U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT HE 77-119-481

HOUSTON CHEMICAL COMPANY
BEAUMONT, TEXAS

APRIL 1978

I. TOXICITY DETERMINATION

It has been determined, based on environmental and medical evidence, that a hazard to the health of workers exposed to Ethylene dibromide(EDB) did not exist at Houston Chemical Company, Beaumont, Texas, during the period of a Health Hazard Evaluation conducted by NIOSH on September 13-15, 1977.

The medical evaluation did, however, reveal some abnormalities in the results obtained that remains unexplainable and merits continued care in the use of EDB. Because of the widely disputed level of an abnormal sperm count, this evaluation's conclusions were based on comparison of workers, not known to be sterile for non-occupational reasons and who provided a sperm specimen with at least 24 hours abstinence with non-exposed controls. Where applicable statistical significance was considered at the $P \leq .05$ level.

Environmental sampling indicated that the employees where not exposed to detectable levels of EDB based on 25 personal breathing zone samples.

Recommendations are included to assist in ensuring worker health and safety.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information 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, Publication Office at the Cincinnati address.

Copies of this report have been sent to:

a) Houston Chemical Company, Beaumont, Texas 77704
b) Authorized Representatives of Employees, Oil, Chemical and Atomic Workers Local 4-243 Beaumont, Texas 77704
c) Oil, Chemical and Atomic Workers International Union, Washington, D.C. 20036
d) U.S. Department of Labor Region VI
e) NIOSH Region VI

For the purpose of informing the approximately 25 "affected employees" the employer shall promptly "post" for a period of thirty calendar days, this Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding worker exposures to Ethylene Dibromide (EDB), produced at Houston Chemical Company, Beaumont, Texas. The request specifically requested a medical evaluation of employees associated with EDB production, to ascertain if any adverse health effects had developed, with particular attention to reproductive effects.

IV. HEALTH HAZARD EVALUATION

A. Facility Description

Houston Chemical Company was founded in approximately 1961 and occupies approximately 90 acres. The facility provides employment for approximately 556 people, with an average plant service of 8 years. The facility produces a variety of organic chemicals, including ethylene dibromide (1,2-dibromoethane). The EDB process is operated by approximately 20 employees who "man" the 3 shifts, 7 days/week operation. The job titles of those individuals include; raw materials operator, EDB "reactor" operator, mixed alkyl fluids operator and blender operators.

The current EDB "reactor" was brought on-stream in 1977 to replace the older deteriorating unit. The new unit is physically removed from other operations.

B. Process Description

Ethylene is reacted with bromine, in a closed system, and the reaction mixture is then neutralized/scrubbed with caustic solution, quenched and then pumped to storage tanks. Excess ethylene is vented to an incinerator and spent caustic is pumped to an effluent treatment facility. The EDB is then mixed with alkyl leads, blended to purchaser specifications with other organic compounds such as ethylene dichloride, toluene and dyes and is then loaded into tank cars. The majority of the systems are entirely closed and most of the EDB is consumed within the facility in producing antiknock gasoline additives.

C. Evaluation Methods

A NIOSH physician, physician's assistant and industrial hygienist conducted environmental and medical surveys during September 13-15, 1977.

An initial conference was conducted with Company officials and Union Officials. A walk-through evaluation was performed by NIOSH, company, and union representatives. This evaluation included shower, eating, first aid, and laboratory facilities.

The work environment appeared to be clean during the walk-through survey. First aid facilities were located in the safety building. It consisted of a waiting area, a nurse's station and two examination rooms. It was well stocked to meet most emergencies, and ambulance service from the city was used to transport injured to the emergency room. The infirmary is managed by a full time nurse present during the day shift. At other times first aid is rendered by available trained supervisory personnel. Shower facilities were provided to the employees, as well as dirty and clean lockers. Overalls were provided daily and as needed if contaminated during the shift. A lunch room was available in the safety building with appropriate wash facilities.

