HETA 99-0348-2786
Fremont Beef Company
Fremont, Nebraska

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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.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Ronald Hall, Kenneth Martinez, and Kristin Gwin of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was preformed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

NIOSH conducted an HHE to evaluate worker exposures during research and development (R&D) procedures that utilized ozone.

The HHE request concerned worker exposures to ozone during R&D procedures for a new sanitation treatment process of raw beef. In response to the request, NIOSH investigators conducted an environmental evaluation at the Fremont Beef Company on Saturday, November 13, 1999.

What NIOSH Did

- Monitored the ozone treatment process
- Took air samples for ozone

What NIOSH Found

- Ozone generator can produce large amounts of ozone
- High ozone concentrations (in excess of applicable exposure criteria) were detected in the plant during the R&D process
- No ozone was detected in the plant 5 hours after the ozone generator was turned off
- Only supplied air respirators or self-contained breathing apparatus (SCBA) should be used to protect the respiratory system from ozone

What Managers Can Do

- Managers have decided not to utilize ozone at the plant and have eliminated the R&D testing procedures

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National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 99-0348-2786
Fremont Beef Company
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SUMMARY

On September 23, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) at the Fremont Beef Company in Fremont, Nebraska. The request, from management officials at the plant, concerned worker exposures to ozone during research and development (R&D) procedures for a new sanitation treatment process of raw beef. In response to the request, NIOSH investigators conducted an environmental evaluation at the Fremont Beef Company on Saturday, November 13, 1999. This evaluation was conducted on a weekend (when the plant was closed) to control worker and public access to the plant.

Prior to the HHE request, the company had conducted two R&D testing procedures. During the first testing process, the workers did not have respiratory protection, and the ozone generator was shut down after approximately 15 minutes when they reported respiratory symptoms (lung discomfort, nose and throat discomfort, and asthma attacks) and nausea. During the second R&D ozone process, workers wore half-mask air purifying respirators equipped with air purifying cartridges intended for ozone (NIOSH does not certify a cartridge for protection against ozone). The company monitored for ozone during this process and reported concentrations of 0.2 parts of ozone per million parts of air (ppm). The workers did not report any symptoms during this testing procedure which lasted approximately 2 hours.

During the NIOSH evaluation, workers and NIOSH representatives wore full face pressure-demand self-contained breathing apparatus (SCBA) to protect the respiratory system from health effects of ozone inhalation. During this evaluation, it was determined that the ozone generator is capable of producing high concentrations of ozone. Peak ozone concentrations of 5 ppm (measured with detector tubes and a real-time monitor) were indicated near the inlet of the tumbler where a worker would occasionally insert raw beef products. Measurements collected with an ozone real-time monitor indicated average ozone concentrations ranging from 0.1 to 1 ppm in the general tumbler area with an 8-hour time-weighted average (TWA) of 0.05 ppm. Ozone detector tube samples taken around the tumbler area during the testing procedures indicated concentrations ranging from 2 to 3 ppm.

The measured peak ozone concentration of 5 ppm exceeds the NIOSH ceiling limit (0.1 ppm), and is at the NIOSH recommended immediately dangerous to life or health (IDLH) limit (5 ppm) for ozone. The 8-hour TWA is below the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL), and is at the American Conference of Governmental Industrial Hygienist (ACGIH)® Threshold Limit Value (TLV)® for exposure during heavy physical exertion. However, ozone peak concentrations exceeded excursion limits. Management personnel at Fremont Beef Company have decided to terminate the R&D testing procedures, and not utilize ozone to kill bacteria in beef products at the plant in the future.

During the NIOSH evaluation it was determined that the ozone generator is capable of producing high concentrations of ozone [up to 5 ppm (IDLH) near the inlet of the tumbler where raw beef is periodically inserted]. When ozone concentrations are above applicable occupational exposure criteria a supplied air respirator or SCBA should be used, and only an SCBA can be utilized in IDLH conditions. The company has terminated the ozone treatment process.

Keywords: SIC Code 2013 (Sausages and Other Prepared Meat Products), ozone, bacteria treatment process, meat processing, respiratory irritants.

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INTRODUCTION

On September 23, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) at the Fremont Beef Company in Fremont, Nebraska. The request, from management officials at the plant, was concerned with worker exposures to ozone during research and development (R&D) procedures for a new disinfection treatment process of raw beef. The reported health effects during the R&D treatment process included lung, nose, and throat discomfort, nausea, and asthma attacks. There were four workers involved in this process.

In response to the request, NIOSH investigators conducted an environmental evaluation at the Fremont Beef Company on Saturday, November 13, 1999. This evaluation was conducted on a weekend (when the plant was closed) to limit the exposure potential in the plant to just those involved with the R&D process.

