HETA 2000-0105-2794
Wampler Foods, Inc.
Hinton, Virginia

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PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of eye, nose, and throat irritation in the First Processing Department

In March 2000, NIOSH conducted a health hazard evaluation (HHE) at Wampler Foods, Inc. We measured levels of air contaminants thought to cause irritation. We evaluated the ventilation system and collected information on health complaints.

What NIOSH Did

We collected air samples for chlorine, chloramine, and ammonia.
We collected information about the process water.
We handed out a questionnaire to evaluate employee health complaints.
We evaluated the ventilation system using fog and observing air flow.

What NIOSH Found

Workers get eye, nose, and throat irritation.
The ventilation system was not working well.
Chlorine and ammonia were either not detected or were at very low levels.
The sodium hypochlorite system can leak and does not control water chlorine levels very well.
Chloramines in the air may be the cause of irritation.

What Wampler Foods, Inc. Managers Can Do

Improve the superchlorination system to ensure consistent chlorine levels.
Promptly fix chlorine system leaks.
Design and install a better ventilation system.

What the Wampler Foods, Inc. Employees Can Do

Quickly report chlorination system problems.
Tell managers when irritation occurs.
Follow all safety rules and participate in company efforts to evaluate problems.

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report # 2000-0105-2794

National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 2000-0105-2794
Wampler Foods, Inc.
Hinton, Virginia
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SUMMARY

On January 6, 2000, The National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) at the Wampler Foods, Inc. turkey processing plant in Hinton, Virginia. The request indicated that employees in the First Processing department (Evisceration, chiller area, Canner Dock, Sizing) were experiencing health problems possibly related to the use of "superchlorinated" water. Reported symptoms were intermittent eye, nose, and throat irritation. Potential exposures included sodium hypochlorite, ammonia, chlorine, and chloramines. NIOSH was asked to evaluate the work environment in the First Processing department, assess potential exposures to workplace contaminants, and make control recommendations.

On March 1-3, 2000, NIOSH researchers conducted a site visit at the turkey processing plant. On March 2 and 3, 2000, area air samples for ammonia and chloramine were collected at six locations in the First Processing department and one control area (Packaging department). Instantaneous air samples for chlorine were collected at various times and locations. Water sampling data (chlorine, pH, temperature) from the product chillers was obtained, and a symptom questionnaire was administered to 65 Wampler employees. Temperature, relative humidity, and carbon dioxide (CO_2) measurements were taken in the First Processing department on March 2nd. Airflow patterns were visually evaluated in various areas using theatrical fog. Work practices were observed and informal discussions were held with workers, the clinic nurse, and the United States Department of Agriculture (USDA) inspectors. A limited inspection of the chlorination system was conducted.

Instantaneous measurements for chlorine resulted in some discoloration of the colorimetric tube at times when eye irritation was being experienced; however, the discoloration was not the expected orange. This indicates that another chemical was responsible for the color change. The average chloramine levels for work areas near the chiller tanks were approximately 1 milligram per cubic meter (mg/m^3). Chloramine levels in the USDA and final inspection areas were somewhat lower at 0.6 mg/m^3. Concentrations were highest early in the morning. Three background samples collected in the packing area were not above the limit of detection. Evaluation criteria for chloramine in air has not been established. Low concentrations of ammonia were detected in all samples collected from the Evisceration area; all samples were well below the NIOSH recommended exposure limit (REL) for ammonia. Ammonia was not detected on a sample collected in the control area.

The general direction of air flow was from the chiller area into the Evisceration area, and stagnant conditions were present in many areas. Under such conditions, air contaminants would not be readily dispersed or removed. CO_2 levels of up to 3000 parts per million (ppm) were measured in the Tray Pack department. The NIOSH REL for CO_2 is 5000 ppm. While performing ventilation tests near the bulk sodium hypochlorite

tank after the production shift ended, a pinhole leak was found in the tubing between the bulk tank and the metering pumps. The investigators noticed a strong chlorine odor and experienced eye irritation.

Over 40% of the workers in the evisceration, canning, and sizing departments and five of six USDA inspectors were interviewed by NIOSH. Six workers in the Packing department were also interviewed as a comparison group. Processing workers complained of symptoms more frequently than packing workers. Stinging eyes, excessive tearing, and runny, stuffy nose were the most common complaints of processing workers. Irritation symptoms and a chlorine-like odor were most commonly reported by workers in the First Processing department following the 8:30 a.m. break.

Consistent complaints of intermittent eye and upper respiratory irritation of varying severity are occurring in the First Processing department. The complaints appear to be associated with superchlorination of the bird washing and chiller water, are greater for workers located near the chillers, and are most commonly experienced after returning from the 8:30 a.m. break. Air sampling found measurable concentrations of chloramine in the areas where workers experienced symptoms; chloramine was not detected in the packing (non-complaint) area. Air flow direction was from the chillers to the First Processing department and stagnant conditions were present. Recommendations were made to improve the integrity and efficiency of the superchlorination system, and improve ventilation.

Keywords: SIC 2015 (Poultry Slaughtering and Processing). Chloramine, Chlorine, Ammonia, Sodium Hypochlorite, Superchlorination, Eye Irritation, Respiratory Irritation, Ventilation.

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INTRODUCTION

Workers and inspectors at poultry processing plants have reported acute eye and upper respiratory tract irritation while at work.[1] The causes of these outbreaks were often not clearly evident, and several explanations have been suggested. However, the outbreaks were usually linked to problems associated with chlorinating the plants' process water. In response to a management request for a health hazard evaluation (HHE), National Institute for Occupational Safety and Health (NIOSH) investigators conducted a site visit on March 1-3, 2000, at Wampler Foods, Inc. in Hinton, Virginia. Management asked NIOSH to evaluate airborne contaminants, the facility ventilation system, and reported worker complaints of eye, nose, and throat irritation in the First Processing department.

During the site visit, NIOSH researchers obtained background information about the reported symptoms and previous evaluations. Area air sampling for ammonia, chloramines, and chlorine was conducted. Visible fog was released to evaluate airflow patterns in the First Processing department. Facility water sampling data from this department were obtained. Questionnaires were administered to 65 workers in the First Processing department and a control area. An interim report describing our initial site visit, preliminary findings, and preliminary recommendations was mailed to management and employee representatives on May 5, 2000.

