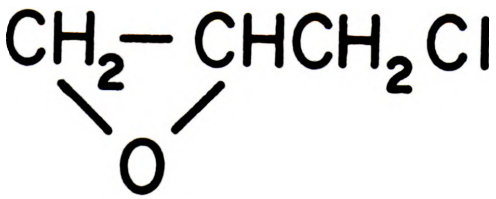
NIOSH

# Current Intelligence Bulletin 30

OCTOBER 12, 1978

# EPICHLOROHYDRIN



*U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE*
*Public Health Service*
*Center for Disease Control*
*National Institute for Occupational Safety and Health*

The NIOSH Current Intelligence Bulletin is the primary product of the Current Intelligence System. The purpose of the Current Intelligence System is to promptly review, evaluate, and supplement new information received by NIOSH on occupational hazards that are either unrecognized or are greater than generally known.

As warranted by this evaluation, the information is capsulized and disseminated to NIOSH staff, other government agencies, and the occupational health community, including labor, industry, academia, and public interest groups. With respect to currently known hazard information this system also serves to advise appropriate members of the above groups of recently acquired specific knowledge which may have an impact on their programs or perception of the hazard. Above all, the Current Intelligence System is designed to protect the health of American workers and to allow them to work in the safest possible environment.

IDENTIFIERS AND SYNONYMS FOR EPICHLOROHYDRIN ARE LISTED

IN THE REAR PORTION OF THIS BULLETIN



**DHEW (NIOSH) Publication No. 79-105**

# CURRENT INTELLIGENCE BULLETIN

# EPICHLOROHYDRIN

October 12, 1978

*The National Institute for Occupational Safety and Health (NIOSH) recommends that as a prudent measure, epichlorohydrin be handled in the workplace as if it were a human carcinogen. This recommendation is based primarily on two recent studies: a long term epidemiologic study showing a significant increase in respiratory cancer deaths of exposed workers, and an inhalation study showing an increase in nasal carcinomas in rats. In addition, cytogenic studies of human peripheral lymphocytes have shown a highly significant increase in chromosome abnormalities in exposed workers. Pending further evaluation of its carcinogenic potential, NIOSH believes it would be prudent to minimize occupational exposure to epichlorohydrin.*

*NIOSH has prepared this Bulletin to advise you of these recent studies, their implications for occupational health, and precautions for handling products containing epichlorohydrin. We request that producers, distributors, and users transmit this information to their customers and employees, and that professional associations and unions inform their members.*

## EXPOSURE STANDARDS

The current Department of Labor, Occupational Safety and Health Administration (OSHA) standard for occupational exposure to epichlorohydrin is 5 ppm (19 mg/cu m) as an 8-hour time-weighted average (1). Studies of carcinogenicity were not available when this standard was developed.

In September 1976, NIOSH recommended an occupational exposure limit of 2 mg/cu m of air (approximately 0.5 ppm) determined as a time-weighted average (TWA) concentration for up to a 10 hour work day in a 40 hour work week, and a ceiling concentration standard of 19 mg/cu m (approximately 5 ppm) as determined by a sampling time of 15 minutes (2). After a comprehensive review of the literature, NIOSH concluded that risks from exposure to epichlorohydrin may include carcinogenesis, mutagenesis and sterility, as well as damage to the kidneys, liver, respiratory tract, and skin. Since most of the available evidence on adverse effects of epichlorohydrin was obtained from animal experiments which were inadequate to determine scientifically acceptable exposure limits, the 1976 NIOSH recommendation was based on professional judgement which quantitatively considered the cumulative toxic effects.

## PRODUCTION, USES, AND OCCUPATIONAL EXPOSURES

Epichlorohydrin is a liquid at room temperatures. In 1978, domestic annual production capacity was 470 million pounds. An important constituent of epoxy resin is synthesized by alkylating bisphenol A with epichlorohydrin (2). Epichlorohydrin is used in the manufacture of epoxy resins, surface active agents, pharmaceuticals, insecticides, agricultural chemicals, textile chemicals, coatings, adhesives, ion-exchange resins, solvents, plasticizers, glycidyl esters, ethynylethylenic alcohol and fatty acid derivatives.

According to the NIOSH National Occupational Hazard Survey (NOHS) (3), an estimated 85,000 workers are potentially exposed to epichlorohydrin in the workplace. Table 1 lists occupations and industries in which a potential exists for exposure to epichlorohydrin. The NOHS survey data were collected during 1972 to 1974 from a sample of approximately 5,000 businesses employing nearly 900,000 workers. 1970 Census figures were used in extrapolating the sample data to the working population employed in industries covered by the Occupational Safety and Health Act of 1970. The potential exposure estimates include data on actual observations of the use of the specific chemical or the use of a trade name product known to contain the chemical as well as additional observations of generic formulations (trade name products suspected of containing the chemical).

