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HETA 94-0034-2403
MARCH 1994
GRAY AND COMPANY
HART, MICHIGAN

NIOSH INVESTIGATOR:
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SUMMARY

In October 1993, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request from Gray and Company, a producer of candied fruits, fruit cake mixes, maraschino cherries, and, since 1992, chocolate-covered cherries. Workers were concerned with odors from silicone lubricants, hot melt glues, and propane-fueled forklift trucks used in the Packaging Area. Health problems described by affected workers included burning eyes, headache, sore throat, sinus problems, upset stomach, and dry cough.

A site visit was conducted on December 8, 1993, during which a walk-through was conducted of the Packaging Area and sampling was performed for carbon dioxide (CO_2), carbon monoxide, volatile organic compounds (VOC), temperature, and relative humidity (RH). The ventilation system used in the Packaging Area to maintain a constant temperature and RH, a Liebert Environmental Control System, was visually examined.

Carbon dioxide levels in the Packaging Area were consistently below 1,000 parts per million (ppm), despite the fact that the environmental control unit which provided ventilation for this department was adjusted to recirculate 100% of the return air. In non-industrial work environments, CO_2 levels below 1000 ppm suggest that sufficient outside air is entering the work space. In the Packaging Area, CO_2 levels may remain low for a variety of reasons, including dilution air entering from surrounding departments and the fact that the Packaging Area is a large volume space with high ceilings.

Temperature and RH were maintained, as designed, at 70°F and 50%, respectively. Short-term measurements for carbon monoxide at several location in the plant suggest that levels should be below the Occupational Safety and Health Administration (OSHA) permissible exposure limit of 50 ppm for an 8-hour time weighted average and below the NIOSH recommended exposure limit of 35 ppm for up to a 10-hour exposure. Levels of 1,1,1-trichloroethane, ethyl acetate, and limonene, the major organic compounds identified in the air sampling conducted in this survey, were well below their respective occupational exposure limits. The visual examination of the environmental control unit serving the Packaging Area revealed incorrectly installed air filters, air filters which were damaged or visibly dirty and in need of replacement, and significant dust on the cooling coils.

No health hazards were observed which would explain the health problems described by affected employees. Although the VOC concentrations in the Packaging Area did not exceed any occupational exposure criteria, the low levels of VOCs in this department may still present some risk of irritation in certain more susceptible individuals. Recommendations have been made to replace the damaged or missing air filters, to clean the cooling coils, and to increase the efficiency of the air filters used in the ventilation unit in the Packaging Area.

KEYWORDS: SIC 2064 (Candy and Other Confectionery Products), carbon monoxide, carbon dioxide, temperature, relative humidity, ventilation, food preparation

INTRODUCTION

In October 1993, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees at Gray and Company, a producer of candied fruits, fruit cake mixes, and maraschino cherries. In 1992, the company began producing a new product, chocolate-covered cherries. Inspection, sorting, and packaging activities for this candy product were performed in a temperature and humidity-controlled area called the Packaging Area. Workers were concerned with odors from silicone lubricants, hot melt glues, and propane-fueled forklift trucks used in the Packaging Area. Health problems described by affected employees included burning eyes, headache, sore throat, sinus problems, upset stomach, and dry cough.

Prior to this NIOSH survey, several changes had been made by Gray and Company to address the concerns of the employees in this area. Some of the propane-fueled forklifts had been replaced by electric forklifts. In addition, the food-grade silicone spray lubricant, used to used by Packaging Area workers to lubricate the conveyors and packaging equipment had been switched from an aerosol propellent applicator to a hand pump spray.
A site visit was conducted on December 8, 1993, during which a walk-through was conducted of the Packaging Area and sampling was performed for CO_2, carbon monoxide, volatile organic compounds (VOCs), temperature, and RH. The ventilation system used in the Packaging Area to maintain a constant temperature and RH, a Liebert Environmental Control System, was visually examined.

BACKGROUND

Gray and Company, with plants located in Michigan and Oregon, produces candied fruits, fruit cake mixes, and maraschino cherries. In 1992, the company began producing chocolate-covered cherries, a candy-making operation which currently employs from 37 to 45 people on a seasonal basis. Some of the activities associated with manufacturing chocolate-covered cherries at this facility include brine storage of cherries; cherry sizing, pitting, and bleaching; cherry coloring and sugar addition; and chocolate coating. Following coating, the chocolate-covered cherries are manually inspected, packed in plastic trays, and then boxed and prepared for shipping. This NIOSH evaluation focussed on these latter packaging operations.

Figure 1 contains a diagram of the Packaging Area, a temperature and RH-controlled department in which approximately 40 people are assigned to inspect, pack, and ship boxes of chocolate-covered cherries in either of two identical production lines. The following chart summarizes the packaging activities.

Activity	Description
Packers	Manually inspection, followed by packing the chocolate-covered cherries in plastic trays. Following packing, the trays are automatically sealed with a plastic film.
Randalls (Box Makers)	Empty cardboard containers which hold the chocolate-covered cherry filled trays are automatically folded and glued by the Randall units. The top of the box is left open.
Tray Packers	The plastic-sealed trays are placed in the cardboard containers emerging from the Randall units.
Peters (Box Sealers)	The Peters units close the filled cardboard containers and glue the lids in place
Packaging and Palletizing	Individual cardboard boxes from both lines are stacked on pallets for shipment to customers

Ventilation for the Packaging Area is provided by a Liebert environmental control unit. This 100% recirculating system provides heating, cooling, and steam humidification for this department 24 hours/day to maintain the temperature and RH at 65°F and 50%, respectively. Controlling temperature and humidity at these levels maintains product integrity and improves the packaging process. The steam used for humidification is obtained from process steam supplied to the plant by either of two gas-fired boilers.

