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HETA 98-0194-2721
U. S. Fish and Wildlife Service
Nashua, New Hampshire

David C. Sylvain, CIH

PREFACE

The Hazard Evaluations and Technical Assistance Branch of 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 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 David C. Sylvain, CIH, of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Edward A. Kaiser, Ph.D. Analytical support was provided by the Division of Physical Sciences and Engineering. Desktop publishing was performed by Pat Lovell. Review and preparation for printing was performed by Penny Arthur.

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Health Hazard Evaluation Report 98-0194-2721
U. S. Fish and Wildlife Service
Nashua, New Hampshire
January 1999

David C. Sylvain, CIH

SUMMARY

In April 1998, the National Institute for Occupational Safety and Health (NIOSH) received a request from management at the U. S. Fish and Wildlife Service (USFWS) Northeast Region, for an evaluation of formaldehyde exposure at Nashua National Fish Hatchery (NFH) in Nashua, New Hampshire. Although no health problems or concerns had been reported, the USFWS was interested in assessing the potential for employee exposure to formaldehyde during the treatment of sea-run Atlantic Salmon.

During a site visit on June 17, 1998, air sampling was conducted to evaluate worker exposure while a worker applied one-gallon of formalin to a broodstock tank using a garden sprayer. Personal breathing zone (PBZ) sampling indicated that the worker's exposure to formaldehyde exceeded the ceiling limits prescribed by the NIOSH Recommended Exposure Limit (REL) and the American Conference of Governmental Industrial Hygienists Threshold Limit Value (ACGIH TLV). The OSHA Permissible Exposure Limit (PEL), however, was not exceeded.

The USFWS should investigate alternative methods for treating broodstock which will reduce employee exposure to formaldehyde. It appears that much of the routine exposure to airborne formaldehyde due to formalin spraying, could be eliminated by applying the formalin beneath the surface of the water in the broodstock tanks, possibly using the aeration system to mix the formalin into the water.

Personal protective equipment (PPE) worn during treatment consisted of a full-face respirator, neoprene apron, and rubber gloves. The effectiveness of the PPE ensemble was limited by: (1) the use of neoprene, which can be permeated by methanol, and (2) uncertainty regarding the type of rubber comprising the gloves.

Exposure to formaldehyde during spraying of broodstock tanks exceeds TLV and REL ceiling limits. It appears that much of the routine exposure due to spraying could be eliminated by adding formalin beneath the water, rather than spraying it into the air. As at other hatcheries where formalin is used, effective PPE and training programs are needed.

Keywords: SIC 0921 (Fish Hatcheries and Preserves). Formaldehyde, formalin, methanol

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INTRODUCTION

In April 1998, the National Institute for Occupational Safety and Health (NIOSH) received a request from management at the U. S. Fish and Wildlife Service (USFWS) Northeast Region, for an evaluation of formaldehyde exposure at Nashua National Fish Hatchery (NFH) in Nashua, New Hampshire. Although no health problems or concerns had been reported, the USFWS was interested in assessing the potential for employee exposure to formalin, which is used to treat infections in sea-run Atlantic Salmon.

During a site visit on June 17, 1998, air sampling for formaldehyde was conducted during treatment of sea-run salmon. In addition, work practices and the use of personal protective equipment (PPE) were reviewed.

BACKGROUND

Federal fish hatcheries produce millions of salmon that are released into New England rivers. Since the mid-1970's, the USFWS Northeast Region has operated a program to restore Atlantic salmon (*Salmo salar*) populations in New England rivers. Prior to the construction of dams, and overfishing during the 1800's, major populations of Atlantic salmon were found in the Merrimack, Connecticut, and Penobscot Rivers. The salmon restoration program has worked to restore populations in these rivers for a number of years, and has been expanded to include several smaller Maine rivers, and the Pawcatuck River in Rhode Island.

Some of the major activities involved in salmon restoration include capturing sea-run salmon, artificial spawning, incubating and hatching eggs, growing fish to the appropriate stage for release, releasing fish into rivers, and reconditioning previously spawned, sea-run adults (kelts).

According to literature provided by one formalin distributor, formalin has been used in fish production since 1909. Formalin used in hatcheries contains 37% formaldehyde, 6-15% methanol, and "inert ingredients." In addition to its use in controlling fungi on eggs, formalin is used prophylactically to control parasites on salmonids, catfish, largemouth bass, and bluegill.