Safety procedures seemed well enforced. All personnel were required to carry escape respirators. Supplied air respirators were required in areas of potentially high exposure.

The medical program is directed by the Corporate Medical Director of PPG Industries in Chicago, Illinois. The medical program is delivered by a local medical practitioner. The medical program consists of a pre-employment physical including history, physical examination, urine analysis, X-ray of chest and spine, blood SMA 24, VDRL, CBC, (audiometry), pulmonary function studies, and an EKG for persons over 50 years old. A periodic physical examination consisting of the same tests occurs yearly for those persons over 50 years old and every two years for those persons under 50 years old. Upon termination, a physical examination is given, but no laboratory tests are performed. A special hazard surveillance is performed for lead. Urinary lead levels are performed every month for field workers. The test is performed every 3 to 6 months for supervisory and office personnel.

1. Environmental Evaluation

General area samples for EDB and other airborne organic vapor contaminants were obtained utilizing 150 milligram(mg) activated charcoal tubes and Sipin* personal sampling pumps operated at airflows of 0.2 liters per minute (lpm).[1] Personal samples were obtained utilizing Sipin* pumps operated at airflows of 0.05 and 0.2 lpm with the adsorption media tubes clipped to the worker's collar to approximate their breathing zone.[1] The samples were analyzed by desorbing the environmental charcoal with 1 milliliter(ml) carbon disulphide(CS_2) and analyzing the solution via gas chromatography[2] mass spectrometry.

Relative humidity and temperature measurements were made with a Bendix* psychrometer.

Indicator tubes for methyl bromide and total hydrocarbons were used to qualitatively assess if those substances were present in the environment.

A bulk sample of EDB was obtained in a glass scintilation vial with a teflon® lined cap. Work practices were observed throughout the facility and Company sampling data for EDB was also reviewed.

2. Medical Evaluation

The NIOSH medical personnel evaluated 24 workers and 3 controls on the initial visit. Twenty-two of the 24 workers were in positions of potential exposure at the time of the survey. Two workers were persons who had prior exposure to EDB on the old EDB distilling column, which is no longer functional. A return visit to the facility on November 7-9, 1977 allowed evaluation of six additional non-exposed volunteers. Persons evaluated were nonvasectionized individuals with no known medical history of sterility prior to working at Houston Chemical Company.

The medical history and physical examinations were conducted by the NIOSH physician. The history included an occupational history, and a medical history including questions on fertility, sexual dysfunction, and diseases which might cause sterility. It also contained questions concerning personal work hygiene. Questions of fertility, sexual dysfunction, and prior diseases were asked by the physician in lay terms. The physical examinations were conducted looking for signs of feminization, including measurement of testicular size and consistency. Testicular size was measured by palpation, then compared to a millimeter ruler. Features evaluated for decreased masculinity were facial hair, body hair, gynecomastia, and body habitus.[11]

*Mention of manufacturer's name does not constitute a NIOSH endorsement.

Laboratory tests included serum (LH) luteinizing hormone, (FSH) follicle stimulating hormone, testosterone, brominated hydrocarbons, and for those who volunteered, a semen density. LH, FSH, and testosterone samples were drawn by venipuncture into a coagulation tube and allowed to coagulate. They were then certrifuged, and the serum was pipetted into transfer tubes and frozen in dry ice. The specimen were sent to National Health Laboratories, Houston, Texas by the laboratory's own courier service.

The serum gonadotropins and testosterone levels were analyzed using radioimmunoassay (RIA). All three of these methodologies were obtained from commercial manufacturers in kit form. The Amershan (FSH) and Serno (testosterone) kits contained anti-sera standarized against a World Health Organization standard. National Health Laboratories did not supply an anti-sera tracing to the Bio-RIA (HLH) kit.

