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HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT NO. TA 78-25

PUREX CORPORATION
LONDON, OHIO

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Study Requested By:
Purex Corporation
London, Ohio

Study Directed By:
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16. Abstract (Limit: 200 words)

In response to a request by the Purex Corporation, London, Ohio, which manufactures steel wool soap pads (SIC-3291), a follow up study was made of a possible health hazard at the facility. Personal and area air samples were analyzed for total and respirable dust, and 25 workers from the original evaluation were tested for pulmonary function. Eleven workers (ten female, one male, mean age 44 years) had abnormal pulmonary function for at least one tested parameter. No medical or smoking related explanation could be found in six. All but two samples of total soap dust measured on three shifts were below the Threshold Limit Value (TLV) for total nuisance dust (10mg/m3), and all were below the TLV for respirable nuisance dust (5mg/m3). Total dust samples ranged from 1.1 to 18.9mg/m3 and concentrations of respirable dust ranged from 0.18 to 0.73 mg/m3. The authors conclude, as did the earlier study, that highly alkaline soap dust may cause reactions in susceptible individuals due to irritation. The following recommendations are presented: existing ventilation should be operative at all times with measurements taken continuously to ensure that dust exposure is minimized, ventilation should be revised to allow for air recirculation and filtration, employees should use personal protective equipment appropriately, employees should be educated in work procedures and safety matters, a vacuum system should be used in cleanup rather than sweeping, and a medical surveillance program should be initiated.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

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I. SUMMARY

Twenty-five Purex employees from three shifts were involved in an environmental-medical study conducted at Purex (March 5-6, 1978). Eleven of the twenty-five were judged to have abnormal pulmonary function test results. Six of the eleven workers found to be abnormal have no explanation for these abnormalities. In an earlier study conducted at Purex (HHE 77-22), it was stated that it was not unreasonable to assume that there may be individuals, because of their hyperactive respiratory airways, who may exhibit some bronchial constriction due to the deposition of particles in the airways of the lung. The study also pointed out that the soap dust was highly alkaline and contained respirable sized particles. Considering this information and the presence of unexplainable pulmonary function changes and the high incidence of upper respiratory symptomatology, it was the investigators opinion that the soap dust be categorized as more than a mere nuisance dust, that the ventilation be operative at all times to reduce dust exposure and that a medical surveillance program be instituted. The feelings of the investigators have not significantly changed and it is still felt that hyperactive airways responding to the alkaline dust may be the explanation for the abnormalities discovered. This warrants serious consideration and following of the recommendations made in the final section of this report.

Concentrations of soap dust measured at Purex on three shifts (March 5-6, 1978) showed all but two samples were below the Threshold Limit Values (TLV's) for total and respirable nuisance dust. The range of the total dust sample concentrations were 1.1 mg/M^3 to 18.9 mg/M^3 and the range of the respirable dust samples were 0.18 mg/M^3 to 0.73 mg/M^3. It is, however, the opinion of the investigators that this particular dust be categorized as more than simply a mere nuisance dust and the references made with respect to nuisance dust criteria are for comparison purposes only. The dust concentrations were in general lower than those measured during the 1977 study but could probably be reduced more with careful implementation of the recommendations made by the investigators.

II. BACKGROUND INFORMATION

The Purex Corporation at London, Ohio requested an environmental-medical follow-up survey to the hazard evaluation which had been conducted at the plant on February 14 and 15, 1977. This additional study was requested for two reasons. First, during the initial study, the local ventilation system was not operative. As a part of the follow-up study, the existing ventilation was in operation, thereby giving an indication of the degree of reduction in the dust levels resulting from its use. The second reason for the follow-up study related to the findings in the medical portion of the first study. Pre and post shift pulmonary function tests were conducted on employees and no statistically significant difference was found between the pre and post shift pulmonary function tests. While the group as a whole showed no significant differences from pre and post shift studies, there were a number of individuals who had abnormal pulmonary function results. Some of these abnormalities were difficult to explain. The follow-up study was conducted to determine if

the unexplainable pulmonary function changes were real, still present, and if some change (improvement or worsening) had occurred with time, as a result of the reduced dust concentrations expected to be present because of the use of local ventilation.

III. EVALUATION

A. Process Description

Purex Corporation in London, Ohio is engaged in manufacturing steel wool soap pads. The survey was conducted in Building 6, where the soap pads are sorted and then bagged or boxed. Two employees per shift work as sorters. The sorters remove, by hand, pads from a conveyor belt that do not meet specifications. The "scrap pads" are then hand packed into plastic bags and placed in cartons for shipment. Two to ten employees at any given time may be working as scrap packers. One to two employees are typically packing pads into boxes by hand. This is a hand operation because of the large number of pads placed in each box. The remainder of the pads are packed into boxes by machines. One machine operator and one helper work at each machine. There are approximately eight machines in operation. In addition, there are approximately two to four employees that work as floorboys on each shift. The floorboys sweep and clean up throughout the area during the shift.

