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LADISH MALTING COMPANY
JEFFERSON JUNCTION, WISCONSIN

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I. SUMMARY

On January 31, 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate reported symptoms of respiratory irritation, fatigue, and neurological problems among employees in the quality control laboratory at the Ladish Malting Company, Jefferson Junction, Wisconsin. This company is engaged in malting barley for use in beer.

In April 1983, NIOSH investigators conducted an initial survey of the facility. In May 1983, a medical survey was conducted during which confidential interviews were administered to employees in the quality control laboratory and in other areas of the plant. Additionally, questionnaires were mailed to all former employees of the quality control laboratory, and to all current Ladish employees not interviewed on site. Pertinent medical records were obtained as well.

Twenty-five (61%) of the 41 employees known to have worked in the control laboratory since 1970 completed questionnaires. No similarity of illness could be identified following a review of the medical records and questionnaires. Four individuals did indicate that they experienced tremors; however, these cases appeared to be of disparate origins.

Questionnaires were completed by 29 (81%) of the 36 employees working in the other areas of the plant. The results did not indicate that those workers were experiencing health problems related to those in the quality control laboratory. Workers in these other areas most frequently reported acute irritant symptoms associated with the use of hypochlorite disinfecting agents.

A review of environmental data collected during two previous surveys in the quality control laboratory, one by the Occupational Safety and Health Administration (OSHA) and one by a private industrial hygiene consultant, did not indicate the presence of detectable levels of sulfur dioxide in 4 samples collected, sulfuric acid in 7 samples, selenium in 2 samples, or 2,4-dinitrophenol in 1 sample. Trace levels of mercury (average 0.002 milligrams per cubic meter of air (mg/M^3)) were detected in four samples during a relatively short (15 minutes) infrequently conducted process (once a week at most). The NIOSH recommended standard for mercury is 0.05 mg/M^3 as an 8 - 10 hour time weighted average (TWA), and the OSHA ceiling standard is 0.1 mg/M^3 for a 15 minute period. Low levels of total dust (average 0.22 mg/M^3) were detected in four samples, and concentrations were below the American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Value (TLV) of 10 mg/M^3 for nuisance dust.

On the basis of the data obtained during this investigation, NIOSH was unable to identify any occupationally related health problems among employees in the quality control laboratory. General recommendations related to laboratory operations as well as other areas of the plant are included in full body of this report.

KEYWORDS: SIC 2084, malt manufacturing, barley, Kjeldahl.

II. INTRODUCTION

On January 31, 1983, a representative of the Brewers and Maltsters, Local Union 53, requested a NIOSH health hazard evaluation at the Ladish Malting Company, Jefferson Junction, Wisconsin. The requestor was concerned with complaints of respiratory irritation, fatigue, and neurological problems among employees working in the facility°s quality control laboratory, particularly during a Kjeldahl procedure. In addition, the requestor was concerned that employees in the research laboratory, compartments, loading floor, and storage bin areas of the facility might also be experiencing health problems related to the problems in the quality control laboratory.

On April 5, 1983, NIOSH investigators conducted an initial survey of the facility. An opening conference was conducted with representatives of management and the union during which background information was obtained relating to the basis for the request, previous environmental surveys, and specific information related to the areas of concern. Following a walk-through inspection of the facility, a closing conference was held with plant and union representatives. On May 26, 1983, a medical survey was conducted during which confidential employee interviews were administered. In addition, questionnaires were mailed to former employees of the quality control laboratory and current employees of Ladish not interviewed on site. The responses to these questionnaires were returned to the NIOSH Region V office for review and analysis.

III. BACKGROUND

The Ladish Malting Company has been in operation since the 1890°s, and approximately 125 workers are currently employed in production, quality control, and maintenance operations, involved in the production of malt. Malting is the process in which barley is germinated, heated, aged, and blended in order to produce malt. This process requires strict cleanliness, purity, and manufacturing controls in order to produce barley that will meet required specifications.

To begin the process, barley arrives at the plant via rail shipment. The grain is unloaded and placed in the barley elevators on the west side of the facility. When ready for use, the barley is cleaned and graded according to size, and conveyed to a malt house. Here, the barley is placed in steeping tanks where the grain is totally immersed in water. After a specified period of time, the grain is discharged from the tanks into a series of growing or germinating compartments where the sprouting of the grain takes place. It is during this process that the barley starch is changed to maltose which eventually becomes fermentable sugar at the brewery. Once germination reaches a specific point, the process must be halted to ensure that the germinated barley (referred to as green malt) retains the desired qualities. To accomplish this, the green barley is conveyed to one of the kilns on the north side of the facility. Here, hot, dry air is pulled upward through the grain in order to stop the germination process, as well as reduce

the moisture content of the grain. After being dryed at three successive levels within the kiln, the grain is dropped into malt hoppers and conveyed to one of six malt elevator groups for aging and curing, prior to blending and shipment to the customer.