A blood and urine specimen was provided by 22 exposed workers and 3 non-exposed controls. Of the 22 exposed workers 6 had no exposure to EDB prior to blood drawing that day. One worker's exposure that day was not recorded and one worker was on "old column" worker with no current exposures. Urine bottles and anticoagulant blood containers were provided by the analytic laboratory. They were expecially cleaned for use to analyze brominated hydrocarbons. Specimens were frozen and mailed to the Center for Bio-Organic Studies, University of New Orleans, New Orleans, La. The report received at the time of this report contains the results of the blood specimens only and the urine results are still being evaluated. The study method was to determine ethylene dibromide by mass spectrometry using a Tekmar LSC-1 Liquid Sample Collectro and Howlett-Packard 5982 and DuPont 21-491 mass spectrometers. The analytical column employed was a stainless steel capillary column (500' x .02" id) coated with 10% solution of SF-96 and 1% Igepal (0 880 and contained Temax/Silica gel). The unit was calibrated with a standard, prepared of ethylene dibromide in methanol at a concentration of 1000 ng/ul. The lowest limit of detection was estimated to 5 PPB, which was ten (10) times the background "noise" level.

Semen specimens for sperm density were collected on exposed workers and non-exposed volunteers.[12, 13, 14] Persons who participated were instructed to abstain from ejaculation until the specimen was produced. The specimen was to be produced by masturbation into a clean wide mouth plastic container just prior to leaving for work the next morning, or the day in which that worker was to report. The specimens were to be brought to the infirmary, where they were refrigerated until received by the laboratory courier service. They were transported to National Health Laboratory, Houston, Texas for analysis of sperm density. Had instructions been followed, this method should guarantee at least 24 hours of sexual abstinence.

All workers providing sperm counts were asked by the NIOSH physician the exact number of hours abstienence, or a questionnaire was mailed for the workers to return to the NIOSH physician reporting the abstinence period. The abstinence period was reported by all but three workers. For all workers with sperm density of less than 20 million cells/ml, arrangements were made to repeat the test to increase accuracy. The highest sperm count was reported. Sperm density was measured by direct microscopic observation in a counting chamber.

D. Evaluation Criteria

1. Environmental

The following occupational exposure criteria were used in evaluating the environmental contaminants found at the time of the survey: (1) National Institute for Occupational Safety and Health (NIOSH), Recommended Criteria for Occupational Exposures, (2) American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values for Substances and Physical Agents in the Workroom Environment and supporting Documentation, and (3) U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Standards (29CFR 1910.1000, Tables 21 and Z3).

Substance	(1) NIOSH (mg/M^3*)	(2)ACGIH(mg/M^3*)	(3)OSHA (mg/M^3*)
Ethyl Chloride		2600	2600
Ethylene Dibromide**	1.0	145	155
Ethylene Dichloride	20	200	200
Toluene(skin)**	375	375	750
Xylene(skin)***	435	435	435

*approximate milligrams of substance per cubic meter air, as an 8-hour time weighted average (TWA) daily exposure.
**Ceiling value not to be exceeded in any fifteen minute period.
***Notation indicates that substance is absorbed thru intact skin.

These criteria are designed to protect the most workers for an eight or ten hour day, forty hour week, during a normal working lifetime. However, there are numerous factors that may influence an individual's response to a particular agent such as age, sex, health status, smoking habits, etc. Also, effects from exposures to combinations of agents may be additive or synergistic when the agents elicit similar physiological responses.

2. Medical Criteria

a. Toxicity of Ethylene Dibromide[3-10]

(1) Ethylene dibromide (1,2-dibromoethane) is a colorless liquid of moderately low vapor pressure. It is used industrially in antiknock gasoline, fumigant mixtures and in small amounts as chemical intermediates, solvents and gauge fluids. Despite the low vapor pressure, toxic concentrations can accumulate during respiratory contact. The liquid is also absorbed through the skin and the gastrointestinal tract.