Propane-fueled forklifts operate in an aisle adjacent to the Packaging Area, moving raw materials (such as bulk cherries) as well as transporting finished product. Transparent strip curtains are used to separate the Packaging Area from this aisle and other adjacent manufacturing areas.

ENVIRONMENTAL EVALUATION

The following chart summarizes the general area air sampling which was conducted on December 8, 1993.

Substance	Operations Monitored	Sampling Methods
CO_2, Temperature, and RH	#1 and #2 Peters Lines; #1 and #2 Packaging Lines; Kitchen; Aisle (outside of Packaging Area); Outside of plant	Direct-reading infrared CO_2 monitor; direct reading temperature and relative humidity meter.
Carbon Monoxide	Electric forklift recharging area (Room A); Palletizing operation in Packaging Area; Aisle (outside of Packing Area); Forklifts Nos. 5, 7, and 8	Direct-reading colorimetric detector tubes (low range) used for spot measurements
General Organic Compounds	Kitchen (on platform); #1 Peters Line; #2 Peters Line; #2 Packaging (near tray sealing machine)	Thermal desorption tubes used to qualitatively scan for organic compounds. Side-by-side charcoal tube samples were collected to quantitate the major VOC components

EVALUATION CRITERIA

In the opinion of the NIOSH investigator, the work tasks in the Packaging Area (primarily inspecting and packing chocolate-covered cherries) result in minimal chemical exposures to the employees. For example, the two chemicals primary used by the workers in this department include a U.S. Food and Drug Administration approved food-grade silicone spray lubricant (to lubricate the candy packaging machinery) and a hot melt glue (used to assemble the cardboard packaging). Since the Liebert environmental control system in this department is intended to maintain a constant temperature and RH, at the time of this investigation the unit was set to recirculate 100% of the room air. Because of these factors, evaluation techniques typically used in non-industrial work settings were incorporated into this study. For example, 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.[1] Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 parts per million [ppm]). Elevated CO_2 concentrations also suggest that other indoor contaminants may also be increased.

In addition to CO_2 monitoring, air samples were collected to measure trace levels of volatile organic compounds (VOCs). VOCs describe a large class of chemicals which are organic (i.e., containing carbon) and have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. These compounds are emitted in varying concentrations from numerous indoor sources including, but not limited to, adhesives, solvents, paints, cleaners, waxes, and combustion sources. In the Packaging Area, VOCs could originate a wide number of sources, including the silicone spray lubricant, the hot melt glue, as well as emissions from the propane-powered forklifts used in adjacent areas.

General Exposure Limits

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 limits 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 limits. 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 limit 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 the following: 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] The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure concentrations and the

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[1] Carbon dioxide levels in the Packaging Area may remain low for reasons other than the introduction of outside air. These reasons include the infiltration of dilution air from surrounding departments and the relatively small worker density in comparison to the large volume of space (created by the high ceilings in the Packaging Area).

recommendations for reducing these concentrations found in this report, it should be noted that the lowest exposure criteria was used; however, industry is legally required to meet those limits specified by the 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 (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

RESULTS

Carbon Dioxide, Temperature, and Relative Humidity

Carbon dioxide, temperature, and RH measurements made in the kitchen and packaging areas are presented in Figures 2, 3, and 4. Levels of CO_2 remained below 1,000 ppm throughout the work shift on December 8, 1993. The temperature and RH levels in the packaging room, as expected, remained fairly constant in this environmentally-controlled area, ranging from 68 to 71°F and 44 to 51%, respectively.

Carbon Monoxide

Short-term measurements using direct-reading colorimetric detector tubes were made for carbon monoxide (CO) at several locations in the plant. The results from these short-term CO samples, shown in the following chart, suggest that the levels below the OSHA PEL of 50 ppm for an 8-hour TWA and below the NIOSH recommended exposure limit of 35 ppm for up to a 10-hour exposure.

Sampling Location	Sample Time	CO Concentration (ppm)
Palletizing area in Packaging Area	8:03 to 8:08 am	Between 5 to 10 ppm
Electric forklift recharging area	8:13 to 8:18 am	Approximately 10 ppm
Aisle adjacent to Packaging Area	8:20 to 8:25 am	Approximately 25 ppm
Comments: 1. ppm = parts per million 2. A propane-fueled forklift was leaving the area as the sample was being collected in the aisle adjacent to Packaging Area		

In an attempt to estimate how well the propane-powered forklift trucks were maintained, CO levels were measured near randomly selected forklift trucks. These samples were collected while standing approximately three feet behind the exhaust of an idling forklift. Using this sampling protocol, CO levels near forklift trucks #5 and #7 were less than 50 ppm. The CO level near forklift truck #8, however, was approximately 100 ppm, suggesting that this truck was not operating as efficiently at the other lifts.

