INDUSTRIAL HYGIENE WALK-THROUGH SURVEY REPORT

of

ARCO Chemical Company
Lyondell Chemical Complex
Channelview, Texas

SURVEY CONDUCTED BY:
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Industrial Hygiene Section
Industrywide Studies Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
Centers for Disease Control
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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 walk-through industrial hygiene survey of a 1,3-Butadiene monomer producing plant and determine the suitability for inclusion in an in-depth survey regarding this substance.
EMPLOYER REPRESENTATIVES CONTACTED:	Edward Bradley, Plant Manager
	Joe Wheat, Superintendent, Safety and Health
	Charles Fryman, Senior Industrial Hygienist
	Randolph Smith, Environmental Engineer
	Jack Kover, Plant Engineer
	Dave Litzenberg, Process Engineer
	William Shaw, M.D., Medical Director
	Gordon Mallery, Employee Relations
	Joe Cambell, 1,3-Butadiene Shift Foreman
	Robert Bonham, Shift Foreman, Tank Yard
EMPLOYEE REPRESENTATIVES CONTACTED:	Employees are not unionized
STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	2869 (Industrial Organic Chemicals, not elsewhere classified)

ABSTRACT

A walk-through survey was conducted at the ARCO Chemical Company, Lyondell Chemical Complex in Channelview, Texas, on May 15, 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 1957, began producing 1,3-butadiene by the Houdry Process. The plant currently produces 1,3-butadiene by the ethylene coproduct process.

A total of 34 workers are employed in the 1,3-butadiene production and storage areas. The company has conducted personal monitoring for 1,3-butadiene in various plant areas. The unweighted mean of all exposure concentrations reported by the company was 5.7 ppm.

The company has personnel records on all employees for the 27 years of plant operation.

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 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 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 researchers are conducting an extent-of-exposure study of workers potentially exposed to the 1,3-butadiene monomer.

EXPOSURE EVALUATION CRITERIA

The current legally allowable air concentration enforced by the Occupational Safety and Health Administration for 1,3-butadiene is 1000 ppm as 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] This change will be considered for formal adoption in 1985.

HISTORY AND DESCRIPTION OF THE PLANT

Ground was broken on September 1, 1955 for construction of the Lyondell Plant of the Texas Butadiene and Chemical Corporation (TB&C). The plant began operations on February 17, 1957, producing approximately 300 tons per day of 1,3-butadiene by the Houdry Process. In 1960, butadiene capacity was increased by 50 percent to 450 tons per day. On August 1, 1962, Sinclair Petrochemical, Incorporated, a subsidiary of Sinclair Oil Corporation, purchased the Lyondell Plant from TB&C.

After the Sinclair purchase, methyl ethyl ketone and styrene-maleic anhydride units were constructed and the capacity of the plant's aviation alkylate production unit was increased by 50 percent. In addition, four minor units producing odorless solvents, propylene hydrogenation, and sulfuric acid concentrate were added.

On March 4, 1969, Sinclair and all subsidiaries were merged with the Atlantic Richfield Company. The Lyondell Plant became part of ARCO Chemical Company, a Division of Atlantic Richfield. Since 1969, butadiene capacity has been increased, and isopropyl alcohol, methyl tertiary butyl ether, and Poly bd^{R} resin units have been built. Current capacity for 1,3-butadiene production is 750 tons/day. The plant has been running at approximately 65 percent of capacity (485 tons/day).

The ARCO Chemical Company constructed two olefin units at the Lyondell Chemical Complex in 1976 and 1977. The units manufacture ethylene, propylene, 1,3-butadiene, butylenes and aromatics at an overall rate of 10,000 tons per day. Because 1,3-butadiene is produced as a coproduct of the production of ethylene, it was no longer necessary to maintain the energy-intensive Houdry Process. Since 1976, the plant has produced 1,3-butadiene by the ethylene coproduct process.

