INDUSTRIAL HYGIENE IN-DEPTH SURVEY REPORT

PAPAYA PACKING/SHIPPING FACILITIES
HILO, HAWAII

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An industrial hygiene survey was conducted at the Papaya Packing/Shipping Facilities (SIC-4581), Hilo, Hawaii to investigate worker exposure to ethylene-dibromide (106934) (EDB) used for pest control in fruit packing plants. The feasibility of conducting cytogenetic and reproductive health surveys among these workers was also investigated. A continuous, low level exposure to EDB was noted for packer/sorter workers. Others who remain in production areas have similar continuous exposures in addition to peak exposures during duties directly in or around the fumigation chambers. Exposure levels are near and sometimes exceed NIOSH standards of 45 parts per billion (ppb) as an 8 hour time weighted average and 130ppb as a 15 minute ceiling level. For forklift operators, numerous samples exceeded the ceiling standard. The author concludes that the facility is suitable for the epidemiological study as there is a range of exposures providing an opportunity for studying possible dose/response relationships among workers, the EDB exposures have continued over a number of years, there are no known confounding exposures, and the management and employees were highly cooperative.

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PURPOSE OF SURVEY:	To evaluate current ethylene dibromide exposures of papaya workers in packing/shippingplants in Hilo, Hawaii as a part of concurrent cytogenetic and reproductive health surveys among these workers.
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STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	4581

Disclaimer

Mention of facility names or products in this report does not constitute endorsement by the National Institute for Occupational Safety and Health. (NIOSH)

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ABSTRACT

In December 1982 and December 1983, industrial hygiene surveys were conducted to evaluate exposures to ethylene dibromide (EDB) in fruit packing plants on the island of Hawaii in the Hawaiian Islands. The primary purpose of these surveys was the measurement of current exposure levels and an assessment of the feasibility of conducting cytogenetic and reproductive health surveys among these workers.

Personal exposure sampling for EDB was conducted among three major work classifications in the six (6) packing plants near Hilo, Hawaii. Exposures for packer/sorters (the largest number of workers) ranged from 23 to 148 ppb, while exposures for forklift operators (who actually enter fumigation chambers) ranged from 39 ppb to 195 ppb over 8 hour workshifts with short term peak exposures as high as 262 ppb. The third work category, fumigator, represented the fewest number of workers with the lowest potential for exposure since these individuals work near EDB only for brief periods. Short term air samples obtained in the breathing zone of fumigators revealed exposures ranging from 12 ppb to 262 ppb. No full shift air samples were collected on fumigators since none of these employees work at this task for a full eight hours. The results of the exposure assessment confirmed that workers are chronically exposed to low airborne concentrations of EDB throughout their work shift. Consequently, this population of workers represents an excellent cohort for epidemiological study of possible health effects due to chronic low level EDB exposures.

INTRODUCTION

Ethylene dibromide (EDB) is widely used throughout the world as a lead scavenger in gasoline and as an active component in numerous pesticides used as soil, fruit, and grain fumigants. This study is an industrial hygiene assessment of exposures to workers in the Hawaiian Islands where EDB is used as a fumigant on papayas destined for shipment throughout the world. While EDB is a highly effective fumigant, the chemical is a recognized mutagen, potent carcinogen, and a spermatotoxin in animals.[1,2]

This report summarizes an industrial hygiene survey which is a companion study to a reproductive and a cytogenetic study of workers exposed to EDB in this occupational setting. Workers in the Hawaiian papaya industry were selected for these studies due to the length of exposure, absence of other confounding exposures, relatively low worker turnover, and an adequate worker population to achieve statistical significance in study results.

The reproductive/cytogenetic studies (reported separately), represent the first epidemiological assessments of the health hazards of long-term repeated exposures to EDB at or near the current NIOSH recommended exposure standards. The reproductive study was an effort to evaluate semen quality among exposed workers as compared to matched control subjects. The cytogenetic study sought to evaluate the levels of sister chromatid exchange and chromosomal aberration in a comparison between the same groups of exposed workers and control subjects.

The industrial hygiene survey described in this report was planned to establish a current estimate of worker exposures to EDB and to investigate confounding exposures (if any) to EDB-exposed workers, as well as workers who volunteered to serve as control subjects. The current estimate of EDB exposure was needed to evaluate any changes in EDB levels which may have arisen since a December 1982 exposure assessment was completed.[3] The earlier study was undertaken to determine the feasibility of the reproductive/cytogenetic studies. The 1982 study surveyed only three (3) of the packing plants on the island of Hawaii; although five plants were known to be in operation at that time. Reported here are exposure results from the five plants in operation at the time of the first study along with a sixth plant which recently began operations. Workers from all six plants participated in the reproductive/cytogenetic study.

Control subjects for the epidemiological studies were selected from the Puna Sugar Company. This company is near one of the packing plants and represented an excellent source of workers not exposed to EDB. An objective of this study was to evaluate the potential for exposures to other chemical or physical exposures which might cause health effects similar to EDB. A description of operations and a list of chemicals in use at the Puna Sugar Company are included as Appendix 1 of this report.

DESCRIPTION OF FACILITIES

There are currently eight (8) known EDB fumigation sites in the Hawaiian islands. Six (6) sites are located near the city of Hilo on the island of Hawaii, while one is located on Kauai and another on Oahu. The facility on Oahu is a plant quarantine station located near the international airport which is engaged in fumigating small quantities of fruit, usually hand carried by passengers on outgoing flights. Five of the other six plants (on the island of Hawaii) are engaged in similar production operations composed of fumigating, packing, and shipping of large quantities of papayas harvested on the island. The sixth plant near Hilo is a new company using temporary facilities until a more permanent site is located. This plant uses the fumigation facilities of a vegetable packing plant during evening hours. This company does not employ a fumigator or forklift operator. Fumigation and forklift operations (as nearly as could be established) are performed by individuals who are not employees of the fruit packing company (but are employees of the vegetable packing plant). The vegetable plant employees were not monitored for exposure or included in the epidemiology study.

