ABRASIVE BLASTING RESPIRATORY PROTECTIVE PRACTICES

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PREFACE

This study was conducted by the Boeing Aerospace Company under contract HSM-99-71-47 with the Division of Laboratories and Criteria Development, National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare. Technical monitoring was provided by two NIOSH project officers, Mr. Richard Lester and Mr. Alan Gudeman of the Engineering Branch, Division of Laboratories and Criteria Development.

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ACKNOWLEDGMENTS

Gratitude is expressed to Mr. George Duff, Executive Vice President, Seattle Chamber of Commerce for acting as intermediary in establishing relationships with his counterparts in the other surveyed cities and in generally aiding in the completion of this project.

Thanks are also given to the following Chamber of Commerce executives who lent their names and local knowledge to help assure the success of this project: Mr. George Garrett and Miss Jayne Olsen (Portland); Mr. Sheldon Morgan (Mobile); Mr. Harry Verdier (Phil8delphia); Mr. Clarence Wesley (Wichita); and Mr. John Westney (Houston).

We are indebted to the management of the many firms which participated in the study and are especially grateful for the assistance of the many blasters who made the field measurement phase possible.

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ABSTRACT

From a preliminary postal survey of 3903 firms a representative population was chosen for on-site survey and monitoring. The results of this study indicate there are approximately one hundred thousand abrasive blasters with personal exposures to silica dust environments up to sixty million manhours per year. The protection afforded these workmen is, on the average, marginal to poor. Equipment deficiencies and lack of maintenance are the rule rather chan the exception. The average sand blaster would appear to have an excellent chance of receiving above TLV quartz exposures and extreme noise exposures.

INTRODUCTION

The Boeing Aerospace Company Safety and Industrial Hygiene organization was awarded a contract, through the National Institute for Occupation Safety and Health (NIOSH), to determine the degree of respiratory protection currently afforded workers in industries which employ abrasive blasting techniques, and to make recommenqations, based on a statistically significant sampling of industry members, for upgrading that protection.

Current information was considered inadequate as to the degree of respiratory protection afforded workers in the various industries employing abrasive blasting techniques. Various heavy abrasive blasting using industries, such as monument making[1-3], foundries[4-6], and metal finishing[7], have been individually surveyed on a regional basis. However, no multi-industry study has as yet been made to define the hazards inherent in abrasive blasting per se or to determine the efficacy of the measures employed to control those hazards.

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1 Porter, H.G.: Survey of Cemetery Memorial Industry in Indiana. Amer. Ind. Hyg. Assoc. Quart. 10:68(Sep. 1949)

2 West Virginia State Health Department, Bureau of Industrial Hygiene: Industrial Hygiene Survey of the Granite and Marble Memorial Industry in West Virginia. 1940. Pneumoconiosis Absts. 11:408(1954).

3 Vee, H. T. and H. G. Bourne: Survey of Monument Indsutry in Ohio. Amer. Ind. Hyg. Assoc. J. 31:503(July 1970).

4 Schardt, R.: Airborne Oust in Foundries. Zentr. Abeitsmed.u. Arbeitschutz 12:157(July 1962).

5 Martin, M. and R. Paton: The Dosage of Quartz in Air Samples Taken in the Foundry. Fonderie 243:179(May 1966).

6 Ayer, H.E., et al: Size-Selective Gravimetric Sampling in Dusty Industries. Amer. Ind. Hyg. Assoc. J. 29:336(July 1968).

7 Kennedy, J.G.: Dust Control in Finishing Industry. Prod. Finishing(London)19:41 (Aug. 1966).

Abrasive blasing is the high velocity bombardment of a surface by an abrasive media propelled by hydraulic or pneumatic pressure or centrifugal force. The operation is normally divided into four processes: dry(pneumatic), wet (hydraulic), airless (centrifugal), and *vacuum* (a pneumatic blast nozzle surrounded by a vacuum cleaner brush arrangement for immediate dust removal).

The purposes of abrasive blasting are:

a. To clean a surface of undesirable rust, scale, paint, etc., in preparation for painting, anodizing, welding, or other processes requiring a clean substrate;

b. To deburr, remove tooling marks, or otherwise finish a crude product;

c. To change metallurgical properties or stress relieve a part by the peening action of multiple impactions;

d. To produce desirable matte or decorative finish; and

e. To provide actual cutting or inscribing of partially masked parts, such as tombstones.

The selection of the abrasive media best suited for a particular task is based upon a complicated number of interrelated economic, metallurgical, and practical engineering factors with, perhaps. less than adequate consideration to worker safety. Where the application does not allow the recovery of the media. the least expensive material readily available which will produce the desired surface is dietated. This is normally sand, the most hazardous mineral abrasive. Where recovery processes are possible, media fatigue life and balling properties also become important considerations. Subsequent operations to be performed on a part also influence media selection. As an eXdmple, an aluminum casting to be Illagnafluxed after cleaning could not be subjected to steel grit blasting.

The paramount hazard in abrasive blasting is from dust inhalation. All dusts are by no means equally toxic[8], nor are they equally respirable[9]. The dusts of major concern are those of aerodynamic size (less than 5 microns) that are pulmonary fibrosis producing (for example sand and granite), fabrile reaction producing (for example copper and zinc, the components of brass), or systemic poisons (for example lead or cadmium). Dusts of larger size which fail to feach the alveoli and nuisance and inert dusts, such as marble and alumina are of lesser concern.

The nature of the dust generated in any blasting process is the sunl of the fragmentation of the blasting media and the material dislodged from the surface blasted. Where a friable abrasive media, such as sand, cobs, or beads is used, or where a friable surface, such as a sand casting, a painted or scaly surface, or masonry is blasted. the dust generated is greatly increased. Where durable media, such as steel shot, is blasted at a relatively clean surface, such as cold rolled steel, the dust generation and resultant degree of hazard is nrinimized. Unfortunately, for economic and practical operational reasons, many processes require friable abrasives to produce the desired degree of cleanliness or surface finish. Also. sand castings are an absolute fact of life in foundry work, and there is little question but that the sand encrusted on a casting is fractured into respirable range particles during the abrasive blasting removal process.

8American National Standards Institute: Z88.2-l969, Practices for Respiratory Protection, New York(1969)

9Harris, R. l.: Dust Hazards Related to Health. Ind. Med. and Surg. 35:262 (Apr. 1966).

Respiratory protection can be provided by an adequate respirator. by keeping the dust out of the worker's breathing zone by adequate ventilation, or by a combination of both measures.

Adequate ventilation is also necessary to maintain visibility so that the operator can safely and efficiently perform his task.

After dust inhalation, the hazard *next* in order of severity in abrasive blasting is that of hearing damage. The noise levels generated during abrasive blasting are really quite high.

Other hazards associated with abrasive blasting are the mechanical hazards of media ricochet and the ever present dangers of one blaster inadvertently shooting another or of a jammed open hose. All of these problems were considered when evaluating protective clothing requirements.

For the convenience of the reader, the program will be described in several discreet sections. as follows:

1) Population selection and preliminary survey approach;
2) Preliminary Survey results;
3) Analytical procedure selection and testing;
4) Field Survey, divided into sUbheadings:
   a) Interview results;
   b) Respirable dust measurements;
   c) Noise level measurements.
   d) General observations, and
5) Summary, Conclusions, and Recommendations.

POPULATION SELECTION AND PRELIMINARY SURVEY APPROACH

The desirable sample population should represent as large a geographic. firm size, area population density. degree of local governmental safety inspection, and pertinent field of economic endeavor variation as practically possible. Ideally. all factors should also be in reasonable proportion to their national importance.

The services of Dun and Bradstreet were employed to obtain the list of contacted firms. The Dun's Market Identifiers (DMJ) service provided the pertinent data on all firms having a credit rating within the area and business line constraints established by Boeing. Dun &Bradstreet furnishes data which could not reasonably be obtained from such conventional sources as city or telephone directories and trade association lists. For survey purposes, some of the more important data furnished are:

Firm chief executive officer (for address purposes);
Mailing address;
Business address;
Number of employees (at plant and total);
Telephone number;
Various lines of business;
Sales volume; and
Net worth.

[10] Bureau of the Budget: Standard Metropolitan Statistical Areas: 1967, U.S. Government Printing Office, Washington D.C.(1967).

We elected to survey the abrasive blaster population in six target locations. The boundaries of the surveyed locations were selected to be the local Standard Metropolitan Statistical Area (SMSA). The SMSA is an Office of Management and Budget (OMS) defined[10] area which contains a county or group of contiguous counties which contain at least one city of 50,000 inhabitants or more, or "twin cities" with a combined population of at least 50,000. In addition to the county, or counties, containing such a city or cities, contiguous counties are included in an SMSA if, according to certain criteria, they are socially and economically integrated with the central city. The counties thus chosen may be in adjacent states. The largest city in the SMSA is considered the nucleus and usually determines the SMSA name. Figure depicts the largest SMSA selected. It can be seen that the area covered by an SMSA can be quite extensive. The Bureau of the Census recognized approximately 250 SMSA's in the 1970 census. Table I gives the SMSA's selected for this study and their proportion of the total national population (203,184,772).

[10]Bureau of the Budget: Standard Metropolitan Statistical Areas: 1967. U.S. Government Printing Office, Washington, D.C. (1967).

TABLE I

LOCATIONS SELECTED FOR SURVEY

SMSA Name	Number of Counties Included	Population (1970 Census)	% National Population
Houston (Tex)	5	1,985,031	0.98
Mobile (Ala)	2	376,690	.19
Philadelphia(Penn-NJ)	5 Penn 3 NJ	4,817,914	2.37
Portland (Me)		141,625	.07
Seattle(Wash)	2	1.421,869	.70
Wichita{Kan)	2	389,352	.19
Total		9,132,481	4.49

The total sample population is summarized by area in Table II.

TARLE II

TOTAL SAMPLE POPULATION BY GEOGRAPHIC AREA

SMSA	Number of Firms
Houston	789
Mobile	192
Philadelphia	1,882
Portland (Me.)	106
Seattle	740
Wichita	194

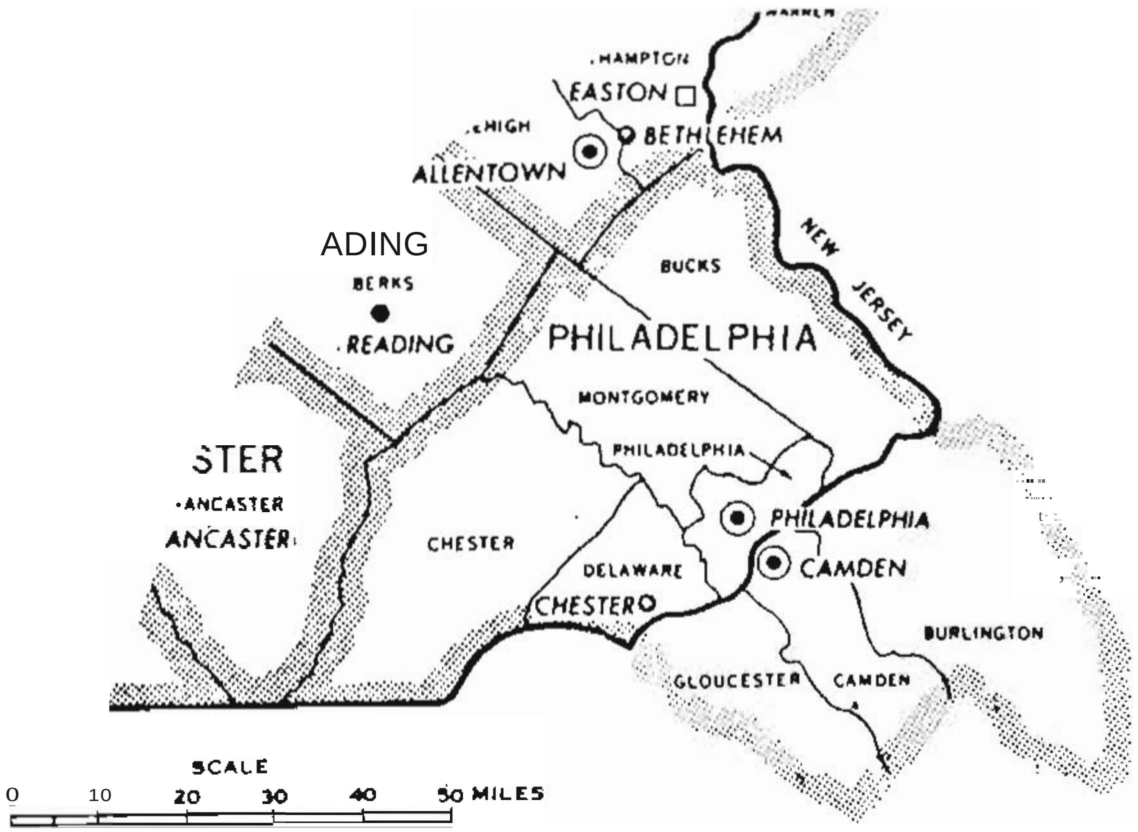

Figure 1. Philadelphia Standard Metropolitan Statistical Area

We elected to survey the abrasive blaster population in 33 Standard Industrial Classification (SIC) coded industries. SIC coding is an OMB devised 4-digit scheme to accurately describe every field of economic activity. The SIC defines[11] industries in accordance with the existing structure of the American economy. A coded industry is a grouping of establishments primarily engaged in the same or similar lines of economic activity. A particular firm may be classified by a prime and one or more subordinate SIC codes. Table III gives the industries selected for this study.

An attempt was made to contact all firms represented by each SIC in each selected SMSA. The OMI service proved useful in this attempt. The DMI data bank lists firms by prime SIC code and up to five subordinate SIC codes. Selection rules preclude a firm from being chosen more than once even if classified under several target SIC codes.

Table III gives the total number of firms in the nation listed by prime SIC in the OMI data bank as of September 1971. While the data bank numbers change daily, it is felt that the numbers given are reasonably close to those as of the August 1971 Boeing run. 88% of the DMI supplied firms were selected by prime SIC while 12% were selected by subordinate SIC. The numbers given in Table III under the heading

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11Bureau of the Budget: Standard Industrial Classification Manual, U.S. Government Printing Office, Washington, D.C. (1967).

"Total Contacted" are the refined numbers achieved after the addition by Boeing of 183 firms. primarily in the fields of monument engraving and commercial sandblasting, and the removal of several hundred spurious listings. Examples of spurious listings are: businesses having moved or ceased to exist (mailing returned by Postal Service); duplicate listings (more than one name for the same firm, confirmed by the same chief executive at the same location); and inappropriate listings (railroad freight offices, sales offices, etc.). In addition, about 25 listings were lost where large corporations, through their corporate headquarters, elected tc participate in one branch or plant only when several were in our original list.

It is interesting to note that the approximate 4% of the national total sample given in Table III agrees rather well with the 4 1/2% of national population given in Table I.