Nashua NFH operates a broodstock facility where sea-run salmon are held for spawning. Beginning in May, sea-run salmon are captured and transported to the broodstock building. The broodstock building is a metal structure, approximately 125 feet long by 30 feet wide by 15 feet high at the peak. The building has three roll-up doors along its length, and a ridge vent. Approximately 75 fish can be held in each of four 22-foot diameter tanks. Each tank is supplied with a continuous flow of fresh water which is not recirculated.

Formalin treatments are initiated if signs of infection appear among captive fish. The treatments are applied daily for 3 days, followed by 3 days without treatment (3 days on, 3 days off). As infection is brought under control, the frequency of treatments is decreased until treatments can be discontinued. The procedure for applying each treatment is as follows: (1) shut-off the water supply to the tank to be treated, and drain the tank to a depth of one foot; (2) pour one gallon of formalin from a plastic jug into a pump-up, pressurized garden sprayer; (3) spray the contents a few inches above the surface of the tank; (4) turn-on tank aeration, and allow fish to be treated for one-hour; (5) fill the tank, and restart the flow of water through the tank. Personal protective equipment used while dispensing and spraying formalin consists of a full-face air purifying respirator equipped with formaldehyde cartridges, a neoprene apron, and rubber gloves (type of rubber is not known).

METHODS

Personal breathing zone (PBZ) and area air samples were collected to evaluate employee exposure to formaldehyde during the application of formalin to one holding tank. Each sample was collected using a battery-powered sampling pump to draw air through two sampling cartridges in series: each cartridge contained 350 milligram (mg) of silica gel coated with 2,4-dinitrophenylhydrazine (DNPH). Pumps were operated at a nominal flow rate of 1.0 liters per minute (lpm), and were calibrated before and after sampling to ensure that the desired flow rate was maintained throughout the sampling period. Formaldehyde samples were analyzed by high performance liquid chromatography (HPLC) according to NIOSH draft Method 2016 (modified).

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] NIOSH encourages employers to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever is the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Formaldehyde

Formaldehyde and other aldehydes may be released from foam plastics, carbonless copy paper, particle board, and plywood. Formaldehyde is a constituent of tobacco smoke and of combustion gases from heating stoves and gas appliances. This chemical has also been used in the fabric and clothing industry to impart permanent press characteristics, in the manufacturer of some cosmetics, and in disinfectants and fumigants. Formaldehyde in ambient air can result from diverse sources such as automobile exhaust, combustion processes, and certain industrial activities such as the production of resins.

Exposure to low concentrations of formaldehyde may result in irritation of the eyes, nose, and throat; headaches, nausea, nasal congestion, skin rashes, and asthma-like symptoms. It is often difficult to ascribe reports of symptoms to specific concentrations of formaldehyde because people vary in their subjective responses and complaints. For example, eye irritation may occur in people exposed to formaldehyde at concentrations below 0.1 parts per million (ppm). Upper airway irritation may occur at 0.1 ppm, but more typically begins at exposures of

1.0 ppm and greater.[4] Some children or elderly persons, those with pre-existing allergies or respiratory disease, and persons who have become sensitized from prior exposure may have symptoms from exposure to concentrations of formaldehyde between 0.05 and 0.10 ppm. Cases of formaldehyde-induced asthma and bronchial hyperreactivity developed specially to formaldehyde are uncommon.[5]

In two studies, formaldehyde induced a rare form of nasal cancer in rodents. Formaldehyde exposure has been identified as a possible causative factor in cancer of the upper respiratory tract in a proportionate mortality study of workers in the garment industry.[6] NIOSH and ACGIH have designated formaldehyde as a suspected human carcinogen and recommend that exposure be reduced to the lowest feasible concentration.[1,4] NIOSH has established the REL for formaldehyde at the lowest concentrations that can be reliably quantified: 0.016 ppm for up to a 10-hour TWA exposure, and 0.1 ppm as a 15-minute ceiling concentration. ACGIH has set the TLV for formaldehyde at 0.3 ppm. The TLV is intended to reduce worker reports of sensory irritation.[4]

The OSHA general industry formaldehyde standard (29 CFR 1910.1048), sets the PEL for airborne exposure to formaldehyde at 0.75 ppm as an 8-hour TWA and 2 ppm as a 15-minute STEL. The standard specifies requirements for exposure monitoring, medical surveillance, hazard communication, housekeeping, and recordkeeping. In addition, the OSHA standard requires that workers be informed that formaldehyde is a potential cancer hazard.