BACKGROUND

Facility and Process Description

The Wampler Foods facility in Hinton, Virginia is a turkey processing plant employing approximately 700 non-union workers. There is considerable employee turnover, and the plant is usually in a hiring phase. Some staffing is seasonal and dependent on demand for turkeys. There are three main production areas: (1) Receiving, Live Hang, Killing, and Defeathering; (2) Evisceration and Inspection (First Processing department); and (3) Final Processing, Deboning, Packaging, and Shipping. Approximately 130 employees work in the First Processing department (Evisceration, Tuck, Canner Area, Sizing), and six United States Department of Agriculture (USDA) inspectors are assigned to this area. A work shift starts at 6:00 a.m. and generally ends at 3:00 p.m.; the quitting time varies depending on the production quota for that day. The facility, located on 37 acres, was constructed in 1948, encompasses 133,000 sqaure feet (ft^2), and has been expanded several times. There have been no facility modifications or process changes in recent years. Production varies based on demand and season; 20,000 to 35,000 turkeys are processed per day (this number increases to 40,000 to 45,000 turkeys per day during Thanksgiving and Christmas). Approximately 33,000 turkeys per day were processed during the NIOSH evaluation. Line speed varies depending on production needs, and there are upper limits monitored by the USDA inspectors. Approximately 250,000 gallons of water per day are used in the First Processing department. Water is obtained from a combination of on-site well and city (Harrisonburg) sources. Incoming water is chlorinated to approximately 1 part per million (ppm), but it is not chloraminated.

Turkeys are obtained from local producers (there are approximately 300 farms in Virginia supplying Wampler's processing plants). Most of the turkeys processed at the Hinton plant are toms weighing between 19-35 lbs. Toms are primarily selected to ensure consistent weights on the processing line and meat quality (hens are mostly sold as whole birds). Approximately 80% of the turkeys processed at the Hinton facility are de-boned; the rest are sold as whole turkeys.

Turkeys to be processed are brought at 5:40 a.m. to the Live Hang area in crates loaded on a semi-truck trailer. Sixteen employees work in the Live Hang department, which is adjacent the Water Treatment plant. The turkeys are unloaded by hand and hung by their feet on a shackle conveyor. The turkeys are electrically stunned and killed by a mechanical throat slitter. An employee in this area will manually slit throats if

the machine fails. The turkeys then pass through a "bleed-out" room into a hot-water scald tank (caustics are added in the scald tank to bring the pH to 8-8.5). Following the scald tank, the turkeys are mechanically defeathered (Picking room). The turkeys then exit the Picking room into the Pinning room, where 3 - 5 employees (pinners) manually remove the few feathers that may be left. Following the Pinning room, the turkeys enter the First Processing department, where their feet are severed, and the turkeys drop onto a metal tray.

In the First Processing department, turkeys are manually shackled for two evisceration lines. Evisceration is a manpower-intensive task with very little automation; most employees in the First Processing department work in this area. Employees stand at their work station, and there is considerable water in the area. There are numerous job descriptions in the First Processing department, most of which are descriptive of the specific task performed. Jobs include oil gland trim, splitting necks, vent cutter, drawer, inspector helper, liver and crow puller, bird suck, bird washing, additional processing, salvage, and final inspection. There are generally 2-3 workers per processing line for each task. USDA inspection also occurs in the Evisceration area; inspectors are stationed on the line and inspect entrails for visible problems that may require condemning a turkey. There are several ancillary stations in Evisceration, including bird washing, additional processing, salvage, feather removal, and final inspection.

After passing through a superchlorinated water spray, the turkeys are conveyed to a mezzanine area above the pre-chiller (Tucking department). Approximately ten employees work on this platform, trimming necks and "tucking" the legs of the birds close to their bodies using plastic holders.

From Tucking, the turkeys are dropped into a large pre-chiller tank of superchlorinated water at approximately 45°F. The complete chilling process takes approximately one hour and involves 3 tanks (pre-chiller, chiller #1, chiller #2). In the Canner area, adjacent chiller #2, turkeys are packed in ice, or further processed. After the turkeys are chilled, they are categorized by size and manually re-hung on shackles in the Sizing area, then conveyed to the Packaging or other (e.g., deboning) final processing steps. The Packaging and final processing area is separated from the First Processing area and no superchlorinated water is used in this area.

History of Irritation Complaints

Worker complaints of irritation in the First Processing department began in 1996 and were thought to be related to a process change involving superchlorination of the chillers. Complaints included eye, nose, and throat irritation of varying severity, with reddening of the eyes. Most of the reported symptoms appeared to resolve after time away from work. A chlorine-like odor was usually associated with the irritation. The odor and irritation were intermittent, and efforts to associate the problem with specific production activities or conditions had been unsuccessful. According to Wampler representatives and clinic records, approximately 6-8 independent episodes of a transient odor and irritation in the First Processing department were being reported each month. Treatment of affected individuals typically involved flushing of eyes and administering eye drops.

METHODS

Upon receipt of the HHE request, additional information was obtained regarding the reported health problems, suspect environmental contaminants, and company efforts to evaluate and resolve these concerns. Literature reviews were conducted and data from previous investigations in the poultry industry concerning similar issues were gathered. Background information was obtained regarding the facility and the First Processing department (i.e., water treatment and monitoring, ventilation system).

Chloramine Sampling

Chloramines have been believed to be a likely cause of irritative symptoms in poultry processing plants. However, no method was available to sample their presence and concentration until recently when a sampling and analytical method was developed by researchers at the Institut National de Recherche et de Securite (INRS) in France.[2] Their sampling method for chloramines in air is based on two successive chemical reactions: (1) at high pH (alkaline conditions), chloramines are decomposed into ammonia and hypochlorite; (2) the hypochlorite ion is reduced to chloride by trivalent arsenic.[2]

Samplers were constructed from 37-millimeter (mm) polystyrene cassettes containing Teflon pre-filters (Millipore AA WP03700), cellulose back-up pads (Millipore AP 1003700), and two quartz fiber filters in series soaked in sodium carbonate ($NaCO_3$) and diarsenic trioxide (As_2O_3).[2] The Teflon pre-filters removed any chlorides contained in airborne water droplets and prevented them from being included in the analysis of trichloramine. The quartz fiber filters were pre-rinsed with twice-distilled water to eliminate any chlorides they may have contained. They were then soaked with 500 microliter (µL) of a solution of 40 grams per liter of sodium carbonate, 4 grams per liter of diarsensic trioxide, and 40 milliliters (mL) per liter of glycerol in twice-distilled water. After drying, the filters were placed in the polystyrene cassettes. As chloramines (mono-,
di-, and trichloramine) in sampled air passed through the quartz fiber filters they were theoretically decomposed by the high pH of the filter media to ammonia and hypochlorite and the hypochlorite was reduced to chloride by the trivalent arsenic. The Teflon filter was discarded after sampling

Area air samples (no personal breathing zone [PBZ] samples were obtained) were collected with the filter cassettes in a closed-face configuration (4.1 mm diameter cassette inlet). The air samples for chloramine were collected using calibrated SKC Hi-Flow sampling pumps at a flow rate of one liter per minute (l/m). The sampling pumps were pre- and post-calibrated using a primary standard to verify the flow rate. Because this was a new monitoring method and information on possible concentrations was not available, multiple samples were collected at each location, and sampling durations were varied (2-hour, 4-hour, full-shift) to maximize the likelihood of collecting any chloramines that may have been present. Samples were collected at the following six locations in the First Processing department: Final Inspection, USDA Inspection, Pre-chiller Corner (Opening J-Cut), Tuck (Mezzanine), Canner Area, and Sizing. At each location, samplers were placed approximately six feet above the floor. Samples were also collected at a "control" location in the Final Packaging department. There had been no reports of irritation in Final Packaging, and neither chloramine nor chlorine compounds were expected there.

