

INDUSTRIAL HYGIENE WALK-THROUGH
SURVEY REPORT

of

Amoco Chemicals Corporation
Chocolate Bayou Plant
Chocolate Bayou, Texas

SURVEY CONDUCTED BY:
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Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
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Mention of company or product name in this report does not constitute endorsement by NIOSH.

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PURPOSE OF SURVEY:

To perform a walkthrough industrial hygiene survey of a 1,3-butadiene monomer producing plant and determine the suitability for inclusion in an in-depth exposure survey regarding this substance.

EMPLOYER REPRESENTATIVES
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EMPLOYEE REPRESENTATIVES
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Employees are not unionized

STANDARD INDUSTRIAL
CLASSIFICATION (SIC) CODE:

2869 (Industrial Organic Chemicals, not elsewhere classified)

ABSTRACT

A walk-through industrial hygiene survey was conducted at the Chocolate Bayou Plant of Amoco Chemicals Corporation in Chocolate Bayou, Texas, on June 21, 1984. The purpose of the survey was to obtain information on the 1,3-butadiene monomer manufacturing process and the potential for occupational exposure to this chemical.

The plant, which opened in 1970, began producing 1,3-butadiene monomer in 1975. The ethylene coproduct process is used for the production of 1,3-butadiene. All the 1,3-butadiene produced is sold to outside customers.

The company has conducted sampling for 1,3-butadiene since 1982. Results of personal monitoring for job categories measured showed the weighted mean of the time-weighted average (TWA) exposures was approximately 2.0 ppm.

The company maintains personnel records on current and past employees.

INTRODUCTION

Inhalation exposure of rats and mice to 1,3-butadiene induced a carcinogenic response at multiple sites. Mammary fibroadenomas/carcinomas, uterine sarcomas, Leydig cell adenomas of the testes, thyroid follicular cell adenomas, exocrine tumors of the pancreas, and Zymbal gland carcinomas were identified in rats exposed at concentrations of 1,000 or 8,000 ppm of 1,3-butadiene. Mice exposed to 625 or 1,250 ppm of 1,3-butadiene developed a high incidence of malignant lymphomas; an increased incidence of other tumors, including hemangiosarcoma; and testicular and ovarian atrophy.^{1,2}

The offspring of pregnant rats exposed to 1,3-butadiene at 8,000 ppm had major skeletal defects. In addition, fetal toxicity was observed when pregnant dams were exposed at 200 ppm, 1,000 ppm, and 8,000 ppm.³

Epidemiological studies of workers employed in facilities producing styrene-butadiene rubber have indicated an increased, but not statistically significant, risk of mortality from neoplasms of the lymphatic and hematopoietic tissues and from leukemia.^{4,5}

Based on these data, the National Institute for Occupational Safety and Health (NIOSH) recommends that 1,3-butadiene be regarded as a potential occupational carcinogen and teratogen and as a possible reproductive hazard.⁶

Due to the number of workers potentially exposed to 1,3-butadiene and the resulting potential health risk, NIOSH is conducting an extent-of-exposure study of the 1,3-butadiene producing industry.

EXPOSURE EVALUATION CRITERIA

The current legally allowable air concentration enforced by the Occupational Safety and Health Administration for 1,3-butadiene is 1000 ppm for an 8-hour TWA. The American Conference of Governmental Industrial Hygienists (ACGIH), has included 1,3-butadiene in their Notice of Intended Changes for the 1984-85 Threshold Limit Values, based upon reported animal carcinogenicity data. The Intended Change identified 1,3-butadiene as an A2 industrial substance suspected of carcinogenic potential for man. A numerical TLV of 10 ppm was proposed in connection with the notice.⁷

NIOSH in their Current Intelligence Bulletin recommends that 1,3-butadiene be regarded as a potential occupational carcinogen and teratogen and as a possible reproductive hazard.⁶

HISTORY AND DESCRIPTION OF THE PLANT

The Amoco Chemicals Corporation is owned and operated by the Standard Oil Company of Indiana. The plant was constructed in 1970 on 2400 acres in Chocolate Bayou, Texas. The plant was built in phases with the No. 1 high-density polyethylene resins unit going on-line in 1970. In 1971, the No. 1 polypropylene resins unit started production followed in 1975 by the No. 1 olefins unit which recovers 1,3-butadiene from the ethylene coproduct stream.