The firm selection was purposely skewed to give a large representation of shipyards. The population was weighted with shipyards in order to provide a control industry wherein the best possible respiratory protective equipment and angoing safety programs might be expected to be found. This skewing was done by selecting five of six SMSA's as seaports. No other purposeful skewing of the sample population was attempted, although 214 firms in Lumber and Wood Products classifications, which would not be expected to be heavy abrasive blast users, were added to provide an internal questionnaire response control. This group would serve to

TABLE III

STANDARD INDUSTRIAL CLASSIFICATIONS SURVEYED

S C CODE	Description	Contacted	% of Sm Business	Approx. Nat'l Total	% Nat'l Total Contacted
1621	Heavy Constr Nec	518	43.8	12,389	4.18
1721	Paintg Ppr Hang Deco	741	79.4	18,894	3.92
1741	Masonry, other StoWk	525	73.9	10,498	5.00
1743	Terazo T le Mrbl MOs	164	75.0	4,407	3.72
2431	Millwork	107	55.1	5,189	2.06
2432	Veneer, Plywood P ant	9	22.2	689	1.31
2499	Wood Product Nec	98	63.3	4,712	2.08
2911	Petroleum Refining	45	17.8	809	5.56
3272	Concrete Pdts Nec	144	47.2	4 058	3.55
3281	Cut Stone, Stone Pdts	121	-	1 188	10.19
3312	Blas Furnace, Stel MI	31	6 5	698	4.44
3316	Co Finshg Steel Shop	11	9 1	196	5.61
3321	Gray Iron Foundries	44	22.7	144	3.85
3322	Mallable Iron Fdrys	7	28.6	146	4.79
3323	Steel Foundries	22	22.7	387	5.68
3341	Sec Nnferrous Metals	20	40.0	424	4.72
3351	Copper Rolling, Drawg	6	16.7	224	2.68
3352	Alum Rolling, Drawing	19	26.3	386	4.92
3356	Rolling, Drawing Nec	20	45.0	295	6.78
3361	Aluminum Castings	43	53.5	,252	3.43
3362	Bras, Bron, Cop Castgs	34	29.4	820	4.15
3369	Nnferrous Castgs Nec	20	45.0	636	3.14
3391	Iron, Steel Forgings	38	21.1	620	6.13
3392	Nonferrous Forgings	1	-	52	1.92
3399	Prim Metal Inds Nec	38	44 7	1,033	3.68
3441	Fab Structural Stee	157	32 5	2,933	5.35
3446	Arch etal Work	151	62 3	1,986	7.60
71	Plating, Polishing	80	-	3,736	2.14
3731	Ship ldg, Repai ng	61	29 5	447	13.65
4	Railr ads, Line-Haul	17	5 9	649	2.62
7349	Msc Bldg. Services	166	37 4	3 506	4.74
7531	Top Body Repair Shop	376	83 5	1 242	3.34
7535	Pai t Shops	69	75 4	1 118	6.17
	TOTAL	903		96,763	

answer the question as to whether a larger or smaller response would be obtained from a segment of industry which would be able to answer "no" to the question of abrasive blasting usage and which would not be faced with the decision as to whether or not on-$ite tests would be permitted.

The codes selected provide a generous representation of small business. Approximately sixty percent of the firms contacted have fewer than ten employees at one location (the definition of a small business for the purpose of this study). The percentage small business data shown on Table III are valueless for SIC's 3281 and 3471 because of the abnormally high "not shown" inputs. The data for SIC 3392 has no statistical significance (a group of one).

For reader convenience and in order to provide more statistically significant population groupings, Table IV and subsequent tables will treat industries by major SIC groupings. This procedure combines all SIC's having identical first two digits. Such industries are considered related, and such groupings are accepted practice.[11] The small business figures for major SIC groupings 32 and 34 do not reflect SIC's 3281 and 3471 because of the previously mentioned high "not shown" inputs.

Questionnaire Design

A preliminary questionnaire was designed and submitted to *NIOSH* for review and approval. Labor Department concurrence was required and,because the survey falls within the scope of the Federal Reports Act, OMS approval was required.

TABLE IV

MAJOR SIC GROUPINGS SURVEYED

SIC	Description	Nat'l Tota	Population Contacted	% Nat'l Tota	Number Small Business	% Smal Business
6	Constr Contr Ex dg	12 389	518	4 8	227	43 8
7	Constr Trade Con	33 799	430	4 23	099	76 9
24	Lmbr Wd Ex Furn	10 590	214	2 02	123	57 5
29	Petro eum Ref ning	809	45	5 56	8	7 8
32	Stone, Gls, Concr Pdts	5 246	265	5 04	68	47 2
33	Primary Meta s Indus	8 3 3	354	4 26	110	3
34	Fab Mt Pdts Ex Mach	8 655	388	4 49	45	47
37	Transportat on Equ p	447	61	13 65	18	29 5
40	Ra road Transportn	649	17	2 62		5 9
73	Business Serv	3,506	166	4 74		37 4
75	Rep Serv Garage	2 360	445	3 60		82 2

The questionnaire asked:

a. Company product or service line;

b. Does company employ abrasive blasting;

c. Type of abrasive blasting process employed;

d. Approximate number of abrasive blasting locations;

e. Area blasting is performed in (room, cabinet, outdoors, etc.);

f. Estimated number of employees engaged in abrasive blasting;

g. Estimated total number of manhours of actual abrasive blasting performed per month;

h. Type(s) of abrasive used;

i. Type of surface(s) blasted;

j. Type and description of respiratory protective equipment supplied; and

k. Willingness of company to participate in subsequent on-site survey and measurement phase of program.

Nowhere on the form was there a place for the company name. Each form was identified by a code number known only to Boeing and the recipient. Each form bore the statement:

> "All replies will be handled in strict confidence and in such a fashion that neither the Department of Health, Education, and Welfare, nor any other federal, state, or 10ca1 governmental agency will be able to identify any specific respondent company."

The form was printed, faced, on a single folded 10 1/2" x 16" sheet. By printing in this manner the firm identification code number (known 0111y to Boeing and the contacted firm) need by stamped only once. An examp e of the questionnaire is given in Figure 2.

PRELIMINARY QUESTIONNAIRE

ABRASIVE BLASTER RESPIRATORY PROTECTION SURVEY

IDENT. NUMBER

OMB Number 68-571039
Approval Expires 6-30-72

INTRODUCTION

This survey is being conducted under contract to the National Institute for Occupational SaFety and Heal th of the Department of Heal th, Educotion, and WeIfare.

The purpose of this nationwide survey is to appraise the Department of Health, Educotion and WeIfare of the degree of respirotary protection currently afforded workmen performin9 obrasive blasting tasks.

All replies will be handled in strict confidence ond in such a fashion that neither the Deportment of Heal th, Education, and Welfare, nor any other federal, state, or local gavernmental agency will be able to identify any specific respondent compony.

NsTRUCTtONS

All respondents are requested to fill aut Questicns 1 and 2.

Should your repiy to Question 2 be "Yes", piease fill out the attached forms as completely as possible and return in the enclosed envelope. This will aid in determining which respondents will be selected for subsequent field surveys and in determining what sped0l equipment will be required to be supplied (at no expense to the respondent) for those surveys. Complete data will also minimize the time requirements for actual on-site surveys and measurements.

Should your reply to Question 2 be "No" you need proceed no further. Please return fjlled out portion in enclosed envelope.

Should your reply to Question 2 be "Yes", please fill in all questions even if your reply to Question 13 is "No". The data on overall respirator usage will be of great value in establishlng a representative respirator population to be sampled in the on-site survey.

The respiro.tor sketches given in Page 4 are to be used only as a guide to Identification. Please supply actual Type/Manufacturer/Model Number where available.

Question 14 may be completed on a separate sheet of plain paper if the respondent so desires.

mpany product or service line

2. Does your company emp[redacted]oy abraSive blastin9? Yes /_7 No 17

Figure 2

(1)

3. Type of abrasive blasting process employed.

4. Approximate number of obrasi ve blosting locations.

6. Estimated number af employees engaged in abrasive blasting.

7. Estimated total number of manhours of actual abrasive blasting performed per month.

8. Type($) of abras ive used.

9. Type of surface(s) blasted.

. Type of respi rator(s) use d . (Use additional sheets iF required.)

Page 4 Type	Description	Manufacturer	Mode I 1/	Number Used

II. Method of supplyi ng ai r to respi rotor.

a Supplied air not used

b. Bottled air

c. Compressor (gi ve de tai ls if possible)

d. Other (give details)

12 Is tra protective equipment ovailable for the use of visiting personnel during monitoring o rations?

a. Yes	
b. Number of sets	
c. • No	

13. Will your company parti ci pate in the on-site survey and measurement phase of this program?

Yes No

14. Person to be contacted for survey.

a. Nome

b. Address

c. Telephone

d Title

RESPIRATOR TYPE IDENTIFICATION CHART

Personal contact was made with the major Chamber of Commerce within each target area to be surveyed prior to questionnaire mailing. The Chamber representatives were thoroughly briefed on the program and were given copies of the questionnaire and cover letter. In every case an excellent relationship and promises of full cooperation were obtained. In essence, Boeing used the offices of the local Chambers of Commerce to:

1) establish the validity of their credentials for making the survey;
2) contact local trade associations; and
3) generally publicize the survey prior to mailing ofthe questionnaire in order to assure the largest possible response.

The Chamber of Commerce contacts in the target areas were alerted three weeks prior to the first mailing. At that time they were asked for assistance and suggestions in publicizing the program so as to assure maximum questionnaire response. The Chambers proved most helpful_

A saturation news release campaign was conducted in each area the week prior to questionnaire mailing. Approximately 155 publications were supplied with copy. An effort was made to penetrate the neighborhood and small community weeklies as well as the large metropolitan dailies. Local Chamber of Commerce pUblications, journals of commerce. trade publications, etc., were also employed.

The OMI data cards were not individua11y inspeeted prjor to commitment to typing of cover letters. This resulted in a number of spurious mailings (described above). It was felt that any expense in spurious mailing would

Tab le V gives the questionnaire response by number of mai 1ings. [t can be seen from these data that as the population was refined, the response percentage improved dramatically. The process of refineme t is also vindicat d as evide c d by the increa ing perce age o respo e ts doing abrasive llasti m.

Table VI gives the ques fonnaire res a se SMSA. One obvio is con- elusion that can oe drawn from th ata is tha le per nt 9e of response goes up in proportion to the local amiliarity with the Boeing name. Boeing is the largest single ell')l1oyer in the Seattle SMSA and was the largest employer in Wichita. Boeing employment in Philadelphia and Houston is insignificant and is nil i :lobile and Portland. Another conclusion that can be drawn from these data is that a great many actual manhours are devoted to abrasive blasting. The numbers indicate the potential for a significan per o ne exposure hazard. u us ton was the orily SMSA in which the blasting responde s showed a significant deviation in willingness a par ici ate in e o -site survey portion of the program.

Table VII gives the total questionnaire res o15 by major SIC group. It is interesting to note the well above average response n le umber and Wood Products classification.

TABLE V

RESPONSE TO QUESTIONNAIRE BY NUMBER OF MAILINGS

	Population	Returns	% Returns
First Mailing	3903		
Total		744	19.0
Blasting		101	2.5
No Blasting		643	16.4
Second Mailing	400		
Total		118	29.5
Blasting		47	11.7
No Blasting		71	17.7
Third Mailing	83		
Total		41	49.3
Blasting		24	28.9
No Blasting		17	20.4
Overall	3903		
Total		903	23.1
Blasting		172	4.4
No Blasting		731	18.7

be more than offset by minimizing the collating error which could result if large numbers of cards were removed (the DMI cards and the questionnaire were serially numbered). The collating and envelope stuffing was subcontracted to United Cerebral Palsy of King County. As no identification othpr than serial number appears on a questionnaire, a collating error could prove disastrous when interpreting questionnaire returns. After mailing, these spurious cards were removed from the file. In the few instances where returns were received from these addressees, the returns were also discarded. In addition to the code numbered questionnaire, the mailing included the Boeing cover letter which explained the project and referred to a specific local Chamber of Commerce contact, a labor Department provided pamphlet ("A Handy Reference Guide-The Wi1liams-Steiger Occupational Safety and Health Act of 1970"). and a business reply envelope. The cover letter assured the recipient that no governmental agency, federal, state, or local, would be informed of the name of any participating firm.

A refined population mailing technique was employed. The mechanics of this technique and the response obtained will be described in the preliminary survey results to follow.

PRELIMINARY SURVEY RESULTS

A refined population mailing technique was used. The initial mailing covered all 3903 selected SIC coded firms in the six SMSA's. The results of the first mailing indicated that some eleven of the selected SIC codes do no appreciable abrasive blasting. Included in these eleven were the three internal response controls comprising major SIC group 24, Lumber and Wood Products Except Furniture. This group was not expected to do abrasive blasting when the experiment was designed, and would have proved worthless as a control had they reported significant blasting.

Twelve of the selected SIC codes were deemed to have enough abrasive blasting users to warrant having all non-respondents contacted during the second mailing. Five other SIC codes were contacted on that mailing only where they were shown to employ more than 50 persons at a single location. First mailing returns for these codes indicated that only the larger members did abrasive blasing. *The* remaining sixteen codes were not contacted in the second mailing. A total of 400 firms were contacted during the second mailing.

Eighty-three large members of obviously abrasive blasting using classifications which had not yet responded were contacted during the third and final mailing. A cutoff date for all responses to be tabulated was set at 40 days from the date of the third mailing.

TABLE V

RESPONSE T   EST ONNA RE BY STANDARD METROPOL TAN STATISTICAL

SMSA	T t Popu at	Number Responding	Responding	u ber ing Blast ng	Number Willing to Participate in On Site Tests	% Blas Willi t articipants	Blasting Manhours/Month Represented by Willing Participants
Houston	789	49	18.8	37			6,623
Mobi	92	44	22.9	4	o		11 280
Philadelphia	882	3 5	16.2	49			
Portland(Me)	06	24	22	7			o00
	740	15	42	46			
Wi	94	66	34 o	19			2 300
	3 903	903	23	172			2o

Table VIII gives the first mailing response by major SIC grouping. The percentage representation of small business (defined for the purpose of this study as firms with fewer than ten employees at a single location) is also given. This data reinforces the observations previously made about the response obtained from the control Lumber and Wood Products classifications. These classifications were not contacted during the second or third mailings. SIC's 3281 and 3471 were omitted for the purpose of this compilation because of the abnormally high percentages of "not shown" inputs in the firm size data. These two SIC's are important abrasive blasting industries. However, the purpose of the Table VIII compilation is to provide data on the relationships of industrial activity, firm size, and questionnaire response. If firm size is not known for a significant fraction of a population group, that fraction must therefore be excluded from the analysis. The Table VIII data is plotted on Figure 3. Even a cursory examination of this Figure substantiates the previously drawn conclusion that segments of industry heavily weighted with small business provide poorer questionnaire response than do larger firms. The relationship is really quite striking. Of even more interest is the extreme departure from the curve of the data point for major SIC grouping 24. This is the Lumber and Wood products control. The three SIC's comprising this major SIC group provided a response percentage very nearly twice what would be predicted from their proportion of small business based upon the results of every other single major SIC grouping. This would certainly seem to strengthen the suspicion that firms that have no fear of having to make an on-site inspection decision are more incl,ned to answer the questionnaire.

Table IX gives the first mailing questionnaire response by number of employees at the location. From these data it can be seen that there is a slight but significant tendency for a poorer response from smaller firms. There is also far less chance that a smaller firm will be engaged in abrasive blasting.

Table X gives the total questionnaire response by number of employees at the location. The most interesting fact to be obtained from the data on this table is that there is no significant difference in the willingness of firms doing abrasive blasting to participate in the on-site measurement phase of the program based on size of firm.

Table XI provides a listing of the reported blasting areas. These data are based on total number of blasting locations reported rather than total amount of blasting. The interesting point is the high proportion of work reported in unconfined areas (outdoors and general work area). Most of the respondents marking "other" on the questionnaire subsequently described the area as a tank or other enclosed space with the worker on the inside. This data indicates that in a large proportion of blasting operations the atmosphere that nearby non-blasting workers are breathing should be a matter for investigation.

