U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-10-258

WESTERN ELECTRIC COMPANY
READING, PENNSYLVANIA

JANUARY 1976

I. TOXICITY DETERMINATION

It has been determined that although airborne concentrations of epoxy resin dust were not excessive in the work atmosphere, there is evidence that there is a problem with dermatitis in a few individuals which is probably job related. The main causative epoxy resin is a black or grey resin purchased in briquette form from various sources under different trade names.

These determinations are based upon environmental measurements, medical interviews with employees, and a limited examination of the skin of some of the workers.

The request was initially submitted for informational purposes to determine if one of the compounds contained asbestos. Information received from Western Electric disclosed that no asbestos was present. However, minute amounts of the fibrous glass were incorporated in one of the resins. Concentrations of air contaminants were not excessive.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Western Electric Company, Reading, Pennsylvania
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region III
d) NIOSH - Region III

For the purpose of informing the approximately 25 "affected employees", the employer shall promptly "post" the Determination Report in a prominent place(s) near where exposed employees work for a period of 30 calendar days.

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 received such a request from an authorized representative of employees regarding exposure to inhalation of dust during injection molding of epoxy resins.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

There are three injection molding rooms designated as 100A, IC and LED located in building 30. All the molding operations utilize similar production methods using different epoxy resins. Epoxy resin dust and dermatitis were of concern in the 100A molding room while fibrous glass was an air contaminant in the IC room.

Most epoxy resins used are made from bisphenol A and epichlorohydrin in varying proportions depending on the properties in the finished product.

Approximately thirteen epoxy or silicone resins having specific dielectric properties are purchased from different manufacturers. These resins may be in either powder, briquette or precast slug form. Electronic components (leads) are inserted in a rack and set in the molding machine. The molding machine is charged with the epoxy resin, utilizing a scoop or tongs. Certain epoxy resins must be preheated prior to charging. The mold is electrically heated to 160-170°C for a preset cycle and the mold is removed. Following removal, the components are dumped in a bin for transfer to another area for deflashing and inspection. Once or twice a day, the molds are cleaned with a formaldehyde urea resin. Exposure to these contaminants would be minimal.

In the Light Emission Diode Room (LED), the molding compound is clear and imparts the desired color to the emitted light. In the Integrated Circuit IC Mold Room, insulation and strength are the only desired properties. In the 100A room power diodes are molded to give strength, insulation, and color coding by value of the diode. The LED and 100A rooms use epoxy resins. The I.C. Room uses a silicone resin.

In the 100A molding room the molders are rotated weekly, so that a given man will usually be operating the same machine one week out of three. The component being molded by each machine is constant.

Ceiling exhaust and make-up air is provided in the 100A molding room with no local exhaust ventilation. In the LED and I.C. rooms each machine is enclosed and equipped with back-draft ventilation.

Personnel in these rooms are supplied cotton gloves, protective creams, and hand soap (company's own formulation).

The plant has an active medical program under the direction of a full time physician. All employees receive a pre-placement physical examination. Those in hazardous jobs, which include working with epoxy resins, get periodic examinations. Also workers in hazardous jobs receive an exit examination.

Workers can be seen at the health unit for both job related and non-job related medical problems. Job related problems are handled by the health unit as far as possible, with referral to outside specialists as necessary. For non-job related illness, the workers are referred to their private doctor except for minor complaints which can be readily handled in the health unit and thus allow the worker to stay on the job. If an employee is out sick more than two days, he must be seen at the health unit before returning to the job. The health unit contacts employees on sick leave weekly.

The health unit personnel visit the production areas to assess job requirements. There is a mechanism of temporary and permanent restrictions to prevent an employee from assuming assignments which require exposures or other working conditions which are detrimental to his health. For example, several of the workers had permanent restrictions from wearing rubber gloves as this caused their hands to break out. Thus, they would be excluded from any assignment where the wearing of rubber gloves was mandatory.

B. Study Progress

On February 19, 1974, an initial visit at the site was conducted by Walter Chrostek, industrial hygienist. A walk-through survey and non-directed medical questionnaires were completed.

An environmental-medical investigation was conducted on January 29, 1975, by Walter Chrostek, industrial hygienist and Dr. Theodore Thoburn, NIOSH medical officer.

C. Evaluation Methods

a. Environmental

Employee exposures to epoxy resin dust and decomposition products were evaluated using preweighed membrane filters and personal air samplers. In molding room 100A where there was no local exhaust ventilation on the machines, general air samples for epichlorohydrin were collected in the 100A molding room utilizing charcoal tubes and low flow air samplers.