After collection, the samples and field blanks were shipped to the INRS laboratory. The carbonate-arsenic impregnated filters were desorbed in 10 mL of twice-distilled water. The resulting solution was passed through a cation exchange resin to eliminate carbonate, which interferes with the analysis of chloride. The cation exchange resin was prepared by successively placing a polyethylene frit disk (Bond-Elut 20 micometers [µm] porosity), resin in the H^+ form (Bio-Rad 50W-X12, 100-200 mesh), which was previously put into suspension by stirring twice-distilled water to a depth of about 15 mm, and a second disk in a cylinder cartridge (Bond-Elut 4 mL volume and 9 mm diameter cartridge).

After the desorption solution was passed through the cartridge, the chlorides were analyzed by ion chromatography (Spectra Physics SP8810 HPLC pump; Alltech 15 cemtimeter [cm] Universal Anion column; Waters 430 conductivity detector). The mobile phase used in chromatographic analysis was a 3×10^{-3} M phthalic acid solution, the pH of which was adjusted to 4.2 by adding lithium hydroxide; the flow rate is 1 mL per minute. The limit of detection for this sampling and analytical method was 0.005 milligram (mg) per sample.

Ammonia

Because the Wampler processing plant uses ammonia as a refrigerant, area air samples were collected in the First Processing department to determine if this could be a potential cause of the irritation experienced by workers. Exposures to ammonia could directly cause eye, nose, and throat irritation, or indirectly if ammonia were absorbed into water (e.g., refrigerant leak into chiller water), where a subsequent reaction with chlorine could form irritating byproducts such as chloramines.

Seven full-shift area air samples for ammonia were collected with low-flow air sampling pumps (SKC Pocket Pump™) at a nominal flow rate of 0.1 l/m. The samples were collected at the same locations as the chloramine samples. The SKC pumps are constant-flow sampling devices and were pre- and post-calibrated using a primary standard (BIOS® Dry-Cal Lite) to verify flow rate. Tygon® tubing was used to connect the sampling media to the pump.

Sampling and analysis was conducted according to NIOSH method 6015.[3] Treated silica gel sorbent tubes (SKC 226-10-06) were used to collect the samples. After collection, the samples, field blanks, and ten media blanks were shipped to the NIOSH contract laboratory (Data Chem, Salt Lake City, Utah) for analysis by automated visible spectrophotometry.

Chlorine

Sampling for chlorine was conducted using direct-reading colorimetric indicator tubes (Dräger 0.2/a CH 24301) and a bellows pump. With this sampling technique, a known volume of air is drawn through a tube and the media inside the indicator tube changes color in proportion to the concentration of a contaminant. According to the manufacturer, the relative standard deviation for this particular sampling method is 10% to 15%.[4]

Temperature, Relative Humidity and Carbon Dioxide

Instantaneous dry bulb temperature, % relative humidity (RH), and Carbon Dioxide (CO_2) levels were determined on March 2, 2000, at the same locations as the chloramine and ammonia area air samples. Outdoor readings were obtained for comparison purposes. Instrumentation consisted of a TSI, Inc. model 8550 Q-Trak™ IAQ monitor with a digital readout. This unit is battery operated and has CO_2, humidity, and temperature sensors on an extendable probe. The temperature range of the meter is 14°F to 140°F and the humidity range is 20% to 95%. The principle of detection for CO_2 is non-dispersive infrared absorption. The instrument was zeroed (zero CO_2 gas source) and calibrated before use with a known CO_2 source (span gas).

Worker Symptom Interviews and Questionnaire Administration

NIOSH investigators selected workers to be interviewed about their experiences of eye and respiratory symptoms while working at Wampler Foods. Workers were interviewed when it was convenient to speak with them and while they worked on the process line. The questionnaire used to collect symptom information is provided in the Appendix. This questionnaire was administered in Spanish to Spanish-speaking workers. Company management provided a list of all production workers in departments in which air sampling was conducted and as many employees in each work group were interviewed as time allowed. Interviewees included USDA inspectors and workers from the Processing, Canning, and Sizing departments. Workers from the Packing department were interviewed as a comparison group, because workers in this department were not exposed to superchlorinated water.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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 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 increases 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 Recommended Exposure Limits (RELs),[5] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[6] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[7] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 95-596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

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 STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Superchlorination and Chloramines

The USDA requires a minimum chlorine residual of 20 ppm in water in certain processing steps (evisceration, re-processing, salvage) to control bacteria.[8] The USDA also requires the water in the chiller tanks to be superchlorinated. At the Wampler facility, superchlorination is accomplished by injecting concentrated (12.5%) sodium hypochlorite into the chiller tanks and water supplying the bird wash stations.

Chloramine, specifically trichloramine (NCl_3), as an undesirable byproduct of water disinfection using chlorine is a recognized eye irritant and odor problem in water, wastewater treatment facilities, and swimming pools.[2,9] Chloramines are formed by the reaction between chlorine disinfectants and nitrogenous compounds such as ammonia, amines, or organic nitrogen-containing material. The species and concentrations of chloramine formation are influenced by the concentration of residual chlorine, ammonia (or other nitrogen sources), pH, and temperature.[11]

Water chlorination (from both gaseous chlorine and sodium hypochlorite) results in the formation of hypochlorous acid (HOCL). Hypochlorous acid must be present to form chloramines.[9,11] In general, the lower the pH and the greater the chlorine:ammonia ratio the higher the likelihood of producing NCl_3.

Chloramination is the addition of both chlorine and ammonia to potable water to reduce the

incidence of trihalomethane (THM) formation.[10] The ammonia compound is added to water to produce a stable chlorine base that will remain in the water distribution system longer.

Eye and Respiratory Irritation in the Poultry Processing Industry

There have been numerous reports of eye and upper respiratory tract irritation among poultry processing workers and USDA inspectors during processing steps involving the use of "superchlorinated" water, and this is considered to be an important problem in this industry.[1,11,12,13] Reported symptoms generally are intermittent in nature, vary in severity, and may be accompanied by reports of a "chlorine-like" odor. The use of sodium hypochlorite or chlorine as the superchlorination source does not appear to influence the reports of irritation.

