HETA 2001-0189-2842
Saint Croix Tribe Of Chippewa Indians
Aquaculture Facility
Danbury, Wisconsin

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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

This report was prepared by Lisa J. Delaney of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by Young Hee Yoon of DataChem Laboratories. Desktop publishing was performed by Nichole Herbert. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Hazards at the St. Croix Chippewa Indian Aquaculture Facility

In March 2001, NIOSH conducted a health hazard evaluation at the St. Croix Chippewa Indian Aquaculture Facility in Danbury, Wisconsin to evaluate Universal Services Midwest (USM) employees' exposures during fiberglass application to the interior seams of fiberglass tanks.

What USM Employees Can Do

- We met with the St. Croix Tribe and USM employees.
- We observed the fiberglass work and toured the facility.
- We took air samples to measure the levels of acetone and styrene.
- We looked at work practices and personal protective equipment.

What NIOSH Found

- Overexposures to styrene could occur when working inside the tank.
- Acetone levels in the air were low.
- Respirators should be used that reduce exposures to styrene.
- The wrong respirators were used when grinding.
- Skin and eye protection was not adequate.
- Some drums and chemical containers were not properly labeled.
- More precautions are necessary to work safely inside the tank.

What USM/ St. Croix Tribe Can Do

- Require employees working inside the tanks to wear half-mask respirators with an organic vapor cartridge.
- Provide gloves that are resistant to styrene and acetone.
- Insure employees wear safety glasses when mixing the resin.
- Label all drums and containers appropriately.
- Review OSHA confined space rules to determine if additional precautions should be taken while working in the tank.
- Encourage employees to wash thoroughly before smoking and eating.

What USM Employees Can Do

- Wear appropriate respirators when working inside the tanks.
- Wear gloves and safety glasses when working with chemicals.
- Wash hands thoroughly before eating and smoking.
- Immediately wash hands if they come into contact with resin.

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National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report HETA 2001-0189-2842
Saint Croix Tribe of Chippewa Indians Aquaculture Facility
Danbury, Wisconsin
May 2001

Lisa J. Delaney, M.S.

SUMMARY

On February 28, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the Saint Croix Chippewa Indian Tribe, to evaluate Universal Services Midwest (USM) employees' potential exposures during fiberglass application to the interior seams of fiberglass tanks. No health problems were reported in the request. In response, a NIOSH investigator conducted a site visit on March 14 and 15, 2001, to meet with the St. Croix tribe and the USM contract employees and observe the fiberglass laying process. Full-shift and short-term (ST) personal breathing zone (PBZ) air samples were collected for styrene and acetone. Work practices, ventilation, and personal protective equipment (PPE) use were also assessed.

All of the measured full-shift and ST PBZ samples for styrene were below the NIOSH Recommended Exposure Limits (RELs) and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). However, one employee's time-weighted average (TWA) exposure to styrene of 43.9 parts per million (ppm) approached the NIOSH REL and OSHA voluntary PEL of 50 ppm and exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 20 ppm. This employee laid fiberglass inside the tank for the entire workshift. One employee's ST exposure to styrene of 92.1 ppm approached the NIOSH short-term exposure limit (STEL) and the OSHA voluntary STEL of 100 ppm and exceeded the ACGIH STEL of 40 ppm. This sample was collected for 15 minutes while the employee laid fiberglass inside the tank. All of the measured full-shift and ST PBZ samples for acetone were well below applicable exposure criteria. The highest exposures were measured for the employees who did the majority of resin and putty mixing. This employee's TWA exposure was 45.6 ppm.

Gloves and eye protection were not used properly, and a need for improved use of PPE was identified. The nitrile gloves worn by contractors were not an effective barrier to prevent dermal exposure to styrene. Employees wore non-NIOSH approved filtering facepiece respirators when grinding the fiberglass seams of the tank, and no respirators were worn to protect employees from exposure to styrene. Eye protection was not worn to protect from splashing when transferring chemicals. Additionally, some chemical containers were not labeled properly. A rigorous evaluation of activities involving working in the tanks has not been conducted, and is necessary to determine appropriate safety precautions and regulatory designation as a confined space. The exhaust ventilation currently in use was not adequate in decreasing exposures to acceptable concentrations.