In 1977, the No. 2 olefins unit began production. This unit also produces 1,3-butadiene by the ethylene coproduct process. The nameplate capacities of each of these units is 292,000 pounds of 1,3-butadiene per day. The total production rate at the time of the survey was 330,000 pounds per day of 1,3-butadiene.

Besides 1,3-butadiene, the Chocolate Bayou plant produces ethylene, propylene, polypropylene resins, and high-density polyethylene resins.

PROCESS DESCRIPTION

Figure 1 is a flow diagram of the 1,3-butadiene monomer production process. The Chocolate Bayou plant has licensed the Shell process for production of 1,3-butadiene. The crude ethylene coproduct C₄ feed to each recovery unit is a blend of C₄ streams from the olefin production process and those received from outside suppliers, and contains 40 to 58 percent 1,3-butadiene. The C₄ stream is fed to a primary extraction tower which uses acetonitrile (ACN) as the solvent for extraction of 1,3-butadiene. The lighter mixed butylenes stream from the tower is washed to remove ACN and pumped via pipeline to Texas City or Amoco's Stratton Ridge facility for storage. The heavier stream which contains 1,3-butadiene is separated from ACN in a secondary extraction tower, with the recovered ACN recycled to the process. A post-fractionating tower removes, as bottoms, impurities such as 1,2-butadiene and cis-butene which are then recycled to the primary extraction tower. The final product, containing 99 percent 1,3-butadiene, is stored in refrigerated spheres. None of the 1,3-butadiene monomer is consumed at the plant. The 1,3-butadiene monomer is shipped to several customers, either via rail, tank car, or barge.

The process includes on-line gas chromatographs at several locations for quality control. In addition, manual open-loop "bomb" samples are taken of the feed, intermediates, and products to ensure product quality. The company plans to install closed-loop sampling points in the near future.

DESCRIPTION OF THE WORKFORCE

Presently there are about 815 production and administrative employees at this plant. At each olefins unit, there are a total of 213 employees. The total is comprised of 64 salaried and 149 hourly personnel.

At the time of the survey, only the No. 2 olefins unit was in operation. In the 1,3-butadiene recovery area of each unit, there is one production worker per shift during normal operations. During upsets, there may be 2-3 workers in the area. Regularly and frequently the worker assigned to the butadiene area is rotated among the four C₄ workers on each shift.

The process technicians work a 12-hour shift, 4 days on and 4 days off. Maintenance personnel usually work an 8-hour shift on days only. The workforce is stable. There is reported to be little worker transfer in and out of the olefins units.

The production employees, all of whom have potential for exposure to 1,3 butadiene, are divided into the following job categories:

Process Technician/Process Area	Responsible for the outdoor activities in the process area. Takes quality control samples, decontaminates the pumps and equipment, and monitors the process. This job is accomplished by 1 employee per olefins unit.
Process Technician/Loading Area	Loads rail cars and barges with final product. Approxiamtely 2 to 3 rail cars are loaded per day. Barges are loaded when they reach the dock, whereas rail cars are loaded only on the day shift. Propylene is also loaded on rail cars by these workers. This job is accomplished by 1 technician.
Process Technician/Control Room Operator	Operates the computerized control room. The worker stays in the air conditioned control room all day. This job is accomplished by 1 employee per olefins unit.
Maintenance Technician	Conducts maintenance and repair on equipment decontaminated by the process technician. The maintenance employees are all Amoco personnel. This job is accomplished by 6 employees per olefins unit (total of 43 employees). Most of the technican's time is spent in the olefins area of the units. (Has potential for intermittent exposure).
C ₄ Foreman	Responsible for activities pertaining to 1,3-butadiene production. Oversees duties of process technicians. Works a 12-hour shift.
Process Supervisor	Works in the main office and is responsible for the overall process. The supervisor is on the unit 2-3 hours per day.