The major area of concern specified in the health hazard evaluation request was the quality control laboratory. Located within the facility°s main administrative building, this laboratory supports a number of routine analytical tests performed in order to determine certain characteristics of the malt and barley. The major activities in this laboratory are briefly described below.

1) The Kjeldahl Analysis utilizes a Pope-Kjeldahl selenium catalyst along with sulfuric acid, sodium hydroxide, and methylene blue to determine the protein content of the barley. During this process, Kjeldajl flasks are removed from heating elements contained in two laboratory hoods to allow for the addition of water, small quantities of catalyst, and sulfuric acid. The mixture is then heated further followed by further addition of sulfuric acid. Although the heating is conducted under a laboratory hood, addition of the water, acid, and catalyst takes place away from the hood.

2) A sulfur dioxide analysis of the malt is conducted infrequently (usually once a month, but once a week during the peak season). This test requires the use of formaldehyde, mercuric chloride, para-rosaniline hydrochloride, and sodium bisulfite, with the entire procedure usually lasting 15 minutes.

3) Determination of the sugar content of malt is conducted in a process which includes heating of a 2,4-dinitrophenol indicator in a water bath.

4) Sizing and grinding of incoming grain is conducted on small aliquots of barley (approximately 30 - 55 gram samples) using small sieves and grinders.

5) Analysis of grain samples for protein and moisture content is carried out using an infrared analyzer.

6) Extraction of the malt for the Kjeldahl analysis is accomplished by germinating barley in a warm humid environment and extracting the grain for later use.

7) Routine cleaning of glassware is carried out using a potassium dichromate solution.

Other areas of the plant were examined for their possible relationship to the reported problems in the control laboratory. These areas included the following:

1) The research laboratory located adjacent to the germinating compartments in the malt house. This laboratory primarily conducts wastewater analysis. Other types of analysis are occasionally performed along with routine cleaning of glassware.

2) On the loading floor, 11 employees are involved in blending of the grain, loading of the malt into railcars for shipment, as well as routine maintenance activities.

3) In the malt house, one employee is responsible for loading and unloading the grain in and out of each of the 6 sets of compartments. Additionally, two employees disinfect the compartments after they are emptied, using a liquid sodium hypochlorate solution (15%) and granular calcium hypochlorite (65%).

4) In the malt and barley storage bin areas where 4 employees are located, pesticides such as Malathion and Pyrethrins are occasionally utilized, usually in the spring.

IV. EVALUATION DESIGN AND METHODS

A. Medical:

The medical survey utilized in this evaluation was designed with a two-fold purpose; first, to determine if a commonality of occupationally related health problems existed among present and past employees of the control laboratory, and second, to determine if health problems reported by employees in other areas of the plant were related to those reported by employees in the control laboratory.

The first portion of this study included all those employees who had worked in the control laboratory at any time since 1970. A questionnaire was administered to current employees on May 26, 1983. The questionnaire sought information concerning symptomatology related to disease of the central or peripheral nervous systems, gastrointestinal tract, eye, ear, and respiratory system. An abridged version of this questionnaire was mailed to former employees of the quality control laboratory, inquiring as to the presence of any health problems experienced by the former employee during or after their work in the laboratory. In those instances where health problems were reported as being potentially related to the individual°s employment, personal medical records were solicited for further review.

The identical questionnaire used in the control laboratory was also administered to current employees in other areas of the plant who were suspected by the requestor of having related symptoms. These employees included those working in the grain storage silos, malt loading areas, compartment unloaders, and sanitation of the compartment areas.

B. Environmental:

Various types of information were considered in the environmental evaluation. First, a walk through survey was conducted and the laboratory activities reviewed. Second, the data collected during previous environmental surveys in the control laboratory were examined (one inspection by OSHA and another by an industrial hygiene consultant), as well as discussions with the investigators in these

surveys. Third, other areas of the facility were inspected for possible exposures which might be affecting employees in the control laboratory, and information on the major substances used in these areas was obtained. Fourth, toxicity data on the substances creating the most likely exposure potential were reviewed. Finally, the information collected during the medical portion of the evaluation was used as a means of pinpointing any potentially hazardous process or contaminant in the control laboratory.

