	39	ND	< LOD 4.3	ND	< LOD 90.00
24546	3	48.29	CS-04	39	ND	< LOD 2.0	ND	< LOD 41.42
24557	OBZ	48.58	CS-04	39	ND	< LOD 2.0	ND	< LOD 41.17
24560	1	48.13	SS-02	40	ND	< LOD 2.0	ND	< LOD 41.55
24565	2	47.95	SS-02	40	ND	< LOD 2.0	ND	< LOD 41.71
24630	3	48.32	SS-02	40	ND	< LOD 2.0	ND	< LOD 41.39
24553	OBZ	48.62	SS-02	40	ND	< LOD 2.0	ND	< LOD 41.14
24525	1	48.13	G-1A	41	ND	< LOD 2.0	ND	< LOD 41.55
24563	2	47.87	G-1A	41	ND	< LOD 2.0	ND	< LOD 41.78
24547	3	48.17	G-1A	41	ND	< LOD 2.0	ND	< LOD 41.52
24526	OBZ	48.91	G-1A	41	ND	< LOD 2.0	ND	< LOD 40.89
24538	1	47.45	G-2A	43	ND	< LOD 2.0	ND	< LOD 42.15

Air Sample Results - Selenium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Selenium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 2.0	ND	< LOD 42.44
24533	3	48.24	G-2A	43	ND	< LOD 2.0	ND	< LOD 41.46
24540	OBZ	48.04	G-2A	43	ND	< LOD 2.0	ND	< LOD 41.63
24528	1	47.99	SSDS-02	44	ND	< LOD 2.0	ND	< LOD 41.68
24544	2	48.00	SSDS-02	44	ND	< LOD 2.0	ND	< LOD 41.67
24567	3	48.46	SSDS-02	44	ND	< LOD 2.0	ND	< LOD 41.27
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 2.0	ND	< LOD 40.51
24571	1	48.05	SS-03	45	ND	< LOD 4.3	ND	< LOD 89.49
24536	2	47.60	SS-03	45	ND	< LOD 2.0	ND	< LOD 42.02
24534	3	48.94	SS-03	45	ND	< LOD 2.0	ND	< LOD 40.87
24570	OBZ	49.61	SS-03	45	ND	< LOD 2.0	ND	< LOD 40.31
24568	1	48.28	G-1B	46	ND	< LOD 2.0	ND	< LOD 41.43
24592	2	47.38	G-1B	46	ND	< LOD 2.0	ND	< LOD 42.21
24593	3	48.17	G-1B	46	ND	< LOD 2.0	ND	< LOD 41.52
24535	OBZ	48.22	G-1B	46	ND	< LOD 2.0	ND	< LOD 41.48
24590	1	47.81	SS-04	47	ND	< LOD 2.0	ND	< LOD 41.83
24605	2	47.78	SS-04	47	ND	< LOD 2.0	ND	< LOD 41.86
24562	3	47.80	SS-04	47	ND	< LOD 2.0	ND	< LOD 41.84
24531	OBZ	48.59	SS-04	47	ND	< LOD 2.0	ND	< LOD 41.16
24527	1	49.48	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 40.42
24569	2	50.35	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 39.72
24584	3	50.24	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 39.81
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 2.0	ND	< LOD 41.44
24600	1	48.34	G-3A	49	ND	< LOD 2.0	ND	< LOD 41.37
24616	2	48.11	G-3A	49	ND	< LOD 2.0	ND	< LOD 41.57
24585	3	47.65	G-3A	49	ND	< LOD 2.0	ND	< LOD 41.97
24583	OBZ	47.99	G-3A	49	ND	< LOD 2.0	ND	< LOD 41.68
24587	1	48.79	G-2B	50	ND	< LOD 2.0	ND	< LOD 40.99
24602	2	48.17	G-2B	50	ND	< LOD 2.0	ND	< LOD 41.52
24564	3	47.81	G-2B	50	ND	< LOD 2.0	ND	< LOD 41.83
24621	OBZ	48.54	G-2B	50	ND	< LOD 2.0	ND	< LOD 41.20
24618	1	49.21	N-01	52	ND	< LOD 2.0	ND	< LOD 40.64
24611	2	47.96	N-01	52	ND	< LOD 2.0	ND	< LOD 41.70
24588	3	48.32	N-01	52	ND	< LOD 2.0	ND	< LOD 41.39
24615	OBZ	48.80	N-01	52	ND	< LOD 2.0	ND	< LOD 40.98
24597	1	49.78	SS-05	53	ND	< LOD 2.0	ND	< LOD 40.18
24599	2	47.68	SS-05	53	ND	< LOD 2.0	ND	< LOD 41.95
24575	3	48.11	SS-05	53	ND	< LOD 2.0	ND	< LOD 41.57
24617	OBZ	48.79	SS-05	53	ND	< LOD 2.0	ND	< LOD 40.99
24609	1	48.98	SG-1A	54	ND	< LOD 2.0	ND	< LOD 40.83
24596	2	48.20	SG-1A	54	ND	< LOD 2.0	ND	< LOD 41.49
24610	3	48.18	SG-1A	54	ND	< LOD 2.0	ND	< LOD 41.51
24576	OBZ	48.47	SG-1A	54	ND	< LOD 10.0	ND	< LOD 206.31
24606	1	49.24	G-4A	55	ND	< LOD 2.0	ND	< LOD 40.62
24620	2	48.37	G-4A	55	ND	< LOD 2.0	ND	< LOD 41.35
24573	3	48.67	G-4A	55	ND	< LOD 2.0	ND	< LOD 41.09
24505	OBZ	48.16	G-4A	55	ND	< LOD 2.0	ND	< LOD 41.53
24340	1	48.38	G-4B	56	ND	< LOD 2.0	ND	< LOD 41.34
24607	2	48.01	G-4B	56	ND	< LOD 2.0	ND	< LOD 41.66
24595	3	48.38	G-4B	56	ND	< LOD 2.0	ND	< LOD 41.34
24598	OBZ	48.42	G-4B	56	ND	< LOD 2.0	ND	< LOD 41.31
24580	1	48.44	CS-05	57	ND	< LOD 2.0	ND	< LOD 41.29
24604	2	47.93	CS-05	57	ND	< LOD 2.0	ND	< LOD 41.73

Air Sample Results - Selenium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Selenium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 2.0	ND	< LOD 41.86
24574	OBZ	30.41	CS-05	57	ND	< LOD 2.0	ND	< LOD 65.77
24614	1	48.58	G-5A	58	ND	< LOD 2.0	ND	< LOD 41.17
24577	2	48.18	G-5A	58	ND	< LOD 2.0	ND	< LOD 41.51
24572	3	48.05	G-5A	58	ND	< LOD 2.0	ND	< LOD 41.62
24582	OBZ	47.83	G-5A	58	ND	< LOD 2.0	ND	< LOD 41.81
24322	1	47.88	G-5B	59	ND	< LOD 2.0	ND	< LOD 41.77
24354	2	48.16	G-5B	59	ND	< LOD 2.0	ND	< LOD 41.53
24510	3	47.98	G-5B	59	ND	< LOD 2.0	ND	< LOD 41.68
24321	OBZ	47.99	G-5B	59	ND	< LOD 2.0	ND	< LOD 41.68
24497	1	48.49	CP-1A	60	ND	< LOD 2.0	ND	< LOD 41.25
24333	2	48.28	CP-1A	60	ND	< LOD 2.0	ND	< LOD 41.43
24326	3	48.19	CP-1A	60	ND	< LOD 2.0	ND	< LOD 41.50
24329	OBZ	47.74	CP-1A	60	ND	< LOD 2.0	ND	< LOD 41.89
24499	1	42.42	CP-1B	62	ND	< LOD 2.0	ND	< LOD 47.15
24506	2	42.02	CP-1B	62	ND	< LOD 2.0	ND	< LOD 47.60
24388	3	42.47	CP-1B	62	ND	< LOD 2.0	ND	< LOD 47.09
24315	OBZ	41.77	CP-1B	62	ND	< LOD 2.0	ND	< LOD 47.88
24318	1	48.56	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.19
24308	2	48.00	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.67
24330	3	48.47	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.26
24230	OBZ	48.31	CG-01	63	ND	< LOD 2.0	ND	< LOD 41.40
24363	1	48.10	G-6A	64	ND	< LOD 2.0	ND	< LOD 41.58
24398	2	47.84	G-6A	64	ND	< LOD 2.0	ND	< LOD 41.81
24351	3	48.06	G-6A	64	ND	< LOD 2.0	ND	< LOD 41.61
24594	OBZ	48.29	G-6A	64	ND	< LOD 2.0	ND	< LOD 41.42
24312	1	48.76	G-6B	65	ND	< LOD 2.0	ND	< LOD 41.02
24484	2	47.45	G-6B	65	ND	< LOD 2.0	ND	< LOD 42.15
24327	3	48.92	G-6B	65	ND	< LOD 2.0	ND	< LOD 40.88
24389	OBZ	48.46	G-6B	65	ND	< LOD 2.0	ND	< LOD 41.27
24348	1	48.59	SG-2A	66	ND	< LOD 2.0	ND	< LOD 41.16
24314	2	47.90	SG-2A	66	ND	< LOD 2.0	ND	< LOD 41.75
24494	3	48.24	SG-2A	66	ND	< LOD 2.0	ND	< LOD 41.46
24337	OBZ	48.30	SG-2A	66	ND	< LOD 4.0	ND	< LOD 82.82
24508	1	48.47	CP-2A	67	ND	< LOD 2.0	ND	< LOD 41.26
24361	2	47.82	CP-2A	67	ND	< LOD 2.0	ND	< LOD 41.82
24359	3	48.22	CP-2A	67	ND	< LOD 4.0	ND	< LOD 82.95
24471	OBZ	48.14	CP-2A	67	ND	< LOD 2.0	ND	< LOD 41.55
24373	1	48.41	CP-2B	68	ND	< LOD 2.0	ND	< LOD 41.31
24468	2	47.90	CP-2B	68	ND	< LOD 2.0	ND	< LOD 41.75
24481	3	48.26	CP-2B	68	ND	< LOD 2.0	ND	< LOD 41.44
24391	OBZ	47.53	CP-2B	68	ND	< LOD 2.0	ND	< LOD 42.08
24356	1	48.56	O-1	69	ND	< LOD 2.0	ND	< LOD 41.19
24470	2	47.89	O-1	69	ND	< LOD 2.0	ND	< LOD 41.76
24467	3	48.67	O-1	69	ND	< LOD 2.0	ND	< LOD 41.09
24313	OBZ	47.78	O-1	69	ND	< LOD 2.0	ND	< LOD 41.86
24501	1	47.96	CS-06	70	ND	< LOD 2.0	ND	< LOD 41.70
24496	2	47.75	CS-06	70	ND	< LOD 2.0	ND	< LOD 41.88
24478	3	48.31	CS-06	70	ND	< LOD 2.0	ND	< LOD 41.40
24503	OBZ	48.04	CS-06	70	ND	< LOD 2.0	ND	< LOD 41.63
24474	1	26.02	SG-1B	71	ND	< LOD 2.0	ND	< LOD 76.86
24469	2	26.02	SG-1B	71	ND	< LOD 2.0	ND	< LOD 76.86
24492	3	26.10	SG-1B	71	ND	< LOD 2.0	ND	< LOD 76.63

Air Sample Results - Selenium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Selenium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 20.0	ND	< LOD 761.90
24489	1	48.42	CP-3A	72	ND	< LOD 2.0	ND	< LOD 41.31
24491	2	47.93	CP-3A	72	ND	< LOD 2.0	ND	< LOD 41.73
24482	3	48.35	CP-3A	72	ND	< LOD 4.0	ND	< LOD 82.73
24486	OBZ	48.32	CP-3A	72	ND	< LOD 4.0	ND	< LOD 82.78
24516	1	36.34	CP-3B	73	ND	< LOD 2.0	ND	< LOD 55.04
24502	2	36.02	CP-3B	73	ND	< LOD 2.0	ND	< LOD 55.52
24515	3	36.48	CP-3B	73	ND	< LOD 4.0	ND	< LOD 109.65
24500	OBZ	40.27	CP-3B	73	ND	< LOD 2.0	ND	< LOD 49.66
24504	1	48.47	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.26
24513	2	48.22	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.48
24458	3	47.94	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.72
24389	OBZ	47.75	G-7A	74	ND	< LOD 2.0	ND	< LOD 41.88
24404	1	48.68	G-7B	75	ND	< LOD 2.0	ND	< LOD 41.08
24451	2	48.06	G-7B	75	ND	< LOD 2.0	ND	< LOD 41.61
24447	3	47.16	G-7B	75	ND	< LOD 2.0	ND	< LOD 42.41
24423	OBZ	47.27	G-7B	75	ND	< LOD 2.0	ND	< LOD 42.31
24456	1	49.19	SS-06	76	ND	< LOD 2.0	ND	< LOD 40.66
24480	2	48.26	SS-06	76	ND	< LOD 2.0	ND	< LOD 41.44
24429	3	47.68	SS-06	76	ND	< LOD 2.0	ND	< LOD 41.95
24418	OBZ	47.83	SS-06	76	ND	< LOD 2.0	ND	< LOD 41.81
24427	1	48.54	CP-4A	78	ND	< LOD 2.0	ND	< LOD 41.20
24435	2	47.71	CP-4A	78	ND	< LOD 2.0	ND	< LOD 41.92
24244	3	49.01	CP-4A	78	ND	< LOD 20.0	ND	< LOD 408.08
24220	OBZ	48.74	CP-4A	78	ND	< LOD 2.0	ND	< LOD 41.03
24460	1	50.05	CP-4B	79	ND	< LOD 2.0	ND	< LOD 39.96
24465	2	48.47	CP-4B	79	ND	< LOD 2.0	ND	< LOD 41.26
24207	3	48.49	CP-4B	79	ND	< LOD 10.0	ND	< LOD 206.23
24390	OBZ	49.02	CP-4B	79	ND	< LOD 2.0	ND	< LOD 40.80
24259	1	48.76	SS-07	80	ND	< LOD 2.0	ND	< LOD 41.02
24421	2	48.13	SS-07	80	ND	< LOD 2.0	ND	< LOD 41.55
24445	3	47.87	SS-07	80	ND	< LOD 2.0	ND	< LOD 41.78
24432	OBZ	48.49	SS-07	80	ND	< LOD 2.0	ND	< LOD 41.25
24459	1	48.96	N-02	81	ND	< LOD 2.0	ND	< LOD 40.85
24417	2	48.11	N-02	81	ND	< LOD 2.0	ND	< LOD 41.57
24442	3	48.01	N-02	81	ND	< LOD 10.0	ND	< LOD 208.29
24386	OBZ	48.19	N-02	81	ND	< LOD 2.0	ND	< LOD 41.50
24452	1	48.20	SG-2B	82	ND	< LOD 2.0	ND	< LOD 41.49
24453	2	48.59	SG-2B	82	ND	< LOD 2.0	ND	< LOD 41.16
24420	3	47.84	SG-2B	82	ND	< LOD 10.0	ND	< LOD 209.03
24444	OBZ	47.95	SG-2B	82	ND	< LOD 20.0	ND	< LOD 417.10
24455	1	48.56	CS-07	83	ND	< LOD 2.0	ND	< LOD 41.19
24433	2	47.96	CS-07	83	ND	< LOD 2.0	ND	< LOD 41.70
24398	3	48.06	CS-07	83	ND	< LOD 2.0	ND	< LOD 41.61
24511	OBZ	47.96	CS-07	83	ND	< LOD 2.0	ND	< LOD 41.70
24454	1	49.34	CPDS-1A	84	ND	< LOD 2.0	ND	< LOD 40.54
24291	2	48.49	CPDS-1A	84	ND	< LOD 2.0	ND	< LOD 41.25
24209	3	48.43	CPDS-1A	84	ND	< LOD 2.0	ND	< LOD 41.30
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 2.0	ND	< LOD 41.01
24204	1	49.46	CPDS-1B	85	ND	< LOD 2.0	ND	< LOD 40.44
24273	2	48.35	CPDS-1B	85	ND	< LOD 2.0	ND	< LOD 41.37
24223	3	48.82	CPDS-1B	85	ND	< LOD 4.0	ND	< LOD 81.93
24466	OBZ	49.96	CPDS-1B	85	ND	< LOD 2.0	ND	< LOD 40.03

Airborne Sample Data Analysis - Selenium

NIOSH REL 200.0 micrograms/cubic meter
OSHA PEL 200.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 41.19	ND	< LOD 41.67	ND	< LOD 41.26	ND	< LOD 41.40
CS-01	ND	< LOD 41.19	ND	< LOD 41.67	ND	< LOD 41.26	ND	< LOD 41.74
CS-02	ND	< LOD 41.60	ND	< LOD 41.81	ND	< LOD 41.66	ND	< LOD 41.68
CS-03	ND	< LOD 41.25	ND	< LOD 41.42	ND	< LOD 41.48	ND	< LOD 41.42
CS-04	ND	< LOD 41.14	ND	< LOD 90.00	ND	< LOD 41.42	ND	< LOD 41.17
CS-05	ND	< LOD 41.29	ND	< LOD 41.73	ND	< LOD 41.86	ND	< LOD 65.77
CS-06	ND	< LOD 41.70	ND	< LOD 41.88	ND	< LOD 41.40	ND	< LOD 41.63
CS-07	ND	< LOD 41.19	ND	< LOD 41.70	ND	< LOD 41.61	ND	< LOD 41.70
CSDS-01	ND	< LOD 41.53	ND	< LOD 41.66	ND	< LOD 41.53	ND	< LOD 41.61
CSDS-02	ND	< LOD 41.21	ND	< LOD 41.36	ND	< LOD 41.40	ND	< LOD 41.86
N-01	ND	< LOD 40.64	ND	< LOD 41.70	ND	< LOD 41.39	ND	< LOD 40.98
N-02	ND	< LOD 40.85	ND	< LOD 41.57	ND	< LOD 208.29	ND	< LOD 41.50
O-1	ND	< LOD 41.19	ND	< LOD 41.76	ND	< LOD 41.09	ND	< LOD 41.86
S-01	ND	< LOD 41.53	ND	< LOD 41.76	ND	< LOD 41.75	ND	< LOD 41.73
S-02	ND	< LOD 41.68	ND	< LOD 41.88	ND	< LOD 41.67	ND	< LOD 41.76
SH-01	ND	< LOD 41.77	ND	< LOD 41.79	ND	< LOD 41.46	ND	< LOD 41.60
SS-01	ND	< LOD 41.29	ND	< LOD 41.75	ND	< LOD 41.37	ND	< LOD 41.41
SS-02	ND	< LOD 41.55	ND	< LOD 41.71	ND	< LOD 41.39	ND	< LOD 41.14
SS-03	ND	< LOD 89.49	ND	< LOD 42.02	ND	< LOD 40.87	ND	< LOD 40.31
SS-04	ND	< LOD 41.83	ND	< LOD 41.86	ND	< LOD 41.84	ND	< LOD 41.16
SS-05	ND	< LOD 40.13	ND	< LOD 41.95	ND	< LOD 41.57	ND	< LOD 40.99
SS-06	ND	< LOD 40.66	ND	< LOD 41.44	ND	< LOD 41.95	ND	< LOD 41.81
SS-07	ND	< LOD 41.02	ND	< LOD 41.55	ND	< LOD 41.78	ND	< LOD 41.25
SSDS-01	ND	< LOD 41.17	ND	< LOD 41.81	ND	< LOD 41.25	ND	< LOD 41.39
SSDS-02	ND	< LOD 41.68	ND	< LOD 41.67	ND	< LOD 41.27	ND	< LOD 40.51
SSDS-03	ND	< LOD 40.42	ND	< LOD 39.72	ND	< LOD 39.81	ND	< LOD 41.44
CP-1A	ND	< LOD 41.25	ND	< LOD 41.43	ND	< LOD 41.50	ND	< LOD 41.89
CP-1B	ND	< LOD 47.15	ND	< LOD 47.60	ND	< LOD 47.09	ND	< LOD 47.88
CP-2A	ND	< LOD 41.26	ND	< LOD 41.82	ND	< LOD 82.95	ND	< LOD 41.55
CP-2B	ND	< LOD 41.31	ND	< LOD 41.75	ND	< LOD 41.44	ND	< LOD 42.08
CP-3A	ND	< LOD 41.31	ND	< LOD 41.73	ND	< LOD 82.73	ND	< LOD 82.78
CP-3B	ND	< LOD 55.04	ND	< LOD 55.52	ND	< LOD 109.65	ND	< LOD 49.66
CP-4A	ND	< LOD 41.20	ND	< LOD 41.92	ND	< LOD 408.08	ND	< LOD 41.03
CP-4B	ND	< LOD 39.96	ND	< LOD 41.26	ND	< LOD 206.23	ND	< LOD 40.80
CPDS-1A	ND	< LOD 40.54	ND	< LOD 41.25	ND	< LOD 41.30	ND	< LOD 41.01
CPDS-1B	ND	< LOD 40.44	ND	< LOD 41.37	ND	< LOD 81.93	ND	< LOD 40.03
G-1A	ND	< LOD 41.55	ND	< LOD 41.78	ND	< LOD 41.52	ND	< LOD 40.89
G-1B	ND	< LOD 41.43	ND	< LOD 42.21	ND	< LOD 41.52	ND	< LOD 41.48
G-2A	ND	< LOD 42.15	ND	< LOD 42.44	ND	< LOD 41.46	ND	< LOD 41.63
G-2B	ND	< LOD 40.99	ND	< LOD 41.52	ND	< LOD 41.83	ND	< LOD 41.20
G-3A	ND	< LOD 41.37	ND	< LOD 41.57	ND	< LOD 41.97	ND	< LOD 41.68
G-4A	ND	< LOD 40.62	ND	< LOD 41.35	ND	< LOD 41.09	ND	< LOD 41.53
G-4B	ND	< LOD 41.34	ND	< LOD 41.66	ND	< LOD 41.34	ND	< LOD 41.31
G-5A	ND	< LOD 41.17	ND	< LOD 41.51	ND	< LOD 41.62	ND	< LOD 41.81
G-5B	ND	< LOD 41.77	ND	< LOD 41.53	ND	< LOD 41.68	ND	< LOD 41.68
G-6A	ND	< LOD 41.58	ND	< LOD 41.81	ND	< LOD 41.61	ND	< LOD 41.42
G-6B	ND	< LOD 41.02	ND	< LOD 42.15	ND	< LOD 40.88	ND	< LOD 41.27
G-7A	ND	< LOD 41.26	ND	< LOD 41.48	ND	< LOD 41.72	ND	< LOD 41.88
G-7B	ND	< LOD 41.08	ND	< LOD 41.61	ND	< LOD 42.41	ND	< LOD 42.31
SG-1A	ND	< LOD 40.83	ND	< LOD 41.49	ND	< LOD 41.51	ND	< LOD 206.31
SG-1B	ND	< LOD 76.86	ND	< LOD 76.86	ND	< LOD 76.63	ND	< LOD 761.90
SG-2A	ND	< LOD 41.16	ND	< LOD 41.75	ND	< LOD 41.46	ND	< LOD 82.82
SG-2B	ND	< LOD 41.49	ND	< LOD 41.16	ND	< LOD 209.03	ND	< LOD 417.10

Bulk Elemental Analysis - Selenium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Selenium		Sample	Selenium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 5.0	J95331-63 PB	ND	< LOD 5.0
CS-01	J95331-34 VB	ND	< LOD 5.0	J95331-34 PB	ND	< LOD 5.0
CS-02	J95331-37 VB	ND	< LOD 5.0	J95331-37 PB	ND	< LOD 5.0
CS-03	J95331-38 VB	ND	< LOD 5.0	J95331-38 PB	ND	< LOD 5.0
CS-04	J95331-39 VB	ND	< LOD 5.0	J95331-39 PB	ND	< LOD 5.0
CS-05	J95331-57 VB	ND	< LOD 5.0	J95331-57 PB	ND	< LOD 5.0
CS-06	J95331-70 VB	ND	< LOD 5.0	J95331-70 PB	ND	< LOD 5.0
CS-07	J95331-83 VB	ND	< LOD 5.0	J95331-83 PB	ND	< LOD 5.0
CSDS-01	J95331-31 VB	ND	< LOD 5.0	J95331-31 PB	ND	< LOD 5.0
CSDS-02	J95331-35 VB	ND	< LOD 5.0	J95331-35 PB	ND	< LOD 5.0
N-01	J95331-52 VB	ND	< LOD 5.0	J95331-52 PB	ND	< LOD 5.0
N-02	J95331-81 VB	ND	< LOD 5.0	J95331-81 PB	ND	< LOD 5.0
O-1	J95331-69 VB	ND	< LOD 5.0	J95331-69 PB	6.60	< LOQ 17.0
S-01	J95331-28 VB	ND	< LOD 5.0	J95331-28 PB	ND	< LOD 5.0
S-02	J95331-29 VB	ND	< LOD 5.0	J95331-29 PB	ND	< LOD 5.0
SH-01	J95331-36 VB	ND	< LOD 5.0	J95331-36 PB	ND	< LOD 5.0
SS-01	J95331-32 VB	ND	< LOD 5.0	J95331-32 PB	ND	< LOD 5.0
SS-02	J95331-40 VB	ND	< LOD 5.0	J95331-40 PB	ND	< LOD 5.0
SS-03	J95331-45 VB	ND	< LOD 5.0	J95331-45 PB	ND	< LOD 5.0
SS-04	J95331-47 VB	ND	< LOD 5.0	J95331-47 PB	ND	< LOD 5.0
SS-05	J95331-53 VB	ND	< LOD 5.0	J95331-53 PB	ND	< LOD 5.0
SS-06	J95331-76 VB	ND	< LOD 5.0	J95331-76 PB	ND	< LOD 5.0
SS-07	J95331-80 VB	ND	< LOD 5.0	J95331-80 PB	ND	< LOD 5.0
SSDS-01	J95331-33 VB	ND	< LOD 5.0	J95331-33 PB	ND	< LOD 5.0
SSDS-02	J95331-44 VB	ND	< LOD 5.0	J95331-44 PB	ND	< LOD 5.0
SSDS-03	J95331-48 VB	ND	< LOD 5.0	J95331-48 PB	ND	< LOD 5.0
CP-1A	J95331-60 VB	ND	< LOD 5.0	J95331-60 PB	ND	< LOD 5.0
CP-1B	J95331-61 VB	ND	< LOD 5.0	J95331-61 PB	ND	< LOD 5.0
CP-2A	J95331-67 VB	ND	< LOD 5.0	J95331-67 PB	ND	< LOD 100.0
CP-2B	J95331-68 VB	ND	< LOD 10.0	J95331-68 PB	ND	< LOD 10.0
CP-3A	J95331-72 VB	ND	< LOD 5.0	J95331-72 PB	ND	< LOD 5.0
CP-3B	J95331-73 VB	ND	< LOD 5.0	J95331-73 PB	7.30	< LOQ 17.0
CP-4A	J95331-78 VB	9.10	< LOQ 17.0	J95331-78 PB	18.00	< LOQ 34.0
CP-4B	J95331-79 VB	ND	< LOD 5.0	J95331-79 PB	ND	< LOD 5.0
CPDS-1A	J95331-84 VB	ND	< LOD 5.0	J95331-84 PB	ND	< LOD 5.0
CPDS-1B	J95331-85 VB	ND	< LOD 5.0	J95331-85 PB	12.00	< LOQ 17.0
G-1A	J95331-41 VB	ND	< LOD 5.0	J95331-41 PB	ND	< LOD 5.0
G-1B	J95331-46 VB	ND	< LOD 5.0	J95331-46 PB	ND	< LOD 5.0
G-2A	J95331-43 VB	ND	< LOD 5.0	J95331-43 PB	ND	< LOD 5.0
G-2B	J95331-50 VB	ND	< LOD 5.0	J95331-50 PB	ND	< LOD 5.0
G-3A	J95331-49 VB	ND	< LOD 5.0	J95331-49 PB	ND	< LOD 5.0
G-4A	J95331-55 VB	ND	< LOD 5.0	J95331-55 PB	ND	< LOD 5.0
G-4B	J95331-56 VB	ND	< LOD 5.0	J95331-56 PB	ND	< LOD 5.0
G-5A	J95331-58 VB	ND	< LOD 5.0	J95331-58 PB	ND	< LOD 5.0
G-5B	J95331-59 VB	ND	< LOD 5.0	J95331-59 PB	ND	< LOD 5.0
G-6A	J95331-64 VB	ND	< LOD 5.0	J95331-64 PB	ND	< LOD 5.0
G-6B	J95331-65 VB	ND	< LOD 5.0	J95331-65 PB	ND	< LOD 5.0
G-7A	J95331-74 VB	ND	< LOD 5.0	J95331-74 PB	ND	< LOD 5.0
G-7B	J95331-75 VB	ND	< LOD 5.0	J95331-75 PB	ND	< LOD 5.0
SG-1A	J95331-54 VB	ND	< LOD 100.0	J95331-54 PB	ND	< LOD 100.0
SG-1B	J95331-71 VB	ND	< LOD 25.0	J95331-71 PB	25.00	< LOQ 85.0
SG-2A	J95331-66 VB	ND	< LOD 25.0	J95331-66 PB	ND	< LOD 25.0
SG-2B	J95331-82 VB	ND	< LOD 25.0	J95331-82 PB	ND	< LOD 25.0

Comparison of Airborne Concentrations to Bulk Concentrations - Selenium

NIOSH REL 200.0 micrograms/cubic meter
OSHA PEL 200.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	ND	ND
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	ND
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	ND	ND	ND	ND
CS-07	ND	ND	ND	ND	ND
CSDS-01	ND	ND	ND	ND	ND
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	ND
N-02	ND	ND	ND	ND	ND
O-1	ND	ND	ND	ND	ND
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	ND
SS-07	ND	ND	ND	ND	ND
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	ND	ND	ND	ND	ND
CP-2A	ND	ND	ND	ND	ND
CP-3A	ND	ND	ND	ND	ND
CP-4A	ND	ND	ND	ND	9.10
CPDS-1A	ND	ND	ND	ND	ND
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	ND	ND	ND	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	ND	ND

APPENDIX B - SILVER

Silver

Silver and soluble silver compounds may cause discoloration or a blue-gray coloring of the eyes, nose, throat, and skin. The NIOSH REL and OSHA PEL for silver are both 10 micrograms/cubic meter of air.

Air Sample Results - Silver

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Silver			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.08	ND	< LOD 1.66
24412	2	47.89	S-01	28	ND	< LOD 0.08	ND	< LOD 1.67
24441	3	47.90	S-01	28	ND	< LOD 0.08	ND	< LOD 1.67
24450	OBZ	47.93	S-01	28	ND	< LOD 0.08	ND	< LOD 1.67
24643	1	47.98	S-02	29	ND	< LOD 0.08	ND	< LOD 1.67
24625	2	47.76	S-02	29	ND	< LOD 0.08	ND	< LOD 1.68
24642	3	48.00	S-02	29	ND	< LOD 0.08	ND	< LOD 1.67
24632	OBZ	47.89	S-02	29	ND	< LOD 0.08	ND	< LOD 1.67
24634	1	48.16	CSDS-01	31	ND	< LOD 0.08	ND	< LOD 1.66
24650	2	48.01	CSDS-01	31	0.990	< LOQ 0.25	20.62	< LOQ 5.21
24644	3	48.16	CSDS-01	31	ND	< LOD 0.08	ND	< LOD 1.66
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 0.08	ND	< LOD 1.66
24640	1	48.44	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24641	2	47.90	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.67
24651	3	48.35	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.66
24646	1	48.58	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.65
24626	2	47.84	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.67
24638	3	48.49	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.65
24647	OBZ	48.32	SSDS-01	33	0.086	< LOQ 0.25	1.78	< LOQ 5.17
24628	1	48.55	CS-01	34	ND	< LOD 0.08	ND	< LOD 1.65
24637	2	48.00	CS-01	34	ND	< LOD 0.08	ND	< LOD 1.67
24624	3	48.47	CS-01	34	ND	< LOD 0.08	ND	< LOD 1.65
24636	OBZ	47.92	CS-01	34	ND	< LOD 0.08	ND	< LOD 1.67
24623	1	48.53	CSDS-02	35	ND	< LOD 0.08	ND	< LOD 1.65
24622	2	48.36	CSDS-02	35	ND	< LOD 0.08	ND	< LOD 1.65
24654	3	48.31	CSDS-02	35	0.094	< LOQ 0.25	1.95	< LOQ 5.17
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 0.08	ND	< LOD 1.67
24629	1	47.88	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24633	2	47.86	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24627	3	48.24	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.66
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.66
24555	1	48.08	CS-02	37	ND	< LOD 0.08	ND	< LOD 1.66
24552	2	47.84	CS-02	37	ND	< LOD 0.08	ND	< LOD 1.67
24541	3	48.01	CS-02	37	ND	< LOD 0.08	ND	< LOD 1.67
24529	OBZ	47.99	CS-02	37	ND	< LOD 0.08	ND	< LOD 1.67
24558	1	48.49	CS-03	38	ND	< LOD 0.08	ND	< LOD 1.65
24524	2	48.29	CS-03	38	ND	< LOD 0.08	ND	< LOD 1.66
24561	3	48.22	CS-03	38	ND	< LOD 0.08	ND	< LOD 1.66
24559	OBZ	48.29	CS-03	38	ND	< LOD 0.08	ND	< LOD 1.66
24543	1	48.61	CS-04	39	ND	< LOD 0.08	ND	< LOD 1.65
24532	2	47.78	CS-04	39	ND	< LOD 0.25	ND	< LOD 5.23
24546	3	48.29	CS-04	39	ND	< LOD 0.08	ND	< LOD 1.66
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.08	ND	< LOD 1.65
24560	1	48.13	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.66
24565	2	47.95	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.67
24630	3	48.32	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.66
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.65
24525	1	48.13	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.66
24563	2	47.87	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.67
24547	3	48.17	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.66
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.64
24538	1	47.45	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.69

Air Sample Results - Silver

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Silver			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.70
24533	3	48.24	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.66
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.67
24528	1	47.99	SSDS-02	44	ND	< LOD 0.08	ND	< LOD 1.67
24544	2	48.00	SSDS-02	44	ND	< LOD 0.08	ND	< LOD 1.67
24567	3	48.46	SSDS-02	44	ND	< LOD 0.08	ND	< LOD 1.65
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.08	ND	< LOD 1.62
24571	1	48.05	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.66
24536	2	47.60	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.68
24534	3	48.94	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.63
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.61
24568	1	48.28	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.66
24592	2	47.38	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.69
24593	3	48.17	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.66
24535	OBZ	48.22	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.66
24590	1	47.81	SS-04	47	ND	< LOD 0.08	ND	< LOD 1.67
24605	2	47.78	SS-04	47	ND	< LOD 0.08	ND	< LOD 1.67
24562	3	47.80	SS-04	47	ND	< LOD 0.08	ND	< LOD 1.67
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.08	ND	< LOD 1.65
24527	1	49.48	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.62
24569	2	50.35	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.59
24584	3	50.24	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.59
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.66
24600	1	48.34	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.65
24616	2	48.11	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.66
24585	3	47.65	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.68
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.67
24587	1	48.79	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.64
24602	2	48.17	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.66
24564	3	47.81	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.67
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.65
24618	1	49.21	N-01	52	ND	< LOD 0.08	ND	< LOD 1.63
24611	2	47.96	N-01	52	ND	< LOD 0.08	ND	< LOD 1.67
24588	3	48.32	N-01	52	ND	< LOD 0.08	ND	< LOD 1.66
24615	OBZ	48.80	N-01	52	ND	< LOD 0.08	ND	< LOD 1.64
24597	1	49.78	SS-05	53	ND	< LOD 0.08	ND	< LOD 1.61
24599	2	47.68	SS-05	53	ND	< LOD 0.08	ND	< LOD 1.68
24575	3	48.11	SS-05	53	ND	< LOD 0.08	ND	< LOD 1.66
24617	OBZ	48.79	SS-05	53	ND	< LOD 0.08	ND	< LOD 1.64
24609	1	48.98	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.63
24596	2	48.20	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.66
24610	3	48.18	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.66
24576	OBZ	48.47	SG-1A	54	ND	< LOD 0.40	ND	< LOD 8.25
24606	1	49.24	G-4A	55	ND	< LOD 0.08	ND	< LOD 1.62
24620	2	48.37	G-4A	55	ND	< LOD 0.08	ND	< LOD 1.65
24573	3	48.67	G-4A	55	ND	< LOD 0.08	ND	< LOD 1.64
24505	OBZ	48.16	G-4A	55	ND	< LOD 0.08	ND	< LOD 1.66
24340	1	48.38	G-4B	56	ND	< LOD 0.08	ND	< LOD 1.65
24607	2	48.01	G-4B	56	ND	< LOD 0.08	ND	< LOD 1.67
24595	3	48.38	G-4B	56	ND	< LOD 0.08	ND	< LOD 1.65
24598	OBZ	48.42	G-4B	56	ND	< LOD 0.08	ND	< LOD 1.65
24580	1	48.44	CS-05	57	ND	< LOD 0.08	ND	< LOD 1.65
24604	2	47.93	CS-05	57	ND	< LOD 0.08	ND	< LOD 1.67

Air Sample Results - Silver

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Silver			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 0.08	ND	< LOD 1.67
24574	OBZ	30.41	CS-05	57	ND	< LOD 0.08	ND	< LOD 2.63
24614	1	48.58	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.65
24577	2	48.18	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.66
24572	3	48.05	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.66
24582	OBZ	47.83	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.67
24322	1	47.88	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.67
24354	2	48.16	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.66
24510	3	47.98	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.67
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.08	ND	< LOD 1.67
24497	1	48.49	CP-1A	60	ND	< LOD 0.08	ND	< LOD 1.65
24333	2	48.28	CP-1A	60	ND	< LOD 0.08	ND	< LOD 1.66
24326	3	48.19	CP-1A	60	ND	< LOD 0.08	ND	< LOD 1.66
24329	OBZ	47.74	CP-1A	60	ND	< LOD 0.08	ND	< LOD 1.68
24499	1	42.42	CP-1B	62	ND	< LOD 0.08	ND	< LOD 1.89
24506	2	42.02	CP-1B	62	ND	< LOD 0.08	ND	< LOD 1.90
24388	3	42.47	CP-1B	62	ND	< LOD 0.08	ND	< LOD 1.88
24315	OBZ	41.77	CP-1B	62	ND	< LOD 0.08	ND	< LOD 1.92
24318	1	48.56	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.65
24308	2	48.00	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.67
24330	3	48.47	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.65
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.66
24363	1	48.10	G-6A	64	ND	< LOD 0.08	ND	< LOD 1.66
24398	2	47.84	G-6A	64	ND	< LOD 0.08	ND	< LOD 1.67
24351	3	48.06	G-6A	64	ND	< LOD 0.08	ND	< LOD 1.66
24594	OBZ	48.29	G-6A	64	ND	< LOD 0.08	ND	< LOD 1.66
24312	1	48.76	G-6B	65	ND	< LOD 0.08	ND	< LOD 1.64
24484	2	47.45	G-6B	65	ND	< LOD 0.08	ND	< LOD 1.69
24327	3	48.92	G-6B	65	ND	< LOD 0.08	ND	< LOD 1.64
24389	OBZ	48.46	G-6B	65	ND	< LOD 0.08	ND	< LOD 1.65
24348	1	48.59	SG-2A	66	ND	< LOD 0.16	ND	< LOD 3.29
24314	2	47.90	SG-2A	66	ND	< LOD 0.08	ND	< LOD 1.67
24494	3	48.24	SG-2A	66	ND	< LOD 0.16	ND	< LOD 3.32
24337	OBZ	48.30	SG-2A	66	ND	< LOD 0.40	ND	< LOD 8.28
24508	1	48.47	CP-2A	67	ND	< LOD 0.08	ND	< LOD 1.65
24361	2	47.82	CP-2A	67	0.140	< LOQ 0.25	2.93	< LOQ 5.23
24359	3	48.22	CP-2A	67	0.660	> LOQ 0.50	13.69	> LOQ 10.37
24471	OBZ	48.14	CP-2A	67	0.230	< LOQ 0.25	4.78	< LOQ 5.19
24373	1	48.41	CP-2B	68	0.110	< LOQ 0.25	2.27	< LOQ 5.16
24468	2	47.90	CP-2B	68	ND	< LOD 0.08	ND	< LOD 1.67
24481	3	48.26	CP-2B	68	0.210	< LOQ 0.25	4.35	< LOQ 5.18
24391	OBZ	47.53	CP-2B	68	ND	< LOD 0.08	ND	< LOD 1.68
24356	1	48.56	O-1	69	ND	< LOD 0.08	ND	< LOD 1.65
24470	2	47.89	O-1	69	ND	< LOD 0.08	ND	< LOD 1.67
24467	3	48.67	O-1	69	ND	< LOD 0.08	ND	< LOD 1.64
24313	OBZ	47.78	O-1	69	ND	< LOD 0.08	ND	< LOD 1.67
24501	1	47.96	CS-06	70	0.093	< LOQ 0.25	1.94	< LOQ 5.21
24496	2	47.75	CS-06	70	ND	< LOD 0.08	ND	< LOD 1.68
24478	3	48.31	CS-06	70	ND	< LOD 0.08	ND	< LOD 1.66
24503	OBZ	48.04	CS-06	70	ND	< LOD 0.08	ND	< LOD 1.67
24474	1	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24469	2	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24492	3	26.10	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07

Air Sample Results - Silver

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Silver			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	0.400	> LOQ 1.30	15.24	> LOQ 49.52
24489	1	48.42	CP-3A	72	0.170	< LOQ 0.25	3.51	< LOQ 5.16
24491	2	47.93	CP-3A	72	0.370	> LOQ 0.25	7.72	> LOQ 5.22
24482	3	48.35	CP-3A	72	0.860	> LOQ 0.25	17.79	> LOQ 5.17
24486	OBZ	48.32	CP-3A	72	0.700	> LOQ 0.25	14.49	> LOQ 5.17
24516	1	36.34	CP-3B	73	0.160	< LOQ 0.25	4.4	< LOQ 6.88
24502	2	36.02	CP-3B	73	0.450	> LOQ 0.25	12.49	> LOQ 6.94
24515	3	36.48	CP-3B	73	0.650	> LOQ 0.25	17.82	> LOQ 6.85
24500	OBZ	40.27	CP-3B	73	0.330	> LOQ 0.25	8.19	> LOQ 6.21
24504	1	48.47	G-7A	74	ND	< LOD 0.08	ND	< LOD 1.65
24513	2	48.22	G-7A	74	0.150	< LOQ 0.25	3.11	< LOQ 5.18
24458	3	47.94	G-7A	74	ND	< LOD 0.08	ND	< LOD 1.67
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.08	ND	< LOD 1.68
24404	1	48.68	G-7B	75	ND	< LOD 0.08	ND	< LOD 1.64
24451	2	48.06	G-7B	75	ND	< LOD 0.08	ND	< LOD 1.66
24447	3	47.16	G-7B	75	ND	< LOD 0.08	ND	< LOD 1.70
24423	OBZ	47.27	G-7B	75	ND	< LOD 0.08	ND	< LOD 1.69
24456	1	49.19	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.63
24480	2	48.26	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.66
24429	3	47.68	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.68
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.67
24427	1	48.54	CP-4A	78	ND	< LOD 0.08	ND	< LOD 1.65
24435	2	47.71	CP-4A	78	0.320	> LOQ 0.25	6.71	> LOQ 5.24
24244	3	49.01	CP-4A	78	3.800	> LOQ 0.40	77.54	> LOQ 8.16
24220	OBZ	48.74	CP-4A	78	0.420	> LOQ 0.25	8.62	> LOQ 5.13
24460	1	50.05	CP-4B	79	0.140	< LOQ 0.25	2.8	< LOQ 5.00
24465	2	48.47	CP-4B	79	0.520	> LOQ 0.25	10.73	> LOQ 5.16
24207	3	48.49	CP-4B	79	1.500	> LOQ 0.50	30.93	> LOQ 10.31
24390	OBZ	49.02	CP-4B	79	0.110	< LOQ 0.25	2.24	< LOQ 5.10
24259	1	48.76	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.64
24421	2	48.13	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.66
24445	3	47.87	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.67
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.65
24459	1	48.96	N-02	81	ND	< LOD 0.08	ND	< LOD 1.63
24417	2	48.11	N-02	81	ND	< LOD 0.08	ND	< LOD 1.66
24442	3	48.01	N-02	81	ND	< LOD 0.08	ND	< LOD 1.67
24386	OBZ	48.19	N-02	81	ND	< LOD 0.08	ND	< LOD 1.66
24452	1	48.20	SG-2B	82	ND	< LOD 0.08	ND	< LOD 1.66
24453	2	48.59	SG-2B	82	ND	< LOD 0.08	ND	< LOD 1.65
24420	3	47.84	SG-2B	82	ND	< LOD 0.08	ND	< LOD 1.67
24444	OBZ	47.95	SG-2B	82	ND	< LOD 0.40	ND	< LOD 8.34
24455	1	48.56	CS-07	83	ND	< LOD 0.08	ND	< LOD 1.65
24433	2	47.96	CS-07	83	ND	< LOD 0.08	ND	< LOD 1.67
24398	3	48.06	CS-07	83	ND	< LOD 0.08	ND	< LOD 1.66
24511	OBZ	47.96	CS-07	83	ND	< LOD 0.08	ND	< LOD 1.67
24454	1	49.34	CPDS-1A	84	ND	< LOD 0.08	ND	< LOD 1.62
24291	2	48.49	CPDS-1A	84	0.130	< LOQ 0.25	2.68	< LOQ 5.16
24209	3	48.43	CPDS-1A	84	0.230	< LOQ 0.25	4.75	< LOQ 5.16
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 0.08	ND	< LOD 1.64
24204	1	49.46	CPDS-1B	85	ND	< LOD 0.08	ND	< LOD 1.62
24273	2	48.35	CPDS-1B	85	0.160	< LOQ 0.25	3.31	< LOQ 5.17
24223	3	48.82	CPDS-1B	85	0.460	> LOQ 0.25	9.42	> LOQ 5.12
24466	OBZ	49.96	CPDS-1B	85	0.089	< LOQ 0.25	1.78	< LOQ 5.00

Airborne Sample Data Analysis - Silver

NIOSH REL 10.0 micrograms/cubic meter
OSHA PEL 10.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.65	ND	< LOD 1.66
CS-01	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.65	ND	< LOD 1.67
CS-02	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 1.67
CS-03	ND	< LOD 1.65	ND	< LOD 1.66	ND	< LOD 1.66	ND	< LOD 1.66
CS-04	ND	< LOD 1.65	ND	< LOD 5.23	ND	< LOD 1.66	ND	< LOD 1.65
CS-05	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 2.63
CS-06	1.94	< LOQ 5.21	ND	< LOD 1.68	ND	< LOD 1.66	ND	< LOD 1.67
CS-07	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.67
CSDS-01	ND	< LOD 1.66	20.62	< LOQ 5.21	ND	< LOD 1.66	ND	< LOD 1.66
CSDS-02	ND	< LOD 1.65	ND	< LOD 1.65	1.95	< LOQ 5.17	ND	< LOD 1.67
N-01	ND	< LOD 1.63	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.64
N-02	ND	< LOD 1.63	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.66
O-1	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.64	ND	< LOD 1.67
S-01	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 1.67
S-02	ND	< LOD 1.67	ND	< LOD 1.68	ND	< LOD 1.67	ND	< LOD 1.67
SH-01	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.66
SS-01	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.65	ND	< LOD 1.66
SS-02	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.65
SS-03	ND	< LOD 1.66	ND	< LOD 1.68	ND	< LOD 1.63	ND	< LOD 1.61
SS-04	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 1.65
SS-05	ND	< LOD 1.61	ND	< LOD 1.68	ND	< LOD 1.66	ND	< LOD 1.64
SS-06	ND	< LOD 1.63	ND	< LOD 1.66	ND	< LOD 1.68	ND	< LOD 1.67
SS-07	ND	< LOD 1.64	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.65
SSDS-01	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.65	1.78	< LOQ 5.17
SSDS-02	ND	< LOD 1.67	ND	< LOD 1.67	ND	< LOD 1.65	ND	< LOD 1.62
SSDS-03	ND	< LOD 1.62	ND	< LOD 1.59	ND	< LOD 1.59	ND	< LOD 1.66
CP-1A	ND	< LOD 1.65	ND	< LOD 1.66	ND	< LOD 1.66	ND	< LOD 1.68
CP-1B	ND	< LOD 1.89	ND	< LOD 1.90	ND	< LOD 1.88	ND	< LOD 1.92
CP-2A	ND	< LOD 1.65	2.93	< LOQ 5.23	13.69	> LOQ 10.37	4.78	< LOQ 5.19
CP-2B	2.27	< LOQ 5.16	ND	< LOD 1.67	4.35	< LOQ 5.18	ND	< LOD 1.68
CP-3A	3.51	< LOQ 5.16	7.72	> LOQ 5.22	17.79	> LOQ 5.17	14.49	> LOQ 5.17
CP-3B	4.4	< LOQ 6.88	12.49	> LOQ 6.94	17.82	> LOQ 6.85	8.19	> LOQ 6.21
CP-4A	ND	< LOD 1.65	6.71	> LOQ 5.24	77.54	> LOQ 8.16	8.62	> LOQ 5.13
CP-4B	2.8	< LOQ 5.00	10.73	> LOQ 5.16	30.93	> LOQ 10.31	2.24	< LOQ 5.10
CPDS-1A	ND	< LOD 1.62	2.68	< LOQ 5.16	4.75	< LOQ 5.16	ND	< LOD 1.64
CPDS-1B	ND	< LOD 1.62	3.31	< LOQ 5.17	9.42	> LOQ 5.12	1.78	< LOQ 5.00
G-1A	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.64
G-1B	ND	< LOD 1.66	ND	< LOD 1.69	ND	< LOD 1.66	ND	< LOD 1.66
G-2A	ND	< LOD 1.69	ND	< LOD 1.70	ND	< LOD 1.66	ND	< LOD 1.67
G-2B	ND	< LOD 1.64	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.65
G-3A	ND	< LOD 1.65	ND	< LOD 1.66	ND	< LOD 1.68	ND	< LOD 1.67
G-4A	ND	< LOD 1.62	ND	< LOD 1.65	ND	< LOD 1.64	ND	< LOD 1.66
G-4B	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.65	ND	< LOD 1.65
G-5A	ND	< LOD 1.65	ND	< LOD 1.66	ND	< LOD 1.66	ND	< LOD 1.67
G-5B	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.67
G-6A	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 1.66
G-6B	ND	< LOD 1.64	ND	< LOD 1.69	ND	< LOD 1.64	ND	< LOD 1.65
G-7A	ND	< LOD 1.65	3.11	< LOQ 5.18	ND	< LOD 1.67	ND	< LOD 1.68
G-7B	ND	< LOD 1.64	ND	< LOD 1.66	ND	< LOD 1.70	ND	< LOD 1.69
SG-1A	ND	< LOD 1.63	ND	< LOD 1.66	ND	< LOD 1.66	ND	< LOD 8.25
SG-1B	ND	< LOD 3.07	ND	< LOD 3.07	ND	< LOD 3.07	15.24	> LOQ 49.52
SG-2A	ND	< LOD 3.29	ND	< LOD 1.67	ND	< LOD 3.32	ND	< LOD 8.28
SG-2B	ND	< LOD 1.66	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 8.34

Bulk Elemental Analysis - Silver

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Silver		Sample	Silver	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.3	J95331-63 PB	2.00	> LOQ 1.0
CS-01	J95331-34 VB	0.39	< LOQ 1.0	J95331-34 PB	0.52	< LOQ 1.0
CS-02	J95331-37 VB	ND	< LOD 0.3	J95331-37 PB	ND	< LOD 0.3
CS-03	J95331-38 VB	0.62	< LOQ 1.0	J95331-38 PB	0.45	< LOQ 1.0
CS-04	J95331-39 VB	ND	< LOD 0.3	J95331-39 PB	ND	< LOD 0.3
CS-05	J95331-57 VB	ND	< LOD 0.3	J95331-57 PB	ND	< LOD 0.3
CS-06	J95331-70 VB	ND	< LOD 0.3	J95331-70 PB	ND	< LOD 0.3
CS-07	J95331-83 VB	ND	< LOD 0.3	J95331-83 PB	ND	< LOD 0.3
CSDS-01	J95331-31 VB	ND	< LOD 0.3	J95331-31 PB	0.41	< LOQ 1.0
CSDS-02	J95331-35 VB	0.41	< LOQ 1.0	J95331-35 PB	0.33	< LOQ 1.0
N-01	J95331-52 VB	ND	< LOD 0.3	J95331-52 PB	ND	< LOD 0.3
N-02	J95331-81 VB	ND	< LOD 0.3	J95331-81 PB	ND	< LOD 1.5
O-1	J95331-69 VB	ND	< LOD 0.3	J95331-69 PB	ND	< LOD 0.3
S-01	J95331-28 VB	ND	< LOD 0.3	J95331-28 PB	ND	< LOD 0.3
S-02	J95331-29 VB	ND	< LOD 0.3	J95331-29 PB	ND	< LOD 0.3
SH-01	J95331-36 VB	0.44	< LOQ 1.0	J95331-36 PB	0.31	< LOQ 1.0
SS-01	J95331-32 VB	ND	< LOD 0.3	J95331-32 PB	0.32	< LOQ 1.0
SS-02	J95331-40 VB	ND	< LOD 0.3	J95331-40 PB	ND	< LOD 0.3
SS-03	J95331-45 VB	ND	< LOD 0.3	J95331-45 PB	ND	< LOD 0.3
SS-04	J95331-47 VB	ND	< LOD 0.3	J95331-47 PB	ND	< LOD 0.3
SS-05	J95331-53 VB	ND	< LOD 0.3	J95331-53 PB	ND	< LOD 0.3
SS-06	J95331-76 VB	ND	< LOD 0.3	J95331-76 PB	ND	< LOD 0.3
SS-07	J95331-80 VB	ND	< LOD 0.3	J95331-80 PB	ND	< LOD 0.3
SSDS-01	J95331-33 VB	0.47	< LOQ 1.0	J95331-33 PB	ND	< LOD 0.3
SSDS-02	J95331-44 VB	ND	< LOD 0.3	J95331-44 PB	ND	< LOD 0.3
SSDS-03	J95331-48 VB	ND	< LOD 0.3	J95331-48 PB	ND	< LOD 0.3
CP-1A	J95331-60 VB	ND	< LOD 0.3	J95331-60 PB	ND	< LOD 0.3
CP-1B	J95331-61 VB	ND	< LOD 0.3	J95331-61 PB	ND	< LOD 0.3
CP-2A	J95331-67 VB	0.98	< LOQ 1.0	J95331-67 PB	1.60	< LOQ 2.0
CP-2B	J95331-68 VB	1.70	< LOQ 2.0	J95331-68 PB	1.20	< LOQ 2.0
CP-3A	J95331-72 VB	2.30	> LOQ 1.0	J95331-72 PB	1.60	> LOQ 1.0
CP-3B	J95331-73 VB	1.80	> LOQ 1.0	J95331-73 PB	2.00	> LOQ 1.0
CP-4A	J95331-78 VB	4.60	> LOQ 1.0	J95331-78 PB	6.70	> LOQ 2.0
CP-4B	J95331-79 VB	5.90	> LOQ 1.0	J95331-79 PB	4.50	> LOQ 1.0
CPDS-1A	J95331-84 VB	0.69	< LOQ 1.0	J95331-84 PB	0.65	< LOQ 1.0
CPDS-1B	J95331-85 VB	0.35	< LOQ 1.0	J95331-85 PB	0.36	< LOQ 1.0
G-1A	J95331-41 VB	ND	< LOD 0.3	J95331-41 PB	ND	< LOD 0.3
G-1B	J95331-46 VB	ND	< LOD 0.3	J95331-46 PB	ND	< LOD 0.3
G-2A	J95331-43 VB	ND	< LOD 0.3	J95331-43 PB	ND	< LOD 0.3
G-2B	J95331-50 VB	ND	< LOD 0.3	J95331-50 PB	ND	< LOD 0.3
G-3A	J95331-49 VB	ND	< LOD 0.3	J95331-49 PB	ND	< LOD 0.3
G-4A	J95331-55 VB	ND	< LOD 0.3	J95331-55 PB	ND	< LOD 0.3
G-4B	J95331-56 VB	ND	< LOD 0.3	J95331-56 PB	ND	< LOD 0.3
G-5A	J95331-58 VB	ND	< LOD 0.3	J95331-58 PB	ND	< LOD 0.3
G-5B	J95331-59 VB	ND	< LOD 0.3	J95331-59 PB	ND	< LOD 0.3
G-6A	J95331-64 VB	ND	< LOD 0.3	J95331-64 PB	ND	< LOD 0.3
G-6B	J95331-65 VB	ND	< LOD 0.3	J95331-65 PB	ND	< LOD 0.3
G-7A	J95331-74 VB	ND	< LOD 0.3	J95331-74 PB	ND	< LOD 0.3
G-7B	J95331-75 VB	ND	< LOD 0.3	J95331-75 PB	ND	< LOD 0.3
SG-1A	J95331-54 VB	ND	< LOD 6.0	J95331-54 PB	ND	< LOD 6.0
SG-1B	J95331-71 VB	ND	< LOD 3.0	J95331-71 PB	ND	< LOD 3.0
SG-2A	J95331-66 VB	ND	< LOD 3.0	J95331-66 PB	ND	< LOD 1.5
SG-2B	J95331-82 VB	ND	< LOD 3.0	J95331-82 PB	ND	< LOD 3.0

Comparison of Airborne Concentrations to Bulk Concentrations - Silver

NIOSH REL 10.0 micrograms/cubic meter
OSHA PEL 10.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	ND	0.39
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	0.62
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	1.94	ND	ND	ND	ND
CS-07	ND	ND	ND	ND	ND
CSDS-01	ND	20.62	ND	ND	ND
CSDS-02	ND	ND	1.95	ND	0.41
N-01	ND	ND	ND	ND	ND
N-02	ND	ND	ND	ND	ND
O-1	ND	ND	ND	ND	ND
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	0.44
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	ND
SS-07	ND	ND	ND	ND	ND
SSDS-01	ND	ND	ND	1.78	0.47
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	ND	ND	ND	ND	ND
CP-2A	ND	2.93	13.69	4.78	0.98
CP-3A	3.51	7.72	17.79	14.49	2.30
CP-4A	ND	6.71	77.54	8.62	4.60
CPDS-1A	ND	2.68	4.75	ND	0.69
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	ND	ND	ND	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	3.11	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	ND	ND

APPENDIX B - SODIUM

Sodium

Sodium and sodium compounds may be irritating to the eyes, skin and mucus membranes. The NIOSH REL and OSHA PEL for sodium are 10,000 and 15,000 micrograms/cubic meter of air, respectively.