In 1980, the ARCO Chemical Company purchased Halcon International's 50 percent share in Oxirane Chemical Company. The Oxirane Channelview Plant was merged with the Lyondell Plant to form the Lyondell Chemical Complex, adding propylene oxide, styrene monomer, and ethyl benzene to the product line. In 1982, a methanol unit with a design capacity of 200 million gallons per year went on line.

The Lyondell Chemical Complex is located on approximately 3,600 acres on Sheldon Road between Interstate 10 and Highway 90, near Channelview, Texas.

The 1,3-butadiene production area is divided into two areas: the original recovery unit (300 area) and the new recovery unit (1200 area). The original recovery area (300 area) was built in 1956 for TB&C. This unit was designed to recover 62,000 tons per year of 1,3-butadiene from the Houdry unit feed. Furfural was initially used as the extraction solvent in this process. Computerized instrumentation in this area was upgraded in 1981 for computer control of the process.

The new recovery unit (1200 area) was built in two phases to correspond with the development of the two olefin units. The process in the new recovery unit is identical to that in the original recovery unit.

The east tank farm was built in 1956. There are 18 spheres, 16 tanks, and 56 pumps in this area for storing and transferring a variety of products and feedstocks such as propylene, butylene, 1,3-butadiene, alkylate, normal butane, and isobutane.

The east terminal loading rack was also built in 1956. The 1,3-butadiene product is shipped by rail, truck, and pipeline. The company has a 15-mile pipeline that goes to Hess Terminal located 9.2 miles from the plant. At the terminal, there are facilities for storage and loading of 1,3-butadiene onto barges and marine vessels. The pipeline continues from Hess to a major user of 1,3-butadiene.

PROCESS DESCRIPTION

The crude ethylene coproduct C_4 feed to the process is obtained from 2 onsite olefin units (OP-1 and OP-2) and blended with C_4 streams from outside suppliers. The C_4 stream from the OP-1 olefins unit is fed to the 1,3-butadiene recovery unit in the 300 area, and the C_4 stream from the OP-2 olefins unit is fed to the recovery unit in the 1200 area. The C_4 streams from the OP-1 and OP-2 units are received via pipeline, whereas the C_4 streams from outside plants arrive by rail or truck.

The lighter fraction from the deoiler contains 1,3-butadiene and is recycled to the C_4 feed stream, whereas the heavier fraction is sent to the olefins alkylation unit.

Most of the 1,3-butadiene product stream is shipped via a pipeline to either a major consumer or to a loading terminal. Approximately 1 percent is converted to poly bd^R resins at the ARCO site.

The process includes a number of on-line gas chromatographs for quality control.

DESCRIPTION OF THE WORK FORCE

As of April 30, 1984, there were 871 ARCO employees and 360 contract employees at the Lyondell Chemical Complex. The employment at this plant has doubled in the last 10 years.

In the 1,3-butadiene production and storage area, there are 34 operators including supervisors. These operators work a rotating 12-hour day, 4 days on and 4 days off. There are 4 shifts with 8 employees per shift, with 2 additional workers on the day shift. The loading rack area for the tank cars is handled by contract employees. These employees work two 8-hour shifts per day with 3 workers/shift.

The job descriptions for the 1,3-butadiene production and loading activities are as follows:

A Operator	Works in control room. There are 2 operators involved.
B Operator	Works outdoors 12 hours/day decontaminating equipment which may

	require maintenance. Takes quality control "bomb" samples. There are 3 operators involved.
Shift Foreman	Responsible for process operation of four major areas of the plant. There is 1 shift foreman.
Loader	Responsible for the transport of 1,3-butadiene by rail, truck and pipeline at the tank farm. Tank car loading is handled by contract employees who works one 8-hour shift 5 days per week. There are 2 operators involved.

The average age of employees at the plant is 34.6 years, with the average employment time being 12 years. The employees are not represented by a union.