Investigations to identify the cause of irritation and determine appropriate remedial action have been conducted by the USDA, NIOSH, and others. Efforts to identify obvious contaminants such as chlorine or ammonia in air as the cause of irritation have generally been inconclusive. Chloramines, specifically NCl_3, have been suspected as a primary cause of the reported symptoms. This is because of the well-documented reactions that can lead to chloramine formation, the association of the irritation with chloraminated water and superchlorination, and data from swimming pool investigations that have identified chloramine as the cause of similar irritant symptoms and odors.

The lack of an acceptable air monitoring technique for chloramines has been a primary obstacle to obtaining conclusive verification of chloramines as a cause of irritation. Air monitoring data are necessary to obtain information on concentrations, exposure, and determining the factors that affect chloramine formation. Additionally, targeting controls is difficult due to the lack of an air monitoring technique to evaluate the efficacy of any implemented modifications. There may be a business reluctance to implement major modifications for controlling chloramine exposures without sufficient evidence of their presence and that the changes will eliminate the problem.

Trichloramine

NCl_3 is a brownish-yellow gas, has a pungent chlorine odor (sometimes described as rotting grapefruit or geraniums) and is a strong irritant and lacrimator.[14,11] NCl_3 has low solubility, aerates easily, and decomposes rapidly in sunlight. Eye and respiratory tract irritation appear to be the primary effects of exposure. The irritant characteristics of NCl_3 seem to be similar to that of chlorine.[15] Occupational exposure criteria for NCl_3 have not been established.

Sodium Hypochlorite

Sodium hypochlorite is a greenish-yellow liquid with a moderate chlorine odor that is commonly used as a general purpose germicidal agent, disinfectant, and bleach.[16] Household bleach is a 5.25% solution of sodium hypochlorite and water. The pH of a 5% aqueous solution of sodium hypochlorite is approximately 10-11; a 15% solution has a pH of 11.2.[16]

Sodium hypochlorite can generate harmful gases such as chlorine or chloramine if mixed with acids, acidic salts, ammonia, or ammonia-containing products. Sodium hypochlorite is an oxidizing agent and can produce a number of different reactions, depending on what other chemicals are mixed with it. There have been a number of cases of severe illness from inhalation of toxic vapors in both residential and commercial settings, resulting from intentional or inadvertent mixing of bleach with incompatible cleaning or disinfecting agents.[17,18,19]

Airborne exposure to sodium hypochlorite is likely to be in the form or an aerosol, or mist. NIOSH, OSHA, or ACGIH occupational exposure criteria have not been established for sodium hypochlorite. The American Industrial Hygiene Association has established a Workplace Environmental Exposure Limit (WEEL) guide for sodium hypochlorite of 2 milligrams per cubic

meter (mg/m^3), however an air sampling method for sodium hypochlorite was not referenced.[16]

Ammonia

Ammonia is a severe irritant of the eyes, respiratory tract, and skin.[20] It may cause coughing, burning, and tearing of the eyes; runny nose; chest pain; cessation of respiration; and death. Symptoms may be delayed in onset. Exposure of the eyes to high gas concentrations may produce temporary blindness and severe eye damage. Exposure of the skin to high concentrations of the gas may cause burning and blistering. The NIOSH REL for ammonia is 25 ppm for a 10-hour TWA; NIOSH has also established a short-term exposure limit (STEL, 15 minutes) for ammonia of 35 ppm.[5] ACGIH has set limits of 25 ppm or as an 8-hour TWA and a STEL of 35 ppm.[6] The OSHA PEL for ammonia is 50 ppm as an 8-hour TWA.[7]

Chlorine

Chlorine is a greenish-yellow gas with a characteristic irritating odor. Exposure to chlorine gas can cause severe irritation of the eyes and respiratory tract, resulting in tearing, runny nose, sneezing, coughing, choking, and chest pain.[20,21] Breathing difficulty, with a delayed onset, can also occur. Severe exposure can result in edema and can be fatal. Mucous membrane and eye irritation has been reported to occur at concentrations as low as 0.2-2 ppm.[20] The NIOSH REL and ACGIH TLV for chlorine is 0.5 ppm; both NIOSH and ACGIH have established a STEL for chlorine of 1 ppm.[5,6] The OSHA PEL for chlorine is 1 ppm as a ceiling limit.[7]

Carbon Dioxide

At high concentrations, CO_2 is a simple asphyxiant, a respiratory stimulant, and both a stimulant and depressant of the central nervous system.[22] Respiratory ventilation is doubled at concentrations of 4% (40,000 ppm) CO_2. Increases in heart rate and blood pressure have been noted at 7.6% (76,000 ppm).[23]

CO_2 is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space. CO_2 is normally present in the atmosphere at concentrations of 350 to 400 ppm. Indoor CO_2 concentrations are usually higher than outdoor concentrations. Measurements of CO_2 are commonly taken during indoor environmental quality evaluations in non-industrial settings (e.g., office building). If there are no sources other than exhaled breath, CO_2 concentrations are usually under 800 ppm in buildings with an adequate supply of outside air.[24] When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased.

The NIOSH REL for CO_2 is 5,000 ppm as a 10-hour TWA with a STEL of 30,000 ppm.[5] The OSHA PEL and ACGIH TLV for CO_2 is 5,000 ppm as an 8-hour TWA with a 30,000 ppm STEL.[7,6]

RESULTS

Workplace Observations

Consistent complaints of irritation, intermittent in nature and of varying severity, are occurring in the First Processing department near the chillers. These complaints were associated with proximity to the chillers, and occur in the following areas: Evisceration, Tuck, Canner, Sizing. The occurrence of irritation appeared to coincide with returning from the 8:30 a.m. and 11:30 a.m. breaks. Eye irritation and a chlorine-like odor in the First Processing department were experienced by NIOSH investigators following the 8:30 a.m. break on March 2, 2000. During this 30-minute break, most workers leave the building and a cleanup crew washes down the area using regular (not superchlorinated) potable water. Reportedly, the pumps on the sodium hypochlorite delivery system serving the two bird wash stations are manually turned off at this time. Failure to shut down this system when the bird wash stations are not in use could result in a buildup of sodium hypochlorite.

A 12.5% sodium hypochlorite solution, delivered from a 300-gallon bulk tank, is used to chlorinate water for the chillers and wash stations. Gaseous chlorine was used until 1996. This bulk tank is located inside the First Processing area adjacent to the pre-chiller, and the facility uses 2-3 tanks per week. The sodium hypochlorite is delivered to the chillers and the bird wash stations via plastic tubing and metering pumps. The pumping system and controls are wall-mounted next to the bulk tank. A limited inspection of the system found that the delivery lines were not labeled and there were no readily available or identified shutoff valves. Flow control devices designed to shut down the system in the event of a leak had not been installed.