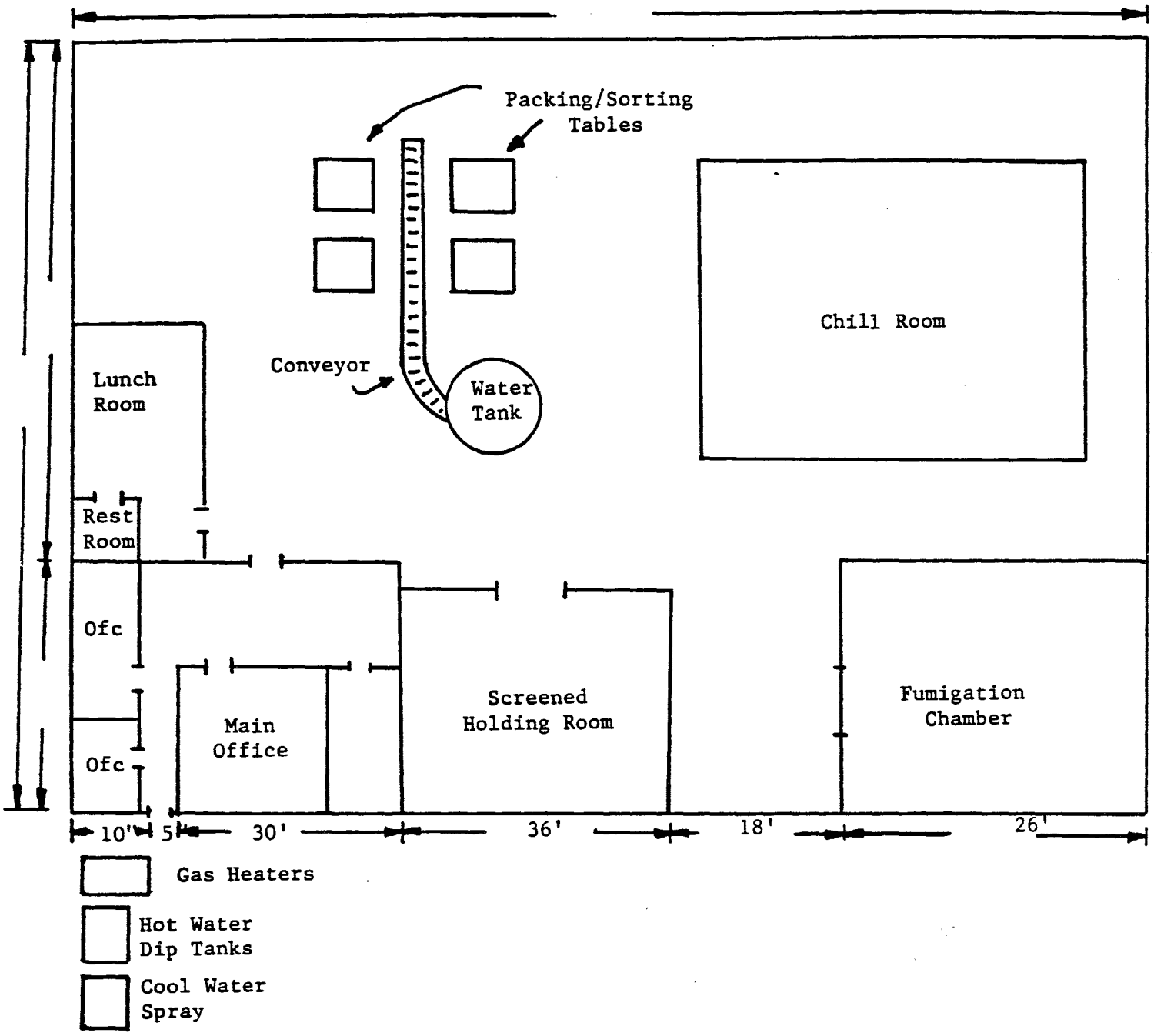
Due to logistical problems of ferrying people and equipment between the physically separate islands of Hawaii, the industrial hygiene and epidemiology studies were limited to the six plants in the vicinity of Hilo. In addition to co-location within a 20 mile radius, these plants constituted the largest concentration of EDB-exposed workers in the Hawaiian islands.

With the exception of the newest plant (plant 6), all of the plants on the island of Hawaii have been in operation for many years commencing in the late 1930's or early 1940's. The plant construction reflects the age of the plants as well as the tropical climate. For the most part, these plants are sheet metal and frame construction erected on a concrete slab. The five older plants visited in this study are roughly the same size, occupying approximately 10,000 square feet of floor space, the sixth plant (the newest plant) is much smaller and is located in a corner of a larger vegetable packing plant.

In all cases, the packing and sorting areas are under one roof. In four of the plants, the administrative offices are in the production area, while in the other two, the office staff is located in a separate building adjacent to the production facility. To provide a general orientation to a typical layout, a dimensioned floor plan of one production facility is shown in Figure 1.

As seen in Figure 1, the typical production facility has three major components: a fumigation vault, a packing and sorting area, and a chill room. In addition, each plant has an administrative area, an eating/break area, and a fruit holding area. Hot water dip tanks and cooling spray facilities are located exterior to the building.

FIGURE 1


Packing/Sorting Tables
Chill Room
Conveyor
Water Tank
Lunch Room
Rest Room
Ofc
Ofc
Main Office
Screened Holding Room
Fumigation Chamber
10'
5'
30'
36'
18'
26'
Gas Heaters
Hot Water Dip Tanks
Cool Water Spray
Fruit Delivery/Shipment Parking Area

DESCRIPTION OF WORKFORCE

The workers in the Hawaiian papaya packing/shipping industry represent a broad range of ethnic and racial origins. Among the residents of the Hawaiian islands, no race predominates and this characteristic is true also for the employees in the papaya packing industry.

The numbers of employees in each of the six plants surveyed are summarized in Table 1. At each plant there was one fumigator, two or three forklift operators, and the remainder of the production employees were packer/sorters.

TABLE 1

NUMBERS OF EMPLOYEES IN PLANTS SURVEYED

		Male	Female
Plant A	production employees	10	18
	administrative employees	2	3
Plant B	production employees	6	14
	administrative employees	1	4
Plant C	production employees	8	19
	administration employees	0	2
Plant D	production employees	6	14
	administration employees	2	2
Plant E	production employees	24	56
	administration employees	4	2
Plant F	production employees	12	6
	administration employees	2	0
TOTALS		77	140

The work is largely performed on a single shift. There is some flexibility in workshifts in this industry in order to meet the seasonal demands for the produce. Employees occasionally work a shift which is shorter or longer than the standard eight hours. Also, in busy seasons, two shifts per day may be scheduled. On some days, the fumigator may work a night shift (usually alone) if a night fumigation is scheduled. The turnover rate among employees was very low, estimated at two or three per year, per plant.

The International Longshore Workers Union (ILWU), Local 142, represents some of the workers in this industry. At present three of the six plants in Hilo are unionized. During this survey, appropriate contacts were made with ILWU Local 142.

DESCRIPTION OF PROCESS

Most of the plants surveyed have experienced similar production changes over the years. At some point in the past, insect control was achieved by a hot

water vapor method. This method "cooked" the fruit to kill insect life, resulting in some losses of fruit. The introduction of EDB in the past 6 to 8 years has led to far more successful control of insect life while virtually eliminating waste fruit.