DESCRIPTION OF PAST POTENTIAL WORKER EXPOSURE

During the 27 years of 1,3-butadiene production at Lyondell Chemical Complex, the process changed from the Houdry Process (1957-1978) to the ethylene coproduct process (1976 to present). These changes occurred as the result of the increased cost of energy required for the Houdry Process.

Industrial hygiene data on 1,3-butadiene has only been collected in 1983. Table 1 presents the personal air monitoring data collected by ARCO Chemical Company for job activities thought to involve 1,3-butadiene exposure. The nature of the company's data reporting scheme does not allow for a direct linkage to be made between job--as stated in Table 1--and previously discussed 1,3-butadiene production jobs. The unweighted mean exposure to 1,3-butadiene for all job activities was 5.7 ppm. The samples were taken using 3M gas badges and analyzed using NIOSH Method No. S91.

To facilitate the understanding of the 1,3-butadiene data discussed in Table 1, the abbreviations used in the table are discussed below:

E/Ld Rk	Loader. Loads tank cars in the east loading rack.
L/Helper	Laboratory Helper. Cleans sample bombs in the laboratory. The bombs are cleaned by steaming and purging the resulting stream to a flare header.
OP-2	Olefins 2 unit.
H/Fract	Hot Fractionator.

Poly bd^{R} Reactors	Batch reaction systems. The chemical stream is heated to high temperature and pressure and pumped through filters as thick molasses type product.
Flt/Chg	Filter Changer. In 1983, the filters were manually removed and popcorn polymer dumped, resulting in high exposures to the operator. Currently, the polymer is floated up with water through a sleeve and exposure potential is reported to be reduced because filters do not have to be removed.
Whseman	Warehouseman. Responsible for storing and shipping of Poly bd^{R}.
1200	New recovery area.
E/TK Fm	East tank farm.

Prior to 1978, benzene samples were taken in the 1,3-butadiene production area because it was generated in the Houdry process.

Basic raw materials used at the Lyondell Chemical Complex include naphtha, gas, oil, diesels, natural gas, ethane, propane, butane, isobutane, butylenes, methanol, oxygen, crude acetone, styrene, maleic anhydride, and ethylbenzene for the production of the following compounds:

Ethylene	Alkylates
Propylene	Isopropyl alcohol
1,3-Butadiene	Methyl tertiary butyl ether (MTBE)
Toluene	Methyl ethyl ketone
Propylene oxide	Styrene maleic anhydride resins
Styrene monomer	Hydrogen
Ethylbenzene	Gasolines
Gaseous and liquid fuels	Isoprene
Methyl alcohol	

The employees in the 1,3-butadiene production area are, however, potentially exposed only to 1,3-butadiene and the extraction solvent.

Maintenance is a major activity in the 1,3-butadiene recovery area. Towers are taken out of service for cleaning every two years. Reboiler fouling occurs regularly and reboiler bundle maintenance occurs in the recovery areas every 3 or 4 days. For reboiler cleaning, valves are blocked off and the reboiler replaced by a spare. The tube bundles are hydroblasted and sandblasted. To clean the towers, the piping is disconnected and steam-cleaned. The residual polymer inside the tower is removed using in-place oxidation.

Manual "bomb" samples for quality control purposes are taken of the feed, intermediates, and product to ensure product quality. There is potential for worker exposure during these sampling and analytical activities.

Engineering Controls

Single mechanical seals are used on the majority of the hydrocarbon pumps to protect against leakage of 1,3-butadiene and other chemicals transferred. The more effective tandem seals are used on pumps handling the extraction solvent. Pump seals usually last 1 to 2 years.

DESCRIPTION OF THE MEDICAL, SAFETY AND INDUSTRIAL HYGIENE PROGRAMS

Medical Program

The company conducts pre-employment physicals on all its employees. Periodic physicals are voluntary and age-dependent. There is a surveillance program in effect which requires certain job categories to participate in an annual physical.

ARCO Chemical Company has a full-time Corporate Medical Director at the Lyondell Chemical Complex. The plant also employs two full-time registered nurses on the first shift. The remaining shifts have employees trained in first aid and emergency medical training. Emergency medical care is available at a nearby hospital.