While performing ventilation tests near the bulk sodium hypochlorite tank after the production shift ended, a pinhole leak was found in the tubing between the bulk tank and the metering pumps. The investigators noticed a strong chlorine odor and experienced eye irritation while standing near the bulk tank.

Maintaining a consistent chlorine residual in the chillers and at the bird wash stations is difficult with the current configuration and operation of the chlorination system. Sodium hypochlorite is metered into the water system at a fixed rate, regardless of water usage, and adjustments are made to the delivery system based on the results of water tests. However, water use fluctuates considerably, and this delayed feedback system for adjusting sodium hypochlorite delivery is incapable of ensuring timely adjustments. Wampler representatives indicated that they target a range of 20-35 ppm residual chlorine. Wampler has been collecting and analyzing water samples from the chillers hourly to monitor chlorine residual and on the bird wash and reprocessing stations at least twice daily.

Twenty-three employees work on the cleanup shift, and sanitation activities occur on both the 2nd and 3rd shifts. According to Wampler representatives, there have been no recent changes in sanitation chemicals, except that a weekly rotation of sanitizers was recently implemented to combat microbial resistance. An alkaline-based cleaner with a defoamer is commonly used to soak equipment. Sodium hypochlorite, a peracetic acid and hydrogen peroxide solution, and a quarternary ammonium cleaner (for cleaning the conveyor belts only) are used for sanitation. According to Wampler representatives, sanitation workers had not reported irritation complaints.

Ventilation Evaluation

The First Processing department is ventilated by seven roof-mounted exhaust fans. Two exhaust fans are located over the Tuck mezzanine, three are over the Evisceration line, and two are over the chillers. There are no exhaust fans in the Sizing department. The plant operates under negative pressure conditions. Two factors adversely affect the effectiveness of the exhaust fans. First, drip pans to collect condensate water were positioned directly under the inlet of each fan. Second, rain caps covered each fan's outlet. With the exception of evaporative cooler units used only during the summer (they were not in operation during the NIOSH site visit), supply air to this area is not conditioned. Exhaust fans are not operated in the winter as there is no supply source of heated air. Comfort fans are located throughout the First Processing department, and some were used during the NIOSH site visit.

On March 2-3, a Roscoe® Fog Machine (model number 1500) was used to evaluate ventilation airflow patterns in the Evisceration, Sizing, Canner area, and various locations around the chillers. Although turkeys were not being processed during these evaluations, the production lines and ventilation systems were operational. After release, the visible fog was observed to determine airflow direction, migration duration, and dispersal. The ventilation tests were videotaped for further analysis.

The visual analysis showed that the general direction of airflow was from the chiller area into the evisceration area. Wampler representatives indicated that this may have been by design for comfort reasons to allow cooler air above the chillers to offset hotter temperatures on the Evisceration line. Stagnant conditions (very little observable air currents) were present in many areas. Under such conditions, any air

contaminants would not be readily dispersed or removed.

To help reduce complaints of irritation, a wall-mounted axial fan had been installed at the back of the First Processing department, behind the chillers. This fan was intended to exhaust contaminants emanating from the chillers. However, the visual smoke tests showed that this fan did not function as intended, and the direction of airflow was from the chiller area into the Evisceration area.

Temperature, Relative Humidity, Carbon Dioxide

The results of the temperature and %RH monitoring are shown in Table 1. High humidity levels in the Evisceration area (Pre-chiller corner, USDA inspection, Wash, Tuck) reflect the water spray in this area during the processing of turkeys. During work breaks (8:30 a.m. , 11:30 a.m.) RH levels in this area fell to approximately 50%.

Monitoring for CO_2 was conducted in the Tray Pack Department, where frozen CO_2 (dry ice) was used for packaging. A CO_2 level of 3000 ppm was measured in this room.

Chlorine Air Sampling

Instantaneous measurements for chlorine were taken in various locations in the First Processing department. The results are shown in Table 2. During the first work break (8:30-9:00 a.m.), eye irritation and a "chlorine-like" odor were detected in the Evisceration and Sizing areas. Some discoloration of the colorimetric tube was found during measurements taken at this time in these locations. However, the discoloration was brown and not orange, which is the expected reaction product between the detector tube reagent (o-tolidine) and chlorine.

Chloramine Air Sampling

The results of the chloramine air samples are presented in Table 3, categorized by the area of the production process where they were collected. Because the range of chloramine concentrations within the plant were unknown, the sample collection times were varied for two, four, or eight hours. A total of 30 samples were collected; 23 on March 2, 2000, and 7 the morning of March 3, 2000. Two samples collected at the cutting and evisceration area on March 2, 2000, yielded questionable results because the proportion of the total chloramines collected by the samplers on the second filter was considerably higher than it was on the other samples. Also, sample CLA-26 was much higher and sample CLA-18 was considerably lower than other samples collected in this work area. It is not known why these results were inconsistent with the other samples.

The average chloramine concentrations are presented by work area in Table 4. None of the three samples collected in the packing area were above the limit of detection. This work area was selected for comparison purposes, since packing workers have not reported eye or respiratory complaints. The average chloramine levels for work areas near the chiller tanks (Cutting, Evisceration, Tucking, Canning, and Sizing) were approximately 1 mg/m^3. Chloramine levels for the USDA and final inspection areas were somewhat lower at 0.6 mg/m^3.

In Table 5, the average chloramine concentrations are presented by day on which they were collected. Since only 4-hour early morning samples were collected on March 3, 2000, (between 6:00 and 10:00 a.m.), these samples were only compared to 4-hour early morning samples collected on March 2, 2000. The samples collected on March 3, 2000, were lower than samples collected on March 2, 2000, (0.99 mg/m^3 versus 1.41 mg/m^3). The average chloramine concentrations are presented by time of day in Table 6. Concentrations were found to be higher early in the morning compared to later in the day.

Ammonia Air Sampling

The results of the integrated air samples collected for ammonia are shown in Table 7. Low concentrations of ammonia were detected in all samples collected from the Evisceration area; all samples were well below the NIOSH REL for ammonia. Trace (between the limit of detection [LOD] and the limit of quantification [LOQ]) concentrations of ammonia were detected in the samples collected from the Sizing and Canner area. No ammonia was detected on the sample collected from the control area (Packing).