Local ventilation is present at the various work sites and was in operation at the time of the survey.

B. Evaluation Design

The environmental-medical survey was conducted on March 5 and 6, 1978. All workers on each of three shifts who had been involved in the original environmental-medical study were invited to participate in the follow-up study. Seventy-two workers had participated in the original study. The evaluation included pre and post shift pulmonary function testing, medical and occupational histories and physical examinations. At the time of the follow-up survey, only twenty-five of the original seventy-two workers were available for repeat pulmonary function tests. A number of workers had left employment with Purex and several who were still working refused to participate for personal reasons.

Pulmonary function tests were performed on the twenty-five individuals using a Medistor electronic pulmonary function machine (Model M010) with automatic printer. Pulmonary function tests were administered pre and post shift with care being taken that each individual patient was tested in both cases by the same examiner and on the same machine. Brief questionnaires including smoking histories were taken.

A personal breathing zone sample for either respirable or total dust was collected on each individual who participated in the pulmonary function tests. During three shifts, a total of 15 total dust and 11 respirable dust personal breathing zone samples were collected. The total dust samples were collected using closed faced cassettes containing DM-800 filters at a flow rate of 1.5 lpm. Respirable dust samples were collected using 10 mm nylon cyclones and DM-800 filters at a flow rate of 1.7 lpm.

C. Evaluation Criteria

Environmental

Soap dust - A review of the literature indicates that soap dust is an entity that has not been investigated with respect to its capability of causing diseases in humans. In the past, it has been considered simply a nuisance dust and has had the standards of 5 mg/M^3 for respirable dust and 10 mg/M^3 for total dust applied to it as is the case with other "nuisance dusts". The investigators, however, do not feel that this is an appropriate category for this particular dust and that environmental levels should be maintained at a lower level.

Medical

The categories of abnormal values of pulmonary function tests were defined as follows:

1.	Forced Vital Capacity	<75% of predicted
2.	Forced Vital Capacity change over a shift	≥10% drop over pre shift value
3.	Forced Expiratory Volume/sec	<80% of predicted
4.	Forced Expiratory Volume/sec change over a shift	≥10% drop over pre shift value
5.	Maximal Midexpiratory flow rate	<60% of predicted
6.	Maximal Midexpiratory flow rate change over a shift	≥20% drop over pre shift value

The normal or predicted values of the pulmonary function tests used were those reported by Morris.[1]

1. Morris, G.F., Koski, A. and Johnson, L.C., Spirometric Standards for Healthy, Nonsmoking Adults, American Review of Respiratory Disease Volume 103, 1971 p. 57-67.

D. Evaluation Results

Tables I, II and III show the results of the pre and post shift pulmonary function studies performed on each individual in the follow-up study. The three parameters measured with the pulmonary function studies were the forced expiratory volume in one second (FEV_1), the forced vital capacity (FVC), and the maximal mid-expiratory flow rate (MMEFR).

A total of twenty-five workers were evaluated during the follow-up study. Eleven of the twenty-five workers were judged to have at least one abnormal parameter using the previously defined criteria. Fourteen were normal.

Of the eleven abnormal workers, there were ten females and one male. Four were smokers and seven were non-smokers. Their mean age was 44 years and mean duration of employment was 9.2 years. Of the fourteen normal workers, there were thirteen females and one male. Five were smokers and nine were non-smokers. Their mean age was 44.5 years with a mean duration of employment of 8.4 years. Only three individuals found to be abnormal in the 1977 study (HHE 77-22) participated in the follow-up study. All three were again found to be abnormal but all three were heavy smokers (greater than 30 pack years).* Two of the other eleven abnormals found in the follow-up study had potential reasons for their pulmonary functions being abnormal. One was a known asthmatic and the other a cigarette smoker with unknown pack year consumption. The remaining six of the eleven workers were abnormal and no smoking or other medical reasons were apparent to explain their abnormalities. All six individuals had abnormalities in their MMEF, FEV or both. This testing indicates that obstruction of the airways is present in these workers and no obvious reason for these abnormalities is available other than they all work in the same area at Purex.