Table 1. Some Occupations and Industries Which Use Epichlorohydrin

| | |
|---|---|
| Occupations[a] | assemblers; miscellaneous specified machine operatives; aircraft machinists; construction and maintanance painters; miscellaneous operatives; chemists; mining operatives; painters of manufactured articles; sheetmetal workers and tinsmiths; pattern and model makers, except paper |
| Industries[b] | chemicals and allied products; transportation equipment; instruments and related products; transportation by air; electrical equipment and supplies; special trade contractors; miscellaneous repair services; rubber and plastics not elsewhere classified; machinery, except electrical; stone, clay, and glass products |

(a) Standard occupational titles from the Bureau of the Census (4)
(b) Standard industrial titles from the Standard Industrial Classification Manual (5).

## HUMAN CARCINOGENICITY

A statistically significant ($p < .05$) increase in deaths due to respiratory cancer has been observed in a long-term epidemiologic study conducted on workers exposed to epichlorohydrin at two facilities of the Shell Chemical Company (6). The data were analyzed by Dr. Philip Enterline of the University of Pittsburgh (7, 8). There were

864 workers identified as having been occupationally exposed to epichlorohydrin for 6 months or more, before January 1, 1966. Ninety-eight percent of the workers were traced as of December 31, 1976. For men estimated to have had moderate to heavy exposure who were followed for 15 years or more, observed deaths were also greater than those expected for the categories of all cancers, leukemia, and suicide, although those differences were not statistically significant. Information was not available for most workers on smoking history, or the extent of exposure to other chemicals (9). NIOSH feels that the study results are suggestive of a carcinogenic effect of epichlorohydrin on humans, and deserve attention.

The Dow Chemical Company has informed NIOSH that it is currently conducting a mortality study of workers engaged in the manufacture and conversion of epichlorohydrin (10). Dow estimates that the results will be made available November, 1978.

## ANIMAL CARCINOGENICITY

In ongoing inhalation studies, rats exposed to epichlorohydrin have shown a statistically significant increase in nasal cancer ($p < .05$) (11). In experiments initiated under Dr. Sidney Laskin and continued under Dr. Norton Nelson at the New York University Institute of Environmental Medicine, 140 rats have been exposed to 100 ppm epichlorohydrin for 6 hours/day, 5 days/week, for 30 days, with subsequent lifetime observation. Fifteen of the animals have died with pathologically confirmed squamous cell nasal cancinoma (11). Another animal developed a nasal papilloma. No spontaneous nasal cancer was seen in a group of 50 controls. Of another group of 100 animals exposed to 30 ppm of epichlorohydrin for 6 hours/day, 5 days/week, in a chronic lifetime study one animal has developed a papilloma of the larynx, another has developed a nasal squamous cell carcinoma (12). In contrast, no spontaneous nasal carcinomas were seen in the 50 animal control group.

Further information on previous studies that investigated the other evidence relating to carcinogenicity of epichlorohydrin can be found in the NIOSH epichlorohydrin criteria document (2, 13).

## HUMAN MUTAGENICITY

Epichlorohydrin has been shown to induce a significant increase in chromosomal aberrations found in the white blood cells of workers occupationally exposed to epichlorohydrin. In 1977, Kucerova et al. (14) conducted a prospective cytogenetic study of 35 workers occupationally exposed to epichlorohydrin. Each worker served as his own control. After exposure for one year, these workers showed a significant increase in chromosomal aberrations. After two years of exposure to epichlorohydrin, the increase in chromosomal aberrations was significant at the $p < .0001$ level.

In 1976, Sram et al. (15) found chromosome abnormalities in human peripheral lymphocytes exposed in vitro to epichlorohydrin. They concluded that a genetic risk for man exists following exposure to epichlorohydrin. A quantitative risk was not estimated.

## OTHER TOXIC EFFECTS

Epichlorohydrin is a highly toxic substance which is easily absorbed through the skin. Skin contact with epichlorohydrin can cause severe chemical burns, although the effects may not appear until sometime after exposure. The latent period can range from several minutes to several days, depending on the duration and intensity of exposure. Allergic response has been noted (16). Exposure to epichlorohydrin vapor induces transient burning of the eyes and nasal passages at concentrations as low as 20 ppm. Exposure to high concentrations (100 ppm) leads to pulmonary edema (fluid accumulation in the lung) and kidney problems in laboratory animals. A comprehensive discussion of the toxic effects is found in the NIOSH epichlorohydrin criteria document (2). Table 2 summarizes the reported toxic effects in humans at varying exposure levels.