Selected Volatile Organic Compounds

Figures 5, 6, 7, and 8 contain chromatograms with the peaks identified which were obtained from thermal desorption samples collected in the Packaging and Kitchen Areas. Based on these qualitative air samples, the VOCs believed to be present in the highest concentration were selected for quantitation from the charcoal tube samples. The results from the four charcoal tube air samples are shown in the following chart. The three solvents selected for quantitation, 1,1,1-trichloroethane, ethyl acetate, and limonene, were selected as the major VOC components present in the thermal desorption samples.

Location	Sample Volume (liters)	Concentration, parts per million		
		1,1,1 Trichloroethane	Ethyl Acetate	Limonene
#2 Peters Conveyor Line	32.0	1.83 ppm	0.10 ppm	ND
#2 Randall, near hot melt glue	32.5	4.75 ppm	ND	ND
#1 Peters Conveyor Line	32.7	3.28 ppm	ND	Trace
Minimum Detectable Concentration (MDC)		0.05 ppm	0.02 ppm	0.02 ppm
Minimum Quantifiable Concentration (MQC)		0.15 ppm	0.09 ppm	0.07 ppm
Comments: ND = Not Detected Trace = concentration between the MDC and the MQC The MDC and MQC values were calculated assuming a sample volume of 32 liters.				

DISCUSSION

Air Contaminants

Levels of 1,1,1-trichloroethane, ethyl acetate, and limonene, the major organic compounds identified in the air sampling conducted in this December 8, 1993, survey, were well below their respective occupational exposure limits. Although the concentrations of 1,1,1-trichloroethane, ethyl acetate, and limonene measured in the Packaging Area do not exceed OSHA, NIOSH, or ACGIH occupational exposure criteria, the low levels of VOCs in this area may still present some risk of irritation in certain more susceptible individuals. For example, indoor environmental quality studies (typically in non-industrial work settings such as offices) have measured wide ranges of VOC concentrations in indoor air as well as differences in the mixtures of chemicals which are present. Research also suggests that the irritant potency of these VOC mixtures can vary. Some researchers have compared VOC levels with human responses (such as headache and irritative symptoms of the eyes, nose, and throat). Research conducted in Europe suggests that complaints by building occupants may be more likely to occur when VOC concentrations increase. *However, neither NIOSH nor OSHA currently have specific exposure criteria for low-level VOC mixtures in the nonindustrial (or industrial) environment.* It should also be emphasized that the highly variable nature of these complex VOC mixtures can greatly affect their irritancy potential. Finally, much of the research which has been conducted has examined non-industrial work areas such as offices and schools and, as such, may not be directly applicable to occupational environments such as those at Gray and Company.

Ventilation

The Liebert System 3 environmental control unit in the Packaging Area provided heating, cooling, humidification, and dehumidification for this area. The following deficiencies were observed when this unit was visually examined on December 8, 1993.

- The disposable panel-type air filters were not correctly installed in the unit, allowing significant bypass (leakage) to occur. One filter panel had a crumbled cardboard. Additionally, a three-inch gap existed on one side of the filter bank.

- The 25 X 20 X 4 inch thick pleated filters used in this unit (Liebert Part No. A-0320) had an American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) rated efficiency of 20%. A filter with a higher efficiency (such as between 30 to 40%) would be more effective in trapping smaller particulate.

- Half of the pleated filters were visibly dirty and may need to be changed. The remaining filters appeared relatively clean. The leakage caused by the missing or damaged air filters could be responsible for some of this disparity in filter loading. In addition, the filter were changed on an irregular schedule (ranging from 14 to 28 days).

- A visible layer of dust was observed on the surface of the cooling coils.

Humidification

The Liebert environmental unit used plant process steam to maintain humidity at 50% in the Packaging Area. This steam, supplied by two gas-fired boilers, was treated to control corrosion and prevent the growth of algae. Two of these boiler additives (LB-80® and BSP-2®, manufactured by Mitco Inc., Grand Rapids, MI) were listed as skin and eye irritants. To eliminate the opportunity for these boiler additives to be released into the Packaging Area during humidification, the steam humidifier in the Liebert environmental unit should have a separate water supply which is free from potentially irritating anti-corrosion agents.

Hearing Conservation Program

It was observed during this evaluation that employees in several of the manufacturing departments were required to wear hearing protection (typically foam ear plugs). However, warning signs were not conspicuously posted at entrances to all areas where hearing protection was required. Since it was not determined as part of this survey whether noise levels were sufficient in the various manufacturing departments to warrant the use of hearing protection by the workers, an noise assessment should be conducted to determine the need for a hearing protection program.

Legionnaires' Disease

Prior to this NIOSH evaluation, Legionnaires' Disease had been a concern to some of the workers at Gray and Company. Investigations by the State of Michigan and a private consultant retained by the company had resolved this issue prior to this NIOSH evaluation. For future reference, Appendices A and B contain information on transmission factors, safety precautions, and preventative measures which may be useful in preventing amplification and dissemination of *Legionella*. Nothing was observed during this evaluation which indicated that any potential problems remained with this issue.

RECOMMENDATIONS

1. The transparent strip curtains separating the Packaging Area from the adjacent aisle should be repaired. During this evaluation several of the plastic strips were missing in two of these curtains, a situation which increases the opportunity for forklift emissions to enter the Packaging Area from the adjacent aisle.

2. The emergency eye wash station situated near the forklift battery recharging area is not capable of flushing the eyes or face with copious amounts of water in the event of an accident. This eye wash station should be replaced with one which can deliver at least 15 uninterrupted minutes of flushing water.