The industrial hygiene sampling data indicate overexposure to styrene can occur at the St. Croix Aquaculture facility during fiberglass lay up. Concentrations of acetone were below relevant exposure criteria. Employees were not wearing appropriate PPE. Recommendations for ventilation and PPE to reduce exposures are given in the recommendation section of this report.

Keywords: SIC: 921 (Fish Hatcheries and Preserves), Fiberglass, styrene, acetone, fishery, aquaculture

TABLE OF CONTENTS

Preface ii

Acknowledgments and Availability of Report ii

HHE Supplement iii

Summary iv

Introduction 1

Background 1

Methods 1

Evaluation Criteria 2
- Styrene 2
- Acetone 3
- Combined Effects 3

Results 3

Discussion And Conclusions 4

Recommendations 4

References 5

INTRODUCTION

On February 28, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the Saint Croix Chippewa Indian Tribe, to evaluate employee exposures during fiberglass application to the interior seams of fiberglass tanks. Universal Services Midwest (USM) employees were contracted by the tribe to perform the fiberglass work. The request concerned employee exposures to styrene and acetone during fiberglass lay-up activities.

On March 14-15, 2001, NIOSH conducted a site visit which consisted of an opening conference with representatives from the St. Croix tribe and the USM contractors, a tour of the facility, and air sampling for styrene and acetone. The personal protective equipment (PPE) in use was evaluated to determine if it was adequate in protecting employees. The NIOSH visit coincided with the first week the contractors began work. No health effects were reported. On March 28, 2001, a letter providing the results of the air sampling and preliminary recommendations was sent to the requestor.

BACKGROUND

The aquaculture facility is owned and operated by the St. Croix Chippewa Indian Tribe, and is currently under construction. It is expected to open in the summer of 2001. The facility occupies 160,000 square feet. The facility will grow and harvest salmon and perch, which will then be sold to consumers. The perch and salmon tanks are located in separate areas of the facility. The facility also has a research and development program that may enable it to expand to grow other species of fish.

Unassembled grow out tanks for the fish were purchased from an outside vendor. The round fiberglass tanks are received in 8 sections that must be bolted together on site. After completion of the project, there will be 84 salmon tanks (5 feet [ft.] by 16 ft. diameter) and 108 perch tanks (4 ft. by 20 ft. diameter). The tanks have an open top and are 4 to 5 ft. deep. At each of these seams, 4 layers of fiberglass must be applied. The tank manufacturer provides all the products necessary to assemble the tanks including the fiberglass, catalyst, and resin.

USM was hired to conduct the fiberglass work. The contractors work 10 hour days, 5 days a week to seam the tanks. The crew consisted of 5 employees (1 supervisor, 2 mixers, and 2 layers). Mixers cut the strips of fiberglass, prepare the resin, and apply resin to the strips of fiberglass. All mixing work is done outside of the tank. Approximately 2 gallons of polyester resin is mixed with 35 cubic centimeters of catalyst. The polyester resin contains styrene, and acetone is used for cleaning purposes. Mixers apply resin to the fiberglass strips with a roll brush and pass the strips to the layers inside the tanks. The layers apply resin to the seam, so the fiberglass will adhere to it, and then roll out the bubbles with a roll brush.

A flexible exhaust hose, which is attached to a fan that exhausts outside, was placed in the tanks while employees worked with the styrene resin and putty. Several comfort fans were set up by the mixing and fiberglass preparation areas in an effort to improve air circulation.

METHODS

Full-shift personal breathing zone (PBZ) air samples were collected for styrene and acetone on all fiberglass workers: 1 supervisor, 2 mixers, and 2 layers. ST PBZ samples for acetone and styrene were collected on 1 layer during lay-up activities inside the tank and on 1 mixer during resin mixing and lay-up activities inside the tank.