RESULTS

Air sampling results are presented in Table 1. PBZ sampling indicates that worker exposure to formaldehyde exceeded the REL (ceiling limit) and TLV while filling of the sprayer and applying formalin to a broodstock tank. The PEL was not exceeded.

The Formaldehyde concentration at the perimeter of the tank was 0.59 ppm during spraying, 0.23 ppm during the first 31 minutes of aeration (following spraying), and 0.03 ppm during the final 35-minute sampling period.

DISCUSSION

This health hazard evaluation (HHE) evaluated formaldehyde exposure during the filling and use of a portable pressurized sprayer to apply one-gallon of formalin to a broodstock tank at Nashua NFH. The one-gallon jug, from which formalin was added to the sprayer, had been filled prior to the HHE; thus, the filling of the jug was neither observed nor sampled. Although unevaluated during this HHE, exposure during jug-filling must be considered when assessing total worker exposure. Sampling at other USFWS hatcheries indicates that airborne formaldehyde concentrations can be expected to exceed the TLV and REL ceiling limits while formalin is being dispensed into a jug from a 55-gallon drum. (During an HHE at Pittsford NFH, dispensing formalin from a 55-gallon drum into a one-gallon container resulted in 2.2 ppm during a 3-minute PBZ sample.) Another factor affecting worker exposure is the technique and skill with which formalin is dispensed into the jug, added to the sprayer, and applied to the tank. If formalin is spilled or splashed, a much greater exposure is likely. Also, total exposure during broodstock treatment is likely to be considerably greater if more than one tank are treated.

A full-face respirator, neoprene apron, and rubber gloves were worn throughout the procedure. Hatchery staff believed that the gloves were made of neoprene, however this could not be confirmed during the HHE. Although neoprene provides limited protection against short-term contact with formaldehyde, it does not provide adequate protection against breakthrough by methanol.[7] Similarly, other types of rubber, such as natural rubber, do not provide adequate protection against methanol or formaldehyde. To minimize risk of breakthrough due to repeated or prolonged contact with formalin, butyl rubber or Viton™ PPE should be used. PPE made of these materials will provide long-term protection against continuous contact with formaldehyde and methanol in the event of a spill or other unusual release.[7]

CONCLUSIONS

Exposure to formaldehyde during spraying of broodstock tanks exceeds TLV and REL ceiling limits. The USFWS should investigate alternative methods for treating broodstock which will reduce employee exposure. It appears that much of the routine exposure to airborne formaldehyde due to formalin spraying, could be eliminated by applying the formalin beneath the surface of the water in the broodstock tanks, possibly using the aeration system to mix the formalin into the water. As at other hatcheries where formalin is used, effective PPE and training programs are needed.

RECOMMENDATIONS

1. The USFWS should investigate other methods of applying formalin to broodstock tanks. If possible, formalin should be applied beneath the water, rather than spraying it into the air above the tank.

2. The PPE program should be evaluated to ensure that appropriate PPE is selected and used. Attention should be given to the fit-testing and training of individuals who wear respiratory protection. PPE should be checked to ensure that it is made of Viton™, butyl rubber, or other materials which provide protection against formaldehyde and methanol. Hatchery staff should be trained in the selection and use of PPE.

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Table 1. Formaldehyde Air Samples. Nashua NFH, (HETA 98-0194)

Sample Type	Location/Operation	Sample No.	Time	Period (minutes)	Volume (liters)	Formaldehyde (ppm)
PBZ	Spraying formalin above broodstock tank	1	0927-0923	6	6.08	1.1
Area	At perimeter of tank during spraying	2	0927-0933	6	6.07	0.59
	At perimeter of tank during aeration	3	0935-1006	31	31.3	0.23
		4	1006-1041	35	35.4	0.03

ppm = Parts per million. Reported values represent the average concentration during the sampling period.

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