(2) Acute toxicity. Acute contact has been studied in animals, but human effects are restricted to individual case studies.

Acute oral and respiratory contact to humans has caused an anesthetic effect, which resulted in dizziness, and restlessness. There was also chest pain, vomiting and diarrhea, abdominal pain, and nervous paralysis.

Upon examination, abnormalities were found in the liver, kidneys, heart and respiratory tract. After sufficient dose, death has resulted.

Acute skin and mucous membrane exposure cause irritation. Irritation to membranes of the eyes (conjunctiva) and lids was reported of an employee exposed to vapors. Accidental spillage to the skin resulted in burning pain with the skin reddened and blistered.

(3) Chronic exposure has been less well studied. In animals, damage to kidneys, liver, lungs, and spleen have been reported. Ethylene dibromide has been sufficiently absorbed through rabbit skin to cause death in some animals. Another organ system affected in both an acute and a chronic nature is the male reproductive system. The only studies are in animals. Bulls have been reported to have reversible decrease in sperm count when exposed to EDB.

(4) Ethylene dibromide has been shown to cause birth defects and cancer (stomach) in animals. It has also been shown to cause defects in genetic material in animals, animal cells, and bacteria. None of these effects have been shown to occur in humans.

(5) There is no recommended treatment specific to ethylene dibromide. Supportive care should be performed specific to the side-effect exhibited. A 48-hour medical observation period for delayed systemic or dermal effects is recommended.

E. Evaluation Results and Discussion

1. Environmental

As indicated by the results of the environmental samples obtained (Table 7) on the survey dates, the employees were not exposed to toxic concentrations of airborne contaminants. EDB was only quantifiably detected in the central area of the EBD unit. (Company sampling data indicated that exposures were higher, ranging from less than 1 to 53 mg/M^3, in the old EDB unit.) This area is posted for respiratory protection, if the unit is entered, thus actual exposures would be considerably less, if the protective equipment is properly used and well maintained. There was physical evidence of corrosion at the site of the old unit, but the new unit is physically removed from the other process areas thus exposure potentials have been further reduced. The product sampling port is within a closed box that is kept at negative pressure and the operator wears a 1/2 face supplied air respirator and gloves thus exposures are not likely and were not measureable. The detector tube measurements for methyl bromide and total hydrocarbons were negative (i.e. non detected).

All employees are required to shower before leaving work and all clothing is supplied and laundered by the company. The hygienic facilities utilize a double locker system and are well maintained.

There are written operating procedures, safety booklets, vessel entry procedures and respiratory protection procedures available to all personnel in addition to periodic safety meetings and training. Contractor personnel are also given training and safety equipment and apparently are well supervised, and not allowed outside of the area where they are assigned.

2. Medical

The questionnaire contained questions to determine symptoms attributable to decrease male testosterone. These symptoms are listed in Table 2, as noted, no exposed worker complained of any of these symptoms.

The physical examination also emphasized physical signs attributable to ethylene dibromide. These signs are listed in Table 3. The testicular sizes are not listed, since no exposed worker had evidence of testicular atrophy.

The medical records were reviewed, and the NIOSH physician noted entries of ethylene dibromide spills for three workers. The exposure caused minimal to severe skin irritation with redness and some swelling; as well as some work loss.

The laboratory values were the most significant aspect of the survey. The laboratory values are reported in Tables 4, 5 and 6. The sperm count values are all listed, however, an abstinence period of at least 24 hours was mandatory. Only those persons who reported an abstinence period of at least twenty-four (24) hours were compared. Control number thirty-one (31) had a acceptable abstinence period, but had evidence of prior infertility. Those sperm densities indicated with an asterisk were eliminated from the statistical evaluation of sperm densities. The exposed workers group showed no statistical difference from the control group ($P<.05$).