Air Sample Results - Sodium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Sodium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	15.00	> LOQ 6.8	311.46	> LOQ 141.20
24412	2	47.89	S-01	28	15.00	> LOQ 6.8	313.22	> LOQ 141.99
24441	3	47.90	S-01	28	23.00	> LOQ 6.8	480.17	> LOQ 141.96
24450	OBZ	47.93	S-01	28	15.00	> LOQ 6.8	312.96	> LOQ 141.87
24643	1	47.98	S-02	29	14.00	> LOQ 6.8	291.79	> LOQ 141.73
24625	2	47.76	S-02	29	14.00	> LOQ 6.8	293.13	> LOQ 142.38
24642	3	48.00	S-02	29	17.00	> LOQ 6.8	354.17	> LOQ 141.67
24632	OBZ	47.89	S-02	29	13.00	> LOQ 6.8	271.46	> LOQ 141.99
24634	1	48.16	CSDS-01	31	25.00	> LOQ 6.8	519.1	> LOQ 141.20
24650	2	48.01	CSDS-01	31	71.00	> LOQ 6.8	1478.86	> LOQ 141.64
24644	3	48.16	CSDS-01	31	200.00	> LOQ 6.8	4152.82	> LOQ 141.20
24645	OBZ	48.07	CSDS-01	31	100.00	> LOQ 6.8	2080.3	> LOQ 141.46
24640	1	48.44	SS-01	32	12.00	> LOQ 6.8	247.73	> LOQ 140.38
24641	2	47.90	SS-01	32	13.00	> LOQ 6.8	271.4	> LOQ 141.96
24651	3	48.35	SS-01	32	12.00	> LOQ 6.8	248.19	> LOQ 140.64
24635	OBZ	48.30	SS-01	32	14.00	> LOQ 6.8	289.86	> LOQ 140.79
24646	1	48.58	SSDS-01	33	15.00	> LOQ 6.8	308.77	> LOQ 139.98
24626	2	47.84	SSDS-01	33	12.00	> LOQ 6.8	250.84	> LOQ 142.14
24638	3	48.49	SSDS-01	33	13.00	> LOQ 6.8	268.1	> LOQ 140.24
24647	OBZ	48.32	SSDS-01	33	14.00	> LOQ 6.8	289.74	> LOQ 140.73
24628	1	48.55	CS-01	34	39.00	> LOQ 6.8	803.3	> LOQ 140.06
24637	2	48.00	CS-01	34	110.00	> LOQ 6.8	2291.67	> LOQ 141.67
24624	3	48.47	CS-01	34	420.00	> LOQ 6.8	8665.15	> LOQ 140.29
24636	OBZ	47.92	CS-01	34	110.00	> LOQ 6.8	2295.49	> LOQ 141.90
24623	1	48.53	CSDS-02	35	46.00	> LOQ 6.8	947.87	> LOQ 140.12
24622	2	48.36	CSDS-02	35	130.00	> LOQ 6.8	2688.17	> LOQ 140.61
24654	3	48.31	CSDS-02	35	470.00	> LOQ 6.8	9728.83	> LOQ 140.76
24653	OBZ	47.78	CSDS-02	35	180.00	> LOQ 6.8	3767.27	> LOQ 142.32
24629	1	47.88	SH-01	36	11.00	> LOQ 6.8	229.74	> LOQ 142.02
24633	2	47.86	SH-01	36	12.00	> LOQ 6.8	250.73	> LOQ 142.08
24627	3	48.24	SH-01	36	13.00	> LOQ 6.8	269.49	> LOQ 140.96
24648	OBZ	48.08	SH-01	36	12.00	> LOQ 6.8	249.58	> LOQ 141.43
24555	1	48.08	CS-02	37	36.00	> LOQ 6.8	748.75	> LOQ 141.43
24552	2	47.84	CS-02	37	78.00	> LOQ 6.8	1630.43	> LOQ 142.14
24541	3	48.01	CS-02	37	280.00	> LOQ 6.8	5832.12	> LOQ 141.64
24529	OBZ	47.99	CS-02	37	110.00	> LOQ 6.8	2292.14	> LOQ 141.70
24558	1	48.49	CS-03	38	41.00	> LOQ 6.8	845.54	> LOQ 140.24
24524	2	48.29	CS-03	38	140.00	> LOQ 6.8	2899.15	> LOQ 140.82
24561	3	48.22	CS-03	38	460.00	> LOQ 6.8	9539.61	> LOQ 141.02
24559	OBZ	48.29	CS-03	38	130.00	> LOQ 6.8	2692.07	> LOQ 140.82
24543	1	48.61	CS-04	39	16.00	> LOQ 6.8	329.15	> LOQ 139.89
24532	2	47.78	CS-04	39	24.00	> LOQ 6.8	502.3	> LOQ 142.32
24546	3	48.29	CS-04	39	48.00	> LOQ 6.8	993.99	> LOQ 140.82
24557	OBZ	48.58	CS-04	39	30.00	> LOQ 6.8	617.54	> LOQ 139.98
24560	1	48.13	SS-02	40	11.00	> LOQ 6.8	228.55	> LOQ 141.28
24565	2	47.95	SS-02	40	14.00	> LOQ 6.8	291.97	> LOQ 141.81
24630	3	48.32	SS-02	40	12.00	> LOQ 6.8	248.34	> LOQ 140.73
24553	OBZ	48.62	SS-02	40	13.00	> LOQ 6.8	267.38	> LOQ 139.86
24525	1	48.13	G-1A	41	12.00	> LOQ 6.8	249.32	> LOQ 141.28
24563	2	47.87	G-1A	41	16.00	> LOQ 6.8	334.24	> LOQ 142.05
24547	3	48.17	G-1A	41	20.00	> LOQ 6.8	415.2	> LOQ 141.17
24526	OBZ	48.91	G-1A	41	18.00	> LOQ 6.8	368.02	> LOQ 139.03
24538	1	47.45	G-2A	43	12.00	> LOQ 6.8	252.9	> LOQ 143.31

Air Sample Results - Sodium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Sodium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24545	2	47.12	G-2A	43	12.00	> LOQ 6.8	254.67	> LOQ 144.31
24533	3	48.24	G-2A	43	11.00	> LOQ 6.8	228.03	> LOQ 140.96
24540	OBZ	48.04	G-2A	43	11.00	> LOQ 6.8	228.98	> LOQ 141.55
24528	1	47.99	SSDS-02	44	17.00	> LOQ 6.8	354.24	> LOQ 141.70
24544	2	48.00	SSDS-02	44	25.00	> LOQ 6.8	520.83	> LOQ 141.67
24567	3	48.46	SSDS-02	44	29.00	> LOQ 6.8	598.43	> LOQ 140.32
24539	OBZ	49.37	SSDS-02	44	35.00	> LOQ 6.8	708.93	> LOQ 137.74
24571	1	48.05	SS-03	45	10.00	> LOQ 10.0	208.12	> LOQ 208.12
24536	2	47.60	SS-03	45	12.00	> LOQ 6.8	252.1	> LOQ 142.86
24534	3	48.94	SS-03	45	12.00	> LOQ 6.8	245.2	> LOQ 138.95
24570	OBZ	49.61	SS-03	45	11.00	> LOQ 6.8	221.73	> LOQ 137.07
24568	1	48.28	G-1B	46	11.00	> LOQ 6.8	227.84	> LOQ 140.85
24592	2	47.38	G-1B	46	11.00	> LOQ 6.8	232.17	> LOQ 143.52
24593	3	48.17	G-1B	46	13.00	> LOQ 6.8	269.88	> LOQ 141.17
24535	OBZ	48.22	G-1B	46	13.00	> LOQ 6.8	269.6	> LOQ 141.02
24590	1	47.81	SS-04	47	16.00	> LOQ 6.8	334.66	> LOQ 142.23
24605	2	47.78	SS-04	47	26.00	> LOQ 6.8	544.16	> LOQ 142.32
24562	3	47.80	SS-04	47	29.00	> LOQ 6.8	606.69	> LOQ 142.26
24531	OBZ	48.59	SS-04	47	26.00	> LOQ 6.8	535.09	> LOQ 139.95
24527	1	49.48	SSDS-03	48	11.00	> LOQ 6.8	222.31	> LOQ 137.43
24569	2	50.35	SSDS-03	48	10.00	> LOQ 6.8	198.61	> LOQ 135.05
24584	3	50.24	SSDS-03	48	12.00	> LOQ 6.8	238.85	> LOQ 135.35
24579	OBZ	48.26	SSDS-03	48	10.00	> LOQ 6.8	207.21	> LOQ 140.90
24600	1	48.34	G-3A	49	11.00	> LOQ 6.8	227.55	> LOQ 140.67
24616	2	48.11	G-3A	49	11.00	> LOQ 6.8	228.64	> LOQ 141.34
24585	3	47.65	G-3A	49	14.00	> LOQ 6.8	293.81	> LOQ 142.71
24583	OBZ	47.99	G-3A	49	9.80	> LOQ 6.8	204.21	> LOQ 141.70
24587	1	48.79	G-2B	50	11.00	> LOQ 6.8	225.46	> LOQ 139.37
24602	2	48.17	G-2B	50	13.00	> LOQ 6.8	269.88	> LOQ 141.17
24564	3	47.81	G-2B	50	11.00	> LOQ 6.8	230.08	> LOQ 142.23
24621	OBZ	48.54	G-2B	50	12.00	> LOQ 6.8	247.22	> LOQ 140.09
24618	1	49.21	N-01	52	12.00	> LOQ 6.8	243.85	> LOQ 138.18
24611	2	47.96	N-01	52	16.00	> LOQ 6.8	333.61	> LOQ 141.78
24588	3	48.32	N-01	52	36.00	> LOQ 6.8	745.03	> LOQ 140.73
24615	OBZ	48.80	N-01	52	28.00	> LOQ 6.8	573.77	> LOQ 139.34
24597	1	49.78	SS-05	53	10.00	> LOQ 6.8	200.88	> LOQ 136.60
24599	2	47.68	SS-05	53	33.00	> LOQ 6.8	692.11	> LOQ 142.62
24575	3	48.11	SS-05	53	12.00	> LOQ 6.8	249.43	> LOQ 141.34
24617	OBZ	48.79	SS-05	53	13.00	> LOQ 6.8	266.45	> LOQ 139.37
24609	1	48.98	SG-1A	54	14.00	> LOQ 6.8	285.83	> LOQ 138.83
24596	2	48.20	SG-1A	54	12.00	> LOQ 6.8	248.96	> LOQ 141.08
24610	3	48.18	SG-1A	54	18.00	> LOQ 6.8	373.6	> LOQ 141.14
24576	OBZ	48.47	SG-1A	54	53.00	> LOQ 34.0	1093.46	> LOQ 701.46
24606	1	49.24	G-4A	55	13.00	> LOQ 6.8	264.01	> LOQ 138.10
24620	2	48.37	G-4A	55	14.00	> LOQ 6.8	289.44	> LOQ 140.58
24573	3	48.67	G-4A	55	22.00	> LOQ 6.8	452.02	> LOQ 139.72
24505	OBZ	48.16	G-4A	55	17.00	> LOQ 6.8	352.99	> LOQ 141.20
24340	1	48.38	G-4B	56	11.00	> LOQ 6.8	227.37	> LOQ 140.55
24607	2	48.01	G-4B	56	15.00	> LOQ 6.8	312.43	> LOQ 141.64
24595	3	48.38	G-4B	56	11.00	> LOQ 6.8	227.37	> LOQ 140.55
24598	OBZ	48.42	G-4B	56	13.00	> LOQ 6.8	268.48	> LOQ 140.44
24580	1	48.44	CS-05	57	13.00	> LOQ 6.8	268.37	> LOQ 140.38
24604	2	47.93	CS-05	57	27.00	> LOQ 6.8	563.32	> LOQ 141.87

Air Sample Results - Sodium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Sodium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24335	3	47.78	CS-05	57	58.00	> LOQ 6.8	1213.9	> LOQ 142.32
24574	OBZ	30.41	CS-05	57	25.00	> LOQ 6.8	822.1	> LOQ 223.61
24614	1	48.58	G-5A	58	11.00	> LOQ 6.8	226.43	> LOQ 139.98
24577	2	48.18	G-5A	58	12.00	> LOQ 6.8	249.07	> LOQ 141.14
24572	3	48.05	G-5A	58	13.00	> LOQ 6.8	270.55	> LOQ 141.52
24582	OBZ	47.83	G-5A	58	11.00	> LOQ 6.8	229.98	> LOQ 142.17
24322	1	47.88	G-5B	59	13.00	> LOQ 6.8	271.51	> LOQ 142.02
24354	2	48.16	G-5B	59	13.00	> LOQ 6.8	269.93	> LOQ 141.20
24510	3	47.98	G-5B	59	13.00	> LOQ 6.8	270.95	> LOQ 141.73
24321	OBZ	47.99	G-5B	59	12.00	> LOQ 6.8	250.05	> LOQ 141.70
24497	1	48.49	CP-1A	60	22.00	> LOQ 6.8	453.7	> LOQ 140.24
24333	2	48.28	CP-1A	60	79.00	> LOQ 6.8	1636.29	> LOQ 140.85
24326	3	48.19	CP-1A	60	120.00	> LOQ 6.8	2490.14	> LOQ 141.11
24329	OBZ	47.74	CP-1A	60	51.00	> LOQ 6.8	1068.29	> LOQ 142.44
24499	1	42.42	CP-1B	62	31.00	> LOQ 6.8	730.79	> LOQ 160.30
24506	2	42.02	CP-1B	62	48.00	> LOQ 6.8	1142.31	> LOQ 161.83
24388	3	42.47	CP-1B	62	200.00	> LOQ 6.8	4709.21	> LOQ 160.11
24315	OBZ	41.77	CP-1B	62	45.00	> LOQ 6.8	1077.33	> LOQ 162.80
24318	1	48.56	CG-01	63	68.00	> LOQ 6.8	1400.33	> LOQ 140.03
24308	2	48.00	CG-01	63	580.00	> LOQ 6.8	12083.33	> LOQ 141.67
24330	3	48.47	CG-01	63	890.00	> LOQ 6.8	18361.87	> LOQ 140.29
24230	OBZ	48.31	CG-01	63	330.00	> LOQ 6.8	6830.88	> LOQ 140.76
24363	1	48.10	G-6A	64	15.00	> LOQ 6.8	311.85	> LOQ 141.37
24398	2	47.84	G-6A	64	29.00	> LOQ 6.8	606.19	> LOQ 142.14
24351	3	48.06	G-6A	64	16.00	> LOQ 6.8	332.92	> LOQ 141.49
24594	OBZ	48.29	G-6A	64	16.00	> LOQ 6.8	331.33	> LOQ 140.82
24312	1	48.76	G-6B	65	12.00	> LOQ 6.8	246.1	> LOQ 139.46
24484	2	47.45	G-6B	65	14.00	> LOQ 6.8	295.05	> LOQ 143.31
24327	3	48.92	G-6B	65	14.00	> LOQ 6.8	286.18	> LOQ 139.00
24389	OBZ	48.46	G-6B	65	18.00	> LOQ 6.8	371.44	> LOQ 140.32
24348	1	48.59	SG-2A	66	9.20	> LOQ 6.8	189.34	> LOQ 139.95
24314	2	47.90	SG-2A	66	11.00	> LOQ 6.8	229.65	> LOQ 141.96
24494	3	48.24	SG-2A	66	13.00	> LOQ 6.8	269.49	> LOQ 140.96
24337	OBZ	48.30	SG-2A	66	ND	< LOD 4.0	ND	< LOD 82.82
24508	1	48.47	CP-2A	67	24.00	> LOQ 6.8	495.15	> LOQ 140.29
24361	2	47.82	CP-2A	67	37.00	> LOQ 6.8	773.73	> LOQ 142.20
24359	3	48.22	CP-2A	67	170.00	> LOQ 14.0	3525.51	> LOQ 290.34
24471	OBZ	48.14	CP-2A	67	70.00	> LOQ 6.8	1454.09	> LOQ 141.25
24373	1	48.41	CP-2B	68	38.00	> LOQ 6.8	784.96	> LOQ 140.47
24468	2	47.90	CP-2B	68	27.00	> LOQ 6.8	563.67	> LOQ 141.96
24481	3	48.26	CP-2B	68	72.00	> LOQ 6.8	1491.92	> LOQ 140.90
24391	OBZ	47.53	CP-2B	68	45.00	> LOQ 6.8	946.77	> LOQ 143.07
24356	1	48.56	O-1	69	11.00	> LOQ 6.8	226.52	> LOQ 140.03
24470	2	47.89	O-1	69	12.00	> LOQ 6.8	250.57	> LOQ 141.99
24467	3	48.67	O-1	69	11.00	> LOQ 6.8	226.01	> LOQ 139.72
24313	OBZ	47.78	O-1	69	13.00	> LOQ 6.8	272.08	> LOQ 142.32
24501	1	47.96	CS-06	70	43.00	> LOQ 6.8	896.58	> LOQ 141.78
24496	2	47.75	CS-06	70	85.00	> LOQ 6.8	1780.1	> LOQ 142.41
24478	3	48.31	CS-06	70	95.00	> LOQ 6.8	1966.47	> LOQ 140.76
24503	OBZ	48.04	CS-06	70	69.00	> LOQ 6.8	1436.3	> LOQ 141.55
24474	1	26.02	SG-1B	71	14.00	> LOQ 6.8	538.05	> LOQ 261.34
24469	2	26.02	SG-1B	71	16.00	> LOQ 6.8	614.91	> LOQ 261.34
24492	3	26.10	SG-1B	71	16.00	> LOQ 6.8	613.03	> LOQ 260.54

Air Sample Results - Sodium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Sodium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	12.00	< LOQ 34.0	457.14	< LOQ 1295.24
24489	1	48.42	CP-3A	72	81.00	> LOQ 6.8	1672.86	> LOQ 140.44
24491	2	47.93	CP-3A	72	170.00	> LOQ 6.8	3546.84	> LOQ 141.87
24482	3	48.35	CP-3A	72	1000.00	> LOQ 6.8	20682.52	> LOQ 140.64
24486	OBZ	48.32	CP-3A	72	830.00	> LOQ 6.8	17177.15	> LOQ 140.73
24516	1	36.34	CP-3B	73	80.00	> LOQ 6.8	2201.43	> LOQ 187.12
24502	2	36.02	CP-3B	73	390.00	> LOQ 6.8	10827.32	> LOQ 188.78
24515	3	36.48	CP-3B	73	530.00	> LOQ 6.8	14528.51	> LOQ 186.40
24500	OBZ	40.27	CP-3B	73	270.00	> LOQ 6.8	6704.74	> LOQ 168.86
24504	1	48.47	G-7A	74	11.00	> LOQ 6.8	226.94	> LOQ 140.29
24513	2	48.22	G-7A	74	12.00	> LOQ 6.8	248.86	> LOQ 141.02
24458	3	47.94	G-7A	74	10.00	> LOQ 6.8	208.59	> LOQ 141.84
24389	OBZ	47.75	G-7A	74	29.00	> LOQ 6.8	607.33	> LOQ 142.41
24404	1	48.68	G-7B	75	11.00	> LOQ 6.8	225.97	> LOQ 139.69
24451	2	48.06	G-7B	75	33.00	> LOQ 6.8	686.64	> LOQ 141.49
24447	3	47.16	G-7B	75	32.00	> LOQ 6.8	678.54	> LOQ 144.19
24423	OBZ	47.27	G-7B	75	30.00	> LOQ 6.8	634.65	> LOQ 143.85
24456	1	49.19	SS-06	76	35.00	> LOQ 6.8	711.53	> LOQ 138.24
24480	2	48.26	SS-06	76	67.00	> LOQ 6.8	1388.31	> LOQ 140.90
24429	3	47.68	SS-06	76	3.50	< LOQ 6.8	73.41	< LOQ 142.62
24418	OBZ	47.83	SS-06	76	44.00	> LOQ 6.8	919.92	> LOQ 142.17
24427	1	48.54	CP-4A	78	41.00	> LOQ 6.8	844.66	> LOQ 140.09
24435	2	47.71	CP-4A	78	76.00	> LOQ 6.8	1592.96	> LOQ 142.53
24244	3	49.01	CP-4A	78	260.00	> LOQ 34.0	5305.04	> LOQ 693.74
24220	OBZ	48.74	CP-4A	78	55.00	> LOQ 6.8	1128.44	> LOQ 139.52
24460	1	50.05	CP-4B	79	21.00	> LOQ 6.8	419.58	> LOQ 135.86
24465	2	48.47	CP-4B	79	40.00	> LOQ 6.8	825.25	> LOQ 140.29
24207	3	48.49	CP-4B	79	160.00	> LOQ 14.0	3299.65	> LOQ 288.72
24390	OBZ	49.02	CP-4B	79	41.00	> LOQ 6.8	836.39	> LOQ 138.72
24259	1	48.76	SS-07	80	19.00	> LOQ 6.8	389.66	> LOQ 139.46
24421	2	48.13	SS-07	80	44.00	> LOQ 6.8	914.19	> LOQ 141.28
24445	3	47.87	SS-07	80	48.00	> LOQ 6.8	1002.72	> LOQ 142.05
24432	OBZ	48.49	SS-07	80	38.00	> LOQ 6.8	783.67	> LOQ 140.24
24459	1	48.96	N-02	81	110.00	> LOQ 6.8	2246.73	> LOQ 138.89
24417	2	48.11	N-02	81	240.00	> LOQ 6.8	4988.57	> LOQ 141.34
24442	3	48.01	N-02	81	910.00	> LOQ 6.8	18954.38	> LOQ 141.64
24386	OBZ	48.19	N-02	81	180.00	> LOQ 6.8	3735.21	> LOQ 141.11
24452	1	48.20	SG-2B	82	33.00	> LOQ 6.8	684.65	> LOQ 141.08
24453	2	48.59	SG-2B	82	33.00	> LOQ 6.8	679.15	> LOQ 139.95
24420	3	47.84	SG-2B	82	22.00	> LOQ 6.8	459.87	> LOQ 142.14
24444	OBZ	47.95	SG-2B	82	24.00	< LOQ 34	500.52	< LOQ 709.07
24455	1	48.56	CS-07	83	59.00	> LOQ 6.8	1214.99	> LOQ 140.03
24433	2	47.96	CS-07	83	150.00	> LOQ 6.8	3127.61	> LOQ 141.78
24398	3	48.06	CS-07	83	580.00	> LOQ 6.8	12068.25	> LOQ 141.49
24511	OBZ	47.96	CS-07	83	130.00	> LOQ 6.8	2710.59	> LOQ 141.78
24454	1	49.34	CPDS-1A	84	26.00	> LOQ 6.8	526.96	> LOQ 137.82
24291	2	48.49	CPDS-1A	84	31.00	> LOQ 6.8	639.31	> LOQ 140.24
24209	3	48.43	CPDS-1A	84	150.00	> LOQ 6.8	3097.25	> LOQ 140.41
24402	OBZ	48.77	CPDS-1A	84	92.00	> LOQ 6.8	1886.41	> LOQ 139.43
24204	1	49.46	CPDS-1B	85	26.00	> LOQ 6.8	525.68	> LOQ 137.48
24273	2	48.35	CPDS-1B	85	34.00	> LOQ 6.8	703.21	> LOQ 140.64
24223	3	48.82	CPDS-1B	85	130.00	> LOQ 6.8	2662.84	> LOQ 139.29
24466	OBZ	49.96	CPDS-1B	85	32.00	> LOQ 6.8	640.51	> LOQ 136.11

Airborne Sample Data Analysis - Sodium

NIOSH REL 10000.0 micrograms/cubic meter (nuisance)
OSHA PEL 15,000.0 micrograms/cubic meter (nuisance)

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	1400.33	> LOQ 140.03	12083.33	> LOQ 141.67	18361.87	> LOQ 140.29	6830.88	> LOQ 140.76
CS-01	803.3	> LOQ 140.06	2291.67	> LOQ 141.67	8665.15	> LOQ 140.29	2295.49	> LOQ 141.90
CS-02	748.75	> LOQ 141.43	1630.43	> LOQ 142.14	5832.12	> LOQ 141.64	2292.14	> LOQ 141.70
CS-03	845.54	> LOQ 140.24	2899.15	> LOQ 140.82	9539.61	> LOQ 141.02	2692.07	> LOQ 140.82
CS-04	329.15	> LOQ 139.89	502.3	> LOQ 142.32	993.99	> LOQ 140.82	617.54	> LOQ 139.98
CS-05	268.37	> LOQ 140.38	563.32	> LOQ 141.87	1213.90	> LOQ 142.32	822.1	> LOQ 223.61
CS-06	896.58	> LOQ 141.78	1780.1	> LOQ 142.41	1966.47	> LOQ 140.76	1436.3	> LOQ 141.55
CS-07	1214.99	> LOQ 140.03	3127.61	> LOQ 141.78	12068.25	> LOQ 141.49	2710.59	> LOQ 141.78
CSDS-01	519.1	> LOQ 141.20	1478.86	> LOQ 141.64	4152.82	> LOQ 141.20	2080.3	> LOQ 141.46
CSDS-02	947.87	> LOQ 140.12	2688.17	> LOQ 140.61	9728.83	> LOQ 140.76	3767.27	> LOQ 142.32
N-01	243.85	> LOQ 138.18	333.61	> LOQ 141.78	745.03	> LOQ 140.73	573.77	> LOQ 139.34
N-02	2246.73	> LOQ 138.89	4988.57	> LOQ 141.34	18954.38	> LOQ 141.64	3735.21	> LOQ 141.11
O-1	226.52	> LOQ 140.03	250.57	> LOQ 141.99	226.01	> LOQ 139.72	272.08	> LOQ 142.32
S-01	311.46	> LOQ 141.20	313.22	> LOQ 141.99	480.17	> LOQ 141.96	312.96	> LOQ 141.87
S-02	291.79	> LOQ 141.73	293.13	> LOQ 142.38	354.17	> LOQ 141.67	271.46	> LOQ 141.99
SH-01	229.74	> LOQ 142.02	250.73	> LOQ 142.08	269.49	> LOQ 140.96	249.58	> LOQ 141.43
SS-01	247.73	> LOQ 140.38	271.4	> LOQ 141.96	248.19	> LOQ 140.64	289.86	> LOQ 140.79
SS-02	228.55	> LOQ 141.28	291.97	> LOQ 141.81	248.34	> LOQ 140.73	267.38	> LOQ 139.86
SS-03	208.12	> LOQ 208.12	252.1	> LOQ 142.86	245.20	> LOQ 138.95	221.73	> LOQ 137.07
SS-04	334.66	> LOQ 142.23	544.16	> LOQ 142.32	606.69	> LOQ 142.26	535.09	> LOQ 139.95
SS-05	200.88	> LOQ 136.60	692.11	> LOQ 142.62	249.43	> LOQ 141.34	266.45	> LOQ 139.37
SS-06	711.53	> LOQ 138.24	1388.31	> LOQ 140.90	73.41	< LOQ 142.62	919.92	> LOQ 142.17
SS-07	389.66	> LOQ 139.46	914.19	> LOQ 141.28	1002.72	> LOQ 142.05	783.67	> LOQ 140.24
SSDS-01	308.77	> LOQ 139.98	250.84	> LOQ 142.14	268.10	> LOQ 140.24	289.74	> LOQ 140.73
SSDS-02	354.24	> LOQ 141.70	520.83	> LOQ 141.67	598.43	> LOQ 140.32	708.93	> LOQ 137.74
SSDS-03	222.31	> LOQ 137.43	198.61	> LOQ 135.05	238.85	> LOQ 135.35	207.21	> LOQ 140.90
CP-1A	453.7	> LOQ 140.24	1636.29	> LOQ 140.85	2490.14	> LOQ 141.11	1068.29	> LOQ 142.44
CP-1B	730.79	> LOQ 160.30	1142.31	> LOQ 161.83	4709.21	> LOQ 160.11	1077.33	> LOQ 162.80
CP-2A	495.15	> LOQ 140.29	773.73	> LOQ 142.20	3525.51	> LOQ 290.34	1454.09	> LOQ 141.25
CP-2B	784.96	> LOQ 140.47	563.67	> LOQ 141.96	1491.92	> LOQ 140.90	946.77	> LOQ 143.07
CP-3A	1672.86	> LOQ 140.44	3546.84	> LOQ 141.87	20682.52	> LOQ 140.64	17177.15	> LOQ 140.73
CP-3B	2201.43	> LOQ 187.12	10827.32	> LOQ 188.78	14528.51	> LOQ 186.40	6704.74	> LOQ 168.86
CP-4A	844.66	> LOQ 140.09	1592.96	> LOQ 142.53	5305.04	> LOQ 693.74	1128.44	> LOQ 139.52
CP-4B	419.58	> LOQ 135.86	825.25	> LOQ 140.29	3299.65	> LOQ 288.72	836.39	> LOQ 138.72
CPDS-1A	526.96	> LOQ 137.82	639.31	> LOQ 140.24	3097.25	> LOQ 140.41	1886.41	> LOQ 139.43
CPDS-1B	525.68	> LOQ 137.48	703.21	> LOQ 140.64	2662.84	> LOQ 139.29	640.51	> LOQ 136.11
G-1A	249.32	> LOQ 141.28	334.24	> LOQ 142.05	415.20	> LOQ 141.17	368.02	> LOQ 139.03
G-1B	227.84	> LOQ 140.85	232.17	> LOQ 143.52	269.88	> LOQ 141.17	269.6	> LOQ 141.02
G-2A	252.9	> LOQ 143.31	254.67	> LOQ 144.31	228.03	> LOQ 140.96	228.98	> LOQ 141.55
G-2B	225.46	> LOQ 139.37	269.88	> LOQ 141.17	230.08	> LOQ 142.23	247.22	> LOQ 140.09
G-3A	227.55	> LOQ 140.67	228.64	> LOQ 141.34	293.81	> LOQ 142.71	204.21	> LOQ 141.70
G-4A	264.01	> LOQ 138.10	289.44	> LOQ 140.58	452.02	> LOQ 139.72	352.99	> LOQ 141.20
G-4B	227.37	> LOQ 140.55	312.43	> LOQ 141.64	227.37	> LOQ 140.55	268.48	> LOQ 140.44
G-5A	226.43	> LOQ 139.98	248.07	> LOQ 141.14	270.55	> LOQ 141.52	229.98	> LOQ 142.17
G-5B	271.51	> LOQ 142.02	269.93	> LOQ 141.20	270.95	> LOQ 141.73	250.05	> LOQ 141.70
G-6A	311.85	> LOQ 141.37	606.19	> LOQ 142.14	332.92	> LOQ 141.49	331.33	> LOQ 140.82
G-6B	246.1	> LOQ 139.46	295.05	> LOQ 143.31	286.18	> LOQ 139.00	371.44	> LOQ 140.32
G-7A	226.94	> LOQ 140.29	248.86	> LOQ 141.02	208.59	> LOQ 141.84	607.33	> LOQ 142.41
G-7B	225.97	> LOQ 139.69	686.64	> LOQ 141.49	678.54	> LOQ 144.19	634.65	> LOQ 143.85
SG-1A	285.83	> LOQ 138.83	248.96	> LOQ 141.08	373.60	> LOQ 141.14	1093.46	> LOQ 701.46
SG-1B	538.05	> LOQ 261.34	614.91	> LOQ 261.34	613.03	> LOQ 260.54	457.14	< LOQ 1295.24
SG-2A	189.34	> LOQ 139.95	229.65	> LOQ 141.96	269.49	> LOQ 140.96	ND	< LOD 82.82
SG-2B	684.65	> LOQ 141.08	679.15	> LOQ 139.95	459.87	> LOQ 142.14	500.52	< LOQ 709.07

Bulk Elemental Analysis - Sodium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Sodium		Sample	Sodium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	370.00	> LOQ 27	J95331-63 PB	780.00	> LOQ 27
CS-01	J95331-34 VB	3900.00	> LOQ 27.0	J95331-34 PB	3200.00	> LOQ 27.0
CS-02	J95331-37 VB	890.00	> LOQ 27.0	J95331-37 PB	940.00	> LOQ 27.0
CS-03	J95331-38 VB	3500.00	> LOQ 27.0	J95331-38 PB	3800.00	> LOQ 27.0
CS-04	J95331-39 VB	67.00	> LOQ 27.0	J95331-39 PB	71.00	> LOQ 27.0
CS-05	J95331-57 VB	42.00	> LOQ 27	J95331-57 PB	61.00	> LOQ 27
CS-06	J95331-70 VB	76.00	> LOQ 27.0	J95331-70 PB	160.00	> LOQ 27.0
CS-07	J95331-83 VB	250.00	> LOQ 27.0	J95331-83 PB	740.00	> LOQ 27.0
CSDS-01	J95331-31 VB	180.00	> LOQ 27.0	J95331-31 PB	350.00	> LOQ 27.0
CSDS-02	J95331-35 VB	3600.00	> LOQ 27.0	J95331-35 PB	3600.00	> LOQ 27.0
N-01	J95331-52 VB	46.00	> LOQ 27	J95331-52 PB	62.00	> LOQ 27
N-02	J95331-81 VB	1600.00	> LOQ 27.0	J95331-81 PB	3400.00	> LOQ 27.0
O-1	J95331-69 VB	ND	< LOD 8.0	J95331-69 PB	ND	< LOD 8.0
S-01	J95331-28 VB	75.00	> LOQ 27.0	J95331-28 PB	53.00	> LOQ 27.0
S-02	J95331-29 VB	29.00	> LOQ 27.0	J95331-29 PB	29.00	> LOQ 27.0
SH-01	J95331-36 VB	ND	< LOD 8	J95331-36 PB	11.00	< LOQ 27.0
SS-01	J95331-32 VB	ND	< LOD 8	J95331-32 PB	ND	< LOD 8
SS-02	J95331-40 VB	ND	< LOD 8	J95331-40 PB	ND	< LOD 8
SS-03	J95331-45 VB	ND	< LOD 8	J95331-45 PB	12.00	< LOQ 27.0
SS-04	J95331-47 VB	22.00	< LOQ 27.0	J95331-47 PB	ND	< LOD 8
SS-05	J95331-53 VB	8.10	< LOQ 27.0	J95331-53 PB	ND	< LOD 8
SS-06	J95331-76 VB	170.00	> LOQ 27.0	J95331-76 PB	150.00	> LOQ 27.0
SS-07	J95331-80 VB	24.00	< LOQ 27.0	J95331-80 PB	15.00	< LOQ 27.0
SSDS-01	J95331-33 VB	ND	< LOD 8	J95331-33 PB	ND	< LOD 8
SSDS-02	J95331-44 VB	38.00	> LOQ 27.0	J95331-44 PB	56.00	> LOQ 27.0
SSDS-03	J95331-48 VB	ND	< LOD 8	J95331-48 PB	ND	< LOD 8
CP-1A	J95331-60 VB	240.00	> LOQ 27	J95331-60 PB	1000.00	> LOQ 27
CP-1B	J95331-61 VB	210.00	> LOQ 27	J95331-61 PB	300.00	> LOQ 27
CP-2A	J95331-67 VB	550.00	> LOQ 27.0	J95331-67 PB	720.00	> LOQ 54.0
CP-2B	J95331-68 VB	650.00	> LOQ 54.0	J95331-68 PB	660.00	> LOQ 54.0
CP-3A	J95331-72 VB	3300.00	> LOQ 27.0	J95331-72 PB	4100.00	> LOQ 27.0
CP-3B	J95331-73 VB	4900.00	> LOQ 27.0	J95331-73 PB	4100.00	> LOQ 27.0
CP-4A	J95331-78 VB	410.00	> LOQ 54.0	J95331-78 PB	440.00	> LOQ 54.0
CP-4B	J95331-79 VB	480.00	> LOQ 27.0	J95331-79 PB	470.00	> LOQ 27.0
CPDS-1A	J95331-84 VB	380.00	> LOQ 27.0	J95331-84 PB	610.00	> LOQ 27.0
CPDS-1B	J95331-85 VB	560.00	> LOQ 27.0	J95331-85 PB	650.00	> LOQ 27.0
G-1A	J95331-41 VB	87.00	> LOQ 27.0	J95331-41 PB	62.00	> LOQ 27.0
G-1B	J95331-46 VB	43.00	> LOQ 27	J95331-46 PB	30.00	> LOQ 27
G-2A	J95331-43 VB	11.00	< LOQ 27.0	J95331-43 PB	9.00	< LOQ 27.0
G-2B	J95331-50 VB	ND	< LOD 8	J95331-50 PB	ND	< LOD 8
G-3A	J95331-49 VB	ND	< LOD 8	J95331-49 PB	35.00	> LOQ 27
G-4A	J95331-55 VB	10.00	< LOQ 27.0	J95331-55 PB	19.00	< LOQ 27.0
G-4B	J95331-56 VB	15.00	< LOQ 27.0	J95331-56 PB	8.80	< LOQ 27.0
G-5A	J95331-58 VB	19.00	< LOQ 27.0	J95331-58 PB	26.00	< LOQ 27.0
G-5B	J95331-59 VB	ND	< LOD 8.0	J95331-59 PB	ND	< LOD 8.0
G-6A	J95331-64 VB	ND	< LOD 8.0	J95331-64 PB	8.50	< LOQ 27.0
G-6B	J95331-65 VB	8.70	< LOQ 27.0	J95331-65 PB	ND	< LOD 8.0
G-7A	J95331-74 VB	ND	< LOD 8.0	J95331-74 PB	ND	< LOD 8.0
G-7B	J95331-75 VB	9.20	< LOQ 27.0	J95331-75 PB	ND	< LOD 8.0
SG-1A	J95331-54 VB	12.00	< LOQ 140	J95331-54 PB	ND	< LOD 40.0
SG-1B	J95331-71 VB	ND	< LOD 40.0	J95331-71 PB	ND	< LOD 40.0
SG-2A	J95331-66 VB	ND	< LOD 40.0	J95331-66 PB	ND	< LOD 40.0
SG-2B	J95331-82 VB	ND	< LOD 40.0	J95331-82 PB	ND	< LOD 40.0

Comparison of Airborne Concentrations to Bulk Concentrations - Sodium

NIOSH REL 10000.0 micrograms/cubic meter (nuisance)
OSHA PEL 15,000.0 micrograms/cubic meter (nuisance)

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	1400.33	12083.33	18361.87	6830.88	370.00
CS-01	803.30	2291.67	8665.15	2295.49	3900.00
CS-02	748.75	1630.43	5832.12	2292.14	890.00
CS-03	845.54	2899.15	9539.61	2692.07	3500.00
CS-04	329.15	502.30	993.99	617.54	67.00
CS-05	268.37	563.32	1213.90	822.10	42.00
CS-06	896.58	1780.10	1966.47	1436.30	76.00
CS-07	1214.99	3127.61	12068.25	2710.59	250.00
CSDS-01	519.10	1478.86	4152.82	2080.30	180.00
CSDS-02	947.87	2688.17	9728.83	3767.27	3600.00
N-01	243.85	333.61	745.03	573.77	46.00
N-02	2246.73	4988.57	18954.38	3735.21	1600.00
O-1	226.52	250.57	226.01	272.08	ND
S-01	311.46	313.22	480.17	312.96	75.00
S-02	291.79	293.13	354.17	271.46	29.00
SH-01	229.74	250.73	269.49	249.58	ND
SS-01	247.73	271.40	248.19	289.86	ND
SS-02	228.55	291.97	248.34	267.38	ND
SS-03	208.12	252.10	245.20	221.73	ND
SS-04	334.66	544.16	606.69	535.09	22.00
SS-05	200.88	692.11	249.43	266.45	8.10
SS-06	711.53	1388.31	73.41	919.92	170.00
SS-07	389.66	914.19	1002.72	783.67	24.00
SSDS-01	308.77	250.84	268.10	289.74	ND
SSDS-02	354.24	520.83	598.43	708.93	38.00
SSDS-03	222.31	198.61	238.85	207.21	ND
CP-1A	453.70	1636.29	2490.14	1068.29	240.00
CP-2A	495.15	773.73	3525.51	1454.09	550.00
CP-3A	1672.86	3546.84	20682.52	17177.15	3300.00
CP-4A	844.66	1592.96	5305.04	1128.44	410.00
CPDS-1A	526.96	639.31	3097.25	1886.41	380.00
G-1A	249.32	334.24	415.20	368.02	87.00
G-2A	252.90	254.67	228.03	228.98	11.00
G-3A	227.55	228.64	293.81	204.21	ND
G-4A	264.01	289.44	452.02	352.99	10.00
G-5A	226.43	249.07	270.55	229.98	19.00
G-6A	311.85	606.19	332.92	331.33	ND
G-7A	226.94	248.86	208.59	607.33	ND
SG-1A	285.83	248.96	373.60	1093.46	12.00
SG-2A	189.34	229.65	269.49	ND	ND

APPENDIX B - TELLERIUM

Tellurium

Physical complaints and findings from reports on exposure to tellurium include sleeplessness, loss of appetite, nausea, metallic taste, and a garlic odor to the breath and perspiration. Tellurium accumulates in the blood, liver, kidneys, lungs, thyroid and spleen. These organs may be affected by acute poisoning. Chronic exposure may result in respiratory depression and circulatory collapse. The NIOSH REL and OSHA PEL for tellurium are both 100 micrograms/cubic meter of air.

Air Sample Results - Tellurium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Tellurium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 0.8	ND	< LOD 16.61
24412	2	47.89	S-01	28	ND	< LOD 0.8	ND	< LOD 16.70
24441	3	47.90	S-01	28	1.60	< LOQ 2.5	33.4	< LOQ 52.19
24450	OBZ	47.93	S-01	28	ND	< LOD 0.8	ND	< LOD 16.69
24643	1	47.98	S-02	29	ND	< LOD 0.8	ND	< LOD 16.67
24625	2	47.76	S-02	29	ND	< LOD 0.8	ND	< LOD 16.75
24642	3	48.00	S-02	29	ND	< LOD 0.8	ND	< LOD 16.67
24632	OBZ	47.89	S-02	29	ND	< LOD 0.8	ND	< LOD 16.70
24634	1	48.16	CSDS-01	31	ND	< LOD 0.8	ND	< LOD 16.61
24650	2	48.01	CSDS-01	31	0.92	< LOQ 2.5	19.16	< LOQ 52.07
24644	3	48.16	CSDS-01	31	ND	< LOD 0.8	ND	< LOD 16.61
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 0.8	ND	< LOD 16.64
24640	1	48.44	SS-01	32	ND	< LOD 0.8	ND	< LOD 16.52
24641	2	47.90	SS-01	32	ND	< LOD 0.8	ND	< LOD 16.70
24651	3	48.35	SS-01	32	ND	< LOD 0.8	ND	< LOD 16.55
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.8	ND	< LOD 16.56
24646	1	48.58	SSDS-01	33	ND	< LOD 0.8	ND	< LOD 16.47
24626	2	47.84	SSDS-01	33	ND	< LOD 0.8	ND	< LOD 16.72
24638	3	48.49	SSDS-01	33	0.80	< LOQ 2.5	16.5	< LOQ 51.56
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.8	ND	< LOD 16.56
24628	1	48.55	CS-01	34	ND	< LOD 0.8	ND	< LOD 16.48
24637	2	48.00	CS-01	34	ND	< LOD 0.8	ND	< LOD 16.67
24624	3	48.47	CS-01	34	ND	< LOD 0.8	ND	< LOD 16.51
24636	OBZ	47.92	CS-01	34	ND	< LOD 0.8	ND	< LOD 16.69
24623	1	48.53	CSDS-02	35	ND	< LOD 0.8	ND	< LOD 16.48
24622	2	48.36	CSDS-02	35	ND	< LOD 0.8	ND	< LOD 16.54
24654	3	48.31	CSDS-02	35	ND	< LOD 0.8	ND	< LOD 16.56
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 0.8	ND	< LOD 16.74
24629	1	47.88	SH-01	36	ND	< LOD 0.8	ND	< LOD 16.71
24633	2	47.86	SH-01	36	ND	< LOD 0.8	ND	< LOD 16.72
24627	3	48.24	SH-01	36	ND	< LOD 0.8	ND	< LOD 16.58
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.8	ND	< LOD 16.64
24555	1	48.08	CS-02	37	ND	< LOD 0.8	ND	< LOD 16.64
24552	2	47.84	CS-02	37	ND	< LOD 0.8	ND	< LOD 16.72
24541	3	48.01	CS-02	37	ND	< LOD 0.8	ND	< LOD 16.66
24529	OBZ	47.99	CS-02	37	ND	< LOD 0.8	ND	< LOD 16.67
24558	1	48.49	CS-03	38	ND	< LOD 0.8	ND	< LOD 16.50
24524	2	48.29	CS-03	38	ND	< LOD 0.8	ND	< LOD 16.57
24561	3	48.22	CS-03	38	ND	< LOD 0.8	ND	< LOD 16.59
24559	OBZ	48.29	CS-03	38	ND	< LOD 0.8	ND	< LOD 16.57
24543	1	48.61	CS-04	39	ND	< LOD 0.8	ND	< LOD 16.46
24532	2	47.78	CS-04	39	ND	< LOD 0.8	ND	< LOD 16.74
24546	3	48.29	CS-04	39	ND	< LOD 0.8	ND	< LOD 16.57
24557	OBZ	48.58	CS-04	39	ND	< LOD 0.8	ND	< LOD 16.47
24560	1	48.13	SS-02	40	ND	< LOD 0.8	ND	< LOD 16.62
24565	2	47.95	SS-02	40	ND	< LOD 0.8	ND	< LOD 16.68
24630	3	48.32	SS-02	40	ND	< LOD 0.8	ND	< LOD 16.56
24553	OBZ	48.62	SS-02	40	ND	< LOD 0.8	ND	< LOD 16.45
24525	1	48.13	G-1A	41	ND	< LOD 0.8	ND	< LOD 16.62
24563	2	47.87	G-1A	41	ND	< LOD 0.8	ND	< LOD 16.71
24547	3	48.17	G-1A	41	ND	< LOD 0.8	ND	< LOD 16.61
24526	OBZ	48.91	G-1A	41	ND	< LOD 0.8	ND	< LOD 16.36
24538	1	47.45	G-2A	43	ND	< LOD 0.8	ND	< LOD 16.86

Air Sample Results - Tellurium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Tellurium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOD 0.8	ND	< LOD 16.98
24533	3	48.24	G-2A	43	ND	< LOD 0.8	ND	< LOD 16.58
24540	OBZ	48.04	G-2A	43	ND	< LOD 0.8	ND	< LOD 16.65
24528	1	47.99	SSDS-02	44	ND	< LOD 0.8	ND	< LOD 16.67
24544	2	48.00	SSDS-02	44	ND	< LOD 0.8	ND	< LOD 16.67
24567	3	48.46	SSDS-02	44	ND	< LOD 0.8	ND	< LOD 16.51
24539	OBZ	49.37	SSDS-02	44	ND	< LOD 0.8	ND	< LOD 16.20
24571	1	48.05	SS-03	45	ND	< LOD 0.8	ND	< LOD 16.65
24536	2	47.60	SS-03	45	ND	< LOD 0.8	ND	< LOD 16.81
24534	3	48.94	SS-03	45	ND	< LOD 0.8	ND	< LOD 16.35
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.8	ND	< LOD 16.13
24568	1	48.28	G-1B	46	ND	< LOD 0.8	ND	< LOD 16.57
24592	2	47.38	G-1B	46	ND	< LOD 0.8	ND	< LOD 16.88
24593	3	48.17	G-1B	46	ND	< LOD 0.8	ND	< LOD 16.61
24535	OBZ	48.22	G-1B	46	ND	< LOD 0.8	ND	< LOD 16.59
24590	1	47.81	SS-04	47	ND	< LOD 0.8	ND	< LOD 16.73
24605	2	47.78	SS-04	47	ND	< LOD 0.8	ND	< LOD 16.74
24562	3	47.80	SS-04	47	ND	< LOD 0.8	ND	< LOD 16.74
24531	OBZ	48.59	SS-04	47	ND	< LOD 0.8	ND	< LOD 16.46
24527	1	49.48	SSDS-03	48	ND	< LOD 0.8	ND	< LOD 16.17
24569	2	50.35	SSDS-03	48	ND	< LOD 0.8	ND	< LOD 15.89
24584	3	50.24	SSDS-03	48	ND	< LOD 0.8	ND	< LOD 15.92
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.8	ND	< LOD 16.58
24600	1	48.34	G-3A	49	ND	< LOD 0.8	ND	< LOD 16.55
24616	2	48.11	G-3A	49	ND	< LOD 0.8	ND	< LOD 16.63
24585	3	47.65	G-3A	49	ND	< LOD 0.8	ND	< LOD 16.79
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.8	ND	< LOD 16.67
24587	1	48.79	G-2B	50	ND	< LOD 0.8	ND	< LOD 16.40
24602	2	48.17	G-2B	50	ND	< LOD 0.8	ND	< LOD 16.61
24564	3	47.81	G-2B	50	ND	< LOD 0.8	ND	< LOD 16.73
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.8	ND	< LOD 16.48
24618	1	49.21	N-01	52	ND	< LOD 0.8	ND	< LOD 16.26
24611	2	47.96	N-01	52	ND	< LOD 0.8	ND	< LOD 16.68
24588	3	48.32	N-01	52	ND	< LOD 0.8	ND	< LOD 16.56
24615	OBZ	48.80	N-01	52	ND	< LOD 0.8	ND	< LOD 16.39
24597	1	49.78	SS-05	53	ND	< LOD 0.8	ND	< LOD 16.07
24599	2	47.68	SS-05	53	ND	< LOD 0.8	ND	< LOD 16.78
24575	3	48.11	SS-05	53	ND	< LOD 0.8	ND	< LOD 16.63
24617	OBZ	48.79	SS-05	53	ND	< LOD 0.8	ND	< LOD 16.40
24609	1	48.98	SG-1A	54	ND	< LOD 0.8	ND	< LOD 16.33
24596	2	48.20	SG-1A	54	ND	< LOD 0.8	ND	< LOD 16.60
24610	3	48.18	SG-1A	54	ND	< LOD 0.8	ND	< LOD 16.60
24576	OBZ	48.47	SG-1A	54	ND	< LOD 4.0	ND	< LOD 82.53
24606	1	49.24	G-4A	55	1.00	< LOQ 2.5	20.31	< LOQ 50.77
24620	2	48.37	G-4A	55	ND	< LOD 0.8	ND	< LOD 16.54
24573	3	48.67	G-4A	55	ND	< LOD 0.8	ND	< LOD 16.44
24505	OBZ	48.16	G-4A	55	ND	< LOD 0.8	ND	< LOD 16.61
24340	1	48.38	G-4B	56	ND	< LOD 0.8	ND	< LOD 16.54
24607	2	48.01	G-4B	56	ND	< LOD 0.8	ND	< LOD 16.66
24595	3	48.38	G-4B	56	ND	< LOD 0.8	ND	< LOD 16.54
24598	OBZ	48.42	G-4B	56	ND	< LOD 0.8	ND	< LOD 16.52
24580	1	48.44	CS-05	57	ND	< LOD 0.8	ND	< LOD 16.52
24604	2	47.93	CS-05	57	ND	< LOD 0.8	ND	< LOD 16.69

Air Sample Results - Tellurium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Tellurium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 0.8	ND	< LOD 16.74
24574	OBZ	30.41	CS-05	57	ND	< LOD 0.8	ND	< LOD 26.31
24614	1	48.58	G-5A	58	ND	< LOD 0.8	ND	< LOD 16.47
24577	2	48.18	G-5A	58	0.95	< LOQ 2.5	19.72	< LOQ 51.89
24572	3	48.05	G-5A	58	ND	< LOD 0.8	ND	< LOD 16.65
24582	OBZ	47.83	G-5A	58	ND	< LOD 0.8	ND	< LOD 16.73
24322	1	47.88	G-5B	59	ND	< LOD 0.8	ND	< LOD 16.71
24354	2	48.16	G-5B	59	ND	< LOD 0.8	ND	< LOD 16.61
24510	3	47.98	G-5B	59	ND	< LOD 0.8	ND	< LOD 16.67
24321	OBZ	47.99	G-5B	59	ND	< LOD 0.8	ND	< LOD 16.67
24497	1	48.49	CP-1A	60	ND	< LOD 0.8	ND	< LOD 16.50
24333	2	48.28	CP-1A	60	ND	< LOD 0.8	ND	< LOD 16.57
24326	3	48.19	CP-1A	60	ND	< LOD 0.8	ND	< LOD 16.60
24329	OBZ	47.74	CP-1A	60	ND	< LOD 0.8	ND	< LOD 16.76
24499	1	42.42	CP-1B	62	ND	< LOD 0.8	ND	< LOD 18.86
24506	2	42.02	CP-1B	62	ND	< LOD 0.8	ND	< LOD 19.04
24388	3	42.47	CP-1B	62	ND	< LOD 0.8	ND	< LOD 18.84
24315	OBZ	41.77	CP-1B	62	ND	< LOD 0.8	ND	< LOD 19.15
24318	1	48.56	CG-01	63	ND	< LOD 0.8	ND	< LOD 16.47
24308	2	48.00	CG-01	63	ND	< LOD 0.8	ND	< LOD 16.67
24330	3	48.47	CG-01	63	ND	< LOD 0.8	ND	< LOD 16.51
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.8	ND	< LOD 16.56
24363	1	48.10	G-6A	64	ND	< LOD 0.8	ND	< LOD 16.63
24398	2	47.84	G-6A	64	ND	< LOD 0.8	ND	< LOD 16.72
24351	3	48.06	G-6A	64	ND	< LOD 0.8	ND	< LOD 16.65
24594	OBZ	48.29	G-6A	64	ND	< LOD 0.8	ND	< LOD 16.57
24312	1	48.76	G-6B	65	ND	< LOD 0.8	ND	< LOD 16.41
24484	2	47.45	G-6B	65	ND	< LOD 0.8	ND	< LOD 16.86
24327	3	48.92	G-6B	65	ND	< LOD 0.8	ND	< LOD 16.35
24389	OBZ	48.46	G-6B	65	ND	< LOD 0.8	ND	< LOD 16.51
24348	1	48.59	SG-2A	66	ND	< LOD 0.8	ND	< LOD 16.46
24314	2	47.90	SG-2A	66	ND	< LOD 0.8	ND	< LOD 16.70
24494	3	48.24	SG-2A	66	ND	< LOD 0.8	ND	< LOD 16.58
24337	OBZ	48.30	SG-2A	66	3.30	< LOQ 5.0	68.32	< LOQ 103.52
24508	1	48.47	CP-2A	67	ND	< LOD 0.8	ND	< LOD 16.51
24361	2	47.82	CP-2A	67	ND	< LOD 0.8	ND	< LOD 16.73
24359	3	48.22	CP-2A	67	ND	< LOD 1.6	ND	< LOD 33.18
24471	OBZ	48.14	CP-2A	67	1.70	< LOQ 2.5	35.31	< LOQ 51.93
24373	1	48.41	CP-2B	68	1.20	< LOQ 2.5	24.79	< LOQ 51.64
24468	2	47.90	CP-2B	68	ND	< LOD 0.8	ND	< LOD 16.70
24481	3	48.26	CP-2B	68	ND	< LOD 0.8	ND	< LOD 16.58
24391	OBZ	47.53	CP-2B	68	ND	< LOD 0.8	ND	< LOD 16.83
24356	1	48.56	O-1	69	ND	< LOD 0.8	ND	< LOD 16.47
24470	2	47.89	O-1	69	ND	< LOD 0.8	ND	< LOD 16.70
24467	3	48.67	O-1	69	ND	< LOD 0.8	ND	< LOD 16.44
24313	OBZ	47.78	O-1	69	1.30	< LOQ 2.5	27.21	< LOQ 52.32
24501	1	47.96	CS-06	70	ND	< LOD 0.8	ND	< LOD 16.68
24496	2	47.75	CS-06	70	ND	< LOD 0.8	ND	< LOD 16.75
24478	3	48.31	CS-06	70	ND	< LOD 0.8	ND	< LOD 16.56
24503	OBZ	48.04	CS-06	70	ND	< LOD 0.8	ND	< LOD 16.65
24474	1	26.02	SG-1B	71	ND	< LOD 0.8	ND	< LOD 30.75
24469	2	26.02	SG-1B	71	ND	< LOD 0.8	ND	< LOD 30.75
24492	3	26.10	SG-1B	71	ND	< LOD 0.8	ND	< LOD 30.65

Air Sample Results - Tellurium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Tellurium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 4.0	ND	< LOD 152.38
24489	1	48.42	CP-3A	72	ND	< LOD 0.8	ND	< LOD 16.52
24491	2	47.93	CP-3A	72	0.84	< LOQ 2.5	17.53	< LOQ 52.16
24482	3	48.35	CP-3A	72	ND	< LOD 0.8	ND	< LOD 16.55
24486	OBZ	48.32	CP-3A	72	ND	< LOD 0.8	ND	< LOD 16.56
24516	1	36.34	CP-3B	73	ND	< LOD 0.8	ND	< LOD 22.01
24502	2	36.02	CP-3B	73	ND	< LOD 0.8	ND	< LOD 22.21
24515	3	36.48	CP-3B	73	ND	< LOD 0.8	ND	< LOD 21.93
24500	OBZ	40.27	CP-3B	73	ND	< LOD 0.8	ND	< LOD 19.87
24504	1	48.47	G-7A	74	ND	< LOD 0.8	ND	< LOD 16.51
24513	2	48.22	G-7A	74	ND	< LOD 0.8	ND	< LOD 16.59
24458	3	47.94	G-7A	74	ND	< LOD 0.8	ND	< LOD 16.69
24389	OBZ	47.75	G-7A	74	ND	< LOD 0.8	ND	< LOD 16.75
24404	1	48.68	G-7B	75	ND	< LOD 0.8	ND	< LOD 16.43
24451	2	48.06	G-7B	75	ND	< LOD 0.8	ND	< LOD 16.65
24447	3	47.16	G-7B	75	ND	< LOD 0.8	ND	< LOD 16.96
24423	OBZ	47.27	G-7B	75	0.84	< LOQ 2.5	17.77	< LOQ 52.89
24456	1	49.19	SS-06	76	ND	< LOD 0.8	ND	< LOD 16.26
24480	2	48.26	SS-06	76	ND	< LOD 0.8	ND	< LOD 16.58
24429	3	47.68	SS-06	76	ND	< LOD 0.8	ND	< LOD 16.78
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.8	ND	< LOD 16.73
24427	1	48.54	CP-4A	78	ND	< LOD 0.8	ND	< LOD 16.48
24435	2	47.71	CP-4A	78	ND	< LOD 0.8	ND	< LOD 16.77
24244	3	49.01	CP-4A	78	10.00	< LOQ 13.0	204.04	< LOQ 265.25
24220	OBZ	48.74	CP-4A	78	0.97	< LOQ 2.5	19.9	< LOQ 51.29
24460	1	50.05	CP-4B	79	ND	< LOD 0.8	ND	< LOD 15.98
24465	2	48.47	CP-4B	79	1.90	< LOQ 2.5	39.2	< LOQ 51.58
24207	3	48.49	CP-4B	79	11.00	< LOQ 13.0	226.85	< LOQ 268.10
24390	OBZ	49.02	CP-4B	79	ND	< LOD 0.8	ND	< LOD 16.32
24259	1	48.76	SS-07	80	2.10	< LOQ 2.5	43.07	< LOQ 51.27
24421	2	48.13	SS-07	80	ND	< LOD 0.8	ND	< LOD 16.62
24445	3	47.87	SS-07	80	ND	< LOD 0.8	ND	< LOD 16.71
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.8	ND	< LOD 16.50
24459	1	48.96	N-02	81	ND	< LOD 0.8	ND	< LOD 16.34
24417	2	48.11	N-02	81	ND	< LOD 0.8	ND	< LOD 16.63
24442	3	48.01	N-02	81	ND	< LOD 0.8	ND	< LOD 16.66
24386	OBZ	48.19	N-02	81	ND	< LOD 0.8	ND	< LOD 16.60
24452	1	48.20	SG-2B	82	ND	< LOD 0.8	ND	< LOD 16.60
24453	2	48.59	SG-2B	82	ND	< LOD 0.8	ND	< LOD 16.46
24420	3	47.84	SG-2B	82	ND	< LOD 0.8	ND	< LOD 16.72
24444	OBZ	47.95	SG-2B	82	ND	< LOD 4.0	ND	< LOD 83.42
24455	1	48.56	CS-07	83	ND	< LOD 0.8	ND	< LOD 16.47
24433	2	47.96	CS-07	83	ND	< LOD 0.8	ND	< LOD 16.68
24398	3	48.06	CS-07	83	0.81	< LOQ 2.5	16.85	< LOQ 52.02
24511	OBZ	47.96	CS-07	83	ND	< LOD 0.8	ND	< LOD 16.68
24454	1	49.34	CPDS-1A	84	1.20	< LOQ 2.5	24.32	< LOQ 50.67
24291	2	48.49	CPDS-1A	84	1.50	< LOQ 2.5	30.93	< LOQ 51.56
24209	3	48.43	CPDS-1A	84	2.50	> LOQ 2.5	51.62	> LOQ 51.62
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 0.8	ND	< LOD 16.40
24204	1	49.46	CPDS-1B	85	ND	< LOD 0.8	ND	< LOD 16.17
24273	2	48.35	CPDS-1B	85	1.30	< LOQ 2.5	26.89	< LOQ 51.71
24223	3	48.82	CPDS-1B	85	ND	< LOD 0.8	ND	< LOD 16.39
24466	OBZ	49.96	CPDS-1B	85	ND	< LOD 0.8	ND	< LOD 16.01

Airborne Sample Data Analysis - Tellurium

NIOSH REL 100.0 micrograms/cubic meter
OSHA PEL 100.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 16.47	ND	< LOD 16.67	ND	< LOD 16.51	ND	< LOD 16.56
CS-01	ND	< LOD 16.48	ND	< LOD 16.67	ND	< LOD 16.51	ND	< LOD 16.69
CS-02	ND	< LOD 16.64	ND	< LOD 16.72	ND	< LOD 16.66	ND	< LOD 16.67
CS-03	ND	< LOD 16.50	ND	< LOD 16.57	ND	< LOD 16.59	ND	< LOD 16.57
CS-04	ND	< LOD 16.46	ND	< LOD 16.74	ND	< LOD 16.57	ND	< LOD 16.47
CS-05	ND	< LOD 16.52	ND	< LOD 16.69	ND	< LOD 16.74	ND	< LOD 26.31
CS-06	ND	< LOD 16.68	ND	< LOD 16.75	ND	< LOD 16.56	ND	< LOD 16.65
CS-07	ND	< LOD 16.47	ND	< LOD 16.68	16.85	< LOQ 52.02	ND	< LOD 16.68
CSDS-01	ND	< LOD 16.61	19.16	< LOQ 52.07	ND	< LOD 16.61	ND	< LOD 16.64
CSDS-02	ND	< LOD 16.48	ND	< LOD 16.54	ND	< LOD 16.56	ND	< LOD 16.74
N-01	ND	< LOD 16.26	ND	< LOD 16.68	ND	< LOD 16.56	ND	< LOD 16.39
N-02	ND	< LOD 16.34	ND	< LOD 16.63	ND	< LOD 16.66	ND	< LOD 16.60
O-1	ND	< LOD 16.47	ND	< LOD 16.70	ND	< LOD 16.44	27.21	< LOQ 52.32
S-01	ND	< LOD 16.61	ND	< LOD 16.70	33.40	< LOQ 52.19	ND	< LOD 16.69
S-02	ND	< LOD 16.67	ND	< LOD 16.75	ND	< LOD 16.67	ND	< LOD 16.70
SH-01	ND	< LOD 16.71	ND	< LOD 16.72	ND	< LOD 16.58	ND	< LOD 16.64
SS-01	ND	< LOD 16.52	ND	< LOD 16.70	ND	< LOD 16.55	ND	< LOD 16.56
SS-02	ND	< LOD 16.62	ND	< LOD 16.68	ND	< LOD 16.56	ND	< LOD 16.45
SS-03	ND	< LOD 16.65	ND	< LOD 16.81	ND	< LOD 16.35	ND	< LOD 16.13
SS-04	ND	< LOD 16.73	ND	< LOD 16.74	ND	< LOD 16.74	ND	< LOD 16.46
SS-05	ND	< LOD 16.07	ND	< LOD 16.78	ND	< LOD 16.63	ND	< LOD 16.40
SS-06	ND	< LOD 16.26	ND	< LOD 16.58	ND	< LOD 16.78	ND	< LOD 16.73
SS-07	43.07	< LOQ 51.27	ND	< LOD 16.62	ND	< LOD 16.71	ND	< LOD 16.50
SSDS-01	ND	< LOD 16.47	ND	< LOD 16.72	16.50	< LOQ 51.56	ND	< LOD 16.56
SSDS-02	ND	< LOD 16.67	ND	< LOD 16.67	ND	< LOD 16.51	ND	< LOD 16.20
SSDS-03	ND	< LOD 16.17	ND	< LOD 15.89	ND	< LOD 15.92	ND	< LOD 16.58
CP-1A	ND	< LOD 16.50	ND	< LOD 16.57	ND	< LOD 16.60	ND	< LOD 16.76
CP-1B	ND	< LOD 18.86	ND	< LOD 19.04	ND	< LOD 18.84	ND	< LOD 19.15
CP-2A	ND	< LOD 16.51	ND	< LOD 16.73	ND	< LOD 33.18	35.31	< LOQ 51.93
CP-2B	24.79	< LOQ 51.64	ND	< LOD 16.70	ND	< LOD 16.58	ND	< LOD 16.83
CP-3A	ND	< LOD 16.52	17.53	< LOQ 52.16	ND	< LOD 16.55	ND	< LOD 16.56
CP-3B	ND	< LOD 22.01	ND	< LOD 22.21	ND	< LOD 21.93	ND	< LOD 19.87
CP-4A	ND	< LOD 16.48	ND	< LOD 16.77	204.04	< LOQ 265.25	19.9	< LOQ 51.29
CP-4B	ND	< LOD 15.98	39.2	< LOQ 51.58	226.85	< LOQ 268.10	ND	< LOD 16.32
CPDS-1A	24.32	< LOQ 50.67	30.93	< LOQ 51.56	51.62	> LOQ 51.62	ND	< LOD 16.40
CPDS-1B	ND	< LOD 16.17	26.89	< LOQ 51.71	ND	< LOD 16.39	ND	< LOD 16.01
G-1A	ND	< LOD 16.62	ND	< LOD 16.71	ND	< LOD 16.61	ND	< LOD 16.36
G-1B	ND	< LOD 16.57	ND	< LOD 16.88	ND	< LOD 16.61	ND	< LOD 16.59
G-2A	ND	< LOD 16.86	ND	< LOD 16.98	ND	< LOD 16.58	ND	< LOD 16.65
G-2B	ND	< LOD 16.40	ND	< LOD 16.61	ND	< LOD 16.73	ND	< LOD 16.48
G-3A	ND	< LOD 16.55	ND	< LOD 16.63	ND	< LOD 16.79	ND	< LOD 16.67
G-4A	20.31	< LOQ 50.77	ND	< LOD 16.54	ND	< LOD 16.44	ND	< LOD 16.61
G-4B	ND	< LOD 16.54	ND	< LOD 16.66	ND	< LOD 16.54	ND	< LOD 16.52
G-5A	ND	< LOD 16.47	19.72	< LOQ 51.89	ND	< LOD 16.65	ND	< LOD 16.73
G-5B	ND	< LOD 16.71	ND	< LOD 16.61	ND	< LOD 16.67	ND	< LOD 16.67
G-6A	ND	< LOD 16.63	ND	< LOD 16.72	ND	< LOD 16.65	ND	< LOD 16.57
G-6B	ND	< LOD 16.41	ND	< LOD 16.86	ND	< LOD 16.35	ND	< LOD 16.51
G-7A	ND	< LOD 16.51	ND	< LOD 16.59	ND	< LOD 16.69	ND	< LOD 16.75
G-7B	ND	< LOD 16.43	ND	< LOD 16.65	ND	< LOD 16.96	17.77	< LOQ 52.89
SG-1A	ND	< LOD 16.33	ND	< LOD 16.60	ND	< LOD 16.60	ND	< LOD 82.53
SG-1B	ND	< LOD 30.75	ND	< LOD 30.75	ND	< LOD 30.65	ND	< LOD 152.38
SG-2A	ND	< LOD 16.46	ND	< LOD 16.70	ND	< LOD 16.58	68.32	< LOQ 103.52
SG-2B	ND	< LOD 16.60	ND	< LOD 16.46	ND	< LOD 16.72	ND	< LOD 83.42

Bulk Elemental Analysis - Tellurium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Tellurium		Sample	Tellurium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 3.0	J95331-63 PB	ND	< LOD 3.0
CS-01	J95331-34 VB	ND	< LOD 3.0	J95331-34 PB	ND	< LOD 3.0
CS-02	J95331-37 VB	ND	< LOD 3.0	J95331-37 PB	ND	< LOD 3.0
CS-03	J95331-38 VB	ND.	< LOD 3.0	J95331-38 PB	ND	< LOD 3.0
CS-04	J95331-39 VB	ND	< LOD 3.0	J95331-39 PB	ND	< LOD 3.0
CS-05	J95331-57 VB	ND	< LOD 3.0	J95331-57 PB	3.40	< LOQ 10.0
CS-06	J95331-70 VB	ND	< LOD 3.0	J95331-70 PB	ND	< LOD 3.0
CS-07	J95331-83 VB	ND	< LOD 3.0	J95331-83 PB	ND	< LOD 3.0
CSDS-01	J95331-31 VB	ND	< LOD 3.0	J95331-31 PB	ND	< LOD 3.0
CSDS-02	J95331-35 VB	ND	< LOD 3.0	J95331-35 PB	ND	< LOD 3.0
N-01	J95331-52 VB	4.50	< LOQ 10.0	J95331-52 PB	ND	< LOD 3.0
N-02	J95331-81 VB	ND	< LOD 3.0	J95331-81 PB	ND	< LOD 3.0
O-1	J95331-69 VB	ND	< LOD 3.0	J95331-69 PB	ND	< LOD 3.0
S-01	J95331-28 VB	ND	< LOD 3.0	J95331-28 PB	ND	< LOD 3.0
S-02	J95331-29 VB	ND	< LOD 3.0	J95331-29 PB	ND	< LOD 3.0
SH-01	J95331-36 VB	ND	< LOD 3.0	J95331-36 PB	ND	< LOD 3.0
SS-01	J95331-32 VB	ND	< LOD 3.0	J95331-32 PB	ND	< LOD 3.0
SS-02	J95331-40 VB	ND	< LOD 3.0	J95331-40 PB	ND	< LOD 3.0
SS-03	J95331-45 VB	ND	< LOD 3.0	J95331-45 PB	ND	< LOD 3.0
SS-04	J95331-47 VB	ND	< LOD 3.0	J95331-47 PB	3.40	< LOQ 10.0
SS-05	J95331-53 VB	ND	< LOD 3.0	J95331-53 PB	ND	< LOD 3.0
SS-06	J95331-76 VB	ND	< LOD 3.0	J95331-76 PB	ND	< LOD 3.0
SS-07	J95331-80 VB	ND	< LOD 3.0	J95331-80 PB	ND	< LOD 3.0
SSDS-01	J95331-33 VB	ND	< LOD 3.0	J95331-33 PB	ND	< LOD 3.0
SSDS-02	J95331-44 VB	ND	< LOD 3.0	J95331-44 PB	3.10	< LOQ 10.0
SSDS-03	J95331-48 VB	ND	< LOD 3.0	J95331-48 PB	ND	< LOD 3.0
CP-1A	J95331-60 VB	3.80	< LOQ 10.0	J95331-60 PB	ND	< LOD 3.0
CP-1B	J95331-61 VB	ND	< LOD 3.0	J95331-61 PB	ND	< LOD 3.0
CP-2A	J95331-67 VB	ND	< LOD 3.0	J95331-67 PB	ND	< LOD 6.0
CP-2B	J95331-68 VB	ND	< LOD 6.0	J95331-68 PB	ND	< LOD 6.0
CP-3A	J95331-72 VB	ND	< LOD 3.0	J95331-72 PB	ND	< LOD 3.0
CP-3B	J95331-73 VB	8.80	< LOQ 10.0	J95331-73 PB	8.40	< LOQ 10.0
CP-4A	J95331-78 VB	ND	< LOD 3.0	J95331-78 PB	ND	< LOD 6.0
CP-4B	J95331-79 VB	10.00	> LOQ 10.0	J95331-79 PB	8.40	< LOQ 10.0
CPDS-1A	J95331-84 VB	ND	< LOD 3.0	J95331-84 PB	7.90	< LOQ 10.0
CPDS-1B	J95331-85 VB	ND	< LOD 3.0	J95331-85 PB	5.60	< LOQ 10.0
G-1A	J95331-41 VB	ND	< LOD 3.0	J95331-41 PB	ND	< LOD 3.0
G-1B	J95331-46 VB	ND	< LOD 3.0	J95331-46 PB	ND	< LOD 3.0
G-2A	J95331-43 VB	3.50	< LOQ 10.0	J95331-43 PB	ND	< LOD 3.0
G-2B	J95331-50 VB	ND	< LOD 3.0	J95331-50 PB	ND	< LOD 3.0
G-3A	J95331-49 VB	ND	< LOD 3.0	J95331-49 PB	3.40	< LOQ 10.0
G-4A	J95331-55 VB	ND	< LOD 3.0	J95331-55 PB	3.30	< LOQ 10.0
G-4B	J95331-56 VB	ND	< LOD 3.0	J95331-56 PB	ND	< LOD 3.0
G-5A	J95331-58 VB	ND	< LOD 3.0	J95331-58 PB	ND	< LOD 3.0
G-5B	J95331-59 VB	ND	< LOD 3.0	J95331-59 PB	ND	< LOD 3.0
G-6A	J95331-64 VB	ND	< LOD 3.0	J95331-64 PB	ND	< LOD 3.0
G-6B	J95331-65 VB	ND	< LOD 3.0	J95331-65 PB	ND	< LOD 3.0
G-7A	J95331-74 VB	ND	< LOD 3.0	J95331-74 PB	ND	< LOD 3.0
G-7B	J95331-75 VB	ND	< LOD 3.0	J95331-75 PB	ND	< LOD 3.0
SG-1A	J95331-54 VB	ND	< LOD 15.0	J95331-54 PB	ND	< LOD 15.0
SG-1B	J95331-71 VB	ND	< LOD 15.0	J95331-71 PB	ND	< LOD 15.0
SG-2A	J95331-66 VB	ND	< LOD 15.0	J95331-66 PB	28.00	< LOQ 50
SG-2B	J95331-82 VB	ND	< LOD 15.0	J95331-82 PB	15.00	< LOQ 50.0

Comparison of Airborne Concentrations to Bulk Concentrations - Tellurium

NIOSH REL 100.0 micrograms/cubic meter
OSHA PEL 100.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	ND	ND
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	ND
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	ND	ND	ND	ND
CS-07	ND	ND	16.85	ND	ND
CSDS-01	ND	19.16	ND	ND	ND
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	4.50
N-02	ND	ND	ND	ND	ND
O-1	ND	ND	ND	27.21	ND
S-01	ND	ND	33.40	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	ND
SS-07	43.07	ND	ND	ND	ND
SSDS-01	ND	ND	16.50	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	ND	ND	ND	ND	3.80
CP-2A	ND	ND	ND	35.31	ND
CP-3A	ND	17.53	ND	ND	ND
CP-4A	ND	ND	204.04	19.90	ND
CPDS-1A	24.32	30.93	51.62	ND	ND
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	3.50
G-3A	ND	ND	ND	ND	ND
G-4A	20.31	ND	ND	ND	ND
G-5A	ND	19.72	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	68.32	ND

APPENDIX B - THALLIUM

Thallium

Thallium is one of the more toxic elements from a standpoint of both acute and chronic poisoning, specifically due to ingestion. However, poisoning from industrial exposure has been rarely reported. A characteristic symptom of acute poisoning is loss of hair. Other symptoms of poisoning relate chiefly to gastrointestinal tract or nervous systems disorders. Incoordination, paralysis of the extremities, endocrine disorders and psychosis may develop. The NIOSH REL and OSHA PEL for thallium are both 100 micrograms/cubic meter of air.