3. The elevated CO levels measured behind one of the propane-fueled forklifts during this evaluation suggests that the lift truck may require maintenance. All of the forklifts should be evaluated on a regular basis to determine if they operating with manufacturing specifications.

4. One of the overhead lights in Room A was not functioning, creating an exceedingly dim work environment for the forklift driver to operate. This light should be repaired or replaced.

5. A visual examination of the Liebert® System 3 environmental unit in the Packaging Area revealed several incorrectly installed air filters and gaps which existed between the air filters and frames, a situation which permits unfiltered air to enter the system and be recirculated back into the Packaging Area. In addition, based on log entries maintained by the maintenance department, the filters were changed on an irregular schedule (ranging from 14 to 28 days). A regular inspection and/or replacement schedule should be implemented. In addition, the manufacturer should be consulted to determine if a pressure system (i.e., monitoring the differential pressure across the air filters) could be installed to indicate when the filters should be changed.

6. The feasibility of introducing a portion of outside air to the Liebert environmental unit should be investigated to eliminate recirculating 100% of the room air. Providing outside air should reduce the already low VOC levels in the Packaging Area.

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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.

APPENDIX A

LEGIONNAIRES' DISEASE - COMMONLY ASKED QUESTIONS AND ANSWERS

Legionnaires' disease is a common name for one of the several illnesses caused by a bacterium called Legionella. Legionnaires' disease is an infection of the lungs that is a form of pneumonia. A person can develop Legionnaires' disease by inhaling water mist contaminated with Legionella bacteria.

Legionella bacteria, in low levels, are widely present in the environment, in lakes, streams, and ponds. At these low levels the chance of getting Legionnaires' disease from a water source is very slight. The problem arises when high concentrations of the organism grow in water sources. Water heaters, cooling towers, and warm, stagnant water can provide ideal conditions for the growth of this organism.

Scientists have learned much about the disease and about the Legionella bacteria since it was first discovered in 1976. To help you learn more about what is currently known about Legionnaires' disease the following questions and answers have been prepared.

Q. What are the symptoms of Legionnaires' disease?

A. Early symptoms of the illness are much like the flu. After a short period of time (in some cases a day or two), more severe pneumonia-like symptoms may appear. Not all individuals with Legionnaires' disease experience the same symptoms. Some individuals will be only flu-like symptoms, while with others, the disease can be fatal.

Early flu-like symptoms:

* slight fever
* headache
* aching joints and muscles
* lack of energy, tired feeling
* loss of appetite

Common pneumonia-like symptoms:

* high fever (102 to 105°F, or 39 to 41°C)
* cough (dry at first and later producing phlegm)
* difficulty in breathing/ shortness of breath
* chills
* chest pains

Q. How common is Legionnaires' disease?

A. In the United States it is estimated that there are approximately 25-50,000 cases of Legionnaires disease every year. This means about one to two cases per year occur among a group of 10,000 people.

Q. *How does a person get Legionnaires' disease?*

A. A person must be exposed to a water source contaminated with the Legionella bacterium. This may happen by inhaling or drinking water contaminated with the Legionella bacteria. For example, inhaling contaminated water mist from a cooling tower, from a humidifier, or even from a shower or sink can cause the disease.

Q. *How soon after being exposed will a person develop symptoms of the disease?*

A. Assuming that the infection process occurs, the disease symptoms usually appear within two to 10 days.

Q. *Are some people at a higher risk of developing Legionnaires' disease?*

A. Yes, some people have a lower resistance to the disease and are more likely to develop Legionnaires' disease. Some of the factors which can increase your risk of getting the disease include:

* organ transplants (kidney, heart, etc.)
* age (older persons are more likely to get disease)
* heavy smoking
* individuals with weakened immune systems
* underlying medical problem (respiratory disease, diabetes, cancer, renal dialysis, etc.)
* certain drug therapies (corticosteroids)
* heavy drinking

Q. *Is Legionnaires' disease spread by person to person contact?*

A. No, Legionnaires' disease is not contagious. It cannot be transmitted from one person to another.

Q. *What causes Legionnaires disease?*

A. Legionnaires' disease is caused by inhaling or ingested water contaminated with a rod-shaped bacteria named Legionella pneumophila. There are over thirty different species of Legionella, many of which can cause disease. Legionella pneumophila is the most common species which causes disease.

Q. *Does everyone who inhales Legionella into the lungs develop Legionnaires disease?*

A. No. Most people have resistance to the disease. It is thought that less than five out of a 100 people who are exposed to high levels of Legionella will develop Legionnaires' disease.

Q. *Is Legionnaires' disease easily diagnosed?*

A. No. The pneumonia disease produced by Legionella bacteria is not easily distinguished from other forms of pneumonia. There are however, a number of diagnostic tests which can be used by a physician to identify the disease. These tests can be performed on a sputum, blood or urine sample obtained from the patient.

Q. *How is Legionnaires' disease treated?*

A. Erythromycin is the current antibiotic of choice. Early treatment reduces the severity and improves chances for recovery. In many instances this antibiotic may be prescribed without the physician's knowledge that the disease is Legionnaires'.