TABLE V

RESPONSE TO QUESTIONNAIRE BY MAJOR SIC GROUP

SIC	Description	Total Population	Number Responding	% Responding	No. Doing Blasting	% of Respondents Doing Blasting	Willing On-Site Participants
16	Constr Contr Ex Bldg	5 8	22			9 0	6
17	Constr Sp Trade Con	430				11 0	8
24	Lmbr Wd Pdts Ex Furn	2 4		39 6	0	0	0
29	Petro eum Ref ning	45	2			38 o	4
32	Stone Gls Concr	354	23			39 8	36
34	Fab Mtl Pdts Ex	388	05			37 2	27
37	Transportation Equ p		28		2	42 9	1
	Ra road Transportn					22 2	
	sc Business Serv				0	0	0
	Auto Rep Garage					4.7	

72

TABLE VIII

FIRST MAILING RESPONSE BY MAJOR STANDARD INDUSTRIAL CLASSIFICATION

SIC	Description	Nat'l Total	Population Contacted	% Nat'l Total	No. Small Business	% Small Business	1st Mailing Response	% Response First Mailing
16	Constr Contr Ex Bldg.	12389	518	4.18	227	43.8	118	22.7
17	Constr Sol Trade Con	33799	1430	4.23	1099	76.9	209	14.6
24	Lmbr Wd Pdts Ex Furn	10590	214	2.02	123	57.5	85	39.6
29	Petroleum Refining	809	45	5.56	8	17.8	13	28.8
32	Stone, Gls, Caner Pdts	4058	144	3.55	68	47.2	30	20.8
33	Primary Metals Indus	8313	354	4.26	110	31.1	84	23.7
34	Fab Mtl Pdts Ex Mach	4919	308	6.26	145	47.1	62	20.1
37	Transportation Equip	447	61	13.65	18	29.5	10	16.4
40	Railroad Transrortn	649	17	2.62	1	5.9	8	47.1
73	Misc Business Serv	3506	166	4.74	62	37.4	39	23.5
75	Auto Rep, Serv, Garage	12360	445	3.60	366	82.2	54	12.1

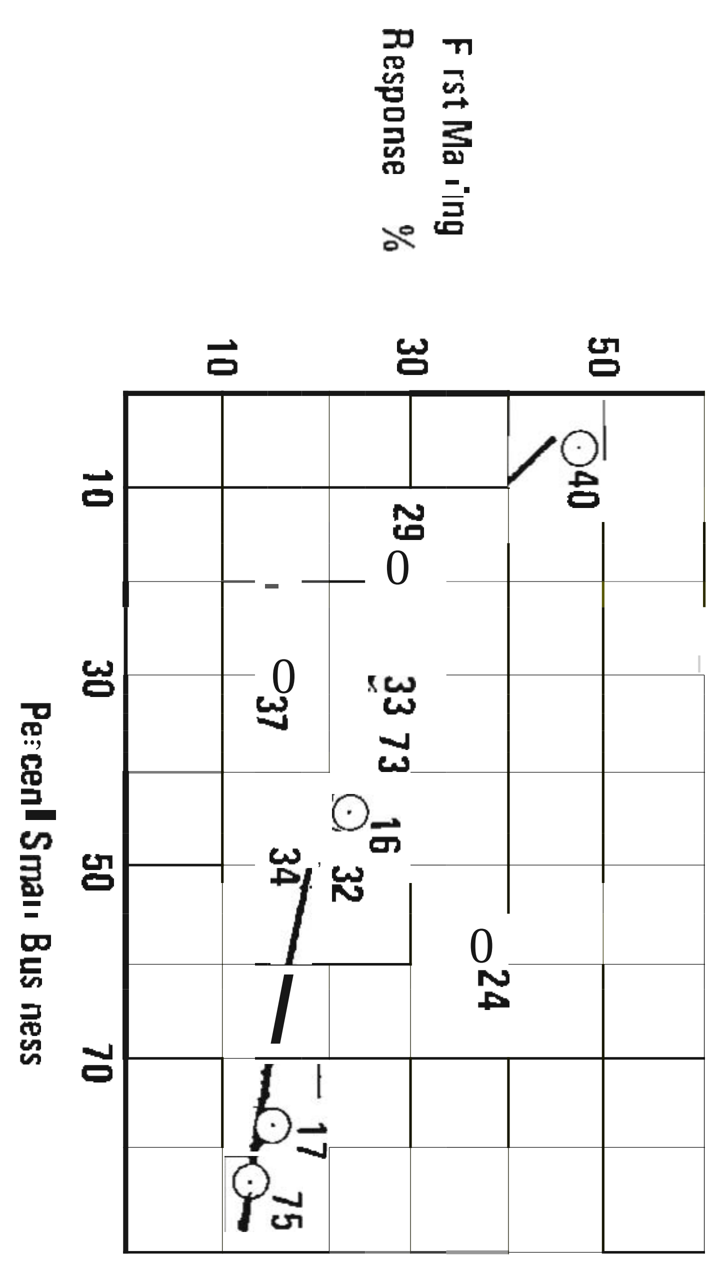

Figure 3 Relationship of First Mailing Response to Firm Size

Table XII relates major SIC grouping to reported blasting area based upon actual number of blasting hours reported. Where a res ond n epor ed more than on yp of blasting a did not assi n specific hours ach, the apportioned th 11 data shif work pr vi u 1 give in T T 1 more towards the intrinsically re aza d us u con in areas. T T XII data also dra tic ly points p h ery high ex os ve per individual blaster. Major SIC grouping 75 was excluded from this listing as the total of 16 reported manhours of blasting per month (equall'y divided between outdoors and genera) work area) is of little statistical significance.

Table XIII describes *the* blasting processes reported in the returned questionnaires. The majority of the blasting reported i the ha d-held hose dry blast process. This is h n s h zardous uf e cesses listed. The o ly other process reported in a ig ifi ant n er of cases is the centrifual or "airless" process. This is normally an automatic process conducted within an enclosure and is generally sidered to be on- azardous. This no - °lar us cl ssifi ion is based upon the presumptio tlat last enclosureoes not leak. This presumption remaine to be teste , and was ested , rir e on-site survey portion of the program. Workers generally do not wear respirators when operating airless blast i 11 Ions.

Tables XIV and XV describe respectively the abrasives used and surfaces blasted. The tables will be discussed together as the dust generated (and resultant hazard) in any blasting process is the sum of the fragmentation of the blasting media and the material dislodged from the surface blasted. Where a friable abrasive media such as sand. cobs. or beads is used. or where a friable surface such as a sand casting, a painted or scaly surface, or masonry is blasted, the dust generated is greatly increased. Where durable media such as steel shot is blasted at a relatively clean surface such as cold rolled steel, the dust generation and resultant degree of hazard is minimized. Unfortunately, for economic and practical operational reasons, many processes require friable abrasives to produce the desired degree of cleanliness or surface finish. Also. sand castings are an absolute fact of life in foundry work, and there is little question but that the sand encrusted on a casting is fractured into respirable range particles during the abrasive blasting removal process. One of the objectives of the on-site measurements was to determine the amount of such silica dust that is generated when sand is not the abrasive used to clean a sand casting. An analysis of the data on these two tables indicates that the colloquial term "sandblasting" is perhaps more nearly descriptive of the process than the accepted term "abrasive blasting." While silica sand is indeed the most hazardous mineral abrasive commonly used, it is also by far the most commonly used abrasive.

Table XVI expands on the "sandblasting" theme by describing the reported use of sand and the blasting of sand castings by industry. The percentage of sand use described here is quite striking. The one low reporting major SIC probably represents the general elimination of sand as a blasting media in the monument making industry (SIC 3281) as previously reported by Vee and Bourne[3]. However, this good news is somewhat offset by the fact that Vermant granite, the universal tomestone standard, is about one-third free silica.

Table XVII gives a breakdown of the respirator types reported by various major SIC groups. The type categories given correspond to the categories given on the Preliminary Questiannaire. The numbers given under each type are the number of establishments reporting the use of that type rather than an actual number of respirators used. The replies were too incomplete to make a meaningful listing of actual numbers or brands of respirators used. This data was obtained during the on-site phase.

This incompleteness is, in itself, quite informative. If it can be assumed that the replies were prepared by the person in the firm who is responsible for personnel safety, and the replies tend to confirm this, then the supposition can be made that that person may *not*, in many cases, be too aware of the protective equipment that is in use. This supposition finds some support when the returned questionnaires are carefully analyzed. One of the drawings on Page 4 of the questionnaire is an

actual sketch of a particular model of a particular brand of respirator. The replies indicate this same respirator model number to be classed in approximately equal numbers under two respirator types. The sketches are in no way similar, which would lead one to assume that the respondents did not know what the respirator looked like.

Other interesting points are the number of firms using nuisance respirators or no respirators at all while doing dry blasting. Several firms doing outdoor sandblasting and doing outdoor abrasive blasting on stone actually report that they use no respiratory protection.

The general impression one gets from reading the returned questionnaires is that many of the respondents are a good deal more informed on and interested in abrasive blasting than on respirators and respiratory protection.

A review of the returned questionnaires shows a surprising number of man-hours devoted to abrasive blasting. The returns indicate over 72,000 manhours per month are performed by 1018 workmen in 160 reporting establishments. A few additional firms reported their manpower expenditures to be too variable to be calculable. The number of blasters employed by a single firm varied from one to 120.

While 123 firms reporting 51, 120 manhours per month of blasting indicated a willingness to participate in the on-site survey, some 49 firms reporting 19,646 manhours per month declined to participate. Thus, 71.6% of the reporting blasting firms are willing to particpate and the willing participants represent 72.2% of the actual blasting reported.

If the population is assumed valid, and if the reported figures accurately represent the monthly averages for the entire year (quite a bit of abrasive blasting is seasonal or sporadic in nature), one can take a 23% return on a 4% national total sample and arrive at the really astounding values of one hundred thousand workmen performing ninety million hours per year of abrasive blasting with up to sixty million of those hours be;n9 ina si1;ca dust environment. These figures represent an astonishingly large occupational exposure to a potentially hazardous environment.

TABLE IX

FIRST LING RESPONSE TO QUESTIONNAIRE BY NUMBER OF EMPLOYEES PRESENT

Employee Number Range	Total Population	Number Responding	Percent Responding	Number Doing Blasting	Percent of Respondents Doing Blasting
0-9		373	6 6	6	4.2
0-19	525		8.	0	0.3
20-49		98	23 5		2
50-99				0	21 7
00-499			25.	4	29 1
500-999	26	9	34.6	2	22 2
000+		8	25.8	6	75 0
Unknown	28	65	23	32	49 2

TABLE X
TOTAL RESPONSE TO QUESTIONNAIRE BY NUMBER OF EMPLOYEES PRESENT

Employee Number Range	Total Population	Number Responding	Percent Responding	Number Doing Blasting	Percent of Respondents Doing Blasting	Number of Willing On-Site Participants	Percent of Willing On-Site Participants
0-9	2246	405	18.0	20	4.9	14	70
10-19	525	113	21.5	16	14.1	11	69
20-49	416	126	30.2	23	18.2	13	57
50-99	192	53	27.6	15	28.3	12	80
100-499	186	64	34.4	22	34.3	16	73
500-999	26	12	46.1	4	33.3	2	50
1000+	31	19	61.2	13	68.4	10	77
Unknown	281	111	39.5	59	53.1	45	76

TABLE XI

QUESTIONNAIRE RESULTS BY BLASTING AREA

Blasting Area	Number Reported	% of Total
Outdoors	92	35 5
Special Room	59	22 7
Cabinet	55	22 2
General Work Area	3[illegible]	2 7
Other	20	7 7
Total	259	

TABLE XII

BLASTING AREA AND HOURS REPORTED BY MAJOR SIC GROUP

SIC	Description	Reported Blasting Manhours Per Month and Percentage of Total										Total Manhours Reported		Average Individual Hours of Blasting Per Month
		Outdoors		Special Room		General Work Area		Cabinet		Other				
16	Constr Contr Ex Bldg	5449	34.9%	4666	29.9%	4666	29.9%			850	5.4%	15,631	86	182
17	Constr Spl Trade Con	9382	50.6			3317	17.9			5832	31.5	18,531	301	62
29	Petroleum Refining	1208	34.8	688	19.8	372	10.9	798	23.0%	400	11.5	3,466	95	36
32	Stone, Gls Conc' Pdts	350	18.3	1320	69.0	70	3.7	164	8.6	10	.5	1,914	38	50
33	Primary Metals Indu,	1144	9.4	4601	37.7	1053	8.6	4376	35.9	1015	8.3	12,189	172	71
34	Fab Mtl Pdts Ex Mach	4123	39.0	1856	17.6	1631	15.4	2790	26.4	166	1.6	1 ,566	191	55
37	Transportation Equip	3221	38.7	2186	26.3	327	3.9	1m	21.3	810	9.7	, 17	111	75
40	Railroad Transportn	666	47.8	666	47.8			60	4.3			1.392	17	82
	TOTAL	25,543	35.5	15,983	22.2	11,436	15.9	9961	13.8	9083	12.6	72,006	1011	71

TABLE XIV

QUESTIONNAIRE RESULTS BY ABRASIVE USED

Abrasive	Number Reported	% of Total
Sand	115	44.7
Steel Shot	43	16.7
Steel Grit	25	9.7
Alumina	24	9.3
Flint/Garnet	18	7.0
Glass Beads	12	4.6
Carbides	9	3.5
Slag	8	3.1
Organics (Cobs, Pecan Shells, etc.)	3	1.1
Total	257	

TABLE XV

QUESTIONNAIRE RESULTS BY SURFACE BLASTED

Surface	Number Reported	% of Total
Iron/Steel	111	44.9
Masonry (brick/stone/concrete/etc.)	46	18.6
Sand Castings	27	10.9
Metal (not specified or NEC)	23	9.3
Aluminum	14	5.6
Copper/Brass	12	4.8
Wood	9	3.6
Glass	4	1.6
Plastic		0.4
Total	247	

TABLE XVI

SAND EXPOSURE BY MAJOR SIC GROUP

SIC	Description	Iota 1 Blasting Firms in SIC	Total Firms Reporting Use of Sand Abrasive	Percentage Using Sand Abrasive	Total Firms Blasting Sand Castings Without Sand Abrasive	Total Firms Reporting Use of Sand Abrasive or Blasting Sand Castings	Percentage Sand Dust Exposure Possible
16	Constr Contr Ex Bldg	11	11	100		11	100
17	Constr Sp1 Trade Con	26	26	100		26	100
29	Petroleum Refining	8	7	88		7	88
32	Stone, GIs, Caner Pdts	22	8	36		8	36
33	Primary Metals Indus	49	24	49	7	31	63
34	Fab Mt1 Pdts Ex Mach	39	27	69		27	69
37	Transportation Equip	12	7	58		7	58
40	Railroad Transportn	2	2	100		2	100
	TOTAL	169	112	66	7	119	70

ANALYTICAL PROCEDURE SELECTION AND TESTING

Sound levels during blasting were measured by use of a system which employed a General Radio 1565A or B sound level meter coupled to a match box, from which four fifty-foot impedence matched cables led to four Sony ECM-16 midgit microphones. A General Radio l562A, modified to accept the microphones, was used for daily calibration. The system is shown in Figure 4. The midget microphones performed admirably, even when peppered with ricochet. We attempted to use a loose Saran-Wrap wind screen but found it unnecessary_ Figure 5 gives a typical calibration curve for two of the microphones, one of which had been abused by a good deal of ricochet. It can be seen that the performance of each microphone is well within experimental expectations. The test set-up performed faultlessly throughout the entire test period providing invaluable inside and outside the helmet sound level comparisons. Octave band analyses were performed from time to time to discern any helmet frequency shift, but the majority Of measurements were straight dBA scale.

Several instruments and combinations of instruments were used to provide a measure of respirable dust.

We procured a Thermo-Systems(T-S) piezoelectric-electrostatic mass monitor. The instrument we have is not the manufacturer's stock model.[12]

[12] Olin, J. G., et a1: Piezoelectric-Electrostatic Aerosol Mass Concentration Monitor. Amer. Ind. Hyg. Assoc. J. 32:209(April 1971).