The samples for total dust and decomposition products were analyzed by the gravimetric method, the charcoal tubes for epichlorohydrin were analyzed by gas chromatography.

b. Medical

The initial medical visit consisted of a walk-through survey of the areas specified on the hazard evaluation request, individual interviews with some of the workers, on-the-line interviews with other workers, and a review of the plant's medical records of workers from the areas in question. A limited examination of the skin was performed on some of the workers who had individual interviews.

For the individual interviews, the following identifying data was obtained, a brief occupational history, and answers to two questions, "Do you have any health problems at work or you feel might be related to your work?" and "Do you have any other health problems?" As many workers as possible, who did not wish to come to the health unit, were seen at their work station. This interview was to confirm that their reluctance was simply that they perceived no problem and therefore did not care to spend the time to see the doctor.

The work force studied is characterized in Table 4. In all, 41 workers were identified in this study. fifteen (15) were interviewed in private, 19 were interviewed at the work site, and 7 could not be interviewed. Medical records on all 41 were reviewed. They were about equal numbers of men and women.

D. Evaluation Criteria

a. Environmental

The Occupational Health Standard relevant to this evaluation as promulgated by the U.S. Department of Labor (Federal Register, Volume 39, June 27, 1974, page 23541)[1] is as follows:

Substance	8-Hour Time Weighted Average
Epichlorohydrin	5 ppm* or 19 mg/M^3**

The American Conference of Governmental Industrial Hygienists[2] standard relevant to this evaluation.

Inert dust	10 mg/m^3 **
Glass, fibrous or dust	10 mg/m^3

*ppm - denotes parts of vapor or gas per million parts of contaminated air by volume.

**mg/m^3 - denotes approximate milligrams of substance per cubic meter of air.

The American Industrial Hygiene Association in the Hygiene Guide Series[3] has no established recommended maximum concentration (8 hours) for the epoxies as a group, however, there may be standards for the individual curing agents, such as 10 ppm for ethylenediamine; 1 ppm for diethylene triamine; 25 ppm for diethylamine; etc.

b) Medical

The epoxy resins and their hardeners are both irritants and sensitizers. As all the formulations in use are solids at room temperature, these reactions would be expected to be less of a problem than might be the case with liquid preparations. The silicone resin should not cause problems except as might relate to its filler.

Exposure to epichlorhydrin results in irritation to the eye, respiratory tract and skin, and systemic toxicity from absorption of the liquid through the skin as well; painful irritation of subcutaneous tissues follows skin contact in man.

Although there have been no reported instances of serious injury to industrial workers during the production and handling of epichlorhydrin, cases of sensitization, with resulting intolerance to trivial exposures, have been observed. Several cases of skin burns have also been experienced from prolonged contact with the liquid.

Most cured resins have little or no toxic effects. If curing is incomplete, there may be residues of some of the above curing agents.[4]

As skin testing to compounds regularly in use in the work site carries some risk of sensitization to the compounds tested for, it was determined to rely on history rather than skin testing as the primary means of separating irritancy from allergy.

E. Evaluation Results and Discussion

a. Environmental

Eleven samples were collected at the rate of 1.5 liters per minute for total dust utilizing polyvinylchloride membranes and personal air sampling equipment. Seven samples were collected in the 100A molding room, three in the Light Emitting Diode room, and one in the Intergrated Circuit room. The dust samples were analyzed gravimetrically for total dust. Dust concentrations ranged from 0.1 to 1.0 mg/m^3. If this material was considered as a totally cured resin (inert dust), or fibrous glass dust, the atmospheric concentrations found would be well below the recommended standards.

Three air samples were collected, utilizing charcoal tubes and low flow, 1 liter per minute air sampling pumps. The average sampling time was 400 minutes. These samples were subsequently analyzed by gas chromatography for epichlorohydrin. All samples were below the lower limit of detection of .008 milligram per sample or approximately .02 mg/M^3.

No sampling was done for formaldehyde. The mold cleaning is usually done at the end of the shift and is of very short duration, and would be very difficult to evaluate. Formaldehyde irritates the eyes, respiratory tract and the skin.