Q. *How did Legionnaires' disease get it's name?*

A. Legionnaires' disease got its name from the first identified outbreak. This outbreak occurred in 1976, in a Philadelphia hotel where the Pennsylvania American Legion was having a convention. Over 200 of the legionnaires and visitors attending this convention developed pneumonia and some died. From lung tissue, a newly discovered bacterium was found to be the cause of the pneumonia. The bacteria was named Legionella pneumophila.

Q. *Is Legionnaire's disease a new disease?*

A. Legionnaires' disease is not new, but has only recently been identified. Unsolved pneumonia outbreaks that had occurred before 1976 are now known to have been Legionnaires' disease. Scientists are still studying this disease to learn more about it.

Q. *Is Legionella bacteria widespread in the environment?*

A. Yes, studies have shown that this bacteria can be found both in natural and man-made water sources. Natural water sources including streams, rivers, fresh water ponds and lakes, and mud can contain the organism in low levels.

Q. *Can I get the disease from natural water sources?*

A. Probably not. In the natural environment the very low levels of this organism in water sources can probably not cause disease.

Q. *What water conditions are best for growth of the organism best?*

A. Warm, stagnant water provides ideal conditions for growth of the organism. At water temperatures between 68 - 122°F the organism can multiply. Temperatures of 90-105°F are ideal for growth. Rust (iron), scale, and other micro-organisms can also promote the growth of Legionella pneumophila in water.

Q. *What common types of water are of greatest concern?*

A. Water mist from cooling towers or evaporative condensers, evaporative coolers (swamp coolers), humidifiers, misters, showers, sinks, and whirlpool baths can be contaminated with the organism and if inhaled or swallowed can cause the disease.

Q. *Can Legionnaires' disease be prevented?*

A. Yes. Avoiding water conditions which allow the organism to grow to high levels is the best means of prevention. Some prevention steps include:

* Regular maintenance and cleaning of cooling towers and evaporative condensers to prevent the growth. This should include twice annual cleaning and periodic use of chlorine or an effective biocide.

* Maintain hot water heaters at least 140°F (60°C). Ideally this should mean that the temperature of the delivery water will be 122°F or higher.

* Avoid conditions which allows water to stagnate. Large water storage tanks exposed to sunlight can produce warm water conditions which will result in high levels of <u>Legionella.</u> Frequent flushing of unused water lines will help alleviate the water stagnation problem.

Q. *What can be done if a water system is already contaminated, or is suspected of being contaminated?*

A. Special cleaning procedures are available for eliminating <u>Legionella</u> from water sources. In many cases these procedures involve the use of chlorine-producing chemicals, or high water temperatures. Professional assistance should be sought before conducting a system cleaning.

Q. *Can my home water heater also be a source of <u>Legionella</u> contamination?*

A. Yes, but there is some evidence which indicates smaller water systems, such as those used in homes, are not as likely to be infected with <u>Legionella</u> as the larger systems which may be installed at work or in public buildings.

Q. *Can the <u>Legionella</u> bacterium cause other diseases?*

A. Yes. In addition to Legionnaires' disease, the same bacteria also causes a flu-like disease called Pontiac fever.

Q. *How does Pontiac fever differ from Legionnaires' disease?*

A. Unlike Legionnaires disease, which is can be a serious, even deadly form of pneumonia, Pontiac fever produces flu-like symptoms. These symptoms may include: fever, headache, tiredness, loss of appetite, muscle and joint pain, chills, nausea, and dry cough. Full recovery occurs for Pontiac fever in two to five days without antibiotics. No deaths have been reported for Pontiac fever.

Q. *Are there other differences between Legionnaires' Disease and Pontiac fever?*

A. Yes. Unlike Legionnaires' disease which causes disease in only a small percentage of the persons who are exposed, Pontiac fever will cause disease approximately 90% of the time. Additionally, the time from exposure to the organism before the disease occurs (incubation period) is generally less for Pontiac fever than for Legionnaires. Pontiac fever symptoms can appear within one to three days after exposure.

APPENDIX B

WATER TREATMENT PROTOCOLS FOR FACILITIES WHICH HAVE EXPERIENCED A LEGIONNAIRES' OUTBREAK

A. BACKGROUND

This section describes actions which must be taken in a building in which an outbreak of Legionnaires' Disease has occurred to ensure that the threat of further infection has been abated. For purposes of this document, an "outbreak of Legionnaires' Disease" may be said to exist when medically confirmed cases of Legionnaires' Disease are epidemiologically associated with a building or some portion of a building. This usually means that two or more confirmed cases of Legionnaires' Disease have been identified within a six-week period at the work site.

Under most circumstances it is not recommended that an evacuation of the building be performed. It will be necessary, following confirmation of an outbreak, to isolate individuals who are at high risk of contracting the disease from all potential sources. These individuals would include the immunosuppressed, such as persons having had organ transplants, individuals receiving chemotherapy including corticosteroids, and other individuals in poor health. In addition, a medical monitoring program must be instituted to track all workers who are currently on sick leave. Following these initial actions, a building inspection must be performed to identify all potential sources, including the cooling towers, evaporative condensers, potable water systems, humidifiers, and any sources of water which is maintained at a temperature of above 20°C (68°F) and have a potential for being aerosolized.

Prior to any flushing or disinfection of the water in these suspected sources, water samples must be taken and submitted for analysis to allow determination of the predominant serotypes and subtypes of Legionella pneumophila present in the water source and to determine the number of colony forming units per of water. This information will be helpful in identifying the source of the disease if the subtype of Legionella pneumophila has been identified in the afflicted worker population. Because of the 10 day to two week delay in obtaining sample results, corrective action should be initiated immediately, and not wait the result of the screening tests.

