EXPOSURE OF WORKERS TO RESPIRATORY HAZARDS AT COLUMBUS COAL AND REFUSE MUNICIPAL ELECTRIC PLANT

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BACKGROUND

The Columbus Refuse and Coal Fired Municipal Electric Plant (RCFMEP) is the largest refuse derived fuel plant in the United States. It became operational in June of 1983. The facility occupies 52 acres, is made up of an eleven story boiler house, a shredder station and a crane area. The boiler house contains six balanced draft boilers where a mixture of 90:10 refuse and coal is burned to generate electricity with a maximum generating capacity of 90 megawatts. These boilers consume between 500,000–750,000 tons of refuse generated by Greater Metropolitan Columbus and Franklin County annually.

The plant is a 24 hour and 365 days per year operation with the majority of the work performed by three workshifts and a workforce of nearly 200 employees.

PROBLEM DESCRIPTION

The RCFMEP has striven to apply existing technologies to new uses, in this case the use of coal fired power equipment for reclaiming energy from refuse. The use of this ill-defined and constantly changing fuel has resulted in a work environment that presents numerous and varied worker exposures to both identified and unidentified contaminants. Since the primary fuel used is refuse, a reasonable assumption is that most anything that is likely to be discarded in the Columbus Metropolitan area and Franklin County, may at some time appear at the plant.

The processing and incinerating of refuse, mechanical and electrical maintenance of the plant, the disposal of the fly and bottom ash, and the production of steam to generate electricity causes a host of hazards to workers. These hazards include microbiological agents, heat, cold, noise, vibration, dust, heavy metals, pesticides, organics, dioxins, free silica and possibly asbestos in addition to stress and ergonomic problems.

Of these hazards free crystalline silica, respirable dust, cadmium, beryllium, arsenic, nickel, and chromium (total and hexavalent) are the respiratory hazards considered in this investigation which is a part of an ongoing comprehensive industrial hygiene and medical surveillance of the plant workforce. The reason for evaluating the adverse health effects and characterization of the airborne levels of these contaminants is their proven capability of causing injury to the lungs by either irritation, scarring or cancer formation.[7,8,9,10,11,12]

METHODOLOGY

Industrial Hygiene

Respiratory hazards under investigation have been chosen based upon analytical results of bulk ash and dust samples collected by NIOSH investigators from eight locations in the plant during a survey in March 1985.[1] In this investigation, bulk ash and dust samples were analyzed for their content of thirty one chemical elements, free silica (quartz) and cristobalite. Cadmium, chromium, beryllium, arsenic, nickel, respirable dust and free silica (quartz) were chosen based upon their presence in the ash and dust, and their definite toxic nature against the pulmonary system.

To characterize levels of the airborne respiratory hazards under study in areas of the plant, the plant was divided into eleven major areas. They are the first floor—quench basins, second floor—boilers, third floor—electrostatic precipitators, first floor B—preheater room, fourth floor—refuse feed, fifth floor, seventh floor, ninth floor, crane area, shredder station and office. The workforce was divided into mechanical maintenance, electrical maintenance, crane operators and area workers, steam operating engineers, boiler operators, laborers-quench basins area, laborers-ash tunnels and system, laborers-shredder house, and laborers-refuse feed area. Mechanical maintenance group works in two twelve hour shifts, the shredder station is operational only for the day shift, office personnel work only the day shift, whereas the rest of the workforce performs the duties on the basis of three eight hour shifts.

Area air sampling was carried out during January, November and December of 1987 where as personal monitoring of the first shift was carried out during January, November and December of 1987 and once per month for 1988 and is an ongoing process to the end of this year. Second and third shifts have been monitored since January of 1988 and will continue to the end of this year.