Air Sample Results - Thallium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Thallium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	ND	< LOD 3.0	ND	< LOD 62.29
24412	2	47.89	S-01	28	ND	< LOD 3.0	ND	< LOD 62.64
24441	3	47.90	S-01	28	ND	< LOD 3.0	ND	< LOD 62.63
24450	OBZ	47.93	S-01	28	ND	< LOD 3.0	ND	< LOD 62.59
24643	1	47.98	S-02	29	ND	< LOD 3.0	ND	< LOD 62.53
24625	2	47.76	S-02	29	ND	< LOD 3.0	ND	< LOD 62.81
24642	3	48.00	S-02	29	ND	< LOD 3.0	ND	< LOD 62.50
24632	OBZ	47.89	S-02	29	ND	< LOD 3.0	ND	< LOD 62.64
24634	1	48.16	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.29
24650	2	48.01	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.49
24644	3	48.16	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.29
24645	OBZ	48.07	CSDS-01	31	ND	< LOD 3.0	ND	< LOD 62.41
24640	1	48.44	SS-01	32	ND	< LOD 3.0	ND	< LOD 61.93
24641	2	47.90	SS-01	32	ND	< LOD 3.0	ND	< LOD 62.63
24651	3	48.35	SS-01	32	ND	< LOD 3.0	ND	< LOD 62.05
24635	OBZ	48.30	SS-01	32	ND	< LOD 3.0	ND	< LOD 62.11
24646	1	48.58	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 61.75
24626	2	47.84	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 62.71
24638	3	48.49	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 61.87
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 3.0	ND	< LOD 62.09
24628	1	48.55	CS-01	34	ND	< LOD 3.0	ND	< LOD 61.79
24637	2	48.00	CS-01	34	ND	< LOD 3.0	ND	< LOD 62.50
24624	3	48.47	CS-01	34	ND	< LOD 3.0	ND	< LOD 61.89
24636	OBZ	47.92	CS-01	34	ND	< LOD 3.0	ND	< LOD 62.60
24623	1	48.53	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 61.82
24622	2	48.36	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 62.03
24654	3	48.31	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 62.10
24653	OBZ	47.78	CSDS-02	35	ND	< LOD 3.0	ND	< LOD 62.79
24629	1	47.88	SH-01	36	ND	< LOQ 3.0	ND	< LOD 62.66
24633	2	47.86	SH-01	36	ND	< LOQ 3.0	ND	< LOD 62.68
24627	3	48.24	SH-01	36	ND	< LOQ 3.0	ND	< LOD 62.19
24648	OBZ	48.08	SH-01	36	ND	< LOQ 3.0	ND	< LOD 62.40
24555	1	48.08	CS-02	37	ND	< LOQ 3.0	ND	< LOD 62.40
24552	2	47.84	CS-02	37	ND	< LOQ 3.0	ND	< LOD 62.71
24541	3	48.01	CS-02	37	ND	< LOQ 3.0	ND	< LOD 62.49
24529	OBZ	47.99	CS-02	37	ND	< LOQ 3.0	ND	< LOD 62.51
24558	1	48.49	CS-03	38	ND	< LOQ 3.0	ND	< LOD 61.87
24524	2	48.29	CS-03	38	ND	< LOQ 3.0	ND	< LOD 62.12
24561	3	48.22	CS-03	38	ND	< LOQ 3.0	ND	< LOD 62.21
24559	OBZ	48.29	CS-03	38	ND	< LOQ 3.0	ND	< LOD 62.12
24543	1	48.61	CS-04	39	ND	< LOQ 3.0	ND	< LOD 61.72
24532	2	47.78	CS-04	39	ND	< LOD 3.0	ND	< LOD 62.79
24546	3	48.29	CS-04	39	ND	< LOQ 3.0	ND	< LOD 62.12
24557	OBZ	48.58	CS-04	39	ND	< LOQ 3.0	ND	< LOD 61.75
24560	1	48.13	SS-02	40	ND	< LOQ 3.0	ND	< LOD 62.33
24565	2	47.95	SS-02	40	ND	< LOQ 3.0	ND	< LOD 62.57
24630	3	48.32	SS-02	40	ND	< LOQ 3.0	ND	< LOD 62.09
24553	OBZ	48.62	SS-02	40	ND	< LOQ 3.0	ND	< LOD 61.70
24525	1	48.13	G-1A	41	ND	< LOQ 3.0	ND	< LOD 62.33
24563	2	47.87	G-1A	41	ND	< LOQ 3.0	ND	< LOD 62.67
24547	3	48.17	G-1A	41	ND	< LOQ 3.0	ND	< LOD 62.28
24526	OBZ	48.91	G-1A	41	ND	< LOQ 3.0	ND	< LOD 61.34
24538	1	47.45	G-2A	43	ND	< LOQ 3.0	ND	< LOD 63.22

Air Sample Results - Thallium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Thallium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	ND	< LOQ 3.0	ND	< LOD 63.67
24533	3	48.24	G-2A	43	ND	< LOQ 3.0	ND	< LOD 62.19
24540	OBZ	48.04	G-2A	43	ND	< LOQ 3.0	ND	< LOD 62.45
24528	1	47.99	SSDS-02	44	ND	< LOQ 3.0	ND	< LOD 62.51
24544	2	48.00	SSDS-02	44	ND	< LOQ 3.0	ND	< LOD 62.50
24567	3	48.46	SSDS-02	44	ND	< LOQ 3.0	ND	< LOD 61.91
24539	OBZ	49.37	SSDS-02	44	ND	< LOQ 3.0	ND	< LOD 60.77
24571	1	48.05	SS-03	45	ND	< LOD 3.0	ND	< LOD 62.43
24536	2	47.60	SS-03	45	ND	< LOQ 3.0	ND	< LOD 63.03
24534	3	48.94	SS-03	45	ND	< LOQ 3.0	ND	< LOD 61.30
24570	OBZ	49.61	SS-03	45	ND	< LOQ 3.0	ND	< LOD 60.47
24568	1	48.28	G-1B	46	ND	< LOD 3.0	ND	< LOD 62.14
24592	2	47.38	G-1B	46	ND	< LOD 3.0	ND	< LOD 63.32
24593	3	48.17	G-1B	46	ND	< LOD 3.0	ND	< LOD 62.28
24535	OBZ	48.22	G-1B	46	ND	< LOD 3.0	ND	< LOD 62.21
24590	1	47.81	SS-04	47	ND	< LOD 3.0	ND	< LOD 62.75
24605	2	47.78	SS-04	47	ND	< LOD 3.0	ND	< LOD 62.79
24562	3	47.80	SS-04	47	ND	< LOD 3.0	ND	< LOD 62.76
24531	OBZ	48.59	SS-04	47	ND	< LOD 3.0	ND	< LOD 61.74
24527	1	49.48	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 60.63
24569	2	50.35	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 59.58
24584	3	50.24	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 59.71
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 3.0	ND	< LOD 62.16
24600	1	48.34	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.06
24616	2	48.11	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.36
24585	3	47.65	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.96
24583	OBZ	47.99	G-3A	49	ND	< LOD 3.0	ND	< LOD 62.51
24587	1	48.79	G-2B	50	ND	< LOD 3.0	ND	< LOD 61.49
24602	2	48.17	G-2B	50	ND	< LOD 3.0	ND	< LOD 62.28
24564	3	47.81	G-2B	50	ND	< LOD 3.0	ND	< LOD 62.75
24621	OBZ	48.54	G-2B	50	ND	< LOD 3.0	ND	< LOD 61.80
24618	1	49.21	N-01	52	ND	< LOD 3.0	ND	< LOD 60.96
24611	2	47.96	N-01	52	ND	< LOD 3.0	ND	< LOD 62.55
24588	3	48.32	N-01	52	ND	< LOD 3.0	ND	< LOD 62.09
24615	OBZ	48.80	N-01	52	ND	< LOD 3.0	ND	< LOD 61.48
24597	1	49.78	SS-05	53	ND	< LOD 3.0	ND	< LOD 60.27
24599	2	47.68	SS-05	53	ND	< LOD 3.0	ND	< LOD 62.92
24575	3	48.11	SS-05	53	ND	< LOD 3.0	ND	< LOD 62.36
24617	OBZ	48.79	SS-05	53	ND	< LOD 3.0	ND	< LOD 61.49
24609	1	48.98	SG-1A	54	ND	< LOD 3.0	ND	< LOD 61.25
24596	2	48.20	SG-1A	54	ND	< LOD 3.0	ND	< LOD 62.24
24610	3	48.18	SG-1A	54	ND	< LOD 3.0	ND	< LOD 62.27
24576	OBZ	48.47	SG-1A	54	ND	< LOD 15.0	ND	< LOD 309.47
24606	1	49.24	G-4A	55	ND	< LOD 3.0	ND	< LOD 60.93
24620	2	48.37	G-4A	55	ND	< LOD 3.0	ND	< LOD 62.02
24573	3	48.67	G-4A	55	ND	< LOD 3.0	ND	< LOD 61.64
24505	OBZ	48.16	G-4A	55	ND	< LOD 3.0	ND	< LOD 62.29
24340	1	48.38	G-4B	56	ND	< LOD 3.0	ND	< LOD 62.01
24607	2	48.01	G-4B	56	ND	< LOD 3.0	ND	< LOD 62.49
24595	3	48.38	G-4B	56	ND	< LOD 3.0	ND	< LOD 62.01
24598	OBZ	48.42	G-4B	56	ND	< LOD 3.0	ND	< LOD 61.96
24580	1	48.44	CS-05	57	ND	< LOD 3.0	ND	< LOD 61.93
24604	2	47.93	CS-05	57	ND	< LOD 3.0	ND	< LOD 62.59

Air Sample Results - Thallium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Thallium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	ND	< LOD 3.0	ND	< LOD 62.79
24574	OBZ	30.41	CS-05	57	ND	< LOD 3.0	ND	< LOD 98.65
24614	1	48.58	G-5A	58	ND	< LOD 3.0	ND	< LOD 61.75
24577	2	48.18	G-5A	58	ND	< LOD 3.0	ND	< LOD 62.27
24572	3	48.05	G-5A	58	ND	< LOD 3.0	ND	< LOD 62.43
24582	OBZ	47.83	G-5A	58	ND	< LOD 3.0	ND	< LOD 62.72
24322	1	47.88	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.66
24354	2	48.16	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.29
24510	3	47.98	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.53
24321	OBZ	47.99	G-5B	59	ND	< LOD 3.0	ND	< LOD 62.51
24497	1	48.49	CP-1A	60	ND	< LOD 3.0	ND	< LOD 61.87
24333	2	48.28	CP-1A	60	ND	< LOD 3.0	ND	< LOD 62.14
24326	3	48.19	CP-1A	60	ND	< LOD 3.0	ND	< LOD 62.25
24329	OBZ	47.74	CP-1A	60	ND	< LOD 3.0	ND	< LOD 62.84
24499	1	42.42	CP-1B	62	ND	< LOD 3.0	ND	< LOD 70.72
24506	2	42.02	CP-1B	62	ND	< LOD 3.0	ND	< LOD 71.39
24388	3	42.47	CP-1B	62	ND	< LOD 3.0	ND	< LOD 70.64
24315	OBZ	41.77	CP-1B	62	ND	< LOD 3.0	ND	< LOD 71.82
24318	1	48.56	CG-01	63	ND	< LOD 3.0	ND	< LOD 61.78
24308	2	48.00	CG-01	63	ND	< LOD 3.0	ND	< LOD 62.50
24330	3	48.47	CG-01	63	ND	< LOD 3.0	ND	< LOD 61.89
24230	OBZ	48.31	CG-01	63	ND	< LOD 3.0	ND	< LOD 62.10
24363	1	48.10	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.37
24398	2	47.84	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.71
24351	3	48.06	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.42
24594	OBZ	48.29	G-6A	64	ND	< LOD 3.0	ND	< LOD 62.12
24312	1	48.76	G-6B	65	ND	< LOD 3.0	ND	< LOD 61.53
24484	2	47.45	G-6B	65	ND	< LOD 3.0	ND	< LOD 63.22
24327	3	48.92	G-6B	65	ND	< LOD 3.0	ND	< LOD 61.32
24389	OBZ	48.46	G-6B	65	ND	< LOD 3.0	ND	< LOD 61.91
24348	1	48.59	SG-2A	66	ND	< LOD 3.0	ND	< LOD 61.74
24314	2	47.90	SG-2A	66	ND	< LOD 3.0	ND	< LOD 62.63
24494	3	48.24	SG-2A	66	ND	< LOD 3.0	ND	< LOD 62.19
24337	OBZ	48.30	SG-2A	66	ND	< LOD 6.0	ND	< LOD 124.22
24508	1	48.47	CP-2A	67	ND	< LOD 3.0	ND	< LOD 61.89
24361	2	47.82	CP-2A	67	3.00	< LOQ 7.5	62.74	< LOQ 156.84
24359	3	48.22	CP-2A	67	6.00	< LOQ 15.0	124.43	< LOQ 311.07
24471	OBZ	48.14	CP-2A	67	ND	< LOD 3.0	ND	< LOD 62.32
24373	1	48.41	CP-2B	68	3.00	< LOQ 7.5	61.97	< LOQ 154.93
24468	2	47.90	CP-2B	68	ND	< LOD 3.0	ND	< LOD 62.63
24481	3	48.26	CP-2B	68	ND	< LOD 3.0	ND	< LOD 62.16
24391	OBZ	47.53	CP-2B	68	ND	< LOD 3.0	ND	< LOD 63.12
24356	1	48.56	O-1	69	3.00	< LOQ 7.5	61.78	< LOQ 154.45
24470	2	47.89	O-1	69	ND	< LOD 3.0	ND	< LOD 62.64
24467	3	48.67	O-1	69	ND	< LOD 3.0	ND	< LOD 61.64
24313	OBZ	47.78	O-1	69	3.00	< LOQ 7.5	62.79	< LOQ 156.97
24501	1	47.96	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.55
24496	2	47.75	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.83
24478	3	48.31	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.10
24503	OBZ	48.04	CS-06	70	ND	< LOD 3.0	ND	< LOD 62.45
24474	1	26.02	SG-1B	71	ND	< LOD 3.0	ND	< LOD 115.30
24469	2	26.02	SG-1B	71	ND	< LOD 3.0	ND	< LOD 115.30
24492	3	26.10	SG-1B	71	ND	< LOD 3.0	ND	< LOD 114.94

Air Sample Results - Thallium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Thallium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 15.0	ND	< LOD 571.43
24489	1	48.42	CP-3A	72	ND	< LOD 3.0	ND	< LOD 61.96
24491	2	47.93	CP-3A	72	ND	< LOD 3.0	ND	< LOD 62.59
24482	3	48.35	CP-3A	72	ND	< LOD 3.0	ND	< LOD 62.05
24486	OBZ	48.32	CP-3A	72	ND	< LOD 3.0	ND	< LOD 62.09
24516	1	36.34	CP-3B	73	ND	< LOD 3.0	ND	< LOD 82.55
24502	2	36.02	CP-3B	73	ND	< LOD 3.0	ND	< LOD 83.29
24515	3	36.48	CP-3B	73	ND	< LOD 3.0	ND	< LOD 82.24
24500	OBZ	40.27	CP-3B	73	ND	< LOD 3.0	ND	< LOD 74.50
24504	1	48.47	G-7A	74	ND	< LOD 3.0	ND	< LOD 61.89
24513	2	48.22	G-7A	74	ND	< LOD 3.0	ND	< LOD 62.21
24458	3	47.94	G-7A	74	ND	< LOD 3.0	ND	< LOD 62.58
24389	OBZ	47.75	G-7A	74	ND	< LOD 3.0	ND	< LOD 62.83
24404	1	48.68	G-7B	75	ND	< LOD 3.0	ND	< LOD 61.63
24451	2	48.06	G-7B	75	ND	< LOD 3.0	ND	< LOD 62.42
24447	3	47.16	G-7B	75	ND	< LOD 3.0	ND	< LOD 63.61
24423	OBZ	47.27	G-7B	75	ND	< LOD 3.0	ND	< LOD 63.47
24456	1	49.19	SS-06	76	ND	< LOD 3.0	ND	< LOD 60.99
24480	2	48.26	SS-06	76	ND	< LOD 3.0	ND	< LOD 62.16
24429	3	47.68	SS-06	76	ND	< LOD 3.0	ND	< LOD 62.92
24418	OBZ	47.83	SS-06	76	ND	< LOD 3.0	ND	< LOD 62.72
24427	1	48.54	CP-4A	78	ND	< LOD 3.0	ND	< LOD 61.80
24435	2	47.71	CP-4A	78	ND	< LOD 3.0	ND	< LOD 62.88
24244	3	49.01	CP-4A	78	ND	< LOD 6.0	ND	< LOD 122.42
24220	OBZ	48.74	CP-4A	78	ND	< LOD 3.0	ND	< LOD 61.55
24460	1	50.05	CP-4B	79	ND	< LOD 3.0	ND	< LOD 59.94
24465	2	48.47	CP-4B	79	ND	< LOD 3.0	ND	< LOD 61.89
24207	3	48.49	CP-4B	79	ND	< LOD 6.0	ND	< LOD 123.74
24390	OBZ	49.02	CP-4B	79	ND	< LOD 3.0	ND	< LOD 61.20
24259	1	48.76	SS-07	80	3.00	< LOQ 7.5	61.53	< LOQ 153.81
24421	2	48.13	SS-07	80	ND	< LOD 3.0	ND	< LOD 62.33
24445	3	47.87	SS-07	80	ND	< LOD 3.0	ND	< LOD 62.67
24432	OBZ	48.49	SS-07	80	ND	< LOD 3.0	ND	< LOD 61.87
24459	1	48.96	N-02	81	ND	< LOD 3.0	ND	< LOD 61.27
24417	2	48.11	N-02	81	ND	< LOD 3.0	ND	< LOD 62.36
24442	3	48.01	N-02	81	ND	< LOD 3.0	ND	< LOD 62.49
24386	OBZ	48.19	N-02	81	ND	< LOD 3.0	ND	< LOD 62.25
24452	1	48.20	SG-2B	82	ND	< LOD 3.0	ND	< LOD 62.24
24453	2	48.59	SG-2B	82	ND	< LOD 3.0	ND	< LOD 61.74
24420	3	47.84	SG-2B	82	ND	< LOD 3.0	ND	< LOD 62.71
24444	OBZ	47.95	SG-2B	82	ND	< LOD 15.0	ND	< LOD 312.83
24455	1	48.56	CS-07	83	ND	< LOD 3.0	ND	< LOD 61.78
24433	2	47.96	CS-07	83	ND	< LOD 3.0	ND	< LOD 62.55
24398	3	48.06	CS-07	83	ND	< LOD 3.0	ND	< LOD 62.42
24511	OBZ	47.96	CS-07	83	ND	< LOD 3.0	ND	< LOD 62.55
24454	1	49.34	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 60.80
24291	2	48.49	CPDS-1A	84	3.00	< LOQ 7.5	61.87	< LOQ 154.67
24209	3	48.43	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 61.95
24402	OBZ	48.77	CPDS-1A	84	ND	< LOD 3.0	ND	< LOD 61.51
24204	1	49.46	CPDS-1B	85	3.00	< LOQ 7.5	60.66	< LOQ 151.64
24273	2	48.35	CPDS-1B	85	3.00	< LOQ 7.5	62.05	< LOQ 155.12
24223	3	48.82	CPDS-1B	85	ND	< LOD 3.0	ND	< LOD 61.45
24466	OBZ	49.96	CPDS-1B	85	ND	< LOD 3.0	ND	< LOD 60.05

Airborne Sample Data Analysis - Thallium

NIOSH REL 100.0 micrograms/cubic meter

OSHA PEL 100.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 61.78	ND	< LOD 62.50	ND	< LOD 61.89	ND	< LOD 62.10
CS-01	ND	< LOD 61.79	ND	< LOD 62.50	ND	< LOD 61.89	ND	< LOD 62.60
CS-02	ND	< LOD 62.40	ND	< LOD 62.71	ND	< LOD 62.49	ND	< LOD 62.51
CS-03	ND	< LOD 61.87	ND	< LOD 62.12	ND	< LOD 62.21	ND	< LOD 62.12
CS-04	ND	< LOD 61.72	ND	< LOD 62.79	ND	< LOD 62.12	ND	< LOD 61.75
CS-05	ND	< LOD 61.93	ND	< LOD 62.59	ND	< LOD 62.79	ND	< LOD 98.65
CS-06	ND	< LOD 62.55	ND	< LOD 62.83	ND	< LOD 62.10	ND	< LOD 62.45
CS-07	ND	< LOD 61.78	ND	< LOD 62.55	ND	< LOD 62.42	ND	< LOD 62.55
CSDS-01	ND	< LOD 62.29	ND	< LOD 62.49	ND	< LOD 62.29	ND	< LOD 62.41
CSDS-02	ND	< LOD 61.82	ND	< LOD 62.03	ND	< LOD 62.10	ND	< LOD 62.79
N-01	ND	< LOD 60.96	ND	< LOD 62.55	ND	< LOD 62.09	ND	< LOD 61.48
N-02	ND	< LOD 61.27	ND	< LOD 62.36	ND	< LOD 62.49	ND	< LOD 62.25
O-1	61.78	< LOQ 154.45	ND	< LOD 62.64	ND	< LOD 61.64	62.79	< LOQ 156.97
S-01	ND	< LOD 62.29	ND	< LOD 62.64	ND	< LOD 62.63	ND	< LOD 62.59
S-02	ND	< LOD 62.53	ND	< LOD 62.81	ND	< LOD 62.50	ND	< LOD 62.64
SH-01	ND	< LOD 62.66	ND	< LOD 62.68	ND	< LOD 62.19	ND	< LOD 62.40
SS-01	ND	< LOD 61.93	ND	< LOD 62.63	ND	< LOD 62.05	ND	< LOD 62.11
SS-02	ND	< LOD 62.33	ND	< LOD 62.57	ND	< LOD 62.09	ND	< LOD 61.70
SS-03	ND	< LOD 62.43	ND	< LOD 63.03	ND	< LOD 61.30	ND	< LOD 60.47
SS-04	ND	< LOD 62.75	ND	< LOD 62.79	ND	< LOD 62.76	ND	< LOD 61.74
SS-05	ND	< LOD 60.27	ND	< LOD 62.92	ND	< LOD 62.36	ND	< LOD 61.49
SS-06	ND	< LOD 60.99	ND	< LOD 62.16	ND	< LOD 62.92	ND	< LOD 62.72
SS-07	61.53	< LOQ 153.81	ND	< LOD 62.33	ND	< LOD 62.67	ND	< LOD 61.87
SSDS-01	ND	< LOD 61.75	ND	< LOD 62.71	ND	< LOD 61.87	ND	< LOD 62.09
SSDS-02	ND	< LOD 62.51	ND	< LOD 62.50	ND	< LOD 61.91	ND	< LOD 60.77
SSDS-03	ND	< LOD 60.63	ND	< LOD 59.58	ND	< LOD 59.71	ND	< LOD 62.16
CP-1A	ND	< LOD 61.87	ND	< LOD 62.14	ND	< LOD 62.25	ND	< LOD 62.84
CP-1B	ND	< LOD 70.72	ND	< LOD 71.39	ND	< LOD 70.64	ND	< LOD 71.82
CP-2A	ND	< LOD 61.89	62.74	< LOQ 156.84	124.43	< LOQ 311.07	ND	< LOD 62.32
CP-2B	61.97	< LOQ 154.93	ND	< LOD 62.63	ND	< LOD 62.16	ND	< LOD 63.12
CP-3A	ND	< LOD 61.96	ND	< LOD 62.59	ND	< LOD 62.05	ND	< LOD 62.09
CP-3B	ND	< LOD 82.55	ND	< LOD 83.29	ND	< LOD 82.24	ND	< LOD 74.50
CP-4A	ND	< LOD 61.80	ND	< LOD 62.88	ND	< LOD 122.42	ND	< LOD 61.55
CP-4B	ND	< LOD 59.94	ND	< LOD 61.89	ND	< LOD 123.74	ND	< LOD 61.20
CPDS-1A	ND	< LOD 60.80	61.87	< LOQ 154.67	ND	< LOD 61.95	ND	< LOD 61.51
CPDS-1B	60.66	< LOQ 151.64	62.05	< LOQ 155.12	ND	< LOD 61.45	ND	< LOD 60.05
G-1A	ND	< LOD 62.33	ND	< LOD 62.67	ND	< LOD 62.28	ND	< LOD 61.34
G-1B	ND	< LOD 62.14	ND	< LOD 63.32	ND	< LOD 62.28	ND	< LOD 62.21
G-2A	ND	< LOD 63.22	ND	< LOD 63.67	ND	< LOD 62.19	ND	< LOD 62.45
G-2B	ND	< LOD 61.49	ND	< LOD 62.28	ND	< LOD 62.75	ND	< LOD 61.80
G-3A	ND	< LOD 62.06	ND	< LOD 62.36	ND	< LOD 62.96	ND	< LOD 62.51
G-4A	ND	< LOD 60.93	ND	< LOD 62.02	ND	< LOD 61.64	ND	< LOD 62.29
G-4B	ND	< LOD 62.01	ND	< LOD 62.49	ND	< LOD 62.01	ND	< LOD 61.96
G-5A	ND	< LOD 61.75	ND	< LOD 62.27	ND	< LOD 62.43	ND	< LOD 62.72
G-5B	ND	< LOD 62.66	ND	< LOD 62.29	ND	< LOD 62.53	ND	< LOD 62.51
G-6A	ND	< LOD 62.37	ND	< LOD 62.71	ND	< LOD 62.42	ND	< LOD 62.12
G-6B	ND	< LOD 61.53	ND	< LOD 63.22	ND	< LOD 61.32	ND	< LOD 61.91
G-7A	ND	< LOD 61.89	ND	< LOD 62.21	ND	< LOD 62.58	ND	< LOD 62.83
G-7B	ND	< LOD 61.63	ND	< LOD 62.42	ND	< LOD 63.61	ND	< LOD 63.47
SG-1A	ND	< LOD 61.25	ND	< LOD 62.24	ND	< LOD 62.27	ND	< LOD 309.47
SG-1B	ND	< LOD 115.30	ND	< LOD 115.30	ND	< LOD 114.94	ND	< LOD 571.43
SG-2A	ND	< LOD 61.74	ND	< LOD 62.63	ND	< LOD 62.19	ND	< LOD 124.22
SG-2B	ND	< LOD 62.24	ND	< LOD 61.74	ND	< LOD 62.71	ND	< LOD 312.83

Bulk Elemental Analysis - Thallium

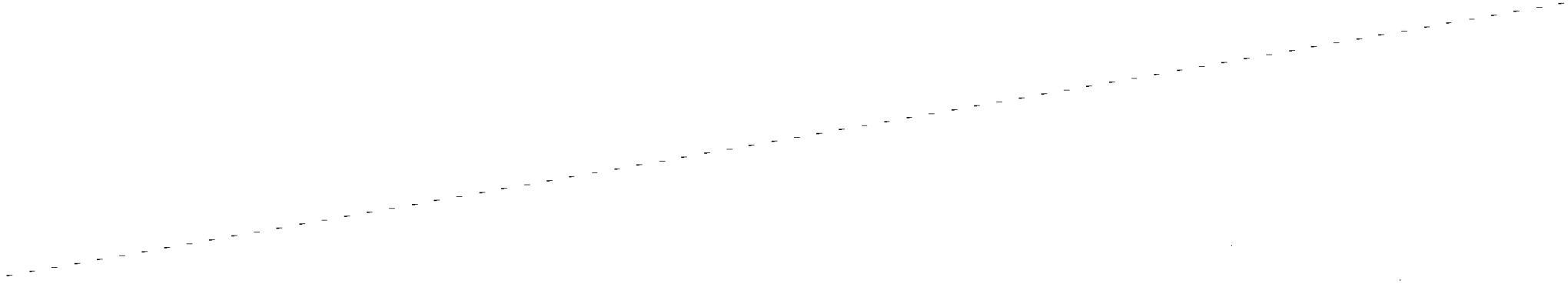
	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Thallium		Sample	Thallium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 9.0	J95331-63 PB	ND	< LOD 9.0
CS-01	J95331-34 VB	ND	< LOD 9.0	J95331-34 PB	ND	< LOD 9.0
CS-02	J95331-37 VB	ND	< LOD 9.0	J95331-37 PB	ND	< LOD 9.0
CS-03	J95331-38 VB	ND	< LOD 9.0	J95331-38 PB	ND	< LOD 9.0
CS-04	J95331-39 VB	ND	< LOD 9.0	J95331-39 PB	ND	< LOD 9.0
CS-05	J95331-57 VB	ND	< LOD 9.0	J95331-57 PB	ND	< LOD 9.0
CS-06	J95331-70 VB	ND	< LOD 9.0	J95331-70 PB	ND	< LOD 9.0
CS-07	J95331-83 VB	ND	< LOD 9.0	J95331-83 PB	ND	< LOD 9.0
CSDS-01	J95331-31 VB	ND	< LOD 9.0	J95331-31 PB	ND	< LOD 9.0
CSDS-02	J95331-35 VB	ND	< LOD 9.0	J95331-35 PB	ND	< LOD 9.0
N-01	J95331-52 VB	ND	< LOD 9.0	J95331-52 PB	ND	< LOD 9.0
N-02	J95331-81 VB	ND	< LOD 9.0	J95331-81 PB	ND	< LOD 9.0
O-1	J95331-69 VB	ND	< LOD 9.0	J95331-69 PB	ND	< LOD 9.0
S-01	J95331-28 VB	ND	< LOD 9.0	J95331-28 PB	ND	< LOD 9.0
S-02	J95331-29 VB	ND	< LOD 9.0	J95331-29 PB	ND	< LOD 9.0
SH-01	J95331-36 VB	ND	< LOD 9.0	J95331-36 PB	ND	< LOD 9.0
SS-01	J95331-32 VB	ND	< LOD 9.0	J95331-32 PB	ND	< LOD 9.0
SS-02	J95331-40 VB	ND	< LOD 9.0	J95331-40 PB	ND	< LOD 9.0
SS-03	J95331-45 VB	ND	< LOD 9.0	J95331-45 PB	ND	< LOD 9.0
SS-04	J95331-47 VB	ND	< LOD 9.0	J95331-47 PB	ND	< LOD 9.0
SS-05	J95331-53 VB	ND	< LOD 9.0	J95331-53 PB	ND	< LOD 9.0
SS-06	J95331-76 VB	ND	< LOD 9.0	J95331-76 PB	ND	< LOD 9.0
SS-07	J95331-80 VB	ND	< LOD 9.0	J95331-80 PB	ND	< LOD 9.0
SSDS-01	J95331-33 VB	ND	< LOD 9.0	J95331-33 PB	ND	< LOD 9.0
SSDS-02	J95331-44 VB	ND	< LOD 9.0	J95331-44 PB	ND	< LOD 9.0
SSDS-03	J95331-48 VB	ND	< LOD 9.0	J95331-48 PB	10.00	< LOQ 30.0
CP-1A	J95331-60 VB	ND	< LOD 9.0	J95331-60 PB	ND	< LOD 9.0
CP-1B	J95331-61 VB	ND	< LOD 9.0	J95331-61 PB	ND	< LOD 9.0
CP-2A	J95331-67 VB	ND	< LOD 9.0	J95331-67 PB	ND	< LOD 18.0
CP-2B	J95331-68 VB	ND	< LOD 18.0	J95331-68 PB	ND	< LOD 18.0
CP-3A	J95331-72 VB	ND	< LOD 9.0	J95331-72 PB	ND	< LOD 9.0
CP-3B	J95331-73 VB	ND	< LOD 9.0	J95331-73 PB	ND	< LOD 9.0
CP-4A	J95331-78 VB	ND	< LOD 9.0	J95331-78 PB	ND	< LOD 18.0
CP-4B	J95331-79 VB	ND	< LOD 9.0	J95331-79 PB	ND	< LOD 9.0
CPDS-1A	J95331-84 VB	ND	< LOD 9.0	J95331-84 PB	ND	< LOD 9.0
CPDS-1B	J95331-85 VB	ND	< LOD 9.0	J95331-85 PB	ND	< LOD 9.0
G-1A	J95331-41 VB	ND	< LOD 9.0	J95331-41 PB	ND	< LOD 9.0
G-1B	J95331-46 VB	ND	< LOD 9.0	J95331-46 PB	ND	< LOD 9.0
G-2A	J95331-43 VB	ND	< LOD 9.0	J95331-43 PB	ND	< LOD 9.0
G-2B	J95331-50 VB	ND	< LOD 9.0	J95331-50 PB	ND	< LOD 9.0
G-3A	J95331-49 VB	ND	< LOD 9.0	J95331-49 PB	ND	< LOD 9.0
G-4A	J95331-55 VB	ND	< LOD 9.0	J95331-55 PB	ND	< LOD 9.0
G-4B	J95331-56 VB	ND	< LOD 9.0	J95331-56 PB	ND	< LOD 9.0
G-5A	J95331-58 VB	ND	< LOD 9.0	J95331-58 PB	ND	< LOD 9.0
G-5B	J95331-59 VB	ND	< LOD 9.0	J95331-59 PB	ND	< LOD 9.0
G-6A	J95331-64 VB	ND	< LOD 9.0	J95331-64 PB	ND	< LOD 9.0
G-6B	J95331-65 VB	ND	< LOD 9.0	J95331-65 PB	ND	< LOD 9.0
G-7A	J95331-74 VB	ND	< LOD 9.0	J95331-74 PB	ND	< LOD 9.0
G-7B	J95331-75 VB	ND	< LOD 9.0	J95331-75 PB	ND	< LOD 9.0
SG-1A	J95331-54 VB	ND	< LOD 45.0	J95331-54 PB	ND	< LOD 45.0
SG-1B	J95331-71 VB	ND	< LOD 45.0	J95331-71 PB	ND	< LOD 45.0
SG-2A	J95331-66 VB	ND	< LOD 45.0	J95331-66 PB	ND	< LOD 45.0
SG-2B	J95331-82 VB	ND	< LOD 45.0	J95331-82 PB	ND	< LOD 45.0

Comparison of Airborne Concentrations to Bulk Concentrations - Thallium

NIOSH REL 100.0 micrograms/cubic meter
OSHA PEL 100.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	ND	ND
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	ND
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	ND	ND	ND	ND
CS-07	ND	ND	ND	ND	ND
CSDS-01	ND	ND	ND	ND	ND
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	ND
N-02	ND	ND	ND	ND	ND
O-1	61.78	ND	ND	62.79	ND
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	ND
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	ND
SS-07	61.53	ND	ND	ND	ND
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	ND	ND	ND	ND	ND
CP-2A	ND	62.74	124.43	ND	ND
CP-3A	ND	ND	ND	ND	ND
CP-4A	ND	ND	ND	ND	ND
CPDS-1A	ND	61.87	ND	ND	ND
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	ND	ND	ND	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	ND	ND

APPENDIX B - TITANIUM



Titanium Dioxide

The effects of titanium dioxide on the body reveal that the substance is relatively inert, not absorbed readily by the body, and exerts little toxic effects. Animal studies show no fibrous effect from inhalation although an increase incidence of lung tumors in animals has been reported. NIOSH previously recommended that "occupational exposures to carcinogens be limited to the lowest feasible concentrations". Therefore, for this study, the analytical limit of quantification is used as the NIOSH REL for titanium. The OSHA PEL for titanium is 15,000 micrograms/cubic meter of air.

Titanium dioxide is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

For the past 20 plus years, NIOSH has subscribed to a carcinogen policy that was published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, which called for "no detectable exposure levels for proven carcinogenic substances [New York Academy of Sciences Annals 1976]." This was in response to a generic OSHA rulemaking on carcinogens.

Because of advances in science and in approaches to risk assessment and risk management, NIOSH has in more recent years adopted a more inclusive policy. NIOSH RELs will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will protect not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy for potential occupational carcinogens will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL. Under the old policy for potential occupational carcinogens, RELs for most carcinogens were non-quantitative values labeled "lowest feasible concentration (LFC)." In 1989, NIOSH adopted several quantitative RELs for carcinogens from OSHA's PEL update. NIOSH will also recommend the complete range of respirators (as determined by the NIOSH Respirator Decision Logic) for carcinogens with quantitative RELs. In this way, respirators will be consistently recommended regardless of whether a substance is a carcinogen or a non-carcinogen.

Air Sample Results - Titanium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Titanium			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24463	1	48.16	S-01	28	11.00	> LOQ 0.43	228.41	> LOQ 8.93
24412	2	47.89	S-01	28	49.00	> LOQ 0.43	1023.18	> LOQ 8.98
24441	3	47.90	S-01	28	150.00	> LOQ 0.43	3131.52	> LOQ 8.98
24450	OBZ	47.93	S-01	28	160.00	> LOQ 0.43	3338.2	> LOQ 8.97
24643	1	47.98	S-02	29	46.00	> LOQ 0.43	958.73	> LOQ 8.96
24625	2	47.76	S-02	29	180.00	> LOQ 0.43	3768.84	> LOQ 9.00
24642	3	48.00	S-02	29	170.00	> LOQ 0.43	3541.67	> LOQ 8.96
24632	OBZ	47.89	S-02	29	55.00	> LOQ 0.43	1148.47	> LOQ 8.98
24634	1	48.16	CSDS-01	31	16.00	> LOQ 0.43	332.23	> LOQ 8.93
24650	2	48.01	CSDS-01	31	81.00	> LOQ 0.43	1687.15	> LOQ 8.96
24644	3	48.16	CSDS-01	31	220.00	> LOQ 0.43	4568.11	> LOQ 8.93
24645	OBZ	48.07	CSDS-01	31	110.00	> LOQ 0.43	2288.33	> LOQ 8.95
24640	1	48.44	SS-01	32	0.52	> LOQ 0.43	10.73	> LOQ 8.88
24641	2	47.90	SS-01	32	4.20	> LOQ 0.43	87.68	> LOQ 8.98
24651	3	48.35	SS-01	32	1.80	> LOQ 0.43	37.23	> LOQ 8.89
24635	OBZ	48.30	SS-01	32	3.70	> LOQ 0.43	76.6	> LOQ 8.90
24646	1	48.58	SSDS-01	33	0.43	> LOQ 0.43	8.85	> LOQ 8.85
24626	2	47.84	SSDS-01	33	1.90	> LOQ 0.43	39.72	> LOQ 8.99
24638	3	48.49	SSDS-01	33	3.00	> LOQ 0.43	61.87	> LOQ 8.87
24647	OBZ	48.32	SSDS-01	33	2.60	> LOQ 0.43	53.81	> LOQ 8.90
24628	1	48.55	CS-01	34	19.00	> LOQ 0.43	391.35	> LOQ 8.86
24637	2	48.00	CS-01	34	58.00	> LOQ 0.43	1208.33	> LOQ 8.96
24624	3	48.47	CS-01	34	260.00	> LOQ 0.43	5364.14	> LOQ 8.87
24636	OBZ	47.92	CS-01	34	56.00	> LOQ 0.43	1168.61	> LOQ 8.97
24623	1	48.53	CSDS-02	35	20.00	> LOQ 0.43	412.12	> LOQ 8.86
24622	2	48.36	CSDS-02	35	71.00	> LOQ 0.43	1468.16	> LOQ 8.89
24654	3	48.31	CSDS-02	35	270.00	> LOQ 0.43	5588.9	> LOQ 8.90
24653	OBZ	47.78	CSDS-02	35	94.00	> LOQ 0.43	1967.35	> LOQ 9.00
24629	1	47.88	SH-01	36	0.37	< LOQ 0.43	7.73	< LOQ 8.98
24633	2	47.86	SH-01	36	0.64	> LOQ 0.43	13.37	> LOQ 8.98
24627	3	48.24	SH-01	36	2.00	> LOQ 0.43	41.46	> LOQ 8.91
24648	OBZ	48.08	SH-01	36	0.58	> LOQ 0.43	12.06	> LOQ 8.94
24555	1	48.08	CS-02	37	26.00	> LOQ 0.43	540.77	> LOQ 8.94
24552	2	47.84	CS-02	37	68.00	> LOQ 0.43	1421.4	> LOQ 8.99
24541	3	48.01	CS-02	37	310.00	> LOQ 0.43	6456.99	> LOQ 8.96
24529	OBZ	47.99	CS-02	37	110.00	> LOQ 0.43	2292.14	> LOQ 8.96
24558	1	48.49	CS-03	38	35.00	> LOQ 0.43	721.8	> LOQ 8.87
24524	2	48.29	CS-03	38	140.00	> LOQ 0.43	2899.15	> LOQ 8.90
24561	3	48.22	CS-03	38	510.00	> LOQ 0.86	10576.52	> LOQ 17.83
24559	OBZ	48.29	CS-03	38	140.00	> LOQ 0.43	2899.15	> LOQ 8.90
24543	1	48.61	CS-04	39	18.00	> LOQ 0.43	370.29	> LOQ 8.85
24532	2	47.78	CS-04	39	63.00	> LOQ 0.43	1318.54	> LOQ 9.00
24546	3	48.29	CS-04	39	160.00	> LOQ 0.43	3313.32	> LOQ 8.90
24557	OBZ	48.58	CS-04	39	84.00	> LOQ 0.43	1729.11	> LOQ 8.85
24560	1	48.13	SS-02	40	1.10	> LOQ 0.43	22.85	> LOQ 8.93
24565	2	47.95	SS-02	40	4.60	> LOQ 0.43	95.93	> LOQ 8.97
24630	3	48.32	SS-02	40	3.70	> LOQ 0.43	76.57	> LOQ 8.90
24553	OBZ	48.62	SS-02	40	4.10	> LOQ 0.43	84.33	> LOQ 8.84
24525	1	48.13	G-1A	41	3.20	> LOQ 0.43	66.49	> LOQ 8.93
24563	2	47.87	G-1A	41	9.20	> LOQ 0.43	192.19	> LOQ 8.98
24547	3	48.17	G-1A	41	15.00	> LOQ 0.43	311.4	> LOQ 8.93
24526	OBZ	48.91	G-1A	41	15.00	> LOQ 0.43	306.69	> LOQ 8.79
24538	1	47.45	G-2A	43	0.92	> LOQ 0.43	19.39	> LOQ 9.06

Air Sample Results - Titanium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Titanium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	5.20	> LOQ 0.43	110.36	> LOQ 9.13
24533	3	48.24	G-2A	43	4.50	> LOQ 0.43	93.28	> LOQ 8.91
24540	OBZ	48.04	G-2A	43	3.70	> LOQ 0.43	77.02	> LOQ 8.95
24528	1	47.99	SSDS-02	44	1.90	> LOQ 0.43	39.59	> LOQ 8.96
24544	2	48.00	SSDS-02	44	8.60	> LOQ 0.43	179.17	> LOQ 8.96
24567	3	48.46	SSDS-02	44	29.00	> LOQ 0.43	598.43	> LOQ 8.87
24539	OBZ	49.37	SSDS-02	44	9.70	> LOQ 0.43	196.48	> LOQ 8.71
24571	1	48.05	SS-03	45	0.22	< LOQ 0.43	4.58	< LOQ 8.95
24536	2	47.60	SS-03	45	0.54	> LOQ 0.43	11.34	> LOQ 9.03
24534	3	48.94	SS-03	45	1.30	> LOQ 0.43	26.56	> LOQ 8.79
24570	OBZ	49.61	SS-03	45	0.78	> LOQ 0.43	15.72	> LOQ 8.67
24568	1	48.28	G-1B	46	1.40	> LOQ 0.43	29	> LOQ 8.91
24592	2	47.38	G-1B	46	12.00	> LOQ 0.43	253.27	> LOQ 9.08
24593	3	48.17	G-1B	46	7.60	> LOQ 0.43	157.77	> LOQ 8.93
24535	OBZ	48.22	G-1B	46	12.00	> LOQ 0.43	248.86	> LOQ 8.92
24590	1	47.81	SS-04	47	2.60	> LOQ 0.43	54.38	> LOQ 8.99
24605	2	47.78	SS-04	47	19.00	> LOQ 0.43	397.66	> LOQ 9.00
24562	3	47.80	SS-04	47	27.00	> LOQ 0.43	564.85	> LOQ 9.00
24531	OBZ	48.59	SS-04	47	17.00	> LOQ 0.43	349.87	> LOQ 8.85
24527	1	49.48	SSDS-03	48	ND	< LOD 0.20	ND	< LOD 4.04
24569	2	50.35	SSDS-03	48	0.30	< LOQ 0.43	5.96	< LOQ 8.54
24584	3	50.24	SSDS-03	48	0.33	< LOQ 0.43	6.57	< LOQ 8.56
24579	OBZ	48.26	SSDS-03	48	0.42	< LOQ 0.43	8.7	< LOQ 8.91
24600	1	48.34	G-3A	49	0.82	> LOQ 0.43	16.96	> LOQ 8.90
24616	2	48.11	G-3A	49	3.10	> LOQ 0.43	64.44	> LOQ 8.94
24585	3	47.65	G-3A	49	4.80	> LOQ 0.43	100.73	> LOQ 9.02
24583	OBZ	47.99	G-3A	49	1.30	> LOQ 0.43	27.09	> LOQ 8.96
24587	1	48.79	G-2B	50	0.50	> LOQ 0.43	10.25	> LOQ 8.81
24602	2	48.17	G-2B	50	5.50	> LOQ 0.43	114.18	> LOQ 8.93
24564	3	47.81	G-2B	50	1.80	> LOQ 0.43	37.65	> LOQ 8.99
24621	OBZ	48.54	G-2B	50	1.20	> LOQ 0.43	24.72	> LOQ 8.86
24618	1	49.21	N-01	52	0.91	> LOQ 0.43	18.49	> LOQ 8.74
24611	2	47.96	N-01	52	3.90	> LOQ 0.43	81.32	> LOQ 8.97
24588	3	48.32	N-01	52	14.00	> LOQ 0.43	289.74	> LOQ 8.90
24615	OBZ	48.80	N-01	52	8.60	> LOQ 0.43	176.23	> LOQ 8.81
24597	1	49.78	SS-05	53	0.41	< LOQ 0.43	8.24	< LOQ 8.64
24599	2	47.68	SS-05	53	1.50	> LOQ 0.43	31.46	> LOQ 9.02
24575	3	48.11	SS-05	53	3.10	> LOQ 0.43	64.44	> LOQ 8.94
24617	OBZ	48.79	SS-05	53	2.40	> LOQ 0.43	49.19	> LOQ 8.81
24609	1	48.98	SG-1A	54	0.48	> LOQ 0.43	9.8	> LOQ 8.78
24596	2	48.20	SG-1A	54	0.49	> LOQ 0.43	10.17	> LOQ 8.92
24610	3	48.18	SG-1A	54	2.30	> LOQ 0.43	47.74	> LOQ 8.92
24576	OBZ	48.47	SG-1A	54	8.10	> LOQ 2.20	167.11	> LOQ 45.39
24606	1	49.24	G-4A	55	20.00	> LOQ 0.43	406.17	> LOQ 8.73
24620	2	48.37	G-4A	55	19.00	> LOQ 0.43	392.81	> LOQ 8.89
24573	3	48.67	G-4A	55	47.00	> LOQ 0.43	965.69	> LOQ 8.84
24505	OBZ	48.16	G-4A	55	53.00	> LOQ 0.43	1100.5	> LOQ 8.93
24340	1	48.38	G-4B	56	5.60	> LOQ 0.43	115.75	> LOQ 8.89
24607	2	48.01	G-4B	56	45.00	> LOQ 0.43	937.3	> LOQ 8.96
24595	3	48.38	G-4B	56	44.00	> LOQ 0.43	909.47	> LOQ 8.89
24598	OBZ	48.42	G-4B	56	42.00	> LOQ 0.43	867.41	> LOQ 8.88
24580	1	48.44	CS-05	57	8.40	> LOQ 0.43	173.41	> LOQ 8.88
24604	2	47.93	CS-05	57	33.00	> LOQ 0.43	688.5	> LOQ 8.97

Air Sample Results - Titanium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Titanium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	68.00	> LOQ 0.43	1423.19	> LOQ 9.00
24574	OBZ	30.41	CS-05	57	23.00	> LOQ 0.43	756.33	> LOQ 14.14
24614	1	48.58	G-5A	58	2.60	> LOQ 0.43	53.52	> LOQ 8.85
24577	2	48.18	G-5A	58	11.00	> LOQ 0.43	228.31	> LOQ 8.92
24572	3	48.05	G-5A	58	16.00	> LOQ 0.25	332.99	> LOQ 5.20
24582	OBZ	47.83	G-5A	58	27.00	> LOQ 0.43	564.5	> LOQ 8.99
24322	1	47.88	G-5B	59	2.60	> LOQ 0.43	54.3	> LOQ 8.98
24354	2	48.16	G-5B	59	8.40	> LOQ 0.43	174.42	> LOQ 8.93
24510	3	47.98	G-5B	59	17.00	> LOQ 0.43	354.31	> LOQ 8.96
24321	OBZ	47.99	G-5B	59	3.30	> LOQ 0.43	68.76	> LOQ 8.96
24497	1	48.49	CP-1A	60	7.10	> LOQ 0.43	146.42	> LOQ 8.87
24333	2	48.28	CP-1A	60	36.00	> LOQ 0.43	745.65	> LOQ 8.91
24326	3	48.19	CP-1A	60	74.00	> LOQ 0.43	1535.59	> LOQ 8.92
24329	OBZ	47.74	CP-1A	60	29.00	> LOQ 0.43	607.46	> LOQ 9.01
24499	1	42.42	CP-1B	62	11.00	> LOQ 0.43	259.31	> LOQ 10.14
24506	2	42.02	CP-1B	62	28.00	> LOQ 0.43	666.35	> LOQ 10.23
24388	3	42.47	CP-1B	62	120.00	> LOQ 0.43	2825.52	> LOQ 10.12
24315	OBZ	41.77	CP-1B	62	25.00	> LOQ 0.43	598.52	> LOQ 10.29
24318	1	48.56	CG-01	63	ND	< LOD 0.20	ND	< LOD 4.12
24308	2	48.00	CG-01	63	0.43	> LOQ 0.43	8.96	> LOQ 8.96
24330	3	48.47	CG-01	63	0.46	> LOQ 0.43	9.49	> LOQ 8.87
24230	OBZ	48.31	CG-01	63	0.47	> LOQ 0.43	9.73	> LOQ 8.90
24363	1	48.10	G-6A	64	11.00	> LOQ 0.43	228.69	> LOQ 8.94
24398	2	47.84	G-6A	64	50.00	> LOQ 0.43	1045.15	> LOQ 8.99
24351	3	48.06	G-6A	64	38.00	> LOQ 0.43	790.68	> LOQ 8.95
24594	OBZ	48.29	G-6A	64	21.00	> LOQ 0.43	434.87	> LOQ 8.90
24312	1	48.76	G-6B	65	2.40	> LOQ 0.43	49.22	> LOQ 8.82
24484	2	47.45	G-6B	65	22.00	> LOQ 0.43	463.65	> LOQ 9.06
24327	3	48.92	G-6B	65	15.00	> LOQ 0.43	306.62	> LOQ 8.79
24389	OBZ	48.46	G-6B	65	32.00	> LOQ 0.43	660.34	> LOQ 8.87
24348	1	48.59	SG-2A	66	0.35	< LOQ 0.43	7.2	< LOQ 8.85
24314	2	47.90	SG-2A	66	0.36	< LOQ 0.43	7.52	< LOQ 8.98
24494	3	48.24	SG-2A	66	0.42	< LOQ 0.43	8.71	< LOQ 8.91
24337	OBZ	48.30	SG-2A	66	1.40	> LOQ 0.86	28.99	> LOQ 17.81
24508	1	48.47	CP-2A	67	28.00	> LOQ 0.43	577.68	> LOQ 8.87
24361	2	47.82	CP-2A	67	76.00	> LOQ 0.43	1589.29	> LOQ 8.99
24359	3	48.22	CP-2A	67	470.00	> LOQ 0.86	9746.99	> LOQ 17.83
24471	OBZ	48.14	CP-2A	67	190.00	> LOQ 0.43	3946.82	> LOQ 8.93
24373	1	48.41	CP-2B	68	75.00	> LOQ 0.43	1549.27	> LOQ 8.88
24468	2	47.90	CP-2B	68	43.00	> LOQ 0.43	897.7	> LOQ 8.98
24481	3	48.26	CP-2B	68	170.00	> LOQ 0.43	3522.59	> LOQ 8.91
24391	OBZ	47.53	CP-2B	68	34.00	> LOQ 0.43	715.34	> LOQ 9.05
24356	1	48.56	O-1	69	ND	< LOD 0.20	ND	< LOD 4.12
24470	2	47.89	O-1	69	0.39	< LOQ 0.43	8.14	< LOQ 8.98
24467	3	48.67	O-1	69	0.87	> LOQ 0.43	17.88	> LOQ 8.84
24313	OBZ	47.78	O-1	69	0.48	> LOQ 0.43	10.05	> LOQ 9.00
24501	1	47.96	CS-06	70	39.00	> LOQ 0.43	813.18	> LOQ 8.97
24496	2	47.75	CS-06	70	96.00	> LOQ 0.43	2010.47	> LOQ 9.01
24478	3	48.31	CS-06	70	83.00	> LOQ 0.43	1718.07	> LOQ 8.90
24503	OBZ	48.04	CS-06	70	63.00	> LOQ 0.43	1311.41	> LOQ 8.95
24474	1	26.02	SG-1B	71	ND	< LOD 0.20	ND	< LOD 7.69
24469	2	26.02	SG-1B	71	ND	< LOD 0.20	ND	< LOD 7.69
24492	3	26.10	SG-1B	71	0.53	> LOQ 0.43	20.31	> LOQ 16.48

Air Sample Results - Titanium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Titanium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	3.80	> LOQ 2.20	144.76	> LOQ 83.81
24489	1	48.42	CP-3A	72	19.00	> LOQ 0.43	392.4	> LOQ 8.88
24491	2	47.93	CP-3A	72	49.00	> LOQ 0.43	1022.32	> LOQ 8.97
24482	3	48.35	CP-3A	72	250.00	> LOQ 0.43	5170.63	> LOQ 8.89
24486	OBZ	48.32	CP-3A	72	230.00	> LOQ 0.43	4759.93	> LOQ 8.90
24516	1	36.34	CP-3B	73	20.00	> LOQ 0.43	550.36	> LOQ 11.83
24502	2	36.02	CP-3B	73	110.00	> LOQ 0.43	3053.86	> LOQ 11.94
24515	3	36.48	CP-3B	73	150.00	> LOQ 0.43	4111.84	> LOQ 11.79
24500	OBZ	40.27	CP-3B	73	70.00	> LOQ 0.43	1738.27	> LOQ 10.68
24504	1	48.47	G-7A	74	11.00	> LOQ 0.43	226.94	> LOQ 8.87
24513	2	48.22	G-7A	74	24.00	> LOQ 0.43	497.72	> LOQ 8.92
24458	3	47.94	G-7A	74	60.00	> LOQ 0.43	1251.56	> LOQ 8.97
24389	OBZ	47.75	G-7A	74	16.00	> LOQ 0.43	335.08	> LOQ 9.01
24404	1	48.68	G-7B	75	7.80	> LOQ 0.43	160.23	> LOQ 8.83
24451	2	48.06	G-7B	75	15.00	> LOQ 0.43	312.11	> LOQ 8.95
24447	3	47.16	G-7B	75	30.00	> LOQ 0.43	636.13	> LOQ 9.12
24423	OBZ	47.27	G-7B	75	7.80	> LOQ 0.43	165.01	> LOQ 9.10
24456	1	49.19	SS-06	76	2.80	> LOQ 0.43	56.92	> LOQ 8.74
24480	2	48.26	SS-06	76	6.90	> LOQ 0.43	142.98	> LOQ 8.91
24429	3	47.68	SS-06	76	0.24	< LOQ 0.43	5.03	< LOQ 9.02
24418	OBZ	47.83	SS-06	76	3.70	> LOQ 0.43	77.36	> LOQ 8.99
24427	1	48.54	CP-4A	78	15.00	> LOQ 0.43	309.02	> LOQ 8.86
24435	2	47.71	CP-4A	78	66.00	> LOQ 0.43	1383.36	> LOQ 9.01
24244	3	49.01	CP-4A	78	360.00	> LOQ 0.86	7345.44	> LOQ 17.55
24220	OBZ	48.74	CP-4A	78	73.00	> LOQ 0.43	1497.74	> LOQ 8.82
24460	1	50.05	CP-4B	79	16.00	> LOQ 0.43	319.68	> LOQ 8.59
24465	2	48.47	CP-4B	79	49.00	> LOQ 0.43	1010.93	> LOQ 8.87
24207	3	48.49	CP-4B	79	250.00	> LOQ 0.86	5155.7	> LOQ 17.74
24390	OBZ	49.02	CP-4B	79	14.00	> LOQ 0.43	285.6	> LOQ 8.77
24259	1	48.76	SS-07	80	1.40	> LOQ 0.43	28.71	> LOQ 8.82
24421	2	48.13	SS-07	80	3.50	> LOQ 0.43	72.72	> LOQ 8.93
24445	3	47.87	SS-07	80	13.00	> LOQ 0.43	271.57	> LOQ 8.98
24432	OBZ	48.49	SS-07	80	1.80	> LOQ 0.43	37.12	> LOQ 8.87
24459	1	48.96	N-02	81	17.00	> LOQ 0.43	347.22	> LOQ 8.78
24417	2	48.11	N-02	81	31.00	> LOQ 0.43	644.36	> LOQ 8.94
24442	3	48.01	N-02	81	130.00	> LOQ 0.43	2707.77	> LOQ 8.96
24386	OBZ	48.19	N-02	81	27.00	> LOQ 0.43	560.28	> LOQ 8.92
24452	1	48.20	SG-2B	82	ND	< LOD 0.20	ND	< LOD 4.15
24453	2	48.59	SG-2B	82	0.33	< LOQ 0.43	6.79	< LOQ 8.85
24420	3	47.84	SG-2B	82	0.36	< LOQ 0.43	7.53	< LOQ 8.99
24444	OBZ	47.95	SG-2B	82	1.80	< LOQ 2.20	37.54	< LOQ 45.88
24455	1	48.56	CS-07	83	54.00	> LOQ 0.43	1112.03	> LOQ 8.86
24433	2	47.96	CS-07	83	110.00	> LOQ 0.43	2293.58	> LOQ 8.97
24398	3	48.06	CS-07	83	560.00	> LOQ 0.43	11652.1	> LOQ 8.95
24511	OBZ	47.96	CS-07	83	110.00	> LOQ 0.43	2293.58	> LOQ 8.97
24454	1	49.34	CPDS-1A	84	39.00	> LOQ 0.43	790.43	> LOQ 8.72
24291	2	48.49	CPDS-1A	84	63.00	> LOQ 0.43	1299.24	> LOQ 8.87
24209	3	48.43	CPDS-1A	84	430.00	> LOQ 0.43	8878.79	> LOQ 8.88
24402	OBZ	48.77	CPDS-1A	84	160.00	> LOQ 0.43	3280.71	> LOQ 8.82
24204	1	49.46	CPDS-1B	85	47.00	> LOQ 0.43	950.26	> LOQ 8.69
24273	2	48.35	CPDS-1B	85	73.00	> LOQ 0.43	1509.82	> LOQ 8.89
24223	3	48.82	CPDS-1B	85	340.00	> LOQ 0.43	6964.36	> LOQ 8.81
24466	OBZ	49.96	CPDS-1B	85	58.00	> LOQ 0.43	1160.93	> LOQ 8.61

Airborne Sample Data Analysis - Titanium

NIOSH REL - Limit of Quantification (Lowest Feasible Concentration)