Since sampling for Legionella can be inconclusive, sampling results alone should not be relied upon to determine an appropriate course of action in a building where an outbreak has occurred. All potential sources of contamination will be assumed to be contaminated and treated accordingly in the event that an outbreak has occurred. Water sampling and testing procedures must be in accordance with current state-of-the-art accepted procedures.

Treatment of potential sources of contamination following sampling is described below. After the treatment, water samples must be collected and analyzed for colony forming units of Legionella pneumophila in order to determine the effectiveness of the treatment. Upon re-use of a water system following treatment it is essential that periodic maintenance and regular water sampling be performed to ensure that the maintenance is continuing to be effective. Included are proper maintenance procedures for controlling the organism in potential water sources within the facility.

B. COOLING TOWERS/EVAPORATIVE CONDENSERS

The function of a condenser water system is to absorb heat at the refrigeration units and reject it to the atmosphere through evaporation at the cooling towers. Evaporative condensers operate similar to cooling towers with the exception that refrigerant coils are located inside the water path, and water passing over the coils directly cools the refrigerant gas. Because both cooling towers and evaporative condensers use a fan system to move air through a re-circulated water system, a considerable amount of water vapor is introduced into the surroundings, despite the presence of drift eliminators designed to limit vapor release. In addition, this water is typically in the 20 - 50°C (68 - 122°F) range, which is ideal for Legionella pneumophila growth.

Water Sampling Protocol

Prior to beginning the decontamination process, collect an adequate number of water samples using sterile containers. These samples should be cultured to determine the degree of contamination and the subtype of Legionella pneumophila present in the source before treatment is performed. At a minimum, three water samples (200 to 1 Liter [L] volume) must be collected. These should include water taken from the incoming make-vp water supply, water from the basin of the unit most distant from the make-up water source, and re-circulated water from the air handling system at its point of return to the unit.

Clean-up Procedure

1. The entire cooling system including attached chillers and/or storage tanks (sumps) must be effectively cleaned and disinfected following procedures similar to those outlined in the "Wisconsin Protocol" Emergency Protocol. In brief, the steps are as follows:

    a. "Shock" treat cooling tower water at 50 parts per million (ppm) free residual chlorine.
    b. Add dispersant.
    c. Maintain 10 ppm chlorine for 24 hours.
    d. Drain system.
    e. Refill and repeat steps (a) through (d).
    f. Visually inspect system.
    g. Perform mechanical cleaning (modified procedures may need to be followed, depending upon the design of the cooling tower).
    h. Refill system, bring chlorine to 10 ppm and circulate for one hour.
    i. Flush system.
    j. Refill with clean water, in accordance with an effective water treatment program. The unit is now ready to be returned to service.

2. All water leaks into the cooling water system should be identified and eliminated.

3. Following completion of step 1, sample the cooling water for the analysis of colony forming units of Legionella Pneumophila. The unit may now be put into service provided the medical monitoring program has been implemented. If sample results from culture indicate that detectable levels of Legionella pneumophila are still present, repeat the chlorination process described in step 1 and re-sample the water.

4. Once, a non-detectable level for Legionella pneumophila has been achieved, a maintenance program must be implemented to insure continued safe and proper operation of the cooling water system, as outlined in the "Wisconsin Protocol." In brief, these guidelines include:

    a. Monthly inspection of equipment.
    b. Quarterly drainage and cleaning.
    c. Effective treatment of circulating water for control of microorganisms, scale, and corrosion. This should include systematic use of biocides and rust inhibitors (preferably supplied by continuous feed) and monthly microbiologic analysis to ensure that total bacterial count is kept under control.
    d. Documentation of operating and maintenance functions via a log or maintenance records book.

5. Monitoring of cooling system water for Legionella must continue at the following intervals to assure that significant growth of Legionella pneumophila has not occurred:

    a. Weekly testing for the first month after resumption of operation.
    b. Testing every other week for the next two months.
    c. Testing every month for the next three months.

One criterion level for Legionella concentration which has been used is <10 colony forming units (CFU) per milliliter (mL). If no cooling water sample is found in excess of this "monitoring criterion" within the six month period, monitoring may then be suspended. The maintenance program must continue indefinitely, however.

If any sample shows a level of Legionella in excess of the 10 CFU per mL criterion, immediate steps must be taken to reduce levels within acceptable limits. These steps may include increased frequency of application or concentration of biocides, pH adjustment, additional "shock" treatments, or any other action which is effective in reducing Legionella levels. Water samples should be re-taken and the sequence of testing be re-initiated.

Results of all water monitoring results should be made available to building occupants

C. POTABLE HOT WATER SYSTEMS

Potable hot water systems are those which are designed to provide heated culinary water for purposes of washing, cleaning, consumption, etc. Multiple independent systems may be present in a large building. These systems typically consist of a boiler or heater, a recirculating piping system, and pipes terminating in taps and fixtures. Operating temperatures may vary depending upon system design, energy conservation programs, and intended use of the hot water. It is recommended that hot water heaters be kept at a minimum of 60°C (140°F) and that all water be delivered at each outlet at a minimum of 50°C (122°F).