Respirable dust, free silica (quartz), cadmium, arsenic, nickel, beryllium, chromium (total) and chromium VI were air sampled. These samples were shipped and analyzed by NATLSCO Industrial Hygiene Laboratory in Chicago, Illinois, for the period prior to June 30, 1988 and Clayton Environmental Consultants Industrial Hygiene Laboratory in Novi, Michigan beginning July 1, 1988. Sampling and analysis were performed according to NIOSH Manual of Analytical Methods, third edition.[2]

Medical Surveillance

New workers are screened during the probationary period of employment with emphasis on the respiratory and cardiovascular systems by means of posterior-anterior X-ray, pulmonary function testing, electrocardiogram and blood chemistry to determine the health status of the worker and his/her ability to use a respirator and work with the forementioned hazards. Emphasis are on new workers at this point where nearly 50 workers have been examined. Eventually all employees, permanent and new, will undergo medical evaluation to establish baseline medical data to be followed by an annual follow-up, the purpose of which is to prospectively follow the health of all workers.

STANDARDS AND CRITERIA OF EXPOSURE

Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH),[3] National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs)[4] and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs)[5] are the sources of standards and criteria of exposure. Table I shows the three standards of exposure to cadmium, nickel, arsenic, chromium-total, chromium VI, respirable dust, beryllium and crystalline free silica (quartz).

RESULTS AND DISCUSSION

Evaluation of airborne arsenic, cadmium, total chromium, beryllium, nickel, respirable dust and free silica in several locations in the plant was attempted to try to detect gross variations in the airborne levels of these contaminants in those areas (Tables II and III). These contaminants were either not detected or below their respective OSHA PELs, NIOSH RELs and ACGIH TLVs and without significant variations between areas. Therefore the idea of characterizing workers' exposure on the basis of estimating area airborne levels of contaminants was abandoned.

Evaluation of workers' exposure to the forementioned contaminants on the basis of breathing zone or personal sampling proved to be more useful. Since the plant operation is a 24 hour operation with work performed in three 8-hour workshifts in the most part, evaluation of personnel was performed accordingly. Concerning workers' exposure to hexavalent chromium, airborne levels of chromium VI were within the OSHA PEL-TWA of 400 $\mu g/m^3$ and ACGIH TLV-TWA of 50 $\mu g/m^3$ for the three shifts and all worker groups (Table IV). However, the NIOSH REL-TWA of 1 $\mu g/m^3$ was exceeded in several samples. First shift mechanical maintenance, laborers-quench basin, laborers-shredder house personnel exposure exceeded the NIOSH REL-TWA with levels of 2.2, 1.8 and 1.2 $\mu g/m^3$ respectively. Of the second shift personnel only steam operating engineers group exceeded the NIOSH REL-TWA at 2.7 $\mu g/m^3$, whereas in the third shift only laborers-ash system group exceeded NIOSH REL-TWA at 1.9 $\mu g/m^3$. A 1985 NIOSH study reported chromium VI levels of ND-.8 $\mu g/m^3$ from 25 samples with none of the levels exceeding the three standards.[1]

Breathing zone samples of the three shifts showed that all airborne arsenic levels fall below the OSHA PEL-TWA of 10 $\mu g/m^3$ and ACGIH TLV-TWA of 200 $\mu g/m^3$ (Table V A). However, the NIOSH REL-TWA of 2 $\mu g/m^3$ was exceeded once where a second shift boiler operator breathing zone sample showed arsenic levels of 5.8 $\mu g/m^3$. The Industrial Commission of Ohio Survey of August 1984 showed levels of arsenic of 0.8–54 $\mu g/m^3$ in five samples where ACGIH

Table I

Standards and Exposure Evaluation Criteria

CONTAMINANT	NIOSH REL-TWA (ug/m3)	OSHA PEL-TWA** (ug/m3)	ACGIH TLV-TWA (ug/m3)
Cadmium	40	200	50
Arsenic	2	10	200
Nickel	15	1,000	1,000
Chromium VI	1	100	50
Beryllium	0.5	2	2
Chromium (Total)*	25	1,000	500
Respirable Dust	5,000	5,000	5,000
Crystalline Silica (Quartz)	50	100	100

* Includes chromium metal, chromium II compounds and chromium III compounds as chromium