In evaluating the statistical comparison between the exposed workers and the nonexposed controls for LH, FSH, and testosterone levels, all workers were included since abstinence periods have no effect on these levels. The FSH and testosterone levels of the exposed and control groups were equally nonsignificant ($.50>P>.10$). The LH values, however, did show a significant difference between the exposed workers and the non-exposed controls ($.02>P>.01$). The LH (luteinizing hormone) is a pituitary gonadotropin which, in the male, regulates testosterone production by Leydig cells in the testis. An elevated level indicates the the Leydig cells require more stimulation to produce normal amounts of testosterone. The effect could be potentially caused by a testicular toxic substance. If a testicular toxic substance in the work environment were the cause, it has not caused any statistically significant effect on the fertility or physical characteristics of the exposed workers. Such a small effect can only be shown epidemiologically by a much larger study with greater quantitation of exposure to ethylene dibromide.

There were two workers (Table 6) with a past exposure to ethylene dibromide, but no exposure for the previous 9-12 months. One of these workers had a lowered sperm count. This person, however, had multiple medical abnormalities that could explain this result. With the small number of these workers and the inability to quantitate exposure, these workers were not included with the exposed workers for analysis.

Along with the unexplained and isolated elevation of the LH values in exposed workers, the other important finding is a difference between the median sperm counts of exposed and control workers (Table 4 and 5). The median sperm count of control workers was 79 million cells/ml, while the exposed workers median sperm count was only 54 million cells/ml. We may compare these values to the work done by Whorton et. al on workers exposed to 1,2 dibromo-3-chloropropane (DBCP).[15] He found a large difference between the median sperm counts of workers exposed to DBCP and the non-exposed controls. The median sperm count of DBCP exposed workers was 45.6 million cells/ml, while the non-exposed median sperm count was 78.7 million cells/ml. Whorton did, however, find differences in the mean sperm count and gonodotropins of DBCP exposed workers and non-exposed controls which were not evident in this study. In Dr. Whorton's report, the mean sperm count of eleven DBCP formulators was 0.2 million cells/ml and 93 million cells/ml for the non-DBCP exposed controls. Whorton also compared 107 workers with any past exposure to .35 non-DBCP exposed controls. The mean sperm count of the DBCP exposed workers was 63.8 million cells/ml and 106.2 million cells/ml for the controls. This difference in the mean sperm count values of Whorton's study is much greater than the difference in this study. This is despite the indicated similarities in the two studies when comparing median sperm count values.

F. Conclusions

The available data indicates that there is a potential toxic effect of ethylene dibromide, as indicated by the LH levels; but there is no overall statistically significant effect on sperm count or evidence of testicular toxicity. This does not mean that ethylene dibromide should not be treated as a toxic agent, since testicular toxicity might be appreciated only with exposures that are more prolonged or intense. As indicated, there are some similarities between the data of this study and the study of DBCP, a recognized testicular toxic agent. The difference in these two studies might be explained if ethylene dibromide acts by a different mechanism on the testis, or if it is a weaker toxic agent; or the small number of exposed workers studied may not have been sufficient to identify a small effect or exposures to EDB were minimal or insufficient to produce this effect. It should be strongly emphasized, therefore, that this study on ethylene dibromide does show some signs of potential testicular toxicity and it should be treated as a toxic agent.

RECOMMENDATIONS

The following recommendations are made to help inprove the health and safety at this facility.

1. All employees should adhere to strict personal hygiene and good work practices to help reduce potential exposures.

2. To assure consistent care, washing, sanitizing, drying, etc. it is advisable that one person per shift be responsible for maintaining respirators. The respirators could be received each shift each day as is the clothing and other safety equipment.

3. Management is encouraged to continue development of its industrial hygiene program and the written program should be detailed and continually updated. Continued efforts in identifying contaminant generation sources are imperative, particularly for new process/product institution.

4. Management should continue its development of a health and safety education/awareness program, which is particularly important for new employees and maintenance personnel. Small group seminars may be a method to utilize.