BACKGROUND

The R&D testing process consisted of a Stargate® ozone generator (capable of producing 50# of ozone in an 8-hour period) that utilized 99.9% liquid oxygen from a liquid oxygen cylinder. Ozone was injected into water and transported through a piping system to spray nozzles located inside a cylindrical tumbler. The raw beef products were then fed into the tumbler where they were sprayed and washed in water containing ozone.

The company had conducted two R&D testing procedures, using ozone to kill bacteria in the raw beef products, prior to our site visit. During the first testing process the ozone generator was shut down after approximately 15 minutes when the workers reported respiratory symptoms (lung, nose, and throat discomfort, and asthma attacks) and nausea. During this testing procedure the workers did not have respiratory protection. The second time the company conducted the R&D ozone process, the workers wore half-mask respirators equipped with air purifying cartridges intended for ozone (NIOSH does not certify respirator cartridges for ozone). The company monitored for ozone during this process and reported concentrations of 0.2 parts of ozone per million parts of air (ppm). The workers did not report any symptoms during this 2-hour testing procedure. However, a management representative reported what he suspected was smelling ozone (a pungent odor), while wearing the air purifying respirator.

The NIOSH site visit was conducted on a Saturday while the plant was closed. This was done to avoid any potential exposures to plant personnel who were not involved with the ozone R&D process. Prior to this site visit, NIOSH representatives also recommended that each worker involved in the testing process wear a self-contained breathing apparatus (SCBA) to protect the respiratory system from ozone exposures.

METHODS

A walk–through inspection of the facility was conducted on November 12, 1999, to familiarize NIOSH personnel with the R&D activities and work areas where ozone concentrations were to be monitored. On November 13, 1999, area air samples for ozone and chlorine were collected during the ozone treatment process near the workers and in different areas of the plant. Samples for chlorine were collected because it is an interfering agent with the real-time ozone monitor, and chlorine may be routinely used during cleaning operations. To help reduce the possibility of chlorine interfering with the ozone monitor, the plant did not utilize any chlorine-based disinfecting agents for three days prior to our visit.

Ozone samples were collected prior to the ozone treatment process (to collect background ozone concentrations), during the ozone

treatment process, and after the process was completed. The ozone R&D treatment process lasted approximately 2 hours. Ozone samples were collected in the office areas, tumbler area, entrance of building, meat freezers, and production areas of the plant after the process, to determine the amount of time necessary for ozone concentrations to return to background levels.

Ozone

Ozone samples were collected using a Metrosonics pm–7700 toxic gas monitor equipped with a gs–7709 ozone sensor (Metrosonics Inc., Rochester, New York). The pm–7700 toxic gas monitor is a direct reading instrument with data–logging capabilities. This monitor was programed to collect four samples per second and report the measured ozone minimum, average, and maximum concentration every five minutes. The monitor also reports peak concentrations and the time–weighted average (TWA) concentration over the entire sample period. The ozone concentrations recorded by the monitor were downloaded to a personal computer for evaluation.

Additionally, monitoring for ozone was conducted with colormetric detector tubes (Draeger 0.05/b, #6733181 – range 0.05 to 0.7 ppm with 10 strokes on the pump). The detector tubes are used by drawing air through the tube with a bellows–type pump. The resulting length of the stain in the tube (produced by a chemical reaction with the sorbent) is proportional to the concentration of the air contaminant. The scale on the detector tube can be modified by using 5 strokes on the bellows-type pump instead of 10. If 5 strokes were employed, then the readings on the tube would be multiplied by a factor of 2. If one stroke on the bellows-type pump was employed, then the resultant stain on the colormetric tube would be multiplied by a factor of 10.

Chlorine

Monitoring for chlorine was conducted with colormetric detector tubes (Draeger 0.2/a, #24301 range 0.2 to 3 ppm using 10 strokes on the bellows-type pump). The detector tubes are used by drawing air through the tube with a bellows–type pump. The resulting length of the stain in the tube (produced by a chemical reaction with the sorbent) is proportional to the concentration of the air contaminant.

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 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 Recommended Exposure Limits (RELs),[1] (2) the American Conference of

Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[2] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] 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 91–596, 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 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.

