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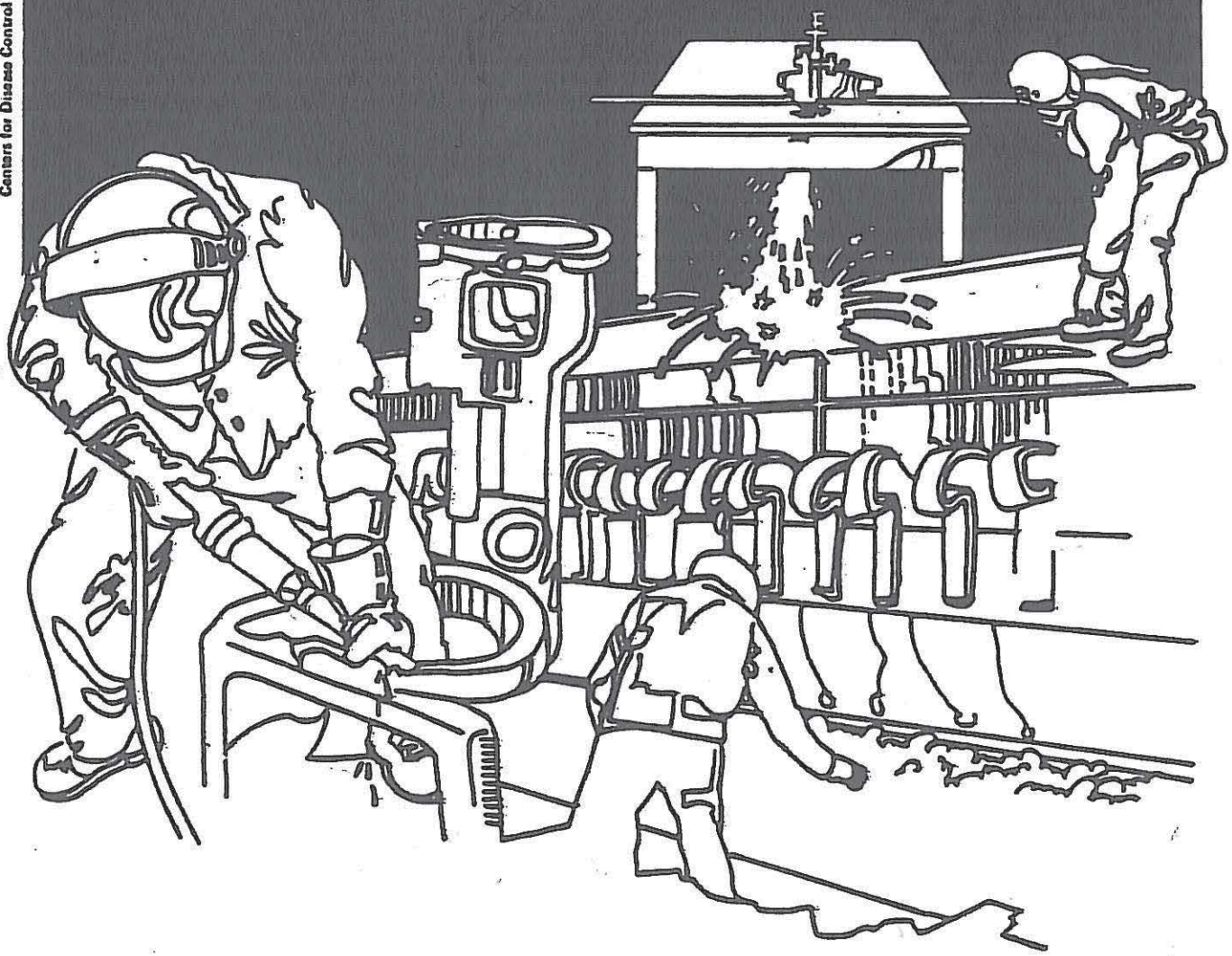
NIOSH



Health Hazard Evaluation Report

HETA 85-031-1706
REVISED
NATIONAL STARCH
INDIANAPOLIS INDIANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 85-031-1706
REVISED September 1986
NATIONAL STARCH
INDIANAPOLIS INDIANA

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I. SUMMARY

On October 23, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at the National Starch and Chemical Corporation, Indianapolis, Indiana. The requestor was concerned that employees of National Starch had increased incidences of pulmonary and cardiovascular disease.