OSHA PEL 15000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 4.12	8.96	> LOQ 8.96	9.49	> LOQ 8.87	9.73	> LOQ 8.90
CS-01	391.35	> LOQ 8.86	1208.33	> LOQ 8.96	5364.14	> LOQ 8.87	1168.61	> LOQ 8.97
CS-02	540.77	> LOQ 8.94	1421.4	> LOQ 8.99	6456.99	> LOQ 8.96	2292.14	> LOQ 8.96
CS-03	721.8	> LOQ 8.87	2899.15	> LOQ 8.90	10576.52	> LOQ 17.83	2899.15	> LOQ 8.90
CS-04	370.29	> LOQ 8.85	1318.54	> LOQ 9.00	3313.32	> LOQ 8.90	1729.11	> LOQ 8.85
CS-05	173.41	> LOQ 8.88	688.5	> LOQ 8.97	1423.19	> LOQ 9.00	756.33	> LOQ 14.14
CS-06	813.18	> LOQ 8.97	2010.47	> LOQ 9.01	1718.07	> LOQ 8.90	1311.41	> LOQ 8.95
CS-07	1112.03	> LOQ 8.86	2293.58	> LOQ 8.97	11652.10	> LOQ 8.95	2293.58	> LOQ 8.97
CSDS-01	332.23	> LOQ 8.93	1687.15	> LOQ 8.96	4568.11	> LOQ 8.93	2288.33	> LOQ 8.95
CSDS-02	412.12	> LOQ 8.86	1468.16	> LOQ 8.89	5588.90	> LOQ 8.90	1967.35	> LOQ 9.00
N-01	18.49	> LOQ 8.74	81.32	> LOQ 8.97	289.74	> LOQ 8.90	176.23	> LOQ 8.81
N-02	347.22	> LOQ 8.78	644.36	> LOQ 8.94	2707.77	> LOQ 8.96	560.28	> LOQ 8.92
O-1	ND	< LOD 4.12	8.14	< LOQ 8.98	17.88	> LOQ 8.84	10.05	> LOQ 9.00
S-01	228.41	> LOQ 8.93	1023.18	> LOQ 8.98	3131.52	> LOQ 8.98	3338.2	> LOQ 8.97
S-02	958.73	> LOQ 8.96	3768.84	> LOQ 9.00	3541.67	> LOQ 8.96	1148.47	> LOQ 8.98
SH-01	7.73	< LOQ 8.98	13.37	> LOQ 8.98	41.46	> LOQ 8.91	12.06	> LOQ 8.94
SS-01	10.73	> LOQ 8.88	87.68	> LOQ 8.98	37.23	> LOQ 8.89	76.6	> LOQ 8.90
SS-02	22.85	> LOQ 8.93	95.93	> LOQ 8.97	76.57	> LOQ 8.90	84.33	> LOQ 8.84
SS-03	4.58	< LOQ 8.95	11.34	> LOQ 9.03	26.56	> LOQ 8.79	15.72	> LOQ 8.67
SS-04	54.38	> LOQ 8.99	397.66	> LOQ 9.00	564.85	> LOQ 9.00	349.87	> LOQ 8.85
SS-05	8.24	< LOQ 8.64	31.46	> LOQ 9.02	64.44	> LOQ 8.94	49.19	> LOQ 8.81
SS-06	56.92	> LOQ 8.74	142.98	> LOQ 8.91	5.03	< LOQ 9.02	77.36	> LOQ 8.99
SS-07	28.71	> LOQ 8.82	72.72	> LOQ 8.93	271.57	> LOQ 8.98	37.12	> LOQ 8.87
SSDS-01	8.85	> LOQ 8.85	39.72	> LOQ 8.99	61.87	> LOQ 8.87	53.81	> LOQ 8.90
SSDS-02	39.59	> LOQ 8.96	179.17	> LOQ 8.96	598.43	> LOQ 8.87	196.48	> LOQ 8.71
SSDS-03	ND	< LOD 4.04	5.96	< LOQ 8.54	6.57	< LOQ 8.56	8.7	< LOQ 8.91
CP-1A	146.42	> LOQ 8.87	745.65	> LOQ 8.91	1535.59	> LOQ 8.92	607.46	> LOQ 9.01
CP-1B	259.31	> LOQ 10.14	666.35	> LOQ 10.23	2825.52	> LOQ 10.12	598.52	> LOQ 10.29
CP-2A	577.68	> LOQ 8.87	1589.29	> LOQ 8.99	9746.99	> LOQ 17.83	3946.82	> LOQ 8.93
CP-2B	1549.27	> LOQ 8.88	897.7	> LOQ 8.98	3522.59	> LOQ 8.91	715.34	> LOQ 9.05
CP-3A	392.4	> LOQ 8.88	1022.32	> LOQ 8.97	5170.63	> LOQ 8.89	4759.93	> LOQ 8.90
CP-3B	550.36	> LOQ 11.83	3053.86	> LOQ 11.94	4111.84	> LOQ 11.79	1738.27	> LOQ 10.68
CP-4A	309.02	> LOQ 8.86	1383.36	> LOQ 9.01	7345.44	> LOQ 17.55	1497.74	> LOQ 8.82
CP-4B	319.68	> LOQ 8.59	1010.93	> LOQ 8.87	5155.70	> LOQ 17.74	285.6	> LOQ 8.77
CPDS-1A	790.43	> LOQ 8.72	1299.24	> LOQ 8.87	8878.79	> LOQ 8.88	3280.71	> LOQ 8.82
CPDS-1B	950.26	> LOQ 8.69	1509.82	> LOQ 8.89	6964.36	> LOQ 8.81	1160.93	> LOQ 8.61
G-1A	66.49	> LOQ 8.93	192.19	> LOQ 8.98	311.40	> LOQ 8.93	306.69	> LOQ 8.79
G-1B	29	> LOQ 8.91	253.27	> LOQ 9.08	157.77	> LOQ 8.93	248.86	> LOQ 8.92
G-2A	19.39	> LOQ 9.06	110.36	> LOQ 9.13	93.28	> LOQ 8.91	77.02	> LOQ 8.95
G-2B	10.25	> LOQ 8.81	114.18	> LOQ 8.93	37.65	> LOQ 8.99	24.72	> LOQ 8.86
G-3A	16.96	> LOQ 8.90	64.44	> LOQ 8.94	100.73	> LOQ 9.02	27.09	> LOQ 8.96
G-4A	406.17	> LOQ 8.73	392.81	> LOQ 8.89	965.69	> LOQ 8.84	1100.5	> LOQ 8.93
G-4B	115.75	> LOQ 8.89	937.3	> LOQ 8.96	909.47	> LOQ 8.89	867.41	> LOQ 8.88
G-5A	53.52	> LOQ 8.85	228.31	> LOQ 8.92	332.99	> LOQ 5.20	564.5	> LOQ 8.99
G-5B	54.3	> LOQ 8.98	174.42	> LOQ 8.93	354.31	> LOQ 8.96	68.76	> LOQ 8.96
G-6A	228.69	> LOQ 8.94	1045.15	> LOQ 8.99	790.68	> LOQ 8.95	434.87	> LOQ 8.90
G-6B	49.22	> LOQ 8.82	463.65	> LOQ 9.06	306.62	> LOQ 8.79	660.34	> LOQ 8.87
G-7A	226.94	> LOQ 8.87	497.72	> LOQ 8.92	1251.56	> LOQ 8.97	335.08	> LOQ 9.01
G-7B	160.23	> LOQ 8.83	312.11	> LOQ 8.95	636.13	> LOQ 9.12	165.01	> LOQ 9.10
SG-1A	9.8	> LOQ 8.78	10.17	> LOQ 8.92	47.74	> LOQ 8.92	167.11	> LOQ 45.39
SG-1B	ND	< LOD 7.59	ND	< LOD 7.69	20.31	> LOQ 16.48	144.76	> LOQ 83.81
SG-2A	7.2	< LOQ 8.85	7.52	< LOQ 8.98	8.71	< LOQ 8.91	28.99	> LOQ 17.81
SG-2B	ND	< LOD 4.15	6.79	< LOQ 8.85	7.53	< LOQ 8.99	37.54	< LOQ 45.88

Bulk Elemental Analysis - Titanium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Titanium		Sample	Titanium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.5	J95331-63 PB	ND	< LOD 0.5
CS-01	J95331-34 VB	1800.00	> LOQ 1.7	J95331-34 PB	1600.00	> LOQ 1.7
CS-02	J95331-37 VB	940.00	> LOQ 1.7	J95331-37 PB	880.00	> LOQ 1.7
CS-03	J95331-38 VB	2000.00	> LOQ 1.7	J95331-38 PB	2200.00	> LOQ 1.7
CS-04	J95331-39 VB	130.00	> LOQ 1.7	J95331-39 PB	170.00	> LOQ 1.7
CS-05	J95331-57 VB	71.00	> LOQ 1.7	J95331-57 PB	89.00	> LOQ 1.7
CS-06	J95331-70 VB	58.00	> LOQ 1.7	J95331-70 PB	110.00	> LOQ 1.7
CS-07	J95331-83 VB	150.00	> LOQ 1.7	J95331-83 PB	400.00	> LOQ 1.7
CSDS-01	J95331-31 VB	140.00	> LOQ 1.7	J95331-31 PB	210.00	> LOQ 1.7
CSDS-02	J95331-35 VB	1600.00	> LOQ 1.7	J95331-35 PB	1600.00	> LOQ 1.7
N-01	J95331-52 VB	13.00	> LOQ 1.7	J95331-52 PB	17.00	> LOQ 1.7
N-02	J95331-81 VB	150.00	> LOQ 1.7	J95331-81 PB	340.00	> LOQ 8.5
O-1	J95331-69 VB	2.50	> LOQ 1.7	J95331-69 PB	4.60	> LOQ 1.7
S-01	J95331-28 VB	190.00	> LOQ 1.7	J95331-28 PB	160.00	> LOQ 1.7
S-02	J95331-29 VB	140.00	> LOQ 1.7	J95331-29 PB	190.00	> LOQ 1.7
SH-01	J95331-36 VB	7.40	> LOQ 1.7	J95331-36 PB	7.20	> LOQ 1.7
SS-01	J95331-32 VB	4.70	> LOQ 1.7	J95331-32 PB	9.20	> LOQ 1.7
SS-02	J95331-40 VB	4.50	> LOQ 1.7	J95331-40 PB	5.60	> LOQ 1.7
SS-03	J95331-45 VB	2.70	> LOQ 1.7	J95331-45 PB	4.40	> LOQ 1.7
SS-04	J95331-47 VB	82.00	> LOQ 1.7	J95331-47 PB	16.00	> LOQ 1.7
SS-05	J95331-53 VB	11.00	> LOQ 1.7	J95331-53 PB	8.40	> LOQ 1.7
SS-06	J95331-76 VB	38.00	> LOQ 1.7	J95331-76 PB	38.00	> LOQ 1.7
SS-07	J95331-80 VB	19.00	> LOQ 1.7	J95331-80 PB	7.90	> LOQ 1.7
SSDS-01	J95331-33 VB	7.40	> LOQ 1.7	J95331-33 PB	7.60	> LOQ 1.7
SSDS-02	J95331-44 VB	73.00	> LOQ 1.7	J95331-44 PB	96.00	> LOQ 1.7
SSDS-03	J95331-48 VB	4.50	> LOQ 1.7	J95331-48 PB	3.30	> LOQ 1.7
CP-1A	J95331-60 VB	120.00	> LOQ 1.7	J95331-60 PB	610.00	> LOQ 1.7
CP-1B	J95331-61 VB	190.00	> LOQ 1.7	J95331-61 PB	220.00	> LOQ 1.7
CP-2A	J95331-67 VB	1200.00	> LOQ 1.7	J95331-67 PB	1900.00	> LOQ 3.4
CP-2B	J95331-68 VB	1500.00	> LOQ 3.4	J95331-68 PB	1700.00	> LOQ 3.4
CP-3A	J95331-72 VB	840.00	> LOQ 1.7	J95331-72 PB	790.00	> LOQ 1.7
CP-3B	J95331-73 VB	870.00	> LOQ 1.7	J95331-73 PB	860.00	> LOQ 1.7
CP-4A	J95331-78 VB	280.00	> LOQ 1.7	J95331-78 PB	530.00	> LOQ 3.4
CP-4B	J95331-79 VB	570.00	> LOQ 1.7	J95331-79 PB	580.00	> LOQ 1.7
CPDS-1A	J95331-84 VB	390.00	> LOQ 1.7	J95331-84 PB	1400.00	> LOQ 1.7
CPDS-1B	J95331-85 VB	1200.00	> LOQ 1.7	J95331-85 PB	1400.00	> LOQ 1.7
G-1A	J95331-41 VB	15.00	> LOQ 1.7	J95331-41 PB	29.00	> LOQ 1.7
G-1B	J95331-46 VB	16.00	> LOQ 1.7	J95331-46 PB	20.00	> LOQ 1.7
G-2A	J95331-43 VB	11.00	> LOQ 1.7	J95331-43 PB	18.00	> LOQ 1.7
G-2B	J95331-50 VB	17.00	> LOQ 1.7	J95331-50 PB	6.00	> LOQ 1.7
G-3A	J95331-49 VB	8.80	> LOQ 1.7	J95331-49 PB	110.00	> LOQ 1.7
G-4A	J95331-55 VB	28.00	> LOQ 1.7	J95331-55 PB	80.00	> LOQ 1.7
G-4B	J95331-56 VB	100.00	> LOQ 1.7	J95331-56 PB	67.00	> LOQ 1.7
G-5A	J95331-58 VB	33.00	> LOQ 1.7	J95331-58 PB	34.00	> LOQ 1.7
G-5B	J95331-59 VB	23.00	> LOQ 1.7	J95331-59 PB	16.00	> LOQ 1.7
G-6A	J95331-64 VB	40.00	> LOQ 1.7	J95331-64 PB	52.00	> LOQ 1.7
G-6B	J95331-65 VB	63.00	> LOQ 1.7	J95331-65 PB	36.00	> LOQ 1.7
G-7A	J95331-74 VB	46.00	> LOQ 1.7	J95331-74 PB	71.00	> LOQ 1.7
G-7B	J95331-75 VB	150.00	> LOQ 1.7	J95331-75 PB	86.00	> LOQ 1.7
SG-1A	J95331-54 VB	28.00	> LOQ 8.5	J95331-54 PB	28.00	> LOQ 8.5
SG-1B	J95331-71 VB	31.00	> LOQ 8.5	J95331-71 PB	32.00	> LOQ 8.5
SG-2A	J95331-66 VB	8.00	< LOQ 8.5	J95331-66 PB	5.30	< LOQ 8.5
SG-2B	J95331-82 VB	11.00	> LOQ 8.5	J95331-82 PB	9.60	> LOQ 8.5

Comparison of Airborne Concentrations to Bulk Concentrations - Titanium

NIOSH REL - Limit of Quantification (Lowest Feasible Concentration)
OSHA PEL 15000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	8.96	9.49	9.73	ND
CS-01	391.35	1208.33	5364.14	1168.61	1800.00
CS-02	540.77	1421.40	6456.99	2292.14	940.00
CS-03	721.80	2899.15	10576.52	2899.15	2000.00
CS-04	370.29	1318.54	3313.32	1729.11	130.00
CS-05	173.41	688.50	1423.19	756.33	71.00
CS-06	813.18	2010.47	1718.07	1311.41	58.00
CS-07	1112.03	2293.58	11652.10	2293.58	150.00
CSDS-01	332.23	1687.15	4568.11	2288.33	140.00
CSDS-02	412.12	1468.16	5588.90	1967.35	1600.00
N-01	18.49	81.32	289.74	176.23	13.00
N-02	347.22	644.36	2707.77	560.28	150.00
O-1	ND	8.14	17.88	10.05	2.50
S-01	228.41	1023.18	3131.52	3338.20	190.00
S-02	958.73	3768.84	3541.67	1148.47	140.00
SH-01	7.73	13.37	41.46	12.06	7.40
SS-01	10.73	87.68	37.23	76.60	4.70
SS-02	22.85	95.93	76.57	84.33	4.50
SS-03	4.58	11.34	26.56	15.72	2.70
SS-04	54.38	397.66	564.85	349.87	82.00
SS-05	8.24	31.46	64.44	49.19	11.00
SS-06	56.92	142.98	5.03	77.36	38.00
SS-07	28.71	72.72	271.57	37.12	19.00
SSDS-01	8.85	39.72	61.87	53.81	7.40
SSDS-02	39.59	179.17	598.43	196.48	73.00
SSDS-03	ND	5.96	6.57	8.70	4.50
CP-1A	146.42	745.65	1535.59	607.46	120.00
CP-2A	577.68	1589.29	9746.99	3946.82	1200.00
CP-3A	392.40	1022.32	5170.63	4759.93	840.00
CP-4A	309.02	1383.36	7345.44	1497.74	280.00
CPDS-1A	790.43	1299.24	8878.79	3280.71	390.00
G-1A	66.49	192.19	311.40	306.69	15.00
G-2A	19.39	110.36	93.28	77.02	11.00
G-3A	16.96	64.44	100.73	27.09	8.80
G-4A	406.17	392.81	965.69	1100.50	28.00
G-5A	53.52	228.31	332.99	564.50	33.00
G-6A	228.69	1045.15	790.68	434.87	40.00
G-7A	226.94	497.72	1251.56	335.08	46.00
SG-1A	9.80	10.17	47.74	167.11	28.00
SG-2A	7.20	7.52	8.71	28.99	8.00

APPENDIX B - VANADIUM

Vanadium

Vanadium dust may cause irritation of the eyes, nose, throat, and also the respiratory tract. It may also cause bronchitis with wheezing and chest pain. Repeated or prolonged exposure may also cause an allergic skin rash. The NIOSH REL and OSHA PEL (Respirable) for vanadium (except vanadium metal and vanadium carbide) are 50 and 500 micrograms/cubic meter of air as ceiling limits, respectively. For the purpose of this study, the OSHA PEL for respirable vanadium was used for total vanadium dust, as there is no PEL for total vanadium dust listed.

Air Sample Results - Vanadium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Vanadium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.110	< LOQ 0.25	2.28	< LOQ 5.19
24412	2	47.89	S-01	28	0.300	> LOQ 0.25	6.26	> LOQ 5.22
24441	3	47.90	S-01	28	1.100	> LOQ 0.25	22.96	> LOQ 5.22
24450	OBZ	47.93	S-01	28	0.510	> LOQ 0.25	10.64	> LOQ 5.22
24643	1	47.98	S-02	29	0.120	< LOQ 0.25	2.5	< LOQ 5.21
24625	2	47.76	S-02	29	0.550	> LOQ 0.25	11.52	> LOQ 5.23
24642	3	48.00	S-02	29	0.700	> LOQ 0.25	14.58	> LOQ 5.21
24632	OBZ	47.89	S-02	29	0.260	> LOQ 0.25	5.43	> LOQ 5.22
24634	1	48.16	CSDS-01	31	0.540	> LOQ 0.25	11.21	> LOQ 5.19
24650	2	48.01	CSDS-01	31	2.900	> LOQ 0.25	60.4	> LOQ 5.21
24644	3	48.16	CSDS-01	31	8.500	> LOQ 0.25	176.5	> LOQ 5.19
24645	OBZ	48.07	CSDS-01	31	4.100	> LOQ 0.25	85.29	> LOQ 5.20
24640	1	48.44	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24641	2	47.90	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.67
24651	3	48.35	SS-01	32	0.100	< LOQ 0.25	2.07	< LOQ 5.17
24635	OBZ	48.30	SS-01	32	0.120	< LOQ 0.25	2.48	< LOQ 5.18
24646	1	48.58	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.65
24626	2	47.84	SSDS-01	33	0.100	< LOQ 0.25	2.09	< LOQ 5.23
24638	3	48.49	SSDS-01	33	0.180	< LOQ 0.25	3.71	< LOQ 5.16
24647	OBZ	48.32	SSDS-01	33	0.120	< LOQ 0.25	2.48	< LOQ 5.17
24628	1	48.55	CS-01	34	0.700	> LOQ 0.25	14.42	> LOQ 5.15
24637	2	48.00	CS-01	34	2.000	> LOQ 0.25	41.67	> LOQ 5.21
24624	3	48.47	CS-01	34	9.200	> LOQ 0.25	189.81	> LOQ 5.16
24636	OBZ	47.92	CS-01	34	2.200	> LOQ 0.25	45.91	> LOQ 5.22
24623	1	48.53	CSDS-02	35	0.590	> LOQ 0.25	12.16	> LOQ 5.15
24622	2	48.36	CSDS-02	35	2.400	> LOQ 0.25	49.63	> LOQ 5.17
24654	3	48.31	CSDS-02	35	9.200	> LOQ 0.25	190.44	> LOQ 5.17
24653	OBZ	47.78	CSDS-02	35	3.000	> LOQ 0.25	62.79	> LOQ 5.23
24629	1	47.88	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24633	2	47.86	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24627	3	48.24	SH-01	36	0.330	> LOQ 0.25	6.84	> LOQ 5.18
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.66
24555	1	48.08	CS-02	37	1.400	> LOQ 0.25	29.12	> LOQ 5.20
24552	2	47.84	CS-02	37	4.000	> LOQ 0.25	83.61	> LOQ 5.23
24541	3	48.01	CS-02	37	17.000	> LOQ 0.25	354.09	> LOQ 5.21
24529	OBZ	47.99	CS-02	37	6.300	> LOQ 0.25	131.28	> LOQ 5.21
24558	1	48.49	CS-03	38	1.100	> LOQ 0.25	22.69	> LOQ 5.16
24524	2	48.29	CS-03	38	4.800	> LOQ 0.25	99.4	> LOQ 5.18
24561	3	48.22	CS-03	38	17.000	> LOQ 0.25	352.55	> LOQ 5.18
24559	OBZ	48.29	CS-03	38	4.600	> LOQ 0.25	95.26	> LOQ 5.18
24543	1	48.61	CS-04	39	0.460	> LOQ 0.25	9.46	> LOQ 5.14
24532	2	47.78	CS-04	39	1.900	> LOQ 0.25	39.77	> LOQ 5.23
24546	3	48.29	CS-04	39	5.300	> LOQ 0.25	109.75	> LOQ 5.18
24557	OBZ	48.58	CS-04	39	2.600	> LOQ 0.25	53.52	> LOQ 5.15
24560	1	48.13	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.66
24565	2	47.95	SS-02	40	0.180	< LOQ 0.25	3.75	< LOQ 5.21
24630	3	48.32	SS-02	40	0.200	< LOQ 0.25	4.14	< LOQ 5.17
24553	OBZ	48.62	SS-02	40	0.220	< LOQ 0.25	4.52	< LOQ 5.14
24525	1	48.13	G-1A	41	0.088	< LOQ 0.25	1.83	< LOQ 5.19
24563	2	47.87	G-1A	41	0.530	> LOQ 0.25	11.07	> LOQ 5.22
24547	3	48.17	G-1A	41	1.900	> LOQ 0.25	39.44	> LOQ 5.19
24526	OBZ	48.91	G-1A	41	1.300	> LOQ 0.25	26.58	> LOQ 5.11
24538	1	47.45	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.69

Air Sample Results - Vanadium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Vanadium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	0.200	< LOQ 0.25	4.24	< LOQ 5.31
24533	3	48.24	G-2A	43	0.310	> LOQ 0.25	6.43	> LOQ 5.18
24540	OBZ	48.04	G-2A	43	0.220	< LOQ 0.25	4.58	< LOQ 5.20
24528	1	47.99	SSDS-02	44	ND	< LOD 0.08	ND	< LOD 1.67
24544	2	48.00	SSDS-02	44	0.320	> LOQ 0.25	6.67	> LOQ 5.21
24567	3	48.46	SSDS-02	44	99.000	> LOQ 0.25	2042.92	> LOQ 5.16
24539	OBZ	49.37	SSDS-02	44	0.370	> LOQ 0.25	7.49	> LOQ 5.06
24571	1	48.05	SS-03	45	ND	< LOD 0.25	ND	< LOD 5.20
24536	2	47.60	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.68
24534	3	48.94	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.63
24570	OBZ	49.61	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.61
24568	1	48.28	G-1B	46	0.110	< LOQ 0.25	2.28	< LOQ 5.18
24592	2	47.38	G-1B	46	0.810	> LOQ 0.25	17.1	> LOQ 5.28
24593	3	48.17	G-1B	46	1.200	> LOQ 0.25	24.91	> LOQ 5.19
24535	OBZ	48.22	G-1B	46	1.500	> LOQ 0.25	31.11	> LOQ 5.18
24590	1	47.81	SS-04	47	0.170	< LOQ 0.25	3.56	< LOQ 5.23
24605	2	47.78	SS-04	47	0.740	> LOQ 0.25	15.49	> LOQ 5.23
24562	3	47.80	SS-04	47	1.100	> LOQ 0.25	23.01	> LOQ 5.23
24531	OBZ	48.59	SS-04	47	0.650	> LOQ 0.25	13.38	> LOQ 5.15
24527	1	49.48	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.62
24569	2	50.35	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.59
24584	3	50.24	SSDS-03	48	0.110	< LOQ 0.25	2.19	< LOQ 4.98
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.66
24600	1	48.34	G-3A	49	0.150	< LOQ 0.25	3.1	< LOQ 5.17
24616	2	48.11	G-3A	49	0.160	< LOQ 0.25	3.33	< LOQ 5.20
24585	3	47.65	G-3A	49	0.450	> LOQ 0.25	9.44	> LOQ 5.25
24583	OBZ	47.99	G-3A	49	0.150	< LOQ 0.25	3.13	< LOQ 5.21
24587	1	48.79	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.64
24602	2	48.17	G-2B	50	0.180	< LOQ 0.25	3.74	< LOQ 5.19
24564	3	47.81	G-2B	50	0.190	< LOQ 0.25	3.97	< LOQ 5.23
24621	OBZ	48.54	G-2B	50	0.150	< LOQ 0.25	3.09	< LOQ 5.15
24618	1	49.21	N-01	52	0.180	< LOQ 0.25	3.66	< LOQ 5.08
24611	2	47.96	N-01	52	0.980	> LOQ 0.25	20.43	> LOQ 5.21
24588	3	48.32	N-01	52	3.700	> LOQ 0.25	76.57	> LOQ 5.17
24615	OBZ	48.80	N-01	52	1.900	> LOQ 0.25	38.93	> LOQ 5.12
24597	1	49.78	SS-05	53	0.250	< LOQ 0.25	5.02	< LOQ 5.02
24599	2	47.68	SS-05	53	0.760	> LOQ 0.25	15.94	> LOQ 5.24
24575	3	48.11	SS-05	53	1.700	> LOQ 0.25	35.34	> LOQ 5.20
24617	OBZ	48.79	SS-05	53	1.100	> LOQ 0.25	22.55	> LOQ 5.12
24609	1	48.98	SG-1A	54	0.230	< LOQ 0.25	4.7	< LOQ 5.10
24596	2	48.20	SG-1A	54	0.270	> LOQ 0.25	5.6	> LOQ 5.19
24610	3	48.18	SG-1A	54	1.400	> LOQ 0.25	29.06	> LOQ 5.19
24576	OBZ	48.47	SG-1A	54	6.900	> LOQ 1.30	142.36	> LOQ 26.82
24606	1	49.24	G-4A	55	0.400	> LOQ 0.25	8.12	> LOQ 5.08
24620	2	48.37	G-4A	55	0.450	> LOQ 0.25	9.3	> LOQ 5.17
24573	3	48.67	G-4A	55	2.600	> LOQ 0.25	53.42	> LOQ 5.14
24505	OBZ	48.16	G-4A	55	0.750	> LOQ 0.25	15.57	> LOQ 5.19
24340	1	48.38	G-4B	56	0.095	< LOQ 0.25	1.96	< LOQ 5.17
24607	2	48.01	G-4B	56	0.800	> LOQ 0.25	16.66	> LOQ 5.21
24595	3	48.38	G-4B	56	1.300	> LOQ 0.25	26.87	> LOQ 5.17
24598	OBZ	48.42	G-4B	56	0.660	> LOQ 0.25	13.63	> LOQ 5.16
24580	1	48.44	CS-05	57	0.630	> LOQ 0.25	13.01	> LOQ 5.16
24604	2	47.93	CS-05	57	2.400	> LOQ 0.25	50.07	> LOQ 5.22

Air Sample Results - Vanadium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Vanadium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	5.700	> LOQ 0.25	119.3	> LOQ 5.23
24574	OBZ	30.41	CS-05	57	2.000	> LOQ 0.25	65.77	> LOQ 8.22
24614	1	48.58	G-5A	58	0.086	< LOQ 0.25	1.77	< LOQ 5.15
24577	2	48.18	G-5A	58	0.470	> LOQ 0.25	9.76	> LOQ 5.19
24572	3	48.05	G-5A	58	1.500	> LOQ 0.25	31.22	> LOQ 5.20
24582	OBZ	47.83	G-5A	58	2.100	> LOQ 0.25	43.91	> LOQ 5.23
24322	1	47.88	G-5B	59	0.110	< LOQ 0.25	2.3	< LOQ 5.22
24354	2	48.16	G-5B	59	1.000	> LOQ 0.25	20.76	> LOQ 5.19
24510	3	47.98	G-5B	59	3.400	> LOQ 0.25	70.86	> LOQ 5.21
24321	OBZ	47.99	G-5B	59	0.520	> LOQ 0.25	10.84	> LOQ 5.21
24497	1	48.49	CP-1A	60	0.150	< LOQ 0.25	3.09	< LOQ 5.16
24333	2	48.28	CP-1A	60	0.650	> LOQ 0.25	13.46	> LOQ 5.18
24326	3	48.19	CP-1A	60	1.500	> LOQ 0.25	31.13	> LOQ 5.19
24329	OBZ	47.74	CP-1A	60	0.560	> LOQ 0.25	11.73	> LOQ 5.24
24499	1	42.42	CP-1B	62	0.190	< LOQ 0.25	4.48	< LOQ 5.89
24506	2	42.02	CP-1B	62	0.610	> LOQ 0.25	14.52	> LOQ 5.95
24388	3	42.47	CP-1B	62	2.500	> LOQ 0.25	58.87	> LOQ 5.89
24315	OBZ	41.77	CP-1B	62	0.490	> LOQ 0.25	11.73	> LOQ 5.99
24318	1	48.56	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.65
24308	2	48.00	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.67
24330	3	48.47	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.65
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.66
24363	1	48.10	G-6A	64	0.750	> LOQ 0.25	15.59	> LOQ 5.20
24398	2	47.84	G-6A	64	3.500	> LOQ 0.25	73.16	> LOQ 5.23
24351	3	48.06	G-6A	64	5.800	> LOQ 0.25	120.68	> LOQ 5.20
24594	OBZ	48.29	G-6A	64	1.700	> LOQ 0.25	35.2	> LOQ 5.18
24312	1	48.76	G-6B	65	0.210	< LOQ 0.25	4.31	< LOQ 5.13
24484	2	47.45	G-6B	65	1.500	> LOQ 0.25	31.61	> LOQ 5.27
24327	3	48.92	G-6B	65	1.400	> LOQ 0.25	28.62	> LOQ 5.11
24389	OBZ	48.46	G-6B	65	1.400	> LOQ 0.25	28.89	> LOQ 5.16
24348	1	48.59	SG-2A	66	2.800	> LOQ 0.25	57.63	> LOQ 5.15
24314	2	47.90	SG-2A	66	2.400	> LOQ 0.25	50.1	> LOQ 5.22
24494	3	48.24	SG-2A	66	3.800	> LOQ 0.50	78.77	> LOQ 10.36
24337	OBZ	48.30	SG-2A	66	16.000	> LOQ 0.50	331.26	> LOQ 10.35
24508	1	48.47	CP-2A	67	1.500	> LOQ 0.25	30.95	> LOQ 5.16
24361	2	47.82	CP-2A	67	4.000	> LOQ 0.25	83.65	> LOQ 5.23
24359	3	48.22	CP-2A	67	25.000	> LOQ 0.50	518.46	> LOQ 10.37
24471	OBZ	48.14	CP-2A	67	9.700	> LOQ 0.25	201.5	> LOQ 5.19
24373	1	48.41	CP-2B	68	3.900	> LOQ 0.25	80.56	> LOQ 5.16
24468	2	47.90	CP-2B	68	2.300	> LOQ 0.25	48.02	> LOQ 5.22
24481	3	48.26	CP-2B	68	8.700	> LOQ 0.25	180.27	> LOQ 5.18
24391	OBZ	47.53	CP-2B	68	1.800	> LOQ 0.25	37.87	> LOQ 5.26
24356	1	48.56	O-1	69	ND	< LOD 0.08	ND	< LOD 1.65
24470	2	47.89	O-1	69	0.110	< LOQ 0.25	2.3	< LOQ 5.22
24467	3	48.67	O-1	69	0.190	< LOQ 0.25	3.9	< LOQ 5.14
24313	OBZ	47.78	O-1	69	ND	< LOD 0.08	ND	< LOD 1.67
24501	1	47.96	CS-06	70	1.400	> LOQ 0.25	29.19	> LOQ 5.21
24496	2	47.75	CS-06	70	3.300	> LOQ 0.25	69.11	> LOQ 5.24
24478	3	48.31	CS-06	70	4.400	> LOQ 0.25	91.08	> LOQ 5.17
24503	OBZ	48.04	CS-06	70	2.600	> LOQ 0.25	54.12	> LOQ 5.20
24474	1	26.02	SG-1B	71	0.086	< LOQ 0.25	3.31	< LOQ 9.61
24469	2	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24492	3	26.10	SG-1B	71	0.350	> LOQ 0.25	13.41	> LOQ 9.58

Air Sample Results - Vanadium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Vanadium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	1.600	> LOQ 1.30	60.95	> LOQ 49.52
24489	1	48.42	CP-3A	72	0.860	> LOQ 0.25	17.76	> LOQ 5.16
24491	2	47.93	CP-3A	72	2.200	> LOQ 0.25	45.9	> LOQ 5.22
24482	3	48.35	CP-3A	72	12.000	> LOQ 0.25	248.19	> LOQ 5.17
24486	OBZ	48.32	CP-3A	72	10.000	> LOQ 0.25	206.95	> LOQ 5.17
24516	1	36.34	CP-3B	73	0.870	> LOQ 0.25	23.94	> LOQ 6.88
24502	2	36.02	CP-3B	73	4.800	> LOQ 0.25	133.26	> LOQ 6.94
24515	3	36.48	CP-3B	73	7.100	> LOQ 0.25	194.63	> LOQ 6.85
24500	OBZ	40.27	CP-3B	73	3.200	> LOQ 0.25	79.46	> LOQ 6.21
24504	1	48.47	G-7A	74	0.450	> LOQ 0.25	9.28	> LOQ 5.16
24513	2	48.22	G-7A	74	0.970	> LOQ 0.25	20.12	> LOQ 5.18
24458	3	47.94	G-7A	74	2.500	> LOQ 0.25	52.15	> LOQ 5.21
24389	OBZ	47.75	G-7A	74	0.600	> LOQ 0.25	12.57	> LOQ 5.24
24404	1	48.68	G-7B	75	0.280	> LOQ 0.25	5.75	> LOQ 5.14
24451	2	48.06	G-7B	75	0.590	> LOQ 0.25	12.28	> LOQ 5.20
24447	3	47.16	G-7B	75	1.300	> LOQ 0.25	27.57	> LOQ 5.30
24423	OBZ	47.27	G-7B	75	0.360	> LOQ 0.25	7.62	> LOQ 5.29
24456	1	49.19	SS-06	76	0.100	< LOQ 0.25	2.03	< LOQ 5.08
24480	2	48.26	SS-06	76	0.300	> LOQ 0.25	6.22	> LOQ 5.18
24429	3	47.68	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.68
24418	OBZ	47.83	SS-06	76	0.140	< LOQ 0.25	2.93	< LOQ 5.23
24427	1	48.54	CP-4A	78	0.550	> LOQ 0.25	11.33	> LOQ 5.15
24435	2	47.71	CP-4A	78	2.800	> LOQ 0.25	58.69	> LOQ 5.24
24244	3	49.01	CP-4A	78	12.000	> LOQ 0.50	244.85	> LOQ 10.20
24220	OBZ	48.74	CP-4A	78	2.700	> LOQ 0.25	55.4	> LOQ 5.13
24460	1	50.05	CP-4B	79	0.630	> LOQ 0.25	12.59	> LOQ 5.00
24465	2	48.47	CP-4B	79	2.000	> LOQ 0.25	41.26	> LOQ 5.16
24207	3	48.49	CP-4B	79	9.200	> LOQ 0.50	189.73	> LOQ 10.31
24390	OBZ	49.02	CP-4B	79	0.560	> LOQ 0.25	11.42	> LOQ 5.10
24259	1	48.76	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.64
24421	2	48.13	SS-07	80	0.094	< LOQ 0.25	1.95	< LOQ 5.19
24445	3	47.87	SS-07	80	0.360	> LOQ 0.25	7.52	> LOQ 5.22
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.65
24459	1	48.96	N-02	81	0.820	> LOQ 0.25	16.75	> LOQ 5.11
24417	2	48.11	N-02	81	1.500	> LOQ 0.25	31.18	> LOQ 5.20
24442	3	48.01	N-02	81	7.300	> LOQ 0.25	152.05	> LOQ 5.21
24386	OBZ	48.19	N-02	81	1.400	> LOQ 0.25	29.05	> LOQ 5.19
24452	1	48.20	SG-2B	82	0.730	> LOQ 0.25	15.15	> LOQ 5.19
24453	2	48.59	SG-2B	82	1.700	> LOQ 0.25	34.99	> LOQ 5.15
24420	3	47.84	SG-2B	82	4.400	> LOQ 0.25	91.97	> LOQ 5.23
24444	OBZ	47.95	SG-2B	82	23.000	> LOQ 1.30	479.67	> LOQ 27.11
24455	1	48.56	CS-07	83	3.000	> LOQ 0.25	61.78	> LOQ 5.15
24433	2	47.96	CS-07	83	7.400	> LOQ 0.25	154.3	> LOQ 5.21
24398	3	48.06	CS-07	83	32.000	> LOQ 0.25	665.83	> LOQ 5.20
24511	OBZ	47.96	CS-07	83	6.800	> LOQ 0.25	141.78	> LOQ 5.21
24454	1	49.34	CPDS-1A	84	2.000	> LOQ 0.25	40.54	> LOQ 5.07
24291	2	48.49	CPDS-1A	84	3.200	> LOQ 0.25	65.99	> LOQ 5.16
24209	3	48.43	CPDS-1A	84	22.000	> LOQ 0.25	454.26	> LOQ 5.16
24402	OBZ	48.77	CPDS-1A	84	8.200	> LOQ 0.25	168.14	> LOQ 5.13
24204	1	49.46	CPDS-1B	85	2.300	> LOQ 0.25	46.5	> LOQ 5.05
24273	2	48.35	CPDS-1B	85	3.900	> LOQ 0.25	80.66	> LOQ 5.17
24223	3	48.82	CPDS-1B	85	18.000	> LOQ 0.25	368.7	> LOQ 5.12
24466	OBZ	49.96	CPDS-1B	85	3.300	> LOQ 0.25	66.05	> LOQ 5.00

Airborne Sample Data Analysis - Vanadium

NIOSH REL 50.0 micrograms/cubic meter Ceiling Limit
OSHA PEL 500.0 micrograms/cubic meter Ceiling Limit

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.65	ND	< LOD 1.66
CS-01	14.42	> LOQ 5.15	41.67	> LOQ 5.21	189.81	> LOQ 5.16	45.91	> LOQ 5.22
CS-02	29.12	> LOQ 5.20	83.61	> LOQ 5.23	354.09	> LOQ 5.21	131.28	> LOQ 5.21
CS-03	22.69	> LOQ 5.16	99.4	> LOQ 5.18	352.55	> LOQ 5.18	95.26	> LOQ 5.18
CS-04	9.46	> LOQ 5.14	39.77	> LOQ 5.23	109.75	> LOQ 5.18	53.52	> LOQ 5.15
CS-05	13.01	> LOQ 5.16	50.07	> LOQ 5.22	119.30	> LOQ 5.23	65.77	> LOQ 8.22
CS-06	29.19	> LOQ 5.21	69.11	> LOQ 5.24	91.08	> LOQ 5.17	54.12	> LOQ 5.20
CS-07	61.78	> LOQ 5.15	154.3	> LOQ 5.21	665.83	> LOQ 5.20	141.78	> LOQ 5.21
CSDS-01	11.21	> LOQ 5.19	60.4	> LOQ 5.21	176.50	> LOQ 5.19	85.29	> LOQ 5.20
CSDS-02	12.16	> LOQ 5.15	49.63	> LOQ 5.17	190.44	> LOQ 5.17	62.79	> LOQ 5.23
N-01	3.66	< LOQ 5.08	20.43	> LOQ 5.21	76.57	> LOQ 5.17	38.93	> LOQ 5.12
N-02	16.75	> LOQ 5.11	31.18	> LOQ 5.20	152.05	> LOQ 5.21	29.05	> LOQ 5.19
O-1	ND	< LOD 1.65	2.3	< LOQ 5.22	3.90	< LOQ 5.14	ND	< LOD 1.67
S-01	2.28	< LOQ 5.19	6.26	> LOQ 5.22	22.96	> LOQ 5.22	10.64	> LOQ 5.22
S-02	2.5	< LOQ 5.21	11.52	> LOQ 5.23	14.58	> LOQ 5.21	5.43	> LOQ 5.22
SH-01	ND	< LOD 1.67	ND	< LOD 1.67	6.84	> LOQ 5.18	ND	< LOD 1.66
SS-01	ND	< LOD 1.65	ND	< LOD 1.67	2.07	< LOQ 5.17	2.48	< LOQ 5.18
SS-02	ND	< LOD 1.66	3.75	< LOQ 5.21	4.14	< LOQ 5.17	4.52	< LOQ 5.14
SS-03	ND	< LOD 5.20	ND	< LOD 1.68	ND	< LOD 1.63	ND	< LOD 1.61
SS-04	3.56	< LOQ 5.23	15.49	> LOQ 5.23	23.01	> LOQ 5.23	13.38	> LOQ 5.15
SS-05	5.02	< LOQ 5.02	15.94	> LOQ 5.24	35.34	> LOQ 5.20	22.55	> LOQ 5.12
SS-06	2.03	< LOQ 5.08	6.22	> LOQ 5.18	ND	< LOD 1.68	2.93	< LOQ 5.23
SS-07	ND	< LOD 1.64	1.95	< LOQ 5.19	7.52	> LOQ 5.22	ND	< LOD 1.65
SSDS-01	ND	< LOD 1.65	2.09	< LOQ 5.23	3.71	< LOQ 5.16	2.48	< LOQ 5.17
SSDS-02	ND	< LOD 1.67	6.67	> LOQ 5.21	2042.92	> LOQ 5.16	7.49	> LOQ 5.06
SSDS-03	ND	< LOD 1.62	ND	< LOD 1.59	2.19	< LOQ 4.98	ND	< LOD 1.66
CP-1A	3.09	< LOQ 5.16	13.46	> LOQ 5.18	31.13	> LOQ 5.19	11.73	> LOQ 5.24
CP-1B	4.48	< LOQ 5.89	14.52	> LOQ 5.95	58.87	> LOQ 5.89	11.73	> LOQ 5.99
CP-2A	30.95	> LOQ 5.16	83.65	> LOQ 5.23	518.46	> LOQ 10.37	201.5	> LOQ 5.19
CP-2B	80.56	> LOQ 5.16	48.02	> LOQ 5.22	180.27	> LOQ 5.18	37.87	> LOQ 5.26
CP-3A	17.76	> LOQ 5.16	45.9	> LOQ 5.22	248.19	> LOQ 5.17	206.95	> LOQ 5.17
CP-3B	23.94	> LOQ 6.88	133.26	> LOQ 6.94	194.63	> LOQ 6.85	79.46	> LOQ 6.21
CP-4A	11.33	> LOQ 5.15	58.69	> LOQ 5.24	244.85	> LOQ 10.20	55.4	> LOQ 5.13
CP-4B	12.59	> LOQ 5.00	41.26	> LOQ 5.16	189.73	> LOQ 10.31	11.42	> LOQ 5.10
CPDS-1A	40.54	> LOQ 5.07	65.99	> LOQ 5.16	454.26	> LOQ 5.16	168.14	> LOQ 5.13
CPDS-1B	46.5	> LOQ 5.05	80.66	> LOQ 5.17	368.70	> LOQ 5.12	66.05	> LOQ 5.00
G-1A	1.83	< LOQ 5.19	11.07	> LOQ 5.22	39.44	> LOQ 5.19	26.58	> LOQ 5.11
G-1B	2.28	< LOQ 5.18	17.1	> LOQ 5.28	24.91	> LOQ 5.19	31.11	> LOQ 5.18
G-2A	ND	< LOD 1.69	4.24	< LOQ 5.31	6.43	> LOQ 5.18	4.58	< LOQ 5.20
G-2B	ND	< LOD 1.64	3.74	< LOQ 5.19	3.97	< LOQ 5.23	3.09	< LOQ 5.15
G-3A	3.1	< LOQ 5.17	3.33	< LOQ 5.20	9.44	> LOQ 5.25	3.13	< LOQ 5.21
G-4A	8.12	> LOQ 5.08	9.3	> LOQ 5.17	53.42	> LOQ 5.14	15.57	> LOQ 5.19
G-4B	1.96	< LOQ 5.17	16.66	> LOQ 5.21	26.87	> LOQ 5.17	13.63	> LOQ 5.16
G-5A	1.77	< LOQ 5.15	9.76	> LOQ 5.19	31.22	> LOQ 5.20	43.91	> LOQ 5.23
G-5B	2.3	< LOQ 5.22	20.76	> LOQ 5.19	70.86	> LOQ 5.21	10.84	> LOQ 5.21
G-6A	15.59	> LOQ 5.20	73.16	> LOQ 5.23	120.68	> LOQ 5.20	35.2	> LOQ 5.18
G-6B	4.31	< LOQ 5.13	31.61	> LOQ 5.27	28.62	> LOQ 5.11	28.89	> LOQ 5.16
G-7A	9.28	> LOQ 5.16	20.12	> LOQ 5.18	52.15	> LOQ 5.21	12.57	> LOQ 5.24
G-7B	5.75	> LOQ 5.14	12.28	> LOQ 5.20	27.57	> LOQ 5.30	7.62	> LOQ 5.29
SG-1A	4.7	< LOQ 5.10	5.6	> LOQ 5.19	29.06	> LOQ 5.19	142.36	> LOQ 26.82
SG-1B	3.31	< LOQ 9.61	ND	< LOD 3.07	13.41	> LOQ 9.58	60.95	> LOQ 49.52
SG-2A	57.63	> LOQ 5.15	50.1	> LOQ 5.22	78.77	> LOQ 10.36	331.26	> LOQ 10.35
SG-2B	15.15	> LOQ 5.19	34.99	> LOQ 5.15	91.97	> LOQ 5.23	479.67	> LOQ 27.11

Bulk Elemental Analysis - Vanadium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Vanadium		Sample	Vanadium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.3	J95331-63 PB	ND	< LOD 0.3
CS-01	J95331-34 VB	67.00	> LOQ 1.0	J95331-34 PB	73.00	> LOQ 1.0
CS-02	J95331-37 VB	57.00	> LOQ 1.0	J95331-37 PB	59.00	> LOQ 1.0
CS-03	J95331-38 VB	100.00	> LOQ 1.0	J95331-38 PB	130.00	> LOQ 1.0
CS-04	J95331-39 VB	5.70	> LOQ 1.0	J95331-39 PB	7.80	> LOQ 1.0
CS-05	J95331-57 VB	4.40	> LOQ 1.0	J95331-57 PB	7.50	> LOQ 1.0
CS-06	J95331-70 VB	3.60	> LOQ 1.0	J95331-70 PB	7.00	> LOQ 1.0
CS-07	J95331-83 VB	14.00	> LOQ 1.0	J95331-83 PB	40.00	> LOQ 1.0
CSDS-01	J95331-31 VB	7.40	> LOQ 1.0	J95331-31 PB	15.00	> LOQ 1.0
CSDS-02	J95331-35 VB	57.00	> LOQ 1.0	J95331-35 PB	64.00	> LOQ 1.0
N-01	J95331-52 VB	4.20	> LOQ 1.0	J95331-52 PB	5.90	> LOQ 1.0
N-02	J95331-81 VB	13.00	> LOQ 1.0	J95331-81 PB	32.00	> LOQ 1.0
O-1	J95331-69 VB	0.55	< LOQ 1.0	J95331-69 PB	0.87	< LOQ 1.0
S-01	J95331-28 VB	3.60	> LOQ 1.0	J95331-28 PB	2.70	> LOQ 1.0
S-02	J95331-29 VB	1.90	> LOQ 1.0	J95331-29 PB	2.40	> LOQ 1.0
SH-01	J95331-36 VB	2.00	> LOQ 1.0	J95331-36 PB	1.70	> LOQ 1.0
SS-01	J95331-32 VB	ND	< LOD 0.3	J95331-32 PB	0.34	< LOQ 1.0
SS-02	J95331-40 VB	0.32	< LOQ 1.0	J95331-40 PB	0.50	< LOQ 1.0
SS-03	J95331-45 VB	ND	< LOD 0.3	J95331-45 PB	ND	< LOD 0.3
SS-04	J95331-47 VB	4.20	> LOQ 1.0	J95331-47 PB	1.00	> LOQ 1.0
SS-05	J95331-53 VB	6.00	> LOQ 1.0	J95331-53 PB	4.70	> LOQ 1.0
SS-06	J95331-76 VB	2.10	> LOQ 1.0	J95331-76 PB	2.90	> LOQ 1.0
SS-07	J95331-80 VB	0.93	< LOQ 1.0	J95331-80 PB	0.33	< LOQ 1.0
SSDS-01	J95331-33 VB	0.34	< LOQ 1.0	J95331-33 PB	0.45	< LOQ 1.0
SSDS-02	J95331-44 VB	4.50	> LOQ 1.0	J95331-44 PB	5.40	> LOQ 1.0
SSDS-03	J95331-48 VB	ND	< LOD 0.3	J95331-48 PB	ND	< LOD 0.3
CP-1A	J95331-60 VB	1.90	> LOQ 1.0	J95331-60 PB	13.00	> LOQ 1.0
CP-1B	J95331-61 VB	10.00	> LOQ 1.0	J95331-61 PB	14.00	> LOQ 1.0
CP-2A	J95331-67 VB	88.00	> LOQ 1.0	J95331-67 PB	120.00	> LOQ 2.0
CP-2B	J95331-68 VB	100.00	> LOQ 2.0	J95331-68 PB	110.00	> LOQ 2.0
CP-3A	J95331-72 VB	53.00	> LOQ 1.0	J95331-72 PB	48.00	> LOQ 1.0
CP-3B	J95331-73 VB	51.00	> LOQ 1.0	J95331-73 PB	51.00	> LOQ 1.0
CP-4A	J95331-78 VB	15.00	> LOQ 1.0	J95331-78 PB	27.00	> LOQ 2.0
CP-4B	J95331-79 VB	30.00	> LOQ 1.0	J95331-79 PB	31.00	> LOQ 1.0
CPDS-1A	J95331-84 VB	51.00	> LOQ 1.0	J95331-84 PB	99.00	> LOQ 1.0
CPDS-1B	J95331-85 VB	90.00	> LOQ 1.0	J95331-85 PB	98.00	> LOQ 1.0
G-1A	J95331-41 VB	2.70	> LOQ 1.0	J95331-41 PB	3.00	> LOQ 1.0
G-1B	J95331-46 VB	12.00	> LOQ 1.0	J95331-46 PB	8.60	> LOQ 1.0
G-2A	J95331-43 VB	1.60	> LOQ 1.0	J95331-43 PB	1.90	> LOQ 1.0
G-2B	J95331-50 VB	1.20	> LOQ 1.0	J95331-50 PB	0.49	< LOQ 1.0
G-3A	J95331-49 VB	1.10	> LOQ 1.0	J95331-49 PB	5.60	> LOQ 1.0
G-4A	J95331-55 VB	0.81	< LOQ 1.0	J95331-55 PB	2.60	> LOQ 1.0
G-4B	J95331-56 VB	3.20	> LOQ 1.0	J95331-56 PB	2.40	> LOQ 1.0
G-5A	J95331-58 VB	2.70	> LOQ 1.0	J95331-58 PB	2.60	> LOQ 1.0
G-5B	J95331-59 VB	2.20	> LOQ 1.0	J95331-59 PB	2.00	> LOQ 1.0
G-6A	J95331-64 VB	4.10	> LOQ 1.0	J95331-64 PB	6.10	> LOQ 1.0
G-6B	J95331-65 VB	7.10	> LOQ 1.0	J95331-65 PB	4.50	> LOQ 1.0
G-7A	J95331-74 VB	3.00	> LOQ 1.0	J95331-74 PB	3.40	> LOQ 1.0
G-7B	J95331-75 VB	10.00	> LOQ 1.0	J95331-75 PB	6.10	> LOQ 1.0
SG-1A	J95331-54 VB	34.00	> LOQ 5.0	J95331-54 PB	33.00	> LOQ 5.0
SG-1B	J95331-71 VB	16.00	> LOQ 5.0	J95331-71 PB	16.00	> LOQ 5.0
SG-2A	J95331-66 VB	110.00	> LOQ 5.0	J95331-66 PB	76.00	> LOQ 5.0
SG-2B	J95331-82 VB	110.00	> LOQ 5.0	J95331-82 PB	110.00	> LOQ 5.0

Comparison of Airborne Concentrations to Bulk Concentrations - Vanadium

NIOSH REL 50.0 micrograms/cubic meter Ceiling Limit
OSHA PEL 500.0 micrograms/cubic meter Ceiling Limit

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	ND
CS-01	14.42	41.67	189.81	45.91	67.00
CS-02	29.12	83.61	354.09	131.28	57.00
CS-03	22.69	99.40	352.55	95.26	100.00
CS-04	9.46	39.77	109.75	53.52	5.70
CS-05	13.01	50.07	119.30	65.77	4.40
CS-06	29.19	69.11	91.08	54.12	3.60
CS-07	61.78	154.30	665.83	141.78	14.00
CSDS-01	11.21	60.40	176.50	85.29	7.40
CSDS-02	12.16	49.63	190.44	62.79	57.00
N-01	3.66	20.43	76.57	38.93	4.20
N-02	16.75	31.18	152.05	29.05	13.00
O-1	ND	2.30	3.90	ND	0.55
S-01	2.28	6.26	22.96	10.64	3.60
S-02	2.50	11.52	14.58	5.43	1.90
SH-01	ND	ND	6.84	ND	2.00
SS-01	ND	ND	2.07	2.48	ND
SS-02	ND	3.75	4.14	4.52	0.32
SS-03	ND	ND	ND	ND	ND
SS-04	3.56	15.49	23.01	13.38	4.20
SS-05	5.02	15.94	35.34	22.55	6.00
SS-06	2.03	6.22	ND	2.93	2.10
SS-07	ND	1.95	7.52	ND	0.93
SSDS-01	ND	2.09	3.71	2.48	0.34
SSDS-02	ND	6.67	2042.92	7.49	4.50
SSDS-03	ND	ND	2.19	ND	ND
CP-1A	3.09	13.46	31.13	11.73	1.90
CP-2A	30.95	83.65	518.46	201.50	88.00
CP-3A	17.76	45.90	248.19	206.95	53.00
CP-4A	11.33	58.69	244.85	55.40	15.00
CPDS-1A	40.54	65.99	454.26	168.14	51.00
G-1A	1.83	11.07	39.44	26.58	2.70
G-2A	ND	4.24	6.43	4.58	1.60
G-3A	3.10	3.33	9.44	3.13	1.10
G-4A	8.12	9.30	53.42	15.57	0.81
G-5A	1.77	9.76	31.22	43.91	2.70
G-6A	15.59	73.16	120.68	35.20	4.10
G-7A	9.28	20.12	52.15	12.57	3.00
SG-1A	4.70	5.60	29.06	142.36	34.00
SG-2A	57.63	50.10	78.77	331.26	110.00

APPENDIX B - YTTRIUM

Yttrium

Yttrium compounds that have become embedded in the eye have caused chemical eye damage in humans. Animal studies have shown yttrium compounds to cause irritation of the lungs, lung damage, and liver damage. The NIOSH REL and OSHA PEL for yttrium are both 1,000 micrograms/cubic meter of air.

Air Sample Results - Yttrium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Yttrium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.120	> LOQ 0.043	2.492	> LOQ 0.831
24412	2	47.89	S-01	28	0.440	> LOQ 0.043	9.188	> LOQ 0.835
24441	3	47.90	S-01	28	1.900	> LOQ 1.700	39.666	> LOQ 35.491
24450	OBZ	47.93	S-01	28	0.610	> LOQ 0.043	12.727	> LOQ 0.835
24643	1	47.98	S-02	29	0.310	> LOQ 0.043	6.461	> LOQ 0.834
24625	2	47.76	S-02	29	1.300	> LOQ 0.043	27.219	> LOQ 0.838
24642	3	48.00	S-02	29	3.000	> LOQ 0.043	62.5	> LOQ 0.833
24632	OBZ	47.89	S-02	29	0.910	> LOQ 0.043	19.002	> LOQ 0.835
24634	1	48.16	CSDS-01	31	0.140	> LOQ 0.043	2.907	> LOQ 0.831
24650	2	48.01	CSDS-01	31	0.800	> LOQ 0.043	16.663	> LOQ 0.833
24644	3	48.16	CSDS-01	31	2.400	> LOQ 0.043	49.834	> LOQ 0.831
24645	OBZ	48.07	CSDS-01	31	1.100	> LOQ 0.043	22.883	> LOQ 0.832
24640	1	48.44	SS-01	32	ND	< LOD 0.020	ND	< LOD 0.413
24641	2	47.90	SS-01	32	0.030	< LOQ 0.043	0.626	< LOQ 0.835
24651	3	48.35	SS-01	32	ND	< LOD 0.020	ND	< LOD 0.414
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.020	ND	< LOD 0.414
24646	1	48.58	SSDS-01	33	ND	< LOD 0.020	ND	< LOD 0.412
24626	2	47.84	SSDS-01	33	ND	< LOD 0.020	ND	< LOD 0.418
24638	3	48.49	SSDS-01	33	0.025	< LOQ 0.043	0.516	< LOQ 0.825
24647	OBZ	48.32	SSDS-01	33	0.021	< LOQ 0.043	0.435	< LOQ 0.828
24628	1	48.55	CS-01	34	0.180	> LOQ 0.043	3.708	> LOQ 0.824
24637	2	48.00	CS-01	34	0.550	> LOQ 0.043	11.458	> LOQ 0.833
24624	3	48.47	CS-01	34	2.300	> LOQ 0.043	47.452	> LOQ 0.825
24636	OBZ	47.92	CS-01	34	0.530	> LOQ 0.043	11.06	> LOQ 0.835
24623	1	48.53	CSDS-02	35	0.170	> LOQ 0.043	3.503	> LOQ 0.824
24622	2	48.36	CSDS-02	35	0.650	> LOQ 0.043	13.441	> LOQ 0.827
24654	3	48.31	CSDS-02	35	2.100	> LOQ 0.043	43.469	> LOQ 0.828
24653	OBZ	47.78	CSDS-02	35	0.830	> LOQ 0.043	17.371	> LOQ 0.837
24629	1	47.88	SH-01	36	ND	< LOD 0.020	ND	< LOD 0.418
24633	2	47.86	SH-01	36	0.023	< LOQ 0.043	0.481	< LOQ 0.836
24627	3	48.24	SH-01	36	0.170	> LOQ 0.043	3.524	> LOQ 0.829
24648	OBZ	48.08	SH-01	36	0.020	< LOQ 0.043	0.416	< LOQ 0.832
24555	1	48.08	CS-02	37	0.290	> LOQ 0.043	6.032	> LOQ 0.832
24552	2	47.84	CS-02	37	0.840	> LOQ 0.043	17.559	> LOQ 0.836
24541	3	48.01	CS-02	37	3.500	> LOQ 0.043	72.901	> LOQ 0.833
24529	OBZ	47.99	CS-02	37	1.300	> LOQ 0.043	27.089	> LOQ 0.834
24558	1	48.49	CS-03	38	0.280	> LOQ 0.043	5.774	> LOQ 0.825
24524	2	48.29	CS-03	38	1.100	> LOQ 0.043	22.779	> LOQ 0.828
24561	3	48.22	CS-03	38	3.800	> LOQ 0.043	78.805	> LOQ 0.830
24559	OBZ	48.29	CS-03	38	1.100	> LOQ 0.043	22.779	> LOQ 0.828
24543	1	48.61	CS-04	39	0.160	> LOQ 0.043	3.292	> LOQ 0.823
24532	2	47.78	CS-04	39	0.470	> LOQ 0.043	9.837	> LOQ 0.837
24546	3	48.29	CS-04	39	1.300	> LOQ 0.043	26.921	> LOQ 0.828
24557	OBZ	48.58	CS-04	39	0.660	> LOQ 0.043	13.586	> LOQ 0.823
24560	1	48.13	SS-02	40	0.020	< LOQ 0.043	0.416	< LOQ 0.831
24565	2	47.95	SS-02	40	0.095	> LOQ 0.043	1.981	> LOQ 0.834
24630	3	48.32	SS-02	40	0.160	> LOQ 0.043	3.311	> LOQ 0.828
24553	OBZ	48.62	SS-02	40	0.073	> LOQ 0.043	1.501	> LOQ 0.823
24525	1	48.13	G-1A	41	0.190	> LOQ 0.043	3.948	> LOQ 0.831
24563	2	47.87	G-1A	41	0.690	> LOQ 0.043	14.414	> LOQ 0.836
24547	3	48.17	G-1A	41	2.500	> LOQ 0.043	51.9	> LOQ 0.830
24526	OBZ	48.91	G-1A	41	1.900	> LOQ 0.043	38.847	> LOQ 0.818
24538	1	47.45	G-2A	43	0.240	> LOQ 0.043	5.058	> LOQ 0.843

Air Sample Results - Yttrium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Yttrium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	1.500	> LOQ 0.043	31.834	> LOQ 0.849
24533	3	48.24	G-2A	43	2.500	> LOQ 0.043	51.824	> LOQ 0.829
24540	OBZ	48.04	G-2A	43	0.900	> LOQ 0.043	18.734	> LOQ 0.833
24528	1	47.99	SSDS-02	44	0.034	< LOQ 0.043	0.708	< LOQ 0.834
24544	2	48.00	SSDS-02	44	0.220	> LOQ 0.043	4.583	> LOQ 0.833
24567	3	48.46	SSDS-02	44	0.660	> LOQ 0.043	13.619	> LOQ 0.825
24539	OBZ	49.37	SSDS-02	44	0.240	> LOQ 0.043	4.861	> LOQ 0.810
24571	1	48.05	SS-03	45	ND	< LOD 0.020	ND	< LOD 0.416
24536	2	47.60	SS-03	45	ND	< LOD 0.020	ND	< LOD 0.420
24534	3	48.94	SS-03	45	0.091	> LOQ 0.043	1.859	> LOQ 0.817
24570	OBZ	49.61	SS-03	45	0.025	< LOQ 0.043	0.504	< LOQ 0.806
24568	1	48.28	G-1B	46	0.120	> LOQ 0.043	2.486	> LOQ 0.829
24592	2	47.38	G-1B	46	1.000	> LOQ 0.043	21.106	> LOQ 0.844
24593	3	48.17	G-1B	46	1.300	> LOQ 0.043	26.988	> LOQ 0.830
24535	OBZ	48.22	G-1B	46	1.500	> LOQ 0.043	31.107	> LOQ 0.830
24590	1	47.81	SS-04	47	0.071	> LOQ 0.043	1.485	> LOQ 0.837
24605	2	47.78	SS-04	47	0.440	> LOQ 0.043	9.209	> LOQ 0.837
24562	3	47.80	SS-04	47	0.630	> LOQ 0.043	13.18	> LOQ 0.837
24531	OBZ	48.59	SS-04	47	0.440	> LOQ 0.043	9.055	> LOQ 0.823
24527	1	49.48	SSDS-03	48	ND	< LOD 0.020	ND	< LOD 0.404
24569	2	50.35	SSDS-03	48	ND	< LOD 0.020	ND	< LOD 0.397
24584	3	50.24	SSDS-03	48	0.041	< LOQ 0.043	0.816	< LOQ 0.796
24579	OBZ	48.26	SSDS-03	48	0.026	< LOQ 0.043	0.539	< LOQ 0.829
24600	1	48.34	G-3A	49	0.920	> LOQ 0.043	19.032	> LOQ 0.827
24616	2	48.11	G-3A	49	2.600	> LOQ 0.043	54.043	> LOQ 0.831
24585	3	47.65	G-3A	49	10.000	> LOQ 0.043	209.864	> LOQ 0.839
24583	OBZ	47.99	G-3A	49	1.100	> LOQ 0.043	22.921	> LOQ 0.834
24587	1	48.79	G-2B	50	0.390	> LOQ 0.043	7.993	> LOQ 0.820
24602	2	48.17	G-2B	50	3.400	> LOQ 0.043	70.583	> LOQ 0.830
24564	3	47.81	G-2B	50	2.100	> LOQ 0.043	43.924	> LOQ 0.837
24621	OBZ	48.54	G-2B	50	0.710	> LOQ 0.043	14.627	> LOQ 0.824
24618	1	49.21	N-01	52	ND	< LOD 0.020	ND	< LOD 0.406
24611	2	47.96	N-01	52	ND	< LOD 0.020	ND	< LOD 0.417
24588	3	48.32	N-01	52	0.083	> LOQ 0.043	1.718	> LOQ 0.828
24615	OBZ	48.80	N-01	52	0.060	> LOQ 0.043	1.23	> LOQ 0.820
24597	1	49.78	SS-05	53	ND	< LOD 0.020	ND	< LOD 0.402
24599	2	47.68	SS-05	53	0.041	< LOQ 0.043	0.86	< LOQ 0.839
24575	3	48.11	SS-05	53	0.150	> LOQ 0.043	3.118	> LOQ 0.831
24617	OBZ	48.79	SS-05	53	0.079	> LOQ 0.043	1.619	> LOQ 0.820
24609	1	48.98	SG-1A	54	ND	< LOD 0.020	ND	< LOD 0.408
24596	2	48.20	SG-1A	54	ND	< LOD 0.020	ND	< LOD 0.415
24610	3	48.18	SG-1A	54	ND	< LOD 0.020	ND	< LOD 0.415
24576	OBZ	48.47	SG-1A	54	0.038	< LOQ 0.043	0.784	< LOQ 0.825
24606	1	49.24	G-4A	55	2.100	> LOQ 0.043	42.648	> LOQ 0.812
24620	2	48.37	G-4A	55	2.400	> LOQ 0.043	49.618	> LOQ 0.827
24573	3	48.67	G-4A	55	16.000	> LOQ 0.043	328.745	> LOQ 0.822
24505	OBZ	48.16	G-4A	55	4.800	> LOQ 0.043	99.668	> LOQ 0.831
24340	1	48.38	G-4B	56	0.570	> LOQ 0.043	11.782	> LOQ 0.827
24607	2	48.01	G-4B	56	5.400	> LOQ 0.043	112.477	> LOQ 0.833
24595	3	48.38	G-4B	56	9.400	> LOQ 0.043	194.295	> LOQ 0.827
24598	OBZ	48.42	G-4B	56	4.600	> LOQ 0.043	95.002	> LOQ 0.826
24580	1	48.44	CS-05	57	0.097	> LOQ 0.043	2.002	> LOQ 0.826
24604	2	47.93	CS-05	57	0.400	> LOQ 0.043	8.346	> LOQ 0.835