PBZ samples for styrene and acetone were collected using SKC® low flow sampling pumps drawing air at a measured sampling rate of approximately 50 milliliters per minute (ml/min). One pump was calibrated to approximately 200 ml/min to increase the air volume for the collection of one of the short-term samples. The sampling pumps were pre- and post-calibrated with a primary standard (BIOS®) to verify flow rates. The samples were collected on charcoal sorbent tubes and analyzed for styrene and acetone using NIOSH methods 1300 and 1501 with modifications.[1] The charcoal tubes were placed as close as possible to the workers' breathing zones and connected via Tygon® tubing to the sampling pump. Employees wore the sampling pump and tube for the

entire work shift. After collection, the samples were placed on ice and shipped via overnight express to the NIOSH contract laboratory.

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),[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[4] 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 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.

Styrene

Styrene is a colorless to yellow oily liquid with a strong odor. It is commonly used in the manufacture of polystyrene plastics, protective coatings, and polyesters and resins. Acute health effects may occur that affect the nervous system such as depression, concentration problems, muscle weakness, tiredness, and nausea, and possibly eye, nose, and throat irritation may occur.[5,6,7] The International Agency for Research on Cancer (IARC) has determined that styrene is possibly carcinogenic to humans.[8] This determination was made based on inadequate evidence in humans and limited evidence in animals of the carcinogenicity of styrene. There is very little data on the human health effects of long-term low exposures to styrene.[5,7] Appendix A contains the Agency for Toxic Substances and Disease Registry (ATSDR) ToxFAQs™ fact sheet which describes common health effects associated with styrene exposure.[6]

Several organizations have established exposure criteria for styrene. The NIOSH REL for styrene is 50 parts per million (ppm) for an 8-hour TWA exposure, with a STEL of 100 ppm which should not be exceeded in any 15-minute period.[2] These limits were based on the central nervous system effects to humans observed at approximately 100 ppm. The OSHA PEL is 100 ppm as an 8-hour TWA, 200 ppm as a STEL, not to be exceeded for more than 5 minutes in any 3-hour period, and 600 ppm as a ceiling limit.[4] Under the OSHA voluntary styrene

compliance program, the styrene industry has adopted the NIOSH REL of 50 ppm for an 8-hour TWA and 100 ppm as a 15 minutes STEL.[9] The ACGIH recommends an 8-hour TWA TLV of 20 ppm, with a STEL of 40 ppm.[5]

Acetone

Acetone is a colorless, highly volatile, flammable liquid with an aromatic odor. It is a widely used industrial solvent and is found in paints, varnishes, and lacquers. Because of its evaporation rate, it is used in parts cleaning and drying. Acute health effects associated with acetone are dry mouth and throat, dizziness, nausea, incoordinated movements, loss of coordinated speech, and drowsiness. The human health effects associated with long-term low exposures are irritation of the respiratory tract, coughing, and headache.[5,10] Appendix B contains the ATSDR ToxFAQs™ fact sheet which describes common health effects associated with acetone exposure.[10]

The NIOSH REL and OSHA PEL for acetone are 250 ppm and 1000 ppm, respectively.[2,4] ACGIH has established a TLV of 500 ppm and a STEL of 750 ppm.[3]

Combined Effects

Some hazardous substances may act in combination with other workplace exposures to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria.

RESULTS

As shown in Table 1, all of the measured full-shift and ST PBZ samples for styrene were below the NIOSH RELs and OSHA PELs. However, one employee's TWA exposure to styrene of 43.9 ppm approached the NIOSH REL and OSHA voluntary PEL of 50 ppm and exceeded the ACGIH TLV of 20 ppm.[2,3,9] This employee laid fiberglass inside the tank for the entire workshift. One employee's ST styrene exposure of 92.1 ppm approached the NIOSH STEL and the OSHA voluntary STEL of 100 ppm and exceeded the ACGIH STEL of 40 ppm.[2,3, 9] This sample was collected for 15 minutes while the employee laid fiberglass inside the tank.

All of the measured full-shift and ST PBZ samples for acetone were well below applicable exposure criteria. The highest exposures were measured for the employee who did the majority of resin and putty mixing. This employees' TWA exposure was 45.6 ppm. The acetone exposure was only a minor contributor to the combined solvent exposures, and no exposures exceeded applicable criteria when the combined exposures were considered.