On December 3, 1984, a NIOSH investigator conducted an initial survey and administered questionnaires to employees working in the West Tank House and Process A. On February 27, 1985, a follow-up survey was conducted by a team of NIOSH investigators and on March 26 & 27, 1985, an environmental survey was conducted to evaluate employee exposures to chemical substances used in Process A, the West Tank House, and the Wet Mill. On October 29, 1985, further environmental sampling for sulfur dioxide (SO_2) was conducted in the Wet Mill.

Results of the March environmental survey indicated that airborne concentrations of hydrochloric acid, sulfuric acid, sodium hydroxide, propylene oxide, and total and respirable starch dust were all below the applicable environmental criteria. Sampling in the Wet Mill for SO_2 indicated that employee exposures in the Wet Mill ranged from 1.7 to 2.4 parts of SO_2 per million parts of air (ppm) and were in excess of the NIOSH and the American Conference of Governmental Industrial Hygienists (ACGIH) environmental criteria.

Airborne concentrations of SO_2 in personal samples collected during the October environmental survey ranged from 1.8 to 2.5 ppm and general area air samples ranged from 1.5 to 3.2 ppm. All samples were above the NIOSH Recommended Exposure Limit (REL) of 0.5 ppm for SO_2, and 5 of the 7 were above the ACGIH Threshold Limit Value (TLV) of 2.0 ppm; however, none of the samples were above the Occupational Safety and Health Administrations (OSHA) Permissible Exposure Limit (PEL) of 5.0 ppm.

Information obtained from the questionnaire and informal interviews indicated that some employees were suffering upper respiratory irritation, seemingly due to SO_2 exposure. A selection of former employees interviewed by telephone reported respiratory problems which could have been caused in part, or exacerbated, by exposure to sulfur dioxide and/or starch dust. No evidence of excess cardiovascular disease was obtained.

Based on the environmental sampling results it has been determined that employees of National Starch working in the Wet Mill were exposed to concentrations of sulfur dioxide (SO_2) in excess of the NIOSH recommended exposure limit. Recommendations for reducing employee exposures are contained in Section VIII of this report.

KEYWORDS: SIC 2046 (Wet Corn Milling), hydrochloric acid, propylene oxide, sodium hydroxide, sulfur dioxide (SO_2), sulfuric acid, starch dust

II. INTRODUCTION

On October 23, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at the National Starch and Chemical Corporation, Indianapolis, Indiana. The request indicated concern about a seeming excess of pulmonary and cardiovascular disease.

On December 3, 1984, a NIOSH investigator conducted an initial survey of the facility, including a walk through inspection of the West Tank House and Process A, and administered a questionnaire to all day shift employees in those two areas. On February 27, 1985, a NIOSH team conducted a follow-up visit which included further assessment of the areas of concern and informal interviews with employees in the West Tank House, Process A, and the Wet Mill. On March 26 & 27, 1985, an environmental survey was conducted to evaluate employee exposures to various chemical substances used in the West Tank House, Process A, and the Wet Mill. The company was informed of the results of the environmental survey via telephone in September 1985, and was advised of potentially high levels of sulfur dioxide (SO_2) in the Wet Mill. On October 29, 1985, further environmental sampling for SO_2 was conducted in the Wet Mill. The results were transmitted to all parties via letter on March 10, 1986.

III. BACKGROUND

A. Plant

National Starch and Chemical Company is a manufacturer of corn starch products. The Indianapolis plant has been in existence since 1908 and was acquired by National Starch in 1939.

B. Process Description and Employee Duties

Starch is obtained by a complex "wet milling" process involving milling, wet gravity and sieving separations, and drying to remove excess water once the starch has been washed free of nonstarchy substances. Starch is widely used in the food processing industry and in the manufacture of textiles, paper, adhesives, and laundry starches; however, the largest use in the United States is for conversion to dextrose and a number of glucose syrups.[1]

At National Starch, starch is obtained from corn. In the Wet Mill cleaned, shelled corn is soaked (steeped) in warm water containing SO_2. The SO_2 acts as a biocide and is used again in a second wash solution. The softened grain is passed through degerminating mills

which disintegrate the kernels. The degermed mash is then washed and passed through a series of sieves and vibrating sieves. The screened liquor is separated into starch and gluten by a series of centrifuges.[1] Employee duties in the Wet Mill include overseeing the various stages of wet milling.