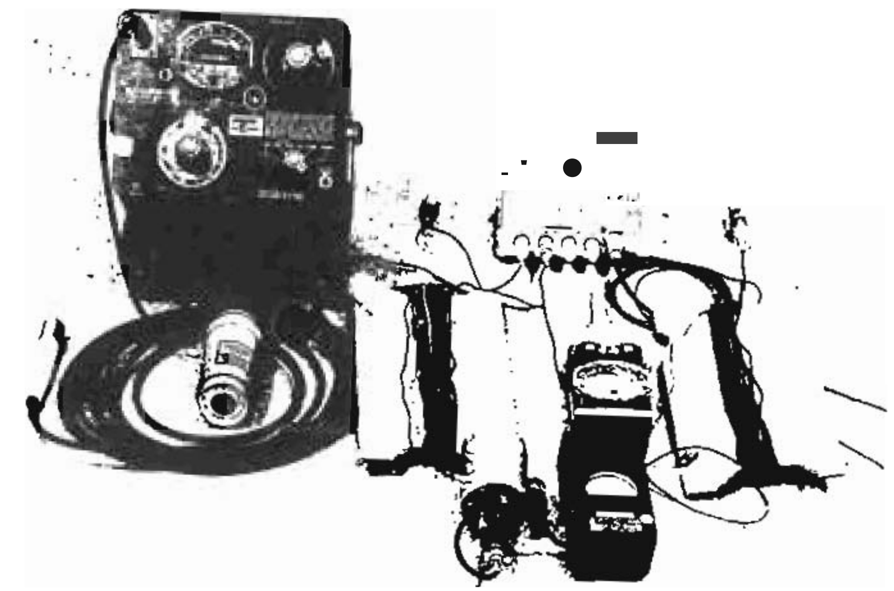

Figure 4 - Noise Monitoring Circuit

SONY MICROPHONE RESPONSE CURVE
MODEL ECM-6
GENERAL RADIO. TYPE 1562-A SOUND LEVEL CALIBRATOR

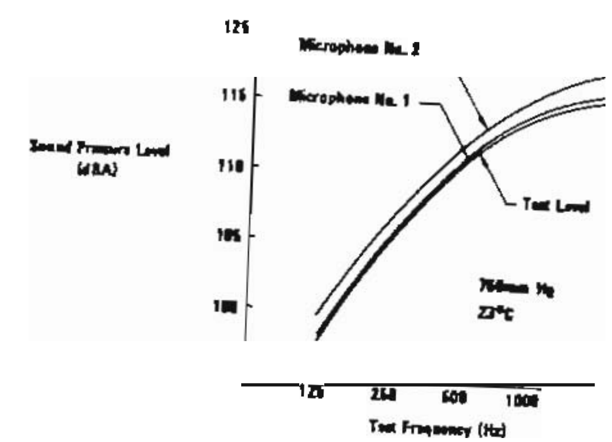

Figure 5 - Sony Microphone Response Curve

which is essentially a laboratory instrument. We ordered ours modified so that it would be useful for field operational conditions. These modifications included: (1) placing the sampling head in a dust-tight case which can be operated remotely from the measuring device, (2) raising the precipitator voltage to improve collection efficiency, and (3) raising the instrument flow-rate to a useful value so that a 10-mm cyclone can be employed. In addition, we found it necessary, in the course of our laboratory and in-shop evaluation of the instrument, to make several circuit modifications in order to provide needed RFI suppression. As delivered, the instrument could not be operated within over one hundred feet of an electric drill, let alone an electrically operated solenoid valve. We employed the instrument in connection with a three-way solenoid valve sampling scheme. Elimination or suppression of electro-magnetic interference was therefore mandatory if the instrument was to be used for field respirable mass monitoring.

The instrument and solenoid combination were made workable by:

a. Tying the counter-oscillator interconnect cable shield to signal ground;
b. Installing 0.01μ f capacitors across power lines in the counter;
c. Installing a shielded cable in the oscillator signal output;
d. Separate routing of power line and signal cable in the oscillator housing to reduce coupling interference; and
e. Installing back-to-back zeners and a .003μ f capacitor across the solenoid power line.

The Thermo-Systems instrument is, without doubt, a laboratory instrument modified for field use. It is portable much the same as a steamer trunk is portable. The operator's only need is for enough porters! Figures 6 and 7 show the instrument. The smaller of the suitcases must be affixed to or near the working blaster. This unit contains the precipitator. The read-out, non dust proofed equipment, can be up to 150 feet away. The instrument exhibits extreme sensitivity, with suitable readings obtained within 30 seconds or less -- after a 30 minute warm up period.

A simple elutriation column was constructed so that some sort of calibration could be performed on a number of dusts against microgravimetric procedures. This is, admittedly, rather like measuring a fly speck with a yard stick. The T-S instrument's reported range (1-10,000 γ/m^3) means that the actual amount of dust collected and measured during an approximate three-minute sampling of a 10 γ/m^3 dust level is of the order of 50 ng. What we did was to continuously sample from the elutriation column on a gravimetric basis for a number of hours until one cubic meter had been sampled. We simultaneously but intermittently sampled with the T-S mass monitor. Both samplings were performed at the same point in the column at a flow stuiable for use of a 10-mm cyclone. Averaging the T-S values over the period of the continuous

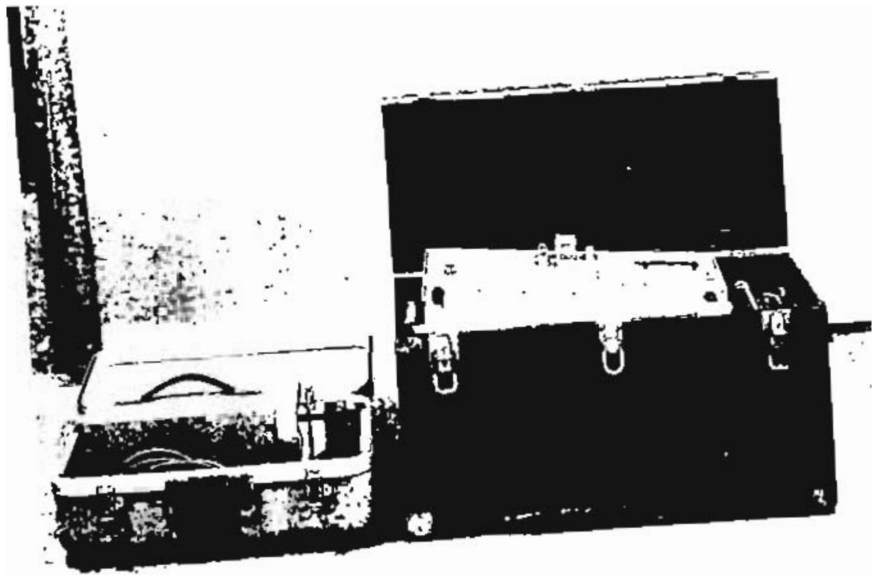

Figure 6 - Thermal Systems Mass Monitor

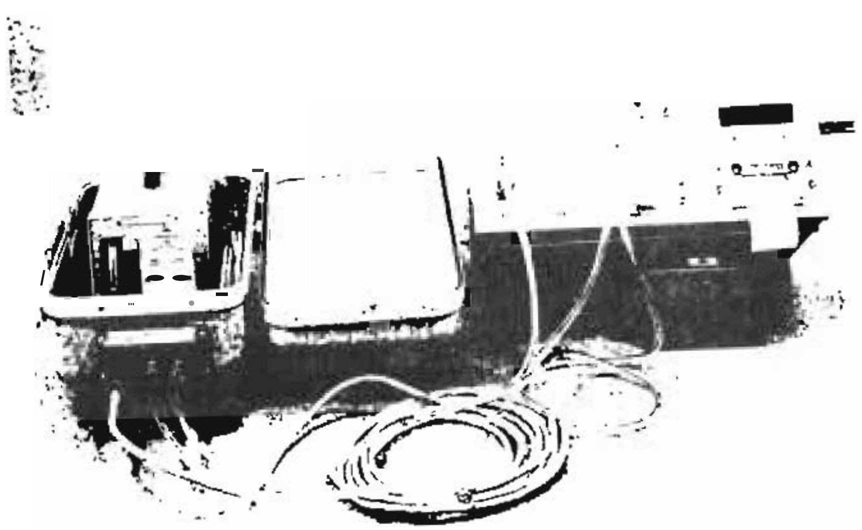

Figure 7 - Thermal Systems Mass Monitor Set-Up

sampling we achieved reasonable agreement. The fine dusts employed were tantalum powder (ρ 16.6), molybdenum powder (ρ 10.2), molybdenum disulfide (ρ 4.8), and silica (ρ 2.6). The instrument operated reasonably and showed no sign of precipilator arcing.

We also employed the GCA 101 and 201 beta absorption mass monitors (Figure 8). These instruments were the "work horses" of our analytical procedure. The 101 is a beta-absorption impactor device[13] which has an effective cut-off for spherical particles of unit density in the order of 0.3 micron. We did not feel this would hurt our program greatly, as most of our particles are of considerably higher density. The instrument was programmed to run for an 8-minute cycle. thus giving us the best possible sensitivity consistent with the work pattern of *an* average abrasive blaster. This instrument was normally used, always with a 10-mm nylon cyclone, to provide inside the mask readings where a mask or helmet was worn and breathing zone measurements where no respiratory protection was provided.

The GCA 201 is a beta-absorption filtration device with no practical lower particle size cut off limit. It has about 1/60 the sensitivity of the 101, and we used it to measure outside the mask or very dusty env;ron-ments. It is also programmed to run for an 8-minute cycle.

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[13]Lilienfeld, Pedro: Beta-Absorption-Impactor Aersol Mass Monitor. Amer. Ind. Hyg. Assoc. J. 31: 722 (Nov. 1970).

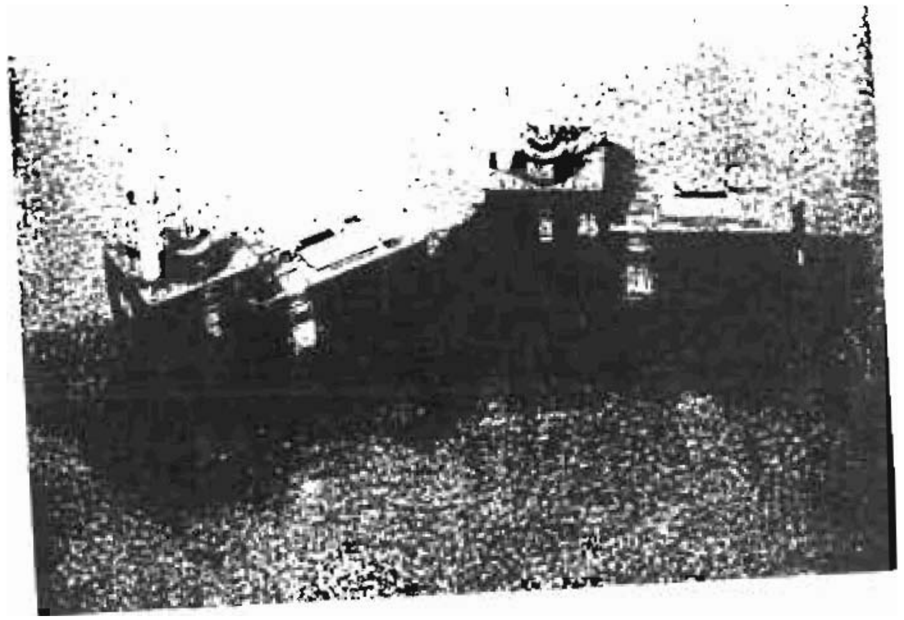

Figure 8 - GCA Mass Monitors

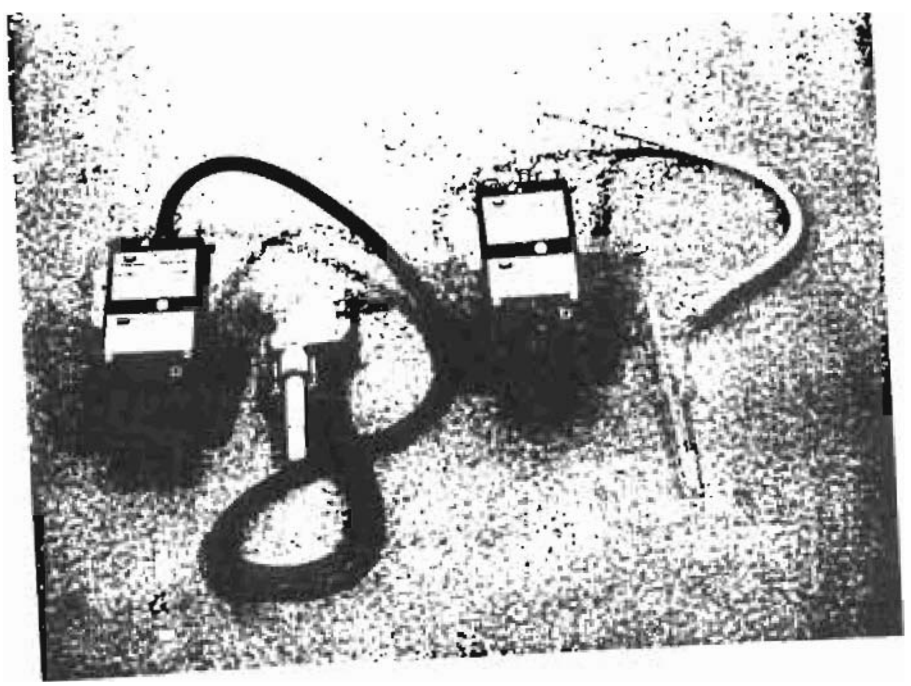

Figure 9 - Unico Mass Monitors

While the GCA instruments are sold as intrinsically safe for use in coal mines, we have not found them intrinsically designed to reliably function in severely dusty environments, such as blast rooms. We would expect coal mines to have similar dust problems. We were forced to replace the pump unit once on the 201 when a heavy dust loading made the compensating flow bypass open to the point where blasting grit fouled the pump. We experienced failures where grit lodged itself in switch housings. In one instance a battery was shorted by grit entering a charging receptacle.

We field tested the GCA units against the T-S unit and against chemical analyses of collected samples and were satisfied with the results.

We used the Bendix UNIeO Micronair Type 3900-10 sampling pump equipped with a 3900-906 cassette/capsule assembly modified to accept a Millipore filter and using a 10-mm nylon cyclone. With this set up (Figure 9) we were able to collect samples for subsequent emission spectrographic analysis, microchemical analysis, x-ray diffraction analysis, electron micophotography. and for oil mists in supplied air. Calcium, copper, chromium, manganese, magnesium. lead and zinc were determined by standard micro atomic absorption techniques to + 0.1 ppm. High silica samples were similarly analyzed where free quartz wasn't needed.

Regular silica (total)[14] and aluminum and iron[15] were performed colorimetrically to + 0.01 ppm. Where free quartz was desired a large grab

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[14] ASTM 0859
[15] ASTM 0857

sample, a sample of the grit, or a sample from outside the respirator was used and tested by the methods of Talvitie[16-18] and Edwards[19]. In the case where a quartz value was determined for the outside the respirator atmosphere the same proportion of quartz in total silica was assumed for the inside the respirator atmosphere so that adequate TLV's could be assessed.

Hydrocarbons (specifically the CH_2 group) were determined by solution in pure CCl_4 and comparison of the 2930 cm^{-1} band. Using a 1 cm cell and a Beckman IR-9, 10^{-3} mg CH_2/ml could easily be determined.

In all cases, with the exception of hydrocarbon analyses, all instruments were run at 2 L/min with 10-mm nylon cyclones especially fitted with a tangential tubular opening so as not to restrict flow. Sampling lines were kept to minimum length, usually 12 inches at most of 1/4 inch i.d. tygon. Exactly equal sampling lines were always employed on the inside and outside the respirator samplers to offset line loss. Where it was necessary to penetrate a tight mask or half-mask respirator a #13 needle of normally 1/2" length was used, both penetrating and outside the respirator.

[16]Talvitie, N.A.: Determination of Quartz in Presence of Silicates Using Phosphoric Acid. Anal. Chem. 23: 623 (1951)

[17]Talvitie, N.A. and F. Hyslop: Colorimetric Determination of Siliceous Atmospheric Contaminants. Amer. Ind. Hyg. Assoc. J. 19: 54 (1958

[18]Talvitie, N.A.: Determination of Free Silica: Gravimetric and Spectrophotometric Procedures Applicable to Air-Borne and Settled Dust. Amer. Ind. Hyg. Assoc. J. 25: 169 (1964)

[19]Edwards, G.H.: Comparison of X-Ray Diffraction, Chemical (Phosphoric Acid), and Dispersion Staining Methods for the Determination of Quartz in Dust. Amer. Ind. Hyg. Assoc. J. 26: 532 (1965)

Table XVIII gives some comparative results obtained in the field using different instrumentation. Data are given only where three or more methods were used to sample the same atmosphere. It should be noted that the detection limit of the 101 and 201 do not overlap well.