It is essential that all portions of the potable water systems in which water may stagnate be identified (e.g., "dead legs" or laterals which have been capped off or storage tanks which may have "dead zones" or which are not frequently used). For treatment to be effective, these stagnant zones must be removed from the system. Rubber and plastic gaskets within the plumbing system may also serve as a growth medium for the bacteria, and efforts should be made to use materials not conducive to growth or to minimize the use of these materials in the system. It is also important to identify and test the integrity of all backflow preventers and steps must be taken to assure that culinary water is protected against cross-contamination from process water through a building code approved method.

Water Sampling Protocol

Prior to initiating any treatment process for the hot water system water samples must be collected to determine potential contamination. Water samples should be collected by drawing a 200 mL to 1 L sample into a sterile container from the draw-off valve of all hot water heaters. The temperature of the water in these units should also be checked to determine if it is significantly lower than the set temperature. A representative number of hot water faucets or outlets should also be sampled. It is important that the faucet not be flushed prior to obtaining the sample because growth of the organism in this end section of the water system may be a source of contamination. Collect a 200 mL to 1 L "pre-flush sample" from the first hot water drawn from the outlet. While allowing the water to run, measure the water temperature and then collect a second "post-flush" sample when the temperature is constant. Submit the water samples to a qualified laboratory for analysis of CFU of Legionella per mL of water.

All hot water systems which have either been tested and found to contain detectable levels of Legionella or have been assumed to be contaminated will be treated as follows:

Clean-up Procedure

1. Disinfect the system through any effective chemical, thermal, or other treatment method.

    a. Pasteurize the hot water system by heating the water temperature to a minimum of 70°C (158°F) and maintain this temperature for a minimum of 24 hours. While maintaining the temperature at 70°C (158°F), continuously flush each faucet on the system with hot water for 20 minutes.
    b. Alternately, an accepted chemical disinfectant such as chlorine or acceptable biocide treatment can be used to clean the system. Following treatment the system must be thoroughly flushed to remove

all traces of chemicals because of the corrosive, and possibly toxic nature of these chemicals.
   c. Other techniques which have been shown to be effective and safe may also be employed.

2. Maintain hot water heaters at 60°C (140°F) and delivered at the faucet at a minimum of 122°F (50°C). In cases where this temperature recommendation cannot be maintained a safe and effective alternative must be implemented which controls Legionella growth.

3. Following treatment, the hot water from each storage tank must be re-sampled. If a detectable level of Legionella is found, the water system must be re-treated and re-sampled. If no measurable levels are found in this system (and all other potential sources have also been addressed) proceed to step 4.

4. Conduct monitoring of the potable hot/warm water system for Legionella at the following intervals to assure that re-contamination has not occurred:

   a. Weekly testing for the first month after resumption of operation.
   b. Every other week for the next two months.
   c. Every month for the next three months.

The Pathcon criteria for Legionella in potable water systems can be used during the monitoring period. Ten CFU per mL of water or more will necessitate re-treatment of the system as per steps 1-3 above. Following re-treatment the sequence of testing then reverts to weekly and the above testing sequence must be repeated. If during the monitoring period, the levels remain below 1 CFU per mL then additional monitoring will not be necessary. If the levels are between 19 CFU per mL, continued monthly sampling of the water source must be performed indefinitely and efforts made to determine the source of contamination.

Monitoring results should be made available to building occupants.

D. TEPID WATER SYSTEMS

Warm water systems or "tepid" water systems which dilute hot water from a hot water heater and mix it with cold water upstream from the outlet source are not recommended. Warm water left in these lines is at ideal temperatures for amplification of Legionella pneumophila. Localized mixing at the source to temper very hot water is a more acceptable solution. Another alternative is "instantaneous" point of delivery heating of water using individual steam heating systems at each outlet.

E. POTABLE COLD WATER SYSTEMS

Potable cold water systems are those which are designed to provide non-heated culinary water for purposes of drinking, washing, cleaning, toilet flushing, etc. Generally these systems have not been considered to be a major source of concern for Legionnaires' disease because at low temperatures Legionella pneumophila will not amplify. Cold water storage and delivery should be accomplished at less than 20°C (68°F) to minimize potential growth. Cold water lines located close to hot water lines should be insulated to maintain this temperature maximum. Efforts should be made to eliminate places in the system in which water can stagnate such as "dead legs" or storage tanks which are not routinely used.

The presence of detectable levels of Legionella pneumophila in the system may indicate contamination of the source water supply which should represent the maximum allowable level in the system.

If sampling of the system indicates a level of contamination significantly in excess of the in-coming potable water system, then effort must be made to treat the system and identify the source of contamination or amplification. By definition, these systems have no provision for heating water, and therefore disinfection must be accomplished by means other than heating if contamination with Legionella within the system is identified.

If cold water systems have been shown to contain measurable Legionella or are assumed to be contaminated, the following steps must be followed:

Clean-up Procedure

1. Clean and disinfect all cold water systems including storage tanks, drinking fountains, water lines, and water outlets.

    a. Use an accepted chemical disinfectant such as chlorine or other acceptable biocide.
    b. Use any other innovative technology which has been shown to be safe and effective.

2. Ensure that cold water systems are maintained such that conditions are not conducive to growth of Legionella. Temperatures should be maintained below 20°C (68 °F) and residual chlorine levels should ideally be in the range of 1 to 2 ppm. In practice, this level of chlorination may be objectionable and may also be excessively corrosive to metal pipes and containers.