5. The following NIOSH courses are recommended for the health and safety personnel: (a) Respiratory Protection, (b) Laboratory Safety, (c) Industrial Hygiene Measurements, (d) Recognition, Evaluation and Control of Occupational Hazards.

6. Maintain the medical program and special lead surveillance program.

The NIOSH investigators would like to thank both management and labor for their cooperation and assistance with particular thanks to Mr. Roger Corley, Houston Chemical Company and Mr. George Shumaker, OCAW Local 4-243.

VI. REFERENCES

1. NIOSH Manual of Sampling Data Sheets S104, DHEW (NIOSH) Publication No. 77-159, Cincinnati, Ohio.

2. NIOSH Manual of Analytical Techniques S104, Second Edition, Volume 2, DHEW(NIOSH) Publication No. 77157B, Cincinnati, Ohio.

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

4. 90 Day Inhalation Toxicity Study in Rats and Mice 1,2-Dibromo-3-Chloropropane (DBCP) Ethylene Dibromide (EDB),Draft Final Report, Hazelton Laboratories, Vienna, Virginia.

5. Background Information on Ethylene Dibromide, Office of Occupational Health Surveillance and Biometrics, NIOSH, Rockville, Maryland. .

6. The Mortality Experience of 161 Employees Exposed to Ethylene Dibromide in Two Production Units,Prepublication Draft, The Dow Chemical Company, Midland, Michigan.

7. Amir, D. 1973. The Sites of the Spermicidal Action of Ethylene Dibromide in Bulls. J. Repro. Fert. Vol 35; 519525

8. Amir, D. and U. Lavon, 1976. Changes in Total Nitrogen, Lipoproteins and Amino Acids in Epididymal and Ejaculated Spermatozoa of Bulls Treated Orally with Ethylene Dibromide. J. Repro. Fert. Vol 47, 73-76.

9. Irish, D. 1963. Halogenated Hydrocarbons: I Alphatic pp 1284-1287. In: F.A. Patty, Ed. Industrial Hygiene and Toxicology, 2nd Edition Vol. II. Interscience Publishers, New York.

10. Plotnick, H.B. and L. Conner, 1976. Tissue Distribution of 14C-Labeled Ethylene Dibromide in the Guinea Pig. Research Communications in Chemical Pathology and Pharmacology. Vol 13. #2 pp 251258.

11. Steinberger, E. 1970. The testes, pg 384399. In: N.G. Schnerber, Ed. Essentials of Clinical Endocrinology. C.V. Mosby Co. St. Louis.

12. MacLeod, J. 1950. The Male Factor in Fertility and Infertility. An Analysis of Ejaculate Volume in 800 Fertile men and in 600 men in Infertile Marriage.

13. MacLeod, J. and R.F. Gold, 1951. The Male Factor in Fertility and Infertility II Spermatozoon Counts in 1000 Men of Known Fertility and in 1000 Cases of Infertile Marriage. J. Urol Vol. 60: 436.

14. Nelson, C.M. and R.G. Bunge, 1974. Semen Analysis: Evidence for Changing Parameters of Male Fertility Potential. Fertility and Sterility Vol. 25 #6..

15. Whorton D., Thomas H. Milby, and Harrison A. Stubbs. Report to Health Hazard Evaluation 77103. DHEW, NIOSH, DHSEFS, HETAB.