Water Sampling Data

Wampler Foods monitors and records the free-available chlorine concentrations in the chillers every hour and in the bird wash and reprocessing station water twice daily-morning and afternoon. Samples were analyzed using a Klenzade Chlorine Test Kit® manufactured by Ecolab Inc. in St. Paul, Minnesota. The chlorine concentration monitoring records for September 27, 1999, through March 3, 2000 were reviewed. The recorded chlorine concentrations in the chillers ranged between 14 and 49 ppm. The concentrations were usually between 20 and 39 ppm, but were occasionally above 40 ppm sometime during the day. The chlorine concentrations in the bird wash and reprocessing water were also usually between 20 and 39 ppm, but occasionally above 40 ppm. Concentrations as high as 70 ppm were recorded in the reprocessing water; on the afternoon of March 2 the chlorine concentration in the reprocessing water was observed to be 64 ppm. The pH of the bird wash and reprocessing water was also monitored and recorded. The pH measurements were always between 7 and 8.

Employee Questionnaire

A total of 65 workers were interviewed to determine the prevalence of eye and respiratory symptoms associated with working at Wampler Foods. The characteristics of the interviewees is presented in Table 8. Although it is not known how representative these 65 workers were of the entire work force, over 40% of the workers in the Evisceration, Canning, and Sizing departments, and five of six USDA inspectors were interviewed. Six interviewees worked in the Packing department, which was used as a comparison group.

The prevalence of symptoms reported by the processing and packing workers is presented in Table 9. Processing workers complained of symptoms much more frequently than packing workers. Stinging eyes, excessive tearing, and runny, stuffy nose were the most common symptoms reported by processing workers. Only one of the six packing workers reported stinging eyes, excessive sneezing, or sore throat associated with working at Wampler, however half of the packing workers reported occasionally smelling a chlorine odor. Approximately 50% (33/65) of the workers said their symptoms most commonly began with in the first few hours after starting work, particularly after the first break. Approximately 20% (12/65) of the workers said their symptoms most commonly began in the afternoon or after leaving work. The remainder of the workers either did not experience symptoms or said they began at variable times.

DISCUSSION

Consistent complaints of intermittent eye, nose, and throat irritation, of varying severity, are occurring in the First Processing department in the areas surrounding the chillers (Evisceration, Tuck, Canner, Sizing). With the exception of the pinning jobs, workers in virtually all jobs in the evisceration area, even those furthest away from the chillers, were experiencing symptoms. The irritation symptoms appear to be associated with the use of superchlorinated water in the chillers and bird wash and reprocessing stations. They are usually accompanied by a chlorine-like odor, and are most often reported after the first (8:30 a.m.) work break. Eye and nose irritation and a "chlorine-like" odor are the most common complaints. Eye irritation and a chlorine odor were experienced by the NIOSH investigators at the time of the first work break on March 2, 2000, and intermittently throughout the site visit.

Evidence that the irritation symptoms may be related to chlorine compounds include reporting a chlorine odor, discoloration on the colorimetric detector tubes, the chloride concentrations measured by the chloramine samplers, and high concentrations of free-available chlorine recorded in the water samples. The reported symptoms are similar to symptoms experienced by workers exposed to irritant gases. Both chlorine chemistry and historical data from swimming pool irritation investigations suggest that chloramine formation, specifically NCl_3, is a likely source of the irritation. Irritation from exposure to sodium hypochlorite aerosol from pipe leaks in a pressurized system may also periodically occur. Although the irritation appears to be related to chlorine compounds, the specific factors contributing to the generation of the irritant are not clear. The cause of the outbreaks is probably multi-factorial in nature. A major contributing factor to the irritation is probably the difficulty in maintaining a consistent chlorine residual in the water system, which is clearly resulting in "over chlorination" at certain times. Chlorine in water, or hypochlorous acid, reacts with ammonia to form three chloramine compounds: monochloramine (NH_2Cl), dichloramine ($NHCl_2$), and NCl_3.[25] The chloramines reach an equilibrium with hypochlorous acid dependent on the temperature and pH of the water. The lower the pH and the higher the chlorine:ammonia ratio, the greater the tendency to produce NCl_3.[26] NCl_3 may also be formed by reaction between hypochlorous acid and degradation products of organic nitrogenous matter, such as urea. NCl_3 has low solubility in water and readily off-gases upon agitation.[27]

NCl_3 is known to be a strong eye and mucous membrane irritant.[25] NCl_3 been reported to cause eye and respiratory irritation among swimmers using indoor swimming pools is most likely formed by the hypochlorous acid in the pool water reacting with ammonia, released from urea in swimmers' urine and sweat.[28,29] The complaints among swimmers were largely eliminated by increasing the dilution ventilation above the pools.

Trichloramine has been suspected of causing irritation complaints at other poultry plants. At one turkey processing plant, trichloramine was suspected of being formed by the reaction of hypochlorous acid with nitrogen-containing organic matter on the birds and in the waste water.[30] Symptoms were especially associated with exposure to the superchlorinated water around the evisceration and reprocessing areas where reaction with high levels of organic matter was most likely. Also, a ventilation assessment demonstrated that alterations in the ventilation system caused isolated areas of either high air turbulence or low air-flow. Therefore, the concentration of chloramines in the breathing-zone of workers could potentially build-up in the low airflow areas.

At the Wampler plant, chloramine concentrations were generally higher in the morning samples than in those collected later in the work shift. This is consistent with reports of irritation in the First Processing department, where irritation and chlorine-like odors were reported during and after the first break period. The reason for this finding is unclear. Low concentrations of ammonia were detected in the First Processing department, indicating that a nitrogen source for possible chloramine formation is present in this area. The source of the ammonia could be from chiller system leaks (ammonia refrigerant) or from endogenous sources associated with the turkeys. Because of poor control of chlorine injection into the chiller, bird wash, and reprocessing water, the chlorine concentrations may be increasing in the morning hours and then equilibrate or decrease later in the day. This excess chlorine in water could either be an irritant itself or more readily form chloramines with the nitrogen-containing waste products.

The sodium hypochlorite delivery system was still under pressure after the production shift had ended and superchlorination is not needed during the cleanup shift. Maintaining a chemical delivery system under pressure during non-use time periods could result in an excess buildup of sodium hypochlorite in the water system, or leaks.

The ventilation assessment found numerous stagnant areas and a general air flow direction from the chillers into the Evisceration line. Thus, aeration of an offending contaminant from the

open chillers would flow into the Evisceration area. The poor efficacy of the wall-mounted axial exhaust fan behind the chillers is due to the existing negative pressure in the building.

It does not appear that sanitation practices are contributing to the irritation. No major changes have been made in sanitation chemicals, and sanitation crews have not reported irritation.

It is likely that resolving the irritation problem will require a combination of ventilation improvements and better control of the sodium hypochlorite system. The current delivery system is also in need of improvement from a piping integrity, emergency shut down valving, and labeling standpoint. Continued data collection, a reliable chloramine air sampling technique, and research is necessary to better understand the factors contributing to the irritation experienced by workers in the First Processing department. This information will allow for better targeting of controls to reduce contaminant generation.