Table 2. Other Toxic Effects of Epichlorohydrin on Humans (2).

| Route of Exposure | Effect |
|---|---|
| dermal | burning sensation, redness, swelling, red papules, itching, blisters, skin erosion, enlarged lymph nodes |
| inhalation | burning of the eyes, nose and throat; cough; chest congestion; running nose; eye tenderness; headache followed by nausea; vomiting; facial swelling; dyspnea |

Exposure to epichlorohydrin has been shown to induce sterility in rats (2), and a fertility study has been conducted in male workers exposed to epichlorohydrin (17). While the study concluded that exposure to epichlorohydrin did not decrease sperm counts or affect hormonal activity in the workers, the data were not analyzed statistically.

## NIOSH RECOMMENDATIONS

**In light of the statistically significant increase in respiratory cancer seen in workers exposed to epichlorohydrin, and the statistically significant increase in nasal carcinomas seen in rat inhalation studies, as well as the chromosomal aberrations seen in the peripheral lymphocytes of exposed workers, NIOSH recommends that epichlorohydrin be treated in the workplace as if it were a human carcinogen. Pending further evaluation of its carcinogenic potential, NIOSH believes it would be prudent to minimize occupational exposure to epichlorohydrin. Exposures should be limited to as few employees as possible while workplace exposure should be minimized with engineering and work practice controls. In particular, skin exposure should be avoided.**

J. Michael Lane, M.D.
Acting Director

## REFERENCES


1. U.S. Department of Labor, Occupational Safety and Health Administration: Occupational Safety and Health General Industry Standards. Publication 2206, 29 CFR 1910.1000, Washington, D.C. (1976)

2. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. Criteria for a Recommended Standard....Occupational Exposure to Epichlorohydrin. Washington, D.C. (1976).

3. NIOSH National Occupational Hazard Survey (NOHS): Personal communication to the NIOSH Technical Evaluation and Review Branch, Office of Extramural Coordination and Special Projects (1978).

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7. Enterline, P.: Updated Mortality in Workers Exposed to Epichlorohydrin, unpublished report to the Shell Oil Company, July 31, 1978.

8. Enterline, P.: Mortality in Workers Exposed to Epichlorohydrin, unpublished report to the Shell Oil Company, August 31, 1977.

9. Joyner, R.E.: Letter from R.E. Joyner, M.D., Corporate Medical Director, Shell Oil Company to J. Michael Lane, M.D., Acting Director, NIOSH, August 7, 1978.

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11. New York University Institute of Environmental Medicine: Personal communication to the NIOSH Technical Evaluation and Review Branch, Office of Extramural Coordination and Special Projects, (1978).

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16. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health: Occupational Diseases: A Guide to Their Recognition. Washington, D.C. (1977).

17. Whorton, D., T.H. Milby, and R.L. Davis: Testicular Function Among ECH Workers at Shell Deer Park and Norco Facilities. Unpublished report to the Shell Oil Company from Environmental Health Associates, August 22, 1978.

## SUGGESTED GUIDELINES FOR MONITORING AND CONTROLLING EMPLOYEE EXPOSURE TO EPICHLOROHYDRIN

NIOSH recommends that it would be prudent to handle epichlorohydrin in the workplace as if it were a human carcinogen. Exposure to epichlorohydrin should be limited to as few employees as possible, and workplace exposure levels should be minimized. The area in which it is used should be restricted to only those employees essential to the process or operation and these employees should be adequately protected.

### EXPOSURE MONITORING

A detailed sampling, and analytical method for epichlorohydrin exposure measurements is described in the NIOSH Manual of Analytical Methods, Second Edition (1) as NIOSH method #S118 in Volume 2.

Initial and routine employee exposure surveys should be made by competent industrial hygiene and engineering personnel. These surveys are necessary to determine the extent of employee exposure and to ensure that controls are effective.

The NIOSH Occupational Exposure Sampling Strategy Manual (2), may be helpful in developing efficient programs to monitor employee exposures to epichlorohydrin. The manual discusses determination of the need for exposure measurements, selection of appropriate employees for exposure evaluation and selection of sampling times.

Employee exposure measurements should primarily consist of 8-hour TWA (time-weighted average) exposure estimates calculated from personal or breathing zone samples (air that would most nearly represent that inhaled by the employees). In addition, short term samples should be taken during periods of maximum expected exposure by using all available knowledge regarding the area, employee work procedures, and process. Area and source measurements may be useful to determine problem areas, processes, and operations.