Air Sample Results - Yttrium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Yttrium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	0.980	> LOQ 0.043	20.511	> LOQ 0.837
24574	OBZ	30.41	CS-05	57	0.310	> LOQ 0.043	10.194	> LOQ 1.315
24614	1	48.58	G-5A	58	0.200	> LOQ 0.043	4.117	> LOQ 0.823
24577	2	48.18	G-5A	58	0.910	> LOQ 0.043	18.888	> LOQ 0.830
24572	3	48.05	G-5A	58	3.200	> LOQ 0.043	66.597	> LOQ 0.832
24582	OBZ	47.83	G-5A	58	4.600	> LOQ 0.043	96.174	> LOQ 0.836
24322	1	47.88	G-5B	59	0.500	> LOQ 0.043	10.443	> LOQ 0.835
24354	2	48.16	G-5B	59	2.200	> LOQ 0.043	45.681	> LOQ 0.831
24510	3	47.98	G-5B	59	7.100	> LOQ 0.043	147.978	> LOQ 0.834
24321	OBZ	47.99	G-5B	59	0.970	> LOQ 0.043	20.213	> LOQ 0.834
24497	1	48.49	CP-1A	60	ND	< LOD 0.020	ND	< LOD 0.412
24333	2	48.28	CP-1A	60	0.099	> LOQ 0.043	2.051	> LOQ 0.829
24326	3	48.19	CP-1A	60	0.150	> LOQ 0.043	3.113	> LOQ 0.830
24329	OBZ	47.74	CP-1A	60	0.074	> LOQ 0.043	1.55	> LOQ 0.838
24499	1	42.42	CP-1B	62	0.025	< LOQ 0.043	0.589	< LOQ 0.943
24506	2	42.02	CP-1B	62	0.048	> LOQ 0.043	1.142	> LOQ 0.952
24388	3	42.47	CP-1B	62	0.270	> LOQ 0.043	6.357	> LOQ 0.942
24315	OBZ	41.77	CP-1B	62	0.046	> LOQ 0.043	1.101	> LOQ 0.958
24318	1	48.56	CG-01	63	ND	< LOD 0.020	ND	< LOD 0.412
24308	2	48.00	CG-01	63	ND	< LOD 0.020	ND	< LOD 0.417
24330	3	48.47	CG-01	63	ND	< LOD 0.020	ND	< LOD 0.413
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.020	ND	< LOD 0.414
24363	1	48.10	G-6A	64	0.880	> LOQ 0.043	18.295	> LOQ 0.832
24398	2	47.84	G-6A	64	4.200	> LOQ 0.043	87.793	> LOQ 0.836
24351	3	48.06	G-6A	64	8.300	> LOQ 0.043	172.701	> LOQ 0.832
24594	OBZ	48.29	G-6A	64	1.600	> LOQ 0.043	33.133	> LOQ 0.828
24312	1	48.76	G-6B	65	0.170	> LOQ 0.043	3.486	> LOQ 0.820
24484	2	47.45	G-6B	65	2.100	> LOQ 0.043	44.257	> LOQ 0.843
24327	3	48.92	G-6B	65	1.600	> LOQ 0.043	32.706	> LOQ 0.818
24389	OBZ	48.46	G-6B	65	1.900	> LOQ 0.043	39.208	> LOQ 0.825
24348	1	48.59	SG-2A	66	ND	< LOD 0.020	ND	< LOD 0.412
24314	2	47.90	SG-2A	66	ND	< LOD 0.020	ND	< LOD 0.418
24494	3	48.24	SG-2A	66	0.620	> LOQ 0.043	12.852	> LOQ 0.829
24337	OBZ	48.30	SG-2A	66	0.040	< LOQ 0.086	0.828	< LOQ 1.656
24508	1	48.47	CP-2A	67	0.190	> LOQ 0.043	3.92	> LOQ 0.825
24361	2	47.82	CP-2A	67	0.500	> LOQ 0.043	10.456	> LOQ 0.836
24359	3	48.22	CP-2A	67	2.900	> LOQ 0.086	60.141	> LOQ 1.659
24471	OBZ	48.14	CP-2A	67	1.200	> LOQ 0.043	24.927	> LOQ 0.831
24373	1	48.41	CP-2B	68	0.490	> LOQ 0.043	10.122	> LOQ 0.826
24468	2	47.90	CP-2B	68	0.300	> LOQ 0.043	6.263	> LOQ 0.835
24481	3	48.26	CP-2B	68	1.100	> LOQ 0.043	22.793	> LOQ 0.829
24391	OBZ	47.53	CP-2B	68	0.250	> LOQ 0.043	5.26	> LOQ 0.842
24356	1	48.56	O-1	69	ND	< LOD 0.020	ND	< LOD 0.412
24470	2	47.89	O-1	69	ND	< LOD 0.020	ND	< LOD 0.418
24467	3	48.67	O-1	69	0.026	< LOQ 0.043	0.534	< LOQ 0.822
24313	OBZ	47.78	O-1	69	ND	< LOD 0.020	ND	< LOD 0.419
24501	1	47.96	CS-06	70	0.380	> LOQ 0.043	7.923	> LOQ 0.834
24496	2	47.75	CS-06	70	0.950	> LOQ 0.043	19.895	> LOQ 0.838
24478	3	48.31	CS-06	70	1.100	> LOQ 0.043	22.77	> LOQ 0.828
24503	OBZ	48.04	CS-06	70	0.700	> LOQ 0.043	14.571	> LOQ 0.833
24474	1	26.02	SG-1B	71	ND	< LOD 0.020	ND	< LOD 0.769
24469	2	26.02	SG-1B	71	ND	< LOD 0.020	ND	< LOD 0.769
24492	3	26.10	SG-1B	71	ND	< LOD 0.020	ND	< LOD 0.766

Air Sample Results - Yttrium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Yttrium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	0.130	< LOQ 0.220	4.952	< LOQ 8.381
24489	1	48.42	CP-3A	72	0.230	> LOQ 0.043	4.75	> LOQ 0.826
24491	2	47.93	CP-3A	72	0.530	> LOQ 0.043	11.058	> LOQ 0.835
24482	3	48.35	CP-3A	72	2.600	> LOQ 0.043	53.775	> LOQ 0.827
24486	OBZ	48.32	CP-3A	72	2.400	> LOQ 0.043	49.669	> LOQ 0.828
24516	1	36.34	CP-3B	73	0.200	> LOQ 0.043	5.504	> LOQ 1.101
24502	2	36.02	CP-3B	73	1.100	> LOQ 0.043	30.539	> LOQ 1.110
24515	3	36.48	CP-3B	73	1.600	> LOQ 0.043	43.86	> LOQ 1.096
24500	OBZ	40.27	CP-3B	73	0.740	> LOQ 0.043	18.376	> LOQ 0.993
24504	1	48.47	G-7A	74	0.160	> LOQ 0.043	3.301	> LOQ 0.825
24513	2	48.22	G-7A	74	0.350	> LOQ 0.043	7.258	> LOQ 0.830
24458	3	47.94	G-7A	74	0.850	> LOQ 0.043	17.73	> LOQ 0.834
24389	OBZ	47.75	G-7A	74	0.240	> LOQ 0.043	5.026	> LOQ 0.838
24404	1	48.68	G-7B	75	0.130	> LOQ 0.043	2.671	> LOQ 0.822
24451	2	48.06	G-7B	75	0.220	> LOQ 0.043	4.578	> LOQ 0.832
24447	3	47.16	G-7B	75	0.410	> LOQ 0.043	8.694	> LOQ 0.848
24423	OBZ	47.27	G-7B	75	0.150	> LOQ 0.043	3.173	> LOQ 0.846
24456	1	49.19	SS-06	76	0.052	> LOQ 0.043	1.057	> LOQ 0.813
24480	2	48.26	SS-06	76	0.140	> LOQ 0.043	2.901	> LOQ 0.829
24429	3	47.68	SS-06	76	ND	< LOD 0.020	ND	< LOD 0.419
24418	OBZ	47.83	SS-06	76	0.120	> LOQ 0.043	2.509	> LOQ 0.836
24427	1	48.54	CP-4A	78	0.170	> LOQ 0.043	3.502	> LOQ 0.824
24435	2	47.71	CP-4A	78	0.670	> LOQ 0.043	14.043	> LOQ 0.838
24244	3	49.01	CP-4A	78	3.500	> LOQ 0.086	71.414	> LOQ 1.632
24220	OBZ	48.74	CP-4A	78	0.690	> LOQ 0.043	14.157	> LOQ 0.821
24460	1	50.05	CP-4B	79	0.170	> LOQ 0.043	3.397	> LOQ 0.799
24465	2	48.47	CP-4B	79	0.480	> LOQ 0.043	9.903	> LOQ 0.825
24207	3	48.49	CP-4B	79	2.300	> LOQ 0.086	47.432	> LOQ 1.650
24390	OBZ	49.02	CP-4B	79	0.160	> LOQ 0.043	3.264	> LOQ 0.816
24259	1	48.76	SS-07	80	0.038	< LOQ 0.043	0.779	< LOQ 0.820
24421	2	48.13	SS-07	80	0.120	> LOQ 0.043	2.493	> LOQ 0.831
24445	3	47.87	SS-07	80	0.310	> LOQ 0.043	6.476	> LOQ 0.836
24432	OBZ	48.49	SS-07	80	0.047	> LOQ 0.043	0.969	> LOQ 0.825
24459	1	48.96	N-02	81	0.100	> LOQ 0.043	2.042	> LOQ 0.817
24417	2	48.11	N-02	81	0.180	> LOQ 0.043	3.741	> LOQ 0.831
24442	3	48.01	N-02	81	0.780	> LOQ 0.043	16.247	> LOQ 0.833
24386	OBZ	48.19	N-02	81	0.150	> LOQ 0.043	3.113	> LOQ 0.830
24452	1	48.20	SG-2B	82	0.022	< LOQ 0.043	0.456	< LOQ 0.830
24453	2	48.59	SG-2B	82	0.020	< LOQ 0.043	0.412	< LOQ 0.823
24420	3	47.84	SG-2B	82	0.022	< LOQ 0.043	0.46	< LOQ 0.836
24444	OBZ	47.95	SG-2B	82	0.160	< LOQ 0.220	3.337	< LOQ 4.588
24455	1	48.56	CS-07	83	0.610	> LOQ 0.043	12.562	> LOQ 0.824
24433	2	47.96	CS-07	83	1.500	> LOQ 0.043	31.276	> LOQ 0.834
24398	3	48.06	CS-07	83	6.600	> LOQ 0.043	137.328	> LOQ 0.832
24511	OBZ	47.96	CS-07	83	1.400	> LOQ 0.043	29.191	> LOQ 0.834
24454	1	49.34	CPDS-1A	84	0.250	> LOQ 0.043	5.067	> LOQ 0.811
24291	2	48.49	CPDS-1A	84	0.390	> LOQ 0.043	8.043	> LOQ 0.825
24209	3	48.43	CPDS-1A	84	2.500	> LOQ 0.043	51.621	> LOQ 0.826
24402	OBZ	48.77	CPDS-1A	84	1.100	> LOQ 0.043	22.555	> LOQ 0.820
24204	1	49.46	CPDS-1B	85	0.280	> LOQ 0.043	5.661	> LOQ 0.809
24273	2	48.35	CPDS-1B	85	0.480	> LOQ 0.043	9.928	> LOQ 0.827
24223	3	48.82	CPDS-1B	85	2.000	> LOQ 0.043	40.967	> LOQ 0.819

Air Sample Results - Yttrium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Yttrium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24466	OBZ	49.96	CPDS-1B	85	0.400	> LOQ 0.043	8.006	> LOQ 0.801

Airborne Sample Data Analysis - Yttrium

NIOSH REL 1000.0 micrograms/cubic meter
OSHA PEL 1000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 0.412	ND	< LOD 0.417	ND	< LOD 0.413	ND	< LOD 0.414
CS-01	3.708	> LOQ 0.824	11.450	> LOQ 0.833	47.45	> LOQ 0.825	11.06	> LOQ 0.835
CS-02	6.032	> LOQ 0.832	17.559	> LOQ 0.836	72.90	> LOQ 0.833	27.089	> LOQ 0.834
CS-03	5.774	> LOQ 0.825	22.779	> LOQ 0.828	78.81	> LOQ 0.830	22.779	> LOQ 0.828
CS-04	3.292	> LOQ 0.823	9.837	> LOQ 0.837	26.92	> LOQ 0.828	13.586	> LOQ 0.823
CS-05	2.002	> LOQ 0.826	8.346	> LOQ 0.835	20.51	> LOQ 0.837	10.194	> LOQ 1.315
CS-06	7.923	> LOQ 0.834	19.895	> LOQ 0.838	22.77	> LOQ 0.828	14.571	> LOQ 0.833
CS-07	12.562	> LOQ 0.824	31.276	> LOQ 0.834	137.33	> LOQ 0.832	29.191	> LOQ 0.834
CSDS-01	2.907	> LOQ 0.831	16.663	> LOQ 0.833	49.83	> LOQ 0.831	22.883	> LOQ 0.832
CSDS-02	3.503	> LOQ 0.824	13.441	> LOQ 0.827	43.47	> LOQ 0.828	17.371	> LOQ 0.837
N-01	ND	< LOD 0.406	ND	< LOD 0.417	1.72	> LOQ 0.828	1.23	> LOQ 0.820
N-02	2.042	> LOQ 0.817	3.741	> LOQ 0.831	16.25	> LOQ 0.833	3.113	> LOQ 0.830
O-1	ND	< LOD 0.412	ND	< LOD 0.418	0.53	< LOQ 0.822	ND	< LOD 0.419
S-01	2.492	> LOQ 0.831	9.188	> LOQ 0.835	39.67	> LOQ 35.491	12.727	> LOQ 0.835
S-02	6.461	> LOQ 0.834	27.219	> LOQ 0.838	62.50	> LOQ 0.833	19.002	> LOQ 0.835
SH-01	ND	< LOD 0.418	0.481	< LOQ 0.836	3.52	> LOQ 0.829	0.416	< LOQ 0.832
SS-01	ND	< LOD 0.413	0.626	< LOQ 0.835	ND	< LOD 0.414	ND	< LOD 0.414
SS-02	0.416	< LOQ 0.831	1.981	> LOQ 0.834	3.31	> LOQ 0.828	1.501	> LOQ 0.823
SS-03	ND	< LOD 0.416	ND	< LOD 0.420	1.86	> LOQ 0.817	0.504	< LOQ 0.806
SS-04	1.485	> LOQ 0.837	9.209	> LOQ 0.837	13.18	> LOQ 0.837	9.055	> LOQ 0.823
SS-05	ND	< LOD 0.402	0.86	< LOQ 0.839	3.12	> LOQ 0.831	1.619	> LOQ 0.820
SS-06	1.057	> LOQ 0.813	2.901	> LOQ 0.829	ND	< LOD 0.419	2.509	> LOQ 0.836
SS-07	0.779	< LOQ 0.820	2.493	> LOQ 0.831	6.48	> LOQ 0.836	0.969	> LOQ 0.825
SSDS-01	ND	< LOD 0.412	ND	< LOD 0.418	0.52	< LOQ 0.825	0.435	< LOQ 0.828
SSDS-02	0.708	< LOQ 0.834	4.583	> LOQ 0.833	13.62	> LOQ 0.825	4.861	> LOQ 0.810
SSDS-03	ND	< LOD 0.404	ND	< LOD 0.397	0.82	< LOQ 0.796	0.539	< LOQ 0.829
CP-1A	ND	< LOD 0.412	2.051	> LOQ 0.829	3.11	> LOQ 0.830	1.55	> LOQ 0.838
CP-1B	0.589	< LOQ 0.943	1.142	> LOQ 0.952	6.36	> LOQ 0.942	1.101	> LOQ 0.958
CP-2A	3.92	> LOQ 0.825	10.456	> LOQ 0.836	60.14	> LOQ 1.659	24.927	> LOQ 0.831
CP-2B	10.122	> LOQ 0.826	6.263	> LOQ 0.835	22.79	> LOQ 0.829	5.26	> LOQ 0.842
CP-3A	4.75	> LOQ 0.826	11.058	> LOQ 0.835	53.78	> LOQ 0.827	49.669	> LOQ 0.828
CP-3B	5.504	> LOQ 1.101	30.539	> LOQ 1.110	43.86	> LOQ 1.096	18.376	> LOQ 0.993
CP-4A	3.502	> LOQ 0.824	14.043	> LOQ 0.838	71.41	> LOQ 1.632	14.157	> LOQ 0.821
CP-4B	3.397	> LOQ 0.799	9.903	> LOQ 0.825	47.43	> LOQ 1.650	3.264	> LOQ 0.816
CPDS-1A	5.067	> LOQ 0.811	8.043	> LOQ 0.825	51.62	> LOQ 0.826	22.555	> LOQ 0.820
CPDS-1B	5.661	> LOQ 0.809	9.928	> LOQ 0.827	40.97	> LOQ 0.819	8.006	> LOQ 0.801
G-1A	3.948	> LOQ 0.831	14.414	> LOQ 0.836	51.90	> LOQ 0.830	38.847	> LOQ 0.818
G-1B	2.486	> LOQ 0.829	21.106	> LOQ 0.844	26.99	> LOQ 0.830	31.107	> LOQ 0.830
G-2A	5.058	> LOQ 0.843	31.834	> LOQ 0.849	51.82	> LOQ 0.829	18.734	> LOQ 0.833
G-2B	7.993	> LOQ 0.820	70.583	> LOQ 0.830	43.92	> LOQ 0.837	14.627	> LOQ 0.824
G-3A	19.032	> LOQ 0.827	54.043	> LOQ 0.831	209.86	> LOQ 0.839	22.921	> LOQ 0.834
G-4A	42.648	> LOQ 0.812	49.618	> LOQ 0.827	328.75	> LOQ 0.822	99.668	> LOQ 0.831
G-4B	11.782	> LOQ 0.827	112.477	> LOQ 0.833	194.30	> LOQ 0.827	95.002	> LOQ 0.826
G-5A	4.117	> LOQ 0.823	18.888	> LOQ 0.830	66.60	> LOQ 0.832	96.174	> LOQ 0.836
G-5B	10.443	> LOQ 0.835	45.681	> LOQ 0.831	147.98	> LOQ 0.834	20.213	> LOQ 0.834
G-6A	18.295	> LOQ 0.832	87.793	> LOQ 0.836	172.70	> LOQ 0.832	33.133	> LOQ 0.828
G-6B	3.486	> LOQ 0.820	44.257	> LOQ 0.843	32.71	> LOQ 0.818	39.208	> LOQ 0.825
G-7A	3.301	> LOQ 0.825	7.258	> LOQ 0.830	17.73	> LOQ 0.834	5.026	> LOQ 0.838
G-7B	2.671	> LOQ 0.822	4.578	> LOQ 0.832	8.69	> LOQ 0.848	3.173	> LOQ 0.846
SG-1A	ND	< LOD 0.408	ND	< LOD 0.415	ND	< LOD 0.415	0.784	< LOQ 0.825
SG-1B	ND	< LOD 0.769	ND	< LOD 0.769	ND	< LOD 0.766	4.952	< LOQ 8.381
SG-2A	ND	< LOD 0.412	ND	< LOD 0.418	12.85	> LOQ 0.829	0.828	< LOQ 1.656
SG-2B	0.456	< LOQ 0.830	0.412	< LOQ 0.823	0.46	< LOQ 0.836	3.337	< LOQ 4.588

Bulk Elemental Analysis - Yttrium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Yttrium		Sample	Yttrium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	0.07	< LOQ 0.17	J95331-63 PB	0.07	< LOQ 0.17
CS-01	J95331-34 VB	18.00	> LOQ 0.17	J95331-34 PB	16.00	> LOQ 0.17
CS-02	J95331-37 VB	13.00	> LOQ 0.17	J95331-37 PB	13.00	> LOQ 0.17
CS-03	J95331-38 VB	27.00	> LOQ 0.17	J95331-38 PB	32.00	> LOQ 0.17
CS-04	J95331-39 VB	1.30	> LOQ 0.17	J95331-39 PB	1.70	> LOQ 0.17
CS-05	J95331-57 VB	0.78	> LOQ 0.17	J95331-57 PB	1.50	> LOQ 0.17
CS-06	J95331-70 VB	1.00	> LOQ 0.17	J95331-70 PB	2.00	> LOQ 0.17
CS-07	J95331-83 VB	3.90	> LOQ 0.17	J95331-83 PB	8.50	> LOQ 0.17
CSDS-01	J95331-31 VB	1.80	> LOQ 0.17	J95331-31 PB	4.10	> LOQ 0.17
CSDS-02	J95331-35 VB	15.00	> LOQ 0.17	J95331-35 PB	16.00	> LOQ 0.17
N-01	J95331-52 VB	0.20	> LOQ 0.17	J95331-52 PB	0.09	< LOQ 1.7
N-02	J95331-81 VB	1.60	> LOQ 0.17	J95331-81 PB	3.40	> LOQ 0.17
O-1	J95331-69 VB	ND	< LOD 0.05	J95331-69 PB	ND	< LOD 0.05
S-01	J95331-28 VB	3.90	> LOQ 0.17	J95331-28 PB	2.70	> LOQ 0.17
S-02	J95331-29 VB	2.20	> LOQ 0.17	J95331-29 PB	14.00	> LOQ 0.17
SH-01	J95331-36 VB	0.94	> LOQ 0.17	J95331-36 PB	0.84	> LOQ 0.17
SS-01	J95331-32 VB	ND	< LOD 0.05	J95331-32 PB	0.30	> LOQ 0.17
SS-02	J95331-40 VB	0.14	< LOQ 0.17	J95331-40 PB	0.12	< LOQ 0.17
SS-03	J95331-45 VB	0.13	< LOQ 0.17	J95331-45 PB	0.18	> LOQ 0.17
SS-04	J95331-47 VB	3.20	> LOQ 0.17	J95331-47 PB	20.00	> LOQ 0.17
SS-05	J95331-53 VB	0.47	> LOQ 0.17	J95331-53 PB	0.34	> LOQ 0.17
SS-06	J95331-76 VB	0.95	> LOQ 0.17	J95331-76 PB	1.00	> LOQ 0.17
SS-07	J95331-80 VB	0.67	> LOQ 0.17	J95331-80 PB	0.37	> LOQ 0.17
SSDS-01	J95331-33 VB	0.09	< LOQ 0.17	J95331-33 PB	0.07	< LOQ 0.17
SSDS-02	J95331-44 VB	3.00	> LOQ 0.17	J95331-44 PB	3.90	> LOQ 0.17
SSDS-03	J95331-48 VB	0.19	> LOQ 0.17	J95331-48 PB	0.21	> LOQ 0.17
CP-1A	J95331-60 VB	0.40	> LOQ 0.17	J95331-60 PB	1.40	> LOQ 0.17
CP-1B	J95331-61 VB	3.00	> LOQ 0.17	J95331-61 PB	4.10	> LOQ 0.17
CP-2A	J95331-67 VB	10.00	> LOQ 0.17	J95331-67 PB	14.00	> LOQ 0.34
CP-2B	J95331-68 VB	13.00	> LOQ 0.34	J95331-68 PB	14.00	> LOQ 0.34
CP-3A	J95331-72 VB	12.00	> LOQ 0.17	J95331-72 PB	12.00	> LOQ 0.17
CP-3B	J95331-73 VB	14.00	> LOQ 0.17	J95331-73 PB	13.00	> LOQ 0.17
CP-4A	J95331-78 VB	3.60	> LOQ 0.17	J95331-78 PB	6.60	> LOQ 0.34
CP-4B	J95331-79 VB	7.10	> LOQ 0.17	J95331-79 PB	7.50	> LOQ 0.17
CPDS-1A	J95331-84 VB	6.80	> LOQ 0.17	J95331-84 PB	11.00	> LOQ 0.17
CPDS-1B	J95331-85 VB	10.00	> LOQ 0.17	J95331-85 PB	11.00	> LOQ 0.17
G-1A	J95331-41 VB	1.90	> LOQ 0.17	J95331-41 PB	3.60	> LOQ 0.17
G-1B	J95331-46 VB	3.30	> LOQ 0.17	J95331-46 PB	4.50	> LOQ 0.17
G-2A	J95331-43 VB	2.70	> LOQ 0.17	J95331-43 PB	9.30	> LOQ 0.17
G-2B	J95331-50 VB	10.00	> LOQ 0.17	J95331-50 PB	6.80	> LOQ 0.17
G-3A	J95331-49 VB	6.40	> LOQ 0.17	J95331-49 PB	3.60	> LOQ 0.17
G-4A	J95331-55 VB	5.40	> LOQ 0.17	J95331-55 PB	14.00	> LOQ 0.17
G-4B	J95331-56 VB	15.00	> LOQ 0.17	J95331-56 PB	14.00	> LOQ 0.17
G-5A	J95331-58 VB	4.40	> LOQ 0.17	J95331-58 PB	5.50	> LOQ 0.17
G-5B	J95331-59 VB	5.50	> LOQ 0.17	J95331-59 PB	4.60	> LOQ 0.17
G-6A	J95331-64 VB	3.80	> LOQ 0.17	J95331-64 PB	6.10	> LOQ 0.17
G-6B	J95331-65 VB	8.20	> LOQ 0.17	J95331-65 PB	5.20	> LOQ 0.17
G-7A	J95331-74 VB	1.30	> LOQ 0.17	J95331-74 PB	1.20	> LOQ 0.17
G-7B	J95331-75 VB	3.80	> LOQ 0.17	J95331-75 PB	2.30	> LOQ 0.17
SG-1A	J95331-54 VB	ND	< LOD .85	J95331-54 PB	ND	< LOD 0.25
SG-1B	J95331-71 VB	ND	< LOD 0.25	J95331-71 PB	ND	< LOD 0.25
SG-2A	J95331-66 VB	ND	< LOD 0.25	J95331-66 PB	0.43	< LOQ 0.85
SG-2B	J95331-82 VB	ND	< LOD 0.25	J95331-82 PB	ND	< LOD 0.25

Comparison of Airborne Concentrations to Bulk Concentrations - Yttrium

NIOSH REL 1000.0 micrograms/cubic meter
OSHA PEL 1000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	ND	ND	ND	0.07
CS-01	3.71	11.46	47.45	11.06	18.00
CS-02	6.03	17.56	72.90	27.09	13.00
CS-03	5.77	22.78	78.81	22.78	27.00
CS-04	3.29	9.84	26.92	13.59	1.30
CS-05	2.00	8.35	20.51	10.19	0.78
CS-06	7.92	19.90	22.77	14.57	1.00
CS-07	12.56	31.28	137.33	29.19	3.90
CSDS-01	2.91	16.66	49.83	22.88	1.80
CSDS-02	3.50	13.44	43.47	17.37	15.00
N-01	ND	ND	1.72	1.23	0.20
N-02	2.04	3.74	16.25	3.11	1.60
O-1	ND	ND	0.53	ND	ND
S-01	2.49	9.19	39.67	12.73	3.90
S-02	6.46	27.22	62.50	19.00	2.20
SH-01	ND	0.48	3.52	0.42	0.94
SS-01	ND	0.63	ND	ND	ND
SS-02	0.42	1.98	3.31	1.50	0.14
SS-03	ND	ND	1.86	0.50	0.13
SS-04	1.49	9.21	13.18	9.06	3.20
SS-05	ND	0.86	3.12	1.62	0.47
SS-06	1.06	2.90	ND	2.51	0.95
SS-07	0.78	2.49	6.48	0.97	0.67
SSDS-01	ND	ND	0.52	0.44	0.09
SSDS-02	0.71	4.58	13.62	4.86	3.00
SSDS-03	ND	ND	0.82	0.54	0.19
CP-1A	ND	2.05	3.11	1.55	0.40
CP-2A	3.92	10.46	60.14	24.93	10.00
CP-3A	4.75	11.06	53.78	49.67	12.00
CP-4A	3.50	14.04	71.41	14.16	3.60
CPDS-1A	5.07	8.04	51.62	22.56	6.80
G-1A	3.95	14.41	51.90	38.85	1.90
G-2A	5.06	31.83	51.82	18.73	2.70
G-3A	19.03	54.04	209.86	22.92	6.40
G-4A	42.65	49.62	328.75	99.67	5.40
G-5A	4.12	18.89	66.60	96.17	4.40
G-6A	18.30	87.79	172.70	33.13	3.80
G-7A	3.30	7.26	17.73	5.03	1.30
SG-1A	ND	ND	ND	0.78	ND
SG-2A	ND	ND	12.85	0.83	ND

APPENDIX B - ZINC

Zinc

Zinc dust is generally considered to be a nuisance dust and have little or no adverse effect on the lungs and does not produce any significant organic disease when exposures are kept under reasonable control. The NIOSH REL and OSHA PEL for zinc are 5,000 and 15,000 micrograms/cubic meter of air, respectively.

Air Sample Results - Zinc

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zinc			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.53	< LOQ 1.7	11	< LOQ 35.30
24412	2	47.89	S-01	28	ND	< LOD 0.5	ND	< LOD 10.44
24441	3	47.90	S-01	28	3.30	> LOQ 1.7	68.89	> LOQ 35.49
24450	OBZ	47.93	S-01	28	0.78	< LOQ 1.7	16.27	< LOQ 35.47
24643	1	47.98	S-02	29	ND	< LOD 0.5	ND	< LOD 10.42
24625	2	47.76	S-02	29	0.97	< LOQ 1.7	20.31	< LOQ 35.59
24642	3	48.00	S-02	29	0.94	< LOQ 1.7	19.58	< LOQ 35.42
24632	OBZ	47.89	S-02	29	ND	< LOD 0.5	ND	< LOD 10.44
24634	1	48.16	CSDS-01	31	ND	< LOD 0.5	ND	< LOD 10.38
24650	2	48.01	CSDS-01	31	0.64	< LOQ 1.7	13.33	< LOQ 35.41
24644	3	48.16	CSDS-01	31	5.80	> LOQ 1.7	120.43	> LOQ 35.30
24645	OBZ	48.07	CSDS-01	31	1.10	< LOQ 1.7	22.88	< LOQ 35.37
24640	1	48.44	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.32
24641	2	47.90	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.44
24651	3	48.35	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.34
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.5	ND	< LOD 10.35
24646	1	48.58	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.29
24626	2	47.84	SSDS-01	33	0.59	< LOQ 1.7	12.33	< LOQ 35.54
24638	3	48.49	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.31
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.5	ND	< LOD 10.35
24628	1	48.55	CS-01	34	ND	< LOD 0.5	ND	< LOD 10.30
24637	2	48.00	CS-01	34	2.10	> LOQ 1.7	43.75	> LOQ 35.42
24624	3	48.47	CS-01	34	2.90	> LOQ 1.7	59.83	> LOQ 35.07
24636	OBZ	47.92	CS-01	34	1.30	< LOQ 1.7	27.13	< LOQ 35.48
24623	1	48.53	CSDS-02	35	ND	< LOD 0.5	ND	< LOD 10.30
24622	2	48.36	CSDS-02	35	1.20	< LOQ 1.7	24.81	< LOQ 35.15
24654	3	48.31	CSDS-02	35	1.60	< LOQ 1.7	33.12	< LOQ 35.19
24653	OBZ	47.78	CSDS-02	35	0.67	< LOQ 1.7	14.02	< LOQ 35.58
24629	1	47.88	SH-01	36	1.20	< LOQ 1.7	25.06	< LOQ 35.51
24633	2	47.86	SH-01	36	1.50	< LOQ 1.7	31.34	< LOQ 35.52
24627	3	48.24	SH-01	36	2.50	> LOQ 1.7	51.82	> LOQ 35.24
24648	OBZ	48.08	SH-01	36	1.40	< LOQ 1.7	29.12	< LOQ 35.36
24555	1	48.08	CS-02	37	1.70	> LOQ 1.7	35.36	> LOQ 35.36
24552	2	47.84	CS-02	37	3.00	> LOQ 1.7	62.71	> LOQ 35.54
24541	3	48.01	CS-02	37	7.30	> LOQ 1.7	152.05	> LOQ 35.41
24529	OBZ	47.99	CS-02	37	3.70	> LOQ 1.7	77.1	> LOQ 35.42
24558	1	48.49	CS-03	38	2.10	> LOQ 1.7	43.31	> LOQ 35.06
24524	2	48.29	CS-03	38	4.80	> LOQ 1.7	99.4	> LOQ 35.20
24561	3	48.22	CS-03	38	16.00	> LOQ 1.7	331.81	> LOQ 35.26
24559	OBZ	48.29	CS-03	38	5.80	> LOQ 1.7	120.11	> LOQ 35.20
24543	1	48.61	CS-04	39	1.20	< LOQ 1.7	24.69	< LOQ 34.97
24532	2	47.78	CS-04	39	1.70	> LOQ 1.7	35.58	> LOQ 35.58
24546	3	48.29	CS-04	39	1.80	> LOQ 1.7	37.27	> LOQ 35.20
24557	OBZ	48.58	CS-04	39	1.50	< LOQ 1.7	30.88	< LOQ 34.99
24560	1	48.13	SS-02	40	1.10	< LOQ 1.7	22.85	< LOQ 35.32
24565	2	47.95	SS-02	40	1.50	< LOQ 1.7	31.28	< LOQ 35.45
24630	3	48.32	SS-02	40	1.80	> LOQ 1.7	37.25	> LOQ 35.18
24553	OBZ	48.62	SS-02	40	1.40	< LOQ 1.7	28.79	< LOQ 34.97
24525	1	48.13	G-1A	41	1.30	< LOQ 1.7	27.01	< LOQ 35.32
24563	2	47.87	G-1A	41	2.00	> LOQ 1.7	41.78	> LOQ 35.51
24547	3	48.17	G-1A	41	3.40	> LOQ 1.7	70.58	> LOQ 35.29
24526	OBZ	48.91	G-1A	41	3.20	> LOQ 1.7	65.43	> LOQ 34.76
24538	1	47.45	G-2A	43	1.20	< LOQ 1.7	25.29	< LOQ 35.83

Air Sample Results - Zinc

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zinc			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	1.50	< LOQ 1.7	31.83	< LOQ 36.08
24533	3	48.24	G-2A	43	1.70	> LOQ 1.7	35.24	> LOQ 35.24
24540	OBZ	48.04	G-2A	43	1.70	> LOQ 1.7	35.39	> LOQ 35.39
24528	1	47.99	SSDS-02	44	1.20	< LOQ 1.7	25.01	< LOQ 35.42
24544	2	48.00	SSDS-02	44	1.70	> LOQ 1.7	35.42	> LOQ 35.42
24567	3	48.46	SSDS-02	44	2.20	> LOQ 1.7	45.4	> LOQ 35.08
24539	OBZ	49.37	SSDS-02	44	1.60	< LOQ 1.7	32.41	< LOQ 34.43
24571	1	48.05	SS-03	45	1.10	< LOQ 1.7	22.89	< LOQ 35.38
24536	2	47.60	SS-03	45	1.20	< LOQ 1.7	25.21	< LOQ 35.71
24534	3	48.94	SS-03	45	1.30	< LOQ 1.7	26.56	< LOQ 34.74
24570	OBZ	49.61	SS-03	45	1.30	< LOQ 1.7	26.2	< LOQ 34.27
24568	1	48.28	G-1B	46	0.91	< LOQ 1.7	18.85	< LOQ 35.21
24592	2	47.38	G-1B	46	2.10	> LOQ 1.7	44.32	> LOQ 35.88
24593	3	48.17	G-1B	46	2.30	> LOQ 1.7	47.75	> LOQ 35.29
24535	OBZ	48.22	G-1B	46	2.50	> LOQ 1.7	51.85	> LOQ 35.26
24590	1	47.81	SS-04	47	0.97	< LOQ 1.7	20.29	< LOQ 35.56
24605	2	47.78	SS-04	47	3.40	> LOQ 1.7	71.16	> LOQ 35.58
24562	3	47.80	SS-04	47	2.10	> LOQ 1.7	43.93	> LOQ 35.56
24531	OBZ	48.59	SS-04	47	1.80	> LOQ 1.7	37.04	> LOQ 34.99
24527	1	49.48	SSDS-03	48	0.89	< LOQ 1.7	17.99	< LOQ 34.36
24569	2	50.35	SSDS-03	48	1.00	< LOQ 1.7	19.86	< LOQ 33.76
24584	3	50.24	SSDS-03	48	1.00	< LOQ 1.7	19.9	< LOQ 33.84
24579	OBZ	48.26	SSDS-03	48	1.10	< LOQ 1.7	22.79	< LOQ 35.23
24600	1	48.34	G-3A	49	1.30	< LOQ 1.7	26.89	< LOQ 35.17
24616	2	48.11	G-3A	49	3.00	> LOQ 1.7	62.36	> LOQ 35.34
24585	3	47.65	G-3A	49	1.50	< LOQ 1.7	31.48	< LOQ 35.68
24583	OBZ	47.99	G-3A	49	1.30	< LOQ 1.7	27.09	< LOQ 35.42
24587	1	48.79	G-2B	50	1.00	< LOQ 1.7	20.5	< LOQ 34.84
24602	2	48.17	G-2B	50	1.70	> LOQ 1.7	35.29	> LOQ 35.29
24564	3	47.81	G-2B	50	1.20	< LOQ 1.7	25.1	< LOQ 35.56
24621	OBZ	48.54	G-2B	50	2.80	> LOQ 1.7	57.68	> LOQ 35.02
24618	1	49.21	N-01	52	3.20	> LOQ 1.7	65.03	> LOQ 34.55
24611	2	47.96	N-01	52	2.70	> LOQ 1.7	56.3	> LOQ 35.45
24588	3	48.32	N-01	52	6.80	> LOQ 1.7	140.73	> LOQ 35.18
24615	OBZ	48.80	N-01	52	6.20	> LOQ 1.7	127.05	> LOQ 34.84
24597	1	49.78	SS-05	53	1.10	< LOQ 1.7	22.1	< LOQ 34.15
24599	2	47.68	SS-05	53	1.40	< LOQ 1.7	29.36	< LOQ 35.65
24575	3	48.11	SS-05	53	2.00	> LOQ 1.7	41.57	> LOQ 35.34
24617	OBZ	48.79	SS-05	53	3.50	> LOQ 1.7	71.74	> LOQ 34.84
24609	1	48.98	SG-1A	54	3.00	> LOQ 1.7	61.25	> LOQ 34.71
24596	2	48.20	SG-1A	54	1.20	< LOQ 1.7	24.9	< LOQ 35.27
24610	3	48.18	SG-1A	54	1.30	< LOQ 1.7	26.98	< LOQ 35.28
24576	OBZ	48.47	SG-1A	54	ND	< LOD 2.5	ND	< LOD 51.58
24606	1	49.24	G-4A	55	3.20	> LOQ 1.7	64.99	> LOQ 34.52
24620	2	48.37	G-4A	55	3.10	> LOQ 1.7	64.09	> LOQ 35.15
24573	3	48.67	G-4A	55	2.30	> LOQ 1.7	47.26	> LOQ 34.93
24505	OBZ	48.16	G-4A	55	1.70	< LOQ 1.7	35.3	< LOQ 35.30
24340	1	48.38	G-4B	56	1.30	< LOQ 1.7	26.87	< LOQ 35.14
24607	2	48.01	G-4B	56	1.80	> LOQ 1.7	37.49	> LOQ 35.41
24595	3	48.38	G-4B	56	2.30	> LOQ 1.7	47.54	> LOQ 35.14
24598	OBZ	48.42	G-4B	56	1.70	> LOQ 1.7	35.11	> LOQ 35.11
24580	1	48.44	CS-05	57	1.40	< LOQ 1.7	28.9	< LOQ 35.09
24604	2	47.93	CS-05	57	1.70	> LOQ 1.7	35.47	> LOQ 35.47

Air Sample Results - Zinc

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zinc			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24335	3	47.78	CS-05	57	2.50	> LOQ 1.7	52.32	> LOQ 35.58
24574	OBZ	30.41	CS-05	57	1.80	> LOQ 1.7	59.19	> LOQ 55.90
24614	1	48.58	G-5A	58	1.30	< LOQ 1.7	26.76	< LOQ 34.99
24577	2	48.18	G-5A	58	1.70	> LOQ 1.7	35.28	> LOQ 35.28
24572	3	48.05	G-5A	58	2.60	> LOQ 1.7	54.11	> LOQ 35.38
24582	OBZ	47.83	G-5A	58	3.10	> LOQ 1.7	64.81	> LOQ 35.54
24322	1	47.88	G-5B	59	1.70	> LOQ 1.7	35.51	> LOQ 35.51
24354	2	48.16	G-5B	59	2.80	> LOQ 1.7	58.14	> LOQ 35.30
24510	3	47.98	G-5B	59	4.30	> LOQ 1.7	89.62	> LOQ 35.43
24321	OBZ	47.99	G-5B	59	1.70	> LOQ 1.7	35.42	> LOQ 35.42
24497	1	48.49	CP-1A	60	5.30	> LOQ 1.7	109.3	> LOQ 35.06
24333	2	48.28	CP-1A	60	16.00	> LOQ 1.7	331.4	> LOQ 35.21
24326	3	48.19	CP-1A	60	50.00	> LOQ 1.7	1037.56	> LOQ 35.28
24329	OBZ	47.74	CP-1A	60	17.00	> LOQ 1.7	356.1	> LOQ 35.61
24499	1	42.42	CP-1B	62	6.90	> LOQ 1.7	162.66	> LOQ 40.08
24506	2	42.02	CP-1B	62	16.00	> LOQ 1.7	380.77	> LOQ 40.46
24388	3	42.47	CP-1B	62	65.00	> LOQ 1.7	1530.49	> LOQ 40.03
24315	OBZ	41.77	CP-1B	62	17.00	> LOQ 1.7	406.99	> LOQ 40.70
24318	1	48.56	CG-01	63	1.80	> LOQ 1.7	37.07	> LOQ 35.01
24308	2	48.00	CG-01	63	2.00	> LOQ 1.7	41.67	> LOQ 35.42
24330	3	48.47	CG-01	63	2.50	> LOQ 1.7	51.58	> LOQ 35.07
24230	OBZ	48.31	CG-01	63	3.10	> LOQ 1.7	64.17	> LOQ 35.19
24363	1	48.10	G-6A	64	2.00	> LOQ 1.7	41.58	> LOQ 35.34
24398	2	47.84	G-6A	64	4.10	> LOQ 1.7	85.7	> LOQ 35.54
24351	3	48.06	G-6A	64	5.30	> LOQ 1.7	110.28	> LOQ 35.37
24594	OBZ	48.29	G-6A	64	2.90	> LOQ 1.7	60.05	> LOQ 35.20
24312	1	48.76	G-6B	65	1.40	< LOQ 1.7	28.71	< LOQ 34.86
24484	2	47.45	G-6B	65	2.30	> LOQ 1.7	48.47	> LOQ 35.83
24327	3	48.92	G-6B	65	2.50	> LOQ 1.7	51.1	> LOQ 34.75
24389	OBZ	48.46	G-6B	65	2.60	> LOQ 1.7	53.65	> LOQ 35.08
24348	1	48.59	SG-2A	66	2.20	> LOQ 1.7	45.28	> LOQ 34.99
24314	2	47.90	SG-2A	66	2.40	> LOQ 1.7	50.1	> LOQ 35.49
24494	3	48.24	SG-2A	66	2.90	< LOQ 3.4	60.12	< LOQ 70.48
24337	OBZ	48.30	SG-2A	66	8.70	> LOQ 3.4	180.12	> LOQ 70.39
24508	1	48.47	CP-2A	67	3.00	> LOQ 1.7	61.89	> LOQ 35.07
24361	2	47.82	CP-2A	67	5.40	> LOQ 1.7	112.92	> LOQ 35.55
24359	3	48.22	CP-2A	67	25.00	> LOQ 3.4	518.46	> LOQ 70.51
24471	OBZ	48.14	CP-2A	67	10.00	> LOQ 1.7	207.73	> LOQ 35.31
24373	1	48.41	CP-2B	68	5.30	> LOQ 1.7	109.48	> LOQ 35.12
24468	2	47.90	CP-2B	68	3.10	> LOQ 1.7	64.72	> LOQ 35.49
24481	3	48.26	CP-2B	68	9.70	> LOQ 1.7	200.99	> LOQ 35.23
24391	OBZ	47.53	CP-2B	68	3.40	> LOQ 1.7	71.53	> LOQ 35.77
24356	1	48.56	O-1	69	2.50	> LOQ 1.7	51.48	> LOQ 35.01
24470	2	47.89	O-1	69	2.00	> LOQ 1.7	41.76	> LOQ 35.50
24467	3	48.67	O-1	69	3.70	> LOQ 1.7	76.02	> LOQ 34.93
24313	OBZ	47.78	O-1	69	2.60	> LOQ 1.7	54.42	> LOQ 35.58
24501	1	47.96	CS-06	70	1.30	< LOQ 1.7	27.11	< LOQ 35.45
24496	2	47.75	CS-06	70	1.70	> LOQ 1.7	35.6	> LOQ 35.60
24478	3	48.31	CS-06	70	1.80	> LOQ 1.7	37.26	> LOQ 35.19
24503	OBZ	48.04	CS-06	70	1.70	> LOQ 1.7	35.39	> LOQ 35.39
24474	1	26.02	SG-1B	71	1.80	> LOQ 1.7	69.18	> LOQ 65.33
24469	2	26.02	SG-1B	71	2.00	> LOQ 1.7	76.86	> LOQ 65.33
24492	3	26.10	SG-1B	71	1.90	> LOQ 1.7	72.8	> LOQ 65.13

Air Sample Results - Zinc

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zinc			
					µg/filter	Filter Notes µg/f	Result µg/m^3	Result Notes
24495	OBZ	26.25	SG-1B	71	2.50	> LOQ 8.5	95.24	> LOQ 323.81
24489	1	48.42	CP-3A	72	100.00	> LOQ 1.7	2065.26	> LOQ 35.11
24491	2	47.93	CP-3A	72	320.00	> LOQ 1.7	6676.4	> LOQ 35.47
24482	3	48.35	CP-3A	72	1400.00	> LOQ 1.7	28955.53	> LOQ 35.16
24486	OBZ	48.32	CP-3A	72	1200.00	> LOQ 1.7	24834.44	> LOQ 35.18
24516	1	36.34	CP-3B	73	110.00	> LOQ 1.7	3026.97	> LOQ 46.78
24502	2	36.02	CP-3B	73	540.00	> LOQ 1.7	14991.67	> LOQ 47.20
24515	3	36.48	CP-3B	73	900.00	> LOQ 1.7	24671.05	> LOQ 46.60
24500	OBZ	40.27	CP-3B	73	370.00	> LOQ 1.7	9187.98	> LOQ 42.22
24504	1	48.47	G-7A	74	1.00	< LOQ 1.7	20.63	< LOQ 35.07
24513	2	48.22	G-7A	74	1.70	> LOQ 1.7	35.26	> LOQ 35.26
24458	3	47.94	G-7A	74	3.30	> LOQ 1.7	68.84	> LOQ 35.46
24389	OBZ	47.75	G-7A	74	2.00	> LOQ 1.7	41.88	> LOQ 35.60
24404	1	48.68	G-7B	75	1.40	< LOQ 1.7	28.76	< LOQ 34.92
24451	2	48.06	G-7B	75	2.30	> LOQ 1.7	47.86	> LOQ 35.37
24447	3	47.16	G-7B	75	2.50	> LOQ 1.7	53.01	> LOQ 36.05
24423	OBZ	47.27	G-7B	75	2.40	> LOQ 1.7	50.77	> LOQ 35.96
24456	1	49.19	SS-06	76	1.20	< LOQ 1.7	24.4	< LOQ 34.56
24480	2	48.26	SS-06	76	1.30	< LOQ 1.7	26.94	< LOQ 35.23
24429	3	47.68	SS-06	76	5.90	> LOQ 1.7	123.74	> LOQ 35.65
24418	OBZ	47.83	SS-06	76	1.50	< LOQ 1.7	31.36	< LOQ 35.54
24427	1	48.54	CP-4A	78	190.00	> LOQ 1.7	3914.3	> LOQ 35.02
24435	2	47.71	CP-4A	78	890.00	> LOQ 1.7	18654.37	> LOQ 35.63
24244	3	49.01	CP-4A	78	5500.00	> LOQ 3.4	112222	> LOQ 69.37
24220	OBZ	48.74	CP-4A	78	1200.00	> LOQ 1.7	24620.43	> LOQ 34.88
24460	1	50.05	CP-4B	79	250.00	> LOQ 1.7	4995	> LOQ 33.97
24465	2	48.47	CP-4B	79	750.00	> LOQ 1.7	15473.49	> LOQ 35.07
24207	3	48.49	CP-4B	79	3800.00	> LOQ 3.4	78366.67	> LOQ 70.12
24390	OBZ	49.02	CP-4B	79	210.00	> LOQ 1.7	4283.97	> LOQ 34.68
24259	1	48.76	SS-07	80	2.10	> LOQ 1.7	43.07	> LOQ 34.86
24421	2	48.13	SS-07	80	2.80	> LOQ 1.7	58.18	> LOQ 35.32
24445	3	47.87	SS-07	80	4.00	> LOQ 1.7	83.56	> LOQ 35.51
24432	OBZ	48.49	SS-07	80	3.30	> LOQ 1.7	68.06	> LOQ 35.06
24459	1	48.96	N-02	81	4.10	> LOQ 1.7	83.74	> LOQ 34.72
24417	2	48.11	N-02	81	8.10	> LOQ 1.7	168.36	> LOQ 35.34
24442	3	48.01	N-02	81	30.00	> LOQ 1.7	624.87	> LOQ 35.41
24386	OBZ	48.19	N-02	81	7.70	> LOQ 1.7	159.78	> LOQ 35.28
24452	1	48.20	SG-2B	82	2.00	> LOQ 1.7	41.49	> LOQ 35.27
24453	2	48.59	SG-2B	82	2.70	> LOQ 1.7	55.57	> LOQ 34.99
24420	3	47.84	SG-2B	82	2.20	> LOQ 1.7	45.99	> LOQ 35.54
24444	OBZ	47.95	SG-2B	82	9.80	> LOQ 8.5	204.38	> LOQ 177.27
24455	1	48.56	CS-07	83	3.80	> LOQ 1.7	78.25	> LOQ 35.01
24433	2	47.96	CS-07	83	3.70	> LOQ 1.7	77.15	> LOQ 35.45
24398	3	48.06	CS-07	83	8.70	> LOQ 1.7	181.02	> LOQ 35.37
24511	OBZ	47.96	CS-07	83	3.20	> LOQ 1.7	66.72	> LOQ 35.45
24454	1	49.34	CPDS-1A	84	3.70	> LOQ 1.7	74.99	> LOQ 34.45
24291	2	48.49	CPDS-1A	84	4.70	> LOQ 1.7	96.93	> LOQ 35.06
24209	3	48.43	CPDS-1A	84	25.00	> LOQ 1.7	516.21	> LOQ 35.10
24402	OBZ	48.77	CPDS-1A	84	10.00	> LOQ 1.7	205.04	> LOQ 34.86
24204	1	49.46	CPDS-1B	85	4.10	> LOQ 1.7	82.9	> LOQ 34.37
24273	2	48.35	CPDS-1B	85	5.80	> LOQ 1.7	119.96	> LOQ 35.16
24223	3	48.82	CPDS-1B	85	22.00	> LOQ 1.7	450.63	> LOQ 34.82
24466	OBZ	49.96	CPDS-1B	85	4.40	> LOQ 1.7	88.07	> LOQ 34.03

Airborne Sample Data Analysis - Zinc

NIOSH REL 5000.0 micrograms/cubic meter
OSHA PEL 15000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	37.07	> LOQ 35.01	41.67	> LOQ 35.42	51.58	> LOQ 35.07	64.17	> LOQ 35.19
CS-01	ND	< LOD 10.30	43.75	> LOQ 35.42	59.83	> LOQ 35.07	27.13	< LOQ 35.48
CS-02	35.36	> LOQ 35.36	62.71	> LOQ 35.54	152.05	> LOQ 35.41	77.1	> LOQ 35.42
CS-03	43.31	> LOQ 35.06	99.4	> LOQ 35.20	331.81	> LOQ 35.26	120.11	> LOQ 35.20
CS-04	24.69	< LOQ 34.97	35.58	> LOQ 35.58	37.27	> LOQ 35.20	30.88	< LOQ 34.99
CS-05	28.9	< LOQ 35.09	35.47	> LOQ 35.47	52.32	> LOQ 35.58	59.19	> LOQ 55.90
CS-06	27.11	< LOQ 35.45	35.6	> LOQ 35.60	37.26	> LOQ 35.19	35.39	> LOQ 35.39
CS-07	78.25	> LOQ 35.01	77.15	> LOQ 35.45	181.02	> LOQ 35.37	66.72	> LOQ 35.45
CSDS-01	ND	< LOD 10.38	13.33	< LOQ 35.41	120.43	> LOQ 35.30	22.88	< LOQ 35.37
CSDS-02	ND	< LOD 10.30	24.81	< LOQ 35.15	33.12	< LOQ 35.19	14.02	< LOQ 35.58
N-01	65.03	> LOQ 34.55	56.3	> LOQ 35.45	140.73	> LOQ 35.18	127.05	> LOQ 34.84
N-02	83.74	> LOQ 34.72	168.36	> LOQ 35.34	624.87	> LOQ 35.41	159.78	> LOQ 35.28
O-1	51.48	> LOQ 35.01	41.76	> LOQ 35.50	76.02	> LOQ 34.93	54.42	> LOQ 35.58
S-01	11	< LOQ 35.30	ND	< LOD 10.44	68.89	> LOQ 35.49	16.27	< LOQ 35.47
S-02	ND	< LOD 10.42	20.31	< LOQ 35.59	19.58	< LOQ 35.42	ND	< LOD 10.44
SH-01	25.06	< LOQ 35.51	31.34	< LOQ 35.52	51.82	> LOQ 35.24	29.12	< LOQ 35.36
SS-01	ND	< LOD 10.32	ND	< LOD 10.44	ND	< LOD 10.34	ND	< LOD 10.35
SS-02	22.85	< LOQ 35.32	31.28	< LOQ 35.45	37.25	> LOQ 35.18	28.79	< LOQ 34.97
SS-03	22.89	< LOQ 35.38	25.21	< LOQ 35.71	26.56	< LOQ 34.74	26.2	< LOQ 34.27
SS-04	20.29	< LOQ 35.56	71.16	> LOQ 35.58	43.93	> LOQ 35.56	37.04	> LOQ 34.99
SS-05	22.1	< LOQ 34.15	29.36	< LOQ 35.65	41.57	> LOQ 35.34	71.74	> LOQ 34.84
SS-06	24.4	< LOQ 34.56	26.94	< LOQ 35.23	123.74	> LOQ 35.65	31.36	< LOQ 35.54
SS-07	43.07	> LOQ 34.86	58.18	> LOQ 35.32	83.56	> LOQ 35.51	68.06	> LOQ 35.06
SSDS-01	ND	< LOD 10.29	12.33	< LOQ 35.54	ND	< LOD 10.31	ND	< LOD 10.35
SSDS-02	25.01	< LOQ 35.42	35.42	> LOQ 35.42	45.40	> LOQ 35.08	32.41	< LOQ 34.43
SSDS-03	17.99	< LOQ 34.36	19.86	< LOQ 33.76	19.90	< LOQ 33.84	22.79	< LOQ 35.23
CP-1A	109.3	> LOQ 35.06	331.4	> LOQ 35.21	1037.56	> LOQ 35.28	356.1	> LOQ 35.61
CP-1B	162.66	> LOQ 40.08	380.77	> LOQ 40.46	1530.49	> LOQ 40.03	406.99	> LOQ 40.70
CP-2A	61.89	> LOQ 35.07	112.92	> LOQ 35.55	518.46	> LOQ 70.51	207.73	> LOQ 35.31
CP-2B	109.48	> LOQ 35.12	64.72	> LOQ 35.49	200.99	> LOQ 35.23	71.53	> LOQ 35.77
CP-3A	2065.26	> LOQ 35.11	6676.4	> LOQ 35.47	28955.53	> LOQ 35.16	24834.44	> LOQ 35.18
CP-3B	3026.97	> LOQ 46.78	14991.67	> LOQ 47.20	24671.05	> LOQ 46.60	9187.98	> LOQ 42.22
CP-4A	3914.3	> LOQ 35.02	18654.37	> LOQ 35.63	112222.00	> LOQ 69.37	24620.43	> LOQ 34.88
CP-4B	4995	> LOQ 33.97	15473.49	> LOQ 35.07	78366.67	> LOQ 70.12	4283.97	> LOQ 34.68
CPDS-1A	74.99	> LOQ 34.45	96.93	> LOQ 35.06	516.21	> LOQ 35.10	205.04	> LOQ 34.86
CPDS-1B	82.9	> LOQ 34.37	119.96	> LOQ 35.16	450.63	> LOQ 34.82	88.07	> LOQ 34.03
G-1A	27.01	< LOQ 35.32	41.78	> LOQ 35.51	70.58	> LOQ 35.29	65.43	> LOQ 34.76
G-1B	18.85	< LOQ 35.21	44.32	> LOQ 35.88	47.75	> LOQ 35.29	51.85	> LOQ 35.26
G-2A	25.29	< LOQ 35.83	31.83	< LOQ 36.08	35.24	> LOQ 35.24	35.39	> LOQ 35.39
G-2B	20.5	< LOQ 34.84	35.29	> LOQ 35.29	25.10	< LOQ 35.56	57.68	> LOQ 35.02
G-3A	26.89	< LOQ 35.17	62.36	> LOQ 35.34	31.48	< LOQ 35.68	27.09	< LOQ 35.42
G-4A	64.99	> LOQ 34.52	64.09	> LOQ 35.15	47.26	> LOQ 34.93	35.3	< LOQ 35.30
G-4B	26.87	< LOQ 35.14	37.49	> LOQ 35.41	47.54	> LOQ 35.14	35.11	> LOQ 35.11
G-5A	26.76	< LOQ 34.99	35.28	> LOQ 35.28	54.11	> LOQ 35.38	64.81	> LOQ 35.54
G-5B	35.51	> LOQ 35.51	58.14	> LOQ 35.30	89.62	> LOQ 35.43	35.42	> LOQ 35.42
G-6A	41.58	> LOQ 35.34	85.7	> LOQ 35.54	110.28	> LOQ 35.37	60.05	> LOQ 35.20
G-6B	28.71	< LOQ 34.86	48.47	> LOQ 35.83	51.10	> LOQ 34.75	53.65	> LOQ 35.08
G-7A	20.63	< LOQ 35.07	35.26	> LOQ 35.26	68.84	> LOQ 35.46	41.88	> LOQ 35.60
G-7B	28.76	< LOQ 34.92	47.86	> LOQ 35.37	53.01	> LOQ 36.05	50.77	> LOQ 35.96
SG-1A	61.25	> LOQ 34.71	24.9	< LOQ 35.27	26.98	< LOQ 35.28	ND	< LOD 51.58
SG-1B	69.18	> LOQ 65.33	76.86	> LOQ 65.33	72.80	> LOQ 65.13	95.24	> LOQ 323.81
SG-2A	45.28	> LOQ 34.99	50.1	> LOQ 35.49	60.12	< LOQ 70.48	180.12	> LOQ 70.39
SG-2B	41.49	> LOQ 35.27	55.57	> LOQ 34.99	45.99	> LOQ 35.54	204.38	> LOQ 177.27

Bulk Elemental Analysis - Zinc

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Zinc		Sample	Zinc	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	4.30	< LOQ 6.7	J95331-63 PB	11.00	> LOQ 6.7
CS-01	J95331-34 VB	9.00	> LOQ 6.7	J95331-34 PB	13.00	> LOQ 6.7
CS-02	J95331-37 VB	12.00	> LOQ 6.7	J95331-37 PB	14.00	> LOQ 6.7
CS-03	J95331-38 VB	88.00	> LOQ 6.7	J95331-38 PB	110.00	> LOQ 6.7
CS-04	J95331-39 VB	ND	< LOD 2.0	J95331-39 PB	ND	< LOD 2.0
CS-05	J95331-57 VB	ND	< LOD 2.0	J95331-57 PB	ND	< LOD 2.0
CS-06	J95331-70 VB	ND	< LOD 2.0	J95331-70 PB	4.30	< LOQ 6.7
CS-07	J95331-83 VB	3.90	< LOQ 6.7	J95331-83 PB	8.30	> LOQ 6.7
CSDS-01	J95331-31 VB	ND	< LOD 2.0	J95331-31 PB	ND	< LOD 2.0
CSDS-02	J95331-35 VB	3.00	< LOQ 6.7	J95331-35 PB	6.40	< LOQ 6.7
N-01	J95331-52 VB	11.00	> LOQ 6.7	J95331-52 PB	13.00	> LOQ 6.7
N-02	J95331-81 VB	58.00	> LOQ 6.7	J95331-81 PB	140.00	> LOQ 6.7
O-1	J95331-69 VB	20.00	> LOQ 6.7	J95331-69 PB	22.00	> LOQ 6.7
S-01	J95331-28 VB	ND	< LOD 2.0	J95331-28 PB	ND	< LOD 2.0
S-02	J95331-29 VB	ND	< LOD 2.0	J95331-29 PB	ND	< LOD 2.0
SH-01	J95331-36 VB	ND	< LOD 2.0	J95331-36 PB	2.30	< LOQ 6.7
SS-01	J95331-32 VB	ND	< LOD 2.0	J95331-32 PB	ND	< LOD 2.0
SS-02	J95331-40 VB	ND	< LOD 2.0	J95331-40 PB	ND	< LOD 2.0
SS-03	J95331-45 VB	ND	< LOD 2.0	J95331-45 PB	ND	< LOD 2.0
SS-04	J95331-47 VB	5.50	< LOQ 6.7	J95331-47 PB	ND	< LOD 2.0
SS-05	J95331-53 VB	6.10	< LOQ 6.7	J95331-53 PB	5.20	< LOQ 6.7
SS-06	J95331-76 VB	3.10	< LOQ 6.7	J95331-76 PB	3.00	< LOQ 6.7
SS-07	J95331-80 VB	3.80	< LOQ 6.7	J95331-80 PB	ND	< LOD 2.0
SSDS-01	J95331-33 VB	ND	< LOD 2.0	J95331-33 PB	ND	< LOD 2.0
SSDS-02	J95331-44 VB	2.90	< LOQ 6.7	J95331-44 PB	ND	< LOD 2.0
SSDS-03	J95331-48 VB	ND	< LOD 2.0	J95331-48 PB	ND	< LOD 2.0
CP-1A	J95331-60 VB	100.00	< LOD 2.0	J95331-60 PB	430.00	> LOQ 6.7
CP-1B	J95331-61 VB	ND	< LOD 2.0	J95331-61 PB	ND	< LOD 2.0
CP-2A	J95331-67 VB	93.00	> LOQ 6.7	J95331-67 PB	120.00	> LOQ 13.0
CP-2B	J95331-68 VB	110.00	> LOQ 13.0	J95331-68 PB	110.00	> LOQ 13.0
CP-3A	J95331-72 VB	6900.00	> LOQ 13.0	J95331-72 PB	5300.00	> LOQ 6.7
CP-3B	J95331-73 VB	5100.00	> LOQ 6.7	J95331-73 PB	5700.00	> LOQ 6.7
CP-4A	J95331-78 VB	8100.00	> LOQ 34	J95331-78 PB	11000.00	> LOQ 13.0
CP-4B	J95331-79 VB	12000.00	> LOQ 6.7	J95331-79 PB	13000.00	> LOQ 6.7
CPDS-1A	J95331-84 VB	76.00	> LOQ 6.7	J95331-84 PB	130.00	> LOQ 6.7
CPDS-1B	J95331-85 VB	110.00	> LOQ 6.7	J95331-85 PB	110.00	> LOQ 6.7
G-1A	J95331-41 VB	ND	< LOD 2.0	J95331-41 PB	ND	< LOD 2.0
G-1B	J95331-46 VB	5.20	< LOQ 6.7	J95331-46 PB	6.20	< LOQ 6.7
G-2A	J95331-43 VB	ND	< LOD 2.0	J95331-43 PB	ND	< LOD 2.0
G-2B	J95331-50 VB	3.10	< LOQ 6.7	J95331-50 PB	ND	< LOD 2.0
G-3A	J95331-49 VB	ND	< LOD 2.0	J95331-49 PB	7.10	> LOQ 6.7
G-4A	J95331-55 VB	2.70	< LOQ 6.7	J95331-55 PB	4.50	< LOQ 6.7
G-4B	J95331-56 VB	ND	< LOD 2.0	J95331-56 PB	ND	< LOD 2.0
G-5A	J95331-58 VB	ND	< LOD 2.0	J95331-58 PB	ND	< LOD 2.0
G-5B	J95331-59 VB	ND	< LOD 2.0	J95331-59 PB	ND	< LOD 2.0
G-6A	J95331-64 VB	ND	< LOD 2.0	J95331-64 PB	3.10	< LOQ 6.7
G-6B	J95331-65 VB	3.80	< LOQ 6.7	J95331-65 PB	ND	< LOD 2.0
G-7A	J95331-74 VB	ND	< LOD 2.0	J95331-74 PB	ND	< LOD 2.0
G-7B	J95331-75 VB	2.80	< LOQ 6.7	J95331-75 PB	ND	< LOD 2.0
SG-1A	J95331-54 VB	ND	< LOD 10.0	J95331-54 PB	ND	< LOD 10.0
SG-1B	J95331-71 VB	12.00	< LOQ 34.0	J95331-71 PB	14.00	< LOQ 34.0
SG-2A	J95331-66 VB	29.00	< LOQ 34.0	J95331-66 PB	12.00	< LOQ 34.0
SG-2B	J95331-82 VB	40.00	> LOQ 67.0	J95331-82 PB	34.00	< LOQ 67.0

Comparison of Airborne Concentrations to Bulk Concentrations - Zinc

NIOSH REL 5000.0 micrograms/cubic meter
OSHA PEL 15000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	37.07	41.67	51.58	64.17	4.30
CS-01	ND	43.75	59.83	27.13	9.00
CS-02	35.36	62.71	152.05	77.10	12.00
CS-03	43.31	99.40	331.81	120.11	88.00
CS-04	24.69	35.58	37.27	30.88	ND
CS-05	28.90	35.47	52.32	59.19	ND
CS-06	27.11	35.60	37.26	35.39	ND
CS-07	78.25	77.15	181.02	66.72	3.90
CSDS-01	ND	13.33	120.43	22.88	ND
CSDS-02	ND	24.81	33.12	14.02	3.00
N-01	65.03	56.30	140.73	127.05	11.00
N-02	83.74	168.36	624.87	159.78	58.00
O-1	51.48	41.76	76.02	54.42	20.00
S-01	11.00	ND	68.89	16.27	ND
S-02	ND	20.31	19.58	ND	ND
SH-01	25.06	31.34	51.82	29.12	ND
SS-01	ND	ND	ND	ND	ND
SS-02	22.85	31.28	37.25	28.79	ND
SS-03	22.89	25.21	26.56	26.20	ND
SS-04	20.29	71.16	43.93	37.04	5.50
SS-05	22.10	29.36	41.57	71.74	6.10
SS-06	24.40	26.94	123.74	31.36	3.10
SS-07	43.07	58.18	83.56	68.06	3.80
SSDS-01	ND	12.33	ND	ND	ND
SSDS-02	25.01	35.42	45.40	32.41	2.90
SSDS-03	17.99	19.86	19.90	22.79	ND
CP-1A	109.30	331.40	1037.56	356.10	100.00
CP-2A	61.89	112.92	518.46	207.73	93.00
CP-3A	2065.26	6676.40	28955.53	24834.44	6900.00
CP-4A	3914.30	18654.37	112222.00	24620.43	8100.00
CPDS-1A	74.99	96.93	516.21	205.04	76.00
G-1A	27.01	41.78	70.58	65.43	ND
G-2A	25.29	31.83	35.24	35.39	ND
G-3A	26.89	62.36	31.48	27.09	ND
G-4A	64.99	64.09	47.26	35.30	2.70
G-5A	26.76	35.28	54.11	64.81	ND
G-6A	41.58	85.70	110.28	60.05	ND
G-7A	20.63	35.26	68.84	41.88	ND
SG-1A	61.25	24.90	26.98	ND	ND
SG-2A	45.28	50.10	60.12	180.12	29.00

APPENDIX B - ZIRCONIUM

Zirconium

Most animal studies indicate zirconium to be of relative low toxicity. Most zirconium compounds are insoluble and are considered to be inert. Some zirconium compounds have been reported to cause radiographic changes in animals due to pulmonary retention or granulomas of the skin. The NIOSH REL and OSHA PEL for zirconium are both 5,000 micrograms/cubic meter of air.