TABLE XVIII

SOME SELECTED VARIATIONS IN VARIOUS MASS MONITORS USED IN THE FiELD

Readings (mg/mJ)

101	201	TS	Chem Anal
	6.87	7.81	7.71
.06		.06	.17
1.96		2.10	2.30
5.00	6.25	6.50	6.30
.08		.21	.26
.17		.18	.17
.19		.18	.17
	1.89	2.00	1.89
	8.76	8.23	10.0
	2.51	2.83	2.87
1.40		.93	1.44
.88		.86	.87
1.60		1.14	1.40
	12.5	9.	14.0

FIELD SURVEY - INTERVIEW RESULTS

At the onset it should be explained that the official field interview form (HSM-T49; OMB Approval No. 68-571039) was designed by NIOSH prior to contract award. The form, 3 pages in length, is reproduced herein for the reader's convenience (Figure 10). It should be noted that the OMB approval has been extended through 6-30-73.

When Boeing undertook this assignment, it was with the understanding that no agency of government, be it federal, state, or local> would be informed as to the identity of any respondent firm. For this reason certain lines in the form have obviously not been used. We are quite certain that it was this understanding that has enabled us to obtain such splendid cooperation from the respondent firms. In fact, several firms requested that the surveyor monitor more than one of their plants or operations. An added indication of the confidence and cooperation obtained from the surveyed firms can be seen from the fact that about half allowed photographs to be taken of equipment and blasting operations.

We now proceed to summarize the interview data obtained. The response to each item on the survey form will be summarized in its turn.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
National Institute for Occupational Safety and Health
1014 Broadway, Cincinnati, Ohio 45202

ABRASIVE BLASTING RESPIRATOR SURVEY

Survey No.__________ Date______________

Identification

Company Name____

Company Address____

____

Name of Person Interviewed________________________________

Title of Person Interviewed _______________________________

Name of Interviewer_______________________________________

Company Description

Products Involved____

Department or Division____________________________________

Process Involved____

Blasting Material____

Types of Blasting Equipment_______________________________

Number of Blasters____

Number of Work Areas______________________________________

Ventilation Control of Process____________________________

____

HSM-T49 (Page 1) Figure 10 O.M.B. No. 68-S71039
8-71 Approval Expires: 6/30/72

Respi ratar Use

For each specific respirator application provide the following information:

1. For what operation ;s the respirator being used?

2. What air contaminant is present?

3. What type of respirator is used?

4. Job title of blaster using respirator

5. Are air contaminant concentrations measured in this environment if so, what are the concentrations?

6. How long does the blaster use the respirator?

7. Is use of the respirator by the blaster voluntary or required?

8. Is the blaster trained in the use of the respirator?

9. How, and by whom, is the respirator cleaned and maintained?

If respirators are used for more than one application in this department or industry, use additional copies of page two of this form.

General Comments

A. How acceptable is the respirator to the blaster?

___ completely ___ generally _ marginal not acceptable

Does the blaster believe a respirator should be used for this process?

What methods can be used to improve respl·rator acceptabi 1i ty?

What other types of respirators shauld be developed for this process?

Other cOllll]ents:

Survey No.

This number is a company identification code number known only to Boeing and the respondent firm.

Date

The date or dates that the surveyor surveys were performed on the particular firm.

Company Name

Not used.

Company Address

Not used.

Name of Person Interviewed

Not used.

Title of Person Interviewed

21 Firm owners.
25 Executives (Pres., V.P., Sec.-Treas., etc.)
27 Upper management (Supts., Mgrs., Directors, etc.)
32 Lower management (Foremen)
16 Safety & Industrial Hygiene Personnel
68 Blasters

It should be noted that in some firms, due to corporate policies, labor relation problems, etc., the interviewers were discouraged from actually talking to the blasting personnel. Also, in some small firms

the actual blaster might carry a key to the executive wash room. In some instances he would be the owner. The small number of safety personnel is quite pertinent when one considers several very large corporations were visited. The safety personnel category above actually incorporates only two industrial hygienists and five safety inspectors. The remainder are managerial. These figures do not portend well from the standpoint of the protection of the working blaster.

Products Involved

5 General Contractors
20 Painting Contractors
5 Sandblasting Contractors
4 Refineries/Petrochemical Mfg.
14 Headstone Manufacturers
6 Basic & Structural Steel
13 Iron and Steel Castings and Forgings
2 Precast Concrete
6 Nonferrous Castings
2 Plating Job Shops
Railroad Cars
7 Heat Treat Job Shops
2 Misc. Component Mfg.
8 Shipyards
2 Auto Body and Paint Shops
Line Haul Railroad

It should be noted at this point that the vast majority of the hazardous blasting is represented by the general. painting, and sandblasting contractors and the shipyards.

Departmen.. or Division

This was a rather unproductive question as the great bulk of the firms visited were either too small or too specialized to compartment themselves. Of those that did, the results were:

6 Paint Shop
6 Fabrication
6 Foundry
7 Maintenance
2 Cleaning Shop
Plate Mill
2 Blast Shop

Proces nvolved

68 Dry Blast (open-hand held)
11 Dry Blast (glove box)
2 Wet Blast
Vacu-blast
14 Airless (cabinet)
7 Airless (continuous feed machine)
5 Airless (tumbleblast)
12 Dry Blast (monument room - hand held)
3 Dry Blast (monument room - automatic)

There were, to be sure, some firms which employed more than one process.

Blasting Material

27 Fine silica sand
26 River sand
12 Mineral aggregate (approx. 5% free silica)
20 Steel shot
7 Steel grit
20 Alumina
3 Glass beads
3 Copper Slag

As will be explained later, the vast bulk of the actual material blown under hazardous conditions was high quartz content material.

Types of Blasting Eguipment

Virtually every manufacturer was represented with pot sizes ranging from the Key 40 ton to the P &G one quart. Airless equipment from small tables to huge custom vertical head mills were observed. It would serve no useful purpose to include a two-page Jisting at this point.

Number of Blasters

Varies	14
	45
2	20
3	7

Number of Blasters (Continued)

4	5
5	2
6	3
7	
8	11
10	2
12	
20	
24	1
31	
40	1
50	
120	

It should be noted that the firms employing the large numbers of blasters (mainly painting contractors and shipyards) also tend to be the heavy users of sand.

Number of Work Areas

Varies	20
	56
2	16
3	10
4	4

Number of Work Areas (Continued)

6	3
12	1
30	1

Ventilation Control of Process

The majority of firms rely upon the vagaries of the Weather Man to provide their ventilation. Fifty-two sites visited blasted outdoors. This number, with the few exceptions where blast rooms were employed, comprised the more hazardous hand held hose dry blast operations. The majority of airless blast operations employed ventilation systems designed for the specific chamber. Homemade and unique was the rule in monument blast room ventilation. Most vented directly outdoors, but, inasmuch as the majority were situated on cemetery grounds, there is no problem of complaints from the neighbors. A compilation of equipment would include:

52 Outdoors - none
3 In shop - none
34 Well designed cyclone/dustube systems
2 Poorly designed or functioning separators
13 Homemade systems
2 Large (> 40,000 cfm) tank blowers
1' Local exhaust on tumbleblast, etc.

Pages 2 and 3 of the Interview Form ask specific questions about each observed respirator use application. We shall now proceed to summarize the answers to these questions. Where *no* respirator was used in a specific application, pages 2 and 3 obviously contain only the comment "none used,"

1. For what operation is the respirator being used?

   For this question we answer by listing both process and operation. The processes involved are:

   33 None used
   81 Dry blasting (hand held hose)
   3 Dry blasting in cabinet
   Large rotoblast operation
   Vacu-blast

   The operations for which the reported respirators were used were:

   57 Rust removal
   28 Paint removal
   12 Scale removal
   8 Headstone marking
   7 Sand removal and casting cleaning
   7 Exposing concrete aggregate (decorative finish)
   3 Cleaning weldments
   3 Mortar removal prior to pointing and waterproofing
   1 Cleaning large commercial cooking kettles (aluminum)

2. What air contaminant is present?

   59 Sand
   57 Iron oxide
   28 Paints (including lead base)
   10 Masonry
   14 Mineral aggregates (normally < 5% quartz)
   11 Alumina
   8 Granite (up to 1/3 quartz)
   3 Brass
   3 Aluminum
   1 Magnesium
   3 Copper Slag

3. What type of respirator is used?

   The variety and condition of the respirators found was qUite extensive. Virtually every major manufacturer and distributor was represented. Some distributors of blasting equipment sell blasting helmets of other approved manufacturers under their own house name. In addition, some intriguing examples of *the* blaster1s ingenuity are found in *the* listing. While the listing is long, it merits inclusion at this point.

   2 Bullard leather covered air supplied (no 8M approval)
   15 Bullard air supplied *19B-57*
   1 Bullard air supplied 19B-40

2 Cesco 690C air supplied

2 Cesco 691 air supplied

3 Clemco ricochet hood only

Clemco ricochet hood over MSA custom comfo BM 2301 nuisance dust respirator

5 Clemco air supplied (MSA)

Clemco air supplied (Bullard)

1 Clemco air supplied (MSA) over 3M

Clemco ricochet hood home-modified to provide fresh air

1 Empire 775 air fed

Guardian 6901C (no approval)

Homemade ricochet hood

2 Homemade air fed helmet

Homemade face shield only

Homemade ricochet hood over 3M mask

Homemade air supplied helmet over 3M mask

1 Homemade ricochet hood over Willson #43 cartridge respirator

Kelco SBH30 ricochet hood over Welsh 7100 nuisance dust respirator

Lindsey ricochet hood

3 MSA Dustfoe 66 nuisance dust respirator

2 MSA 19B-34 air line respirator plus sweat shirt hood

4 MSA tight mask abrasive mask

1 MSA Blastfoe over 3M

7 MSA Blastfoe air fed helmets

1 P &G 905-00 air fed helmet

5 Pangborn heavy duty air fed helmet

2 Pulmosan ricochet hood only

2 Pulmosan ricochet hood over MSA Oustfoe 77

2 Pulmosan BM2160 nuisance dust respirator

Pulmosan ricochet hood over dirty undershirt covering nose and mouth

2 Pulmosan ricochet hood over Scott full face air line respirator

Pulmosan ricochet hood over Welsh Monomask nuisance dust respirator

Pulmosan air supplied helmet without air line hooked up

3 Pulmosan HA-99 air fed helmet

Safeline BM 21A-81 under canvas ricochet hood

Sandstorm #32 air fed helmet

2 Sandstorm ricochet hood

1 Welsh Bantam 7200 nuisance dust respirator

Welsh 7100 air aider dust respirator with chemical worker's face shield

Whitecap #988 helmet

Whitecap "Breatheasy" respirator

3 Wilson #52 heavy duty air fed helmet

3 3M nuisance dust respirator only

1 3M nuisance dust respirator under a face shield

1 Respirator varies with each job - rented

4. Job title of blaster using respirator.

Pres iden t

45 Blaster

22 Bl as terjPa inter

8 Painter

6 Worker

Cemetery Superintendent

Blasting Foreman

Au to Mechanic

Truck Driver/Blaster

1 Carman

5. Are air contaminant concentrations measured in this environment - if so, what are the concentrations?

In no case was the interviewed firm found to be monitoring airborne contaminants. The interviewer monitored contaminants to detennine protection factors in 60 of the 70 firms where respirators are used. In the remaining 10 firms no work was in progress during the survey visit period.

6. How long does the blaster use the respirator?

Hours/ Day	Number
	4
2	6
3	7

Hours/Day	Number
4	12
5	16
6	23
7	11
8	4
9	
10	2

While the above nozzle hours seem astonishingly high at first glance, it should be borne in mind that much of the blasting is done by building trades workers who work long days and in shipyards where large surfaces are available for blasting.

7. Is use of the respirator by the blaster voluntary or required?

72 Required

3 Optional

10 Voluntary (employee initiative)

8. Is the blaster trained in the use of the respirator?

Quite frankly, the large proportion of "yes" answers to this question is. by observation, more apt to be related to the companies' desire to show a safety conscious image than to be safety conscious.

Extensive safety education program

53 Yes
3 Yes (?)
2 Self trained
2 Union trained
9 Not too obviously
2 No
12 On the job

9. How, and by whom, is the respirator cleaned and maintained?

In virtually all cases, with three notable exceptions, the "how" can be answered by "poorly!" The whom would be:

47 Blaster
11 Tool room
5 Maintenance dept.
3 Shop janitorial service
2 Foreman
Safety man
Lead man
Business owner
4 Thrown away after use
12 No discernible evidence of maintenance

How acceptable is the respirator to the blaster?

36 Completely
14 Generally
11 Marginal
7 Not acceptable

Does the blaster believe a respirator should be used for this process?

50 Yes
2 Don't know
2 Need something better
"good as any"
Refused comment
Improve air inlet

What methods can be used to improve respirator acc tability?

29 Satisfied - none
5 Improve window seal
5 Make lighter weight
4 Improve neck seal
3 Increase window size
4 Remove screen from Window - sunlight reflections make visibi poor
4 Reduce noise of inrus in9 air
Provide more air

Provide longer apron

2 Design a dust respirator that will not cause wearer to perspire

1 Change to a standard airline connector such as a Hansen 3000.

Incorporate in-line filter in supply air line to helmet

Too bul ky

The small number of blasters who objected to the high air turbulance noise level resultant from incoming air in the helmets is rather surprising considering the high noise levels measured when the helmets were worn without the blasting hose being turned on. This number *may* in some way be explained by the number of blasters who were observed to be wearing hearing aids!

What other types of respirators should be developed for this process?

Most of the interviewed blasters had no comment on this question. Those who did comment suggested:

5 Prefer a non-Bureau of Mines approved design (such as the leather Bullard)

3 Want lighter construction

3 Would like to try the 3M

2 Would like an air fed helmet but can't afford it

Wants a tight mask helmet

The number of tons of blasting media purchased per year was obtained where possible in order to gauge the extent of each blasting operation. Listed below are the numbers we were able to obtain. It can be seen that abrasive blasting operations vary tremendously in magnitude and that sand is the predominant media used in blasting.

TonS/Yr.	Media
372,000	Sand
112.000	
2,000	"
1,500	"
1,150	"
1,000	"
100	"
100	"
100	"
100	"
80	"
75	"
SO	"
40	"
20	"

Tons/Yr.	Media	
14	Sand	
5	"	
2	"	
53,000	Mineral	aggregate
4,000	"	"
1,000	"	"
1,000	"	"
200	"	"
0.1	"	"
150	Shot	
24	"	
12	Alumina	
11	"	
4	"	
3	"	
2	"	
1	"	
0.5	"	
	Glass beads	

The alumina mentioned above rs used almost exclusive1y in the headstone industry. Only one firm was found to be blowing monuments with sand.

FIELD SURVEY - RESPIRABLE DUST MEASUREMENTS

This section of the report will describe the respirable dust measurement results, with protection factors and exposures vs. threshold limit values (TLV) observed.

Where respirators were found to be worn no suggestions as to proper fitting were made prior to measurement. The data that was wanted was the protection afforded by *the* respirators as normally worn.

Table XIX summarizes the working areas monitored. The nationwide percentage of such work areas as defined by the preliminary questionnaire phase are included for comparison purposes.