Ventilation measurements were made utilizing an Alnor, Jr. velometer and air flow indicator tubes. Observation of the air flow patterns in the 100A molding room indicated that the ceiling ventilation was erratic or non-existant in certain areas. The molding machines in the Light Emitting Diode room are enclosed with back-draft ventilation. the ventilation rates on two machines were adequate (700-800 feet per minute) at the duct and (100 feet per minute) at the face of the hood. On machine No. 141, the ventilation rate at the duct was 150 feet per minute and less than 50 feet per minute at the face of the hood. On closer observation, it was noted that the duct was partially blocked with extraneous matter. Removal of this material increased the ventilation to the levels noted on the two other machines.

b. Medical

Review of a previous OSHA Log Summary showed the plant had five cases of occupationally related skin problems, one requiring some lost time.

Table III summarizes the results of questioning the workers. Responses referred to the past and also to the particular day of the interview. Two of the workers had physical findings, one suggesting an acute, current problem.

In general, complaints about the dust concerned nasal and sinus congestion, some dryness of eyes, nose and/or throat, and collection of colored dust in the nose. These were judged to be primarily nuisance complaints. In all, 10 out of the 44 workers had complaints about the dust.

The formaldehyde - urea mold cleaner used in both 100A and LED molding operations was reported as causing irritation in 2 workers (out of 35). According to medical records, this was due to sensitization in one of the workers who is no longer working in the area under study.

Of the 2 workers (out of 14) in the L.E.D. molding room who reported problems with the molding compound, one reported a history compatable with an allergic reaction which cleared on using gloves and tongs. The other developed sore fingers which cleared with treatment and the use of gloves. One is no longer working in the molding room.

Of the 3 workers (out of 21) in the 100A molding room, two were molders and the third a loader. All identified the same machine with skin problems relating to the molding compounds as being the problem - one using gray or black briquettes which required preheating. Both molders complained that this particular machine caused their problems to get worse, with improvement when they were away from the plant or while assigned to other machines for two out of the three weeks. The skin of their hands would become dry and develop a rash. The finger tips particularly were affected and became sore and a little raw. One of the workers showed a pink, dry rash on the fingers of his right hand at the time of the interview suggesting an acute, current problem. The usual practice is to move the preheated briquettes to the molding machine by hand, the only protection being white cotton gloves. One of the molders used two pairs of gloves per shift, the other one pair per shift. The loader with skin complaints worked primarily on this particular machine. She sometimes would get a dry pealing rash on the back of her right hand which would burn when she washed. This rash cleared when away from work. The right hand is the hand which would be the closest to the machine while she worked. She also complained of her scalp itching at work. At the time of the interview, the back of her right hand showed some increase in pigmentation and was slightly dryer than the back of her left hand.

c. General

The inspection tour showed the general housekeeping to be very good. The I.C. molding room was the dustiest of the three and was not in operation much of the time. The 100A molding room had some dust on

the tops of the machines. The L.E.D. molding room was almost dustless.

Conversations with the employees: (1) indicated that they were concerned regarding the possible presence of asbestos in the resin molded, (2) the amount of dust on the filters in the ventilation system, and (3) the episodes of dermatitis, when working with black or gray resins in the 100A molding room. As previously mentioned, fibrous glass may be present in the formulated resin, however, asbestos is not. The Epoxy Resin Formulators Division of the Society of Plastic Industry[5] recommends that forced draft ventilation at the point of work, where vapors are generated, is essential when handling and curing formulated epoxy compounds. The vapors should be drawn away from the operator and vented outside the building. Overhead ventilation at work areas should be avoided since it may pull vapors from the bench into the worker's face.

F. Conclusions

Epoxy molding compounds are potentially hazardous on skin contact, particularly if handled warm.

In Molding Room 100A there is evidence that there is dermatitis problem caused by handling preheated briquettes in spite of using cotton gloves for protection. Two workers gave a history of problems when working with the machine using these briquettes. One employee currently working at this machine also had physical finding of dermatitis. This same machine may have a ventilation problem as suggested by history and physical findings of irritation involving a loader.

There is history of skin problems when working with epoxy resins in the L.E.D. molding room but no evidence of current problems with this.

There is no evidence that the mold cleaning compound used once or twice a shift can cause irritation as shown by the history of problems in two workers when working with this compound.

There does not appear to be any current problem with toxicity in the I.C. molding room or the L.E.D. molding room.

V. RECOMMENDATIONS

A. Environmental

1. Establish a periodic maintenance program on all ventilation systems.

2. When purchasing new machinery or redesigning the existing units, back-draft ventilation should be installed.

B. Medical

The Medical Department at the plant has the capability to follow-up on the skin problems and should do so.