DESCRIPTION OF PAST POTENTIAL WORKER EXPOSURES

Although the Chocolate Bayou plant has been in operation for 14 years, 1,3-butadiene has been manufactured at this facility only since 1975.

Personal monitoring for 1,3-butadiene has been conducted by the company mostly since 1982. Table 1 summarizes Amoco's air monitoring data for various job categories. A total of 78 short-term and time-weighted average (TWA) samples were taken. Results for short-term samples ranged from 1-220 ppm; results for TWA samples ranged from 0.1 to 7.1 ppm. The weighted mean of the TWA exposures for process and area technicians and for the maintenance technicians was approximately 2.0 ppm. Industrial hygiene monitoring is routinely conducted at the plant for benzene, welding fumes, and additives used in the production of certain polymers produced at the plant.

Table 2 presents the results of eight time-weighted average measurements for laboratory personnel. The laboratory workers are responsible for analyzing the quality control bomb samples. The chemist performing wet tests has lower exposures presumably because the wet analyses are conducted under a hood having a face velocity reported to be greater than 100 feet per minute.

All samples were reported to be collected on charcoal tubes and analyzed by a method similar to NIOSH Method S-91.

Both slip-tube and magnetic gauges are used for monitoring the filling of rail tank cars with 1,3-butadiene.

Towers are cleaned once every two years. The procedure consists of "blinding" the towers, purging with nitrogen, and steam cleaning. Hydroblasting is used for removing polymer contamination (popcorn polymer).

Open-loop sampling techniques are used for collection of quality control bomb samples. The company is, however, considering the implementation of closed-loop sampling systems at several locations in the process.

Engineering Controls

Engineering controls at the plant include single mechanical seals on all pumps in the 1,3-butadiene recovery area for protection against leakage. The pumps in the olefins units are also equipped with dual mechanical seals. All drain systems for 1,3-butadiene pumps are sealed to prevent exposure when a pump is drained for maintenance.

DESCRIPTION OF MEDICAL, SAFETY, AND HYGIENE PROGRAMS

Medical Program

The company conducts pre-employment and annual physicals for all production and maintenance workers. The secretarial staff and other clerical employees who are not exposed to the plant environment undergo a physical every 3 years until the age of 40, every 2 years between the ages of 40 and 50, and annual physicals after the age of 50.

The plant has one part-time company physician who is at the plant on Mondays, Wednesdays, and Fridays. One licensed full-time registered nurse is on duty

at the plant during the day shift. There are 42 employees with emergency medical training. The plant has 2 ambulances on site and has an agreement for emergency care with a hospital, located 20 miles from the plant.

Amoco has computerized all employees' comprehensive medical records generated since 1978. Records are updated with respect to the employee's job description only at the time of the yearly physical.

Safety Program

The company maintains an organized safety program. The program is headed by a safety superintendent. Additional staff include 1 safety engineer, 1 safety supervisor, 1 safety clerk, 4 fire and safety technicians, and 1 summer co-op. The company's philosophy is that safety is a line organization responsibility.

The company holds safety meetings for production managers on a monthly basis. There is also a steering committee made up of supervisors and hourly employees. The frequency of departmental meetings varies from weekly to once a quarter.

The safety department also provides the support for industrial hygiene monitoring.

The only personal protective equipment required by the company are hard hats and safety glasses. Rubber gloves are required for collecting quality control bomb samples. Scott Air-Packs^R and Norton 7500^R half-face organic vapor respirators are available for emergency use. Showers and a central clothing change area are provided but reported not to be in frequent use. All workers provide their own clothing which is commonly worn home. Smoking is not permitted in the production area because of the explosion hazard of 1,3-butadiene.