The undried corn starch from the Wet Mill is pumped as a slurry to the conversion plants (Tank House West and Process A) where it is chemically treated to modify the cooking characteristics of the corn starch for specific industrial uses. These operations are batch process operations and employee responsibilties include following a specific recipe and monitoring the control panels for proper pH. The corn starch slurry is pumped into a large vessel where it is mixed with specified amounts of various chemicals. The chemicals (e.g. sulfuric acid, hydrochloric acid, sodium hydroxide, etc.) are piped (metered) into the vessels through an enclosed system. Occasionally, the process operator may have to dump sacks of dry chemicals into the vessels through chutes located on the third floor.

Following the conversion process the starch slurry is pumped to the dryer area where it is filtered and dried to a stable moisture content. Employee duties in the dryer area include monitoring the process.

C. Engineering, Administrative, and Personal Protective Controls

All employees are required to wear safety glasses and hard hats. Safety shoes are recommended but not required. Additionally, special personal protective equipment (i.e. face shields, gloves, etc.) are required for certain operations as defined in manuals located in the supervisors' offices.

Each vessel in Process A and Tank House West is individually vented to the outside and employees rotate between the starch conversion areas and the dryers every two weeks.

Currently, all newly hired employees receive a pre-employment physical exam which includes, among other procedures, chest X ray and spirometry. No periodic screening or exit examinations are currently performed.

IV. EVALUATION DESIGN AND METHOD

During the December 1984 initial survey, information was collected relating to the process and confidential questionnaires were administered to the 5 employees working on the day shift in the West Tank House, and also to all 5 day shift employees in Process A.

Additionally, telephone interviews were conducted with four former employees of National Starch. The questionnaire solicited demographic information and work history, and inquired about health complaints and whether any health complaint could be attributed to the job. A smoking history was also obtained.

In February 1985, a plant survey was conducted during which informal interviews were conducted with a selection of employees on duty in the West Tank House, Process A, and the Wet Mill. Information was obtained about each employee's job responsibilities and health status. Additionally, copies of the Occupational Injury and Illness Summary (OSHA No. 200) for the years 1971 - 1984 were obtained and reviewed.

In March 1985, an environmental survey was conducted consisting of personal and general area air sampling in Process A, the West Tank House, and the Wet Mill. In the West Tank House and Process A samples were collected for hydrochloric acid, sulfuric acid, sodium hydroxide, propylene oxide, and total and respirable starch dust. All pertinent sample collection data for these substances are contained in Table 1. In the Wet Mill, samples were collected for SO_2 using a KOH impregnated filter.

In October 1985, further environmental sampling for SO_2 was conducted in the Wet Mill to verify the results of the March survey. Personal and general area air samples for SO_2 were collected using a two filter sampling train consisting of a mixed cellulose ester membrane (AA) filter followed in series by a potassium hydoxide (KOH) impregnated cellulose filter.[2] Personal samples were collected by placing the filter cassettes near the employees' breathing zone and general area samples were placed in areas where the employees were likely to be present. The filters were connected via Tygoné tubing to a battery powered pump operating at 1.5 liters per minute (lpm). Filters were analyzed via ion chromatography according to NIOSH analytical method P&CAM 268.[3] Samples were analyzed by determining particulate sulfate and sulfite concentrations on the AA filters and then determining the gaseous sulfate and sulfite concentrations on the KOH impregnated cellulose filter and calculating the SO_2 concentrations according to a formula provided in P&CAM 268.[3]

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from

adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is required by the Occupational Safety and Health Act of 1970 (29 USC 651, et seq.) to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8 to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures.

A. Sulfur dioxide (SO_2)

The current OSHA standard for SO_2 is 5 parts of SO_2 per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 13 milligrams of SO_2 per cubic meter of air (mg/M^3). NIOSH has recommended that the permissible exposure limit be reduced to 0.5 ppm as a time weighted average for up to a 10-hour work shift, 40-hour work week.[4] The ACGIH recommends a TLV of 2 ppm as an 8-hour TWA and 5 ppm as a 15-minute STEL.[5]

Sulfur dioxide can affect the body if it is inhaled or comes in contact with the eyes or skin. The gas is intensely irritating to the eyes and the respiratory tract, causing burning and tearing of the eyes, coughing, and chest tightness and may also cause severe breathing difficulties.[4] Long-term exposure to SO_2 at concentrations ranging from 0.4 - 3.0 ppm has been associated with decreased lung function. Corresponding increases in some symptoms of respiratory disease and in days off work for illness have also been noted.[6]

B. Starch Dust

Starch dust, while not normally considered a significant respiratory hazard, may aggravate certain lung conditions. Individuals with dust allergies are at particular risk of developing respiratory problems.[7]

C. Other Substances

Table 2 contains a summary of environmental criteria and health effects of sulfur dioxide, starch dust, and other substances for which environmental sampling was conducted.