Employees reported this was not a typical day and that activities during the morning (mixing and lay-up of fiberglass) were more representative of future work. Employees initially hired to do this work did not properly putty the seams of approximately 7 tanks, and USM contractors had to grind and re-apply the putty to the seams in the afternoon. Additionally, employees reported the resin they used from a new drum in the afternoon did not dry as quickly as the resin in the previous drum, therefore they focused on grinding and applying putty to the tank seams. A question was raised as to whether all of the drums of resin were the same formulation and if they were properly labeled.

Employees laying fiberglass wore N-DEX Plus (100% nitrile, non-latex gloves) and mixers wore Ansell Edmont Solvex 37155 (nitrile gloves). Employees reported cleaning their gloves with acetone. Employees did not wear gloves when cutting the fiberglass sheets from the roll. Some employees wore Tyvek® suits for the entire work day. Employees wore non-NIOSH approved filtering facepiece respirators (dust masks) and safety glasses while grinding. Employees did not wear safety glasses when mixing the resin or cleaning with acetone. This mixing activity poses an eye splash hazard. The acetone was not stored in an approved safety can. Secondary containers were not labeled properly.

DISCUSSION AND CONCLUSIONS

The PBZ samples collected for the employee applying fiberglass and putty on the interior of the tanks indicate exposures exceeding the ACGIH TLV and STEL and approaching the NIOSH REL and STEL. Based on these sampling results, employees have the potential for overexposure to styrene when working inside the tanks. Precautions such as respiratory protection and improved ventilation are necessary to reduce styrene exposures to acceptable levels. According to USM, employees were medically cleared and fit tested to wear respirators prior to employment at the aquaculture facility.

The use of PPE was inadequate to protect employees from exposures during fiberglass work. Nitrile gloves are not an effective barrier to prevent dermal exposure to styrene.[11] The practice of washing gloves with acetone can degrade the glove and cause dermal exposure. Glove degradation by acetone can occur in less than 1 hour. Dermal exposure to the raw fiberglass strips during cutting can cause skin irritation, redness, and swelling. Tyvek® suits may have a potential to develop a static charge and, therefore, are not recommended for wear in flammable atmospheres.[12] The tank has the potential for a flammable atmosphere due to the vaporization of the styrene. Styrene can be trapped in the tank and accumulate because it is heavier than air. According to the OSHA respiratory protection standard, employees may only wear NIOSH-certified respirators. Respirators that have not been approved by NIOSH may not provide adequate protection against workplace contaminants. Since air sampling was not conducted to assess employees' exposures to dust during grinding activities, it is unknown if respiratory protection is required. Filtering facepiece respirators do not provide protection against styrene or acetone; only respirators equipped with organic vapor cartridges provide protection against these solvents.

The USM supervisor reported he used a direct reading instrument to measure the oxygen content inside the tanks and the measured oxygen levels inside were always 20 percent. No other employees are allowed to work in the tank area until the fiberglass work on all tanks is completed. These precautions were taken after OSHA cited another contractor initially performing the work for not implementing confined space procedures.

The current contractor questioned whether or not the aquaculture tanks are considered a confined space from a regulatory standpoint. NIOSH defines a confined space as, "a space which by design has limited openings for entry and exit; unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy."[13] Based on this definition, these tanks are considered a confined space. OSHA has established a comprehensive standard concerning confined spaces (CFR 1910.146) that contains requirements to protect employees in general industry from hazards associated with confined spaces.[14] OSHA also provides a confined space advisor on its website to allow you to determine if your work space is subject to the permit required confined spaces standard.

RECOMMENDATIONS

1. Respiratory protection should be worn by employees applying resin or putty inside the tanks as an interim measure until engineering controls such as additional local exhaust ventilation can be implemented. At a minimum, workers should wear a half-mask, air-purifying respirator equipped with organic vapor cartridges and certified under 42 CFR 84. A dual cartridge with both an organic vapor cartridge and high-efficiency filter could be worn to protect employees against dust and styrene. Because exposures were less than 10 times the ACGIH TLV, a half-mask respirator, which has an assigned protection factor (APR) of 10, should provide sufficient protection to employees. Since measured full-shift and ST samples from the employee working inside the tank approached the NIOSH REL and OSHA voluntary REL, and exceeded the ACGIH TLV, all employees applying putty or resin in the tank for either a full-shift or a short duration should wear the recommended respirator. A respiratory protection program should be established at the facility.[15] The program should include medical clearance, annual fit testing, and training. Workers issued respirators should also be clean shaven in the face-to-respirator seal area.