ACKNOWLEDGEMENTS

Report Written By:

Gary L. White
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and
Technical Assistance Branch
Cincinnati, Ohio

Jeffery Lybarger, M.D.
Medical Officer
Medical Section
Hazard Evaluations and
Technical Assistance Branch
Cincinnati, Ohio

Originating Office:	Jerome P. Flesch Acting Chief Hazard Evaluations and Technical Assistance Branch Cincinnati, Ohio
Medical Assistance:	Raymond Stroman, MX Physician Assistant Medical Section Hazard Evaluations and Technical Assistance Branch
Laboratory Analysis	Ardith Grote Chemist Measurement Support Services Division Physical Science and Engineering Cincinnati, Ohio
	Larry Lowry, Ph. D. Clinical Chemist Clinical and Biochemical Support Section Biological Support Branch Cincinnati, Ohio
Report Typed By:	Linda Morris Clerk-typist Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch Cincinnati, Ohio

TABLE 1

Houston Chemical Company
HE 77-119

August - November 1977

Demography

Age	Workers Exposed to EDB	Controls Not-Exposed to EDB
	N=22	N=9
Range	26-46	23-50
Mean	35.2	38
Yrs. Houston Chemical		
	N=22	N=9
Range	1.5-18.5	.5-21
Mean	9.6	9.6

TABLE 2

Houston Chemical Company
HE 77-119

Physical Symptomatic Complaints from Workers Exposed to EDB

August - November 1977

Symptom	Number of Workers	Percent
Change in facial hair	-0-	-0-
Change in body hair	-0-	-0-
Gynecomastia (breast enlargement)	-0-	-0-
Decrease in muscle mass	-0-	-0-
Change in testicle sizes	-0-	-0-
Inability to maintain erection	-0-	-0-
Decrease libido	-0-	-0-

TABLE 3

Houston Chemical Company
HE 77-119

Physical Signs of Workers exposed to EDB

August - November 1977

Sign	Number of Workers	Percent
abnormal male hair distribution	-0-	-0-
gynecomastia (breast enlargement)	-0-	-0-
decrease in muscle mass	-0-	-0-
testicular atrophy	-0-	-0-

TABLE 4

Houston Chemical Company
HF 77-119

Laboratory Results on Currently Exposed Workers

Numbers	Highest sperm count million/ml	Abstinence period hours	*if not adequate abstinence period	LH Milli IU/ml	FSH Milli IU/ml	Testosterone ng/dl
Normal				6-30	5-25	400-1000
1				31	11.5	485
2	40	24		15.9	7.2	608
3	4.6	55		47	37	765
4	217	72		9	17.5	648
5	33	N.R.	*	27	22	465
6	60	8	*	52	31	300
7	56	60		16.5	12	400
8	23	48		26	13.8	600
9				39	18	613
10	107	24		31	21	300
11	60	24		20	13.5	335
12				19	8.4	195
13	98	12	*	8	7.7	495
14	142	78		20	7.3	380
15	77	N.R.	*	21	17	543
16				15	10	500
17	52	36		23	9.5	1035
18	61	N.R.	*	13	8.3	753
19	40	48		19	13	305
20	64	84		15	8.6	583
25				18	10	340

Houston Chemical Company
HE 77-119
TABLE 4 (con't)

Numbers	Highest sperm count million/ml	Abstinence period hours	*if not adequate abstinence period	LH Milli IU/ml	FSH Milli IU/ml	Testosterone ng/dl	
Normal				6-30	5-25	400-1000	
26	22	24		16	7	950	
of adequate samples							
mean	69.0			22.8	14.2	527.2	mean
median	54.0						
S.D.	59.8			11.3	7.9	214.0	S.D.

TABLE 5

Houston Chemical Company
HE 77-119

Laboratory Results on Non-Exposed Controls (EDB)

Numbers	Highest sperm count million/ml	Abstinence period hours	*if not adequate abstinence period	LH Milli IU/ml	FSH Milli IU/ml	Testosterone ng/dl
Normal				6-30	5-25	400-1000
21	79	56		16	20	600
22	102	31		11.2	8	420
24	79	10	*	11.2	1.3	520
28	58	60		21	12	520
29	102	60		13	5	518
30	96	54		11	7	800
31	23	55	*	10	7	770
32	93	60		14	10	455
33	37	70		10	4	1200
mean	81			mean 13.0	9.6	644.8
median	79					
S.D.	24.9			S.D. 3.6	4.9	245.9

TABLE 6

Houston Chemical Company

HF 77-119

August - November 1977

Workers with prior exposure to EDB but no current exposure.