Approximately three years ago, all plants converted to a closed system for metering liquid EDB into the fumigation vaporization chambers. Using this method, liquid EDB is fed by gravity from a 30 or 50 gallon bulk storage drum positioned on top of the fumigation chamber. The liquid moves through a closed system of tubing into two electric frying pans enclosed in the fumigation chamber ventilation duct. The frying pans are heated and a measured volume of EDB is metered into the frying pans and vaporized into the stream of ventilation air circulating through the chamber. The closed system for metering EDB to the vaporization chamber clearly lessens potential exposures over the old method where a fumigator physically poured liquid EDB by hand from a storage container into a graduated cylinder which in turn was poured by hand directly into the frying pans. The old method presented many opportunities for spills and skin contact.

The fumigation chambers are constructed from sheet steel welded together to form a chamber approximately 25 feet square and 10 feet high. Each chamber has two large doors for placing and removing fruit into and from the chamber. The doors are equipped with rubber seals and a latching mechanism to close the doors tightly. In some plants, one of the two chamber doors was permanently sealed shut, presumably to minimize exposures to employees. All of the chambers examined during this study leaked EDB vapor (as verified by direct-reading instrument measurements). The U.S. Department of Agriculture (USDA) checks the fumigation chambers with smoke every three months in an effort to locate leaks which the packing companies are directed to repair.

In all of the plants visited, employee eating areas were located adjacent to the production area. In one plant, the designated eating area was directly adjacent to the fumigation chamber. On certain days, fumigation was underway during the lunch period suggesting the possibility of higher (unnecessary) EDB exposures to employees.

The general sequence of treatment and handling of papaya may be summarized in the following steps:

1. Forklift operators unload fruit from delivery trucks and place the fruit (in open crates) into a hot water dip to reduce stem-end rot, surface contamination, and the quantity of EDB needed for fumigation.

2. Forklift operators remove crates of fruit from dip tanks and cool fruit to ambient temperature under a cool water spray.

3. Forklift operators fill fumigation chambers with crates of fruit. After the chamber is filled and the door sealed shut, a fumigator (in the presence of a Federal inspector) begins the fumigation cycle by adding 8 oz. (by weight) of EDB per 1000 cubic feet of chamber volume for a chamber loaded no more than 1/2 the floor to ceiling height. Ten oz. of EDB is used for the occasional cycles when chambers are more fully filled.

4. Following the two-hour fumigation period, the fumigator ventilates the fumigation chamber to exhaust the EDB-laden air from the chamber for 2 hours or longer. During the exhaust cycle, two of the six plants roll a portable recirculating fan (equipped with charcoal filters) into the fumigation chamber to adsorb additional EDB during the exhaust cycle. The fumigator is not continually present during fumigation and exhaust cycles, but only appears briefly to start the process, then leaves.

5. Forklift operators enter the chamber to remove fumigated fruit and place crates of fruit in a temporary storage area to allow further off-gassing of EDB in an area open to natural ventilation.

6. In those cases where fruit is kept for extended periods, it is moved by forklift truck to a refrigerated space equipped with charcoal filters to continue the removal of EDB in recirculated air.

7. Immediately following fumigation, or following temporary storage, fumigated fruit is moved by forklift truck to the packing operation. (Two plants use a water delivery trough to transfer fruit from lug boxes to the packing line, providing some additional removal of residual EDB).

8. Once the fruit is delivered to the packing operation, sorters separate fruit by size and ripeness and packers box fruit by hand into cushioned papaya cartons sealed with tape. Cushion materials may be paper or polyethylene. Packers/sorters work in close proximity and use similar work practices; hence, they were grouped as one job category.

9. Packed fruit is moved by forklift truck and stored in refrigerated rooms until loaded into shipping vans for surface shipment or into air freight containers for air shipment (Charcoal filtration is used in refrigeration chambers).

10. Fruit shipment. Fruit is shipped from the island by one of the following modes:

    a. Shipment to Honolulu by barge in refrigerated container (approximately 30 hours), followed by air (approximately 10 hours) or surface (sea van) shipment to mainland (approximately 7 days).

    b. Air freight direct from Hilo to Japan or California.

DESCRIPTION OF PAST EXPOSURES

When the State of California adopted the NIOSH recommended ceiling standard for EDB in 1981, the packing plants made major efforts to reduce residual EDB on fruit readied for shipment (much of the packed fruit is shipped to California, requiring compliance with those State standards). These improvements included the following:

1. An extended fumigation cycle. The current fumigation cycle is approximately four hours in length. In the first two hours, EDB laden air is circulated through the fruit to insure that the chemical penetrates deeply into the fruit. The second two hours are an aeration cycle, during which the chamber is vented to the outside air and the fruit off-gasses the absorbed EDB. In earlier years, the aeration cycle was as short as one-half hour.

2. Charcoal filtration in refrigeration rooms. While fruit is cooled after fumigation, the recirculating chilled air is passed through a bank of charcoal filters installed in racks in the refrigeration vaults to adsorb EDB off-gassed from the fruit.

3. Portable charcoal filters in the fumigation chamber. In two of the six plants surveyed, a portable air recirculating device is wheeled into the fumigation chamber during the aeration cycle. The recirculating device is built from sheet metal to form a small enclosure equipped with racks of activated charcoal and a fan to circulate air through charcoal filters to adsorb EDB.

4. Hot water treatment. As noted earlier, when the fruit is delivered to the packing plants, it is dipped into a hot water tank. This procedure reduces the EDB required for fumigation by half while also reducing stem-end rot and surface contamination.

The procedural changes implemented by the industry have resulted in reduced exposures to workers in the Hawaii packing plants. There is evidence that EDB exposures were considerably higher in past years. In a report for the Puna Papaya Company in 1979, one worker was found to be exposed to 2.9 ppm (or 2900 ppb) over a 26 minute sampling period. Another worker in the same study was found to be exposed to 1.8 ppm over a 25 minute sampling period[4]. None of the exposures measured in the most recent NIOSH surveys approach these previous levels.

In addition to the procedural changes which are in place, the industry has experimented with other techniques to reduce residual EDB levels on fruit shipped to market. In one study, the industry attempted revising the hot water treatment-fumigation sequence so that the fruit was hot water dipped after fumigation[5]. In another study, activated charcoal was packed with fruit in shipping containers to adsorb additional EDB during shipment[6]. Neither of these experiments were considered successful.

At least four industrial hygiene surveys have been conducted in the Hilo papaya packing plants in the past three years. Two surveys were completed by a local industrial hygiene laboratory, the first in 1979 [4] and a second in 1981[7]. A NIOSH Health Hazard Evaluation (HHE) was completed in 1980[8]. Hawaii OSHA conducted walk-through surveys at seven (7) fruit packing plants on Hawaii, Oahu, and Kauai in 1980 and 1981. Two of these reports contain exposure data for plants near Hilo, ranging from 4 to 150 ppb[9]. The results from these surveys were inconsistent and that uncertainty led to the walk through survey conducted in 1982.[3] An evaluation of the results of the earlier surveys (compared to the NIOSH 1982 survey) has suggested that some losses occurred from the sample media resulting in the estimation of lower than actual exposure levels.