2. Employees should be provided with appropriate gloves when working with the styrene resin and acetone. Silver Shield™ or 4H™ gloves offer good

permeation resistance to styrene. Employees should discontinue washing the gloves with acetone. Gloves should be inspected before and after each use and, as gloves harden or deteriorate, they should be discarded and new gloves should be worn. Employees should wear gloves when cutting and handling the raw fiberglass strips. A vendor knowledgeable on selecting appropriate gloves should be consulted and employees should participate in the selection process.

3. Ensure employees wear eye protection when mixing resin and during grinding to prevent foreign material and splashes to the eye.

4. Discontinue the use of Tyvek® suits inside the tanks. A vendor knowledgeable in selecting appropriate PPE should be consulted to find an alternative suit.

5. Encourage employees to practice good hygiene (e.g., thoroughly washing hands) before smoking, eating, and leaving work. Employees that come into contact with the resin should immediately wash the affected area. Utilizing proper hygiene practices in the workplace will help prevent dermal exposures to the resin and fiberglass.

6. Ensure the resin drums, supplied by the manufacturer of the tanks, are properly labeled according to the OSHA hazard communication program. Labels should contain the chemical name, any known hazards associated with the chemical, and the manufacturer's name. Employees should use portable, approved safety cans when transferring or storing solvents.

7. Review the OSHA confined space regulation to determine what necessary precautions should be taken and what protective and emergency equipment is required when working inside the tanks.

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Table 1
St. Croix Aquaculture Facility
Personal Air Sampling Results
HETA 2001-0189
March 15, 2001

Job Title	Job Task	Time (minutes)	Styrene (ppm)	Acetone (ppm)
Full-Shift Personal Breathing Zone Samples				
Supervisor	Supervising	7:39 - 11:37 (238)	1.7	3.6
		12:12 - 17:35 (323)	3.1	6.0
TWA Exposure			2.5	5.0
Fiberglass Layer	Laid fiberglass inside tank	7:27 - 11:56 (269)	25.0	4.5
	Wrapped pipe with fiberglass and resin; ground inside tank	11:58 - 3:15 (257)*	6.5	8.7
TWA Exposure			16.0	6.5
Fiberglass Layer	Laid fiberglass inside tank	7:34 - 12:06 (272)	47.1	5.3
	Applied putty inside tank	12:10 - 17:34 (324)	41.2	6.6
TWA Exposure			43.9	6.0
Mixer	Cut fiberglass and prepared fiberglass	7:31 - 12:02 (271)	3.5	4.9
	Cut fiberglass and applied putty inside tank	12:03 - 14:22 (139)*	1.4	5.7
TWA Exposure			2.8	5.2
Mixer	Mixed resin and prepared fiberglass	7:26 - 10:31 (185)*	5.6	20.3
	Mixed putty and applied putty to inside of tanks	12:04 - 17:34 (330)	18.9	59.8
TWA Exposure			14.1	45.6
Short-Term Personal Breathing Zone Samples				
Mixer	Mixed putty outside tank and applied inside tank	14:54 - 15:11 (17)	21.0	13.8
Fiberglass Layer	Applied putty inside tank	15:38 - 15:54 (16)	92.1	6.3
NIOSH Recommended Exposure Limit (REL)			50/ST 100	250
ACGIH Threshold Limit Value (TLV)			20/ST 40	500/ST 750
OSHA Voluntary Permissible Exposure Limit (PEL)			50/ST 100	N/A
OSHA PEL			100/C 200	1000

N/A = not applicable
ppm = parts per million
ST = Short-Term Exposure Limit is a 15-minute time-weighted average exposure that should not be exceeded at any time during a workday.
C = Ceiling concentrations must not be exceeded during any part of a workday
* = Pump failure
TWA Calculation = $\frac{C_1T_1 + C_2T_2 + C_nT_n}{T_1 + T_2 + T_n}$, where C = concentration and T = time

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