Tables IV, V and VI show the concentrations of soap dust measured on March 5 and 6, 1978. Only a few employees working in the area wear disposable dust masks, so in general the environmental dust measurements represent personal exposures. A review of the tables show only two total dust concentrations exceeded the TLV for total nuisance dust. The respirable dust sample were all below the current recommended respirable dust levels for nuisance dust of 5 mg/M^3. Table VII shows the mean and average soap dust concentrations for both the 1977 and 1978 studies on a a shift basis. The data shows that the dust levels were reduced when the ventilation was in operation.

*pack year - a pack of cigarettes per day for a year

E. Conclusion

Six of eleven workers found to be abnormal by pulmonary function tests have no explanation for these abnormalities. Although the results may represent testing or other errors it is possible that they are due to the work exposure. In an earlier report (HHE 77-22) it was stated that the soap dust which was highly alkaline and some of which was respirable in nature, could be responsible, in certain susceptible individuals, for obstructive airway diseases. The investigators feel that it is still possible that hyperreactive airways responding to an alkaline, irritating substance may be an explanation for the abnormalities discovered. This warrants consideration and because of these findings, the following recommendations are made.

F. Recommendations

1. The existing ventilation should be operative at all times and measurements made to see that dust exposures are reduced to the lowest possible levels.

2. The ventilation system should be changed to provide for recirculation, including filtration of air. The recirculation of air requires the proper selection of a particulate air cleaner. A review of exhaust air recirculation criteria can be found in HEW Publication No. (NIOSH) 76-186, "Recirculation of Exhaust Air". This change would eliminate the waste of energy involved in heating the air in the cold winter months and then expelling it outside through the ventilation system.

3. Employees using personal protective equipment should be provided with the appropriate respirator and instructed in the proper use, fitting and cleaning of that respirator according with the requirements of 1910.134.

4. Employees should be educated in proper work procedures and handling methods of this material so as to help reduce airborne concentrations.

5. A vacuum system could be used for clean-up procedures rather than sweeping. This procedure would help reduce airborne concentrations of dust.

6. A medical surveillance program should be instituted which includes a preplacement history, physical examination, a chest x-ray and basic pulmonary function studies. These tests should be repeated on a routine basis, every one to three years, depending on the age of the employee.

Table I

Pulmonary Function Testing
Purex Inc. - 1st Shift
London, Ohio
February 1978

Worker Number	Forced Expiratory Volume (1 sec)(liters)			Forced Vital Capacity (liters)			Maximal Midexpiratory Flow (liters/sec)		
	Pred	Pre	Post	Pred	Pre	Post	Pred	Pre	Post
* 001 1978	2.32	2.40	2.47	3.12	3.40	3.54	2.68	1.54	1.63
* 002 1978	2.87	2.29	1.85	3.50	2.65	2.09	3.37	2.89	3.31
003 1978	2.86	2.27	2.28	4.48	3.33	3.27	3.40	2.11	2.07
*004 1978	4.45	3.51	3.37	5.74	3.90	3.74	4.57	6.60	6.88
005 1978	3.08	3.62	3.64	4.18	4.61	4.31	3.19	3.68	3.77
006 1978	2.48	2.71	2.74	3.24	3.72	3.64	2.89	2.66	2.85
009 1978	2.31	1.98	2.05	3.05	2.40	2.46	2.74	2.34	2.49
*010 1978	3.07	2.00	2.13	2.74	2.69	2.88	3.59	2.15	2.58
012 1978	2.84	2.27	2.20	3.68	2.70	2.57	3.19	2.48	2.87
014 1978	2.90	3.01	2.95	3.73	3.43	3.36	3.46	4.05	4.06
*015 1978	1.87	1.54	1.49	2.54	1.90	2.04	2.35	0.77	1.36
*016 1978	2.98	2.18	2.06	3.78	3.30	3.46	3.40	1.41	1.25

* - Abnormals
Pred - Predicted values
Pre - Pre-shift
Post - Post shift

Table II

Pulmonary Function Testing
Purex Inc. - 2nd Shift
London, Ohio
February 1978

Worker Number		Forced Expiratory Volume (1sec) (liters)			Forced Vital Capacity (liters)			Maximal Midexpiratory Flow (liters/sec)		
		Pred	Pre	Post	Pred	Pre	Post	Pred	Pre	Post
101	1978	2.52	2.56	2.62	3.37	3.05	3.04	2.80	5.45	6.62
*103	1978	2.27	0.69	0.51	2.99	1.26	0.91	2.74	0.39	0.22
104	1978	2.12	2.10	2.17	2.85	2.51	2.61	2.53	2.74	4.73
106	1978	2.85	2.66	2.63	3.74	4.17	3.87	3.10	2.40	2.30
107	1978	3.28	2.63	2.67	4.07	3.34	3.28	3.76	2.54	3.10
108	1978	2.94	2.86	2.97	3.88	3.98	3.95	2.78	2.70	3.62
*110	1978	2.73	1.90	1.84	3.54	3.07	2.46	3.13	1.11	1.66
*111	1978	2.89	2.12	2.19	3.74	3.17	3.13	3.22	2.25	2.30