### CONTROLLING EMPLOYEE EXPOSURE

There are four basic methods of limiting employee exposure to epichlorohydrin. None of these is a simple industrial hygiene or management decision and careful planning and thought should be used prior to implementation.

o Product Substitution

The substitution of an alternative material with a lower potential health risk is one method. However, extreme care must be used when selecting possible substitutes. Alternatives to epichlorohydrin should be fully evaluated with regard to possible human effects. Unless the toxic effects of the alternative have been thoroughly evaluated a seemingly safe replacement, possibly only after years of use, may be found to induce serious health effects.

o Contaminant Controls

The most effective control of epichlorohydrin where feasible, is at the source of contamination by enclosure of the operation and/or local exhaust ventilation. Guidelines for selected processes and operations can be found in the NIOSH Recommended Industrial Ventilation Guidelines (3).

If feasible, the process or operation should be enclosed with a slight vacuum so that any leakage will result in the flow of external air into the enclosure.

The next most effective means of control would be a well designed local exhaust ventilation system that physically encloses the process as much as possible, with sufficient capture velocity to keep the contaminant from entering the work atmosphere.

To ensure that ventilation equipment is working properly, effectiveness (e.g., air velocity, static pressure, or air volume) should be checked at least every three months. System effectiveness should be checked soon after any change in production, process, or control which might result in significant increases in airborne exposure to epichlorohydrin.

o Employee Isolation

A third alternative is the isolation of employees. It frequently involves the use of automated equipment operated by personnel observing from a closed control booth or room. The control room is maintained at a greater air pressure than that surrounding the process equipment so that air flow is out of, rather than into, the room. This type of control will not protect those employees that must do process checks, adjustments, maintenance, and related operations.

o Personal Protective Equipment

The least preferred method is the use of personal protective equipment. This equipment, which may include respirators, goggles, gloves, etc., should not be used as the only means to prevent or minimize exposure during routine operations.

Exposure to epichlorohydrin should not be controlled with the use of respirators except:

-- During the time period necessary to install or implement engineering or work practice controls; or

-- In work situations in which engineering and work practice controls are technically not feasible; or

-- For maintenance; or

-- For operations which require entry into tanks or closed vessels; or

-- In emergencies.

Only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of Federal regulations 30 CFR 11 should be used. Refer to Cumulative Supplement June 1977, NIOSH Certified Equipment (4) for a listing of NIOSH-approved respirators. Note that the use of faceseal coverlets or socks with respirators voids NIOSH approvals.

Quantitative faceseal fit test equipment (such as sodium chloride, dioctyl phthalate, or equivalent) should be used. Refer to NIOSH's A Guide to Industrial Respiratory Protection (5) for guidelines on appropriate respiratory protection programs.

In addition, proper maintenance procedures, good housekeeping in the work area, and employee education are all vital aspects of a good control program. Employees should be informed as to the nature of the hazard, its control, and appropriate personal hygiene procedures.

## REFERENCES FOR SUGGESTED GUIDELINES


1) NIOSH Manual of Analytical Methods, 2nd Edition, Vol. 1: GPO #017-033-00267-3, $8.75: Vol. 2: GPO #017-033-00260-6, $9.75: Vol. 3: GPO #017-033-0247-9, $9.00.

2) NIOSH Occupational Exposure Sampling Strategy Manual, GPO #017-033-00247-9, $2.75.

3) NIOSH Recommended Industrial Ventilation Guidelines, GPO #017-033-00136-7, $3.90.

4) NIOSH Cumulative Supplement June 1977, NIOSH Certified Equipment, NIOSH # 77-195, no charge.

5) A Guide to Industrial Respiratory Protection, GPO #017-033-00153-7, $2.30.

GPO publications must be ordered from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Reference #4 can be ordered from:

Publications Dissemination, DTS
NIOSH
4676 Columbia Parkway
Cincinnati, Ohio 45226

## IDENTIFIERS AND SYNONYMS FOR EPICHLOROHYDRIN

Chemical Abstracts Service Registry Number: 106-89-8
NIOSH RTECS Number: TX4900000
Chemical Formula: $C_3H_5OCl$

1-Chloro-2,3-epoxypropane
3-Chloro-1,2-epoxypropane
3-Chloro-1,2-propylene oxide
(Chloromethyl)ethylene oxide
(Chloromethyl)oxirane
2-Chloromethyl oxyrane
3-Chloropropene-1,2-oxide
Chloropropylene oxide
γ-Chloropropylene oxide
ECH
ECHH
Epichlorohydrin
α-Epichlorohydrin
1,2-Epoxy-3-chloropropane
2,3-Epoxypropyl chloride
Glycerol epichlorohydrin
Glycidyl chloride
Oxirane, (chloromethyl)-
Oxirane, 2-(Chloromethyl)-
Propane, 1-chloro-2,3-epoxy-
SKEKhG