Air Sample Results - Zirconium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zirconium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24463	1	48.16	S-01	28	0.120	< LOQ 0.25	2.49	< LOQ 5.19
24412	2	47.89	S-01	28	0.430	> LOQ 0.25	8.98	> LOQ 5.22
24441	3	47.90	S-01	28	1.700	> LOQ 0.25	35.49	> LOQ 5.22
24450	OBZ	47.93	S-01	28	0.510	> LOQ 0.25	10.64	> LOQ 5.22
24643	1	47.98	S-02	29	0.330	> LOQ 0.25	6.88	> LOQ 5.21
24625	2	47.76	S-02	29	1.600	> LOQ 0.25	33.5	> LOQ 5.23
24642	3	48.00	S-02	29	2.600	> LOQ 0.25	54.17	> LOQ 5.21
24632	OBZ	47.89	S-02	29	0.890	> LOQ 0.25	18.58	> LOQ 5.22
24634	1	48.16	CSDS-01	31	0.490	> LOQ 0.25	10.17	> LOQ 5.19
24650	2	48.01	CSDS-01	31	2.100	> LOQ 0.25	43.74	> LOQ 5.21
24644	3	48.16	CSDS-01	31	4.500	> LOQ 0.25	93.44	> LOQ 5.19
24645	OBZ	48.07	CSDS-01	31	2.700	> LOQ 0.25	56.17	> LOQ 5.20
24640	1	48.44	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24641	2	47.90	SS-01	32	0.100	< LOQ 0.25	2.09	< LOQ 5.22
24651	3	48.35	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.65
24635	OBZ	48.30	SS-01	32	ND	< LOD 0.08	ND	< LOD 1.66
24646	1	48.58	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.65
24626	2	47.84	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.67
24638	3	48.49	SSDS-01	33	0.089	< LOQ 0.25	1.84	< LOQ 5.16
24647	OBZ	48.32	SSDS-01	33	ND	< LOD 0.08	ND	< LOD 1.66
24628	1	48.55	CS-01	34	0.670	> LOQ 0.25	13.8	> LOQ 5.15
24637	2	48.00	CS-01	34	2.000	> LOQ 0.25	41.67	> LOQ 5.21
24624	3	48.47	CS-01	34	8.700	> LOQ 0.25	179.49	> LOQ 5.16
24636	OBZ	47.92	CS-01	34	1.900	> LOQ 0.25	39.65	> LOQ 5.22
24623	1	48.53	CSDS-02	35	0.690	> LOQ 0.25	14.22	> LOQ 5.15
24622	2	48.36	CSDS-02	35	2.500	> LOQ 0.25	51.7	> LOQ 5.17
24654	3	48.31	CSDS-02	35	8.200	> LOQ 0.25	169.74	> LOQ 5.17
24653	OBZ	47.78	CSDS-02	35	3.300	> LOQ 0.25	69.07	> LOQ 5.23
24629	1	47.88	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24633	2	47.86	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.67
24627	3	48.24	SH-01	36	0.180	< LOQ 0.25	3.73	< LOQ 5.18
24648	OBZ	48.08	SH-01	36	ND	< LOD 0.08	ND	< LOD 1.66
24555	1	48.08	CS-02	37	0.820	> LOQ 0.25	17.05	> LOQ 5.20
24552	2	47.84	CS-02	37	2.400	> LOQ 0.25	50.17	> LOQ 5.23
24541	3	48.01	CS-02	37	10.000	> LOQ 0.25	208.29	> LOQ 5.21
24529	OBZ	47.99	CS-02	37	3.600	> LOQ 0.25	75.02	> LOQ 5.21
24558	1	48.49	CS-03	38	1.300	> LOQ 0.25	26.81	> LOQ 5.16
24524	2	48.29	CS-03	38	5.100	> LOQ 0.25	105.61	> LOQ 5.18
24561	3	48.22	CS-03	38	18.000	> LOQ 0.25	373.29	> LOQ 5.18
24559	OBZ	48.29	CS-03	38	5.000	> LOQ 0.25	103.54	> LOQ 5.18
24543	1	48.61	CS-04	39	0.570	> LOQ 0.25	11.73	> LOQ 5.14
24532	2	47.78	CS-04	39	1.800	> LOQ 0.25	37.67	> LOQ 5.23
24546	3	48.29	CS-04	39	4.000	> LOQ 0.25	82.83	> LOQ 5.18
24557	OBZ	48.58	CS-04	39	2.300	> LOQ 0.25	47.34	> LOQ 5.15
24560	1	48.13	SS-02	40	ND	< LOD 0.08	ND	< LOD 1.66
24565	2	47.95	SS-02	40	0.280	> LOQ 0.25	5.84	> LOQ 5.21
24630	3	48.32	SS-02	40	0.220	< LOQ 0.25	4.55	< LOQ 5.17
24553	OBZ	48.62	SS-02	40	0.240	< LOQ 0.25	4.94	< LOQ 5.14
24525	1	48.13	G-1A	41	ND	< LOD 0.08	ND	< LOD 1.66
24563	2	47.87	G-1A	41	0.200	< LOQ 0.25	4.18	< LOQ 5.22
24547	3	48.17	G-1A	41	0.510	> LOQ 0.25	10.59	> LOQ 5.19
24526	OBZ	48.91	G-1A	41	0.380	> LOQ 0.25	7.77	> LOQ 5.11
24538	1	47.45	G-2A	43	ND	< LOD 0.08	ND	< LOD 1.69

Air Sample Results - Zirconium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zirconium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24545	2	47.12	G-2A	43	0.140	< LOQ 0.25	2.97	< LOQ 5.31
24533	3	48.24	G-2A	43	0.180	< LOQ 0.25	3.73	< LOQ 5.18
24540	OBZ	48.04	G-2A	43	0.120	< LOQ 0.25	2.5	< LOQ 5.20
24528	1	47.99	SSDS-02	44	0.110	< LOQ 0.25	2.29	< LOQ 5.21
24544	2	48.00	SSDS-02	44	0.290	> LOQ 0.25	6.04	> LOQ 5.21
24567	3	48.46	SSDS-02	44	0.810	> LOQ 0.25	16.71	> LOQ 5.16
24539	OBZ	49.37	SSDS-02	44	0.580	> LOQ 0.25	11.75	> LOQ 5.06
24571	1	48.05	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.66
24536	2	47.60	SS-03	45	ND	< LOD 0.08	ND	< LOD 1.68
24534	3	48.94	SS-03	45	0.200	< LOQ 0.25	4.09	< LOQ 5.11
24570	OBZ	49.61	SS-03	45	0.110	< LOQ 0.25	2.22	< LOQ 5.04
24568	1	48.28	G-1B	46	ND	< LOD 0.08	ND	< LOD 1.66
24592	2	47.38	G-1B	46	0.220	< LOQ 0.25	4.64	< LOQ 5.28
24593	3	48.17	G-1B	46	0.260	> LOQ 0.25	5.4	> LOQ 5.19
24535	OBZ	48.22	G-1B	46	0.280	> LOQ 0.25	5.81	> LOQ 5.18
24590	1	47.81	SS-04	47	0.099	< LOQ 0.25	2.07	< LOQ 5.23
24605	2	47.78	SS-04	47	0.590	> LOQ 0.25	12.35	> LOQ 5.23
24562	3	47.80	SS-04	47	0.960	> LOQ 0.25	20.08	> LOQ 5.23
24531	OBZ	48.59	SS-04	47	0.640	> LOQ 0.25	13.17	> LOQ 5.15
24527	1	49.48	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.62
24569	2	50.35	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.59
24584	3	50.24	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.59
24579	OBZ	48.26	SSDS-03	48	ND	< LOD 0.08	ND	< LOD 1.66
24600	1	48.34	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.65
24616	2	48.11	G-3A	49	0.110	< LOQ 0.25	2.29	< LOQ 5.20
24585	3	47.65	G-3A	49	0.340	> LOQ 0.25	7.14	> LOQ 5.25
24583	OBZ	47.99	G-3A	49	ND	< LOD 0.08	ND	< LOD 1.67
24587	1	48.79	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.64
24602	2	48.17	G-2B	50	0.120	< LOQ 0.25	2.49	< LOQ 5.19
24564	3	47.81	G-2B	50	0.120	< LOQ 0.25	2.51	< LOQ 5.23
24621	OBZ	48.54	G-2B	50	ND	< LOD 0.08	ND	< LOD 1.65
24618	1	49.21	N-01	52	ND	< LOD 0.08	ND	< LOD 1.63
24611	2	47.96	N-01	52	0.120	< LOQ 0.25	2.5	< LOQ 5.21
24588	3	48.32	N-01	52	0.390	> LOQ 0.25	8.07	> LOQ 5.17
24615	OBZ	48.80	N-01	52	0.270	> LOQ 0.25	5.53	> LOQ 5.12
24597	1	49.78	SS-05	53	ND	< LOD 0.08	ND	< LOD 1.61
24599	2	47.68	SS-05	53	0.120	< LOQ 0.25	2.52	< LOQ 5.24
24575	3	48.11	SS-05	53	0.260	> LOQ 0.25	5.4	> LOQ 5.20
24617	OBZ	48.79	SS-05	53	0.170	< LOQ 0.25	3.48	< LOQ 5.12
24609	1	48.98	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.63
24596	2	48.20	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.66
24610	3	48.18	SG-1A	54	ND	< LOD 0.08	ND	< LOD 1.66
24576	OBZ	48.47	SG-1A	54	ND	< LOD 1.30	ND	< LOD 26.82
24606	1	49.24	G-4A	55	0.450	> LOQ 0.25	9.14	> LOQ 5.08
24620	2	48.37	G-4A	55	0.510	> LOQ 0.25	10.54	> LOQ 5.17
24573	3	48.67	G-4A	55	1.400	> LOQ 0.25	28.77	> LOQ 5.14
24505	OBZ	48.16	G-4A	55	1.000	> LOQ 0.25	20.76	> LOQ 5.19
24340	1	48.38	G-4B	56	0.180	< LOQ 0.25	3.72	< LOQ 5.17
24607	2	48.01	G-4B	56	0.710	> LOQ 0.25	14.79	> LOQ 5.21
24595	3	48.38	G-4B	56	0.890	> LOQ 0.25	18.4	> LOQ 5.17
24598	OBZ	48.42	G-4B	56	0.680	> LOQ 0.25	14.04	> LOQ 5.16
24580	1	48.44	CS-05	57	0.280	> LOQ 0.25	5.78	> LOQ 5.16
24604	2	47.93	CS-05	57	0.970	> LOQ 0.25	20.24	> LOQ 5.22

Air Sample Results - Zirconium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zirconium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24335	3	47.78	CS-05	57	1.600	> LOQ 0.25	33.49	> LOQ 5.23
24574	OBZ	30.41	CS-05	57	0.630	> LOQ 0.25	20.72	> LOQ 8.22
24614	1	48.58	G-5A	58	ND	< LOD 0.08	ND	< LOD 1.65
24577	2	48.18	G-5A	58	0.200	< LOQ 0.25	4.15	< LOQ 5.19
24572	3	48.05	G-5A	58	0.490	> LOQ 0.25	10.2	> LOQ 5.20
24582	OBZ	47.83	G-5A	58	0.450	> LOQ 0.25	9.41	> LOQ 5.23
24322	1	47.88	G-5B	59	0.084	< LOQ 0.25	1.75	< LOQ 5.22
24354	2	48.16	G-5B	59	0.270	> LOQ 0.25	5.61	> LOQ 5.19
24510	3	47.98	G-5B	59	0.740	> LOQ 0.25	15.42	> LOQ 5.21
24321	OBZ	47.99	G-5B	59	0.170	< LOQ 0.25	3.54	< LOQ 5.21
24497	1	48.49	CP-1A	60	0.120	< LOQ 0.25	2.47	< LOQ 5.16
24333	2	48.28	CP-1A	60	0.550	> LOQ 0.25	11.39	> LOQ 5.18
24326	3	48.19	CP-1A	60	0.760	> LOQ 0.25	15.77	> LOQ 5.19
24329	OBZ	47.74	CP-1A	60	0.320	> LOQ 0.25	6.7	> LOQ 5.24
24499	1	42.42	CP-1B	62	0.220	< LOQ 0.25	5.19	< LOQ 5.89
24506	2	42.02	CP-1B	62	0.320	> LOQ 0.25	7.62	> LOQ 5.95
24388	3	42.47	CP-1B	62	1.200	> LOQ 0.25	28.26	> LOQ 5.89
24315	OBZ	41.77	CP-1B	62	0.290	> LOQ 0.25	6.94	> LOQ 5.99
24318	1	48.56	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.65
24308	2	48.00	CG-01	63	0.096	< LOQ 0.25	2	< LOQ 5.21
24330	3	48.47	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.65
24230	OBZ	48.31	CG-01	63	ND	< LOD 0.08	ND	< LOD 1.66
24363	1	48.10	G-6A	64	0.160	< LOQ 0.25	3.33	< LOQ 5.20
24398	2	47.84	G-6A	64	0.710	> LOQ 0.25	14.84	> LOQ 5.23
24351	3	48.06	G-6A	64	0.930	> LOQ 0.25	19.35	> LOQ 5.20
24594	OBZ	48.29	G-6A	64	0.410	> LOQ 0.25	8.49	> LOQ 5.18
24312	1	48.76	G-6B	65	0.085	< LOQ 0.25	1.74	< LOQ 5.13
24484	2	47.45	G-6B	65	0.430	> LOQ 0.25	9.06	> LOQ 5.27
24327	3	48.92	G-6B	65	0.370	> LOQ 0.25	7.56	> LOQ 5.11
24389	OBZ	48.46	G-6B	65	0.280	> LOQ 0.25	5.78	> LOQ 5.16
24348	1	48.59	SG-2A	66	ND	< LOD 0.08	ND	< LOD 1.65
24314	2	47.90	SG-2A	66	ND	< LOD 0.08	ND	< LOD 1.67
24494	3	48.24	SG-2A	66	ND	< LOD 0.08	ND	< LOD 1.66
24337	OBZ	48.30	SG-2A	66	ND	< LOD 0.16	ND	< LOD 3.31
24508	1	48.47	CP-2A	67	0.680	> LOQ 0.25	14.03	> LOQ 5.16
24361	2	47.82	CP-2A	67	1.600	> LOQ 0.25	33.46	> LOQ 5.23
24359	3	48.22	CP-2A	67	9.800	> LOQ 0.50	203.24	> LOQ 10.37
24471	OBZ	48.14	CP-2A	67	4.100	> LOQ 0.25	85.17	> LOQ 5.19
24373	1	48.41	CP-2B	68	1.700	> LOQ 0.25	35.12	> LOQ 5.16
24468	2	47.90	CP-2B	68	0.980	> LOQ 0.25	20.46	> LOQ 5.22
24481	3	48.26	CP-2B	68	3.500	> LOQ 0.25	72.52	> LOQ 5.18
24391	OBZ	47.53	CP-2B	68	0.690	> LOQ 0.25	14.52	> LOQ 5.26
24356	1	48.56	O-1	69	ND	< LOD 0.08	ND	< LOD 1.65
24470	2	47.89	O-1	69	ND	< LOD 0.08	ND	< LOD 1.67
24467	3	48.67	O-1	69	ND	< LOD 0.08	ND	< LOD 1.64
24313	OBZ	47.78	O-1	69	ND	< LOD 0.08	ND	< LOD 1.67
24501	1	47.96	CS-06	70	1.300	> LOQ 0.25	27.11	> LOQ 5.21
24496	2	47.75	CS-06	70	3.200	> LOQ 0.25	67.02	> LOQ 5.24
24478	3	48.31	CS-06	70	1.800	> LOQ 0.25	37.26	> LOQ 5.17
24503	OBZ	48.04	CS-06	70	1.800	> LOQ 0.25	37.47	> LOQ 5.20
24474	1	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24469	2	26.02	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07
24492	3	26.10	SG-1B	71	ND	< LOD 0.08	ND	< LOD 3.07

Air Sample Results - Zirconium

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Run	Zirconium			
					µg/filter	Filter Notes µg/f	Result µg/m³	Result Notes
24495	OBZ	26.25	SG-1B	71	ND	< LOD 0.40	ND	< LOD 15.24
24489	1	48.42	CP-3A	72	1.200	> LOQ 0.25	24.78	> LOQ 5.16
24491	2	47.93	CP-3A	72	3.000	> LOQ 0.25	62.59	> LOQ 5.22
24482	3	48.35	CP-3A	72	14.000	> LOQ 0.25	289.56	> LOQ 5.17
24486	OBZ	48.32	CP-3A	72	13.000	> LOQ 0.25	269.04	> LOQ 5.17
24516	1	36.34	CP-3B	73	1.300	> LOQ 0.25	35.77	> LOQ 6.88
24502	2	36.02	CP-3B	73	6.600	> LOQ 0.25	183.23	> LOQ 6.94
24515	3	36.48	CP-3B	73	9.100	> LOQ 0.25	249.45	> LOQ 6.85
24500	OBZ	40.27	CP-3B	73	4.200	> LOQ 0.25	104.3	> LOQ 6.21
24504	1	48.47	G-7A	74	0.530	> LOQ 0.25	10.93	> LOQ 5.16
24513	2	48.22	G-7A	74	1.100	> LOQ 0.25	22.81	> LOQ 5.18
24458	3	47.94	G-7A	74	2.600	> LOQ 0.25	54.23	> LOQ 5.21
24389	OBZ	47.75	G-7A	74	0.720	> LOQ 0.25	15.08	> LOQ 5.24
24404	1	48.68	G-7B	75	0.370	> LOQ 0.25	7.6	> LOQ 5.14
24451	2	48.06	G-7B	75	0.680	> LOQ 0.25	14.15	> LOQ 5.20
24447	3	47.16	G-7B	75	1.300	> LOQ 0.25	27.57	> LOQ 5.30
24423	OBZ	47.27	G-7B	75	0.370	> LOQ 0.25	7.83	> LOQ 5.29
24456	1	49.19	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.63
24480	2	48.26	SS-06	76	0.120	< LOQ 0.25	2.49	< LOQ 5.18
24429	3	47.68	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.68
24418	OBZ	47.83	SS-06	76	ND	< LOD 0.08	ND	< LOD 1.67
24427	1	48.54	CP-4A	78	0.780	> LOQ 0.25	16.07	> LOQ 5.15
24435	2	47.71	CP-4A	78	3.500	> LOQ 0.25	73.36	> LOQ 5.24
24244	3	49.01	CP-4A	78	20.000	> LOQ 1.30	408.08	> LOQ 26.53
24220	OBZ	48.74	CP-4A	78	3.900	> LOQ 0.25	80.02	> LOQ 5.13
24460	1	50.05	CP-4B	79	0.900	> LOQ 0.25	17.98	> LOQ 5.00
24465	2	48.47	CP-4B	79	2.700	> LOQ 0.25	55.7	> LOQ 5.16
24207	3	48.49	CP-4B	79	13.000	> LOQ 0.50	268.1	> LOQ 10.31
24390	OBZ	49.02	CP-4B	79	0.800	> LOQ 0.25	16.32	> LOQ 5.10
24259	1	48.76	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.64
24421	2	48.13	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.66
24445	3	47.87	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.67
24432	OBZ	48.49	SS-07	80	ND	< LOD 0.08	ND	< LOD 1.65
24459	1	48.96	N-02	81	0.910	> LOQ 0.25	18.59	> LOQ 5.11
24417	2	48.11	N-02	81	1.600	> LOQ 0.25	33.26	> LOQ 5.20
24442	3	48.01	N-02	81	5.700	> LOQ 0.25	118.73	> LOQ 5.21
24386	OBZ	48.19	N-02	81	1.500	> LOQ 0.25	31.13	> LOQ 5.19
24452	1	48.20	SG-2B	82	ND	< LOD 0.08	ND	< LOD 1.66
24453	2	48.59	SG-2B	82	ND	< LOD 0.08	ND	< LOD 1.65
24420	3	47.84	SG-2B	82	ND	< LOD 0.08	ND	< LOD 1.67
24444	OBZ	47.95	SG-2B	82	ND	< LOD 1.60	ND	< LOD 33.37
24455	1	48.56	CS-07	83	2.100	> LOQ 0.25	43.25	> LOQ 5.15
24433	2	47.96	CS-07	83	3.900	> LOQ 0.25	81.32	> LOQ 5.21
24398	3	48.06	CS-07	83	14.000	> LOQ 0.25	291.3	> LOQ 5.20
24511	OBZ	47.96	CS-07	83	3.700	> LOQ 0.25	77.15	> LOQ 5.21
24454	1	49.34	CPDS-1A	84	0.880	> LOQ 0.25	17.84	> LOQ 5.07
24291	2	48.49	CPDS-1A	84	1.300	> LOQ 0.25	26.81	> LOQ 5.16
24209	3	48.43	CPDS-1A	84	8.400	> LOQ 0.25	173.45	> LOQ 5.16
24402	OBZ	48.77	CPDS-1A	84	3.200	> LOQ 0.25	65.61	> LOQ 5.13
24204	1	49.46	CPDS-1B	85	1.100	> LOQ 0.25	22.24	> LOQ 5.05
24273	2	48.35	CPDS-1B	85	1.600	> LOQ 0.25	33.09	> LOQ 5.17
24223	3	48.82	CPDS-1B	85	6.700	> LOQ 0.25	137.24	> LOQ 5.12
24466	OBZ	49.96	CPDS-1B	85	1.300	> LOQ 0.25	26.02	> LOQ 5.00

Airborne Sample Data Analysis - Zirconium

NIOSH REL 5000.0 micrograms/cubic meter
OSHA PEL 5000.0 micrograms/cubic meter

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	µg/m³	Note	µg/m³	Note	µg/m³	Note	µg/m³	Note
CG-01	ND	< LOD 1.65	2	< LOQ 5.21	ND	< LOD 1.65	ND	< LOD 1.66
CS-01	13.8	> LOQ 5.15	41.67	> LOQ 5.21	179.49	> LOQ 5.16	39.65	> LOQ 5.22
CS-02	17.05	> LOQ 5.20	50.17	> LOQ 5.23	208.29	> LOQ 5.21	75.02	> LOQ 5.21
CS-03	26.81	> LOQ 5.16	105.61	> LOQ 5.18	373.29	> LOQ 5.18	103.54	> LOQ 5.18
CS-04	11.73	> LOQ 5.14	37.67	> LOQ 5.23	82.83	> LOQ 5.18	47.34	> LOQ 5.15
CS-05	5.78	> LOQ 5.16	20.24	> LOQ 5.22	33.49	> LOQ 5.23	20.72	> LOQ 8.22
CS-06	27.11	> LOQ 5.21	67.02	> LOQ 5.24	37.26	> LOQ 5.17	37.47	> LOQ 5.20
CS-07	43.25	> LOQ 5.15	81.32	> LOQ 5.21	291.30	> LOQ 5.20	77.15	> LOQ 5.21
CSDS-01	10.17	> LOQ 5.19	43.74	> LOQ 5.21	93.44	> LOQ 5.19	56.17	> LOQ 5.20
CSDS-02	14.22	> LOQ 5.15	51.7	> LOQ 5.17	169.74	> LOQ 5.17	69.07	> LOQ 5.23
N-01	ND	< LOD 1.63	2.5	< LOQ 5.21	8.07	> LOQ 5.17	5.53	> LOQ 5.12
N-02	18.59	> LOQ 5.11	33.26	> LOQ 5.20	118.73	> LOQ 5.21	31.13	> LOQ 5.19
O-1	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.64	ND	< LOD 1.67
S-01	2.49	< LOQ 5.19	8.98	> LOQ 5.22	35.49	> LOQ 5.22	10.64	> LOQ 5.22
S-02	6.88	> LOQ 5.21	33.5	> LOQ 5.23	54.17	> LOQ 5.21	18.58	> LOQ 5.22
SH-01	ND	< LOD 1.67	ND	< LOD 1.67	3.73	< LOQ 5.18	ND	< LOD 1.66
SS-01	ND	< LOD 1.65	2.09	< LOQ 5.22	ND	< LOD 1.65	ND	< LOD 1.66
SS-02	ND	< LOD 1.66	5.84	> LOQ 5.21	4.55	< LOQ 5.17	4.94	< LOQ 5.14
SS-03	ND	< LOD 1.66	ND	< LOD 1.68	4.09	< LOQ 5.11	2.22	< LOQ 5.04
SS-04	2.07	< LOQ 5.23	12.35	> LOQ 5.23	20.08	> LOQ 5.23	13.17	> LOQ 5.15
SS-05	ND	< LOD 1.61	2.52	< LOQ 5.24	5.40	> LOQ 5.20	3.48	< LOQ 5.12
SS-06	ND	< LOD 1.63	2.49	< LOQ 5.18	ND	< LOD 1.68	ND	< LOD 1.67
SS-07	ND	< LOD 1.64	ND	< LOD 1.66	ND	< LOD 1.67	ND	< LOD 1.65
SSDS-01	ND	< LOD 1.65	ND	< LOD 1.67	1.84	< LOQ 5.16	ND	< LOD 1.66
SSDS-02	2.29	< LOQ 5.21	6.04	> LOQ 5.21	16.71	> LOQ 5.16	11.75	> LOQ 5.06
SSDS-03	ND	< LOD 1.62	ND	< LOD 1.59	ND	< LOD 1.59	ND	< LOD 1.66
CP-1A	2.47	< LOQ 5.16	11.39	> LOQ 5.18	15.77	> LOQ 5.19	6.7	> LOQ 5.24
CP-1B	5.19	< LOQ 5.89	7.62	> LOQ 5.95	28.26	> LOQ 5.89	6.94	> LOQ 5.99
CP-2A	14.03	> LOQ 5.16	33.46	> LOQ 5.23	203.24	> LOQ 10.37	85.17	> LOQ 5.19
CP-2B	35.12	> LOQ 5.16	20.46	> LOQ 5.22	72.52	> LOQ 5.18	14.52	> LOQ 5.26
CP-3A	24.78	> LOQ 5.16	62.59	> LOQ 5.22	289.56	> LOQ 5.17	269.04	> LOQ 5.17
CP-3B	35.77	> LOQ 6.88	183.23	> LOQ 6.94	249.45	> LOQ 6.85	104.3	> LOQ 6.21
CP-4A	16.07	> LOQ 5.15	73.36	> LOQ 5.24	408.08	> LOQ 26.53	80.02	> LOQ 5.13
CP-4B	17.98	> LOQ 5.00	55.7	> LOQ 5.16	268.10	> LOQ 10.31	16.32	> LOQ 5.10
CPDS-1A	17.84	> LOQ 5.07	26.81	> LOQ 5.16	173.45	> LOQ 5.16	65.61	> LOQ 5.13
CPDS-1B	22.24	> LOQ 5.05	33.09	> LOQ 5.17	137.24	> LOQ 5.12	26.02	> LOQ 5.00
G-1A	ND	< LOD 1.66	4.18	< LOQ 5.22	10.59	> LOQ 5.19	7.77	> LOQ 5.11
G-1B	ND	< LOD 1.66	4.64	< LOQ 5.28	5.40	> LOQ 5.19	5.81	> LOQ 5.18
G-2A	ND	< LOD 1.69	2.97	< LOQ 5.31	3.73	< LOQ 5.18	2.5	< LOQ 5.20
G-2B	ND	< LOD 1.64	2.49	< LOQ 5.19	2.51	< LOQ 5.23	ND	< LOD 1.65
G-3A	ND	< LOD 1.65	2.29	< LOQ 5.20	7.14	> LOQ 5.25	ND	< LOD 1.67
G-4A	9.14	> LOQ 5.08	10.54	> LOQ 5.17	28.77	> LOQ 5.14	20.76	> LOQ 5.19
G-4B	3.72	< LOQ 5.17	14.79	> LOQ 5.21	18.40	> LOQ 5.17	14.04	> LOQ 5.16
G-5A	ND	< LOD 1.65	4.15	< LOQ 5.19	10.20	> LOQ 5.20	9.41	> LOQ 5.23
G-5B	1.75	< LOQ 5.22	5.61	> LOQ 5.19	15.42	> LOQ 5.21	3.54	< LOQ 5.21
G-6A	3.33	< LOQ 5.20	14.84	> LOQ 5.23	19.35	> LOQ 5.20	8.49	> LOQ 5.18
G-6B	1.74	< LOQ 5.13	9.06	> LOQ 5.27	7.56	> LOQ 5.11	5.78	> LOQ 5.16
G-7A	10.93	> LOQ 5.16	22.81	> LOQ 5.18	54.23	> LOQ 5.21	15.08	> LOQ 5.24
G-7B	7.6	> LOQ 5.14	14.15	> LOQ 5.20	27.57	> LOQ 5.30	7.83	> LOQ 5.29
SG-1A	ND	< LOD 1.63	ND	< LOD 1.66	ND	< LOD 1.66	ND	< LOD 26.82
SG-1B	ND	< LOD 3.07	ND	< LOD 3.07	ND	< LOD 3.07	ND	< LOD 15.24
SG-2A	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 1.66	ND	< LOD 3.31
SG-2B	ND	< LOD 1.66	ND	< LOD 1.65	ND	< LOD 1.67	ND	< LOD 33.37

Bulk Elemental Analysis - Zirconium

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Zirconium		Sample	Zirconium	
Type	No.	µg/g	Notes	No.	µg/g	Notes
CG-01	J95331-63 VB	ND	< LOD 0.3	J95331-63 PB	ND	< LOD 0.3
CS-01	J95331-34 VB	63.00	> LOQ 1.0	J95331-34 PB	51.00	> LOQ 1.0
CS-02	J95331-37 VB	32.00	> LOQ 1.0	J95331-37 PB	31.00	> LOQ 1.0
CS-03	J95331-38 VB	77.00	> LOQ 1.0	J95331-38 PB	87.00	> LOQ 1.0
CS-04	J95331-39 VB	2.90	> LOQ 1.0	J95331-39 PB	3.50	> LOQ 1.0
CS-05	J95331-57 VB	2.10	> LOQ 1.0	J95331-57 PB	1.70	> LOQ 1.0
CS-06	J95331-70 VB	1.20	> LOQ 1.0	J95331-70 PB	1.90	> LOQ 1.0
CS-07	J95331-83 VB	5.40	> LOQ 1.0	J95331-83 PB	8.50	> LOQ 1.0
CSDS-01	J95331-31 VB	3.30	> LOQ 1.0	J95331-31 PB	2.90	> LOQ 1.0
CSDS-02	J95331-35 VB	54.00	> LOQ 1.0	J95331-35 PB	57.00	> LOQ 1.0
N-01	J95331-52 VB	0.56	< LOQ 1.0	J95331-52 PB	0.80	< LOQ 1.0
N-02	J95331-81 VB	11.00	> LOQ 1.0	J95331-81 PB	21.00	> LOQ 1.0
O-1	J95331-69 VB	ND	< LOD 0.3	J95331-69 PB	ND	< LOD 0.3
S-01	J95331-28 VB	6.80	> LOQ 1.0	J95331-28 PB	5.10	> LOQ 1.0
S-02	J95331-29 VB	7.60	> LOQ 1.0	J95331-29 PB	11.00	> LOQ 1.0
SH-01	J95331-36 VB	0.32	< LOQ 1.0	J95331-36 PB	0.45	< LOQ 1.0
SS-01	J95331-32 VB	ND	< LOD 0.3	J95331-32 PB	0.35	< LOQ 1.0
SS-02	J95331-40 VB	0.39	< LOQ 1.0	J95331-40 PB	ND	< LOD 0.3
SS-03	J95331-45 VB	ND	< LOD 0.3	J95331-45 PB	ND	< LOD 0.3
SS-04	J95331-47 VB	2.70	> LOQ 1.0	J95331-47 PB	0.70	< LOQ 1.0
SS-05	J95331-53 VB	1.10	> LOQ 1.0	J95331-53 PB	0.79	< LOQ 1.0
SS-06	J95331-76 VB	0.50	< LOQ 1.0	J95331-76 PB	0.53	< LOQ 1.0
SS-07	J95331-80 VB	ND	< LOD 0.3	J95331-80 PB	ND	< LOD 0.3
SSDS-01	J95331-33 VB	ND	< LOD 0.3	J95331-33 PB	ND	< LOD 0.3
SSDS-02	J95331-44 VB	3.70	> LOQ 1.0	J95331-44 PB	4.40	> LOQ 1.0
SSDS-03	J95331-48 VB	0.42	< LOQ 1.0	J95331-48 PB	ND	< LOD 0.3
CP-1A	J95331-60 VB	1.50	> LOQ 1.0	J95331-60 PB	6.10	> LOQ 1.0
CP-1B	J95331-61 VB	2.40	> LOQ 1.0	J95331-61 PB	3.10	> LOQ 1.0
CP-2A	J95331-67 VB	33.00	> LOQ 1.0	J95331-67 PB	46.00	> LOQ 2.0
CP-2B	J95331-68 VB	41.00	> LOQ 2.0	J95331-68 PB	43.00	> LOQ 2.0
CP-3A	J95331-72 VB	55.00	> LOQ 1.0	J95331-72 PB	61.00	> LOQ 1.0
CP-3B	J95331-73 VB	63.00	> LOQ 1.0	J95331-73 PB	61.00	> LOQ 1.0
CP-4A	J95331-78 VB	14.00	> LOQ 1.0	J95331-78 PB	29.00	> LOQ 2.0
CP-4B	J95331-79 VB	27.00	> LOQ 1.0	J95331-79 PB	32.00	> LOQ 1.0
CPDS-1A	J95331-84 VB	1.80	> LOQ 1.0	J95331-84 PB	35.00	> LOQ 1.0
CPDS-1B	J95331-85 VB	33.00	> LOQ 1.0	J95331-85 PB	35.00	> LOQ 1.0
G-1A	J95331-41 VB	0.44	< LOQ 1.0	J95331-41 PB	0.74	< LOQ 1.0
G-1B	J95331-46 VB	1.20	> LOQ 1.0	J95331-46 PB	0.70	< LOQ 1.0
G-2A	J95331-43 VB	ND	< LOD 0.3	J95331-43 PB	0.39	< LOQ 1.0
G-2B	J95331-50 VB	0.59	< LOQ 1.0	J95331-50 PB	ND	< LOD 0.3
G-3A	J95331-49 VB	ND	< LOD 0.3	J95331-49 PB	3.30	> LOQ 1.0
G-4A	J95331-55 VB	1.40	> LOQ 1.0	J95331-55 PB	2.30	> LOQ 2.0
G-4B	J95331-56 VB	2.60	> LOQ 1.0	J95331-56 PB	1.90	> LOQ 1.0
G-5A	J95331-58 VB	1.30	> LOQ 1.0	J95331-58 PB	1.60	> LOQ 1.0
G-5B	J95331-59 VB	0.99	< LOQ 1.0	J95331-59 PB	0.63	< LOQ 1.0
G-6A	J95331-64 VB	1.90	> LOQ 1.0	J95331-64 PB	2.10	> LOQ 1.0
G-6B	J95331-65 VB	2.00	> LOQ 1.0	J95331-65 PB	1.20	> LOQ 1.0
G-7A	J95331-74 VB	2.80	> LOQ 1.0	J95331-74 PB	3.80	> LOQ 1.0
G-7B	J95331-75 VB	7.90	> LOQ 1.0	J95331-75 PB	5.10	> LOQ 1.0
SG-1A	J95331-54 VB	ND	< LOD 3.0	J95331-54 PB	ND	< LOD 3.0
SG-1B	J95331-71 VB	ND	< LOD 1.5	J95331-71 PB	ND	< LOD 1.5
SG-2A	J95331-66 VB	ND	< LOD 1.5	J95331-66 PB	ND	< LOD 5.0
SG-2B	J95331-82 VB	ND	< LOD 3.0	J95331-82 PB	ND	< LOD 3.0

Comparison of Airborne Concentrations to Bulk Concentrations - Zirconium

NIOSH REL 5000.0 micrograms/cubic meter
OSHA PEL 5000.0 micrograms/cubic meter

Abrasive Type	@ Make-up Air Area Fixed Station #1 µg/m³	@ Operator Area Fixed Station #2 µg/m³	@ Exhaust Area Fixed Station #3 µg/m³	Operator 's Breathing Zone (OBZ) µg/m³	Virgin Bulk Percentage µg/g
CG-01	ND	2.00	ND	ND	ND
CS-01	13.80	41.67	179.49	39.65	63.00
CS-02	17.05	50.17	208.29	75.02	32.00
CS-03	26.81	105.61	373.29	103.54	77.00
CS-04	11.73	37.67	82.83	47.34	2.90
CS-05	5.78	20.24	33.49	20.72	2.10
CS-06	27.11	67.02	37.26	37.47	1.20
CS-07	43.25	81.32	291.30	77.15	5.40
CSDS-01	10.17	43.74	93.44	56.17	3.30
CSDS-02	14.22	51.70	169.74	69.07	54.00
N-01	ND	2.50	8.07	5.53	0.56
N-02	18.59	33.26	118.73	31.13	11.00
O-1	ND	ND	ND	ND	ND
S-01	2.49	8.98	35.49	10.64	6.80
S-02	6.88	33.50	54.17	18.58	7.60
SH-01	ND	ND	3.73	ND	0.32
SS-01	ND	2.09	ND	ND	ND
SS-02	ND	5.84	4.55	4.94	0.39
SS-03	ND	ND	4.09	2.22	ND
SS-04	2.07	12.35	20.08	13.17	2.70
SS-05	ND	2.52	5.40	3.48	1.10
SS-06	ND	2.49	ND	ND	0.50
SS-07	ND	ND	ND	ND	ND
SSDS-01	ND	ND	1.84	ND	ND
SSDS-02	2.29	6.04	16.71	11.75	3.70
SSDS-03	ND	ND	ND	ND	0.42
CP-1A	2.47	11.39	15.77	6.70	1.50
CP-2A	14.03	33.46	203.24	85.17	33.00
CP-3A	24.78	62.59	289.56	269.04	55.00
CP-4A	16.07	73.36	408.08	80.02	14.00
CPDS-1A	17.84	26.81	173.45	65.61	1.80
G-1A	ND	4.18	10.59	7.77	0.44
G-2A	ND	2.97	3.73	2.50	ND
G-3A	ND	2.29	7.14	ND	ND
G-4A	9.14	10.54	28.77	20.76	1.40
G-5A	ND	4.15	10.20	9.41	1.30
G-6A	3.33	14.84	19.35	8.49	1.90
G-7A	10.93	22.81	54.23	15.08	2.80
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	ND	ND

APPENDIX B -

Respirable Silica Quartz

Respirable Silica-Quartz

Respirable silica-quartz causes silicosis after chronic exposure. The formation of scattered, rounded or stellate silica-containing nodules of scar tissue in the lungs characterize classical silicosis. It may be slowly progressive, even in the absence of continued exposure. Acute silicosis may occur under conditions of extremely high crystalline quartz dust exposures, particularly when the particle size of the dust is very small. This disease differs from classical silicosis in that it is rapidly progressive with diffuse pulmonary involvement. Animal studies have indicated an increased risk of lung cancer. The NIOSH REL for respirable quartz is 0.05 milligrams/cubic meter of air. The OSHA PEL for respirable quartz is 10 milligrams/cubic meter of air divided by % silica + 2.

Respirable Quartz Airborne Samples:

The following seven of the respirable quartz airborne samples were quantified by primary peak height measurement due to problematical integration data for these samples: (96-4771 garnet G-2B), (96-4795 garnet G-2B), (96-4783 garnet G-2B), (96-4380 garnet G-4A), (96-4774 garnet G-3A), (96-4781 garnet G-3A), and (96-4819 silica sand with dust suppressant SSDS-03). Samples (96-4441 silica sand with dust suppressant SSDS-03) and (96-4537 nickel slag N-01) were analyzed by secondary peak height analysis due to nearby interference of the primary peak.

Total Quartz Bulk Samples:

The following virgin and post bulk samples had interference problems in the primary peak area and were analyzed by peak height measurement of the secondary peak: garnet G-2A, garnet G-2B, specular hematite, and nickel slag N-01. The virgin and post bulk samples of garnet G-2B and nickel slag N-01were also checked microscopically for quartz which identified the samples as non-detectable (<5%, <3%, <3%, and <1%). The garnet virgin bulk samples G-1B and G-4A had interference problems, but were analyzed by long range qualititative scan (5 to 90 degrees two theta). They appeared to have primary and secondary quartz peaks, but showed no other quartz peaks. The virgin and post bulk samples of garnet G-3A and steel grit SG-1A and the post bulk samples of garnet G-1B and garnet G-4A had interference problems in the primary peak area and were checked microscopically for quartz.

Air Sample Results - Respirable Quartz

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Quartz Gravemetric mg/filter	Quartz Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m³	Calculations Notes	Calculations OSHA PEL
PVC 96-2604	1	40.51	S-01	0.16		ND	< LOD 0.01	ND	ND	< LOD 0.2468	NA
PVC 96-2576	2	40.99	S-01	0.99		ND	< LOD 0.01	ND	ND	< LOD 0.2440	NA
PVC 96-2582	3	40.99	S-01	2.80		ND	< LOD 0.01	ND	ND	< LOD 0.2440	NA
PVC 96-2590	OBZ	41.29	S-01	0.63		ND	< LOD 0.01	ND	ND	< LOD 0.2422	NA
PVC 96-2561	1	40.72	S-02	0.07		ND	< LOD 0.01	ND	ND	< LOD 0.2456	NA
PVC 96-2831	2	41.14	S-02	1.11		0.02	< LOQ 0.030	1.80%	0.49	< LOQ 0.7293	2.632
PVC 96-2577	3	40.72	S-02	1.41		ND	< LOD 0.01	ND	ND	< LOD 0.2456	NA
PVC 96-2694	OBZ	40.72	S-02	0.48		ND	< LOD 0.01	ND	ND	< LOD 0.2456	NA
PVC 96-2798	1	40.82	CSDS-01	0.12		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-2802	2	40.81	CSDS-01	0.35		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-2786	3	40.86	CSDS-01	0.51		ND	< LOD 0.01	ND	ND	< LOD 0.2447	NA
PVC 96-2788	OBZ	41.00	CSDS-01	0.23		ND	< LOD 0.01	ND	ND	< LOD 0.2439	NA
PVC 96-2789	1	41.00	SS-01	0.26		0.26	> LOQ 0.030	100.00%	6.34	> LOQ 0.7316	0.098
PVC 96-2781	2	41.08	SS-01	0.87		0.82	> LOQ 0.030	94.25%	19.96	> LOQ 0.7304	0.104
PVC 96-2768	3	40.88	SS-01	1.88		1.38	> LOQ 0.030	73.40%	33.75	> LOQ 0.7338	0.133
PVC 96-2771	OBZ	40.78	SS-01	0.55		0.57	> LOQ 0.030	100.00%	13.49	> LOQ 0.7357	0.098
PVC 96-2446	1	41.03	SSDS-01	0.23		0.26	> LOQ 0.030	100.00%	5.61	> LOQ 0.7312	0.098
PVC 96-2456	2	40.79	SSDS-01	0.98		0.86	> LOQ 0.030	87.76%	21.09	> LOQ 0.7355	0.111
PVC 96-2454	3	40.87	SSDS-01	1.25		1.30	> LOQ 0.030	100.00%	30.58	> LOQ 0.7340	0.098
PVC 96-2449	OBZ	41.65	SSDS-01	0.94		0.71	> LOQ 0.030	75.53%	17.05	> LOQ 0.7203	0.129
PVC 96-2475	1	40.90	CS-01	0.28		ND	< LOD 0.01	ND	ND	< LOD 0.2445	NA
PVC 96-2750	2	40.82	CS-01	1.12		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-2764	3	41.00	CS-01	1.29		ND	< LOD 0.01	ND	ND	< LOD 0.2439	NA
PVC 96-2772	OBZ	43.86	CS-01	0.62		ND	< LOD 0.01	ND	ND	< LOD 0.2280	NA
PVC 96-2437	1	40.96	CSDS-02	0.06		ND	< LOD 0.01	ND	ND	< LOD 0.2442	NA
PVC 96-2432	2	41.05	CSDS-02	0.42		ND	< LOD 0.01	ND	ND	< LOD 0.2436	NA
PVC 96-2429	3	40.72	CSDS-02	0.29		ND	< LOD 0.01	ND	ND	< LOD 0.2456	NA
PVC 96-2491	OBZ	39.70	CSDS-02	0.22		ND	< LOD 0.01	ND	ND	< LOD 0.2519	NA
PVC 96-2518	1	41.03	SH-01	0.14		ND	< LOD 0.01	ND	ND	< LOD 0.2437	NA
PVC 96-2498	2	40.81	SH-01	0.42		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-2505	3	40.78	SH-01	0.62		ND	< LOD 0.01	ND	ND	< LOD 0.2452	NA
PVC 96-2517	OBZ	39.08	SH-01	0.50		ND	< LOD 0.01	ND	ND	< LOD 0.2559	NA
PVC 96-2485	1	40.94	CS-02	0.19		ND	< LOD 0.01	ND	ND	< LOD 0.2442	NA
PVC 96-3190	2	40.74	CS-02	0.73		ND	< LOD 0.01	ND	ND	< LOD 0.2455	NA
PVC 96-3183	3	40.88	CS-02	0.55		ND	< LOD 0.01	ND	ND	< LOD 0.2446	NA
PVC 96-3187	OBZ	40.75	CS-02	0.72		ND	< LOD 0.01	ND	ND	< LOD 0.2454	NA

Air Sample Results - Respirable Quartz

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Quartz Gravemetric mg/filter	Quartz Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m^3	Calculations Notes	Calculations OSHA PEL
PVC 96-3177	1	40.92	CS-03	0.23		ND	< LOD 0.01	ND	ND	< LOD 0.2444	NA
PVC 96-3168	2	41.00	CS-03	0.95		ND	< LOD 0.01	ND	ND	< LOD 0.2439	NA
PVC 96-3161	3	40.75	CS-03	0.95		ND	< LOD 0.01	ND	ND	< LOD 0.2454	NA
PVC 96-3172	OBZ	41.58	CS-03	0.69		ND	< LOD 0.01	ND	ND	< LOD 0.2405	NA
PVC 96-3137	1	40.94	CS-04	0.12		ND	< LOD 0.01	ND	ND	< LOD 0.2442	NA
PVC 96-3144	2	40.82	CS-04	0.55		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-3153	3	40.67	CS-04	1.11		ND	< LOD 0.01	ND	ND	< LOD 0.2459	NA
PVC 96-3140	OBZ	41.48	CS-04	0.54		ND	< LOD 0.01	ND	ND	< LOD 0.2411	NA
PVC 96-3130	1	40.80	SS-02	0.57		0.40	> LOQ 0.030	70.18%	9.80	> LOQ 0.7353	0.139
PVC 96-3121	2	40.75	SS-02	1.13		1.06	> LOQ 0.030	93.81%	26.01	> LOQ 0.7362	0.104
PVC 96-3114	3	40.76	SS-02	2.05		1.76	> LOQ 0.030	85.85%	43.17	> LOQ 0.7359	0.114
PVC 96-3102	OBZ	41.29	SS-02	1.19		0.84	> LOQ 0.030	70.59%	20.34	> LOQ 0.7265	0.138
PVC 96-2981	1	40.91	G-1A	0.04		ND	< LOD 0.01	ND	ND	< LOD 0.2445	NA
PVC 96-2965	2	40.81	G-1A	0.27		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-2961	3	41.04	G-1A	0.37		ND	< LOD 0.01	ND	ND	< LOD 0.2437	NA
PVC 96-3104	OBZ	41.10	G-1A	0.19		ND	< LOD 0.01	ND	ND	< LOD 0.2433	NA
PVC 96-3573	1	41.38	G-2A	0.12		ND	< LOD 0.01	ND	ND	< LOD 0.2417	NA
PVC 96-3578	2	40.96	G-2A	0.31		0.02	< LOQ 0.030	6.45%	0.49	< LOQ 0.7325	1.183
PVC 96-3577	3	40.92	G-2A	0.57		0.02	< LOQ 0.030	3.51%	0.49	< LOQ 0.7331	1.815
PVC 96-3565	OBZ	39.68	G-2A	0.35		0.02	< LOQ 0.030	5.71%	0.50	< LOQ 0.7560	1.297
PVC 96-3622	1	41.36	SSDS-02	ND	< LOD 0.02mg	ND	< LOD 0.01	ND	ND	< LOD 0.2418	NA
PVC 96-3632	2	40.67	SSDS-02	0.41		0.17	> LOQ 0.030	41.46%	4.18	> LOQ 0.7377	0.23
PVC 96-3617	3	41.08	SSDS-02	0.56		0.18	> LOQ 0.030	32.14%	4.38	> LOQ 0.7304	0.293
PVC 96-3108	OBZ	40.91	SSDS-02	0.39		0.14	> LOQ 0.030	35.90%	3.42	> LOQ 0.7334	0.264
PVC 96-3654	1	41.08	SS-03	0.11		0.10	> LOQ 0.030	90.91%	2.43	> LOQ 0.7304	0.108
PVC 96-3655	2	40.66	SS-03	0.62		0.45	> LOQ 0.030	72.58%	11.07	> LOQ 0.7379	0.134
PVC 96-3641	3	41.18	SS-03	0.16		0.19	> LOQ 0.030	100.00%	3.89	> LOQ 0.7284	0.098
PVC 96-3651	OBZ	40.92	SS-03	0.16		0.12	> LOQ 0.030	75.00%	2.93	> LOQ 0.7331	0.13
PVC 96-3091	1	40.88	G-1B	0.05		ND	< LOD 0.01	ND	ND	< LOD 0.2446	NA
PVC 96-3067	2	40.80	G-1B	0.61		ND	< LOD 0.01	ND	ND	< LOD 0.2451	NA
PVC 96-3062	3	40.48	G-1B	0.28		ND	< LOD 0.01	ND	ND	< LOD 0.2471	NA
PVC 96-4452	OBZ	41.33	G-1B	0.37		ND	< LOD 0.01	ND	ND	< LOD 0.2420	NA
PVC 96-3064	1	40.84	SS-04	ND	< LOD 0.02mg	ND	< LOD 0.01	ND	ND	< LOD 0.2449	NA
PVC 96-3071	2	40.84	SS-04	2.23		0.53	> LOQ 0.030	23.77%	12.98	> LOQ 0.7346	0.388
PVC 96-3098	3	40.75	SS-04	0.43		0.13	> LOQ 0.030	30.23%	3.19	> LOQ 0.7362	0.31
PVC 96-3090	OBZ	41.14	SS-04	1.26		0.31	> LOQ 0.030	24.60%	7.54	> LOQ 0.7293	0.376

Air Sample Results - Respirable Quartz

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Quartz Gravemetric mg/filter	Quartz Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m^3	Calculations Notes	OSHA PEL
PVC 96-4445	1	42.75	SSDS-03	0.05		ND	< LOD 0.01	ND	ND	< LOD 0.2339	NA
PVC 96-4441	2	42.80	SSDS-03	0.12		0.09	< LOQ 0.16	75.00%	2.10	> LOQ 0.7009	0.13
PVC 96-4810	3	42.53	SSDS-03	n/a	LPOF	0.12	> LOQ 0.030	ND	ND	NA	NA
PVC 96-4819	OBZ	41.45	SSDS-03	0.62		0.04	> LOQ 0.030	6.45%	0.96	> LOQ 0.7238	1.183
PVC 96-4785	1	40.62	G-3A	0.11		ND	< LOD 0.01	ND	ND	< LOD 0.2462	NA
PVC 96-4774	2	40.86	G-3A	0.71		0.04	> LOQ 0.030	5.63%	0.98	> LOQ 0.7342	1.311
PVC 96-4781	3	40.94	G-3A	0.58		0.04	> LOQ 0.030	6.90%	0.98	> LOQ 0.7327	1.124
PVC 96-4805	OBZ	41.02	G-3A	1.61		0.28	> LOQ 0.030	17.39%	6.83	> LOQ 0.7314	0.516
PVC 96-4788	1	41.04	G-2B	0.11		ND	< LOD 0.01	ND	ND	< LOD 0.2437	NA
PVC 96-4771	2	40.72	G-2B	0.55		0.04	> LOQ 0.030	7.27%	0.98	> LOQ 0.7368	1.079
PVC 96-4795	3	41.33	G-2B	0.29		0.05	> LOQ 0.030	17.24%	1.21	> LOQ 0.7259	0.52
PVC 96-4783	OBZ	40.63	G-2B	0.29		0.03	> LOQ 0.30	10.34%	0.74	> LOQ 0.7383	0.81
PVC 96-4426	1	40.85	N-01	0.14		ND	< LOD 0.01	ND	ND	< LOD 0.2448	NA
PVC 96-4537	2	41.22	N-01	0.34		ND	< LOD 0.08	ND	ND	< LOD 0.2426	NA
PVC 96-4530	3	40.99	N-01	0.95		ND	< LOD 0.01	ND	ND	< LOD 0.2440	NA
PVC 96-4518	OBZ	40.93	N-01	1.19		ND	< LOD 0.01	ND	ND	< LOD 0.2443	NA
PVC 96-4522	1	41.11	SS-05	0.19		0.17	> LOQ 0.030	89.47%	4.13	> LOQ 0.7297	0.109
PVC 96-4524	2	41.16	SS-05	1.04		0.66	> LOQ 0.030	63.46%	16.03	> LOQ 0.7289	0.153
PVC 96-4520	3	40.88	SS-05	2.13		1.25	> LOQ 0.030	58.69%	30.58	> LOQ 0.7338	0.165
PVC 96-4513	OBZ	40.85	SS-05	1.27		0.90	> LOQ 0.030	70.87%	22.03	> LOQ 0.7344	0.137
PVC 96-4404	1	40.79	SG-1A	0.26		ND	< LOD 0.01	ND	ND	< LOD 0.2452	NA
PVC 96-4396	2	40.80	SG-1A	1.38		ND	< LOD 0.01	ND	ND	< LOD 0.2451	NA
PVC 96-4389	3	40.70	SG-1A	0.90		ND	< LOD 0.01	ND	ND	< LOD 0.2457	NA
PVC 96-4401	OBZ	40.73	SG-1A	0.79		ND	< LOD 0.01	ND	ND	< LOD 0.2455	NA
PVC 96-4394	1	41.08	G-4A	0.08		ND	< LOD 0.01	ND	ND	< LOD 0.2435	NA
PVC 96-4383	2	40.73	G-4A	0.76		0.03	> LOQ 0.030	3.95%	0.74	> LOQ 0.7366	1.681
PVC 96-4393	3	40.78	G-4A	0.87		0.02	> LOQ 0.030	2.30%	0.49	> LOQ 0.7357	2.326
PVC 96-4380	OBZ	40.13	G-4A	0.75		0.05	> LOQ 0.030	6.67%	1.25	> LOQ 0.7476	1.153
PVC 96-4755	1	40.92	G-4B	0.14		ND	< LOD 0.01	ND	ND	< LOD 0.2444	NA
PVC 96-4758	2	40.81	G-4B	1.33		0.08	> LOQ 0.030	6.02%	1.96	> LOQ 0.7351	1.247
PVC 96-4741	3	41.28	G-4B	0.25		0.01	< LOQ 0.030	4.00%	0.24	< LOQ 0.7267	1.667
PVC 96-4752	OBZ	40.61	G-4B	1.95		0.15	> LOQ 0.030	7.69%	3.69	> LOQ 0.7388	1.032
PVC 96-4744	1	40.75	CS-05	0.11		ND	< LOD 0.01	ND	ND	< LOD 0.2454	NA
PVC 96-4722	2	40.75	CS-05	1.32		ND	< LOD 0.01	ND	ND	< LOD 0.2454	NA
PVC 96-4715	3	40.31	CS-05	0.57		ND	< LOD 0.01	ND	ND	< LOD 0.2481	NA
PVC 96-4719	OBZ	41.29	CS-05	0.34		ND	< LOD 0.01	ND	ND	< LOD 0.2422	NA

Air Sample Results - Respirable Quartz

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Quartz Gravemetric mg/filter	Quartz Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m^3	Calculations Notes	Calculations OSHA PEL
PVC 96-4709	1	41.02	G-5A	0.11		ND	< LOD 0.01	ND	ND	< LOD 0.2438	NA
PVC 96-4699	2	41.02	G-5A	0.45		ND	< LOD 0.01	ND	ND	< LOD 0.2438	NA
PVC 96-4692	3	40.84	G-5A	0.54		ND	< LOD 0.01	ND	ND	< LOD 0.2449	NA
PVC 96-4696	OBZ	41.27	G-5A	0.35		ND	< LOD 0.01	ND	ND	< LOD 0.2423	NA
PVC 96-4661	1	40.85	G-5B	0.08		ND	< LOD 0.01	ND	ND	< LOD 0.2448	NA
PVC 96-4651	2	40.82	G-5B	1.00		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-4645	3	41.15	G-5B	1.86		ND	< LOD 0.01	ND	ND	< LOD 0.2430	NA
PVC 96-4656	OBZ	41.08	G-5B	0.94		ND	< LOD 0.01	ND	ND	< LOD 0.2435	NA
PVC 96-2955	1	40.74	CP-1A	0.16		ND	< LOD 0.01	ND	ND	< LOD 0.2455	NA
PVC 96-2946	2	40.62	CP-1A	1.13		ND	< LOD 0.01	ND	ND	< LOD 0.2462	NA
PVC 96-2939	3	41.21	CP-1A	1.30		ND	< LOD 0.01	ND	ND	< LOD 0.2427	NA
PVC 96-2942	OBZ	41.04	CP-1A	0.66		ND	< LOD 0.01	ND	ND	< LOD 0.2437	NA
PVC 96-3355	1	35.51	CP-1B	0.26		ND	< LOD 0.01	ND	ND	< LOD 0.2816	NA
PVC 96-3346	2	35.60	CP-1B	1.49		ND	< LOD 0.01	ND	ND	< LOD 0.2809	NA
PVC 96-3339	3	35.56	CP-1B	1.76		ND	< LOD 0.01	ND	ND	< LOD 0.2812	NA
PVC 96-3327	OBZ	35.26	CP-1B	1.12		ND	< LOD 0.01	ND	ND	< LOD 0.2836	NA
PVC 96-3317	1	41.26	CG-01	0.32		ND	< LOD 0.01	ND	ND	< LOD 0.2424	NA
PVC 96-3309	2	41.03	CG-01	2.30		ND	< LOD 0.01	ND	ND	< LOD 0.2437	NA
PVC 96-3316	3	41.14	CG-01	2.88		ND	< LOD 0.01	ND	ND	< LOD 0.2431	NA
PVC 96-3304	OBZ	40.87	CG-01	2.10		ND	< LOD 0.01	ND	ND	< LOD 0.2447	NA
PVC 96-3293	1	40.90	G-6A	0.13		ND	< LOD 0.01	ND	ND	< LOD 0.2445	NA
PVC 96-3285	2	40.90	G-6A	1.10		ND	< LOD 0.01	ND	ND	< LOD 0.2445	NA
PVC 96-3277	3	41.04	G-6A	0.36		0.01	< LOQ 0.030	2.78%	0.24	< LOQ 0.7310	2.092
PVC 96-3281	OBZ	41.30	G-6A	0.80		0.01	< LOQ 0.030	1.25%	0.24	< LOQ 0.7263	3.077
PVC 96-3282	1	41.40	G-6B	0.28		ND	< LOD 0.01	ND	ND	< LOD 0.2415	NA
PVC 96-3261	2	39.90	G-6B	0.50		ND	< LOD 0.01	ND	ND	< LOD 0.2506	NA
PVC 96-3238	3	40.03	G-6B	1.29		ND	< LOD 0.01	ND	ND	< LOD 0.2498	NA
PVC 96-3242	OBZ	40.99	G-6B	0.65		ND	< LOD 0.01	ND	ND	< LOD 0.2440	NA
PVC 96-3231	1	41.00	SG-2A	0.20		ND	< LOD 0.01	ND	ND	< LOD 0.2439	NA
PVC 96-3222	2	40.92	SG-2A	0.34		ND	< LOD 0.01	ND	ND	< LOD 0.2444	NA
PVC 96-3215	3	40.63	SG-2A	1.28		ND	< LOD 0.01	ND	ND	< LOD 0.2461	NA
PVC 96-3219	OBZ	41.00	SG-2A	0.62		ND	< LOD 0.01	ND	ND	< LOD 0.2439	NA
PVC 96-4293	1	40.80	CP-2A	0.18		ND	< LOD 0.01	ND	ND	< LOD 0.2451	NA
PVC 96-3199	2	40.82	CP-2A	0.52		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-3203	3	40.68	CP-2A	0.26		ND	< LOD 0.01	ND	ND	< LOD 0.2458	NA
PVC 96-3220	OBZ	40.79	CP-2A	0.43		ND	< LOD 0.01	ND	ND	< LOD 0.2452	NA

Air Sample Results - Respirable Quartz

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Quartz Gravemetric mg/filter	Quartz Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m^3	Calculations Notes	OSHA PEL
PVC 96-4262	1	41.05	CP-2B	0.17		ND	< LOD 0.01	ND	ND	< LOD 0.2436	NA
PVC 96-4272	2	40.79	CP-2B	0.33		ND	< LOD 0.01	ND	ND	< LOD 0.2452	NA
PVC 96-4271	3	40.66	CP-2B	0.73		ND	< LOD 0.01	ND	ND	< LOD 0.2460	NA
PVC 96-4277	OBZ	40.40	CP-2B	0.28		ND	< LOD 0.01	ND	ND	< LOD 0.2475	NA
PVC 96-4268	1	40.67	O-1	0.27		ND	< LOD 0.01	ND	ND	< LOD 0.2459	NA
PVC 96-4270	2	40.85	O-1	1.77		ND	< LOD 0.01	ND	ND	< LOD 0.2448	NA
PVC 96-4276	3	40.56	O-1	1.74		ND	< LOD 0.01	ND	ND	< LOD 0.2465	NA
PVC 96-4252	OBZ	40.51	O-1	1.62		ND	< LOD 0.01	ND	ND	< LOD 0.2468	NA
PVC 96-1468	1	40.98	CS-06	0.42		ND	< LOD 0.01	ND	ND	< LOD 0.2440	NA
PVC 96-1460	2	40.99	CS-06	1.55		ND	< LOD 0.01	ND	ND	< LOD 0.2440	NA
PVC 96-1455	3	40.79	CS-06	1.67		ND	< LOD 0.01	ND	ND	< LOD 0.2452	NA
PVC 96-1482	OBZ	40.58	CS-06	0.69		ND	< LOD 0.01	ND	ND	< LOD 0.2464	NA
PVC 96-1465	1	22.16	SG-1B	0.02		ND	< LOD 0.01	ND	ND	< LOD 0.4513	NA
PVC 96-1324	2	22.22	SG-1B	0.09		ND	< LOD 0.01	ND	ND	< LOD 0.4500	NA
PVC 96-1363	3	22.11	SG-1B	0.05		ND	< LOD 0.01	ND	ND	< LOD 0.4524	NA
PVC 96-1367	OBZ	18.58	SG-1B	0.03		ND	< LOD 0.01	ND	ND	< LOD 0.5382	NA
PVC 96-1360	1	41.02	CP-3A	0.13		ND	< LOD 0.01	ND	ND	< LOD 0.2438	NA
PVC 96-1355	2	40.93	CP-3A	0.40		ND	< LOD 0.01	ND	ND	< LOD 0.2443	NA
PVC 96-1388	3	41.11	CP-3A	0.98		ND	< LOD 0.01	ND	ND	< LOD 0.2432	NA
PVC 96-1392	OBZ	40.56	CP-3A	0.35		ND	< LOD 0.01	ND	ND	< LOD 0.2465	NA
PVC 96-1385	1	30.70	CP-3B	0.22		ND	< LOD 0.01	ND	ND	< LOD 0.3257	NA
PVC 96-1380	2	30.53	CP-3B	0.73		ND	< LOD 0.01	ND	ND	< LOD 0.3276	NA
PVC 96-1413	3	30.77	CP-3B	0.41		ND	< LOD 0.01	ND	ND	< LOD 0.3250	NA
PVC 96-1416	OBZ	34.33	CP-3B	0.50		ND	< LOD 0.01	ND	ND	< LOD 0.2913	NA
PVC 96-1322	1	40.66	G-7A	0.36		ND	< LOD 0.01	ND	ND	< LOD 0.2460	NA
PVC 96-1441	2	40.76	G-7A	1.20		ND	< LOD 0.01	ND	ND	< LOD 0.2453	NA
PVC 96-1438	3	40.50	G-7A	0.97		ND	< LOD 0.01	ND	ND	< LOD 0.2469	NA
PVC 96-1430	OBZ	40.68	G-7A	0.75	LPOF	ND	< LOD 0.01	ND	ND	< LOD 0.2458	NA
PVC 96-4202	1	41.21	G-7B	0.39		ND	< LOD 0.01	ND	ND	< LOD 0.2427	NA
PVC 96-4203	2	40.67	G-7B	1.94		ND	< LOD 0.01	ND	ND	< LOD 0.2459	NA
PVC 96-4204	3	40.03	G-7B	ND	< LOD 0.02mg	ND	< LOD 0.01	ND	ND	< LOD 0.2498	NA
PVC 96-4206	OBZ	40.16	G-7B	1.39		ND	< LOD 0.01	ND	ND	< LOD 0.2490	NA
PVC 96-4185	1	40.70	SS-06	0.66		0.21	> LOQ 0.030	31.82%	5.16	> LOQ 0.7370	0.296
PVC 96-4178	2	40.61	SS-06	1.36		0.41	> LOQ 0.030	30.15%	10.10	> LOQ 0.7388	0.311
PVC 96-4184	3	40.52	SS-06	2.56		0.69	> LOQ 0.030	26.95%	17.02	> LOQ 0.7403	0.345
PVC 96-4175	OBZ	42.37	SS-06	1.93		0.51	> LOQ 0.030	26.42%	12.03	> LOQ 0.7080	0.352