VI. RESULTS AND DISCUSSION

Results of the March environmental survey showed that airborne concentrations of hydrochloric acid, sulfuric acid, sodium hydroxide, propylene oxide, and total and respirable starch dust were all below the applicable environmental criteria in the two starch treatment areas (Tank House West and Process A). Results of short-term sampling for hydrochloric acid ranged from below the analytical limit of detection (LOD) to 0.93 milligrams per cubic meter of air (mg/M^3). The ACGIH TLV and the OSHA PEL for hydrochloric acid are 7 mg/M^3 as a ceiling concentration during a 15 minute sample. Results of long-term sampling for sulfuric acid ranged from below the LOD to 0.05 mg/M^3. The NIOSH, ACGIH, and OSHA environmental criteria are 1 mg/M^3. Results of long-term sampling for sodium hydroxide ranged from 0.005 to 0.042 mg/M^3. The OSHA PEL for sodium hydroxide is 2 mg/M^3 as an eight-hour TWA. Results of sampling for respirable starch dust ranged from 0.04 to 0.33 mg/M^3. The OSHA PEL and ACGIH TLV are 5 mg/M^3. Results of sampling for total starch dust ranged from 1.06 to 2.36 mg/M^3. The ACGIH TLV and OSHA PEL are 10 mg/M^3 and 15 mg/M^3, respectively.

Sampling conducted in the Wet Mill for SO_2 indicated that employee exposures in the Wet Mill were in excess of the NIOSH and the ACGIH environmental criteria. During this survey, the AA filter for particulate sulfates and sulfites was not used, only the KOH impregnated filter was used to determine the amount of SO_2 vapors. Results of SO_2 sampling along with all pertinent sampling data are presented in Table 3.

Results of the October follow-up environmental survey showed no detectable concentrations of particulate sulfates and sulfites on the AA filters. However, the KOH impregnated cellulose filters did show detectable concentrations of SO_2 on both personal and general area air samples. Personal samples ranged from 1.8 to 2.5 ppm and general area air samples ranged from 1.5 to 3.2 ppm. All samples collected were above the NIOSH recommended exposure limit of 0.5 ppm for SO_2, and 5 of the 7 were above the ACGIH TLV of 2.0 ppm. However, none of the samples were above the OSHA PEL of 5.0 ppm. Complete sample results and pertinent sampling data are provided in Table 4.

Analysis of the December 1984 questionnaires revealed no significant findings (Table 5). All 10 respondents were male, ranging in age from 37-59 years of age. Six of the 10 have been cigarette smokers. There were no health complaints reported from any of the 5 workers in the West Tank House. One worker in Process A reported a work-related back injury and previous open heart surgery and a second worker reported being treated for hypertension.

The four former employees interviewed by telephone each reported significant health complaints. These were primarily respiratory problems, often marked by shortness of breath. Three of the four had been cigarette smokers (one quit in 1951) and one had worked in a coal mine for 12 years. While it is impossible to make a determination solely from a telephone interview, it is conceivable that the respiratory problems of these men could have been caused or aggravated by their work at National Starch. All four men worked a significant amount of time (21-32 years) at the plant. One man (age 53 years) reported having a bypass surgery in 1984. He had smoked cigarettes since age 16.

During the informal interviews conducted in February 1985, some complaints of upper respiratory irritation were registered by workers from the Process A Area. Complaints of that type were more consistently and strenuously registered among workers in the Wet Mill Area. They attributed these complaints, plausibly, to SO_2 exposure.

A review of the OSHA Injury and Illness Summaries revealed a total of 14 recorded incidents (over 14 years) of "respiratory conditions due to toxic agents." The majority occurred during the late 1970's.

VII. CONCLUSION

Based upon the environmental sampling results and the employee interviews/questionnaires, it has been determined that a hazard from exposure to SO_2 did exist at National Starch. The results of

the environmental sampling indicate that employees working in the Wet Mill were exposed to airborne concentrations of SO_2 in excess of the NIOSH recommended exposure limit of 0.5 ppm and none of the workers were observed wearing respiratory protection. General area samples also indicate excessive levels of SO_2 in the third floor control office, the third floor centrifuge area, and the fourth floor steep top area.