Several observations from the prior data were used in planning the two most recent surveys to increase the likelihood of a more accurate exposure assessment. On the 1980 NIOSH HHE,[8] samples were shipped to the mainland for analysis. Due to time and temperature effects in shipment, it is likely that a substantial fraction of the EDB migrated off the sampling media during shipment and was lost prior to analysis. OSHA EDB studies show recoveries of only 75% after 9 days if stored/shipped at ambient conditions and only 80% if refrigerated for the same period[10]. As a result of discovering these potential problems, frozen sample storage/shipment along with prompt analysis were adopted to minimize potential losses. Furthermore, blind spikes were prepared to estimate the degree of sample loss during field handing and storage/shipment.

DESCRIPTION OF SURVEY METHODS

To reduce the likelihood of possible EDB losses from sampling media, extra effort was expended in the 1982 survey and repeated in this survey to control for expected losses in handling, shipping and analysis. These included:

1. The use of two types of sampling pumps to provide a low and a high sampling rate (50 cc/min and 200 cc/min) to obtain a range of sample volumes (approximately 20 to 80 liters of air volume in a typical work shift).

2. The use of the NIOSH priority analysis laboratory (as opposed to the standard NIOSH analytical laboratory in Salt Lake City, Utah) to obtain prompt analysis of samples upon receipt and a written report of results within two weeks.

3. The preparation of field spikes and quality control spikes to estimate expected losses due to time and temperature effects in shipment.

All samples were breathing zone samples collected by placing the sample media (standard 150-mg activated charcoal tubes) on the collar of each worker, connected by tubing to a sample pump. Sample pumps were MDA Co. Accuhaler^{tm} and Dupont Co. P200^{tm} pumps calibrated at 50 cc/min and 200

cc/min, respectively. The NIOSH Standard Method (P&CAM 260)[11] in effect at the time of the survey recommended a sampling rate of 50 cc/min for the full shift (8-hour), with a total sample volume of approximately 20 liters to insure a resultant EDB concentration on the tube in the working range of the analytical instrumentation. If ambient concentrations were extremely low, the 20-liter sample volume could be inadequate. Hence, larger sample volumes (approximately 80 liters) were collected on some samples to increase the likelihood of adsorbing sufficient EDB for detection by the analytical laboratory.

Samples were collected in all plants on at least two separate days. This replication was intended to estimate variations in exposure on different days throughout the work week. To the extent possible, workers were sampled for a full 8-hour shift unless their duty cycle dictated a shorter sampling period. In each plant, workers for sampling were chosen based upon numbers of workers in each job category and equipment availability. One fumigator was sampled each day, one or two forklift operators, and three or four packer/sorters. The actual selection of workers was based upon willingness to participate, representativeness of exposure, and plant supervisor recommendations.

The field spikes and the quality control spike were prepared by injecting a known quantity of EDB directly onto the charcoal of a single tube. To perform the injection, the liquid EDB standard was prepared so that 2 ul (volume) of solution was equivalent to 2 ug (weight) of EDB injected on the charcoal. The spiking solution was prepared by diluting EDB in a measured volume of benzene in methanol (the desorbing solution). Each day's spikes were obtained from a separate vial of standard; thus any given vial was never re-used on a succeeding day once the septum of the vial had been punctured. All spikes were submitted to the analytical laboratory as normal field samples (blind), to insure equivalent processing as ordinary field samples.

Blank samples were routinely prepared on each day for inclusion with the field samples sent to the laboratory. The blank samples served as a check on possible contamination of the charcoal due to inadvertent handling in manufacturing or in the field, as well as a possible indication of errors in analysis by the laboratory.

The field samples, blanks, and spikes were sent to the NIOSH priority analysis laboratory in Boston, Massachusetts. All samples were analyzed within two weeks of receipt, in accordance with recommended NIOSH methods.[11]

APPLICABLE STANDARDS AND RECOMMENDED LIMITS

Currently, the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for EDB is 20 ppm as a time-weighted average (TWA) for an eight-hour workshift.[12] OSHA has recently published a notice of proposed rulemaking to reduce this standard to 100 ppb TWA for

an eight-hour shift. NIOSH currently recommends 45 ppb TWA for an eight-hour shift with a recommended ceiling standard of 130 ppb in any 15-minute period during the day.[13] The American Conference of Governmental Industrial Hygienists (ACGIH) lists EDB as a suspect human carcinogen for which no standard is recommended but for which exposure should be limited to the lowest feasible levels.[14]

RESULTS

Nearly all sample results were reported to be within the detectable range of the analytical instrumention. There were very few "non-detectable" (ND) samples and there was no evidence of breakthrough, thus confirming adequate sampling rates, volumes, and the absence of humidity problems. Results of sampling at 50 cc/min and 200 cc/min resulted in comparable concentrations confirming the adequacy of sampling in this environment at the standard flow rate (50 cc/min). The blind spikes submitted to the laboratories provided an index of recovery of EDB from field samples. All blanks analyzed were reported as non-detectable. The spike results are summarized in Table 2.

TABLE 2

RESULTS OF BLIND SPIKED SAMPLES SUBMITTED TO LABORATORY
(micrograms)

Sample Number	Spiked Weight	Recovered Weight	% Recovery.
HHL 2	3.0	2.6	87.
HHL 9	8.0	6.6	83.
HHL 21	4.0	3.4	85.
HHL 48	4.0	6.2	155.**
HHL 64	8.0	6.6	83.
HHL 93	9.0	8.2	91.
HHL 94	4.0	3.8	95.
HHL 98	9.0	8.0	89.
HHL 99	4.0	3.3	83.
HHL 100	3.0	2.6	87.
HHL 101	5.0	4.1	82.
HHL 103	6.0	5.0	83.
HHL 104	7.0	5.8	83.
HHL 109	10.0	7.4	74.
HHL 110	8.0	5.3	66.
HHL 111	1.0	0.8	80.
HHL 144	6.0	4.9	82.
HHL 145	6.0	5.2	87.
Q 791*	10.0	8.5	85.
Q 792	10.0	8.5	85.
Q 793	7.0	5.6	80.
Q 794	7.0	6.0	86.

* "Q" labeled samples are quality control spikes prepared and shipped from Cincinnati NIOSH laboratories.

** The high recovery for spiked sample 48 is attributed to either field spiking error or laboratory error.

The spiking results show a recovery approximating the expected recovery of 90%. The losses in the field spikes (all labeled HHL) are slightly greater than the NIOSH laboratory-generated quality control spikes (labeled Q) and these increased losses are attributed to the effects of time and temperature in shipment (Hilo, Hawaii to Boston, Massachusetts). The analytical laboratory in Boston prepared routine internal quality control spikes of their own (not shown in Table 2) also demonstrating recovery of approximately 90%. The consistency of the spiking results among three sources are in good agreement. Consequently, the field data (personal sample results) were not adjusted for storage/shipment losses.