* - Abnormals
Pred - Predicted values
Pre - Pre-shift
Post - Post shift

Table III

Pulmonary Function Testing
Purex Inc. - 3rd Shift
London, Ohio
February 1978

Worker Number		Forced Expiratory Volume (1 sec (liters)			Forced Vital Capacity (liters)			Maximal Midexpiratory Flow (liters/sec)		
		Pred	Pre	Post	Pred	Pre	Post	Pred	Pre	Post
*202	1978	2.80	2.26	2.04	3.53	3.78	3.05	3.28	2.33	2.07
204	1978	3.25	3.36	3.46	4.04	4.30	4.19	3.73	3.06	3.93
205	1978	2.05	2.34	2.37	2.77	2.63	2.67	2.47	3.89	3.45
207	1978	2.57	2.21	2.07	3.40	3.34	3.03	2.89	1.76	1.84
*209	1978	2.60	2.24	2.24	3.49	3.60	3.50	2.83	1.69	1.67

* - Abnormals
Pred - Predicted values
Pre - Pre-shift
Post - Post shift

Table IV

Purex Corporation
London, Ohio

Personal Breathing Zone Airborne Dust Concentrations
March 6, 1978
(Shift 7:00am - 3:00pm)

Sample Location	Sample Number	Sampling Period	Sampling Volume (liters)	Total Dust Concentration (mg/M^3)
Boxer	DM-84	7:20-14:36	616	1.1
Machine Operator	DM-175	7:20-14:37	655	1.3
Floorboy	DM-77	7:50-14:25	592	5.2
Machine Operator	DM-73	7:50-14:35	607	4.1
Scrap Packer	DM-74	8:25-14:45	570	5.7
Sorter	DM-87	8:30-14:47	565	18.9
Machine Operator	DM-91	8:35-14:32	535	4.2
Floater	DM-76	8:35-14:25	525	7.7
				Respirable Dust Concentration
Scrap Packer	DM-82	7:40-14:05	654	0.52
Floorboy	DM-181	7:35-14:40	722	0.22
Machine Operator	DM-80	8:10-14:50	680	0.28
Boxer	DM-90	8:10-14:45	671	0.28
Packer	Dm-78	8:25-14:26	613	0.73

Table V

Purex Corporation
London, Ohio

Personal Breathing Zone Airborne Dust Concentrations
March 6, 1978
(Shift 3:00pm - 11:00pm)

Sample Location	Sample Number	Sampling Period	Sampling Volume (liters)	Total Dust Concentration (mg/M^3)
Relief Worker	DM-273	15:25-22:55	675	41.5 *
Machine Operator	DM-268	15:30-22:50	660	2.6
Machine Operator	DM-276	15:48-22:38	615	1.1
Floorboy	DM-278	16:02-22:50	612	1.4
				Respirable Dust Concentration
Machine Operator	DM-81	15:37-22:45	727	0.34
Machine Operator	DM-75	15:45-22:57	734	0.25
Gluer	DM-93	15:53-22:45	700	0.24
Floorboy	DM-79	16:15-22:38	651	0.41

* questionable sample

Table VI

Purex Corporation
London, Ohio

Personal Breathing Zone Airborne Dust Concentrations
March 5, 1978
(Shift 11:00pm - 7:00am)

Sample Location	Sample Number	Sampling Period	Sampling Volume (liters)	Total Dust Concentration (mg/M^3)
Boxer	DM-89	23:37-6:55	657	1.1
Machine Operator	DM-191	23:51-6:50	628	1.8
Water Softener	DM-88	00:20-7:00	510	4.1
				Respirable Dust Concentration
Floorboy	DM-94	23:57-6:40	685	0.28
Machine Operator	DM-92	23:43-6:45	717	0.18

Table VII

Purex Corporation
London, Ohio

1977 and 1978 Dust Concentrations on Each Shift

		Mean Concentration (mg/M^3)		Average Concentration (mg/M^3)	
		1977	1978	1977	1978
Shift 1	Total Dust	3.5	4.7	3.0	6.1
	Respirable	0.67	0.28	0.67	0.41
Shift 2	Total Dust	4.6	2.0	2.7	1.7
	Respirable	0.54	0.30	0.56	0.31
Shift 3	Total Dust	2.7	1.8	4.6	2.3
	Respirable	0.56	0.23	0.54	0.23