Ozone

Low concentrations of ozone (0.01 ppm to 0.05 ppm) may produce a sharp, irritating odor even during brief exposures.[4] Symptoms of ozone exposure include irritation of the eyes, dryness of the nose and throat, and cough. If ozone concentrations continue to rise, more severe symptoms may develop. These symptoms may include headache, pain or tightness in the chest, and shortness of breath or tiredness.[4] Short–term exposure (a few hours) to ozone concentrations on the order of 0.1 ppm has been shown to produce temporary decreases in measured lung volumes in humans.[5]

The NIOSH REL for ozone is 0.1 ppm and is to be measured as a ceiling limit.[1] A ceiling limit is a peak concentration that should not be exceeded at any time during the workday. NIOSH has also recommended an immediately dangerous to life and health (IDLH) limit of 5 ppm for ozone.[6] The current NIOSH definition for an IDLH exposure condition, as stipulated in the NIOSH Respirator Decision Logic,[7] is a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." The purpose of establishing an IDLH exposure is to "ensure that a worker can escape from a given contaminated environment in the event of failure of the respiratory equipment." [6,7] The current OSHA PEL for ozone is 0.1 ppm for an 8–hour (40–hour work week) TWA.[3] The current ACGIH® TLV® is based on the amount of physical

exertion or work load required for the job being accomplished and is to be averaged over an 8–hour period. The TLV® is 0.1 ppm for jobs requiring light physical exertion, for moderate physical exertion the TLV® is lowered to 0.08 ppm, and for heavy physical exertion the TLV® is lowered to 0.05 ppm.[2] ACGIH has developed excursion limits to protect worker health to substances that do not have short-term exposure limits. Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than 30 minutes during a work day, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.[2]

RESULTS

Ozone

Real-Time Monitor

Figure 1 presents the minimum, average, and maximum ozone concentrations collected for each five minutes during the sampling period in the tumbler area. The peak ozone concentration during the R&D testing procedure was 5 ppm. This measurement was collected near the entrance of the tumbler (at breathing zone height) where a worker would occasionally insert raw beef products. This peak concentration exceeds the NIOSH ceiling limit, and is at the NIOSH recommended IDLH limit for ozone. Average ozone concentrations in the general area near the tumbler during the R&D procedures ranged from 0.1 to 1 ppm. The 8-hour TWA ozone concentration at the tumbler area was 0.05 ppm. The 8-hour TWA is below the OSHA PEL, and is at the ACGIH TLV for heavy physical exertion. However, ozone peak concentrations exceeded ACGIH excursion limits. The TWA was based on the two hour R&D process utilizing ozone. If the ozone sanitizing operation was in full production, one could assume that the TWA would be well over applicable exposure criteria.

The ozone generator operated approximately 2 hours during the R&D testing procedures. The ozone real-time monitor was reporting ozone concentrations at background levels (ozone concentrations before the R&D procedure) within 2 hours after the ozone generator was turned off.

Detector Tubes

Detector tube samples taken around the tumbler area during the R&D testing procedures ranged in concentration from 2 to 3 ppm. The detector tube samples collected at the entrance of the tumbler (at breathing zone height where a worker would occasionally insert raw beef products) indicated an ozone peak concentration of 5 ppm.

Detector tube samples for ozone were collected throughout the plant after the R&D testing procedures to determine when ozone concentrations were at acceptable levels to work without respiratory protection. Table 1 indicates the time and areas where the ozone measurements were taken. Ozone measurements were also collected approximately five hours after the ozone generator had been turned off. No ozone was detected (limit of detection 0.05 ppm) in the plant at this time.

The detector tube samples consistently indicated higher ozone concentrations than the real-time ozone monitor in the tumbler area. However, both methods indicated ozone peak concentrations of 5 ppm at the entrance of the tumbler.

Chlorine

Chlorine samples were collected with colormetric detector tubes (Draeger 0.2/a, #24301 range 0.2 to 3 ppm using 10 strokes on the bellows-type pump) near the tumbler during the R&D ozone treatment process. No chlorine was detected during the evaluation with detector tubes.

DISCUSSION AND CONCLUSIONS

Prior to the NIOSH evaluation, the company had conducted two R&D testing procedures utilizing the ozone generator. During the first test, the workers reported symptoms consistent with ozone exposures (lung, nose, and throat discomfort, nausea, and asthma attacks). The first test was terminated after approximately 15 minutes because of the reported respiratory symptoms. During the second test the workers wore half-mask respirators with air purifying cartridges intended for ozone. Workers did not experience ozone exposure symptoms during the second test. However, a management representative (when working at the opening of the tumbler) reported, what he suspected was smelling ozone (a pungent odor), while wearing the air purifying respirator. This indicates that concentrations at this location were high enough to break through the air purifying medium in the respirator cartridges. During this test, the company monitored for ozone and reported concentrations in the general area near the tumbler of 0.2 ppm.