A summary of the collected field data is shown in Tables 3 and 4. The data in these tables are arranged to show a comparison of both 1982 and 1983 surveys of exposure to these workers. Both full shift personal samples and short-term personal samples were taken. The data from full-shift (8 hours) samples are presented in Table 3. It should be noted that statistical analysis of the industrial hygiene data assumed lognormal distribution of the data; hence, geometric means and standard deviations are shown.

Table 3.

EXPOSURE RESULTS: FULL SHIFT SAMPLES FOR EDB CONCENTRATIONS, PAPAYA PACKING PLANTS
(parts per billion)

Date	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6
			PACKER/SORTER			
'83	23(2.0)(8)	55(3.3)(8)	70(1.4)(8)	49(3.6)(6)	72(1.3)(9)	148(2.1)(7)
'82	73(1.6)(5)	95(1.3)(4)	61(1.5)(8)	na	na	na
			FORKLIFT OPERATOR			
'83	39(1.3)(2)	68(1.2)(2)	213(1.2)(2)	152(1.0)(2)	16(10.5)(2)	na
'82	89(---)(1)	125(1.0)(2)	145(1.4)(2)	na	na	na

Notes:
Data shown are geometric mean (geometric standard deviation)(number of samples)
na=not available/not sampled

Fumigator category not included in full shift sampling

Seventeen (17) of sixty-two (62) personal samples collected over full shifts exceeded the OSHA proposed PEL of 100 ppb as an 8-hour TWA, but all sixty-two personal samples were far below the current PEL of 20 ppm (20,000 ppb). Numerous individual samples exceeded either the NIOSH full-shift recommended standard of 45 ppb or the ceiling recommended standard of 130 ppb. In some cases, the geometric mean values also exceeded these standards although there were insufficient numbers of samples for a statistical conclusion. There was little consistent observable variation between job category or plant except for plant 6 where geometric mean exposures for packers/sorters were double the geometric mean exposure at the other five plants.

Packer/sorters work inside all day, but do not enter the fumigation chamber where excursions in exposure were likely, hence no short-term samples were collected for this job category. The geometric mean exposures for these workers ranged from a low of 23 ppb (plant 1) to 148.5 ppb (plant 6). The high exposures in Plant 6 were very likely due to the fact that sorting and packing was done in the fumigation chamber itself where employees work directly adjacent to off-gassing fruit without any form of exhaust or dilution ventilation.

There was some expectation that forklift operators would have higher potential exposures, since these workers enter the fumigation chamber itself for short periods (a confined area with highest exposure potential). The full-shift results in Table 3 do not reveal significant differences between forklift operators and packer/sorters consistently across plants. It was suspected, however, that these workers were exposed to significant peaks in exposure during the short periods they entered the fumigation chambers. To explore these peak exposures, several short-term measurements were collected while forklift operators loaded and unloaded the fumigation chambers as shown in Table 4. The highest peak exposure seen for forklift operators was 260 ppb while the geometric mean of all 5 peak measurements taken in two separate plants was 87 ppb (taken over 14-75 minute sampling periods). Despite these peak values, the lower full shift samples were attributed to the fact that these operators also work outside the plants for considerable periods (where there is theoretically zero exposure) hence their resultant overall exposure is largely a function of the short, infrequent peak exposures during entry into fumigation chambers.

Table 4.

EXPOSURE RESULTS: SHORT-TERM SAMPLES FOR EDB CONCENTRATIONS, PAPAYA PACKING PLANTS
(parts per billion)

	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6
			FORKLIFT OPERATOR			
'83	26(4.0)(2)	195(1.4)(3)	na	na	na	na
'82	na	na	na	na	na	na
			FUMIGATOR			
'83	12(3.2)(4)	118(3.6)(3)	262(--)(1)	69(2.8)(2)	na	na
'82	27(1.6)(2)	39(4.3)(4)	96(2.5)(2)	na	na	na

Note: Data shown are geometric mean (geometric standard deviation) (number of samples)

na=not available/not sampled

Packer/sorter category not included in short-term sampling

As with forklift operators, fumigators can be exposed to short-term peaks since their assigned duties require activity in close proximity to concentrated EDB (although for limited periods). Limited samples of this work category were collected since there were few workers (usually one individual at each plant), and when not fumigating these individuals typically had other duties during most of the day with no EDB exposure. Peak exposures for fumigators ranged from 12 ppb to 262 ppb.

ANALYSIS AND DISCUSSION

The results of this survey confirmed several important issues regarding worker exposure to EDB in the Hilo, Hawaii papaya packing plants:

1. There is a continuous, low level exposure to EDB for packer/sorter workers in this industry in Hilo, Hawaii. Other workers who remain in production areas (e.g. forklift operators, administrative staff) have similar continuous exposures in addition to peak exposures during duties directly in or around the fumigation chambers.

2. The level of exposure is near (and sometimes exceeds) the NIOSH recommended standards of 45 ppb as an 8 hour TWA and 130 ppb as a 15-minute ceiling level. For the forklift operators, numerous samples exceeded the NIOSH ceiling standard.

3. The exposures among five of the six plants visited was similar despite differences in layout, production levels, or general housekeeping. The sixth plant has demonstrably higher levels indicating that placing workers near off-gassing fruit in an unventilated, confined space can significantly increase exposure levels.

4. The geometric standard deviation (GSD) for exposures within plants and jobs generally remained well below 3.0 indicating moderate to low variability of exposure from day to day.

Based upon the assessment of EDB exposures, this population is considered suitable for the reproductive and cytogenetic epidemiology study, since:

1. There is a range of exposures providing an opportunity for studying possible dose-response relationships among workers exposed at different levels.

2. The EDB exposures in these plants have continued over a number of years (probably at higher levels in the past) providing significant person-years of exposure for statistical purposes.

3. There are no known confounding exposures among EDB-exposed or control workers which may cause similar adverse reproductive or cytogenetic health effects.

4. The management and employees were highly cooperative and there has been relatively little employee turnover (estimated at 2-3 employees per year per plant).

CONCLUSIONS AND RECOMMENDATIONS

Workers in Hawaiian fruit packing plants are currently exposed to levels of EDB approaching the NIOSH recommended standard and prior data suggest that exposure has been higher in earlier years. Furthermore these exposures have continued over an extended period (approximately 10 years).

The field techniques employed in this study definitely helped to establish higher confidence in exposure profiles. Field spiking (and quality control spiking by the NIOSH Cincinnati laboratory) demonstrated that sample handling, shipping, and analysis were well within control. The good recovery results were aided through the use of the NIOSH priority contract laboratory where analysis was completed within two weeks of receipt of the sample shipment.

