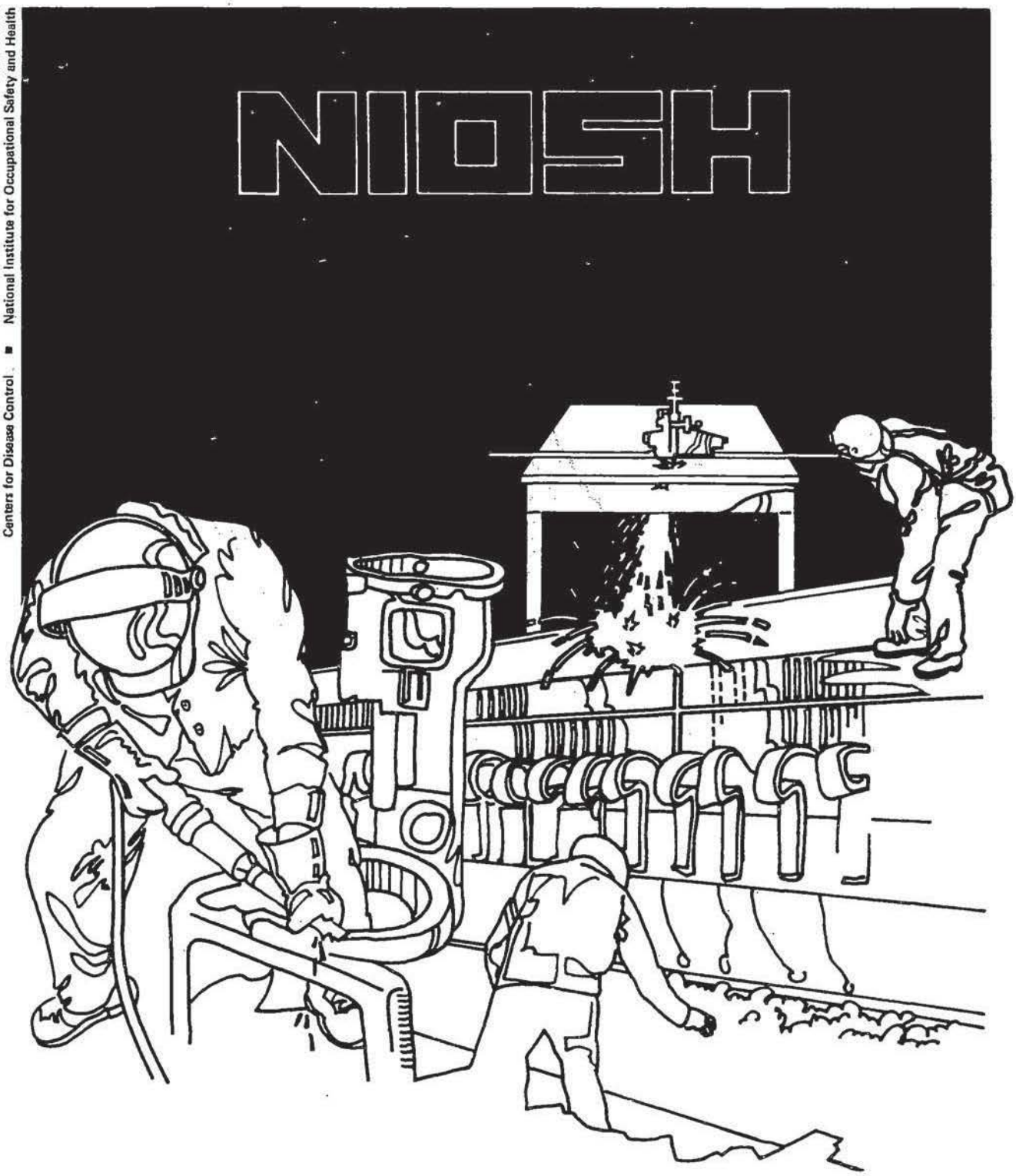
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-408-1389
U.S. FOREST SERVICE
DILLON DISTRICT
FRISCO, COLORADO

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.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 83-408-1389
NOVEMBER 1983
U.S.FOREST SERVICE
DILLON DISTRICT
FRISCO, COLORADO

NIOSH INVESTIGATORS:
Theodore W. Thoburn, M.D.
Bobby J. Gunter, Ph.D., IH

I. SUMMARY

On August 16, 1983 the NIOSH Region VIII Office was requested by the Dillon, Colorado, District Office of the U.S. Forest Service, to evaluate rashes experienced by two forest workers. The rashes developed after they had removed a plastic covering from piles of wood which had been previously sprayed with ethylene dibromide (EDB) to destroy pine beetles.