3. Perform initial testing consistent with sampling guidelines. If test results show no measurable levels of Legionella (and all other potential sources have been addressed) proceed to step 4.

4. Flush all cold water outlets and fountains for four minutes, 12 hours prior to re-entry.

5. When steps 1 through 4 have been successfully completed, the building can be returned to normal operational status, but monitoring of the potable cold water system for Legionella must continue at the following intervals to assure that significant bacterial growth has not occurred:

    a. Weekly testing for the first month after resumption of operation.
    b. Every other week for the next two months.
    c. Every month for the next three months.

The same criteria used for hot water systems described above will also be used for the cold water system during the monitoring period. Ten CFU per mL of water or more will necessitate re-treatment of the system as per steps 1-3 above. Following re-treatment the sequence of testing then reverts to weekly and the above testing sequence (step 4) must be repeated. If during the monitoring period the levels remain below 1 CFU per mL then additional monitoring will not be necessary. If the levels are between 1-9 CFU per mL, continued monthly sampling of the water source must be performed indefinitely and effort made to determine the source of contamination.

Monitoring results should be made available to building occupants.

F. HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC) DISTRIBUTION SYSTEMS

Under normal conditions the HVAC systems is not likely to be a source of contamination with Legionella pneumophila unless water contaminated with the bacteria is continually entering the system. Under normal conditions, condensate pans on coiling coils should not serve as a water source in which amplification of the bacteria can occur because the temperature of the water is below 20°C (68°F). Improperly drained condenser pans may produce tepid water conditions which will lead to a variety of microbial and fungal growth conditions. Proper maintenance to eliminate this condition will lessen problems related to other diseases such as humidifier fever and asthmatic responses, and will minimize the possibility of a Legionnaires' outbreak.

Most probably, for a Legionnaires' Disease outbreak to be linked directly with the ventilation system, a source of Legionella-contaminated water must be continuously entering the system and become aerosolized and delivered to the buildings' occupants. An examination of the systems should be conducted to rule out this possibility.

1. Visually examine the entire air distribution system (including return and exhaust systems) for evidence of water accumulation.

2. Eliminate all sources of water leakage and remove any standing water found in the system. Replace or eliminate any water damaged insulation within the system.

3. Operate the HVAC system using 100% outside air for EIGHT hours prior to returning the building to normal operation. Sampling of the air in the ducts is not required to prove that the duct system is free of Legionella due to the following:

   a. No reliable means of detection of Legionella in an air medium is available.
   b. Legionella can only live in water environments. If the ducts are dried out, they cannot serve as a source of Legionella.

Following return of the building to normal operational status, outside air supply rates should be kept as high as possible for one month. At a minimum, the outdoor air requirements of ASHRAE Ventilation Standard 62-1989 must be met.

G. HUMIDIFIERS/MISTERS

Many HVAC systems supply humidified water to building occupants in order to maintain the RH within recommended comfort limits. Improperly maintained units can serve as both amplifiers and disseminators of a variety of bioaerosols, however, generally the cool temperatures present in the HVAC systems are not conducive to growth for Legionella pneumophila. Cold water humidifiers in HVAC systems must be connected to a potable water source and provided with a drain line to remove the water. Stand alone, console-type humidifiers which recirculate water for humidification should not be used because the water in these systems will become rapidly contaminated with micro-organisms. These stand alone units have been linked to an outbreak of Legionnaires' disease in a hospital setting. Ideally, HVAC humidifiers should use steam injection systems which eliminate potential microbial problems.

The use of cold water humidifiers will require rigorous maintenance to ensure that the water source does not contribute to potential problems. Since humidifiers discharge into the HVAC air distribution system, this should be inspected for standing water and treated according to the HVAC Air Distribution System protocol above. Where water in humidifiers has been sampled and has been shown to contain measurable Legionella or where such water has been assumed to be contaminated with Legionella, the following protocol must be used:

1. Disinfect water in piping or reservoirs feeding the humidifier through addition of chlorine, or by using other effective biocides.

2. Sample the humidifier water to assure "kill" of Legionella. Samples must show no detectable CFU of Legionella per mL of water; if not, treatment and sampling must be repeated.

3. Ensure that an adequate maintenance program is in effect to reduce the growth of Legionella. Water storage temperatures should be kept outside of the 20 to 50°C (68 - 122°F) range and the system must be maintained in a clean condition.

4. Prior to use of the humidifier, the piping and/or reservoir must be thoroughly flushed to assure that biocides are not present when the humidifier is placed in operation.

5. When steps 1 through 4 have been successfully completed, the humidifier may be placed back in operation, but monitoring of the humidifier water system for Legionella must continue at the following intervals to assure that significant recontamination has not occurred:

   a. Weekly testing for the first month after resumption of operation.
   b. Every other week for the next two months.
   c. Every month for the next three months.

The criterion for Legionella in humidifier water systems during the monitoring phase is < 1 CFU per mL. If no sample during the monitoring phase is found to be in excess of the criterion, monitoring may then be suspended, but the maintenance program must continue indefinitely.

If any sample shows levels of Legionella of 1 CFU per mL or more, additional treatment must be performed and the system must be retested. The initial sequence of testing is then repeated. Monitoring results should be made available to building occupants.