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 U.S.C. 651, et seq. to meet only 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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures. A summary of the environmental criteria is presented in Table 3.

A brief discussion of the health hazards of the primary substances utilized or possibly present in the control laboratory is given below.

A. Sulfur Dioxide

Sulfur dioxide is a colorless gas that is particularly irritating to the mucous membranes of the upper respiratory tract. Chronic exposure may result in nasophayngitis, fatigue, altered sense of smell, and chronic bronchitis. Acute over-exposure can result in death from asphyxia.

B. Sulfuric Acid

Sulfuric acid mist may cause irritation of the mucous membranes of the respiratory tract and the eyes. The mist also causes etching of the dental enamel which can lead to deterioration of the teeth. Repeated overexposures over long periods of time may lead to chronic bronchitis, chronic eye inflammation, nasal discharge and bleeding.

C. Selenium

Selenium in its elemental state is considered to be relatively nonirritating and poorly absorbed. An early sign of selenium absorption is a garlic odor of the breath. Less specific systemic effects which have been reported include pallor, lassitude, irritability, indigestion, and giddiness. Although no harm to vital organs is apparent, liver and kidney damage should be regarded as possible.[1]

D. Mercury

Mercury, when present in the elemental or inorganic state, is a primary irritant of the skin and mucous membranes. Exposure to low levels of mercury over prolonged periods of time produce many different symptoms, depending on the individual. These may include, weakness, fatigability, loss of weight, insomnia, indigestion, diarrhea, loss of memory, irritability, and tremors of fingers, eyelids, lips, or tongue.[1]

E. 2,4 Dinitrophenol

2,4-Dinitrophenol may cause dermatitis, either through primary irritation or sensitization. Dinitrophenols are known to disrupt oxidative phosphorylation, resulting in increased metabolism, oxygen consumption, and heat production[2]. Additionally, in rabbits dinitrophenol has been found to cause cataracts when applied to lenses in laboratory conditions.[1]

F. Potassium Dichromate

Potassium dichromate may cause stomach and kidney problems. Skin exposure to chromates may cause ulceration of the skin. Repeated or prolonged exposure to chromate dust or mist may cause an ulceration or perforation of the nasal septum. Although some forms of chromium have been found to cause increased respiratory cancer among workers, sodium dichromate is believed to be non-carcinogenic.[1]

VI. RESULTS

A. Environmental

1. Control Laboratory

The results of the environmental data collected by OSHA and the Industrial Hygiene Consultant are presented in Tables 1 and 2. A review of this data did not indicate the presence of detectable levels of sulfur dioxide in 4 samples collected, sulfuric acid in 7 samples, selenium in 2 samples, or 2,4-dinitrophenol in 1 sample. Trace levels of mercury (average 0.002 milligrams per cubic meter of air (mg/M^3)) were detected in four samples during a relatively short (15 minutes) infrequently conducted process (once a week at most). The NIOSH recommended standard for mercury is 0.05 mg/M^3 as an 8 - 10 hour time weighted average (TWA), and the OSHA ceiling standard is 0.1 mg/M^3 for a 15 minute period. Low levels of total dust (average 0.22 mg/M^3) were detected in four samples, and concentrations were below the American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Value (TLV) of 10 mg/M^3 for nuisance dust.

The substances monitored for in specific operations included, sulfur dioxide, sulfuric acid, selenium, tellurium, and lead during the Kjeldahl process; mercury during the sulfur dioxide analysis, nuisance dust and fungal agents in areas of the lab where grain samples were handled, and 2,4-dinitrophenol in the sugar analysis. These results indicate very low or non-detectable levels of the contaminants expected to present the greatest exposure potential in the control laboratory.

2. Other Areas of the Plant

Examination of the other areas of the plant did not reveal any exposure which would be expected to affect employees in the control laboratory. The disinfecting process which utilized sodium and calcium hypochlorite was identifed as presenting a potential hazard if not properly conducted, however, these substances were primarily used in areas of the plant physically removed from the control laboratory. In addition, the information obtained through the medical survey did not indicate any potentially occupationally related problems in the control laboratory that were present in other areas of the plant, which would not seem to indicate a common exposure in these areas.