Industrial Hygiene Program

The company has, over the years, conducted industrial hygiene air monitoring for a number of potential air contaminants. However, due to the high Threshold Limit Value (TLV) of 1,3-butadiene currently in effect, extensive monitoring was deemed to be not warranted for this chemical. The safety department has the industrial hygiene responsibility for the plant. A corporate industrial hygienist is assigned to the Chocolate Bayou plant. However, this person splits his time with Amoco's Texas City plants. The corporate industrial hygienist also conducts sampling. Every 2 years an air sampling campaign is undertaken in 1 major area of the plant; this would include sampling for benzene, other hydrocarbons, and 1,3-butadiene (if present).

The company uses Spectrix Corporation in Houston, Texas for its analytical services for 1,3-butadiene samples. Amoco Research Center in Naperville, Illinois does the routine analytical services for other compounds. Spectrix

Corporation uses an analytical method which is analogous to the NIOSH Method S-91.

The company did not report any deleterious health effects resulting from exposures at the Chocolate Bayou plant.

DESCRIPTION OF PERSONNEL RECORD SYSTEM

Amoco Chemical Corporation maintains personnel records on terminated as well as current employees. The records date back to 1970. However, records of terminated employees are purged every 10 years. The personnel records are maintained on standard forms for each employee, and provide the following information:

1. Name
2. Social Security Number
3. Date of birth
4. Date of employment
5. Date of termination

The records are not detailed enough to identify the unit in which an employee worked. The employee's time card would, however, be charged against the specific unit but would not identify the department within the unit.

Employees at the plant are covered by a life insurance policy; coverage is lost upon an employee's termination.

The turnover rate of employees at the Amoco plant is below the average industry rate of 5 percent.

CONCLUSIONS

Amoco Chemicals Corporation manufactures 1,3-butadiene by the ethylene coproduct process, using acetonitrile as the solvent for extraction of 1,3-butadiene. The production occurs in a closed system, tightly maintained for both economic and fire hazard reasons.

The company has conducted limited industrial hygiene sampling for 1,3-butadiene since 1982. The weighted mean of the TWA exposures to 1,3-butadiene for job categories measured was approximately 2.0 ppm.

Open-loop sampling techniques are used for collection of quality control bomb samples. There appears to be potential for significant exposure to 1,3-butadiene during use of these techniques.

RECOMMENDATIONS

Since there appears to be potential for significant exposure to 1,3-butadiene during quality control sampling, consideration should be given to installation of a sampling system that would reduce the potential for 1,3-butadiene

exposure from this source. (The company is considering the implementation of closed-loop sampling systems at several locations in the process.)

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TABLE 1

SUMMARY OF AMOCO'S PERSONAL AIR MONITORING RESULTS FOR 1,3-BUTADIENE
IN PROCESS AND LOADING AREAS, 1982 - 1984

Job Title/Location	Short-Term exposures, ppm				TWA exposures, ppm**			
	No. of Samples	Duration* minutes	Range	Mean	No. of Determinations	Duration* hours	Range	Mean
Process Technician/ Process Area	34	30	1 - 81	5.8	5	12	0.1-7.1	2.6
Process Technician/ Loading Area	5	30	1 - 28	7.0	2	12	0.5	0.5
Maintenance Technician	1	5	220	--	1	12	2.3	--
Maintenance Technician ¹					30	8	0.1-25***	3.6

¹ Unit shutdown activities

* Per sample

** Time-weighted average for the sample period

*** Peak TWA during shutdown of unit

TABLE 2

AMOCO'S PERSONAL AIR MONITORING RESULTS FOR 1,3-BUTADIENE
IN PLANT LABORATORY

<u>Job Title/Responsibility</u>	<u>TWA*, ppm</u>
Chemist/Gas Chromatograph	0.8
Chemist/Gas Chromatograph	0.2
Chemist/Gas Chromatograph	0.8
Chemist/Gas Chromatograph	0.3
Chemist/Wet Tests	0.5
Chemist/Wet Tests	0.1
Chemist/Wet Tests	0.1
Chemist/Wet Tests	0.1

*Time-weighted average (no sample period reported)