TABLE XIX -- WORKING AREA OF EMPLOYEES MONITORED

Area	Number	%	Prel imi nary Questionnaire
Outdoors	47	42	35.5
Cabinet (Rotoblast, Tumb1eb1ast, Other Airless Process)	17	15	13.8
Special Room			
Monument Blast Room	13		
Regular Blast Room	12		
Total	25	22	22.2
General Work Area			
Open Shop	3		
Glove Box	10		
Total	13	12	75.9
Other			
Tank or other confined space	8		
Not elsewhere classified	3		
Total	11	9	12.6
TOTAL	113	100	100

Numerous cases of inadequate or inappropriate respiratory protection were observed. Table XX summarizes the general types of respiratory protection observed,

TABLE XX

RESPIRATORY PROTECTION OBSERVED

	Number
Air-Fed Helmet plus Nuisance Dust Respirator	3
Homemade Air-Fed Helmet plus Nuisance Dust Respirator	1
Air-Fed Helmet Only	42
Homemade Air-Fed Helmet Only	1
Ricochet Hood plus Air Line Respirator (includes Tight Mask Blasting Helmets)	6
Ricochet Hood plus Nuisance Dust Respirator	6
Ricochet Hood plus Rag over Mouth and Nose	1
Ricochet Hood Only	8
Air Line Respirator plus Sweat Shirt Hood	2
Chemical Workers' Face Shield Only	1
Face Shield plus Nuisance Dust Respirator	1
Goggles Plus Nuisance Dust Respirator	1
Nuisance Dust Respirator Only (required by nature of operation)	3
Nuisance Oust Respirator Only (not required by nature of operation)	4
No Respiratory Protection Worn Nor Required by Nature of operation	26
No Respiratory Protection Worn Although Nature of Operation Indicates the Need for Protection	7

In many instances the management of the visited firms were unaware of the inadequacy of their equipment, Many expressed thanks that the deficiencies were found at this time rather than by an insurance inspector or OSHA

compliance officer at a later date. A number of firms have promised to obtain approved respiratory devices and to set up positive hearing loss prevention programs as a result of this survey.

We will also include, in this section, a number of photographs to better acquaint the reader with the various conditions observed.

For the purpose of this analysis we propose to divide the blasting population into five logical segments:

a. Memorial monument makers

b. Shipyards

c, Painting/Sandblasting contractors

d. Primary metals industries (dry blasting)

e, Primary metals industries (airless blasting)

Each of these industrial segments have peculiar problems and procedures. These peculiarities warrant their individual treatment. This does not say that a particular segment may not comprise many industries, Primary metals industry includes everything from basic steel. forge shops, foundries, to commercial heat treat shops - the common denominator being common practices and procedures.

Monument Shops

This segment of the abrasive blasting industry is basically one of the cleanest and best studied 1-3 of all .

For those unfamiliar with the industry. the stone is masked with rubber, the inscription stenciled out. and the stone placed in a blast room (usually about 8' x 10'). The blaster (the term is stone blowing) works through a Ruemelin curtain of leather or rubber strips that can be raised or lowered so that he can at all times maintain a perpendicular attack of the blast hose to the stone face. Angled attack results in angled letters and unpaid bills, Stone blowers are artisans and generally not too fond of safety devices.

Figure 11 - Typical Monument Blast Set-Up

Respirators are rarely used and seldom necessary due to the inward suction through the curtain. Safety glasses are universally ignored, but the Ruemelin window abave the opening offers reasonable protection. Old time stone blowers do tend to have frosted spectacles due to the ricochet of the media (usually alumina) from the rubber masking. The normal pot size is 300-600#, the normal nozzle, a nominal 3/16" at 85 psig. Modern shops have installed automatic blasters which continually pass back and forth and up and down over the marker face. This allows a blower to handle two rooms or to experience less noise while cutting stencils. Also, he gets less

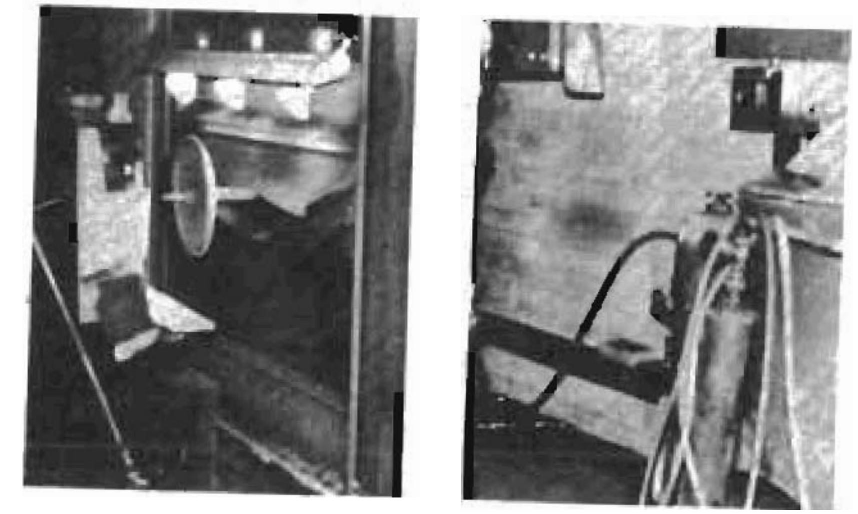


Figure 12 - Automatic Monument Blast Machine

dust exposure. The prime dust exposure during monument making is sweeping, coating, grinding and cutting, and tooling. Tooling is not sandblasting, per set but the art of chipping away background to produce raised letters. Fortunately the economic facts of life have relegated the tooled marker to a rarity, and most of these are custom made in Barre where controls may be better. Dust removal devices often amount to nothing more than a push broom. The spraying is also done immediately after *the* stone is blown and before the respirable dust has had a chance to disperse. As a matter of interest Barre granite is one-third free silica. Much edge grinding and cutting is now done under water spray.

Figure 13 - Marker Spraying

Figure 14 - Marker Tooling

Figure 15 - A Typical Blast Room Oust Removal Scheme

Shipyards

Shipyards have better equipment on the whole although they do precisely the same work as Painting/Sandblasting Contractors. They have active safety programs and Navy inspectors. Figures 16 and 17 show some well outfitted yard workers. Shipyards were included in this study to start with to provide an internal control wherein good safety practices might be expected to be found. By and large we were not too disappointed, with exception of the noise level data to be discussed in the next section.

Figure 16 - Typical Shipyard Worker with a Lightweight Helmet

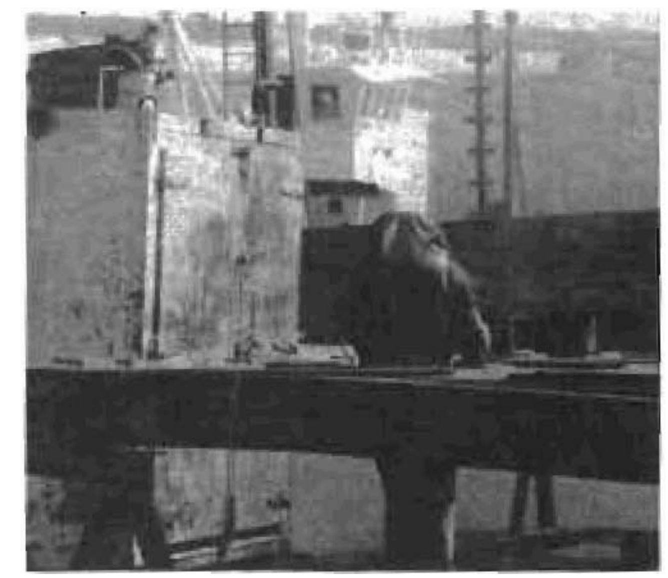


figure 17 - Typical Shipyard Worker Using an Excellent Tight Mask Helmet

Painting/Sandblasting Contractors

Few firms do sandblasting exclusively. This investigator has visited some firms where 100 were employed more or less full time, but, frankly, most sandblasting is done in preparation for painting.

These people normally take a blasting job to get the painting contract. Their equipment and working conditions are the most primitive of all categories mentioned in this report. They are after all a construction trade. and construction workers are accustomed to putting in a full eight hour shift with an element of risk.

Pots will normally vary from a 300# one man operation to a one ton with hopper (Figure 18) to the Key 40 Ton (Figure 19).

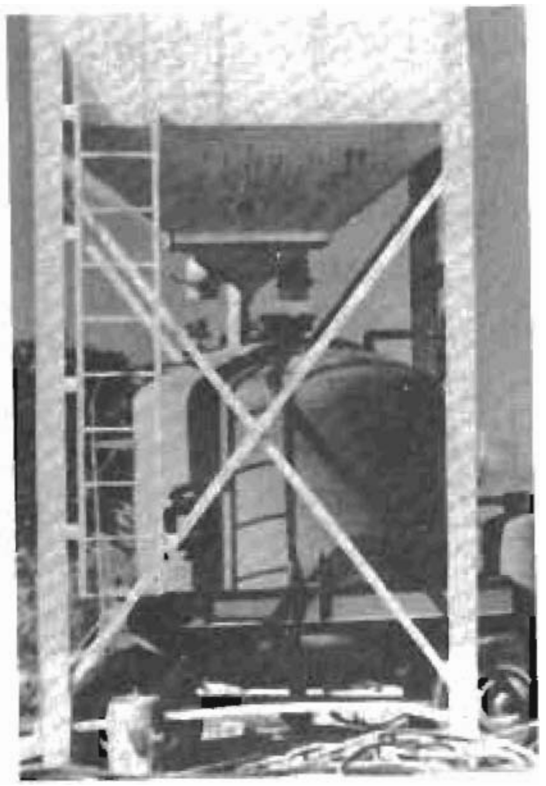


Figure 18 - One Ton with Hopper

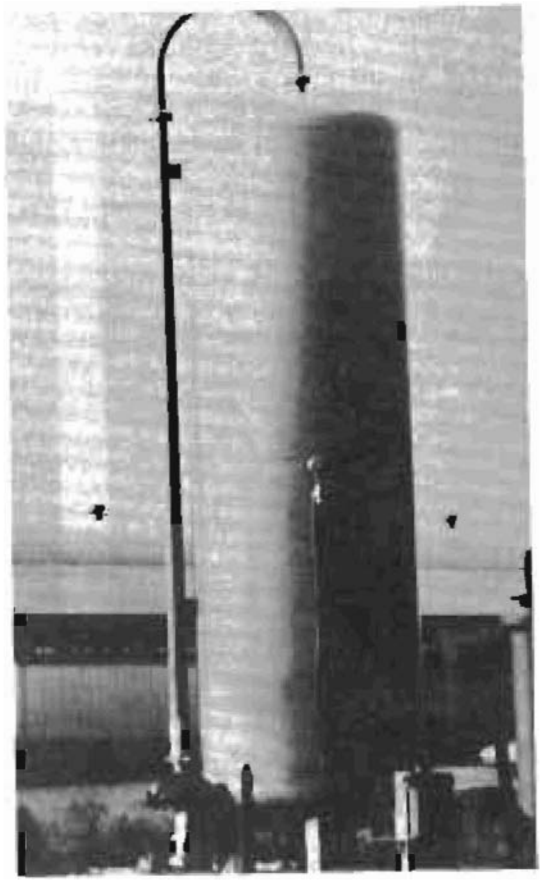


Figure 19 - Key 40 Ton Pot

Equipment varies from the very good air fed helments (Figures 20-22) to many ricochet helmets often worn alone or over an inadequate dust

Figure 20 - Excellent MSA Tight Mask Respirator

Figure 21 - Excellent Metal Helmet (Not Schedule 198 Type CE)

Figure 22 - Metal Helmet with Better Apron

Figure 23 - An Inadequate Ricochet Hood for Sandblasting

respirator (Figure 23). This last and quite prevalent case is a clear violation of the law where sand is the blasting media, and in this category sand is the universal media.

Primary Metals Industry (Dry Blasting)

Here we find a great deal of variety of conditions. Much work is done in glove boxes (Figure 24 and 25) where no respirators are required if the gloves don't leak (Figure 26). Other work may be done in blast rooms

Figure 24 - Typical Dry Honing Glove Box Apparatus

Figu , 25 - Typica1 GlDve Box

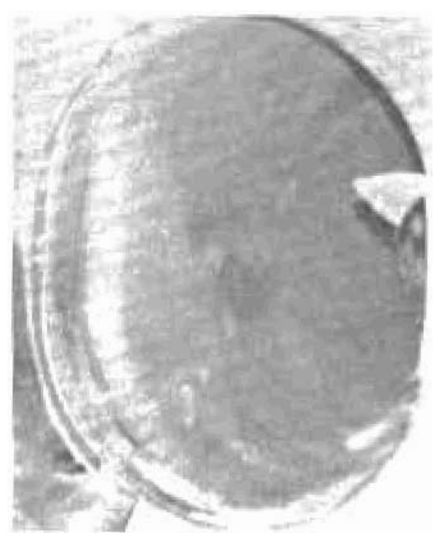


Figure 26 - Leaking Glove Port

where very good heavy duty equipment (Figure 27) is required to protect the blaster from the steel shot usually used under *such* conditions.

Some small marginal foundries use very worn out helmets (Figure 28),

Figure 28 - A Badly Worn-out Helmet (Note Condition of Apron)

Figure 27 - Excellent Heavy Duty Equipment Suitable for Steel Shot Work

and the classic of all, a dirty undershirt worn bandit fashion (Figure 29) and covered by a tattered ricochet *hood* while sandblasting copper (33X TLV).

Figure 29 - A Unique Respirator

Primary Metals Industry (Airless Blasting)

Here we discuss rotoblasts (Figure 30), tumbleblasts (Figure 31), large head mills (Figure 32), and other processes where the blast grit (usually steel shot) is confined, the workers are outside, and no respiratory protection is dictated. These are fairly safe operations if one ignores ricochet through poorly closed doors and ball bearings allover the floor.

Figure 30 - Typical Foundry Rotoblast

Figure 31 - Tumbleblast

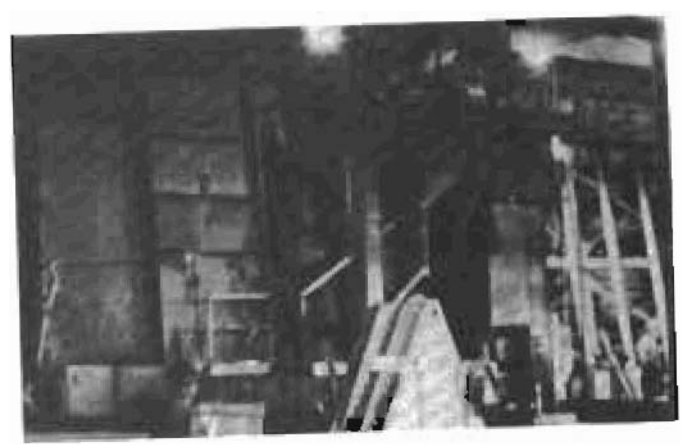


Figure 32 - Large Head Mill Blaster

Data Presentation

Tables will now be presented showing the protection factors and exposures vis-a-vis the calculated TLV's.

Each table will be divided int[illegible]e columns:

a. Column 1 is the respirator code given at the end of the table series. Several marketers sell the same helmet manufactured by the same firm under different trade names. Others sell several of their own approved helmets under the same trade name. Where possible USBM approval numbers will be used.

b. Column 2 is the breathing zone respirable dust measured. Where no entry appeared in Column 1 only breathing zone (BZ) tests were made as no respirator was worn.

c. Column 3 gives the ambient respirable dust concentration. Where no notation occurs no respirator was worn.

d. Column 4 gives the protection factor calculated where a respirator was worn using the formula:

$$PF = \frac{\text{Ambient Respirable Dust}}{\text{BZ(in mask) Respirable Dust}}$$

e. Column 5 lists symbols for the predominant respirable dust contaminants as measured chemically. Calculations were made on the basis of the most likely oxide.

f. Column 6 lists the exposure hours per day for each monitored workman. Some of these are startling.

g. Column 7 is the assigned TLV based upon the chemical and x-ray diffraction analyses of the dusts collected.

h. Column 8 ;s an 8-hour day exposure factor based on the working hours and assigned TLV.

i. Column 9 is a "Times TLV" factor to better evaluate the efficacy of the particular dust exposure situation.