All medical data is being computerized at Corporate headquarters.

Safety Program

The company has an organized safety program. The plant has a safety committee with employee representation. There are monthly safety meetings in all the departments. The plant has a safety manager who coordinates all these activities. The safety manager also supervises the safety inspectors. The safety inspectors are responsible for issuing permits, monitoring housekeeping, and conducting the safety training.

The only personal protective equipment required by the company are safety glasses and hard hats. Showers and clothing change areas are available but reported not to be in frequent use. All workers provide their own work clothes which are commonly worn home. Smoking is not permitted in the production area because of the explosion hazard of 1,3-butadiene.

Industrial Hygiene Program

The plant has an industrial hygienist on location. ARCO Chemical Company has corporate guidelines for all procedures involving hazardous chemicals. At the corporate level, a computerized system called Assess Control Exposure (ACE) is being developed. The system will include a chemical agent

inventory, exposure task evaluation (job description, exposure profile, safety equipment), and exposure montioring data.

Annual industrial hygiene audits of each plant site are conducted by divisional Corporate industrial hygienists.

DESCRIPTION OF PERSONNEL RECORD SYSTEM

The ARCO Chemical Company has had two previous owners and when the company was purchased, records were transferred to the new owner.

The company has personnel records on all former and current employees that date back to 1957. However, every five years, the records are purged and sent to Record Archives, Incorporated, in Houston, Texas for storage. Any employee record can be retrieved within 48 hours.

With the establishment of the Training Record System, work histories for all employees are current since 1974. Prior to 1974, weekly shift schedules (which are available) represent the only mechanism for developing a complete work history of an employee. The shift schedules are reported to be very accurate. For those workers who die of cancer, the shift schedules are used by the company to develop a work history. A basic life insurance policy is provided to all Atlantic Richfield employees. Survivors must file for benefits with a certified death certificate.

A computerized personnel record system is currently being maintained on all current employees. The records are maintained at corporate headquarters in Los Angeles. The records contain the following information for each employee:

1. Name
2. Social Security Number
3. Date of employment
4. Address
5. Emergency contact
6. Education
7. Sex
8. Race
9. Citizenship and Country
10. Work History - department and job title

The company did not know how many people they have records on over the last 27 years. However, the computerized system is effective and current for the 871 ARCO employees.

CONCLUSIONS

ARCO Chemical Company manufactures 1,3-butadiene by the ethylene coproduct process. The production occurs in a closed system, tightly maintained for economic and fire hazard reasons.

Due to the high TLV, no sampling was done for 1,3-butadiene prior to 1983. In 1983, exposure monitoring was conducted for different job categories; the data show the unweighted mean of the exposures to 1,3-butadiene was 5.7 ppm.

The areas of concern for worker exposure are quality control sampling and laboratory analysis. The production process has on-line gas chromatographs; however, sample "bombs" are taken throughout the process for quality assurance. The samples are collected using an open-loop system and there is potential for worker exposure to 1,3-butadiene when releasing some of the pressure from the bombs to the atmosphere. Equipment decontamination activities could also result in high exposures to the operators.

RECOMMENDATIONS

Since quality control sampling procedures appear to generate the potential for significant exposure to 1,3-butadiene, consideration should be given to installation of a sampling system that would reduce the potential for exposure from this source.