The concurrent epidemiology study of these workers should yield a meaningful assessment of health effects due to chronic low level exposure to EDB. EDB exposures have existed in these plants for some time and will probably continue at these levels as long as EDB is in use. Apart from total isolation from EDB, reduction of exposures below the levels reported here appears unlikely. An EPA ban of EDB, which has been enforced since the time of this study, will force the industry to implement alternative, non chemical methods of pest control. Since the ban of EDB, the industry has chosen to implement a "double-dip" hot water treatment to reduce pests to acceptable levels. This method has not been totally acceptable and preliminary, unofficial reports indicate that the industry will turn to radiation as the method of choice.

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Appendix 1

PUNA SUGAR PLANT OPERATIONS

As a part of this industrial hygiene survey, a walk-through survey was conducted of the operations of the Puna Sugar Company and a review of company records to determine chemicals in use. The control subjects in the concurrent reproductive/cytogenetic epidemiology study were drawn from the population of workers at this Company (theoretically not exposed to EDB). The results of the assessment of potential exposures is included here.

The Puna Sugar Plant commenced operations in approximately 1901 and has been in continuous operation since that time. The plant is located directly adjacent to a large stand of sugar cane which constitutes the raw material for the sugar operations. The mature sugar cane is harvested from these fields and trucked to the plant for processing. The steps of the cane processing are summarized as follows:

1. Cane Cleaning: the cane stalks are processed through two water washing processes to remove rock and dirt prior to further processing.

2. Shredding: Power driven hammers are used to thoroughly shred and fiberize cane by breaking the cane into shorter pieces and rupturing cane cells.

3. Diffusing: Shredded fibers are piled about 3 feet high and water is pumped through the stack to extract sugar (sucrose). The temperature of the diffuser operation is maintained at approximately 170^{o} F. to prevent a fungal growth which produces dextrose. Dextrose, if present, will inhibit crystal growth in further processing. The water saturated cane is conveyed to a roller mill (squeezer) where sugar water is removed. The cane fiber remaining after squeezing is called "bagasse" and is used as fuel in the power plant of the sugar plant. The sugar water is concentrated by recirculation in the diffuser. The most concentrated sugar water is removed from the diffuser and neutralized with lime to adjust the Ph to 8.3 to accelerate decomposition into fructose and glucose. A small amount of sulfur is added at this point to whiten the sugar.

4. Flash Tank: The sugar water is clarified by removing "mud" (soil, organic matter, etc.) by the addition of an anionic polyacrylamide ("Separan"^{tm} manufactured by Dow Chemical). This chemical accelerates the separation of the mud from the liquid.

5. Evaporation: The clarified sugar water is processed through a five step evaporation process to produce a syrup.

6. Crystallization: Seed crystals blended with isopropyl alcohol are added to the syrup in heated seed pans to promote the growth of sugar crystals in the added syrup.

7. Striking and Centrifugation: Crystalline sugar is removed from seed pans and the liquid fraction (molasses) is centrifugally separated from crystals resulting in familiar pure white cane sugar, the final product of the refining operations.

The industrial hygiene assessment of sugar operations did not reveal any exposures with reproductive health consequences; hence, the employees of the sugar plant represented an excellent source of control subjects for the reproductive study. A complete list of chemicals identified in the sugar operations, specifying recognized hazards, is attached as Appendix 2 to this report.

Appendix 2

PUNA SUGAR COMPANY, LTD.
LIST OF CHEMICALS IN USE

TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Aatrex 80W (Atrazine)	Herbicide Powder form	Geigy Agri Chem 914-478-3131	Atrazine: 2 Chloro-4-Ethyl-Amino-6-Isopropylamino-S-Triazine- 76% Related Compounds -4% Inert Ingred. -20%	Eye Irritant Skin Irritant Inhalation	Harmful if swallowed Avoid contact with eyes Avoid contact with skin Avoid inhalation of dust
Ametryne (Evik)	Herbicide Powder form	Geigy Agri Chem 914-478-3131	Ametryne: 2-Ethyl-Amino-4-Isopropyl-Amino-6-Methylthio-S-Triazine-76% Inert Ingred. -20%	Eye Irritant Skin Irritant Inhalation	Harmful if swallowed Avoid contact with eyes Avoid contact with skin Avoid inhalation of dust Breathing spray mist
Asulox	Herbicide Liquid form	Rhone Poulenc, Inc. 800-424-9300	Sodium Salt of Asulam 37.2% Inert Ingred. -62.8%	Eye irritant Skin irritant	Avoid contact with eyes Avoid contact with skin
Aromatic Oil	Herbicide Liquid form			Eye irritant Skin irritant	Avoid contact with eyes Avoid contact with skin
Benlate	Fungicide	E.I. DuPont De	Methyl 1-(Butylcarbamoyl		

PUNA SUGAR COMPANY, LTD.
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TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Atrazine 80 - Wettable (Aatrex 80W)	Herbicide Powder form (Odorless)	Agricultural Div. Ciba-Geigy Corp. 919-292-7100 914-478-3131	Atrazine = 76% Related compounds = 4% Synonyms = Aatrex, Atrazine = 2-chloro- 4-ethylamino-6-isopropyl-amino-s-triazine	Inhalation Skin Irritant Eye irritant	Avoid inhalation Avoid contact with eyes or skin
Aatrex Nine - 0	Herbicide Powder form (Odorless)	Agricultural Div. Ciba-Geigy 919-292-7100 914-478-3131	Atrazine Active (2-chloro-4-ethylamino-6-isopropyl-amino-s-triazine)=85.5% Related compounds=4.5% Inert Ingred.=10.0%	Eye Irritant Skin Irritant Inhalation	Avoid contact with eyes/ skin Avoid inhalation Breathing spray mist
Polado					
Ratafin	Control rats White powder	Amchem Products, Inc. 215-646-1700	Chemical Name & Synonyms 3-(alpha-acetonylfur-furyl) 4-hydroxycoumain Trade Name=furmarin22 Chemical family=coumarin	Hemorrhaging may occur with exposure	Avoid inhalation or ingestion Avoid contact with skin and eyes