** Revised exposure limit published by OSHA June 7, 1988

Table II

Area Air Samples of Arsenic, Cadmium, Total Chromium, Beryllium and Nickel

AREA	n	DURATION RANGE (MINUTES)	CONCENTRATION RANGE (ug/m3) ARSENIC	CADMIUM	CHROMIUM	BERYLLIUM	NICKEL
First Floor-690 Level Quench Basins	2	422-476	0.18-0.23	ND-0.29	0.34-0.77	ND	ND-0.58
Second Floor-713 Level Boiler Floor	2	420-470	0.078-0.12	0.087-0.099	ND-2.3	ND	ND-0.18
Third Floor-723 Level Electrostatic Precipitators	2	415-462	0.080-0.62	0.92-.94	ND-1.6	ND	0.37-0.64
Fourth Floor-735 Level Refuse Feed & Boilers	3	404-460	0.038-0.091	ND-0.1	ND-1.5	ND	ND
Fifth Floor-757 Level	1	458	0.16	0.10	0.4	ND	ND
Seventh Floor-775 Level	2	391-452	ND-0.14	0.099-0.10	0.5-1.6	ND	ND
Eighth Floor-785 Level	2	380-440	ND-0.043	ND-0.043	1.0-1.4	ND	ND-.31
Nineth Floor-799 Level	2	388-447	ND-0.16	0.098-0.11	0.49-4.8	ND	0.20-0.32
Shredder House	3	372-453	ND-0.076	ND-0.11	ND-2.3	ND	ND-0.30
First Floor B-Preheater Room	1	420	0.30	0.095	1.1	ND	0.38
Office Area	1	387	ND	0.11	0.42	ND	0.21

ND - Not Detected

Table III

Area Air Samples of Respirable Dust and Free Silica (Quartz)

AREA	n	DURATION RANGE (MINUTES)	RESPIRABLE DUST RANGE (mg/m3)	SILICA (ug/m3)
First Floor - 690 Level	2	359 - 420	0.17 - 0.36	ND
Second Floor - Boiler Floor 713 Level	2	352 - 420	0.27 - 0.33	ND
Third Floor - Electrostatic Precipitators 732 Level	2	355 - 420	0.49 - 2.2	ND
Fourth Floor - 735 Level	3	350 - 420	0.013 - 0.72	ND
Fifth Floor - 757 Level	1	336	0.37	ND
Seventh Floor - 775 Level	2	327 - 400	0.22 - 0.29	ND
Eighth Floor - 785 Level	2	347 - 400	0.16 - 0.32	ND
Ninth Floor - 799 Level	2	323 - 396	0.29 - 0.59	ND
Shredder House	4	348 - 453	0.031 - 0.088	ND
First Floor B Preheater Room	1	420	0.066	ND

ND - Not Detected

Table IV

Personal Air Samples of Hexavalent Chromium for the Three Work Shifts

WORKER GROUP	n			DURATION RANGE (MINUTES)			CONCENTRATION RANGE (ug/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance	3	3	-	414-681	720-820	-	ND-2.2	ND-0.56	-
Laborers - Quench Basins	2	3	2	360-480	480	480	ND-1.8	ND-0.98	.30-.76
Crane Operators and Area	2	2	1	352-388	360	480	0.27-0.85	ND-.75	0.36
Boiler Operators	5	4	5	388-420	230-480	480	0.27-.82	ND-.94	ND-.73
Electrical Maintenance	3	1	2	392-400	480	464-480	ND-.54	ND	ND-.43
Laborers - Refuse Feed	2	2	3	396-420	480	480	.24-.45	ND-.47	ND-.38
Laborers - Shredder House	5	-	-	384-720	-	-	.31-1.2	-	-
Steam Operating Engineers	3	2	3	392-461	455-480	480	ND	ND-2.7	ND
Laborer - Ash System	2	1	2	400-420	480	261-480	0.33-0.54	0.38	.91-1.9