TABLE X)I

RESPIRATORY PROTECTION OBSERVED IN THE MONUMENT INDUSTRY

Resp Code (1)	BZ (2)	Ambient (3)	Prot'n Factor (4)	Contaminants (5)	Exp Hrs (6)	Assigned TLV (7)	Expos (8)	X TLV (9)
	1.08			5i-A1-Fe	6	0.40	0.81	2.00
	.19			" " "	4	.36	.09	.25
66	.09	0.35	3.9	A1	6	5.00	.07	.01
	1. 20			Al	2	5.00	.30	.06
66	1.43	3.73	2.6	5i-A1	6	.60	1. 07	1. 80
66	.12	.36	3.0	" "	8	3.90	·12	.31
	.33			" "	8	1. 50	.33	.22
Mono/Ric	.14	2.45	17.5	S1	6	.10	.10	1.00
	.05			A1	4	5.00	.03	. 01
2160	.48	1.44	3.0	5i-A1-Fe	3	.45	· 18	.40
	1. 73			" " "	2	.27	.43	1.60
	2.55			" " "	2	1.00	.64	.64
3M	1. 75	3.50	2.0	" " "	6	.33	1.32	4.00

TABLE XXII

RESPIRATORY PROTECTION OBSERVED IN SHIPYARDS

19B-57	.10	16.90	169.0	Al	7	5.00	.08	.02
19B··57	.03	28.70	955.0	Al	7	5.00	.03	.01
19B-57	.08	49.60	622.0	Al	7	5.00	.07	.01
LB	.68	48.90	72.0	A1	7	5.00	.60	. 12
HA-99	.19	16.00	85.0	Al	7	5.00	·17	.03
Blastfoe	. 13	35.70	275.0	Al	7	5.00	. 11	.02
Clem/Ric	.69	2.50	3.6	S;	4	.11	.34	3.10
Clem/Met	.67	6.73	10.0	Si-Pb	5	.20	.42	2.10
19B-57	.50	5.10	10. 1	5i-Fe	6	.46	.37	.80
6901C	.54	2.70	5.0	" "	7	.38	.47	1.20
MSA Tight	1. 40	14.00	10.0	AI-Si-Fe	7	.33	1.23	3.70
19B 57	4.16	73.65	17.7	Si-Pb-Fe	7	.20	3.66	18.30
19B-34	.08	11.3	114.0	Si-Pb-Fe	6	.20	.06	.30
MSA Tight	.08	20.6	255.0	Pb-Fe	6	.40	.06	.15
MSA Tight	.21	13. 1	63.0	Si-Fe	6	.50	.16	.28
19B-34	.02	21. 9	1095.9	$;-PB-Fe	6	.20	.02	.10

TABLE XXIII

RESPIRATORY PROTECTION OBSERVED IN PAINTINGjSANBLASTING CONTRACTORS

Resp Code (1)	BZ (2)	Ambient (3)	Prot'n Factor (4)	Contami-nants (5)	Exp Hrs (6)	Assigned TLV (7)	Expos (8)	X TLV (9)
Ric/2301	.8	15.32	1.7	Si-F	5	4.70	5.56	1.18
Pul/Ric	3.37	5.37	1.6	" "	3	.20	1.26	6.29
HM	2.'5	7.24	3.3	5i	6	.10	1.62	16.20
Clem/Ric	5.23	8.88	1.7	"	8	.10	5.23	*52.30*
Sanst/Ric	4.35	8.28	1.9	"	5	.10	2.72	27.20
Ric/77	1.33	7.62	5.7	Si-Al	8	.26	1.33	5.22
HA-99	.19	2.50	13.1	Si	8	.10	·19	1.90
MSA Tight	.07	11.00	158.0	A1	8	5.00	.07	.01
Ric/Cus C	.35	1.25	3.6	Si	8	.11	.35	3.17
Clem Ric	.57	3.20	5.6	Si	5	.10	.36	3.60
B1astfoe	.05	3.25	65.0	Al	7	5.00	.04	.01
Blastfoe	.63	7.71	12.1	Si-Fe	4	.68	.32	.47
Cesco 691	2.28	9.98	4.2	Si	8	.12	2.28	18.90
Cesco 691	6.30	11.92	1.9		9	.12	6.30	52.20
Blastfoe	.20	15.30	76.7		2	.13	.05	.38
19B-53	.26	29.40	113.0		5	.10	.16	1.60
19B-53	1.70	49.40	28.9		5	.10	I.06	10.60
19B-53/3M	.17	34.70	203.0		5	.10	.11	I.10
19B-53	.62	43.40	70.0		5	.26	.39	1.49
19B-53/3M	.08	9.40	117.0	"	5	.10	.05	.50
19B-40	.04	3.77	94.0	"	5	.10	.03	.30
Sul/no BM	.53	2.00	3.8	Si-Fe	4	.59	.26	.24
B1astfoe	.07	6.20	89.0	Si	6	.10	.05	.50
19B-57	.05	4.80	96.0	"	3	.10	.02	.20
Ric/Air In	.02	7.20	360.0	"	3	.10	.01	.10
Pu1/Ric	.88	4.88	5.5	Si-Pb	3	.20	.32	1.60
Ric/Air Ln	.49	7.94	16.2	Si-Fe	2	.13	·12	.93
198-40	.05	3.75	75.0	" "	7	.19	.05	.26
Cesco 690C	.10	1.55	15.5	" "	6	.17	·07	.41
SBH30/Wal	.12	14.60	*122.0*	5i	6	.23	.09	.39
Hom-Air	.17	10.00	58.0	Si-Pb	6	.22	·13	.65
19B-57	.12	268.00	2220.0*	" "	6	.12	.09	.75
Hon-ir/3M	.79	-.60	7.1	Si	5	.24	.49	2.10
Shie1d/3M	.18	9.00	50.0	Si-Pb	6	.10	.13	1.34
MSA Tight	.21	1.80	151.0	Si	6	.10	.15	1.50
19B-57	.04	150.00	3750.0*	Si-Pb	6	.12	.03	.25

* Air volume supplied to helmet over 18 cfm.

TABLE XXIV

RESPIRATORY PROTECTION OBSERVED *IN* PRIMARY METALS IN 'STRIES (DRY PROCESS)

Resp Co e (1)	BZ (2)	Ambient (3)	Prot n Factor (4)	Contami-nants (5)	Exp Hrs (6)	Assi ned TL (?)	Expos (8)	X TlV (9)
9	.43	3.97	*9.0*	Fe	4	5.	2.10	0.42
	1 .2	142.91	1.8	5i-fe-Al	2	.22	19.90	90.50
	.06	1.25	21.0	Fe	4	5. 0	.03	.01
Pang	.60	33.10	*55.0*	"	4	5.00	.30	.06
Pan lin	.10	1.87	18.7	"	4	5.00	.05	.01
Pul/R	2.7J	8.45	3.1	Si	2	.11	.68	6.20
We1sh 7200	.05	1.90	38.0	Al	2	5.00	.01	.01
	.54			"	6	5.00	.41	.08
	1.85			"	6	5.00	1.39	.28
	.26			"	6	5.00	.19	.05
	2.03	.28	2.1	"	6	5.00	1.52	.03
	.24	5.60	23.2	Si	6	.12	.18	1.51
	I.23	.19	5.3	"	8	.11	1.23	11.20
	4.90	42.50	8.7	Si-Cu	6	.17	3.68	33.30
	.32	5.60	17.5	*Fe*	6	5.00	.24	.05
	.88			Si-Al	2	1.26	.22	.17
19B-57	.05	71.70	1430.0	Al	6	5.00	.0	.01
Fa e Shield	.55	1.S	.8	"	1	5.00	7	.02
19B-57	1.10	2.50	2.3	5i	4	.10	5	5.50
	.17			A1	2	5.00	.04	.01
Pang HO	.22	24.	109.0	Si	4	.10	.1)	1.10
	12.50			Al-Fe	1	5.00	5.31	1.06
Ri ./S f	1.2	lost		Si-Mg	6	.23	.92	*4.00*
0B-5	1.68	31.20	18.6	Al-Si	6	11	1.26	1.40
B1astfoe	.36	14.40	40.0	Pb-Fe	5	.40	.22	.56
B st foe/Sa f	.13	82.00	630.0	Si-Fe	5	.10	.08	.80

TABLE XXV

RESPIRATORY PROTECTION OBSERVED IN

PRIMARY METALS INDUSTRIES

(AIRLESS PROCESS)

Resp Code (1)	BZ (2)	Ambient (3)	Prot'n Factor (4)	Contami- nants (5)	Exp Hrs (6)	Assigned TlV (7)	Expos (8)	X TLV (9)
	9.29			Fe	6	5.00	7.00	1.40
	27.7			5i-Fe	4	1.80	13.90	7.75
	7.06			" "	3	.24	2.70	1.12
	nil			Fe	2			.00
	.85			glass	2	5.00	2.10	.42
	.18			Fe	1	5.00	.24	.01
	1.21			5i-Fe	4	.41	.60	1.47
	.15			Fe	4	5.00	.07	.01
	.30				8	5.00	.30	.06
	.25				2	5.00	.06	.01
	.22				2	5.00	.05	.01
Wi1 52	.39	84.0	215.		6	5.00	.29	.06
	.04				6	5.00	.03	.01
	2.10				8	5.00	2.10	.42
	.06				6	5.00	.05	.01
	.09				3	5.00	.03	.01
	.76			"	2	5.00	.19	..04
	2.87			Fe-A1	1	5.00	.36	.07
	1.44			" "	1	5.00	.18	.03
	.86			Fe	2	5.00	.21	.04
	.34			Fe	2	5.00	.08	.17

Respirator Code

Code	Description
66	MSA Dustfoe 66 nuisance dust
Mono/Ric	Welsh Monomask under Pulmosan ri:ochet hood
2160	Pulmosan ?160 nuisance dust respirator
3M	3M mask (nuisance dust)
19B-57	Bullard 19B-57 air fed helmet
LB	leather covered Bullard (no BM approval)
HA-99	Pulmosan HA-99 air feed helmet
Blastfoe	MSA Blastfoe air fed helmet
Clem/Ric	C1emco ricochet hood only
Clem/Met	C1emco metal air fed helmet (no 8M approval number obvious)
690lC	Guardian 6901C air fed helmet
MSA Tight	MSA 8M approved with tight full face air line respirator under apron
Ri c/2301	Clemco ricochet hood over MSA 2301 organic vapor cartridge half mask
Pul/Ric	Pu1mosan ricochet hood only
HM	Home made ricochet hood only
Sans t/Ric	Sanstorm ricochet hood only
Ric/77	Pu1mosan r;cochet hood over MSA Dustfoe 77 nuisance dust respirator
Ric/Cus C	Empire rocochet hood over MSA Custorne Comfo nuisance dust respirator

Code	Description
Cesco 691	Cesco #691 air supplied helmet
19B-53	MSA Leadfoe (not CE approved)
19B-53/3M	*19B-53* with 3M underneath
198-40	Bullard 198-40 air supplied helmet
Bull /no 8M	Bullard (no BM approval)
Ric/Air Ln	Pulmosan ricochet hood over Scott full face air line respirator
Cesco 690C	Cesco 690C air supplied helmet (no apparent BM approval)
988	Whitecap 988 air supplied helmet
Brea thzy	Whitecap Breatheasy air supplied hood
Pang HO	Pangborn heavy duty air supplied helmet
Welsh 7200	Welsh Bantam 7200 nuisance dust respirator
pulm NO	Pulmosan nuisance dust respirator
Pulmo AF	Pulmosan air fed helmet
Rag/Ric	Dirty undershirt wrapped bandit fashion over nose and mouth (Figure 29) and covered with a worn out Pulmosan ricochet hood
Wil 52	Wilson #52 air fed helmet
Face Shield	Home made 5-mil face Shield only
SBH30/Wel	Kelco SBH-30 ricochet helmet over Welsh 7100 nuisance dust respirator
Home air	Homemade air supplied helmet
Home Air/3M	Homemade air supplied helmet over 3M nuisance dust respirator

Code	Description
Shield/3M	3M under face shield
Ric/Saf	Ricochet hood over Safeline nuisance dust respirator
Blastfoe/Saf	MSA Blastfoe over Safeline nuisance dust respirator
198-34	Air line respirator plus sweat shirt hood

Field Survey Oust Data Summary

If we ignore one or two obviously unrepresentative pieces of data an excellent comparison can be given of the comparative protection from respirable dust afforded workers in the selected categories as shown in Table XXVI below.

TABLE XXVI

COMPARISON OF TLV EXPOSURES TO RESPIRABLE OUST IN SEVERAL INDUSTRIAL SEGMENTS

Industry	Ave X TLV
Monument	0.95
Shipyards	0.79
Painting/Sandblasting Contractors	6.11
Primary Metals (Dry Blasting)	2.71
Primary Metals (Airless Blasting)	0.65

Where respirators are provided, the average protection factors afforded workers in the various industrial segments (again excluding one or two unrepresentative data points) are: monument making, 5.3; shipyards,

235.1i painting/sandblasting contractors, 60.6; primary metals (dry blasting), 128.2 and; primary metals (airless blasting), 215.0.

Field Survey Photomicrograph Analysis

Samples were occasionally taken from a blaster's breathing zone for analysis by electron microscopy in order to determine the mean size of particles the worker was breathing. Figures 33 through 35 are representative. In Figure 33 the worker was breathing a mean 1.3 micron sand. In Figure 34 the worker was subjected to a somewhat higher concentration of a mean 0.8 micron garnet. In Figure 35 the worker was exposed to the irregular particle shapes of a mineral aggregate (copper slag in this particular case with a 0.4 micron mean particle diameter). In all cases the particles observed were well within the respirable range.

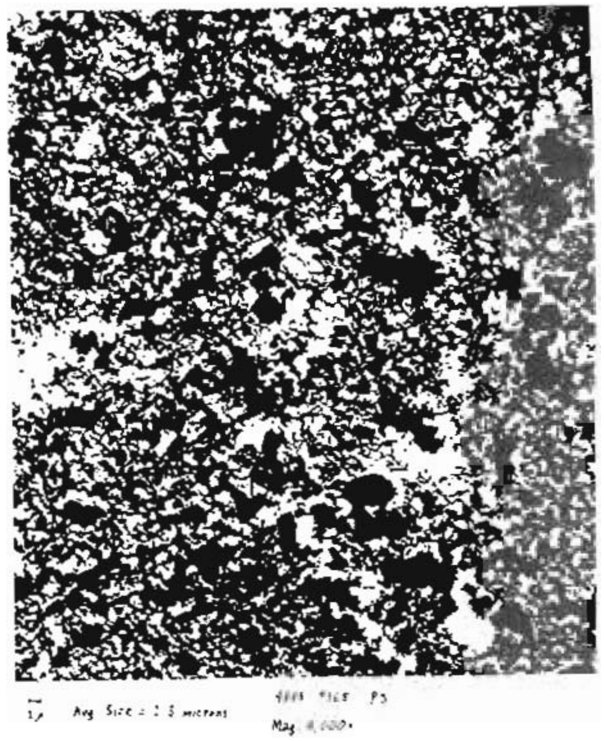
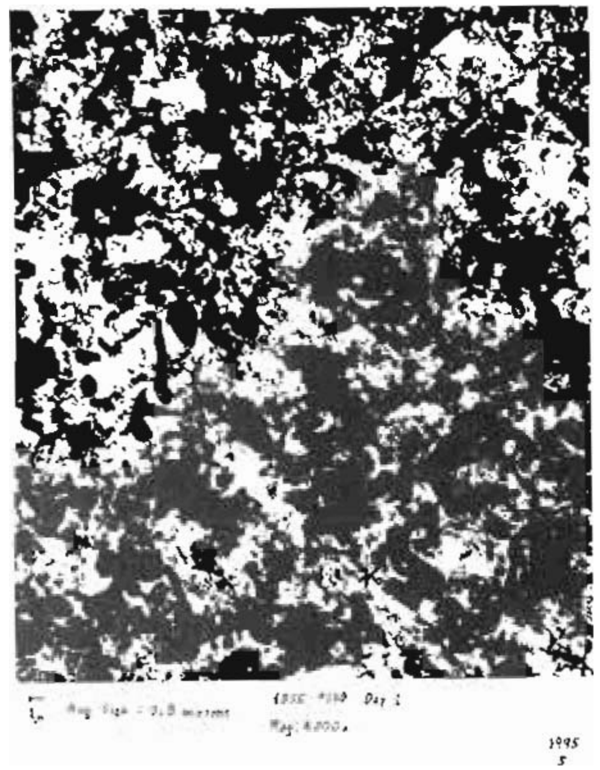


Figure 33. Photomicrograph {San



re 34. Photomicrograph (Garnet)

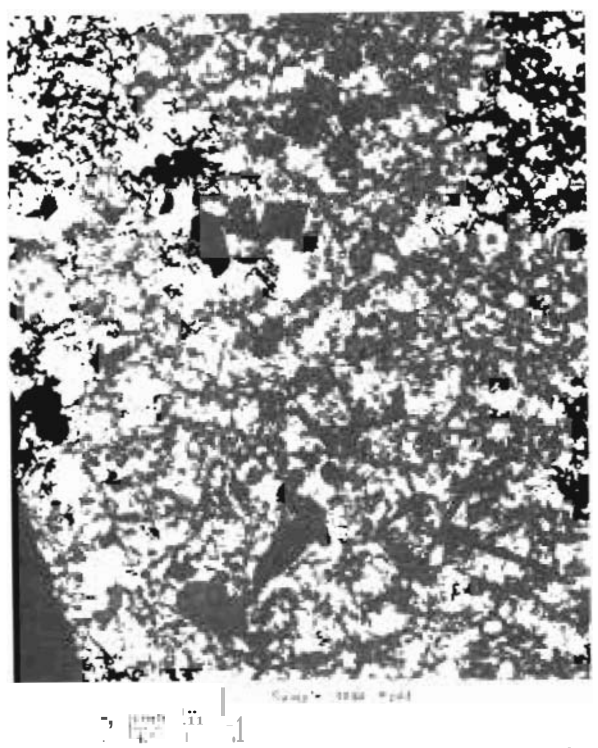


Figure 35. ho ıı cr og raph (per Slag)

FIELD SURVEY

NOISE LEVEL MEASUREMENTS

The degree of worker noise exposure has proved to be the real sleeper in the program. The noise hdzard has been found to be almost universally ignored. Of 112 individuals monitored for noise data:

a. 15 were required by company work rules to wear hearing protection;
b. 9 actually were observed wearing hearing protection where required;
c. 3 wore hearing protection where not required by their employer; and
d. 76 (or 68%) needed and did not have hearing protection (based upon time-weighted measurements actually made).