PUNA SUGAR COMPANY, LTD
LIST OF CHEMICALS IN USE

TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Karmex (DCMU)	Herbicide Powder Form	E.I. DuPont De Nemours & Co. (202) 483-7616	Diuron 3-(3,4-dichlorophenyl)-1-,1-dimethylurea=80% Inert ingre.=20%	Eye irritant Skin irritant Nose & Throat irritant	Avoid breathing dust or spray mist. Avoid contact with skin, eyes, & clothing
Paraquat	Herbicide Liquid Form	Chevron	Paraquat dichloride (1,1'-Dimethyl-4-4' Bipyridinium dichloride) -29.1% Inert ingred.-70.9%	Eye irritant Skin irritant Inhalation	Avoid contact with eyes, skin Do not breath spray mist Harmful if swallowed
Polaris	Ripener Powder form	Monsanto (314) 694-1000	Glyphosine-85.0% Inert-15.0%	Skin, eyes, clothing, irritation	Avoid contact with eyes, skin, inhalation of dust Wash clothes after handl. Harmful if swalled
Zinc phosphate treat-oats	Control rats Grpats	Gaspro, Inc. 215-646-1700	Zinc phosphine 1.88% Inert Ingred. 98.1%	Skin irritant Do not inhale	Avoid contact w/skin, avoid inhalation of dust or fumes, wash hands after use, harmful if swallowed, Persons with open sores should not hdl
Roundup	Herbicide Liquid form	Monsanto Co. (314) 694-1000	Isoproylamine, Salt of glyphosate 41.0% Inert Ingred. 59.0%	Eye irritant Skin irritant	Avoid contact with eyes, skin & clothing Harmful if swallowed
TCA	Herbicide Pellet form	Akzo Zout Chemie 05400-53911	Sodium trichloroacetate 95.0% Inert Ingred. 5.0%	Eye irritant Skin irritant	Avoid contact with eyes, skin

PUNA SUGAR COMPANY, LTD.
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TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Tordon	Herbicide Liquid form	Dow Chemical Co. 517-636-4400	Picloram, (4-amino-3,5, 6-trichloropicolinic acid) as the potassium salt 24.4% Inert Ingred. 75.6%	Eye irritant Skin irritant Inhalation	Avoid contact with eyes, skin, do not breath spray mist, harmful if swallowed
24-d Amine No. 6	Herbicide Liquid form	Rhone-Pouelnc, Inc.	Dimethylaminde salt of 2, 4-D - 69.7% Inert Ingred. 30.3%	Eye irritant Skin irritant	Avoid contact with eyes, skin, harmful if swallowed
Velpar	Herbicide Powder form	E.I. DuPont De Nemours & Co. 202-483-7616	3-Cyclohexyl-6-(dimethylamino)-1-Methyl-1,3, 5-Troazome-2,4 (1H,3H), dione - 90% Inert Ingred. 10%	Eye irritant Skin irritant Nose & Throat irritant	Avoid breathing dust or spray mist; avoid contact with skin, eyes, and clothing
Dalapon (Dowpon)	Herbicide Powder form	Dow Chemical Co. 517-636-4400	2,2 Dichloropropionic Acid sodium Salt-72.5% 2,2 Dichloropropionic 12.0% acid, Magnesium Salt Inert Ingr. related compounds - 15.5%	Eye irritant Inhalation Skin irritant	Avoid contact with eyes Avoid contact with skin Avoid inhalation of dust spray mist Avoid contact with clothing

PUNA SUGAR COMPANY, INC.
LIST OF CHEMICALS IN USE

TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Sodium Chloride	White crystals or granules, or powder odorless	Mallinckrodt, Inc. Paris, KY 606/987-7000	Chemical family = inorganic salt Formula - NaCl	Eye irritant Skin irritant May cause gastro-intestinal (lg. ds) irritation	Avoid getting into eyes, skin contact, inhalation
Sulfamic acid	White crystalline powder with no odor	Nissan Chemical Industries, Ltd. Tokyo, Japan 296-8182	Molecular formula = NH_2SO_3H, chromium, copper, lead, manganese	Causes eye burn; irritation of nose, throat & skin	Avoid getting in eyes, skin contact
Lime	White lumps pebbles or granuales	Flint Kote Lime Co. Monterey Park, CA (213) 265-5300	Chemical name = Calcium oxide (quicklime) Formula CaO or CaO·MgO	Eye irritant Skin irritant*	Avoid getting in eyes, skin contact
Sulfuris Acid	Oily liquid	J.T. Baker Chemical New Jersey (201) 859-2151	Synonym or cross ref. Oil of vitriol, Oleum Formula=H_2SO_4	Severe burns	Avoid geeting in eyes, skin contact, on clothing or breathing vapor wash after handling
Mogax Magnesium Oxide	White powder	Basic Chemical Div. Cleveland, OH (216) 241-5000	Magnesium oxide	Dust tends to dehydrate mucuos memb.	Avoid contact with skin, breathing dust

PUNA SUGAR COMPANY, LTD.
LIST OF CHEMICALS IN USE

TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Hydrated Lime					
Hydrochloric acid	Clear odorless to light yellow liquid acrid	J.T. Baker Chemical New Jersey (201) 859-2151	Synonym or Cross ref. Hydrogen chloride Hydrochloride Formula = HCl	Causes severe burn; may be harmful if swallowed	Avoid contact with eyes, skin, clothing-do not breathe vapor-wash after handling
Lead sub-acetate	White slight odor of acetic acid	Mallinckrody, Inc. Paris, KY (606) 987-7000	Chemical name = lead sub acetate-Trade name lead acetate, Basic	Cumulative poison Inhalation poison	Avoid breathing dusts, skin & eye contact, inhalation
Separan AP273 Polymer	White free flowing amphrous solid little odor	Dow Chemical USA Midland, MI (517) 636-4400	Hydrolyzed polyacrylamide	Minor eye irr. throat dryness	Avoid getting in eyes, skin contact, on clothing or breathing vapor wash after handling
SO_2					
Sodium hydroxide (50% aqueous)	Clear water white, slightly gray odorless	Hooker Industrial Chemicals Mallinckrodt, Inc. (606) 987-7000	(Chemcial formula) NaOH	Severe corrosive to tissue Burns mucuos membranes	Do not get in eyes, on skin, inhale dust or mist or on clothing

TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Phosphate-free cleaner #360		A.W. Chesterton Co. (617) 438-7000 day (617) 438-7013 ngt.	Not listed	Skin contact Ingestion Eye contact Inhalation	Avoid skin contact, do not ingest, avoid eye contact, use adequate ventilation
WRD-160	Red transparent liquid cinnamon odor	Spartan Chemical Co (419) 531-5551	High flash mineral spirits-95% Isopropyl Las-5%	Eye contact Skin contact Ingestion	Avoid contact with eyes, skin, clothing, do not ingest
Aqua-Sol	Fluorescent green blend of wetting agents	Certified Labs. Div. of NCH Corp. (214) 438-0541	Sodium metasilicate penahydrate-6.5% Sodium linear alkyl Benzene sulfonate-1.4% 2-butoxyethanol-3.8%	Eye contact Skin contact Ingestion	Avoid contact with eyes and skin
Saf-sol	Transparent liquid	Certified Labs Div. of NCH Corp. (214) 438-0541	methylene chloride 15% perchloroetyhlene 35% aliphatic petroleum distillates 50%	Eye contact Skin contact Ingestion Inhalation	Avoid contact with eyes, skin, do not ingest, use with adequate ventilation
Chevron inhibited insulating oil CMS 241407		Chevron (415) 232-1514 Ext. 4178 or 2027	Paraffins (Insl. naphthenes) 96% Aromatics 4% Additives 0.1%	Eye contact Skin contact Ingestion Inhalation	Avoid contact with eyes, skin, do not ingest, use with adequate ventilation Avoid contat with clothing