Air Sample Results - Respirable Quartz

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Quartz Gravemetric mg/filter	Quartz Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m^3	Calculations Notes	Calculations OSHA PEL
PVC 96-3930	1	41.16	CP-4A	0.25		ND	< LOD 0.01	ND	ND	< LOD 0.2430	NA
PVC 96-3919	2	40.40	CP-4A	1.54		0.02	< LOQ 0.030	1.30%	0.50	< LOQ 0.7425	3.03
PVC 96-3906	3	40.85	CP-4A	0.54		ND	< LOD 0.01	ND	ND	< LOD 0.2448	NA
PVC 96-3920	OBZ	40.85	CP-4A	1.65		0.03	> LOQ 0.30	1.82%	0.74	> LOQ 0.7344	2.618
PVC 96-4212	1	40.86	CP-4B	0.26		ND	< LOD 0.01	ND	ND	< LOD 0.2447	NA
PVC 96-4217	2	41.08	CP-4B	1.37		0.01	< LOQ 0.030	0.73%	0.24	< LOQ 0.7304	3.663
PVC 96-4218	3	40.90	CP-4B	1.36		ND	< LOD 0.01	ND	ND	< LOD 0.2445	NA
PVC 96-3917	OBZ	41.42	CP-4B	1.83	LPOF	ND	< LOD 0.01	ND	ND	< LOD 0.2414	NA
PVC 96-4146	1	40.48	SS-07	0.33		0.14	> LOQ 0.030	42.42%	3.46	> LOQ 0.7412	0.225
PVC 96-4154	2	40.88	SS-07	0.98		0.29	> LOQ 0.030	29.59%	7.09	> LOQ 0.7338	0.317
PVC 96-4147	3	40.54	SS-07	1.77		0.65	> LOQ 0.030	36.72%	16.03	> LOQ 0.7401	0.258
PVC 96-4148	OBZ	40.97	SS-07	1.28		0.44	> LOQ 0.030	34.38%	10.74	> LOQ 0.7323	0.275
PVC 96-1037	1	40.44	N-02	0.06		ND	< LOD 0.01	ND	ND	< LOD 0.2473	NA
PVC 96-0727	2	41.00	N-02	ND	< LOD 0.02mg	ND	< LOD 0.01	ND	ND	< LOD 0.2439	NA
PVC 96-0974	3	40.60	N-02	NA	LPOF	ND	< LOD 0.01	ND	ND	NA	NA
PVC 96-1036	OBZ	40.57	N-02	0.67		ND	< LOD 0.01	ND	ND	< LOD 0.2465	NA
PVC 96-0912	1	41.03	SG-2B	ND	< LOD 0.02mg	ND	< LOD 0.01	ND	ND	< LOD 0.2437	NA
PVC 96-0903	2	40.61	SG-2B	0.07		ND	< LOD 0.01	ND	ND	< LOD 0.2463	NA
PVC 96-0896	3	41.09	SG-2B	0.03		ND	< LOD 0.01	ND	ND	< LOD 0.2434	NA
PVC 96-0900	OBZ	41.74	SG-2B	0.11		ND	< LOD 0.01	ND	ND	< LOD 0.2396	NA
PVC 96-0889	1	41.14	CS-07	0.05		ND	< LOD 0.01	ND	ND	< LOD 0.2431	NA
PVC 96-0880	2	41.28	CS-07	0.59		ND	< LOD 0.01	ND	ND	< LOD 0.2422	NA
PVC 96-0873	3	41.16	CS-07	0.28		ND	< LOD 0.01	ND	ND	< LOD 0.2430	NA
PVC 96-0877	OBZ	40.72	CS-07	0.22		ND	< LOD 0.01	ND	ND	< LOD 0.2456	NA
PVC 96-3863	1	40.82	CPDS-1A	0.03		ND	< LOD 0.01	ND	ND	< LOD 0.2450	NA
PVC 96-3879	2	40.04	CPDS-1A	0.32		ND	< LOD 0.01	ND	ND	< LOD 0.2497	NA
PVC 96-3880	3	40.62	CPDS-1A	0.39		ND	< LOD 0.01	ND	ND	< LOD 0.2462	NA
PVC 96-3887	OBZ	42.90	CPDS-1A	0.20		ND	< LOD 0.01	ND	ND	< LOD 0.2331	NA
PVC 96-3865	1	40.79	CPDS-1B	0.09		ND	< LOD 0.01	ND	ND	< LOD 0.2452	NA
PVC 96-3850	2	40.45	CPDS-1B	0.64		ND	< LOD 0.01	ND	ND	< LOD 0.2472	NA
PVC 96-3873	3	40.57	CPDS-1B	0.80		ND	< LOD 0.01	ND	ND	< LOD 0.2465	NA
PVC 96-3853	OBZ	40.55	CPDS-1B	0.50		ND	< LOD 0.01	ND	ND	< LOD 0.2466	NA

Airborne Sample Data Analysis - Respirable Quartz
NIOSH REL 0.05 milligrams/cubic meter
OSHA PEL As Calculated

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	mg/m^3	Note	mg/m^3	Note	mg/m^3	Note	mg/m^3	Note
CG-01	ND	< LOD 0.2424	ND	< LOD 0.2437	ND	< LOD 0.2431	ND	< LOD 0.2447
CS-01	ND	< LOD 0.2445	ND	< LOD 0.2450	ND	< LOD 0.2439	ND	< LOD 0.2280
CS-02	ND	< LOD 0.2442	ND	< LOD 0.2455	ND	< LOD 0.2446	ND	< LOD 0.2454
CS-03	ND	< LOD 0.2444	ND	< LOD 0.2439	ND	< LOD 0.2454	ND	< LOD 0.2405
CS-04	ND	< LOD 0.2442	ND	< LOD 0.2450	ND	< LOD 0.2459	ND	< LOD 0.2411
CS-05	ND	< LOD 0.2454	ND	< LOD 0.2454	ND	< LOD 0.2481	ND	< LOD 0.2422
CS-06	ND	< LOD 0.2440	ND	< LOD 0.2440	ND	< LOD 0.2452	ND	< LOD 0.2464
CS-07	ND	< LOD 0.2431	ND	< LOD 0.2422	ND	< LOD 0.2430	ND	< LOD 0.2456
CSDS-01	ND	< LOD 0.2450	ND	< LOD 0.2450	ND	< LOD 0.2447	ND	< LOD 0.2439
CSDS-02	ND	< LOD 0.2442	ND	< LOD 0.2436	ND	< LOD 0.2456	ND	< LOD 0.2519
N-01	ND	< LOD 0.2448	ND	< LOD 0.2426	ND	< LOD 0.2440	ND	< LOD 0.2443
N-02	ND	< LOD 0.2473	ND	< LOD 0.2439	ND	NA	ND	< LOD 0.2465
O-1	ND	< LOD 0.2459	ND	< LOD 0.2448	ND	< LOD 0.2465	ND	< LOD 0.2468
S-01	ND	< LOD 0.2468	ND	< LOD 0.2440	ND	< LOD 0.2440	ND	< LOD 0.2422
S-02	ND	< LOD 0.2456	0.49	< LOQ 0.7293	ND	< LOD 0.2456	ND	< LOD 0.2456
SH-01	ND	< LOD 0.2437	ND	< LOD 0.2450	ND	< LOD 0.2452	ND	< LOD 0.2559
SS-01	6.34	> LOQ 0.7316	19.96	> LOQ 0.7304	33.75	> LOQ 0.7338	13.49	> LOQ 0.7357
SS-02	9.80	> LOQ 0.7353	26.01	> LOQ 0.7362	43.17	> LOQ 0.7359	20.34	> LOQ 0.7265
SS-03	2.43	> LOQ 0.7304	11.07	> LOQ 0.7379	3.89	> LOQ 0.7284	2.93	> LOQ 0.7331
SS-04	ND	< LOD 0.2449	12.98	> LOQ 0.7346	3.19	> LOQ 0.7362	7.54	> LOQ 0.7293
SS-05	4.13	> LOQ 0.7297	16.03	> LOQ 0.7289	30.58	> LOQ 0.7338	22.03	> LOQ 0.7344
SS-06	5.16	> LOQ 0.7370	10.10	> LOQ 0.7388	17.02	> LOQ 0.7403	12.03	> LOQ 0.7080
SS-07	3.46	> LOQ 0.7412	7.09	> LOQ 0.7338	16.03	> LOQ 0.7401	10.74	> LOQ 0.7323
SSDS-01	5.61	> LOQ 0.7312	21.09	> LOQ 0.7355	30.58	> LOQ 0.7340	17.05	> LOQ 0.7203
SSDS-02	ND	< LOD 0.2418	4.18	> LOQ 0.7377	4.38	> LOQ 0.7304	3.42	> LOQ 0.7334
SSDS-03	ND	< LOD 0.2339	2.10	> LOQ 0.7009	ND	NA	0.96	> LOQ 0.7238
CP-1A	ND	< LOD 0.2455	ND	< LOD 0.2462	ND	< LOD 0.2427	ND	< LOD 0.2437
CP-1B	ND	< LOD 0.2816	ND	< LOD 0.2809	ND	< LOD 0.2821	ND	< LOD 0.2836
CP-2A	ND	< LOD 0.2451	ND	< LOD 0.2450	ND	< LOD 0.2458	ND	< LOD 0.2452
CP-2B	ND	< LOD 0.2436	ND	< LOD 0.2452	ND	< LOD 0.2460	ND	< LOD 0.2475
CP-3A	ND	< LOD 0.2438	ND	< LOD 0.2443	ND	< LOD 0.2432	ND	< LOD 0.2465
CP-3B	ND	< LOD 0.3257	ND	< LOD 0.3276	ND	< LOD 0.3242	ND	< LOD 0.2913
CP-4A	ND	< LOD 0.2430	0.50	< LOQ 0.7425	ND	< LOD 0.2448	0.74	> LOQ 0.7344
CP-4B	ND	< LOD 0.2447	0.24	< LOQ 0.7304	ND	< LOD 0.2445	ND	< LOD 0.2414
CPDS-1A	ND	< LOD 0.2450	ND	< LOD 0.2497	ND	< LOD 0.2462	ND	< LOD 0.2331
CPDS-1B	ND	< LOD 0.2452	ND	< LOD 0.2472	ND	< LOD 0.2465	ND	< LOD 0.2466
G-1A	ND	< LOD 0.2445	ND	< LOD 0.2450	ND	< LOD 0.2437	ND	< LOD 0.2433
G-1B	ND	< LOD 0.2446	ND	< LOD 0.2451	ND	< LOD 0.2471	ND	< LOD 0.2420
G-2A	ND	< LOD 0.2417	0.49	< LOQ 0.7325	0.49	< LOQ 0.7331	0.50	< LOQ 0.7560
G-2B	ND	< LOD 0.2437	0.98	> LOQ 0.7368	1.21	> LOQ 0.7259	0.74	> LOQ 0.7383
G-3A	ND	< LOD 0.2462	0.98	> LOQ 0.7342	0.98	> LOQ 0.7327	6.83	> LOQ 0.7314
G-4A	ND	< LOD 0.2435	0.74	> LOQ 0.7366	0.49	> LOQ 0.7357	1.25	> LOQ 0.7476
G-4B	ND	< LOD 0.2444	1.96	> LOQ 0.7351	0.24	< LOQ 0.7267	3.69	> LOQ 0.7388
G-5A	ND	< LOD 0.2438	ND	< LOD 0.2438	ND	< LOD 0.2449	ND	< LOD 0.2423
G-5B	ND	< LOD 0.2448	ND	< LOD 0.2450	ND	< LOD 0.2430	ND	< LOD 0.2435
G-6A	ND	< LOD 0.2445	ND	< LOD 0.2445	0.24	< LOQ 0.7310	0.24	< LOQ 0.7263
G-6B	ND	< LOD 0.2415	ND	< LOD 0.2506	ND	< LOD 0.2498	ND	< LOD 0.2440
G-7A	ND	< LOD 0.2460	ND	< LOD 0.2453	ND	< LOD 0.2469	ND	< LOD 0.2458
G-7B	ND	< LOD 0.2427	ND	< LOD 0.2459	ND	< LOD 0.2498	ND	< LOD 0.2490
SG-1A	ND	< LOD 0.2452	ND	< LOD 0.2451	ND	< LOD 0.2457	ND	< LOD 0.2455
SG-1B	ND	< LOD 0.4513	ND	< LOD 0.4500	ND	< LOD 0.4524	ND	< LOD 0.5382
SG-2A	ND	< LOD 0.2439	ND	< LOD 0.2444	ND	< LOD 0.2461	ND	< LOD 0.2439
SG-2B	ND	< LOD 0.2437	ND	< LOD 0.2463	ND	< LOD 0.2434	ND	< LOD 0.2396

Bulk Elemental Analysis, Percent by Weight - Total Quartz

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive Type	Sample No.	Quartz total %	Quartz comments	Sample No.	Quartz total %	Quartz comments
CG-01	J95331-63 VB	ND	< LOD 0.8	J95331-63 PB	ND	< LOD 0.8
CS-01	J95331-34 VB	ND	< LOD 0.8	J95331-34 PB	ND	< LOD 0.8
CS-02	J95331-37 VB	ND	< LOD 0.8	J95331-37 PB	ND	< LOD 0.8
CS-03	J95331-38 VB	ND	< LOD 0.8	J95331-38 PB	ND	< LOD 0.8
CS-04	J95331-39 VB	ND	< LOD 0.8	J95331-39 PB	ND	< LOD 0.8
CS-05	J95331-57 VB	ND	< LOD 0.8	J95331-57 PB	ND	< LOD 0.8
CS-06	J95331-70 VB	ND	< LOD 0.8	J95331-70 PB	ND	< LOD 0.8
CS-07	J95331-83 VB	ND	< LOD 0.8	J95331-83 PB	ND	< LOD 0.8
CSDS-01	J95331-31 VB	2.90	> LOQ 1.5	J95331-31 PB	ND	< LOD 0.8
CSDS-02	J95331-35 VB	ND	< LOD 0.8	J95331-35 PB	ND	< LOD 0.8
N-01	J95331-52 VB	ND	< LOD 4.0	J95331-52 PB	ND	< LOD 0.8
N-02	J95331-81 VB	ND	< LOD 0.8	J95331-81 PB	ND	< LOD 0.8
O-1	J95331-69 VB	ND	< LOD 0.8	J95331-69 PB	ND	< LOD 0.8
S-01	J95331-28 VB	1.00	< LOQ 1.50	J95331-28 PB	ND	< LOD 0.8
S-02	J95331-29 VB	0.90	< LOQ 1.50	J95331-29 PB	3.00	> LOQ 1.5
SH-01	J95331-36 VB	ND	< LOD 4.0	J95331-36 PB	ND	< LOD 4.0
SS-01	J95331-32 VB	81.00	> LOQ 1.5	J95331-32 PB	101.00	> LOQ 1.5
SS-02	J95331-40 VB	73.00	> LOQ 1.5	J95331-40 PB	63.00	> LOQ 1.5
SS-03	J95331-45 VB	75.00	> LOQ 1.5	J95331-45 PB	75.00	> LOQ 1.5
SS-04	J95331-47 VB	55.00	> LOQ 1.5	J95331-47 PB	62.00	> LOQ 1.5
SS-05	J95331-53 VB	70.00	> LOQ 1.5	J95331-53 PB	90.00	> LOQ 1.5
SS-06	J95331-76 VB	39.00	> LOQ 1.5	J95331-76 PB	39.00	> LOQ 1.5
SS-07	J95331-80 VB	52.00	> LOQ 1.5	J95331-80 PB	53.00	> LOQ 1.5
SSDS-01	J95331-33 VB	79.00	> LOQ 1.5	J95331-33 PB	80.00	> LOQ 1.5
SSDS-02	J95331-44 VB	42.00	> LOQ 1.5	J95331-44 PB	69.00	> LOQ 1.5
SSDS-03	J95331-48 VB	88.00	> LOQ 1.5	J95331-48 PB	87.00	> LOQ 1.5
CP-1A	J95331-60 VB	ND	< LOD 0.8	J95331-60 PB	ND	< LOD 0.8
CP-1B	J95331-61 VB	ND	< LOD 0.8	J95331-61 PB	ND	< LOD 0.8
CP-2A	J95331-67 VB	ND	< LOD 0.8	J95331-67 PB	ND	< LOD 0.8
CP-2B	J95331-68 VB	ND	< LOD 0.8	J95331-68 PB	ND	< LOD 0.8
CP-3A	J95331-72 VB	ND	< LOD 0.8	J95331-72 PB	ND	< LOD 0.8
CP-3B	J95331-73 VB	ND	< LOD 0.8	J95331-73 PB	ND	< LOD 0.8
CP-4A	J95331-78 VB	ND	< LOD 0.8	J95331-78 PB	ND	< LOD 0.8
CP-4B	J95331-79 VB	ND	< LOD 0.8	J95331-79 PB	ND	< LOD 0.8
CPDS-1A	J95331-84 VB	ND	< LOD 0.8	J95331-84 PB	ND	< LOD 0.8
CPDS-1B	J95331-85 VB	ND	< LOD 0.8	J95331-85 PB	ND	< LOD 0.8
G-1A	J95331-41 VB	ND	< LOD 0.8	J95331-41 PB	ND	< LOD 0.8
G-1B	J95331-46 VB	ND	< LOD 0.8	J95331-46 PB	ND	< LOD 0.8
G-2A	J95331-43 VB	4.40	< LOQ 7.5	J95331-43 PB	4.70	< LOQ 7.5
G-2B	J95331-50 VB	4.50	< LOQ 7.5	J95331-50 PB	ND	< LOD 4.0
G-3A	J95331-49 VB	ND	< LOD 0.8	J95331-49 PB	ND	< LOD 0.8
G-4A	J95331-55 VB	ND	< LOD 0.8	J95331-55 PB	ND	< LOD 0.8
G-4B	J95331-56 VB	3.30	> LOQ 1.5	J95331-56 PB	ND	< LOD 0.8
G-5A	J95331-58 VB	ND	< LOD 0.8	J95331-58 PB	ND	< LOD 0.8
G-5B	J95331-59 VB	ND	< LOD 0.8	J95331-59 PB	ND	< LOD 0.8
G-6A	J95331-64 VB	ND	< LOD 0.8	J95331-64 PB	ND	< LOD 0.8
G-6B	J95331-65 VB	1.10	< LOQ 1.5	J95331-65 PB	ND	< LOD 0.8
G-7A	J95331-74 VB	ND	< LOD 0.8	J95331-74 PB	ND	< LOD 0.8
G-7B	J95331-75 VB	ND	< LOD 0.8	J95331-75 PB	ND	< LOD 0.8
SG-1A	J95331-54 VB	ND	< LOD 0.8	J95331-54 PB	ND	< LOD 0.8
SG-1B	J95331-71 VB	ND	< LOD 0.8	J95331-71 PB	ND	< LOD 0.8
SG-2A	J95331-66 VB	ND	< LOD 0.8	J95331-66 PB	ND	< LOD 0.8
SG-2B	J95331-82 VB	ND	< LOD 0.8	J95331-82 PB	ND	< LOD 0.8

Comparison of Airborne Concentrations to Bulk Concentrations - Respirable Quartz

NIOSH REL 0.05 milligrams/cubic meter
OSHA PEL As Calculated

Abrasive Type	@ Make-up Air Area Fixed Station #1 mg/m³	@ Operator Area Fixed Station #2 mg/m³	@ Exhaust Area Fixed Station #3 mg/m³	Operator 's Breathing Zone (OBZ) mg/m³	Virgin Bulk Percentage
CG-01	ND	ND	ND	ND	ND
CS-01	ND	ND	ND	ND	ND
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	ND
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	ND	ND	ND	ND
CS-07	ND	ND	ND	ND	ND
CSDS-01	ND	ND	ND	ND	2.90
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	ND
N-02	ND	ND	ND	ND	ND
O-1	ND	ND	ND	ND	ND
S-01	ND	ND	ND	ND	1.00
S-02	ND	0.49	ND	ND	0.90
SH-01	ND	ND	ND	ND	ND
SS-01	6.34	19.96	33.75	13.49	81.00
SS-02	9.80	26.01	43.17	20.34	73.00
SS-03	2.43	11.07	3.89	2.93	75.00
SS-04	ND	12.98	3.19	7.54	55.00
SS-05	4.13	16.03	30.58	22.03	70.00
SS-06	5.16	10.10	17.02	12.03	39.00
SS-07	3.46	7.09	16.03	10.74	52.00
SSDS-01	5.61	21.09	30.58	17.05	79.00
SSDS-02	ND	4.18	4.38	3.42	42.00
SSDS-03	ND	2.10	ND	0.96	88.00
CP-1A	ND	ND	ND	ND	ND
CP-2A	ND	ND	ND	ND	ND
CP-3A	ND	ND	ND	ND	ND
CP-4A	ND	0.50	ND	0.74	ND
CPDS-1A	ND	ND	ND	ND	ND
G-1A	ND	ND	ND	ND	ND
G-2A	ND	0.49	0.49	0.50	4.40
G-3A	ND	0.98	0.98	6.83	ND
G-4A	ND	0.74	0.49	1.25	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	0.24	0.24	ND
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	ND	ND

APPENDIX B -

Respirable Silica Cristobalite

Respirable Silica-Cristobalite

Animal studies have shown cristobalite to be more fibrotic than quartz, and the fibrosis that develops to be more diffuse than nodular. Thus, the OSHA limit set for cristobalite is set at one-half that of quartz. The NIOSH REL for respirable cristobalite is 0.05 milligrams/cubic meter of air. The OSHA PEL for respirable cristobalite is one-half of 10 milligrams/cubic meter of air divided by % silica + 2.

Air Sample Results - Respirable Cristobalite

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Cristobalite Gravemetric mg/filter	Cristobalite Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m³	Calculations Notes	Calculations OSHA PEL
PVC 96-2604	1	40.51	S-01	0.16		ND	< LOD 0.02	ND	ND	< LOD 0.4937	NA
PVC 96-2576	2	40.99	S-01	0.99		ND	< LOD 0.02	ND	ND	< LOD 0.4879	NA
PVC 96-2582	3	40.99	S-01	2.80		ND	< LOD 0.02	ND	ND	< LOD 0.4879	NA
PVC 96-2590	OBZ	41.29	S-01	0.63		ND	< LOD 0.02	ND	ND	< LOD 0.4844	NA
PVC 96-2561	1	40.72	S-02	0.07		ND	< LOD 0.02	ND	ND	< LOD 0.4912	NA
PVC 96-2831	2	41.14	S-02	1.11		ND	< LOD 0.02	ND	ND	< LOD 0.4862	NA
PVC 96-2577	3	40.72	S-02	1.41		ND	< LOD 0.02	ND	ND	< LOD 0.4912	NA
PVC 96-2694	OBZ	40.72	S-02	0.48		ND	< LOD 0.02	ND	ND	< LOD 0.4912	NA
PVC 96-2798	1	40.82	CSDS-01	0.12		ND	< LOD 0.02	ND	ND	< LOD 0.4899	NA
PVC 96-2802	2	40.81	CSDS-01	0.35		ND	< LOD 0.02	ND	ND	< LOD 0.4901	NA
PVC 96-2786	3	40.86	CSDS-01	0.51		ND	< LOD 0.02	ND	ND	< LOD 0.4895	NA
PVC 96-2788	OBZ	41.00	CSDS-01	0.23		ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-2789	1	41.00	SS-01	0.26		ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-2781	2	41.08	SS-01	0.87		ND	< LOD 0.02	ND	ND	< LOD 0.4869	NA
PVC 96-2768	3	40.88	SS-01	1.88		ND	< LOD 0.02	ND	ND	< LOD 0.4892	NA
PVC 96-2771	OBZ	40.78	SS-01	0.55		ND	< LOD 0.02	ND	ND	< LOD 0.4905	NA
PVC 96-2446	1	41.03	SSDS-01	0.23		ND	< LOD 0.02	ND	ND	< LOD 0.4875	NA
PVC 96-2456	2	40.79	SSDS-01	0.98		ND	< LOD 0.02	ND	ND	< LOD 0.4903	NA
PVC 96-2454	3	40.87	SSDS-01	1.25		ND	< LOD 0.02	ND	ND	< LOD 0.4893	NA
PVC 96-2449	OBZ	41.65	SSDS-01	0.94		ND	< LOD 0.02	ND	ND	< LOD 0.4802	NA
PVC 96-2475	1	40.90	CS-01	0.28		ND	< LOD 0.02	ND	ND	< LOD 0.4890	NA
PVC 96-2750	2	40.82	CS-01	1.12		ND	< LOD 0.02	ND	ND	< LOD 0.4899	NA
PVC 96-2764	3	41.00	CS-01	1.29		ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-2772	OBZ	43.86	CS-01	0.62		ND	< LOD 0.02	ND	ND	< LOD 0.4560	NA
PVC 96-2437	1	40.96	CSDS-02	0.06		ND	< LOD 0.02	ND	ND	< LOD 0.4883	NA
PVC 96-2432	2	41.05	CSDS-02	0.42		ND	< LOD 0.02	ND	ND	< LOD 0.4872	NA
PVC 96-2429	3	40.72	CSDS-02	0.29		ND	< LOD 0.02	ND	ND	< LOD 0.4912	NA
PVC 96-2491	OBZ	39.70	CSDS-02	0.22		ND	< LOD 0.02	ND	ND	< LOD 0.5038	NA
PVC 96-2518	1	41.03	SH-01	0.14		ND	< LOD 0.02	ND	ND	< LOD 0.4875	NA
PVC 96-2498	2	40.81	SH-01	0.42		ND	< LOD 0.02	ND	ND	< LOD 0.4901	NA
PVC 96-2505	3	40.78	SH-01	0.62		ND	< LOD 0.02	ND	ND	< LOD 0.4905	NA
PVC 96-2517	OBZ	39.08	SH-01	0.50		ND	< LOD 0.02	ND	ND	< LOD 0.5117	NA
PVC 96-2485	1	40.94	CS-02	0.19		ND	< LOD 0.02	ND	ND	< LOD 0.4885	NA
PVC 96-3190	2	40.74	CS-02	0.73		ND	< LOD 0.02	ND	ND	< LOD 0.4909	NA
PVC 96-3183	3	40.88	CS-02	0.55		ND	< LOD 0.02	ND	ND	< LOD 0.4892	NA
PVC 96-3187	OBZ	40.75	CS-02	0.72		ND	< LOD 0.02	ND	ND	< LOD 0.4908	NA

Air Sample Results - Respirable Cristobalite

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Cristobalite Gravemetric mg/filter	Cristobalite Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m³	Calculations Notes	Calculations OSHA PEL
PVC 96-3177	1	40.92	CS-03	0.23		ND	< LOD 0.02	ND	ND	< LOD 0.4888	NA
PVC 96-3168	2	41.00	CS-03	0.95		ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-3161	3	40.75	CS-03	0.95		ND	< LOD 0.02	ND	ND	< LOD 0.4908	NA
PVC 96-3172	OBZ	41.58	CS-03	0.69		ND	< LOD 0.02	ND	ND	< LOD 0.4810	NA
PVC 96-3137	1	40.94	CS-04	0.12		ND	< LOD 0.02	ND	ND	< LOD 0.4885	NA
PVC 96-3144	2	40.82	CS-04	0.55		ND	< LOD 0.02	ND	ND	< LOD 0.4899	NA
PVC 96-3153	3	40.67	CS-04	1.11		ND	< LOD 0.02	ND	ND	< LOD 0.4918	NA
PVC 96-3140	OBZ	41.48	CS-04	0.54		ND	< LOD 0.02	ND	ND	< LOD 0.4821	NA
PVC 96-3130	1	40.80	SS-02	0.57		ND	< LOD 0.02	ND	ND	< LOD 0.4902	NA
PVC 96-3121	2	40.75	SS-02	1.13		ND	< LOD 0.02	ND	ND	< LOD 0.4908	NA
PVC 96-3114	3	40.76	SS-02	2.05		ND	< LOD 0.02	ND	ND	< LOD 0.4906	NA
PVC 96-3102	OBZ	41.29	SS-02	1.19		ND	< LOD 0.02	ND	ND	< LOD 0.4844	NA
PVC 96-2981	1	40.91	G-1A	0.04		ND	< LOD 0.02	ND	ND	< LOD 0.4889	NA
PVC 96-2965	2	40.81	G-1A	0.27		ND	< LOD 0.02	ND	ND	< LOD 0.4901	NA
PVC 96-2961	3	41.04	G-1A	0.37		ND	< LOD 0.02	ND	ND	< LOD 0.4873	NA
PVC 96-3104	OBZ	41.10	G-1A	0.19		ND	< LOD 0.02	ND	ND	< LOD 0.4866	NA
PVC 96-3573	1	41.38	G-2A	0.12		ND	< LOD 0.02	ND	ND	< LOD 0.4834	NA
PVC 96-3578	2	40.96	G-2A	0.31		ND	< LOD 0.02	ND	ND	< LOD 0.4883	NA
PVC 96-3577	3	40.92	G-2A	0.57		ND	< LOD 0.02	ND	ND	< LOD 0.4888	NA
PVC 96-3565	OBZ	39.68	G-2A	0.35		ND	< LOD 0.02	ND	ND	< LOD 0.5040	NA
PVC 96-3622	1	41.36	SSDS-02	ND	< LOD 0.02mg	ND	< LOD 0.02	ND	ND	< LOD 0.4835	NA
PVC 96-3632	2	40.67	SSDS-02	0.41		ND	< LOD 0.02	ND	ND	< LOD 0.4918	NA
PVC 96-3617	3	41.08	SSDS-02	0.56		ND	< LOD 0.02	ND	ND	< LOD 0.4869	NA
PVC 96-3108	OBZ	40.91	SSDS-02	0.39		ND	< LOD 0.02	ND	ND	< LOD 0.4889	NA
PVC 96-3654	1	41.08	SS-03	0.11		ND	< LOD 0.02	ND	ND	< LOD 0.4869	NA
PVC 96-3655	2	40.66	SS-03	0.62		ND	< LOD 0.02	ND	ND	< LOD 0.4919	NA
PVC 96-3641	3	41.18	SS-03	0.16		ND	< LOD 0.02	ND	ND	< LOD 0.4856	NA
PVC 96-3651	OBZ	40.92	SS-03	0.16		ND	< LOD 0.02	ND	ND	< LOD 0.4888	NA
PVC 96-3091	1	40.88	G-1B	0.05		ND	< LOD 0.02	ND	ND	< LOD 0.4892	NA
PVC 96-3067	2	40.80	G-1B	0.61		ND	< LOD 0.02	ND	ND	< LOD 0.4902	NA
PVC 96-3062	3	40.48	G-1B	0.28		ND	< LOD 0.02	ND	ND	< LOD 0.4941	NA
PVC 96-4452	OBZ	41.33	G-1B	0.37		ND	< LOD 0.02	ND	ND	< LOD 0.4839	NA
PVC 96-3064	1	40.84	SS-04	ND	< LOD 0.02mg	ND	< LOD 0.02	ND	ND	< LOD 0.4898	NA
PVC 96-3071	2	40.84	SS-04	2.23		ND	< LOD 0.02	ND	ND	< LOD 0.4898	NA
PVC 96-3098	3	40.75	SS-04	0.43		ND	< LOD 0.02	ND	ND	< LOD 0.4908	NA
PVC 96-3090	OBZ	41.14	SS-04	1.26		ND	< LOD 0.02	ND	ND	< LOD 0.4862	NA

Air Sample Results - Respirable Cristobalite

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Cristobalite Gravemetric mg/filter	Cristobalite Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m³	Calculations Notes	Calculations OSHA PEL
PVC 96-4445	1	42.75	SSDS-03	0.05		ND	< LOD 0.02	ND	ND	< LOD 0.4678	NA
PVC 96-4441	2	42.80	SSDS-03	0.12		ND	< LOD 0.02	ND	ND	< LOD 0.4673	NA
PVC 96-4810	3	42.53	SSDS-03	n/a	LPOF	ND	< LOD 0.02	ND	ND	NA	NA
PVC 96-4819	OBZ	41.45	SSDS-03	0.62		ND	< LOD 0.02	ND	ND	< LOD 0.4825	NA
PVC 96-4785	1	40.62	G-3A	0.11		ND	< LOD 0.02	ND	ND	< LOD 0.4924	NA
PVC 96-4774	2	40.86	G-3A	0.71		ND	< LOD 0.02	ND	ND	< LOD 0.4895	NA
PVC 96-4781	3	40.94	G-3A	0.58		ND	< LOD 0.02	ND	ND	< LOD 0.4885	NA
PVC 96-4805	OBZ	41.02	G-3A	1.61		ND	< LOD 0.02	ND	ND	< LOD 0.4876	NA
PVC 96-4788	1	41.04	G-2B	0.11		ND	< LOD 0.02	ND	ND	< LOD 0.4873	NA
PVC 96-4771	2	40.72	G-2B	0.55		ND	< LOD 0.02	ND	ND	< LOD 0.4912	NA
PVC 96-4795	3	41.33	G-2B	0.29		ND	< LOD 0.02	ND	ND	< LOD 0.4839	NA
PVC 96-4783	OBZ	40.63	G-2B	0.29		ND	< LOD 0.02	ND	ND	< LOD 0.4922	NA
PVC 96-4426	1	40.85	N-01	0.14		ND	< LOD 0.02	ND	ND	< LOD 0.4896	NA
PVC 96-4537	2	41.22	N-01	0.34		ND	< LOD 0.02	ND	ND	< LOD 0.4852	NA
PVC 96-4530	3	40.99	N-01	0.95		ND	< LOD 0.02	ND	ND	< LOD 0.4879	NA
PVC 96-4518	OBZ	40.93	N-01	1.19		ND	< LOD 0.02	ND	ND	< LOD 0.4886	NA
PVC 96-4522	1	41.11	SS-05	0.19		ND	< LOD 0.02	ND	ND	< LOD 0.4865	NA
PVC 96-4524	2	41.16	SS-05	1.04		ND	< LOD 0.02	ND	ND	< LOD 0.4859	NA
PVC 96-4520	3	40.88	SS-05	2.13		ND	< LOD 0.02	ND	ND	< LOD 0.4892	NA
PVC 96-4513	OBZ	40.85	SS-05	1.27		ND	< LOD 0.02	ND	ND	< LOD 0.4896	NA
PVC 96-4404	1	40.79	SG-1A	0.26		ND	< LOD 0.02	ND	ND	< LOD 0.4903	NA
PVC 96-4396	2	40.80	SG-1A	1.38		ND	< LOD 0.02	ND	ND	< LOD 0.4902	NA
PVC 96-4389	3	40.70	SG-1A	0.90		ND	< LOD 0.02	ND	ND	< LOD 0.4914	NA
PVC 96-4401	OBZ	40.73	SG-1A	0.79		ND	< LOD 0.02	ND	ND	< LOD 0.4911	NA
PVC 96-4394	1	41.08	G-4A	0.08		ND	< LOD 0.02	ND	ND	< LOD 0.4869	NA
PVC 96-4383	2	40.73	G-4A	0.76		ND	< LOD 0.02	ND	ND	< LOD 0.4911	NA
PVC 96-4393	3	40.78	G-4A	0.87		ND	< LOD 0.02	ND	ND	< LOD 0.4905	NA
PVC 96-4380	OBZ	40.13	G-4A	0.75		ND	< LOD 0.02	ND	ND	< LOD 0.4984	NA
PVC 96-4755	1	40.92	G-4B	0.14		ND	< LOD 0.02	ND	ND	< LOD 0.4888	NA
PVC 96-4758	2	40.81	G-4B	1.33		ND	< LOD 0.02	ND	ND	< LOD 0.4901	NA
PVC 96-4741	3	41.28	G-4B	0.25		ND	< LOD 0.02	ND	ND	< LOD 0.4845	NA
PVC 96-4752	OBZ	40.61	G-4B	1.95		ND	< LOD 0.02	ND	ND	< LOD 0.4925	NA
PVC 96-4744	1	40.75	CS-05	0.11		ND	< LOD 0.02	ND	ND	< LOD 0.4908	NA
PVC 96-4722	2	40.75	CS-05	1.32		ND	< LOD 0.02	ND	ND	< LOD 0.4908	NA
PVC 96-4715	3	40.31	CS-05	0.57		ND	< LOD 0.02	ND	ND	< LOD 0.4962	NA
PVC 96-4719	OBZ	41.29	CS-05	0.34		ND	< LOD 0.02	ND	ND	< LOD 0.4844	NA

Air Sample Results - Respirable Cristobalite

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric mg/filter	Gravemetric Filter Notes mg/f	Cristobalite Gravemetric mg/filter	Cristobalite Gravemetric Filter Notes mg/f	Calculations %	Calculations mg/m^3	Calculations Notes	Calculations OSHA PEL
PVC 96-4709	1	41.02	G-5A	0.11		ND	< LOD 0.02	ND	ND	< LOD 0.4876	NA
PVC 96-4699	2	41.02	G-5A	0.45		ND	< LOD 0.02	ND	ND	< LOD 0.4876	NA
PVC 96-4692	3	40.84	G-5A	0.54		ND	< LOD 0.02	ND	ND	< LOD 0.4898	NA
PVC 96-4696	OBZ	41.27	G-5A	0.35		ND	< LOD 0.02	ND	ND	< LOD 0.4846	NA
PVC 96-4661	1	40.85	G-5B	0.08		ND	< LOD 0.02	ND	ND	< LOD 0.4896	NA
PVC 96-4651	2	40.82	G-5B	1.00		ND	< LOD 0.02	ND	ND	< LOD 0.4899	NA
PVC 96-4645	3	41.15	G-5B	1.86		ND	< LOD 0.02	ND	ND	< LOD 0.4861	NA
PVC 96-4656	OBZ	41.08	G-5B	0.94		ND	< LOD 0.02	ND	ND	< LOD 0.4869	NA
PVC 96-2955	1	40.74	CP-1A	0.16		ND	< LOD 0.02	ND	ND	< LOD 0.4909	NA
PVC 96-2946	2	40.62	CP-1A	1.13		ND	< LOD 0.02	ND	ND	< LOD 0.4924	NA
PVC 96-2939	3	41.21	CP-1A	1.30		ND	< LOD 0.02	ND	ND	< LOD 0.4853	NA
PVC 96-2942	OBZ	41.04	CP-1A	0.66		ND	< LOD 0.02	ND	ND	< LOD 0.4873	NA
PVC 96-3355	1	35.51	CP-1B	0.26		ND	< LOD 0.02	ND	ND	< LOD 0.5632	NA
PVC 96-3346	2	35.60	CP-1B	1.49		ND	< LOD 0.02	ND	ND	< LOD 0.5619	NA
PVC 96-3339	3	35.56	CP-1B	1.76		ND	< LOD 0.02	ND	ND	< LOD 0.5624	NA
PVC 96-3327	OBZ	35.26	CP-1B	1.12		ND	< LOD 0.02	ND	ND	< LOD 0.5672	NA
PVC 96-3317	1	41.26	CG-01	0.32		ND	< LOD 0.02	ND	ND	< LOD 0.4848	NA
PVC 96-3309	2	41.03	CG-01	2.30		ND	< LOD 0.02	ND	ND	< LOD 0.4875	NA
PVC 96-3316	3	41.14	CG-01	2.88		ND	< LOD 0.02	ND	ND	< LOD 0.4862	NA
PVC 96-3304	OBZ	40.87	CG-01	2.10		ND	< LOD 0.02	ND	ND	< LOD 0.4893	NA
PVC 96-3293	1	40.90	G-6A	0.13		ND	< LOD 0.02	ND	ND	< LOD 0.4890	NA
PVC 96-3285	2	40.90	G-6A	1.10		ND	< LOD 0.02	ND	ND	< LOD 0.4890	NA
PVC 96-3277	3	41.04	G-6A	0.36		ND	< LOD 0.02	ND	ND	< LOD 0.4873	NA
PVC 96-3281	OBZ	41.30	G-6A	0.80		ND	< LOD 0.02	ND	ND	< LOD 0.4842	NA
PVC 96-3282	1	41.40	G-6B	0.28		ND	< LOD 0.02	ND	ND	< LOD 0.4831	NA
PVC 96-3261	2	39.90	G-6B	0.50		ND	< LOD 0.02	ND	ND	< LOD 0.5013	NA
PVC 96-3238	3	40.03	G-6B	1.29		ND	< LOD 0.02	ND	ND	< LOD 0.4996	NA
PVC 96-3242	OBZ	40.99	G-6B	0.65		ND	< LOD 0.02	ND	ND	< LOD 0.4879	NA
PVC 96-3231	1	41.00	SG-2A	0.20		ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-3222	2	40.92	SG-2A	0.34		ND	< LOD 0.02	ND	ND	< LOD 0.4888	NA
PVC 96-3215	3	40.63	SG-2A	1.28		ND	< LOD 0.02	ND	ND	< LOD 0.4922	NA
PVC 96-3219	OBZ	41.00	SG-2A	0.62		ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-4293	1	40.80	CP-2A	0.18		ND	< LOD 0.02	ND	ND	< LOD 0.4902	NA
PVC 96-3199	2	40.82	CP-2A	0.52		ND	< LOD 0.02	ND	ND	< LOD 0.4899	NA
PVC 96-3203	3	40.68	CP-2A	0.26		ND	< LOD 0.02	ND	ND	< LOD 0.4916	NA
PVC 96-3220	OBZ	40.79	CP-2A	0.43		ND	< LOD 0.02	ND	ND	< LOD 0.4903	NA

Air Sample Results - Respirable Cristobalite

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric		Cristobalite Gravemetric		Calculations			
				mg/filter	Filter Notes mg/f	mg/filter	Filter Notes mg/f	%	mg/m^3	Notes	OSHA PEL
PVC 96-4262	1	41.05	CP-2B	0.17		ND	< LOD 0.02	ND	ND	< LOD 0.4872	NA
PVC 96-4272	2	40.79	CP-2B	0.33		ND	< LOD 0.02	ND	ND	< LOD 0.4903	NA
PVC 96-4271	3	40.66	CP-2B	0.73		ND	< LOD 0.02	ND	ND	< LOD 0.4919	NA
PVC 96-4277	OBZ	40.40	CP-2B	0.28		ND	< LOD 0.02	ND	ND	< LOD 0.4950	NA
PVC 96-4268	1	40.67	O-1	0.27		ND	< LOD 0.02	ND	ND	< LOD 0.4918	NA
PVC 96-4270	2	40.85	O-1	1.77		ND	< LOD 0.02	ND	ND	< LOD 0.4896	NA
PVC 96-4276	3	40.56	O-1	1.74		ND	< LOD 0.02	ND	ND	< LOD 0.4931	NA
PVC 96-4252	OBZ	40.51	O-1	1.62		ND	< LOD 0.02	ND	ND	< LOD 0.4937	NA
PVC 96-1468	1	40.98	CS-06	0.42		ND	< LOD 0.02	ND	ND	< LOD 0.4880	NA
PVC 96-1460	2	40.99	CS-06	1.55		ND	< LOD 0.02	ND	ND	< LOD 0.4879	NA
PVC 96-1455	3	40.79	CS-06	1.67		ND	< LOD 0.02	ND	ND	< LOD 0.4903	NA
PVC 96-1482	OBZ	40.58	CS-06	0.69		ND	< LOD 0.02	ND	ND	< LOD 0.4928	NA
PVC 96-1465	1	22.16	SG-1B	0.02		ND	< LOD 0.02	ND	ND	< LOD 0.9026	NA
PVC 96-1324	2	22.22	SG-1B	0.09		ND	< LOD 0.02	ND	ND	< LOD 0.8999	NA
PVC 96-1363	3	22.11	SG-1B	0.05		ND	< LOD 0.02	ND	ND	< LOD 0.9047	NA
PVC 96-1367	OBZ	18.58	SG-1B	0.03		ND	< LOD 0.02	ND	ND	< LOD 1.0765	NA
PVC 96-1360	1	41.02	CP-3A	0.13		ND	< LOD 0.02	ND	ND	< LOD 0.4876	NA
PVC 96-1355	2	40.93	CP-3A	0.40		ND	< LOD 0.02	ND	ND	< LOD 0.4886	NA
PVC 96-1388	3	41.11	CP-3A	0.98		ND	< LOD 0.02	ND	ND	< LOD 0.4865	NA
PVC 96-1392	OBZ	40.56	CP-3A	0.35		ND	< LOD 0.02	ND	ND	< LOD 0.4931	NA
PVC 96-1385	1	30.70	CP-3B	0.22		ND	< LOD 0.02	ND	ND	< LOD 0.6515	NA
PVC 96-1380	2	30.53	CP-3B	0.73		ND	< LOD 0.02	ND	ND	< LOD 0.6551	NA
PVC 96-1413	3	30.77	CP-3B	0.41		ND	< LOD 0.02	ND	ND	< LOD 0.6500	NA
PVC 96-1416	OBZ	34.33	CP-3B	0.50		ND	< LOD 0.02	ND	ND	< LOD 0.5826	NA
PVC 96-1322	1	40.66	G-7A	0.36		ND	< LOD 0.02	ND	ND	< LOD 0.4919	NA
PVC 96-1441	2	40.76	G-7A	1.20		ND	< LOD 0.02	ND	ND	< LOD 0.4906	NA
PVC 96-1438	3	40.50	G-7A	0.97		ND	< LOD 0.02	ND	ND	< LOD 0.4938	NA
PVC 96-1430	OBZ	40.68	G-7A	0.75	LPOF	ND	< LOD 0.02	ND	ND	< LOD 0.4916	NA
PVC 96-4202	1	41.21	G-7B	0.39		ND	< LOD 0.02	ND	ND	< LOD 0.4853	NA
PVC 96-4203	2	40.67	G-7B	1.94		ND	< LOD 0.02	ND	ND	< LOD 0.4918	NA
PVC 96-4204	3	40.03	G-7B	ND	< LOD 0.02mg	ND	< LOD 0.02	ND	ND	< LOD 0.4996	NA
PVC 96-4206	OBZ	40.16	G-7B	1.39		ND	< LOD 0.02	ND	ND	< LOD 0.4980	NA
PVC 96-4185	1	40.70	SS-06	0.66		ND	< LOD 0.02	ND	ND	< LOD 0.4914	NA
PVC 96-4178	2	40.61	SS-06	1.36		ND	< LOD 0.02	ND	ND	< LOD 0.4925	NA
PVC 96-4184	3	40.52	SS-06	2.56		ND	< LOD 0.02	ND	ND	< LOD 0.4935	NA
PVC 96-4175	OBZ	42.37	SS-06	1.93		ND	< LOD 0.02	ND	ND	< LOD 0.4720	NA

Air Sample Results - Respirable Cristobalite

Sample No.	Station No.	Volume (l/filter)	Abrasive Type	Gravemetric		Cristobalite Gravemetric		Calculations			
				mg/filter	Filter Notes mg/f	mg/filter	Filter Notes mg/f	%	mg/m^3	Notes	OSHA PEL
PVC 96-3930	1	41.16	CP-4A	0.25		ND	< LOD 0.02	ND	ND	< LOD 0.4859	NA
PVC 96-3919	2	40.40	CP-4A	1.54		ND	< LOD 0.02	ND	ND	< LOD 0.4950	NA
PVC 96-3906	3	40.85	CP-4A	0.54		ND	< LOD 0.02	ND	ND	< LOD 0.4896	NA
PVC 96-3920	OBZ	40.85	CP-4A	1.65		ND	< LOD 0.02	ND	ND	< LOD 0.4896	NA
PVC 96-4212	1	40.86	CP-4B	0.26		ND	< LOD 0.02	ND	ND	< LOD 0.4895	NA
PVC 96-4217	2	41.08	CP-4B	1.37		ND	< LOD 0.02	ND	ND	< LOD 0.4869	NA
PVC 96-4218	3	40.90	CP-4B	1.36		ND	< LOD 0.02	ND	ND	< LOD 0.4890	NA
PVC 96-3917	OBZ	41.42	CP-4B	1.83	LPOF	ND	< LOD 0.02	ND	ND	< LOD 0.4828	NA
PVC 96-4146	1	40.48	SS-07	0.33		ND	< LOD 0.02	ND	ND	< LOD 0.4941	NA
PVC 96-4154	2	40.88	SS-07	0.98		ND	< LOD 0.02	ND	ND	< LOD 0.4892	NA
PVC 96-4147	3	40.54	SS-07	1.77		ND	< LOD 0.02	ND	ND	< LOD 0.4934	NA
PVC 96-4148	OBZ	40.97	SS-07	1.28		ND	< LOD 0.02	ND	ND	< LOD 0.4882	NA
PVC 96-1037	1	40.44	N-02	0.06		ND	< LOD 0.02	ND	ND	< LOD 0.4946	NA
PVC 96-0727	2	41.00	N-02	ND	< LOD 0.02mg	ND	< LOD 0.02	ND	ND	< LOD 0.4878	NA
PVC 96-0974	3	40.60	N-02	NA	LPOF	ND	< LOD 0.02	ND	ND	NA	NA
PVC 96-1036	OBZ	40.57	N-02	0.67		ND	< LOD 0.02	ND	ND	< LOD 0.4930	NA
PVC 96-0912	1	41.03	SG-2B	ND	< LOD 0.02mg	ND	< LOD 0.02	ND	ND	< LOD 0.4875	NA
PVC 96-0903	2	40.61	SG-2B	0.07		ND	< LOD 0.02	ND	ND	< LOD 0.4925	NA
PVC 96-0896	3	41.09	SG-2B	0.03		ND	< LOD 0.02	ND	ND	< LOD 0.4868	NA
PVC 96-0900	OBZ	41.74	SG-2B	0.11		ND	< LOD 0.02	ND	ND	< LOD 0.4792	NA
PVC 96-0889	1	41.14	CS-07	0.05		ND	< LOD 0.02	ND	ND	< LOD 0.4862	NA
PVC 96-0880	2	41.28	CS-07	0.59		ND	< LOD 0.02	ND	ND	< LOD 0.4845	NA
PVC 96-0873	3	41.16	CS-07	0.28		ND	< LOD 0.02	ND	ND	< LOD 0.4859	NA
PVC 96-0877	OBZ	40.72	CS-07	0.22		ND	< LOD 0.02	ND	ND	< LOD 0.4912	NA
PVC 96-3863	1	40.82	CPDS-1A	0.03		ND	< LOD 0.02	ND	ND	< LOD 0.4899	NA
PVC 96-3879	2	40.04	CPDS-1A	0.32		ND	< LOD 0.02	ND	ND	< LOD 0.4995	NA
PVC 96-3880	3	40.62	CPDS-1A	0.39		ND	< LOD 0.02	ND	ND	< LOD 0.4924	NA
PVC 96-3887	OBZ	42.90	CPDS-1A	0.20		ND	< LOD 0.02	ND	ND	< LOD 0.4662	NA
PVC 96-3865	1	40.79	CPDS-1B	0.09		ND	< LOD 0.02	ND	ND	< LOD 0.4903	NA
PVC 96-3850	2	40.45	CPDS-1B	0.64		ND	< LOD 0.02	ND	ND	< LOD 0.4944	NA
PVC 96-3873	3	40.57	CPDS-1B	0.80		ND	< LOD 0.02	ND	ND	< LOD 0.4930	NA
PVC 96-3853	OBZ	40.55	CPDS-1B	0.50		ND	< LOD 0.02	ND	ND	< LOD 0.4932	NA

Airborne Sample Data Analysis - Respirable Cristobalite
NIOSH REL 0.05 milligrams/cubic meter
OSHA PEL As Calculated

	@ Make-up Air Area		@ Operator Area		@ Exhaust Area		Operator 's Breathing Zone	
Abrasive	Fixed Station #1		Fixed Station #2		Fixed Station #3		(OBZ)	
Type	mg/m³	Note	mg/m³	Note	mg/m³	Note	mg/m³	Note
CG-01	ND	< LOD 0.4848	ND	< LOD 0.4875	ND	< LOD 0.4862	ND	< LOD 0.4893
CS-01	ND	< LOD 0.4890	ND	< LOD 0.4899	ND	< LOD 0.4878	ND	< LOD 0.4560
CS-02	ND	< LOD 0.4885	ND	< LOD 0.4909	ND	< LOD 0.4892	ND	< LOD 0.4908
CS-03	ND	< LOD 0.4888	ND	< LOD 0.4878	ND	< LOD 0.4908	ND	< LOD 0.4810
CS-04	ND	< LOD 0.4885	ND	< LOD 0.4899	ND	< LOD 0.4918	ND	< LOD 0.4821
CS-05	ND	< LOD 0.4908	ND	< LOD 0.4908	ND	< LOD 0.4962	ND	< LOD 0.4844
CS-06	ND	< LOD 0.4880	ND	< LOD 0.4879	ND	< LOD 0.4903	ND	< LOD 0.4928
CS-07	ND	< LOD 0.4862	ND	< LOD 0.4845	ND	< LOD 0.4859	ND	< LOD 0.4912
CSDS-01	ND	< LOD 0.4899	ND	< LOD 0.4901	ND	< LOD 0.4895	ND	< LOD 0.4878
CSDS-02	ND	< LOD 0.4883	ND	< LOD 0.4872	ND	< LOD 0.4912	ND	< LOD 0.5038
N-01	ND	< LOD 0.4896	ND	< LOD 0.4852	ND	< LOD 0.4879	ND	< LOD 0.4886
N-02	ND	< LOD 0.4946	ND	< LOD 0.4878	ND	NA	ND	< LOD 0.4930
O-1	ND	< LOD 0.4918	ND	< LOD 0.4896	ND	< LOD 0.4931	ND	< LOD 0.4937
S-01	ND	< LOD 0.4937	ND	< LOD 0.4879	ND	< LOD 0.4879	ND	< LOD 0.4844
S-02	ND	< LOD 0.4912	ND	< LOD 0.4862	ND	< LOD 0.4912	ND	< LOD 0.4912
SH-01	ND	< LOD 0.4875	ND	< LOD 0.4901	ND	< LOD 0.4905	ND	< LOD 0.5117
SS-01	ND	< LOD 0.4878	ND	< LOD 0.4869	ND	< LOD 0.4892	ND	< LOD 0.4905
SS-02	ND	< LOD 0.4902	ND	< LOD 0.4908	ND	< LOD 0.4906	ND	< LOD 0.4844
SS-03	ND	< LOD 0.4869	ND	< LOD 0.4919	ND	< LOD 0.4856	ND	< LOD 0.4888
SS-04	ND	< LOD 0.4898	ND	< LOD 0.4898	ND	< LOD 0.4908	ND	< LOD 0.4862
SS-05	ND	< LOD 0.4865	ND	< LOD 0.4859	ND	< LOD 0.4892	ND	< LOD 0.4896
SS-06	ND	< LOD 0.4914	ND	< LOD 0.4925	ND	< LOD 0.4935	ND	< LOD 0.4720
SS-07	ND	< LOD 0.4941	ND	< LOD 0.4892	ND	< LOD 0.4934	ND	< LOD 0.4882
SSDS-01	ND	< LOD 0.4875	ND	< LOD 0.4903	ND	< LOD 0.4893	ND	< LOD 0.4802
SSDS-02	ND	< LOD 0.4835	ND	< LOD 0.4918	ND	< LOD 0.4869	ND	< LOD 0.4889
SSDS-03	ND	< LOD 0.4678	ND	< LOD 0.4673	ND	NA	ND	< LOD 0.4825
CP-1A	ND	< LOD 0.4909	ND	< LOD 0.4924	ND	< LOD 0.4853	ND	< LOD 0.4873
CP-1B	ND	< LOD 0.5632	ND	< LOD 0.5619	ND	< LOD 0.5642	ND	< LOD 0.5672
CP-2A	ND	< LOD 0.4902	ND	< LOD 0.4899	ND	< LOD 0.4916	ND	< LOD 0.4903
CP-2B	ND	< LOD 0.4872	ND	< LOD 0.4903	ND	< LOD 0.4919	ND	< LOD 0.4950
CP-3A	ND	< LOD 0.4876	ND	< LOD 0.4886	ND	< LOD 0.4865	ND	< LOD 0.4931
CP-3B	ND	< LOD 0.6515	ND	< LOD 0.6551	ND	< LOD 0.6484	ND	< LOD 0.5826
CP-4A	ND	< LOD 0.4859	ND	< LOD 0.4950	ND	< LOD 0.4896	ND	< LOD 0.4896
CP-4B	ND	< LOD 0.4895	ND	< LOD 0.4869	ND	< LOD 0.4890	ND	< LOD 0.4828
CPDS-1A	ND	< LOD 0.4899	ND	< LOD 0.4995	ND	< LOD 0.4924	ND	< LOD 0.4662
CPDS-1B	ND	< LOD 0.4903	ND	< LOD 0.4944	ND	< LOD 0.4930	ND	< LOD 0.4932
G-1A	ND	< LOD 0.4889	ND	< LOD 0.4901	ND	< LOD 0.4873	ND	< LOD 0.4866
G-1B	ND	< LOD 0.4892	ND	< LOD 0.4902	ND	< LOD 0.4941	ND	< LOD 0.4839
G-2A	ND	< LOD 0.4834	ND	< LOD 0.4883	ND	< LOD 0.4888	ND	< LOD 0.5040
G-2B	ND	< LOD 0.4873	ND	< LOD 0.4912	ND	< LOD 0.4839	ND	< LOD 0.4922
G-3A	ND	< LOD 0.4924	ND	< LOD 0.4895	ND	< LOD 0.4885	ND	< LOD 0.4876
G-4A	ND	< LOD 0.4869	ND	< LOD 0.4911	ND	< LOD 0.4905	ND	< LOD 0.4984
G-4B	ND	< LOD 0.4888	ND	< LOD 0.4901	ND	< LOD 0.4845	ND	< LOD 0.4925
G-5A	ND	< LOD 0.4876	ND	< LOD 0.4876	ND	< LOD 0.4898	ND	< LOD 0.4846
G-5B	ND	< LOD 0.4896	ND	< LOD 0.4899	ND	< LOD 0.4861	ND	< LOD 0.4869
G-6A	ND	< LOD 0.4890	ND	< LOD 0.4890	ND	< LOD 0.4873	ND	< LOD 0.4842
G-6B	ND	< LOD 0.4831	ND	< LOD 0.5013	ND	< LOD 0.4996	ND	< LOD 0.4879
G-7A	ND	< LOD 0.4919	ND	< LOD 0.4906	ND	< LOD 0.4938	ND	< LOD 0.4916
G-7B	ND	< LOD 0.4853	ND	< LOD 0.4918	ND	< LOD 0.4996	ND	< LOD 0.4980
SG-1A	ND	< LOD 0.4903	ND	< LOD 0.4902	ND	< LOD 0.4914	ND	< LOD 0.4911
SG-1B	ND	< LOD 0.9026	ND	< LOD 0.8999	ND	< LOD 0.9047	ND	< LOD 1.0765
SG-2A	ND	< LOD 0.4878	ND	< LOD 0.4888	ND	< LOD 0.4922	ND	< LOD 0.4878
SG-2B	ND	< LOD 0.4875	ND	< LOD 0.4925	ND	< LOD 0.4868	ND	< LOD 0.4792

Bulk Elemental Analysis, Percent by Weight - Total Cristobalite

	Virgin (Pre Blast) Bulk			Post (Blast) Bulk		
Abrasive	Sample	Cristobalite	Cristobalite	Sample	Cristobalite	Cristobalite
Type	No.	Total %	comments	No.	Total %	comments
CG-01	J95331-63 VB	ND	< LOD 0.08	J95331-63 PB	ND	< LOD 0.08
CS-01	J95331-34 VB	**	0 < 10 mm	J95331-34 PB	ND	< LOD 0.8
CS-02	J95331-37 VB	ND	n/a	J95331-37 PB	ND	n/a
CS-03	J95331-38 VB	ND	n/a	J95331-38 PB	ND	n/a
CS-04	J95331-39 VB	ND	n/a	J95331-39 PB	ND	n/a
CS-05	J95331-57 VB	ND	< LOD 0.08	J95331-57 PB	ND	< LOD 0.08
CS-06	J95331-70 VB	ND	< LOD 0.8	J95331-70 PB	ND	< LOD 0.8
CS-07	J95331-83 VB	ND	< LOD 0.8	J95331-83 PB	ND	< LOD 0.8
CSDS-01	J95331-31 VB	**	0 < 10 mm	J95331-31 PB	**	0 < 10 mm
CSDS-02	J95331-35 VB	**	0 < 10 mm	J95331-35 PB	**	0 < 10 mm
N-01	J95331-52 VB	ND	< LOD 0.8	J95331-52 PB	ND	< LOD 0.8
N-02	J95331-81 VB	ND	< LOD 0.8	J95331-81 PB	ND	< LOD 0.8
O-1	J95331-69 VB	ND	< LOD 0.8	J95331-69 PB	ND	< LOD 0.8
S-01	J95331-28 VB	ND	< LOD 0.8	J95331-28 PB	ND	< LOD 0.8
S-02	J95331-29 VB	ND	< LOD 0.8	J95331-29 PB	ND	< LOD 0.8
SH-01	J95331-36 VB	ND	n/a	J95331-36 PB	ND	n/a
SS-01	J95331-32 VB	**	0 < 10 mm	J95331-32 PB	ND	< LOD 0.8
SS-02	J95331-40 VB	ND	n/a	J95331-40 PB	ND	< LOD 0.8
SS-03	J95331-45 VB	ND	n/a	J95331-45 PB	ND	< LOD 0.8
SS-04	J95331-47 VB	ND	< LOD 0.8	J95331-47 PB	ND	< LOD 0.8
SS-05	J95331-53 VB	ND	< LOD 0.8	J95331-53 PB	ND	< LOD 0.8
SS-06	J95331-76 VB	ND	< LOD 0.8	J95331-76 PB	ND	< LOD 0.8
SS-07	J95331-80 VB	ND	< LOD 0.8	J95331-80 PB	ND	< LOD 0.8
SSDS-01	J95331-33 VB	**	0 < 10 mm	J95331-33 PB	ND	< LOD 0.8
SSDS-02	J95331-44 VB	ND	n/a	J95331-44 PB	ND	< LOD 0.8
SSDS-03	J95331-48 VB	ND	< LOD 0.8	J95331-48 PB	ND	< LOD 0.8
CP-1A	J95331-60 VB	ND	< LOD 0.08	J95331-60 PB	ND	< LOD 0.08
CP-1B	J95331-61 VB	ND	< LOD 0.08	J95331-61 PB	ND	< LOD 0.08
CP-2A	J95331-67 VB	ND	< LOD 0.8	J95331-67 PB	ND	< LOD 0.8
CP-2B	J95331-68 VB	ND	< LOD 0.8	J95331-68 PB	ND	< LOD 0.8
CP-3A	J95331-72 VB	ND	< LOD 0.8	J95331-72 PB	ND	< LOD 0.8
CP-3B	J95331-73 VB	ND	< LOD 0.8	J95331-73 PB	ND	< LOD 0.8
CP-4A	J95331-78 VB	ND	< LOD 0.8	J95331-78 PB	ND	< LOD 0.8
CP-4B	J95331-79 VB	ND	< LOD 0.8	J95331-79 PB	ND	< LOD 0.8
CPDS-1A	J95331-84 VB	ND	< LOD 0.8	J95331-84 PB	ND	< LOD 0.8
CPDS-1B	J95331-85 VB	ND	< LOD 0.8	J95331-85 PB	ND	< LOD 0.8
G-1A	J95331-41 VB	ND	n/a	J95331-41 PB	ND	n/a
G-1B	J95331-46 VB	ND	< LOD 0.8	J95331-46 PB	ND	< LOD 0.8
G-2A	J95331-43 VB	ND	n/a	J95331-43 PB	ND	< LOD 0.8
G-2B	J95331-50 VB	ND	< LOD 0.8	J95331-50 PB	ND	< LOD 0.8
G-3A	J95331-49 VB	ND	< LOD 0.8	J95331-49 PB	ND	< LOD 0.8
G-4A	J95331-55 VB	ND	< LOD 0.8	J95331-55 PB	ND	< LOD 0.8
G-4B	J95331-56 VB	ND	< LOD 0.08	J95331-56 PB	ND	< LOD 0.08
G-5A	J95331-58 VB	ND	< LOD 0.08	J95331-58 PB	ND	< LOD 0.08
G-5B	J95331-59 VB	ND	< LOD 0.08	J95331-59 PB	ND	< LOD 0.08
G-6A	J95331-64 VB	ND	< LOD 0.08	J95331-64 PB	ND	< LOD 0.08
G-6B	J95331-65 VB	ND	< LOD 0.08	J95331-65 PB	ND	< LOD 0.08
G-7A	J95331-74 VB	ND	< LOD 0.8	J95331-74 PB	ND	< LOD 0.8
G-7B	J95331-75 VB	ND	< LOD 0.8	J95331-75 PB	ND	< LOD 0.8
SG-1A	J95331-54 VB	ND	< LOD 0.8	J95331-54 PB	ND	< LOD 0.8
SG-1B	J95331-71 VB	ND	< LOD 0.8	J95331-71 PB	ND	< LOD 0.8
SG-2A	J95331-66 VB	ND	< LOD 0.08	J95331-66 PB	ND	< LOD 0.08
SG-2B	J95331-82 VB	ND	< LOD 0.8	J95331-82 PB	ND	< LOD 0.8