REFERENCES

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TABLE 1.
SUMMARY OF ARCO'S MONITORING RESULTS FOR
1,3-BUTADIENE AT THE LYONDELL PLANT, 1983

UNIT	JOB	TASK	DATE	1,3-BUTADIENE CONCENTRATION PPM	DURATION MINUTES
E/Ld Rk	Loader	TC Ld	10/07/83	7.46	226
E/Ld Rk	Loader	TC Ld	10/10/83	19.20	257
E/Ld Rk	Loader	TC Ld	10/11/83	3.37	137
E/Ld Rk	Loader	TC Ld	10/14/83	4.75	200
Lab	L/Helper	All	10/06/83	0.26	714
Lab	L/Helper	All	10/06/83	0.31	720
Lab	L/Helper	All	10/07/83	2.46	715
Lab	L/Helper	All	10/07/83	1.07	700
Lab	L/Helper	All	10/10/83	0.42	700
Lab	L/Helper	All	10/10/83	0.23	723
Lab	L/Helper	All	10/11/83	1.21	705
Lab	L/Helper	All	10/11/83	0.40	715
OP-2	H/Frac	All	09/26/83	0.42	685
OP-2	H/Frac	All	09/27/83	0.43	717
OP-2	H/Frac	All	09/29/83	0.42	695
OP-2	H/Frac	All	09/29/83	0.42	695
OP-2	H/Frac	All	09/30/83	0.41	715
OP-2	H/Frac	All	09/03/83	9.24	685
OP-2	H/Frac	All	09/04/83	0.41	725
OP-2	H/Frac	All	09/05/83	4.96	665
Poly bd	Reactors	All	09/26/83	9.79	688
Poly bd	Reactors	All	09/26/83	3.64	677
Poly bd	Reactors	All	09/27/83	3.19	716
Poly bd	Reactors	Flt/Chg	09/27/83	59.00	005
Poly bd	Reactors	Flt/Chg	09/27/83	18.27	005
Poly bd	Recovery	All	09/27/83	5.33	716
Poly bd	Reactors	All	09/28/83	4.97	659
Poly bd	Recovery	All	09/28/83	1.82	679
Poly bd	Reactors	All	09/29/83	10.03	685
Poly bd	Recovery	All	09/29/83	2.32	695
Poly bd	Reactors	All	09/30/83	2.44	685
Poly bd	Reactors	Flt/Chg	09/30/83	28.70	004
Poly bd	Recovery	All	09/30/83	4.63	685
Poly bd	Reactors	Flt/Chg	09/30/83	22.96	005
Poly bd	Reactors	All	10/03/83	4.00	680
Poly bd	Recovery	All	10/03/83	6.58	686
Poly bd	Reactors	All	10/04/83	15.51	719
Poly bd	Recovery	All	10/04/83	12.67	725
Poly bd	Reactors	All	10/05/83	6.60	701
Poly bd	Recovery	All	10/05/83	3.36	701
Poly bd	Wbseman	All	10/07/83	0.57	495
Poly bd	Wbseman	All	10/10/83	0.66	434
Poly bd	Wbseman	All	10/11/83	0.64	460
Poly bd	Wbseman	All	10/14/83	0.62	455

TABLE 1. (Cont.)
SUMMARY OF ARCO'S MONITORING RESULTS FOR
1,3-BUTADIENE AT THE LYONDELL PLANT, 1983

UNIT	JOB	TASK	DATE	1,3-BUTADIENE CONCENTRATION PPM	DURATION MINUTES
Recovery	1200	All	09/29/83	2.48	680
Recovery	1200	All	10/03/83	6.55	671
Recovery	1200	All	10/04/83	3.90	717
Recovery	1200	All	10/05/83	0.61	704
Recovery	1200	All	10/06/83	5.77	710
Recovery	1200	All	10/07/83	0.39	710
Recovery	1200	All	10/10/83	4.25	695
Recovery	E/Tk Fm	All	10/12/83	1.30	690
Recovery	E/Tk Fm	All	10/14/83	2.36	650
Recovery	E/Tk Fm	All	10/18/83	5.63	676
Recovery	E/Tk Fm	All	10/20/83	1.86	655

Codes:

E/Ld Rk = East Loading Rack
TC Ld = Tank Car Loading
Poly bd = Poly bd^{R} resin
Flt/Chg = Filter Change
H/Frac = Hot Fractionator
L/Helper = Lab Helper (Entire job consists of cleaning sample bombs in laboratory)
All = All tasks associated with job unless otherwise specified