PUNA SUGAR COMPANY, LTD.
LIST OF CHEMICALS IN USE

TRADE NAME	USAGE	MANUFACTURED BY	ACTIVE INGREDIENTS	HAZARD	PRECAUTIONS RECOMMENDED
Alcohol (isopropyl anhydrous)	Clear colorless liquid	Exxon Chemical Co. (713) 656-3600	Formula-$(CH_3)_2CHOH$ Family-Aliphatic alcohol	Vapor irritate eyes, nose, throat, skin irritant	Avoid breathing vapor, contact with eyes, skin (both vapor & liquid)
Alcohol (methyl)	Clear colorless liquid Sweet odor	Central Solvents & Chemical Co., CA (302) 654-8900	Family-alcohol Formula-CH_3OH	Drinking may be fatal or cause blindness Harmful inhald	Do not inhale vapor or mist, avoid contact with eyes, keep container closed
Buffer Solution	Clear colorless liquid	J.T. Baker Chemical New Jersey (202) 859-2151	N/A	Low hazard rating	None recommended
Caustic soda Flake		Pennwalt Corp.	Sodium hydroxide NaOH Family-Alkali	Severe burns to mucuos membranes & skin, blindness	Do not get in eyes, on skin or clothing-do not breath dust, vapor, mist gas
Ether anhydrous	Colorless liquid Anesthetic odor	J.T. Baker Chemical New Jersey (201) 859-2151	Synonym or cross ref. ethyl esther: diethyl ether Formula=$(C_2H_5)_2O$	Harmful if inhaled, skin & eye irrit.	Avoid contact with eyes, skin, clothing, breathing vapor, wash throughly after handling

Appendix 3

HAWAII EDB EXPOSURE SURVEY 1983
RAW DATA

Sample No.	Date	Plant	Job Title	Sample Type	Exposure (ppb)	Comments
10	11/29	A	Fumigator	st(8)	23	
27	11/29	A	Forklift	FS	31	
32	11/29	A	Packer/Sorter	FS	42	
24	11/29	A	Packer/Sorter	FS	78	
43	11/29	A	Packer/Sorter	FS	18	
14	11/29	A	Fumigator	st(12)	2	
39	11/29	A	Packer/Sorter	FS	9	
19	11/29	A	Forklift	st(14)	170	
51	11/29	B	Packer/Sorter	FS	92	
38	11/29	B	Packer/Sorter	FS	94	
16	11/29	B	Packer/Sorter	FS	79	
53	11/29	B	Packer/Sorter	FS	79	
17	11/29	B	Fumigator	st(17)	60	
7	11/29	B	Forklift	FS	59	
54	11/29	E	Packer/Sorter	FS	80	
60	11/29	E	Packer/Sorter	FS	79	
50	11/29	E	Packer/Sorter	FS	28	
46	11/29	E	Packer/Sorter	FS	81	
55	11/29	B	Forklift	st(8)	ND	
23	11/30	A	Fumigator	st(29)	23	
4	11/30	A	Forklift	FS	49	
20	11/30	A	Packer/Sorter	FS	40	
23	11/30	A	Packer/Sorter	FS	13	
40	11/30	A	Packer/Sorter	FS	20	
52	11/30	A	Packer/Sorter	FS	15	
49	11/30	A	Forklift	st(22)	4	
18	11/30	B	Fumigator	st(20)	17	
58	11/30	D	Packer/Sorter	FS	646	Pump rem'd, put in cooler
8	11/30	D	Packer/Sorter	FS	126	Pump rem'd, put in cooler
59	11/30	D	Packer/Sorter	FS	83	
57	11/30	D	Packer/Sorter	FS	78	
17	11/30	B	Fumigator	st(13)	25	
41	11/30	B	Forklift	st(20)	211	
12	11/30	D	Fumigator	st(17)	126	
42	11/30	F	Packer/Sorter	FS	157	
44	11/30	F	Packer/Sorter	FS	239	Pump stopped
108	11/30	F	Packer/Sorter	FS	157	
33	11/30	F	Packer/Sorter	st(60)	4	
13	11/30	F	Packer/Sorter	st(70)	ND	
29	11/30	F	Packer/Sorter	FS	461	
34	11/30	F	Packer/Sorter	st(60)	362	
45	12/1	B	Packer/Sorter	st(15)	52	
1	12/1	B	Packer/Sorter	FS	3	
6	12/1	B	Packer/Sorter	FS	74	

HAWAII EDB EXPOSURE SURVEY 1983
RAW DATA
(continued)

Sample No.	Date	Plant	Job Title	Sample Type	Exposure (ppb)	Comments
25	12/1	B	Packer/Sorter	FS	65	
31	12/1	B	Packer/Sorter	FS	110	
30	12/1	B	Forklift	FS	78	
105	12/1	D	Packer/Sorter	FS	12	
147	12/1	D	Forklift	FS	150	
91	12/1	D	Packer/Sorter	FS	140	
106	12/1	D	Forklift	FS	155	
150	12/1	D	Packer/Sorter	FS	8	
138	12/1	D	Packer/Sorter	FS	155	
69	12/2	E	Packer/Sorter	FS	56	
67	12/2	E	Packer/Sorter	FS	69	
79	12/2	E	Packer/Sorter	FS	74	
65	12/2	E	Packer/Sorter	FS	44	
70	12/2	E	Packer/Sorter	FS	69	
148	12/5	C	Packer/Sorter	FS	64	
149	12/5	C	Forklift	FS	246	
82	12/5	C	Fumigator	st(10)	262	
143	12/5	C	Packer/Sorter	FS	86	
62	12/5	C	Packer/Sorter	FS	55	
136	12/5	C	Packer/Sorter	FS	50	
78	12/5	D	Fumigator	st(24)	29	
146	12/5	E	Forklift	FS	84	
76	12/5	F	Packer/Sorter	FS	134	
107	12/5	F	Packer/Sorter	FS	36	
84	12/5	F	Packer/Sorter	FS	140	
142	12/5	F	Packer/Sorter	FS	208	
61	12/6	E	Forklift	FS	3	
90	12/6	C	Packer/Sorter	FS	113	
88	12/6	C	Packer/Sorter	FS	67	
68	12/6	C	Packer/Sorter	FS	52	
71	12/6	C	Forklift	FS	185	
73	12/6	C	Packer/Sorter	FS	92	
139	12/6	B	Forklift	st(35)	260	
75	12/6	B	Forklift	st(75)	136	
26	12/6	D	Puree	FS	ND	
72	12/2	C	Shipping	FS	9	
89	12/2	D	Shipping	FS	9	Bkgnd Area Sample