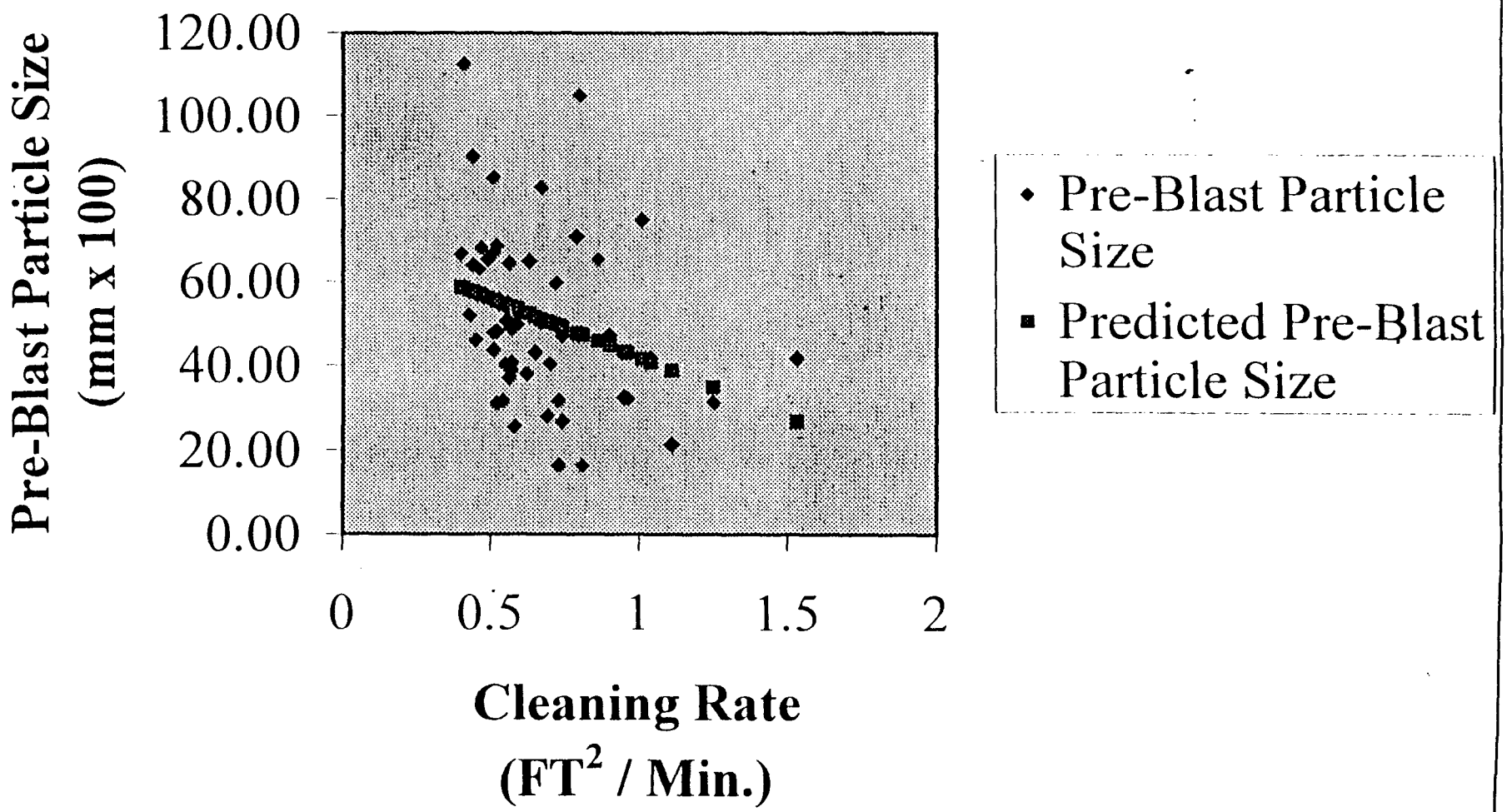
Comparison of Airborne Concentrations to Bulk Concentrations - Respirable Cristobalite

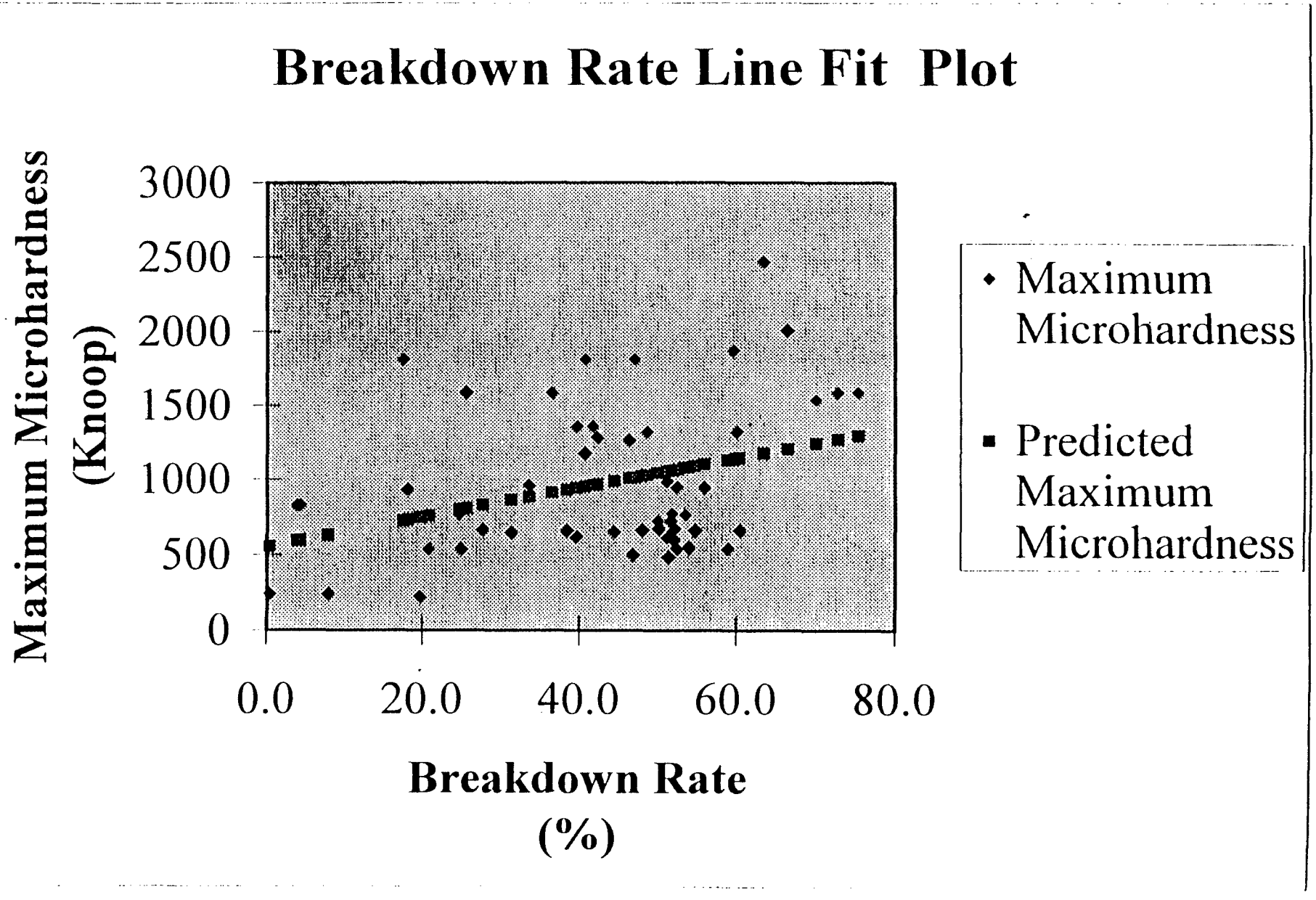
NIOSH REL 0.05 milligrams/cubic meter
OSHA PEL As Calculated

Abrasive Type	@ Make-up Air Area Fixed Station #1 mg/m³	@ Operator Area Fixed Station #2 mg/m³	@ Exhaust Area Fixed Station #3 mg/m³	Operator 's Breathing Zone (OBZ) mg/m³	Virgin Bulk Percentage
CG-01	ND	ND	ND	ND	**
CS-01	ND	ND	ND	ND	ND
CS-02	ND	ND	ND	ND	ND
CS-03	ND	ND	ND	ND	ND
CS-04	ND	ND	ND	ND	ND
CS-05	ND	ND	ND	ND	ND
CS-06	ND	ND	ND	ND	ND
CS-07	ND	ND	ND	ND	**
CSDS-01	ND	ND	ND	ND	**
CSDS-02	ND	ND	ND	ND	ND
N-01	ND	ND	ND	ND	ND
N-02	ND	ND	ND	ND	ND
O-1	ND	ND	ND	ND	ND
S-01	ND	ND	ND	ND	ND
S-02	ND	ND	ND	ND	ND
SH-01	ND	ND	ND	ND	**
SS-01	ND	ND	ND	ND	ND
SS-02	ND	ND	ND	ND	ND
SS-03	ND	ND	ND	ND	ND
SS-04	ND	ND	ND	ND	ND
SS-05	ND	ND	ND	ND	ND
SS-06	ND	ND	ND	ND	ND
SS-07	ND	ND	ND	ND	**
SSDS-01	ND	ND	ND	ND	ND
SSDS-02	ND	ND	ND	ND	ND
SSDS-03	ND	ND	ND	ND	ND
CP-1A	ND	ND	ND	ND	ND
CP-2A	ND	ND	ND	ND	ND
CP-3A	ND	ND	ND	ND	ND
CP-4A	ND	ND	ND	ND	ND
CPDS-1A	ND	ND	ND	ND	ND
G-1A	ND	ND	ND	ND	ND
G-2A	ND	ND	ND	ND	ND
G-3A	ND	ND	ND	ND	ND
G-4A	ND	ND	ND	ND	ND
G-5A	ND	ND	ND	ND	ND
G-6A	ND	ND	ND	ND	ND
G-7A	ND	ND	ND	ND	ND
SG-1A	ND	ND	ND	ND	ND
SG-2A	ND	ND	ND	ND	ND

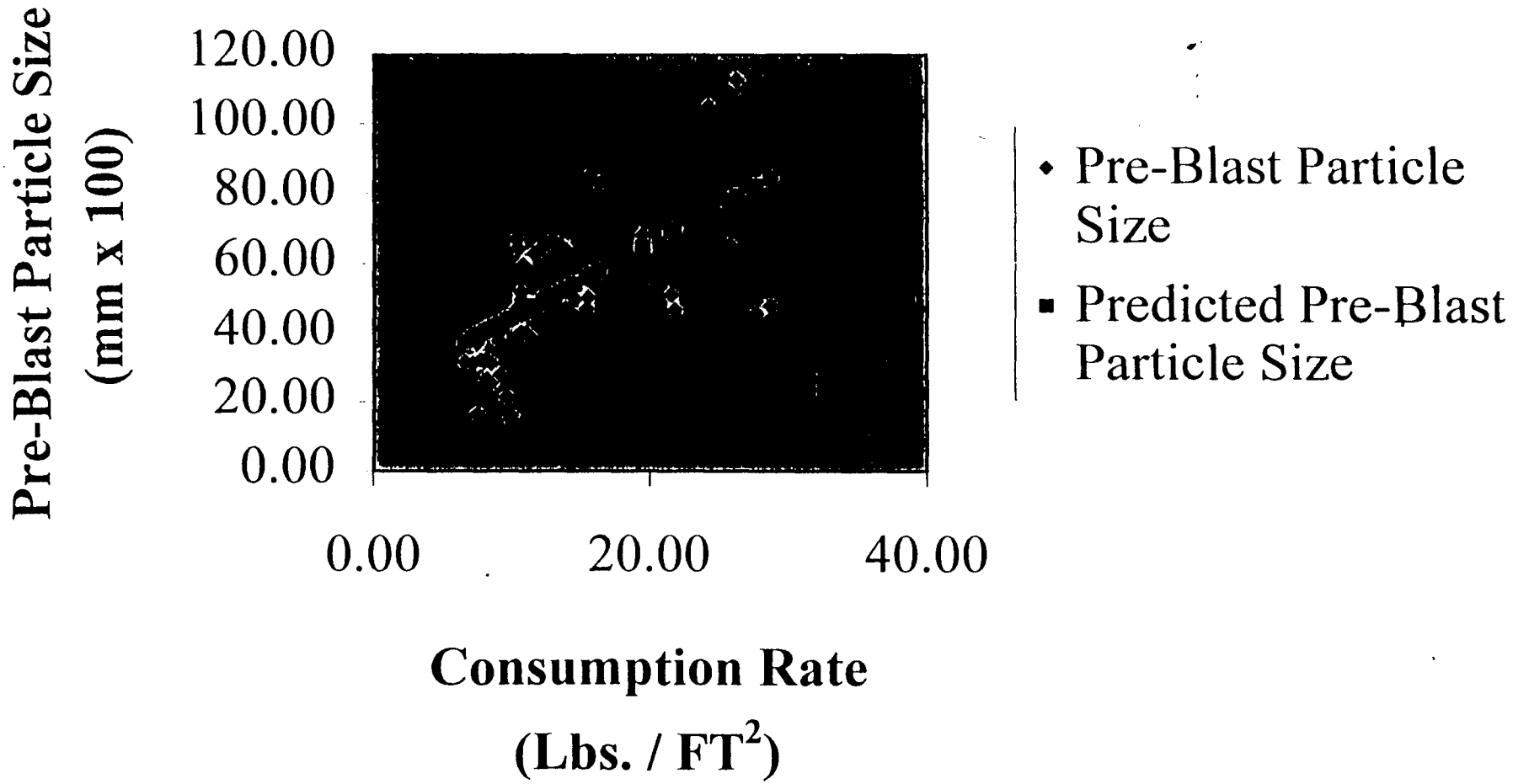
APPENDIX C

Cleaning Rate Line Fit Plot

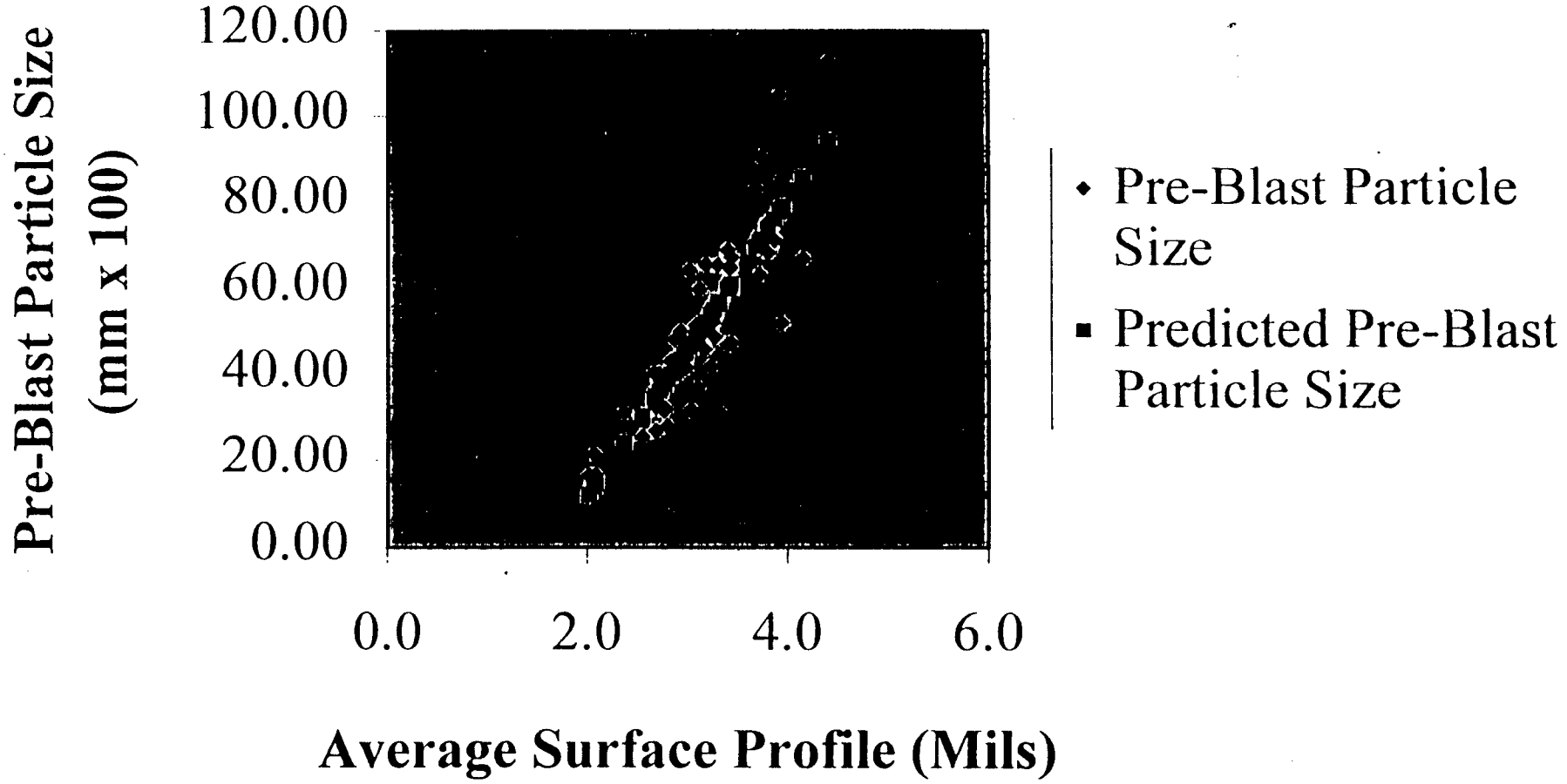



Breakdown Rate Line Fit Plot
Maximum Microhardness (Knoop)
3000
2500
2000
1500
1000
500
0
0.0
20.0
40.0
60.0
80.0
Breakdown Rate (%)
Maximum Microhardness
Predicted Maximum Microhardness

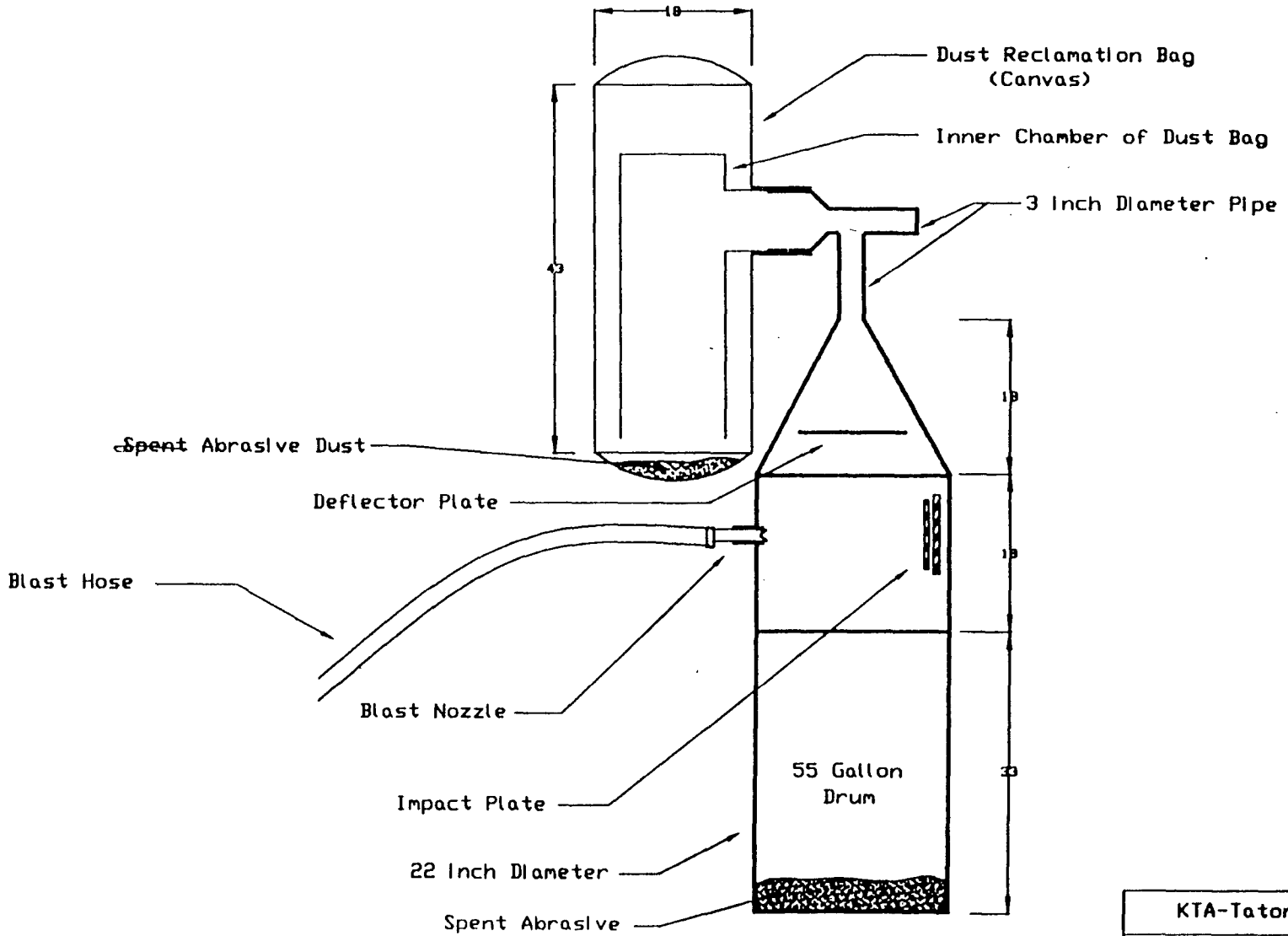
Consumption Rate Line Fit Plot



Average Surface Profile Line Fit Plot



KTA-TATOR ABRASIVE BREAKDOWN CHAMBER



KTA-Tator, Inc.
Blast Reclamation Chamber

APPENDIX D

TABLE D1
Abrasive Cleaning Cost Summary

Abrasive No.	Generic Abrasive	Size Designation	Nozzle Size	Flow rate (ton/hr.)	Mat'l Cost ($/ton)	Disposal ($/ton)	Equipment ($/hr.)	Labor ($/hr.)	No. of Uses	Cleaning Rate (sq ft/hr.)	Cleaning Cost ($/sq ft)
CG-01	Crushed Glass	2040	1/4	0.180578	100.00	30	7.59	36.60	1	32.9	**2.06**
CS-01	Coal Slag	1240	1/4	0.160171	51.00	30	7.59	36.60	1	27.5	**2.07**
CS-02	Coal Slag	2043	1/4	0.150830	44.00	30	7.59	36.60	1	30.9	**1.79**
CS-03	Coal Slag	2040	1/4	0.209351	35.00	30	7.59	36.60	1	33.9	**1.70**
CS-04	Coal Slag	2049	1/4	0.160301	37.00	30	7.59	36.60	1	30.7	**1.79**
CS-05	Coal Slag	2040	1/4	0.183824	29.00	30	7.59	36.60	1	34.4	**1.60**
CS-06	Coal Slag	2040	1/4	0.188784	38.00	30	7.59	36.60	1	41.4	**1.38**
CS-07	Coal Slag	2040	1/4	0.190107	63.90	30	7.59	36.60	1	42.0	**1.48**
CS-AVG[1]	Coal Slag	2040	1/4	0.203502	38.00	30	7.59	36.60	1	39.0	**1.49**
CS-13[2]	Coal Slag	2040	3/8	0.376356	38.00	30	7.59	36.60	1	94.8	**0.74**
CS-14[2]	Coal Slag	2040	7/16	0.447513	38.00	30	7.59	36.60	1	114.6	**0.65**
CSDS-01	Coal Slag with Dust Suppressant	2040	1/4	0.188561	51.00	30	7.59	36.60	1	35.4	**1.68**
CSDS-02	Coal Slag with Dust Suppressant	1240	1/4	0.229241	61.00	30	7.59	36.60	1	37.6	**1.73**
N-01	Nickel Slag	2050	1/4	0.218050	41.00	30	7.59	36.60	1	34.9	**1.71**
N-02	Nickel Slag	2040	1/4	0.376712	57.56	30	7.59	36.60	1	47.6	**1.62**
O-01	Olivine	40	1/4	0.175638	70.00	30	7.59	36.60	1	43.8	**1.41**
S-01	Staurolite	XL	1/4	0.164216	121.50	30	7.59	36.60	1	43.7	**1.58**
S-02	Staurolite	Regular	1/4	0.241222	105.40	30	7.59	36.60	1	48.7	**1.58**
SH-01	Specular Hematite	#50	1/4	0.106529	130.00	30	7.59	36.60	1	32.3	**1.90**
SS-01	Silica Sand	20-30	1/4	0.175610	22.00	30	7.59	36.60	1	33.7	**1.58**
SS-02	Silica Sand	#1	1/4	0.324910	25.50	30	7.59	36.60	1	24.7	**2.52**
SS-03	Silica Sand	3	1/4	0.194342	35.05	30	7.59	36.60	1	34.2	**1.66**
SS-04	Silica Sand	2340	1/4	0.167593	13.00	30	7.59	36.60	1	37.0	**1.39**
SS-05	Silica Sand	JC 20	1/4	0.156658	22.25	30	7.59	36.60	1	30.4	**1.72**
SS-06	Silica Sand	16 x 40	1/4	0.198156	27.07	30	7.59	36.60	1	29.4	**1.89**
SS-07	Silica Sand	#16	1/4	0.173717	23.68	30	7.59	36.60	1	26.6	**2.01**
SSDS-01	Silica Sand with Dust Suppressant	20-30	1/4	0.185338	32.00	30	7.59	36.60	1	26.7	**2.09**
SSDS-02	Silica Sand with Dust Suppressant	2340	1/4	0.169396	23.00	30	7.59	36.60	1	38.8	**1.37**
SSDS-03	Silica Sand with Dust Suppressant	3.0	1/4	0.180971	45.05	30	7.59	36.60	1	33.9	**1.70**
CP-01	Copper Slag	16 x 50	1/4	0.593478	51.25	30	13.36	36.60	2	91.6	**0.81**
CP-02	Copper Slag	16/30	1/4	0.414990	84.50	30	13.36	36.60	2	54.0	**1.37**
CP-03	Copper Slag	16/30	1/4	0.665640	36.75	30	13.36	36.60	2	51.6	**1.40**
CP-04	Copper Slag	16/30	1/4	0.253054	30.00	30	13.36	36.60	2	32.7	**1.76**
CPDS-01	Copper Slag with Dust Suppressant	16/30	1/4	0.292986	76.00	30	13.36	36.60	2	40.3	**1.62**
G-01	Garnet	2050	1/4	0.145859	300.00	30	13.36	36.60	2	34.6	**2.14**
G-02	Garnet	#36	1/4	0.111088	243.00	30	13.36	36.60	2	31.2	**2.09**
G-03	Garnet	#40	1/4	0.125174	230.00	30	13.36	36.60	2	33.7	**1.97**
G-04	Garnet	#36	1/4	0.222490	200.00	30	13.36	36.60	3	57.8	**1.16**
G-05	Garnet	30 x 60	1/4	0.320245	200.00	30	13.36	36.60	3	66.7	**1.12**
G-06	Garnet	30/40	1/4	0.317610	210.00	30	13.36	36.60	2	75.0	**1.17**
G-07	Garnet	#36	1/4	0.231420	180.00	30	13.36	36.60	2	57.0	**1.30**
SG-01	Steel Grit	40, 50, 80 Blend	1/4	0.448500	460.00	30	13.36	36.60	25	31.2	**1.88**
SG-02	Steel Grit	40/50 Blend	1/4	0.482927	494.00	30	13.36	36.60	25	44.4	**1.35**

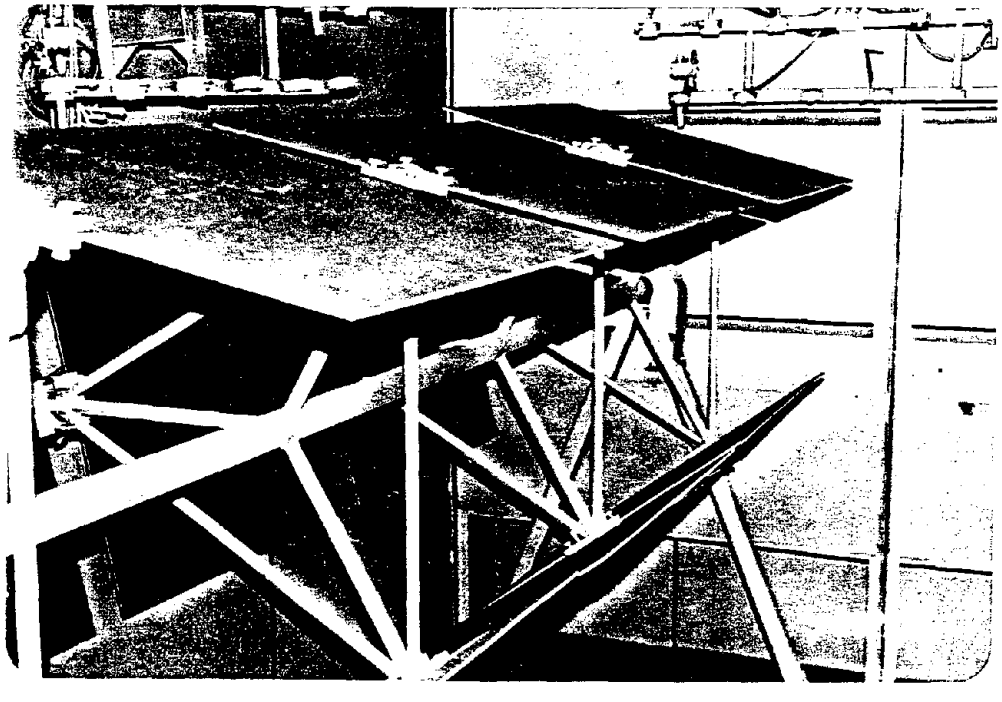
[1] – Average of the process control checks with a single coal slag abrasive. The same abrasive was used for the additional runs using the larger nozzle orifice sizes.

[2] – Two additional runs made with coal slag using the same equipment and operating restrictions, except that the nozzle was increased. Costs per square foot were reduced by more than one-half.

APPENDIX E

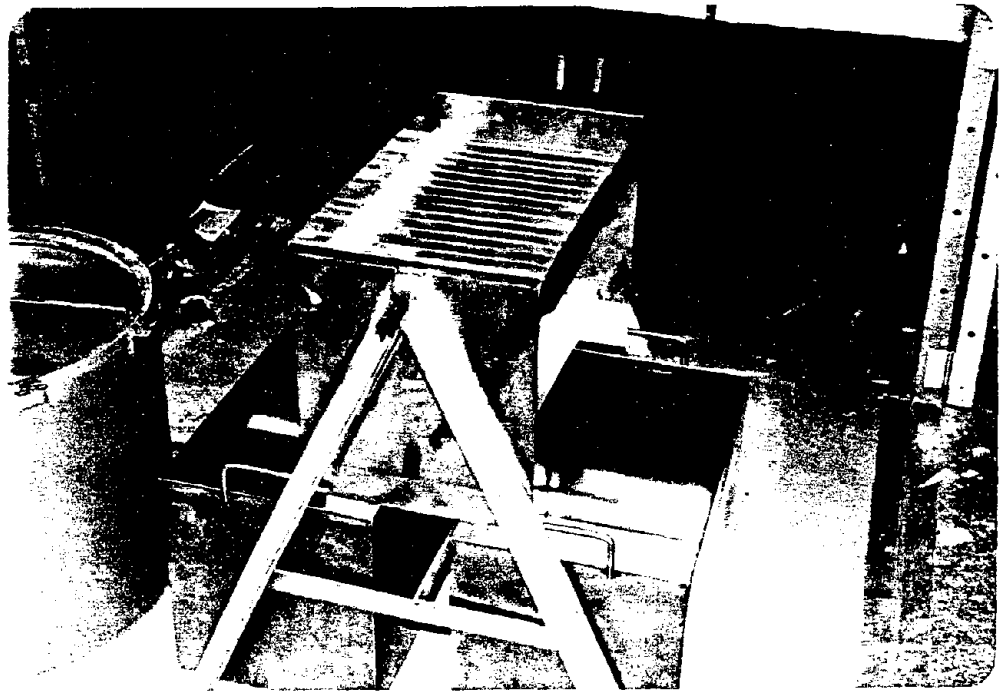
PHOTOGRAPH NO. 1

Test panel storage



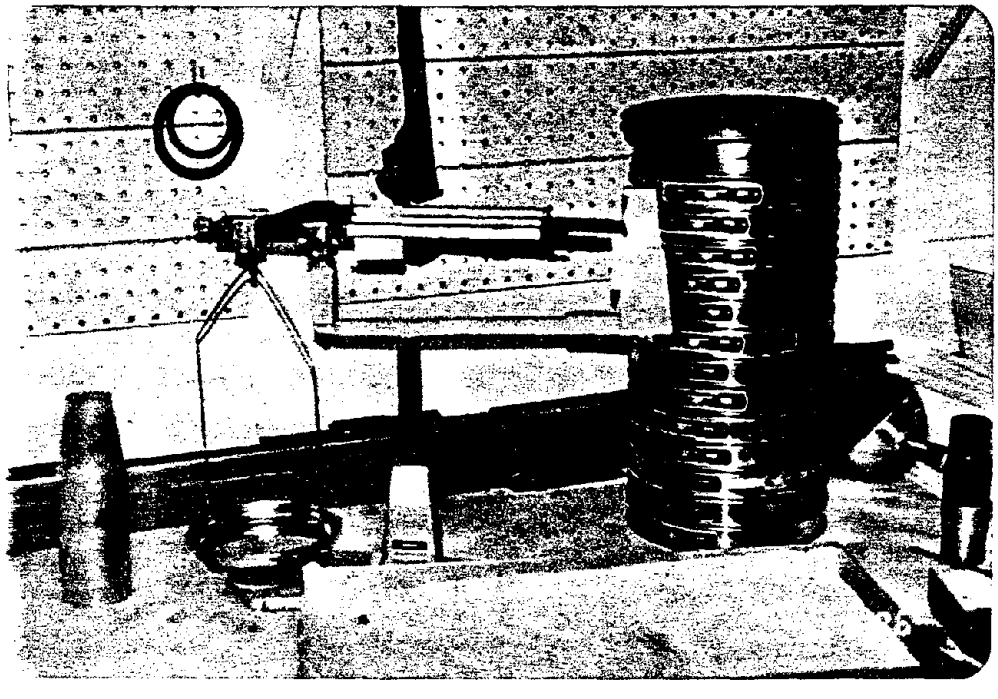
PHOTOGRAPH NO. 2

Panels mounted in blast cleaning rack



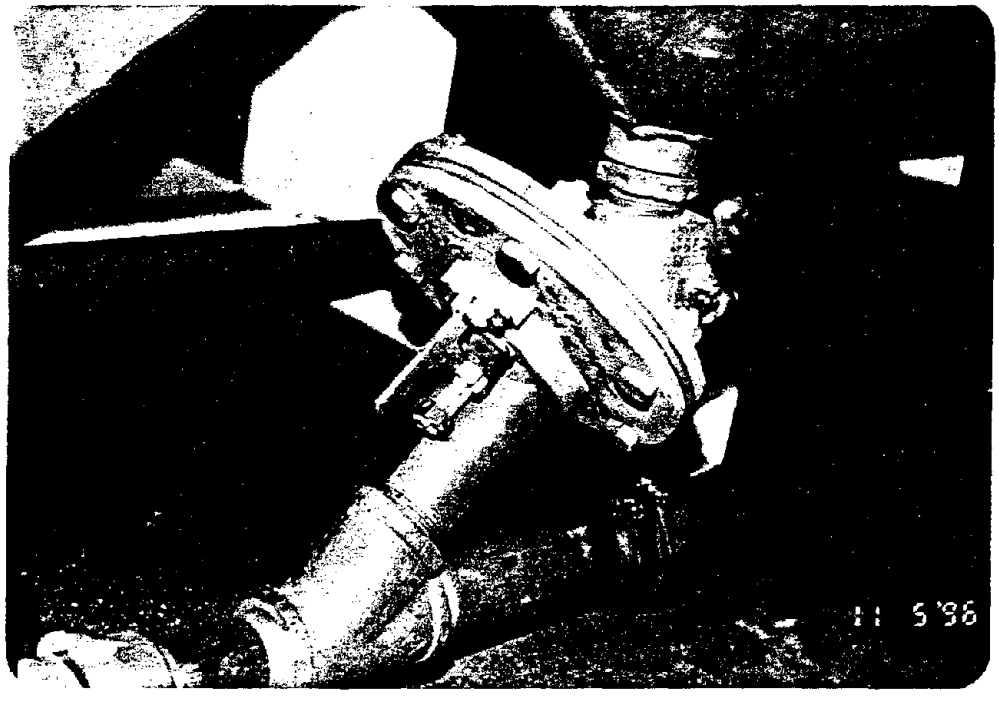
PHOTOGRAPH NO. 3

Abrasive riffle



PHOTOGRAPH NO. 4

Abrasive screens

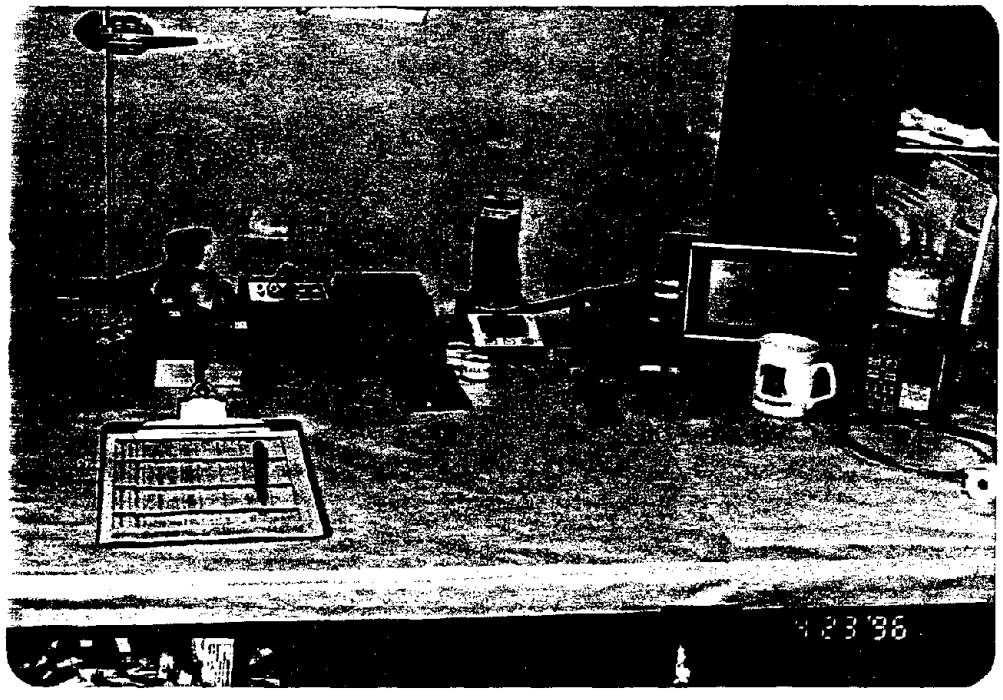


PHOTOGRAPH NO. 5

Abrasive metering valve

PHOTOGRAPH NO. 6

Cross draft ventilation check

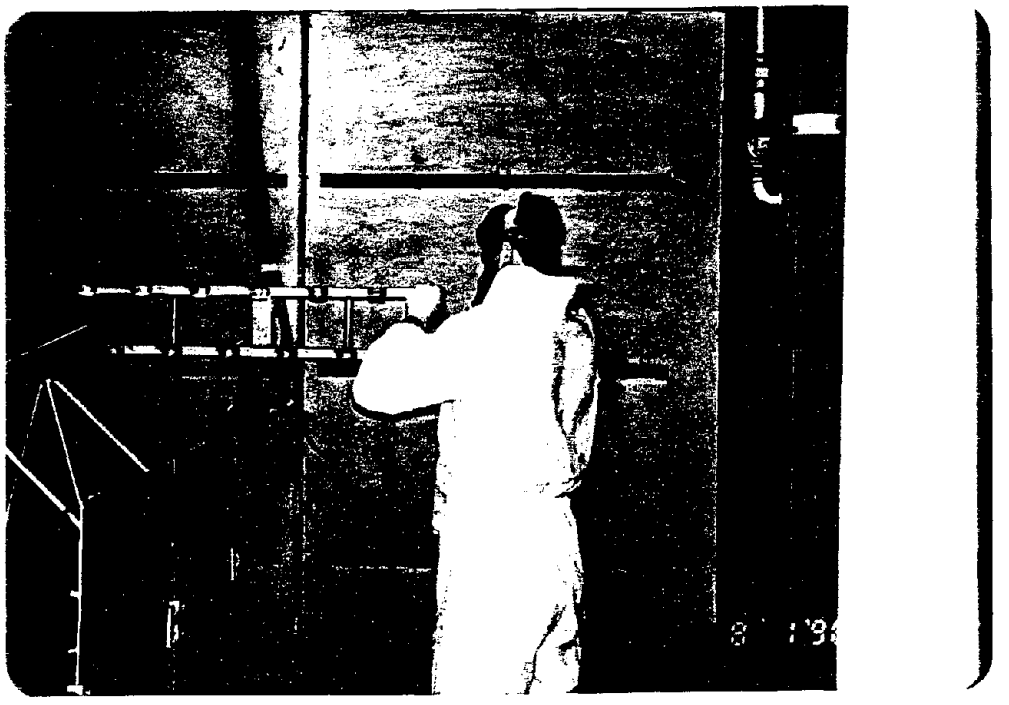


PHOTOGRAPH NO. 7

IH calibration equipment

PHOTOGRAPH NO. 8

Calibration and record keeping



PHOTOGRAPH NO. 9

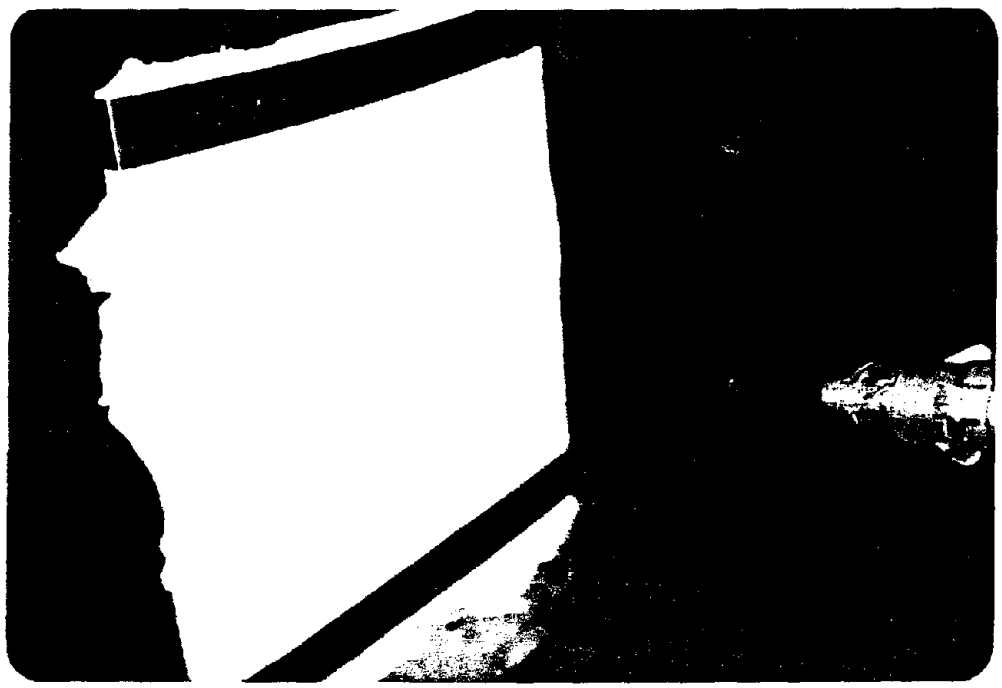
Mounting of fixed station #3 air sampling cassettes

PHOTOGRAPH NO. 10

Mounting of operator's breathing zone air sampling cassettes

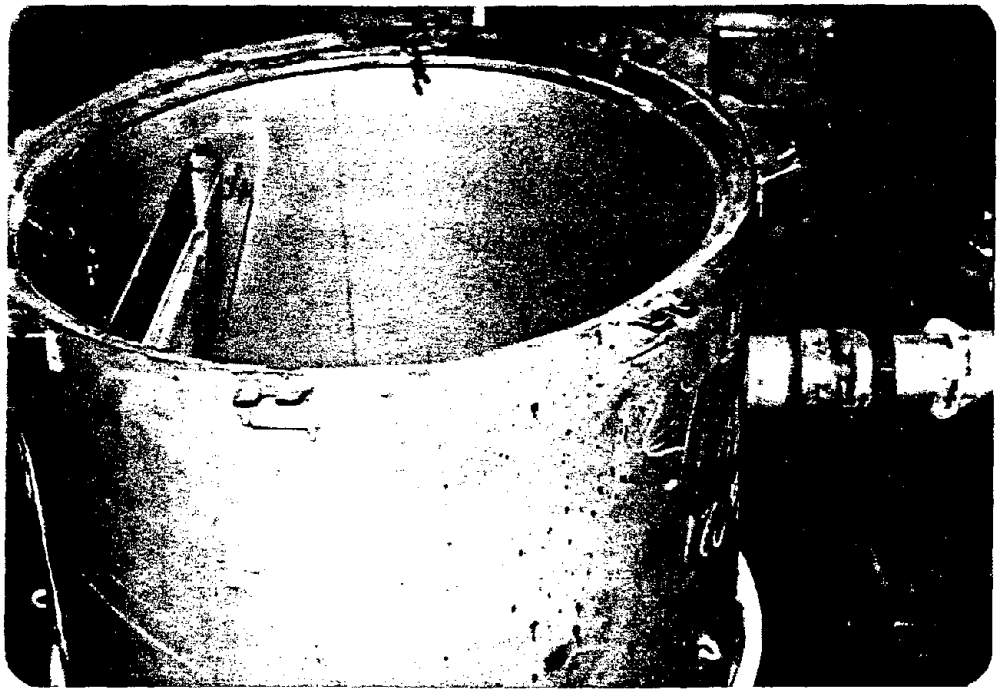
PHOTOGRAPH NO. 11

Setting nozzle distance



PHOTOGRAPH NO. 12

Blotter test for compressed air cleanliness

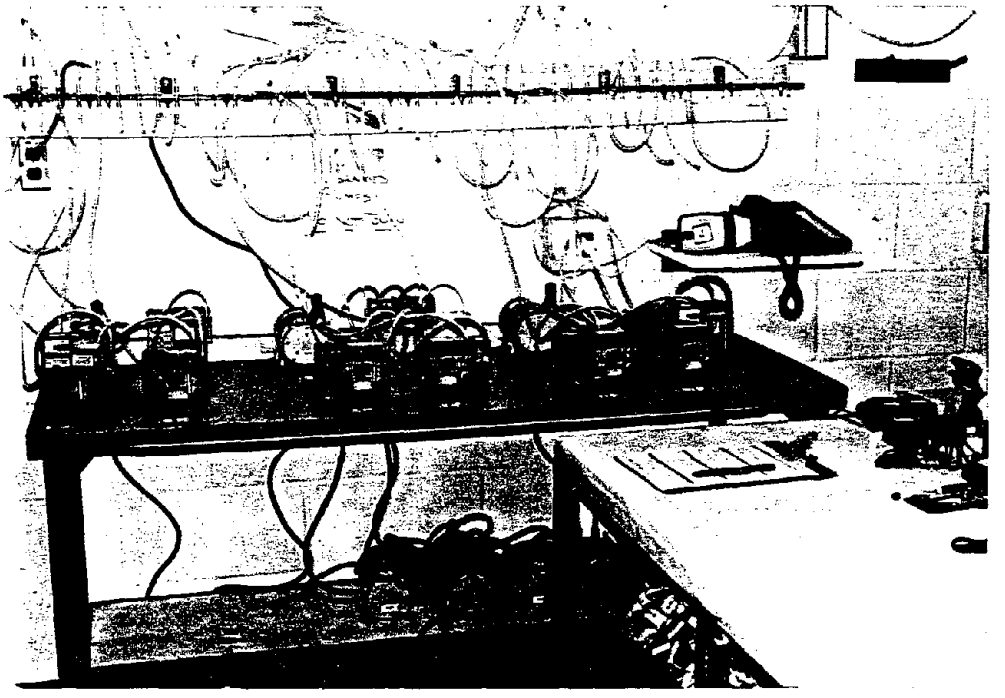


PHOTOGRAPH NO. 13

Breakdown chamber

PHOTOGRAPH NO. 14

Breakdown cycle in operation

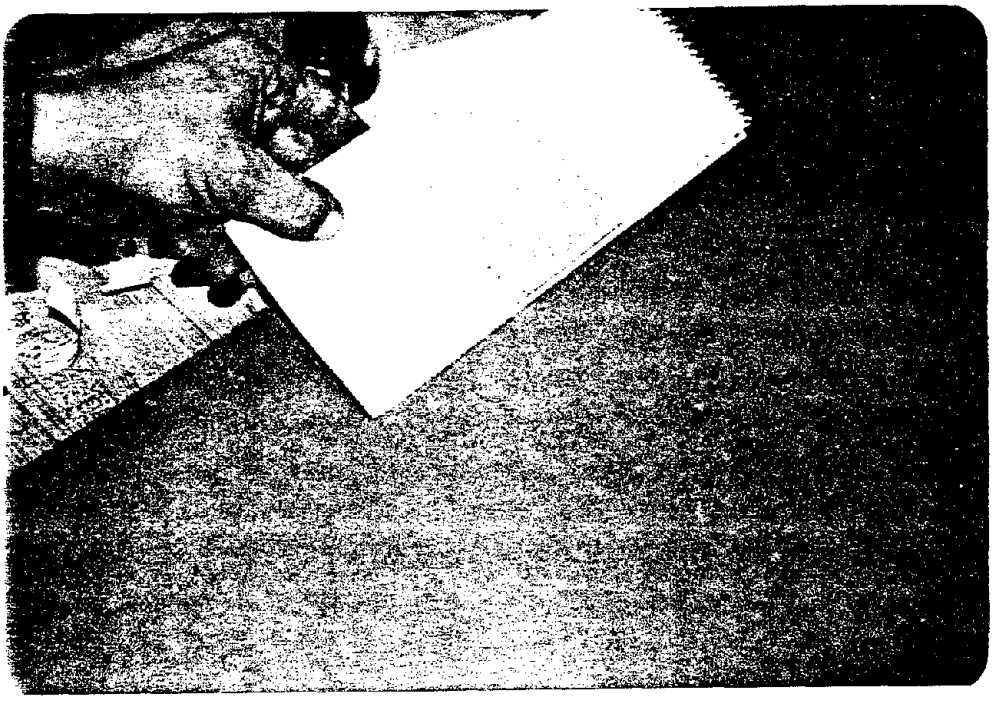


PHOTOGRAPH NO. 15

Air sampling in progress

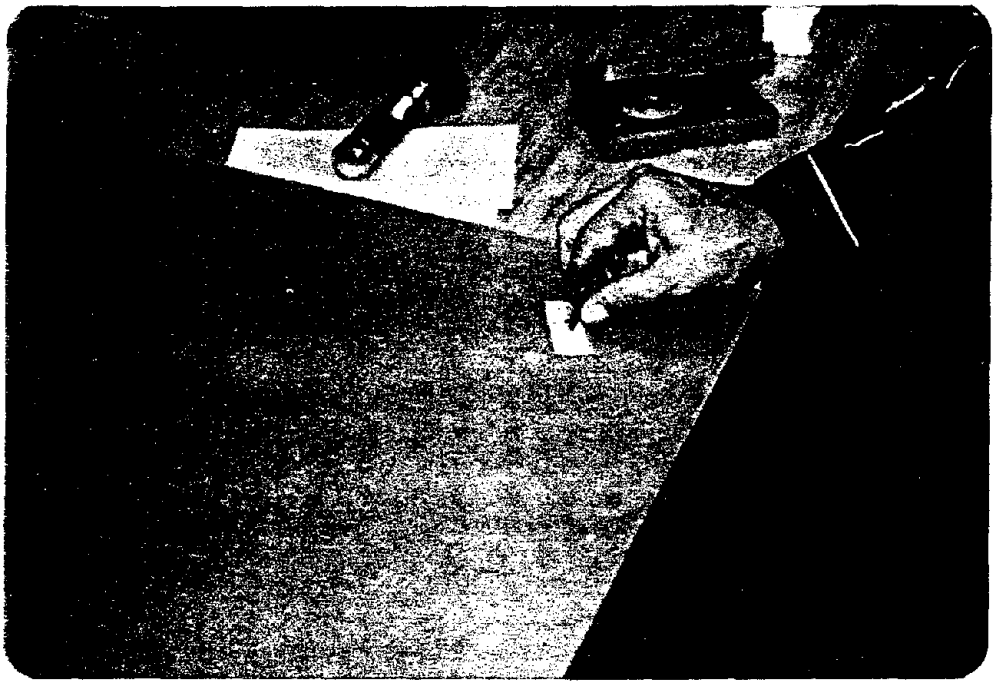
PHOTOGRAPH NO. 16

Air curtain abrasive reclaiming operation in progress



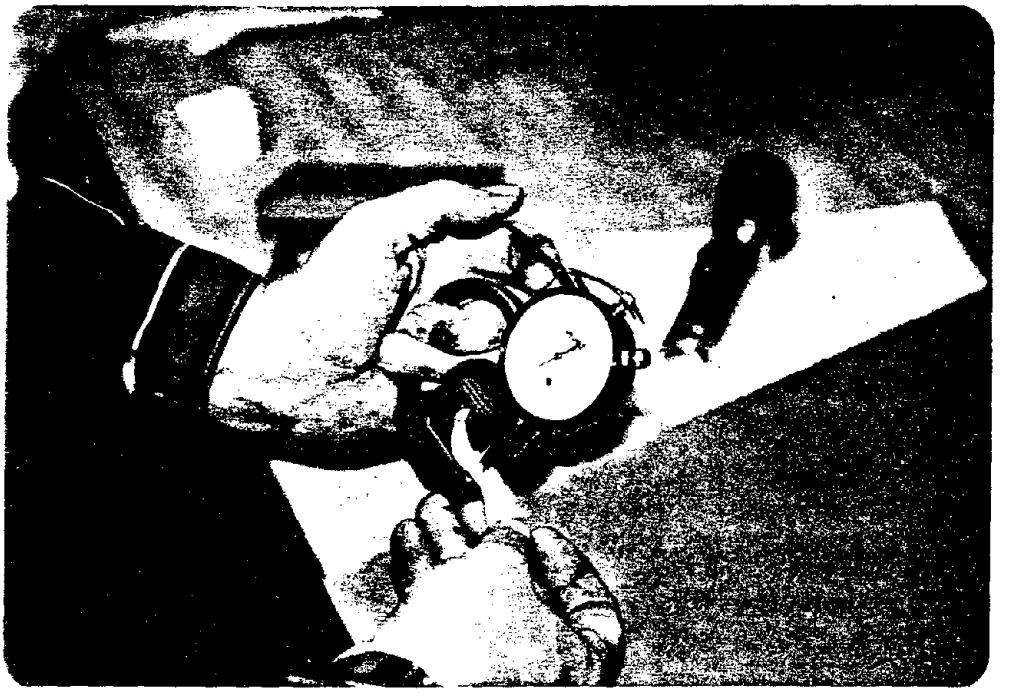
PHOTOGRAPH NO. 17

Cleanliness test



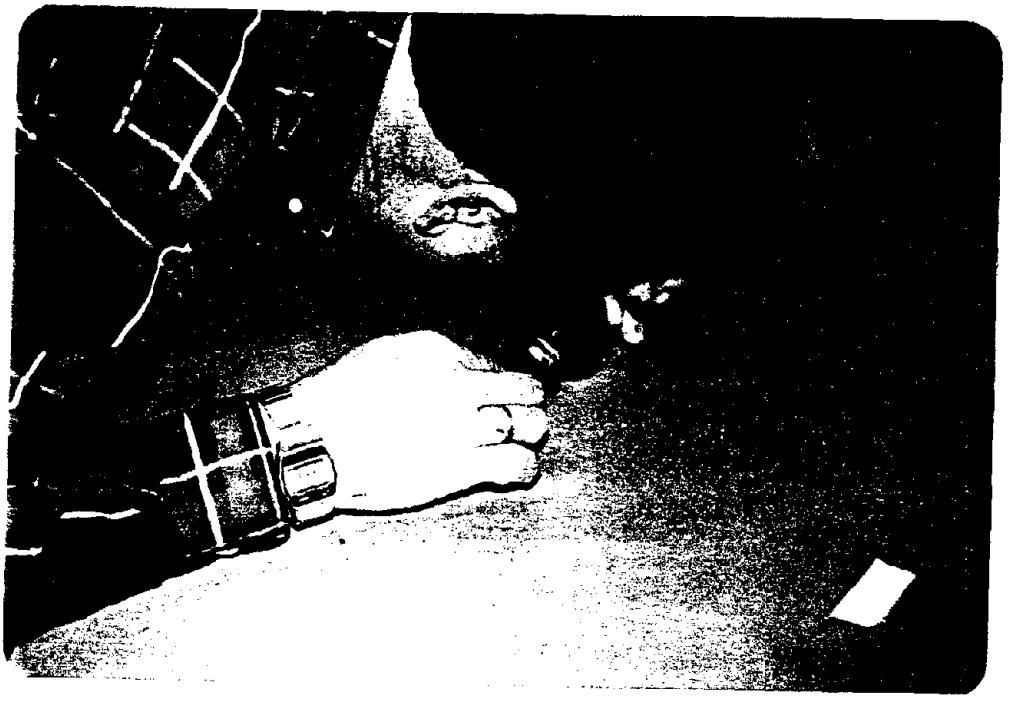
PHOTOGRAPH NO. 18

Profile test



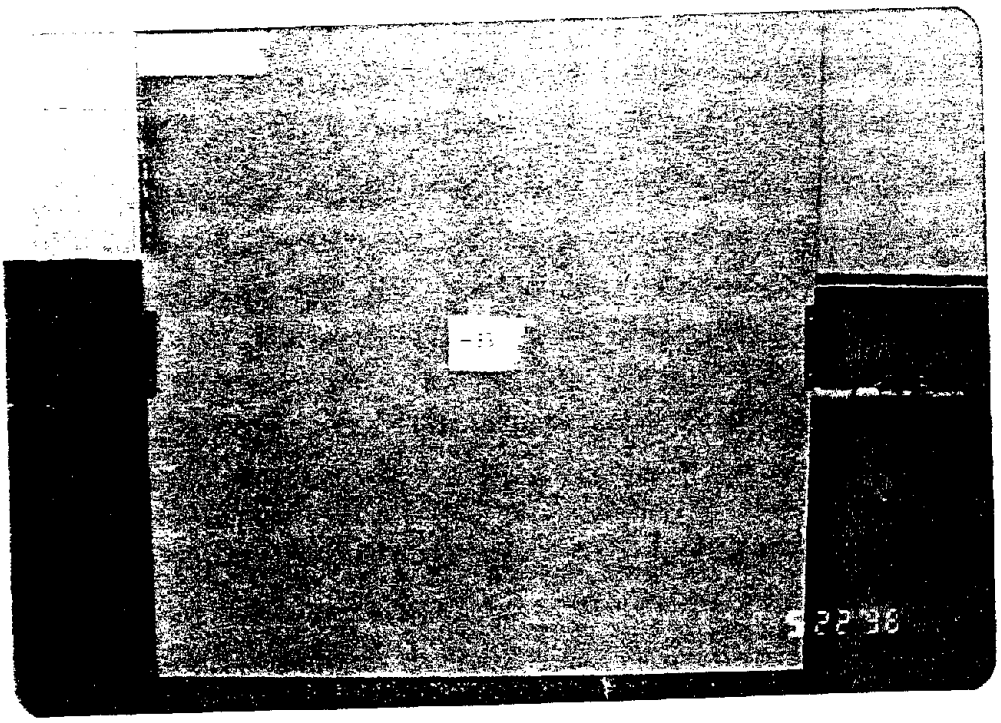
PHOTOGRAPH NO. 19

Profile test



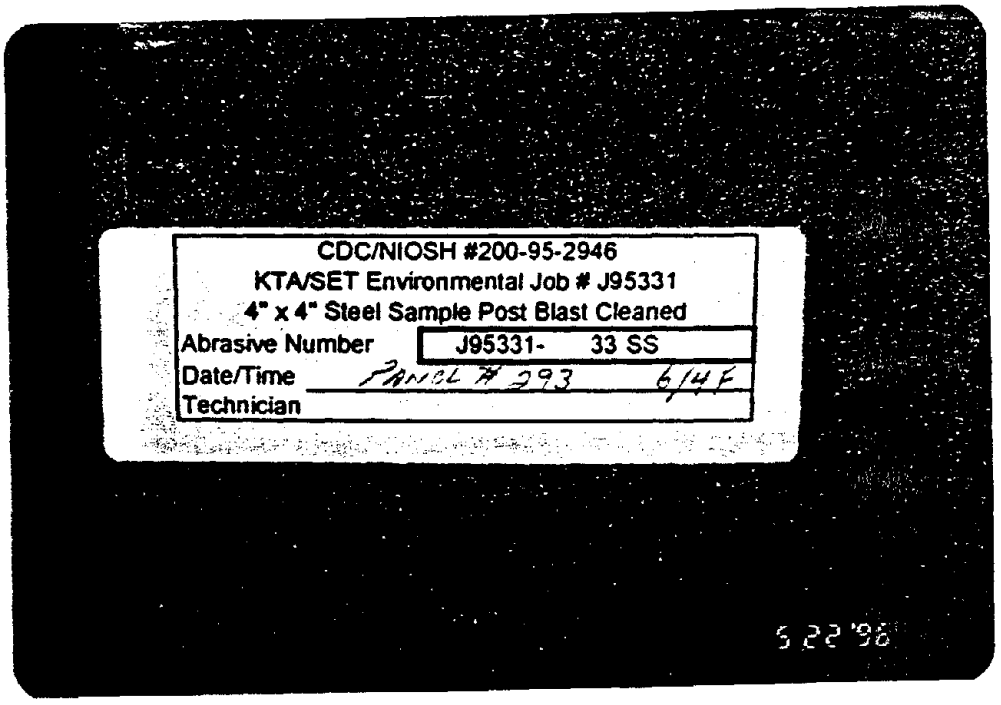
PHOTOGRAPH NO. 20

Embed ment test



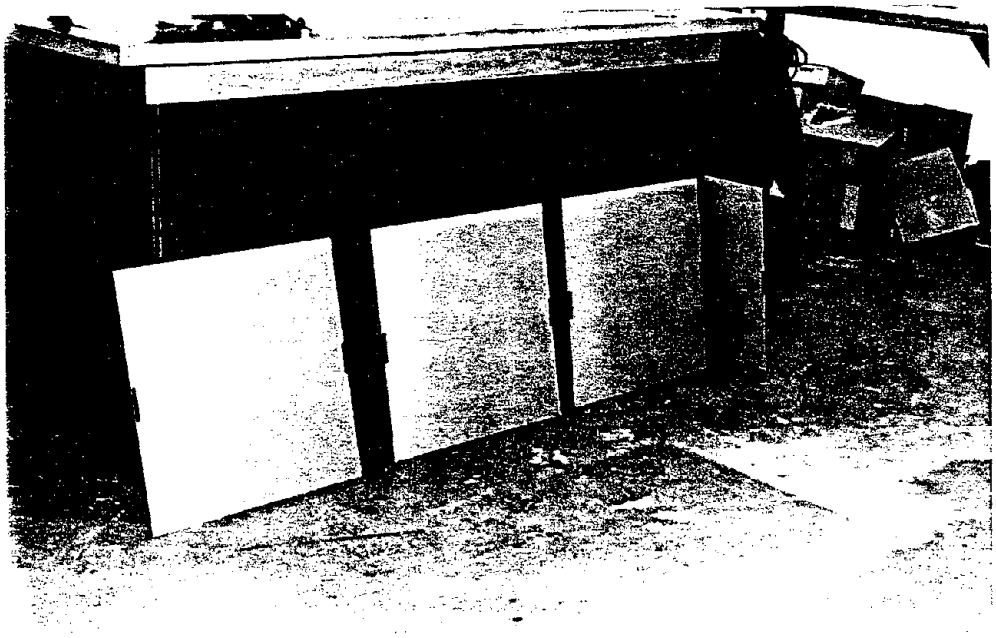
PHOTOGRAPH NO. 21

Photographic documentation



PHOTOGRAPH NO. 22

Photographic documentation



PHOTOGRAPH NO. 23

Cleaning rate determination

PHOTOGRAPH NO. 24

Sample storage