Number	Highest sperm million/ml	Abstinence period hours	LH Milli IU/ml	FSH Milli IU/ml	Testosterone ng/dl
Normal			6-30	5-25	400-1000
23	31	N.R.	15	17	330
27	13	36	12	11.3	530

Table 7

Results of Charcoal Tube Samples for Airborne Organic Vapors

Houston Chemical Company
September 13, 14, 15, 1977

HE 77-119

Environmental Conditions: Partly Cloudy, Intermittent Showers, Variable Winds, 80°-85°F, R.H. 65-100%

Sample Number	Time	Description	Results (mg/M^3)* EDB[1]	EDC[2]	Ethyl Chloride[3]	Toluene	Xylene
CT-1	1437-1832	Personal Sample (P.S.) Mixed Alkyl Fluids (MAF) Operator	N.D.[4]	N.D.[4]	N.D.[5]	-	-
CT-11	1835-2248		N.D.	N.D.	N.D.	-	-
CT-12	1439-1855	P.S. Raw Materials Operator	N.D.	N.D.	N.D.	-	-
CT-14	1857-2145		N.D.	N.D.	N.D.	-	-
CT-3	1440-1850	P.S. EDB Column Operator	N.D.	N.D.	15	-	-
CT-13	1852-2140		N.D.	N.D.	N.D.	-	-
CT-4	1442-1815	P.S. EDB Blender A Operator	N.D.	N.D.	N.D.	-	-
CT-10	1818-2153		N.D.	N.D.	N.D.	-	-
CT-5	1451-1844	P.S. EDB Blender B Operator (Female)	N.D.	N.D.	N.D.	-	-
CT-12	1845-2153		N.D.	N.D.	N.D.	-	-
CT-6	1523-2050	General Area (G.A.) EDB Column Control Room	0.88	N.D.	N.D.	-	-
CT-7	1525-2100	G.A. Operator's Desk 1st Floor Blender Area	N.D.	N.D.	N.D.	-	-
CT-8	1539-2101	G.A. Above Weigh Station #2 Blender Area	N.D.	N.D.	N.D.	-	-
CT-9	2-3 minutes	P.S. Operator Sampling Clarifier	N.D.	N.D.	N.D.	-	-
CT-17	0645-1440	P.S. EDB Column Operator	N.D.	N.D.	N.D.	-	-
CT-18	0650-1430	P.S. Blender A Operator	N.D.	N.D.	6.4	-	-
CT-19	0700-1435	P.S. MAF Operator	N.D.	N.D.	N.D.	-	-
CT-21	0709-1416	P.S. Raw Materials Handler	N.D.	N.D.	N.D.	-	-
CT-22	0716-1419	P.S. Blender B Operator	N.D.	N.D.	N.D.	-	-
CT-23	0720-1447	P.S. Maintenance (Replacing EDB Line)	N.D.	N.D.	N.D.	-	-
CT-24	0722-1431	P.S. Tank Car Loader	N.D.	N.D.	3.8	-	-
CT-25	0800-1517	P.S. Electrician (Electrical Tie-ins Blender Rock)	N.D.	N.D.	N.D.	-	-
CT-26	0732-1450	P.S. Tank Car Loader (Tetra Ethyl Lead)	N.D.	N.D.	N.D.	-	-
CT-27	0736-1430	P.S. Raw Materials Operator	N.D.	N.D.	N.D.	-	-
CT-28	0746-1451	P.S. Tank Car Loader	N.D.	N.D.	N.D.	-	-
CT-29	0909-1519	G.A. Laboratory (Next to Balance)	N.D.	N.D.	0.78	-	-
CT-30	10 minutes	P.S. Blender Operator (Sampled Product)[6]	N.D.	N.D.	N.D.	-	-