The two forest workers were interviewed and examined several days after being exposed. The first worker (seen 6 days after exposure) reported having had an itchy rash involving the sides of the chest and abdomen. The rash became redder with scratching. By the time the worker was examined, the rash was almost gone. The other worker had developed a purple rash on the arms and spreading to the back, abdomen, and legs. The rash went on to turn bright red with itching, and the worker developed blisters on the legs four days after the rash first appeared. The rash improved after treatment with steroids. When the worker was first seen by the NIOSH physician 11 days after exposure, slightly red welts were still clearly visible on arms and legs.

Three U.S. Public Health Service workers exposed to similarly treated wood in 1982 were also interviewed. Two had developed rashes after cutting and handling the wood, and one had had no symptoms.

Results of the analysis of the plastic, condensate on the plastic, and bark of the pine wood treated with EDB showed residual EDB with values ranging from 4.71 ug in the condensate to 558 ug on the plastic and a high of 16 ppm in the pine bark. Pine bark samples sprayed as far back as 1982 showed levels of 0.013 and 0.056 ppm of ethylene dibromide.

On the basis of environmental and medical data, NIOSH concluded that a health hazard existed from exposure to ethylene dibromide. This potential exposure also exists for any person handling the wood that has been sprayed with EDB. Because EDB has been shown to be an animal carcinogen, exposure for both forest workers and the public should be reduced as much as possible. Recommendations for reducing exposure are included in Section VIII of this report. These include warnings for the buying and using public.

KEYWORDS SIC: 0851 (Forestry Services/Pest control), Ethylene dibromide (EDB), Pine beetle, fumigation.

II. INTRODUCTION

On August 16, 1983 the Region VIII office of the National Institute for Occupational Safety and Health (NIOSH) received a telephone call from the Dillon District Office of the U.S. Forest Service regarding a rash experienced by two of their workers after removing the plastic covering from piles of wood which had been previously sprayed with ethylene dibromide (EDB) to destroy pine beetles. On August 18, 1983 the medical investigator visited the office in Frisco, Colorado, interviewed one of the two workers involved, and made arrangements for the industrial hygienist to collect samples on August 22, 1983. The other worker was interviewed on that day. The workers and the state and federal forest services were notified of initial findings on September 9, 1983 and some additional samples collected.

III. BACKGROUND

In an effort to prevent undue timber loss due to pine beetles in the national forests in Colorado, the U.S. Forest Service has individual contractors cut down pine beetle killed trees, cut them into approximately 8 foot lengths and stack them. The state forest service, under contract, then covers the piles with heavy plastic, seals the edges with dirt, and then injects an insecticide mixture containing 4.6% ethylene dibromide in water through holes in the plastic.

The holes are then sealed with tape and the pile is left undisturbed for about a month. Following this the U.S. Forest Service sells the wood to the public for firewood. Although the individual(s) buying a pile of wood is supposed to dispose of the plastic, on occasions the Forest Service personnel have to dispose of the plastic themselves.

The 1983 season was considerably wetter than most years and there was said to be considerably more condensate under the plastic at the end of a month than is usually seen.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Using three widely separated locations, undisturbed piles of pine logs that had been sprayed with a 4.6% mixture of ethylene dibromide were included in the study. These piles had been sprayed on July 15, 20 and 25, 1983. Three types of samples were collected on August 22, 1983. They were:

1. Condensate (about 3 ml.).
2. Plastic (about 1 square foot).
3. Filter paper wipe samples (wiping about 36 sq. inches) of the wet underside of the plastic.

These samples were frozen, placed in a blue ice filled container, and forwarded to the laboratory for analysis. On September 10, 1983 several ounces of bark were collected for ethylene dibromide analysis from the identical locations and piles (now disturbed). In addition, two other pine bark samples taken from wood sprayed in the Spring of 1982 were also analyzed for ethylene dibromide.