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

Table V A

Personal Air Samples of the Three Work Shifts for Arsenic

WORKER GROUP	n			DURATION RANGE (MINUTES)			ARSENIC CONCENTRATION RANGE (ug/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	5	3	-	217-455	700-720	-	.14-.47	ND-.26	-
Electrical Maintenance	6	2	2	354-465	456-480	470-480	ND-.48	ND	ND
Steam Operating Engineers	4	2	3	420-476	480	381-480	ND-.11	ND	ND
Boiler Operators	6	3	5	321-477	480	401-480	ND-.41	ND-5.8	ND
Crane Operators & Area	4	2	1	420-473	360-480	480	ND	ND	ND
Laborers-Shredder House**	9	-	-	346-450	-	-	ND-.18	-	-
Laborers Quench Basins	5	3	3	291-491	480	369-480	ND-.21	ND-.60	ND-.81
Laborers Refuse Feed	2	2	3	420-450	480	335-480	ND	ND	ND-.25
Laborers-Ash System	4	2	1	320-480	359-480	480	0.10-0.70	.19-.40	.24

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

arsenic standard was not exceeded. However, NIOSH standard was exceeded in three of four samples and OSHA standard was exceeded in two samples.[6] As for cadmium, airborne levels were all below the OSHA PEL-TWA of 200 $\mu g/m^3$ and with the exception of one sample all were below the NIOSH REL-TWA of 40 $\mu g/m^3$ (Table V B). The one sample that exceeded NIOSH REL-TWA described the exposure of a first shift electrical maintenance worker with 64 $\mu g/m^3$. On the other hand, all samples with the exception of two were below the ACGIH TVL-TWA of 5 $\mu g/m^3$, where a first shift electrical maintenance worker and a second shift boiler operator exposure exceeded ACGIH TVL-TWA at 64 and 11 $\mu g/m^3$ respectively. The NIOSH study showed airborne cadmium levels of ND-18 $\mu g/m^3$ in 38 samples with none of the samples exceeding the three standards.[1] The Industrial Commission of Ohio study reported airborne cadmium levels of 0.4–25 $\mu g/m^3$ in 5 samples with none of the levels exceeding the three standards.[6]

Total chromium airborne levels were at or below the NIOSH REL-TWA of 25 $\mu g/m^3$, the OSHA PEL-TWA of 1000 $\mu g/m^3$ and the ACGIH TVL-TWA of 500 $\mu g/m^3$ (Table V C). The Industrial Commission of Ohio study reported airborne total chromium levels of 0.4–15 $\mu g/m^3$ with none of the samples exceeding the three standards.[6] Similarly, beryllium airborne levels were below NIOSH REL-TWA of 0.5 $\mu g/m^3$, OSHA REL-TWA of 2 $\mu g/m^3$ and ACGIH TLV-TWA of 2 $\mu g/m^3$ for all shifts and worker groups (Table V D). For nickel, airborne levels were below the OSHA PEL-TWA and ACGIH TLV-TWA of 1000 $\mu g/m^3$ for all shifts and worker groups (Table V E). However, NIOSH REL-TWA of 15 $\mu g/m^3$ was exceeded twice where a first shift electrical maintenance worker and second shift boiler operator showed exposures of 16 and 24 $\mu g/m^3$ respectively. The NIOSH study reported airborne nickel levels of ND-11 in 38 samples where none of the samples exceeded the three standards.[4]

Respirable dust levels were below OSHA PEL-TWA of 5 mg/m^3, NIOSH REL-TWA of 5 mg/m^3 and ACGIH TLV-TWA of 10 mg/m^3 with the exception of two situations (Table VI A). In these two situations, a first shift electrical maintenance worker and a second shift worker in the cranes area were exposed to 1700 and 19 mg/m^3 respectively. The NIOSH study reported respirable dust levels of 0.09–14 mg/m^3 in 29 samples with only one sample exceeding the three standards.[1] As for crystalline silica (quartz), airborne levels of this contaminant were below the ACGIH TLV-TWA of 100 $\mu g/m^3$ and NIOSH REL-TWA of 50 $\mu g/m^3$ with the exception of one instance (Table VI B). In this situation a worker in the crane area was exposed to 220 $\mu g/m^3$.