While airborne concentrations of starch dust were not above the environmental criteria used, exposure to starch dust must be kept to a minimum. Starch dust can aggravate pre-existing respiratory conditions, such as emphysema and it is conceivable that this phenomenon may have occurred with former employees of National Starch. Given the lack of occupational exposure to suspected cardiotoxic agents and the lack of cardiovascular disease reported by the employees, no excess risk of cardiovascular disease was documented at this time.

VIII. RECOMMENDATIONS

1. Airborne SO_2 concentrations in the Wet Mill should be reduced by the installation of effective engineering controls, improved employee work practices, and the use of respiratory protection.

2. Steep top lids should be kept closed to prevent the escape of SO_2 into the general workroom environment.

3. An effective maintenance program for processing equipment should be established. Seals on the centrifuges and other processing equipment should be effectively maintained to prevent the release of SO_2.

4. The use of direct reading monitoring equipment should be used to monitor airborne concentrations of SO_2 and to locate sources of leaks.

5. Employees should be provided with adequate respiratory protection until appropriate engineering controls are installed or until airborne SO_2 concentrations are reduced to levels below the NIOSH recommended exposure limit of 0.5 ppm.

6. Airborne concentrations of starch should continue to be controlled through proper maintenance of equipment and good housekeeping practices.

7. Use of respirators until engineering controls are installed may require modification and/or expansion of the existing respiratory protection program. All aspects of this program must comply with the requirements provided in 29 CFR 1910.134.

8. A thorough work history and a medical history should be added to the pre-employment examinations given by the company.

9. In addition, to the pre-employment exam, NIOSH recommends[8] that "comprehensive ... annual medical examinations shall be provided for all workers subject to exposure to SO_2. The examination shall be

directed toward but not limited to the eyes and the cardiopulmonary system; particular attention shall be focused on complaints of mucous membrane irritation and cough. An evaluation of the advisability of a worker using negative- or positive-pressure respirators shall also be made."

10. Starch dust may aggravate pre-existing respiratory conditions therefore, workers exposed to starch dust should receive a similiar annual medical examination.

IX. REFERENCES

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IX. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), Port Royal Road, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH publications office at the Cincinnati address. Copies of this report have been sent to the following:

A. Oil, Chemical and Atomic Workers Union, OCAW Local #7-706

B. National Starch and Chemical Corporation, Indianapolis, Indiana

C. U.S. Department of Labor, OSHA - Region V

D. NIOSH, Region V

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE 1

Sampling and Analysis Methodology

National Starch and Chemical Corporation
Indianapolis, Indiana
HETA 85-031

Substance	Collection Media	Flowrate (LPM)	Analysis	Detection Limit (ug/sample)	NIOSH Reference Method
STARCH DUST (respirable)	PVC Filter with 10 mm cyclone	1.7	Gravimetric	10	0600
STARCH DUST (total)	PVC Filter	1.5	Gravimetric	10	0600
HYDROCHLORIC ACID	Solid Sorbent Tube	0.5	Ion Chromatography	2	7903
SULFURIC ACID	Solid Sorbent Tube	0.5	Ion Chromatography	4	7903
SODIUM HYDROXIDE	Teflon® Filter	1.5	Atomic Absorption	1	P&CAM 173
PROPYLENE OXIDE	Charcoal Tubes	0.5	Gas Chromatography	0.03	1612
SULFUR DIOXIDE (SO_2)	AA Pre-filter KOH impregnated filter	1.5	Ion Chromatography	8-10	P&CAM 268

TABLE 2

Environmental Evaluation Criteria and Health Effects Summary
National Starch and Chemical Corporation
Indianapolis, Indiana
HETA 85-031