B. Medical

1. Control Laboratory

Symptoms:

Forty-one employees were known to have worked in the control laboratory since 1970. Questionnaires were returned by 25 of these employees. Twelve reported no health problems during or after their work in the laboratory. Nine reported eye, nose, and throat irritation during their employment. Three reported headaches associated with the work in the control laboratory, specifically the Kjeldahl process. Five reported unusual fatigue when working with the Kjeldahl process. Four indicated tremors and two noted numbness and tingling of their hands. Three reported recurrent psychological depression since beginning their employment in the control laboratory. However, review of the medical record of the employees indicated that these neurological problems appear to be of disparate origins.

Diseases:

A variety of diseases were either reported by the employees, and/or documented by medical records supplied by the employees, since beginning their work at the control laboratory. Two employees (one who had worked only 3 months, and one who had worked for 2 years) suffered premature cataracts 2-1/2 and 8 years following departure from the laboratory. Neither employee had substantive exposure to 2,4 dinitrophenol during their employment in the laboratory.

No other disease was found to be affecting more than one individual. Further, no group of diseases with potentially common causative factors was identified in this group of workers.

2. Other Areas of the Plant

Twenty-nine of a potential 36 employees were interviewed or returned questionnaires. Twenty-two of these employees reported acute problems associated with exposure to hypochlorite use. These symptoms included tiredness, nausea, diarrhea, headaches, numbness and tingling of hands, wheezing, shortness of breath, chest tightness, and almost all reported irritation of eyes, nose, or throat.

No other problems were reported by these workers except one grain handler reported the development of Parkinson°s Disease after 33 years of employment. Six employees reported no health problems related to work and no symptoms.

The research laboratory technicians reported multiple problems, including irritation related to the disinfecting process.

VII. DISCUSSION

Despite the lack of detectable levels of the contaminants sampled for in the Kjeldahl process, it was evident from the data generated by the medical questionnaires that this process can cause acute irritation to the mucous membranes of the eyes, nose, and throat of the employee performing the test. Since the actual heating of the flasks takes place in laboratory type hoods equipped with local exhaust ventilation, exposure to the irritating substances appeared to take place during the addition of reagents outside of the hood. One employee indicated that failure to allow the Kjeldahl flasks to properly cool before addition of reagents, appeared to further intensify this problem.

Results of the environmental data collected during other operations in the laboratory did not reveal any significant airborne exposures. Mercury was detected only at trace levels during the sulfur dioxide analysis, and the infrequent nature of this operation would not appear to present a health hazard provided that proper work practices are followed.

When an overall comparison was made of the available medical records and questionnaires for workers employed in the control laboratory since 1970, no similarity of illness could be identified. The neurologic problems of the four individuals indicating tremors on their questionnaires would appear to be of disparate origins. Furthermore, no relationship was found between the symptomatology of the employees in the control laboratory and those employees in the other areas of the plant. Though no evidence of past exposure was available, in light of the environmental and medical findings in this evaluation it was felt that at this time no additional medical testing or evaluation was necessary. However, we cannot rule out past exposure in the plant being related to the current medical problems of individual employees.

General concerns currently exist in the grain handling and storage industry over the use of fumigants or pesticides. This was evaluated as a possible cause of the complaints of the employees in the control laboratory through a review of the literature and a comparison of the questionnaires and medical information collected from control laboratory employees and employees from other areas of the plant. It was concluded that any adverse health problems from these substances would also be expected to be present among those employees directly involved in the grain handling and storage operations where the potential for exposure would be much greater than in the control laboratory where comparatively minute quantities of grain are handled. In view of this, the medical findings did not indicate that fumigant or pesticide exposure was a factor in this evaluation.

The medical questionnaires did reveal a substantial number of employees in the grain handling areas who frequently reported acute irritant symptoms associated with the hypochlorites used in the disinfecting process. While those employees directly involved in application of these materials were provided with respirators and other personal protective equipment, employees in adjacent areas and employees reentering the disinfected areas often experienced irritation and other symptomatology. During the initial survey, the company had indicated plans to modify the ventilation system in the research laboratory where this problem had been reported to occur.

VIII. RECOMMENDATIONS

1. Efforts should be made to eliminate the transient irritation experienced during the addition of reagents by the employee performing the Kjeldahl analysis. Possible corrections to this process would be to extend the cooling periods for the flasks, or perform the reagent addition within a laboratory hood.