B. Medical

The NIOSH medical investigator individually interviewed the two workers; one at the initial visit (9-18-83) and the other at the time initial samples were collected (9-22-83). Their rashes were examined. The worker not available at the time of the initial visit was being seen by an industrial toxicologist at the time, so permission was obtained, and the doctor contacted concerning his findings. After initial laboratory results suggested a chemical basis for the rashes, three Region VIII, U.S. Public Health Service employees who had purchased U.S. Forest Service beetle-killed wood during 1982 were interviewed on September 13, 1983. Samples from wood handled by these employees had been obtained by the industrial hygienist for EDB analysis.

V. EVALUATION CRITERIA

A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff usually employ environmental evaluation criteria for assessment of airborne exposure to 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. In this particular study, airborne exposure was probably minimal as exposure occurred outdoors. Recommended air levels are given solely as a reference for the order of magnitude of toxicity.

In this study direct skin contact is the important route of exposure. Although concentration of EDB is of some importance, extent and duration of exposure are the more important factors, particularly if exposure occurs in covered areas of skin. In this particular case, no exact concentrations at time of exposure are available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding

OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that private industry is legally required to meet only those specified by an OSHA standard.

Also, one should be aware that evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

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

	Environmental Exposure Limits	
	NIOSH	OSHA
Ethylene dibromide.....	1 mg/M^3 C (15 Min)	20 ppm (TWA)
.....	(0.13 ppm)	30 ppm C

---

mg/M^3 = milligrams of substance per cubic meter of air.
ppm = parts of contaminant per million parts of air.
C = Ceiling value which should never be exceeded.
TWA = 8 Hour Time-Weighted Average

B. Physical Properties and Toxicology[1,2,3,4,5,6]

Ethylene dibromide (EDB) is a dense, colorless liquid at room temperature with a specific gravity of 2.18 (water = 1), a melting point of 10°C (50°F), and a boiling point of 131.7°C (269°F). At room temperature only 0.43 parts of EDB will dissolve in 100 parts of water. EDB has a characteristic, mildly sweet odor barely detectable at 10 to 20 parts contaminant to a million parts of air (ppm). Vapor pressure at 25°C (77°F)is 12.0 millimeters of mercury (mm Hg) which would give a concentration of about 15,800 ppm of EDB at sea level if the air had a chance to become saturated. At 20°C (68°F) in neutral water (neither acidic nor alkaline) it takes about 14 years for half of the EDB to decompose (the half-life). Animal studies have shown biologic half-lives of less than 48 hours when injected intravenously.

EDB has both local and systemic effects. EDB liquid or solution is irritating to skin and mucous membranes and can lead to a burning or tingling sensation followed by redness, swelling, and even blistering. The inflammation and blistering may be delayed by 15-20 hours. Healing may take 7 to 13 days, but is usually complete. Skin effects are considerably worse if the wet area is covered. Most common clothing materials can be penetrated by EDB including shoe leather. EDB vapors are irritating to the mucus membranes of the eyes, nose, and throat, and also to the lining of the bronchi and lungs.

Systemic effects include mild anesthesia. There can also be liver, kidney, and heart muscle damage. Animal studies have identified EDB as a mutagen, teratogen, and potent carcinogen. Animal studies have also shown that disulfiran (Antiabuse (R), tetraethylthiuram disulfide), a drug used as an alcohol deterrent, greatly increases the systemic toxicity of EDB. Absorption through the skin can be a significant source of exposure.

Human studies on EDB's carcinogenicity have been inconclusive, but NIOSH recommends that proven animal carcinogens be considered as possible human carcinogens as well. Exposure should, therefore, be reduced to the lowest feasible level. If possible less hazardous substances should be substituted for the EDB.

VI. RESULTS

A. Environmental

Results of analysis of the condensate, plastic and wipe samples collected on August 22, may be reviewed in Table 1. Ethylene dibromide (EDB) was found in the condensate and plastic with the highest values on the plastic sprayed on July 25, 1983. The condensate values per sample were: July 15 (4.71 ug), July 20 (0.50 ug), and July 25 (1.68 ug). The values of the plastic per sample were: July 15 (141.60 ug), July 20 (117.86 ug), and July 25 (558 ug). The wipe samples were all nondetectible (N.D.) for all three dates. The reason for nondetectible values of ethylene dibromide on the wipes could be due to the following: (1) The filter paper wipes were too small for wiping the areas on the plastic, (2) the filter paper dried out very fast, and (3) due to conditions such as excessive moisture, the paper became saturated very fast and the plastic wasn't wiped appropriately.