CONCLUSIONS

Worker complaints of eye and nasal irritation, associated with the use of superchlorinated water and a chlorine-like odor, have occurred in the First Processing department. Industrial hygiene monitoring identified chloramines in the areas experiencing the irritation and these compounds are likely contributors to the irritation. Monitoring for ammonia and chlorine did not identify significant concentrations of these compounds in the work area. The configuration of the sodium hypochlorite delivery system is such that undetected leaks can occur, and it is not optimal for ensuring a consistent chlorine residual; the potential exists for higher than desired superchlorinated water concentrations. This could be a factor in the irritation experienced. Ventilation assessments found stagnant areas (where generated contaminants would not be readily dispersed) and a direction of airflow from the chillers into the First Processing department.

RECOMMENDATIONS

1. A thorough review and inspection of the hypochlorite injection system should be conducted, and improvements should be made. The hypochlorite piping and valve system integrity should be improved to ensure that leaks are prevented, shutoff valves are readily accessible, and the piping and valves are labeled properly. Alternative dispensing systems that allow for better control of chlorine residual (e.g., based on water demand) and equipped with automatic flow control and fail-safe shut down devices should be investigated and installed if feasible. The system should be depressurized when not in use.

2. Ventilation in the First Processing department is insufficient and should be evaluated by a qualified mechanical engineer experienced with the design and operation of industrial ventilation systems. It is probable that modifications and ventilation upgrades will be necessary. Design goals should include providing sufficient supply of conditioned air to occupied areas, and sufficient exhaust of workplace air, with the direction of flow away from the Evisceration line. Proper ventilation is likely a major component of the solution to reducing contaminant levels in the work area.

3. Repeat employee interviews, or air sampling after changes are made to determine if irritation complaints have been resolved.

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Table 1
Temperature, %RH, Monitoring Results
Wampler Foods, Inc.
March 2, 2000, 7:30 a.m.
HETA# 2000-0105-2794

Location	°F	%RH
Laboratory (2nd floor)	65.5	34
Packing	62	46
Sizing	56	54
Canner Dock	53	45
Tuck (mezzanine)	58	98
Pre-chiller Corner	61	99
USDA Inspection	62	99
Wash Station	64	93

Table 2
Chlorine Detector Tube Sampling
Wampler Foods, Inc.
March 2, 2000
HETA# 2000-0105-2794

Location	Time	Concentration (ppm)	Comment
Sizing Hallway	7:30 a.m.	Trace	Faint “chlorine” odor
Pre-chiller Corner	8:00 a.m.	Trace - brown discoloration	Faint “chlorine” odor
Pre-chiller Corner	9:00 a.m.	Trace	“chlorine” odor, eye irritation
Pre-chiller Corner	1:30 p.m.	ND	no odor
Sizing Hallway	1:45 p.m.	ND	no odor

ND = none detected
Trace = some color change was detected but was below the limit of quantification (less than 0.2 ppm).

Table 3
Results of Chloramine Air Sampling
Wampler Foods, Inc.
March 2-3, 2000
HETA# 2000-0105-2794

Sample #	Day	Sample Time	Sample Duration (Hrs.)	Air Volume (Liters)	Chloramine Concentration (mg/m^3)
Cutting and Opening					
CLA-26	3/2	6:09 - 8:05	1.93	116	5.27*
CLA-10	3/2	6:09 - 10:46	4.62	277	1.15
CLA-25	3/2	10:46 - 12:47	2.02	121	0.78
CLA-18	3/2	10:46 - 14:52	4.10	246	0.23*
CLA-08	3/3	5:54 - 9:44	3.83	230	1.41
USDA Inspection Stations					
CLA-15	3/2	6:01 - 7:53	1.87	112	0.38
CLA-28	3/2	6:01 - 10:43	4.70	282	0.78
CLA-21	3/2	10:44 - 12:45	2.02	121	0.69
CLA-29	3/2	10:44 - 14:50	4.13	248	0.40
CLA-06	3/3	5:54 - 9:43	3.82	229	0.63
Final Inspection & Bird Wash					
CLA-23	3/2	5:53 - 7:52	1.95	117	0.21
CLA-20	3/2	5:53 - 10:40	4.78	287	1.86
CLA-11	3/2	10:42 - 12:44	2.03	122	0.36
CLA-13	3/2	10:41 - 14:46	4.08	245	0.35
CLA-12	3/3	5:54 - 9:42	3.80	228	0.50
Tucking					
CLA-35	3/2	6:20 - 10:48	4.47	268	1.12
CLA-27	3/2	10:48 - 14:56	4.13	248	0.39
CLA-22	3/2	6:20 - 14:56	8.60	516	0.71
CLA-01	3/3	5:55 - 9:46	3.85	231	1.06

Table 3
Results of Chloramine Air Sampling
Wampler Foods, Inc.
March 2-3, 2000
HETA# 2000-0105-2794

Sample #	Day	Sample Time	Sample Duration (Hrs.)	Air Volume (Liters)	Chloramine Concentration (mg/m^3)
Canning					
CLA-32	3/2	6:32 - 10:50	4.30	258	1.74
CLA-31	3/2	10:50 - 15:02	4.20	252	0.38
CLA-14	3/2	6:32 - 15:02	8.50	510	1.05
CLA-03	3/3	5:55 - 9:48	3.85	231	1.33
Sizing					
CLA-34	3/2	6:48 - 10:52	4.07	244	1.79
CLA-19	3/2	10:52 - 15:08	4.27	256	0.56
CLA-17	3/2	6:48 - 10:52	4.07	244	1.79
CLA-04	3/3	5:57 - 9:48	3.85	231	1.02
Packing					
CLA-09	3/2	7:05 - 10:54	3.81	229	<0.02
CLA-16	3/2	10:54 - 15:13	4.32	259	<0.02
CLA-33	3/3	5:54 - 9:49	3.92	235	<0.02

* The results of these samples were questionable, because the ratios of the chloramine concentrations on the first and second stages of the samplers were unusual and the results were not consistent with comparable samplers. These samples were deleted from data set analysis and interpretation.

Table 4 Chloramine Air Sampling by Area Wampler Foods, Inc. March 2-3, 2000 HETA# 2000-0105-2794			
Area	# Samples	Mean (Std. Deviation) (mg/m^3)	Range (mg/m^3)
Cutting & Opening	3	1.11 (0.32)	0.78 - 1.41
USDA Inspection	5	0.58 (0.18)	0.38 - 0.78
Final Inspect & Bird Wash	5	0.66 (0.68)	0.21 - 1.86
Tucking	4	0.82 (0.34)	0.39 - 1.12
Canning	4	1.13 (0.57)	0.38 - 1.74
Sizing	4	1.10 (0.51)	0.56 - 1.79
Packing*	3	<0.02	
Overall	25	0.87 (0.48)	<0.02 - 1.86

* The three packing area samples were all below the limit of detection and were not included among the overall samples. The packing area was considered the control area.