One of the most interesting facets of the blasting noise level problem is that of the air turbu1ance noise within air-fed helmets. The mean absolute background (no blasting noise) sound pressure level in the helmets measured was 92 dBA. The mean noise above ambient (no blasting) was 12 dB. Tables XXVII and XXVlrr summarize this data.

TABLE XXVII -- AIR-FED HELMET ABSOLUTE BACKGROUND SOUND LEVEL

Range (dBA)	Number	
70-79	4	8
80-89	16	31
90-99	22	43
100-109	9	113

TABLE XXVIII -- AIR-FED HELMET NOISE ABOVE AMBIENT

Range (dBA)	Number	%
< 0	5	10
0-9	16	33
10-19	12	24
20-29	14	29
30-	2	4

The outside the helmet noise level of hand held hose blasting operations is very high. The mean for 56 air-fed helmeted operations was 114 dBA with extremes of 98-126 dBA. Attenuation afforded by the helmet ranged from 0 to 23 dBA with a mean of 11. The range data is given in Table XXIX.

TABLE XXIX -- AIR-FED HELMET NOISE ATTENUATION DURING BLASTING

Range (dBA)	Number	%
0-4	9	16
5-9	10	18
10-14	21	37
15-19	10	18
20-	6	11

Table XXX gives the exposure norms of workers in several industries employing differing processes. It can be seen that dirless processes generally do not ge erate a noise exposure hazard. Paintin a sandblasting contractors. due to their high use of non air-fed hoods,

dnd shipyards, due to their high use of tight masks and air line respirators, both have extreme average noise hazard levels. While shipyards are far superior to painting/sandblasting contractors ;n general respirable dust exposure levels there is little to choose between them in average sound pressure level exposures. When the average so nd pressure level dnd average exposure time data from Table XXX are compared with the Table XXXI permissible exposures. it can be seen that hearing prot tiv ui ent use is dictated in every category except the airless processes. As previously noted. essentially no job requirement for or use of hearing protection was observed. In virtually every case, management assumed that the helmets they provided afforded adequate hearing protection. In only 3% of the cases studied have regular audiometric tests been required, and two of these involved exposure to the less severe condition of the airless process.

The results of the few octave band analyses that were made seem to indicate (1) a general diminution of the noise level at frequencies above about 500 Hz where good air fed helmets are worn; (2) no appreciable reduction in lower frequency sound pressure levels where any type of protective headgear was worn; (3) significant differences in frequency shift curves for various types of air fed helmets; and (4) rather erratic behavior where ricochet hoods only are worn, with some showing an inside the hood frequency shift towards lower frequencies and others merely showing a lessening of higher frequency sound pressure level. The octave bond analysis data was, in general. too sparse to be conclusive.

TABLE XXX -- NOISE EXPOSURE SUMMARY

Process/Business/Equipment	Total Number	Ave. Exposure Time (hrs/day)	Ave. Sound Pressure Level (dBA)	Maximum Sound Pressure Level (dBA)
Air-Fed Helmets	56	5.3	100.5	126
Non Air-Fed Hoods	15	5.3	106.1	126
Monument Shops	13	4.8	101.3	112
Shipyards	16	6.0	104.8	126
Painting/Sandblasting Contractors	32	5.6	105.4	118
Primary Metals Industries				
Airless Process	14	3.5	95.5	114
Dry Process	22	4.2	99.1	112

TABLE XXXI PERMISSIBLE NOISE EXPOSURES*

Duration per day, hours	Sound Level dBA Slow Response
8	90
6	92
4	95
[illegible]	97
2	00
5	02
	05
0 5	110
0 25 or [illegible]	115

*From OSHA Standards Table G- 6 29 CFR 9 0.95

FIELD SURVEY

GENERAL OBSERVATIONS

Very little can be said in defense of the generally deplorable condition of respiratory equipment observed during this program. As a rule, it seems that minimal equipment that will find employee acceptance is used. OSHA had visited very few of the firms surveyed.

The average firm safety man, where one exists - and this is usually a duty in addition to some normal "productive" function - seems unaware of the problems of respirable dust dnd noise.

The average blaster seems unconcerned by equipment deficiencies. His trade has always been dusty and noisy.

In general. little care ;n selection and no or minimal maintenance is the rule. Daily helmet cleaning is just not done. Many of the helmets observed obviously received no maintenance save for window changing when they became opaque.

Safety devices, such as dead-man switches, are items to be ignored. or circumvented by wiring open. After all, "the pot man can see if anything goes wrong" -- if he happens to be looking up from his normal chore of shoveling sand into the pot:

Many blasters were observed to have changed or modified their respirator inlet air valve to allow a higher than Schedule 19B permitted air flow

in order to reduce the dust inside the hood atmosphere. This, of course, increased the noise level.

Lines and fittings are universally interchanged. The interviewer did not see one case or meet one person that was aware that Schedule 19B certifies type CE respirators and air lines as an assembly. When used separatly the certification is void, and the world of the working blaster could apparently care less. Lines are normally made up in needed lengths by the blasting contractor from bulk air line hose. Fittings are normal Hansen 3000 or equivalent. It would seem that suppliers have been negligent in not informing their customers about the compatibility rule. There is some question in the author's mind as to the worth of the rule.

Storage of respirators is generally where convenient: in the corner, on a hook, in a work bench, but generally where last used. One large contractor issued each man a garbage can to put his helmet in. At least this kept down the spread of disease as each man had his own helmet. However, this contractor didn't tell the men to clean the outside of the helmet before dropping it into the can at night, so as a consequence tomorrow's inside ended up starting as dirty as yesterday's outside.

Expansion valves are commonly used (usually in violation of 19B) in order to keep the air breathable in hot climates. These vortex tubes are well accepted by the workers.

Water condensate in air supply lines far outstrips oil mist as a nuisance value, especially in warm climates. Reasonable amounts of oil mists (0.5-7.8 mg/M^3 with a mean of 2.5) were found, but compared to air hoses that behaved like garden hoses this was nothing.

Aprons are commonly dispensed with (except for shot blasting) in favor of coveralls.

Surprisingly, gloves are not always worn, but usually are where needed.

In monument room work the rule is no safety equipment - and that includes non-safety prescription spectacles. An old time blaster looks through glasses almost as opaque as a bathroom window. A good deal of ricochet returns through even a well kept up monument blast room curtain.

Grit is normally allowed to accumulate on the floor of a blast room until it is needed to refill the pot.

All wheelabrators leak to some degree and the danger of eye damage from this is always present. The floor in front of the average wheelabrator is a sea of ball bearings making walking a first magnitude hazard.

By and large. when other means of control, such as local exhaust) glove boxes, and monument rooms are used, respirators are neither worn nor needed to maintain below TLV exposures.

Some mention should be made of respirator fit. They don't. They are designed in a single size which. in the opinions of the interviewed

blasters, fit no one. The man with excess facial hair is obviously disadvantaged when it comes to tight masks, but even *the* he1mets seem able to fall from everyone's head whenever he stoops over, the normal position of work in dry blasting. No wearer of a half mask Or a tight mask had been instructed in *the* accepted methods of fit verification when *the* respirator is put on. m only four instances were the observed users given a choice of respirators, and each were as ill fitting, but various workers preferred one or the other helmet due to weight or visibility factors.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Population Selection & Preliminary Survey Approach

Details are given of the method of selection, structure, and approach to the population contacted in the preliminary questionnaire phase of a survey of current abrasive blasting protective practices. The firms contacted represent the bulk of all firms in 33 Standard Industrial Classifications in six Standard Metropolitan Statistical Areas. The sample area represents slightly more than four percent of the national population, and the firms contacted represent slightly over four percent of the national total for such firms (average value).

The DMI service provides the researcher with a potent tool in establishing an industria1 sample population.

The Chamber of Commerce approach is most helpful in gaining acceptance and publicity for a survey. This is an especially useful technique where there is no single trade association or union with which the researcher can deal.

The population described herein represents what we believe to be an entirely adequate sample from which to obtain an understanding of the operating conditions and protective measures employed in abrasive blasting throughout the country.

Preliminary Survey Results

The response obtained and information gathered from the preliminary questionnaire phase of the survey are discussed. The survey of the 3903 firms was conducted in three mailings using a refined population technique. The final overall response was 23.1%, with 71.6% of the blasting respondents expressing a willingness to participate in subsequent on-site surveys. The replies indicate a typical abrasive blasting operation to be a handheld dry blast hose using silica sand on steel or stone in an open area with marginal respiratory protection. Approximately 70% of the abrasiv-blasting performed results in silica dust generation.

It can be concluded from the replies that the persons responsible for selecting abrasive blasting respiratory protective equipment are none too informed nor interested in the subJ"ect. Their concern is with abrasive blasting per se and not with safety measures. A serious education effort is indicated.

Protection Afforded Respirator Wearers

Protection factors were determl'ned where reSplratory protection was found to be worn. Where nuisance dust respirators alone were worn, factors from 2.0 to 38.0 were found. Where ricochet hoods alone were worn, factors from 1.6 to 5.6 were found. Where a comblnation of a nuisance dust respirator plus a ricochet hood was found to be worn, factors from J.7 to 122. were found. Where air supplied helmets were used, protection factors from 1.9 to 3750 were noted. The remarkable range of these latter figures is attributable to the condit1on of the individual equipment rather than to any particular brand superiority. Very high values are also associated with very high helmet inlet air flow rates with resultant high air turbulence noise levels.

Fit and Maintenance

Observations indicated only four conscious attempts to offer the wearer a reasonable selection of respirators so that one more nearly providing a face fit could be obtained. Helmets are made in one universal size which seems to please no wearer. Where half masks were worn in low dust operations, no attempt to ascertain fit was observed. Users should be afforded a selection to find the mask they prefer and should be given reasonable professional fitting instructions.

Maintenance was universally poor to non-existent. Helmets were observed in use with missing face piece seals and protective collars. Such poor maintenance invariably leads to poor protection factors. The outsides of helmets were never cleaned prior to storage to prevent dirt transfer to the inside. Maintenance requirements written into CFR 1910.134 should be enforced and should be restated under 1910.94(a).

Design of Respirators

Helmets are not well designed from the wearer's standpoint. Most provide poor visibility. Those with screens over the windows are impossible to

see out of when the sun catches the screen. Air inlets are far too noisy. about which more will be said later. The average helmet has a tendency to fall from the wearer's shoulders when he stoops - a normal blasting posture. Schedule 19B should concentrate more on these items.

Effect of Supervision

No effective supervision of respirator wearing was observed.

Local ExhdUSt Effect

Where jobs were being performed, such as dry honing, tumble blasting, or other airless processes such as use of large wheelabrators, it was generally noted that breathing zone measurements ind;cated no respiratory protection to be required. This was also true in monument blast rooms, except where the marker maker would stick his head through the curtain to inspect the work or would enter too soon after blasting to clean up. In general, the local exhaust was adequate.

Recommended CFR Changes

Many requirements pertaining to abrasive blasting found scattered throughout Part 1910 should be stated under a single section such as 1910.94(a) which is the only place where abrasive blasting is mentioned per se. This would be of great help to the small operator. In the interviews conducted it wd5 determined that a great many such operators simply do not comprehend all of the requirements pertaining to their trade scattered throughout Part 1910. It is recommended that section 1910.94(a) have included requirements for: (1) the periodic physical examinations (with chest x-rays and audiometric tests); (2) the use of hearing protection by both blasters and pot men; (3) the use of dead man switches for hand held dry blasting where nozzle and operator are not physically separated; (4) the wearing of Type CE approved respirators by all blasters working under the conditions specified in 1910.94 (a)(5)(1i), and; (5) the wearing of nuisance dust respirators by pot men working on sand blast operations.

It is further proposed that the formula for the calculation of the allowable working concentration of respirable quartz, as given in Table G-3; 29 CFR 1910.93, be restated, perhaps by merely less crowding, to avoid confusion. Numerous instances were discovered where the management of blasting firms were interpreting this value to be 10 mg/m^3 rather than the formula 10 $mg/m^3 \div (\%\ SiO_2 + 2)$. Even some safety personnel were found to have made this error. If the table were merely spread out so as to clearly indicate that a formula and not a simple value is presented we are confident that this confusion could be eliminated. Blasting firm management are not accustomed to reading environmental guides designed for use by the industrial hygienist,

Future Research

A program is proposed wherein all approved Type CE helmets be subjected to a similar blasting regime while inside and outside the helmet noise

were simultaneously monitored. Measurements would be made with the helmet inlet air only on as well as during blasting. Measurements would be made at several inlet air flows from the required minimum to the allowed maximum. Working blasters have been observed to vary their air flows over as wide a range as the valve permits. On the basis of these tests new approval criteria for Type CE helmets could be prepared. Nozzle sizes up to 3/8 inch and line pressures to 100 psig would be used to truly simulate actual field conditions. The 3/16 inch nozzle, 40-70 psi air pressure currently employed in Bureau of Mines acceptance tests is rather small and low compared with normal usage.

Another area of potential future research is on the respirable dust (especially silica) exposures encountered by workmen in the proximity of abrasive blast operations. Pot men and other workers in a blasting area should be monitored for exposures. This study could be conducted under laboratory conditions at a lower cost, but would be much more meaningful if conducted as a field experiment under actual construction conditions. Workers at several azimuths and several distances from the blaster would be monitored as would local wind data. Shipyards, large blasting contractors, and petro-chemical operations might be a cogent choice of industries for monitoring.

Immediate Improvement

The best way that NIOSH and OSHA could remedy many of the deficiencies cited is to concentrate on the local equipment suppliers. These are the men upon whom the average blaster depends for advice on selection. fit, use. maintenance, and all aspects of safety. The average abrasive blasting company cannot afford the luxury of a safety or industrial hygiene staff or consultant. The supplier is their staff or consultant.

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