Since ethylene dibromide was found on the condensate and plastic, pine bark samples were collected at the same three locations. Ethylene dibromide was found on all three bark samples. These levels may be reviewed in Table 2. The EDB was highest in the bark sprayed on July 15, 1983 (16 ppm)*, the other 2 bark samples had values of 0.49 ppm on July 20 and 0.25 ppm on July 25. It was interesting to note that for

logs sprayed in 1983 the concentration of EDB in the bark was inversely related to the length of time since spraying. Two pine bark samples were analyzed that had been sprayed during the spring of 1982 and EDB was still present showing levels of 0.013 ppm and 0.056 ppm.

B. Medical

The less affected worker had worked with the plastic from the log piles for two days, six to seven days prior to being seen. Primary activity was loading the plastic into a truck and transporting it to the dump. As the weather was warm, the worker did sweat some, but only showered in the morning before work. As the worker had other duties, care was taken to avoid soiling the uniform from the moist plastic. The first symptom was itching by the end of the day, at first thought to be gnat bites or heat rash. A fine rash developed in armpits, down both sides and across the upper abdomen. On scratching the lesions increased, from about 1 millimeter (mm) in size to 2 to 3 mm, became redder, and somewhat indurated. The rash receded within half an hour of stopping scratching. The rash was at its worst 5 days prior to being seen. When seen the rash was barely discernible, consisting of slightly raised papules about 1 mm in diameter over the indicated area.

*parts per million parts of bark

The more affected worker worked with the plastic the first day the first worker was involved, but was not seen by the NIOSH physician until 11 days later. Clothing was soaked with the condensate from the plastic with considerable bare skin exposure as well. A rash developed that same evening starting on arms and spreading to back, abdomen, and legs. The rash was purple to bright red, later developing itching and reportedly going on to blistering on the legs by the 4th day after exposure. As initial treatment did not seem to be effective, the worker was seen by an industrial toxicologist 7 days after exposure. Although the lesions and itching were severe at that time, there was no frank blistering evident. The patient was started on systemic steroids, later tapered down, and finally switched to local steroids for the worst areas. This worker was seen by the NIOSH physician 11 days after exposure. At that time the rash was a dull red with numerous slightly raised welts about 1 centimeter (cm) wide by several cm long running at angles on the arms suggestive of the direction liquid might have dripped off the arm. In other areas the welts were rounder or the rash more papular.

Of the three U.S. Public Health Service workers exposed to beetle-killed wood during the 1982 season, two had experienced rashes after working with the wood and one had not. The bark and/or plastic was damp when they started to work with the wood. For one of the affected workers exposure was to the wood only. Activity was primarily splitting the wood using a power splitter with no protective clothing

and short sleeves. The rash was red, raised, patchy, and itchy; involved arms, face, and chest; was first noticed the day following exposure; and lasted a week in spite of local treatment. The other effected worker had to remove the plastic and then used a chain-saw with gloves and long sleeves (but rolled up to the elbow). The rash was red, blotchy, itchy, and raised in some areas; involved the forearms extending up to the shoulders; was first noticed the evening of exposure; and lasted 5 to 7 days in spite of local treatment which did help the itch. The third worker, who had no medical effects, was involved in removing plastic and carrying logs for about half a day. Both workers developing rashes had histories of allergies. The uneffected worker did not.

VII. DISCUSSION AND CONCLUSIONS

Considering the physical properties of EDB it is expected that the EDB will vaporize under the sealed plastic, particularly during the day when it is hot, and then condense under the plastic, particularly at night when it is cooler. In this respect it would be acting very similar to water. Thus the condensate under the plastic could be expected to be a solution of EDB in water. The environmental analysis confirmed this. EDB was also found on the plastic in the absence of gross liquid condensate suggesting that the EDB may also have been absorbed onto the plastic.

The rashes which developed on the two forest workers and two of three U.S. Public Health Service employees are consistent with rashes following EDB exposure.

We conclude that there is residual EDB in the condensate under the plastic, on the plastic itself, and in the bark of the treated logs, in sufficient amounts to cause skin effects in more heavily exposed individuals and in more sensitive individuals.

VIII. RECOMMENDATIONS

1. Protective clothing to prevent skin exposure should be used when handling beetle-kill wood which has been sprayed with a mixture containing Ethylene Dibromide (EDB). Eye protection is also recommended if condensate is present. (If the work is done in an unventilated area, respiratory protection should be included as well.)