Table 5
Comparison of Chloramine Air Sampling by Day
Wampler Foods, Inc.
March 2-3, 2000
HETA# 2000-0105-2794

Day	# Samples	Mean (Std. Deviation) (mg/m^3)	Range (mg/m^3)
March 2	6	1.41 (0.45)	0.78 - 1.86
March 3	6	0.99 (0.37)	0.50 - 1.41

Table 6
Comparison of Chloramine Air Sampling by Time of Day
Wampler Foods, Inc.
March 2-3, 2000
HETA# 2000-0105-2794

Time of Day	# Samples	Mean (Std.)(mg/m^3)	Range (mg/m^3)
Early Morning	14	1.07 (0.52)	0.21 - 1.86
Later in Day	8	0.49 (0.17)	0.35 - 0.78
Full Shift	3	0.93 (0.19)	0.71 - 1.05

Table 7 Wampler Foods, Inc. Air Sampling Survey: Ammonia March 2, 2000 HETA# 2000-0105-2794		
Sample Location	Sample Time (min)	Concentration (ppm)
Final Inspection (Wash)	05:53-12:41 (408)	0.19
USDA Inspection	06:01-12:46 (405)	0.31
Pre-chiller Corner (Opening J-Cut)	06:09-13:11 (422)	0.26
Tuck (Mezzanine)	06:20-11:45 (325)	0.27
Canner Area (Adjacent chiller #2)	06:32-14:31 (479)	(0.12)
Sizing (Adjacent Product Research)	06:48-15:08 (500)	(0.09)
Packing (Control Area)	07:03-15:13 (490)	<0.06
NIOSH REL for Ammonia[5]		**10**

Notes:
PPM = parts per million of gas or vapor per million parts air
() = values in parentheses indicate the concentration was between the analytical limit of detection (LOD) and the limit of quantification (LOQ)
< = less than

Table 8 Characteristics of Workers Interviewed Wampler Foods, Inc. March 2-3, 2000 HETA# 2000-0105-2794		
Characteristic	# Workers	%
Sex		
Male	32	49.2
Female	33	50.8
Race		
White	51	78.4
Black	4	6.2
Hispanic	8	12.3
Asian	2	3.1
Smoking Status		
Smoker	30	46.2
Nonsmoker	35	53.8
	Mean (Std.) (Years)	Range (Years)
Age	37.2 (11.4)	19 - 65
Tenure	6.4 (7.1)	1 month

Table 9
Responses of Workers to Symptoms Interview
Wampler Foods, Inc.
March 2-3, 2000
HETA# 2000-0105-2794

Symptom	Processing Workers (n = 59)		Packing Workers (n = 6)
	% Mild	% Moderate-Severe	% Mild
Stinging Eyes	45.8	42.4	16.7
Excessive Tearing	33.9	32.2	0
Eyes Sensitive to Light	20.3	8.5	0
Difficulty Keeping Eyes Open	25.4	13.6	0
Blurred Vision	16.9	11.9	0
Runny/Stuffy Nose	44.1	28.8	0
Excessive Sneezing	37.3	20.3	16.7
Sore Throat	30.5	11.9	0
Cough	44.1	18.7	16.7
Chest Tightness	27.1	5.1	0
Headache	35.6	10.2	33.3
Smell Chlorine Odor	67.8		50.0

Appendix
Questionnaire: Worker Interviews Concerning Eye and Respiratory Symptoms

Date: _____

Interviewer Initials: _____

Symptoms Questionnaire

Wampler Foods - Hinton, Virginia
HETA 2000-0105-2794

I. Personal Information

Subject ID No: _____ _____ _____

Name: _____

Date of Birth _____ _____ - _____ _____ - _____ _____

Race: _____

Sex _____

Do you wear glasses? _____

Do you wear contact lens? _____

Do you smoke cigarettes? Yes No

Current Job: _____

Shift: _____

When did you begin working at Wampler Foods? _____ _____ - _____ _____(month--year)

II. Symptoms

Are you experiencing or have you ever experienced while working at Wampler Foods:

1. Sensitivity to light? _____

   When:
   What job:
   How frequent:

2. Stinging or smarting of the eye? _____

   When:
   What job:

How frequent:

3. Excessive tearing or watering? _____

   When:
   What job:
   How frequent:

4. Blurred vision? _____

   When:
   What job:
   How frequent:

5. Difficulty keeping eyes open? _____

   When:
   What job:
   How frequent:

6. Excessive sneezing? _____

   When:
   What job:
   How frequent:

7. Runny/stuffy nose? _____

   When:
   What job:
   How frequent:

8. Cough? _____

   When:
   What job:
   How frequent:

9. Sore throat? _____

   When:
   What job:
   How frequent:

10. Headache? _____

    When:

What job:
How frequent:

11. Shortness of breath or tightness in chest? _____

When:
What job:
How frequent:

12. Other Symptoms:

a.

b.

c.

When:
What job:
How frequent:

Questions pertaining to all symptoms:

If you have had any symptoms associated with your work at Wampler Foods, when do they typically begin?

Soon after the shift begins ____
Within two hours after the shift begins ____
Within four to six hours after the shift begins ___
After I have left work ___

How frequently do these symptoms occur?

Every day ___
A few times per week ___
Once per week ___
Sporadically for a while and then disappear ___
Rarely (about once per month) ___

Are the symptoms associated with a particular odor? Yes No

If yes, describe the odor:

WAMPLER FOODS DAILY QUESTIONNAIRE (HETA 2000-0105-2794)

TODAY'S DATE IS: _____ ____ / _____ _____, 2000

NAME: _____

PLEASE CIRCLE ONE OF THE FOLLOWING CHOICES TO INDICATE HOW YOU PERSONALLY, WERE AFFECTED IN TERMS OF EYE AND/OR RESPIRATORY IRRITATION AT WORK TODAY.

1 - NONE ("I did not have any personal symptoms or irritation.")

2 - MILD ("I had slight symptoms of irritation personally, but they did not interfere with my normal activities.")

3 - MODERATE ("I had definite symptoms of irritation personally, that slightly interfered with my normal activities.")

4 - SEVERE ("I had extreme symptoms of irritation personally, that markedly interfered with my normal activities.")

At what time did symptoms begin? _____

For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1-800-35-NIOSH (356-4674)
or visit the NIOSH Web site at:
www.cdc.gov/niosh

National Institute for Occupational Safety and Health
NIOSH

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