2. An up-to-date file should be kept containing material safety data sheets for all materials utilized in the laboratory. Workers should be thoroughly instructed as to the routes of exposure, required work practices and personal protection to be used with each substance they encounter.

3. Although it was not the primary focus of this evaluation, based on the results of the medical survey, it appears that the hypochlorite disinfecting process should be reevaluated; not only to ensure that adequate protection is given to the employees performing the job, but also to ensure that other employees working in neighboring areas are not subjected to irritation resulting from this process. Additionally, any pesticide use within the facility should be conducted with strict supervision with attention to proper protection for workers required to enter these areas while the possibility of airborne levels of these substances might exist. In addition, it is recommended that an environmental monitoring program be implemented to asess levels of fumigants and pesticides potentially present in incoming grain shipments.

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Brewers and Maltsters, D.A.L.U. 53, AFL-CIO
2. Ladish Malting, Incorporated
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

RESULTS OF SAMPLES COLLECTED IN THE QUALITY CONTROL LABORATORY
BY THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
(April 30, 1982)

Sample Type	Process Sampled	Sample Time (minutes)	Contaminant Sampled	Sample Results TWA Concentration
Personal	Kjeldahl	200	Sulfur Dioxide	None Detected
Personal	Kjeldahl	205	Sulfur Dioxide	None Detected
Area	Kjeldahl	196	Sulfur Dioxide	None Detected
Area	Kjeldahl	193	Sulfur Dioxide	None Detected
Personal	Kjeldahl	405	Sulfuric Acid	None Detected
Area	Kjeldahl	389	Sulfuric Acid	None Detected
Personal	Kjeldahl	384	Mercury	0.002 mg/M^3
Personal	So_2 Test	293	Mercury	0.003 mg/M^3
Area	So_2 Test	56	Mercury	0.001 mg/M^3
Area	So_2 Test	307	Mercury	0.002 mg/M^3
Personal	Kjeldahl	413	Selenium	None Detected
Personal	Kjeldahl	413	Lead	None Detected
Personal	Kjeldahl	413	Tellurium	None Detected
Area	Kjeldahl	389	Selenium	None Detected
Area	Kjeldahl	389	Lead	None Detected
Area	Kjeldahl	389	Tellurium	None Detected

TWA - Time Weighted Average for duration of sample collection

Table 2

RESULTS OF SAMPLES COLLECTED IN THE QUALITY CONTROL LABORATORY
BY THE INDUSTRIAL HYGIENE CONSULTANT
(February 8, 1983)

Sample Type	Process/Area Sampled	Sample Time (minutes)	Contaminant Sampled	Sample Results TWA Concentration
Area	Kjeldahl	175	Sulfuric Acid	None Detected
Area	Kjeldahl	175	Sulfuric Acid	None Detected
Area	Kjeldahl	175	Sulfuric Acid	None Detected
Area	Kjeldahl	154	Sulfuric Acid	None Detected
Area	Kjeldahl	154	Sulfuric Acid	None Detected
Area	Sugar Analysis	50	2,4-Dinitrophenol	None Detected
Area	Office-Milling Rm.	207	Nuisance Dust*	0.16 mg/M^3
Area	Grinding	336	Nuisance Dust*	0.13 mg/M^3
Area	Extraction	330	Nuisance Dust*	0.12 mg/M^3
Area	Testing-Storage	175	Nuisance Dust*	0.48 mg/M^3

*Samples for fungal agents were also collected at these locations

TWA - Time Weighted Average for duration of sample collection
mg/M^3 - milligrams of contaminant per cubic meter of air

Limits of Detection: Sulfuric Acid - 20 micrograms per sample
2,4-Dinitrophemol - 10 micrograms per sample

Table 3

SUMMARY OF ENVIRONMENTAL CRITERIA

Ladish Malting Company
Jefferson Junction, Wisconsin

Contaminant	NIOSH OSHA PEL	ACGIH Recommendation	TLV
Sulfur Dioxide	5 ppm	0.5 ppm	2 ppm
Sulfuric Acid	1 mg/M^3	1 mg/M^3	1 mg/M^3
Selenium 0.2 mg/M^3	-----	0.2 mg/M^3	
Mercury 0.1 mg/M^3(ceiling)	0.05 mg/M^3	0.1 mg/M^3	
Nuisance Particulate	15 mg/M^3	------	10 mg/M^3
2,4-Dinitrophenol*			

* There is currently no standard for this substance, however; a useful guideline of 0.2 mg/m^3 is based on data for dinitro-o-cresol.[1]