2. The piles of wood should be posted as having been treated with EDB, a toxic substance.

3. The public buying the wood should be warned of the hazards of working with EDB treated wood without adequate protective clothing.

4. Purchasers of this wood should be given written instructions on proper handling and use of the wood. This should include protection from skin exposure, proper ventilation of stored wood, and avoidance of exposure to smoke from burning the wood.

5. Considering the hazards associated with the plastic, particularly when wet with condensate, the U.S. Forest Service, or other organization selling the beetle-kill wood, should assume the responsibility of removing and properly disposing of the plastic. The workers assigned to this task should be properly trained and use appropriate protective equipment.

6. Consideration should be given to removing the plastic from the logs some time before putting the wood on sale.

IX. REFERENCES

1. Clayton, G.D., & Clayton, F.E., Patty's Industrial Hygiene and Toxicology, Vol 2B, 3rd Revised Ed. John Wiley & Sons, New York. 1981.

2. Dean, J.A., Ed., Lange's Handbook of Chemistry, 12th Ed. McGraw-Hill Book Co., New York. 1979.

3. NIOSH, Criteria for a Recommended Standard . . . . Occupational Exposure to Ethylene Dibromide. DHEW (NIOSH) Publication No. 77-221. August 1977.

4. NIOSH, Current Intelligence Bulletin 23, Ethylene Dibromide and Disulfiram Toxic Interaction. DHEW (NIOSH) Publication No. 78-145. April 11, 1978.

5. NIOSH, Current Intelligence Bulletin 37, Ethylene Dibromide (EDB) (Revised). DHHS (NIOSH) Publication No. 82-105. October 26, 1981.

6. Millar, J.D., Director, NIOSH, Statement before Committee on Education and Labor, Subcommittee on Labor Standards, United States House of Representatives, September 13, 1983.

X. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By:

Theodore W. Thoburn, M.D.
Medical Officer
NIOSH, Region VIII.
Denver, Colorado

Bobby J. Gunter, Ph.D
Regional Industrial Hygienist
NIOSH, Region VIII
Denver, Colorado

Originating Office:

Hazard Evaluation and Technical Assistance Branch (HETAB)
Division of Surveillance, Hazard, Evaluation, and Field Studies (DSHEFS)
NIOSH, Cincinnati, Ohio

Report Edited and Formated By: Kristi Ramsey
NIOSH, Region VIII.
Denver, Colorado

XII. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. U.S. Forest Service, Dillon District.
2. U.S. Forest Service, Denver Regional Office.
3. U.S. Department of Labor/OSHA - Region VIII.
4. NIOSH - Region VIII.
4. Colorado State Health Department.
5. Colorado State Forestry Service.

For the purpose of informing affected employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

ETHYLENE DIBROMIDE AS FOUND
IN THE CONDENSATE, PLASTIC AND WIPE SAMPLES
FROM PINE BEETLE-KILL WOOD PILES

Summit County, Colorado
August 22, 1983

SAMPLE NUMBER	TYPE OF SAMPLE	DATE SPRAYED	ug ETHYLENE DIBROMIDE
Pile 1	Condensate	7-15-83	4.71
Pile 1	Plastic	7-15-83	141.60
Pile 1	Wipe	7-15-83	ND
Pile 1	Wipe	7-15-83	ND
Pile 2	Condensate	7-20-83	0.50
Pile 2	Plastic	7-20-83	117.86
Pile 2	Wipe	7-20-83	ND
Pile 2	Wipe	7-20-83	ND
Pile 3	Condensate	7-25-83	1.68
Pile 3	Plastic	7-25-83	558.00
Pile 3	Wipe	7-25-83	ND
Pile 3	Wipe	7-25-83	ND

Laboratory Limit of Detection (Ng/mL): 2.5

TABLE II

ETHYLENE DIBROMIDE CONCENTRATIONS
IN BEETLE-KILL PINE TREE BARK

Summit County, Colorado
September 12, 1983

SAMPLE NUMBER	DATE SPRAYED	PPM ETHYLENE DIBROMIDE
1	7-15-83	16.0
2	7-20-83	0.49
3	7-25-83	0.25
4	Spring 1982	0.013
5	Spring 1982	0.056

Laboratory Limit of Detection (ng): 0.12