The Medical Department at Western Electric should arrange this through their local dermatologist as necessary.

IV. REFERENCES

1. Federal Register, Vol. 39, No. 125, Part II, Subpart G, June 27, 1974.
2. American Conference of Governmental Industrial Hygiene, "Threshold Limit Values for Chemical Substances in the Workroom Environment for 1975."
3. American Industrial Hygiene Association, Hygienic Guide Series, "Epoxy Resin Systems," 1974.
4. Dangerous Properties of Industrial Materials; Third Edition, N. Irving Sax.
5. Epoxy Resin formulators Division of the Society of Plastics Industry, Inc. "Recommended Procedures for Safe Use of Formulated Epoxy Compounds."

VII. AUTHORSHIP AND ACKNOWLEDGEMENT

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Table I
Total Particulate Air Concentrations
January 29, 1975

Sample No.	Location	Time (Min.)	Air Concentrations mg/m^3*	TWA	Remarks
100-A Room					
80280	LE-82-127	410	0.5	0.4	Operator's Exposure
80281	LE-82-133	375	0.6	0.5	Operator's Exposure
80282	LE-82-158	404	0.7	0.6	Operator's Exposure
80283	LE-82-159	356	0.4	0.3	Operator's Exposure
80284	LE-82-163	378	0.8	0.7	Operator's Exposure
80285	LE-82-90	430	0.1		General Air, Center of Room
80286	LE-82-139	378	1.0	0.8	Operator's Exposure
L.E.D. Room					
80287	LE-82-162	313	0.5	0.3	Operator's Exposure
80288	LE-82-141	315	0.3	0.2	Operator's Exposure
80290	LE-73-45	300	0.9	0.6	Operator's Exposure
IC Room					
80291		298	0.5	0.3	Operator's Exposure

* denotes milligrams of dust per cubic meter of air sampled

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Table II
Epichlorohydrin Air Concentrations
January 28, 1975

Sample No.	Machine	Time (Min.)	Concentration mg	Remarks
100-A Room				
750	82-159	395	N.D.*	Operator's Exposure
751	82-158	425	N.D.	Operator's Exposure
L.E.D. Room				
752	82-141	357	N.D.	Operator's Exposure

*N.D. means "none detected". For the purposes of this study, the lower limit of detection was considered to be less than .008 milligram or approximately .02 mg/M^3.

TABLE III

RESULTS OF INTERVIEWS AND HISTORY REVIEW

Workers are grouped by their current assignment if still working in the study area, or former assignment within the study area is currently assigned elsewhere.

	ROOM 100A	I.C.	LED	TOTAL STUDY GROUP #	%
Total/Included	21	6	14	44	100
No problems related to skin, or work in area	3	1	7	11	27
Complaints of dustiness and/or dryness of eyes, nose or throat or dust caking in nose	9	1	0	10	24
Skin problems possibly related to working with the molding compounds	3	0	2	5	12
Reactions probably caused by the mold release compound (formaldehyde-urea resin)	1	0	1	2	5
Skin problems from wearing rubber gloves or boots	1	2	1	4	10
Reactions probably caused by tricholoethylene	1	0	1	2	5
Dry Hands	2	0	0	2	5
History of Acne	3	1	0	4	10
History of dermatitis or rash probably or definitely not job related	6	3	1	10	24

TABLE IV

CHARACTERIZATION OF SAMPLE

	Shift	Seen Individually	Seen at Worksite	Not Seen	Total of Interest
Room 100A, Molders	1st	6	0	0	6
	2nd	2	2	0	4
	3rd	1	1	0	2
Others	1st	2	1	0	3
	2nd	2	0	0	2
Total Room 100A		13	4	0	17
I.C., Molders	1st	0	2	0	2
	2nd	0	1	0	1
	Leave	0	0	1	1
Total, I.C.		0	3	1	4
LED Room Molders	1st	0	4	1	5
	2nd	0	0	1	1
	3rd	0	1	0	1
Others	1st	0	2	0	2
Total, LED		0	7	2	9
Others, primarily workers assigned to the jobs in question.	1st	0	1	0	1
	2nd	.2	2	1	5
	3rd	0	2	2	4
	Leave	0	0	1	1
Total Other		2	5	4	11
GRAND TOTALS		15	19	7	41