It is obvious from the personal sampling data that exposure patterns are not highly unpredictable. This is true since the majority of employees do not perform the exact same duties and are not present in the exact same location every day. In addition, the major groups, mechanical maintenance, electrical maintenance, boiler operators rovers and steam operating engineers rovers perform duties that are different from one day to the next. Perhaps the most important factor

Table V B

Personal Air Samples of the Three Work Shifts for Cadmium

WORKER GROUP	n			DURATION RANGE (MINUTES)			CADMIUM CONCENTRATION RANGE (ug/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	5	3	-	217-455	700-720	-	ND-.92	ND-.79	-
Electrical Maintenance	6	2	2	354-465	456-480	470-480	ND-64	ND	ND
Steam Operating Engineers	4	2	3	420-476	480	381-480	ND	ND	ND
Boiler Operators	6	3	5	321-477	480	401-480	ND-.18	ND	ND
Crane Operators & Area	4	2	1	420-473	360-480	480	ND-.45	ND-11	ND-.54
Laborers-Shredder House**	9	-	-	346-450	-	-	ND	-	-
Laborers Quench Basins	5	3	3	291-491	480	369-480	ND-.38	ND-1.4	ND-1.4
Laborers Refuse Feed	2	2	3	420-450	480	335-480	ND	ND	ND-.11
Laborers-Ash System	4	2	1	320-480	359-480	480	ND-1.6	.21-.31	.45

ND - Not Detected

*- There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

Table V C

Personal Air Samples of the Three Work Shifts for Chromium

WORKER GROUP	n			DURATION RANGE (MINUTES)			CHROMIUM CONCENTRATION RANGE (ug/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	5	3	-	217-455	700-720	-	.30-14	.71-14	-
Electrical Maintenance	6	2	2	354-465	456-480	470-480	ND-16	ND-.23	ND-.55
Steam Operating Engineers	4	2	3	420-476	480	381-480	ND-2.9	ND-.22	ND-1.0
Boiler Operators	6	3	5	321-477	480	401-480	ND-25	ND-11	ND-1.6
Crane Operators & Area	4	2	1	420-473	360-480	480	ND-.53	ND	ND
Laborers-Shredder House**	9	-	-	346-450	-	-	ND-.98	-	-
Laborers Quench Basins	5	3	3	291-491	480	369-480	.51-2.6	.54-3.0	ND-2.7
Laborers Refuse Feed	2	2	3	420-450	480	335-480	ND-1.5	.15-.22	ND-1.1
Laborers-Ash System	4	2	1	320-480	359-480	480	.36-3.6	.23-1.7	ND

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

Table V D

Personal Air Samples of the Three Work Shifts for Beryllium

WORKER GROUP	n			DURATION RANGE (MINUTES)			BERYLLIUM CONCENTRATION RANGE (ug/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	5	3	-	217-455	700-720	-	ND	ND	-
Electrical Maintenance	6	2	2	354-465	456-480	470-480	ND-.40	ND	ND
Steam Operating Engineers	4	2	3	420-476	480	381-480	ND	ND	ND
Boiler Operators	6	3	5	321-477	480	401-480	ND	ND	ND
Crane Operators & Area	4	2	1	420-473	360-480	480	ND	ND	ND
Laborers-Shredder House**	9	-	-	346-450	-	-	ND	-	-
Laborers Quench Basins	5	3	3	291-491	480	369-480	ND	ND	ND-0.1
Laborers Refuse Feed	2	2	3	420-450	480	335-480	ND	ND	ND
Laborers-Ash System	4	2	1	320-480	359-480	480	ND	ND	ND

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

Table V E

Personal Air Samples of the Three Work Shifts for Nickel

WORKER GROUP	n			DURATION RANGE (MINUTES)			NICKEL CONCENTRATION RANGE (ug/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	5	3	-	217-455	700-720	-	ND-.46	.23-5.3	-
Electrical Maintenance	6	2	2	354-465	456-480	470-480	ND-16	ND-.23	ND
Steam Operating Engineers	4	2	3	420-476	480	381-480	ND-.19	ND	ND
Boiler Operators	6	3	5	321-477	480	401-480	ND-1.2	ND-24	ND-.36
Crane Operators & Area	4	2	1	420-473	360-480	480	ND-.71	ND	ND
Laborers-Shredder House**	9	-	-	346-450	-	-	ND-1.4	-	-
Laborers Quench Basins	5	3	3	291-491	480	369-480	ND-1.1	.23-2.8	ND-.72
Laborers Refuse Feed	2	2	3	420-450	480	335-480	.37-.92	ND-.30	ND
Laborers-Ash System	4	2	1	320-480	359-480	480	.16-.83	ND-.23	0.15