Substance	Environmental Criteria* NIOSH PEL	OSHA PEL	ACGIH TLV	Primary Health Effects
Hydrochloric acid	---	7(c)	7 STEL	A strong irritant of the eyes, mucous membranes, and skin. Irritant effect of vapors on the respiratory tract may produce laryngitis, glottal edema, bronchitis, and pulmonary edema.
Starch dust	---	5	5	Regulated as a nuisance dust. However, it may aggravate certain lung conditions such as emphysema. The International Labor Organization (ILO) recommends that individuals sensitive to dust should not work in dusty areas.
Starch dust (total)	---	15	10	Same as above.
Propylene oxide	---	240 ppm	50 ppm	An irritant of the eyes, mucous membranes, and skin; at high concentrations it causes narcosis in animals, and it is expected that severe exposure will produce the same effect in humans. No chronic or systemic effects have been reported in humans.
Sodium hydroxide	2(c)	2	2(c)	Dermatitis may result from repeated exposure to dilute solutions in the form of liquids, dusts, or mists.
Sulfur dioxide (SO_2)	0.5 ppm	5 ppm	2 ppm	A severe irritant of the mucous membranes of the upper respiratory tract.
Sulfuric acid	1	1	1	Sulfuric acid mist exposure causes irritation of the mucous memebranes, including the eye, but principally the respiratory tract epithelium.

* - Values are given in milligrams per cubic meter of air unless otherwise noted as parts per million (ppm).
STEL - short-term exposure limit, considered a maximum allowable concentration for a 15-minute sample period.
(c) - ceiling limit, considered a maximum allowable concentration for a 15-minute sample period.

TABLE 3

Personal Sampling Results for Sulfur Dioxide (SO_2)
National Starch and Chemical Corporation
Indianapolis, Indiana
HETA 85-031

Date	Location/Job	Sampling Duration	Sample Volume (liters)	Sulfur dioxide (ppm)
3/26/85	Wet mill operator #1	06:50 - 09:30	240	3.2
		09:30 - 12:43	298	2.0
		12:43 - 14:35	168	1.8
				Total TWA = 2.4
3/27/85	" " " "	06:47 - 09:41	261	2.7
		09:41 - 12:38	266	1.3
		12:38 - 14:30	168	1.8
				Total TWA = 1.9
3/26/85	Wet mill operator #2	06:52 - 09:28	234	1.5
		09:28 - 12:40	288	2.2
		12:40 - 15:18	237	1.9
				Total TWA = 1.9
3/27/85	" " " "	06:50 - 09:37	250	1.9
		09:37 - 12:35	267	1.7
		12:35 - 14:41	189	1.6
				Total TWA = 1.7
3/26/85	Wet mill operator #3	07:15 - 09:27	198	1.7
		09:27 - 12:34	280	2.2
		12:34 - 15:13	238	2.9
				Total TWA = 2.3
3/27/85	" " " "	06:57 - 09:32	232	2.0
		09:32 - 12:27	262	2.5
		12:27 - 14:45	207	1.5
				Total TWA = 2.0
Environmental Criteria:		NIOSH		0.5
		ACGIH		2.0
		OSHA		5.0

TABLE 4

Personal and General Area Air Sampling Results for Sulfur Dioxide (SO_2)
National Starch and Chemical Corporation
Indianapolis, Indiana
HETA 85-031

Date	Location/Job	Sampling Duration	Sample Volume (liters)	Sulfur dioxide (ppm)
		PERSONAL SAMPLES		
10/29/85	Wet mill/operator	08:14 - 11:13	268	2.4
		11:13 - 15:10	356	2.5
			Total TWA =	2.5
10/29/85	Wet mill/operator	07:31 - 10:55	306	2.5
		11:05 - 14:54	344	1.8
			Total TWA =	2.1
		GENERAL AREA SAMPLES		
10/29/85	3rd floor control office	08:17 - 15:19	533	1.5
10/29/85	3rd floor centrifuge area, adjacent to sink	07:53 - 15:18	668	3.2
10/29/85	4th floor steep tops, between tanks 3 & 4	09:59 - 15:22	484	3.0
Environmental Criteria:		NIOSH		0.5
		ACGIH		2.0
		OSHA		5.0

TABLE 5

Questionnaire Results
December 1984
National Starch and Chemical Corporation
Indianapolis, Indiana
HETA 85-031

	TANK HOUSE WEST	PROCESS A
# of questionnaires	n=5	n=5
Age (mean ± standard deviation)	46.8 ± 7.9 yrs.	55.2 ± 2.5 yrs.
Yrs. at Nat. Starch (mean + std. dev.)	23.1 ± 7.8 yrs.	28.2 ± 2.9 yrs.
Alleged work-related health problems	0/5 (0%)	1/5 (20%) *
Type of work-related health problem	- -	back injury
Cigarette smoker	4/5 (80%)	2/5 (40%)

* Two workers in Process A mentioned high noise levels as a potential problem.