During the NIOSH evaluation it was determined that the ozone generator is capable of producing high concentrations of ozone [up to 5 ppm (IDLH) near the inlet of the tumbler where raw beef is inserted]. NIOSH does not certify air purifying cartridges for respiratory protection against ozone. Therefore, during the NIOSH evaluation, workers and NIOSH representatives wore pressure-demand SCBA's to protect the respiratory system from health effects of ozone inhalation. When ozone concentrations are above applicable occupational exposure criteria a supplied air respirator or SCBA should be used, and only an SCBA can be utilized in IDLH conditions. For respirators to be worn by employees, an appropriate respiratory protection program must be utilized and be in accordance with OSHA regulation 29 CFR 1910.134.[8] OSHA requires that respiratory protection programs include written standard operating procedures; respirator selection on the basis of hazard; fit testing; user instruction and training; respirator cleaning, disinfection, storage, and inspection; surveillance of work area conditions; evaluation of the respiratory protection program; medical evaluation of employee fitness to wear respirators; and use of certified respirators.

Management personnel at Fremont Beef Company have decided to terminate the R&D testing procedures, and not utilize ozone to kill bacteria in beef products at the plant.

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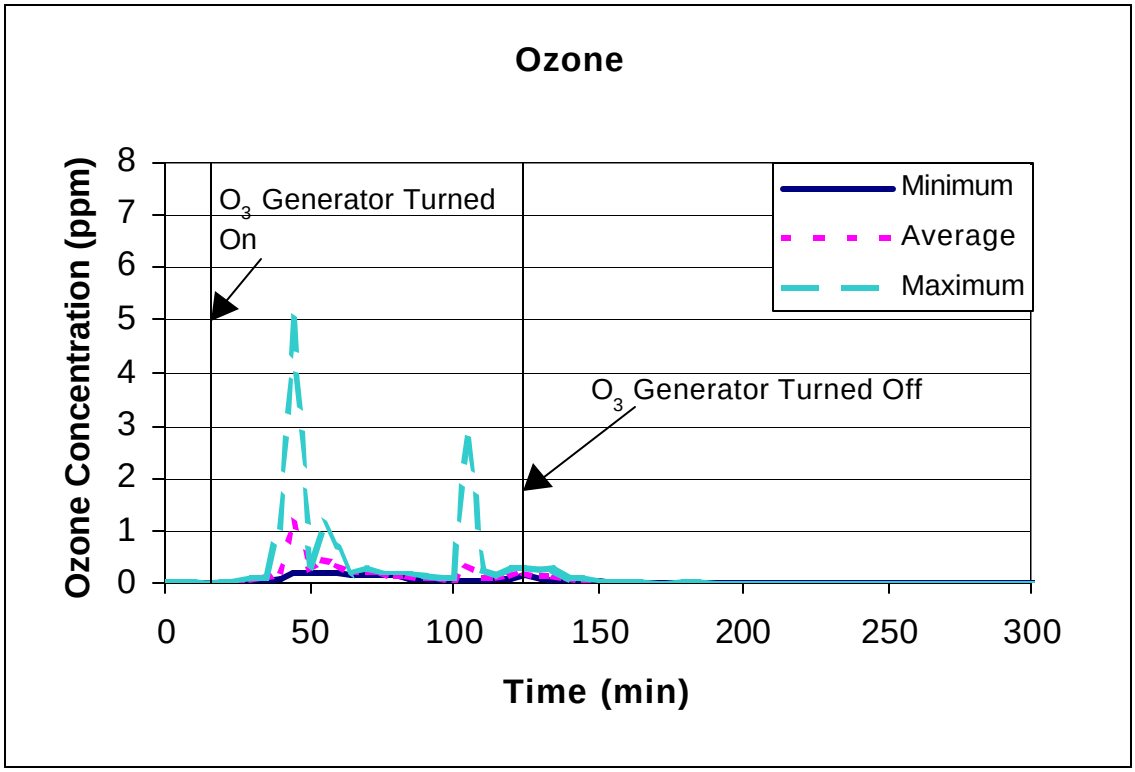

Figure 1. Ozone concentrations in tumbler area near workers.

Table 1. Ozone concentrations in the plant after the ozone generator was turned off. Measurements were collected with detector tubes.

Area	Ozone Concentration (ppm)	Time*
Office area	<0.05	11:17 a.m.
First Aid Room	0.05	11:29 a.m.
Freezer Area	<0.05	11:30 a.m.
Liver S&D area	0.2	11:36 a.m.
Near Tumbler	0.15	11:50 a.m.
Beef Department	<0.05	11:55 a.m.
* Ozone generator was turned off at approximately 10:45 a.m.		

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