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

Table VI A

Personal Air Samples of Respirable Dust and Free Silica for the Three Work Shifts

JOB TITLE/GROUP	n			DURATION RANGE (MINUTES)			RESPIRABLE DUST CONCENTRATION RANGE (mg/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	3	4	-	420-707	670-820	-	0.10-1.2	ND-3.1	-
Electrical Maintenance	6	2	2	373-447	480	480	ND-1700	ND-.069	ND-.048
Steam Operating Engineers	2	2	4	448-473	480	480	ND-.24	ND-.16	ND-.27
Boiler Operators	5	4	5	231-480	480	445-480	.24-.50	ND-.26	.073-.70
Crane Operators & Area	2	2	1	237-497	390-480	480	.065-.072	.39-19	.30
Laborers-Shredder House**	8	-	-	333-480	-	-	.11-.51	-	-
Laborers-690 Level	5	3	4	420-496	480	480	.30-.83	.20-.67	.13-.30
Laborers-4th Floor	3	2	2	420-447	480	480	ND-.22	ND-.08	.07-.20
Laborers-Ash System	5	1	2	420-497	480	480	.20-1.7	.20	.07-.30

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

Table VI B

Personal Air Samples of Respirable Dust and Free Silica for the Three Work Shifts

JOB TITLE/GROUP	n			DURATION RANGE (MINUTES)			FREE SILICA CONCENTRATION RANGE (mg/m3)		
	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT	1ST SHIFT	2ND SHIFT	3RD SHIFT
Mechanical Maintenance*	3	4	-	420-707	670-820	-	ND	ND	_
Electrical Maintenance	6	2	2	373-447	480	480	ND	ND	ND
Steam Operating Engineers	2	2	4	448-473	480	480	ND	ND	ND
Boiler Operators	5	4	5	231-480	480	445-480	ND	ND	ND
Crane Operators & Area	2	2	1	237-497	390-480	480	ND	ND-220	ND
Laborers-Shredder House**	8	-	-	333-480	-	-	ND-31	-	-
Laborers-690 Level	5	3	4	420-496	480	480	ND	ND	ND
Laborers-4th Floor	3	2	2	420-447	480	480	ND	ND	ND
Laborers-Ash System	5	1	2	420-497	480	480	ND	ND	ND

ND - Not Detected

* There is no third shift, rather there are two 12 hour shifts

** Laborers of the shredder house work only the first shift

in the exposure of personnel is the unpredictably variable nature of the refuse which makes it impossible to establish definite exposure trends.

Medical surveillance of workers is still at an infant stage, where only approximately 50 new workers have been examined for the purpose of establishing baseline medical data. This data includes X-ray, pulmonary function testing, electrocardiogram and blood chemistry where the majority of workers examined have been found with normal health. The goal of this medical screening program is to eventually establish baseline medical data on all employees followed with an annual follow-up medical examination to prospectively follow trends in the health of all employees.

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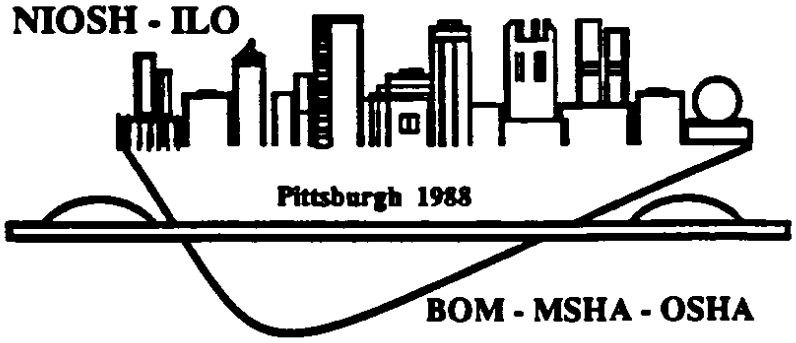
II



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