ABSTRACT

HEALTH HAZARD EVALUATION REPORT 73-1

REPORT 73-1 – 66

Toxic Substance: Formaldehyde

Industry: Plastic - Injection Molding

Study Data: Workroom air concentration (breathing zone and work area) Noise survey (A weight network with slow meter response)

Study Date: April 16 and May 17-18, 1973

Study Results: An evaluation was conducted of plastic injection mold operators exposed to decomposition products of a resin made from the polymerization of formaldehyde. The toxic decomposition product of this resin is formaldehyde. Operators were monitored for exposure to formaldehyde with continuous breathing zone samples. Ceiling concentrations were evaluated with detector tubes. Physical examinations (concentrating on the eyes, nose, and throat) of exposed workers were accomplished at the start and end of shift. Environmental results were well below the 8-hour time weighted-average and ceiling exposure standards. Results of physical examinations did not indicate over exposure to formaldehyde.

Toxicity Determination: It was judged that a toxic exposure to formaldehyde does not exist at the concentration found in this work environment.

HEALTH HAZARD EVALUATION REPORT 73-1
HAZARD EVALUATION SERVICES BRANCH
DIVISION OF TECHNICAL SERVICES

Establishment	:	Robin Products Company 27027 Groesbeck Warren, Michigan
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September 1973

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

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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HEALTH HAZARD EVALUATION REPORT 73-1
ROBIN PRODUCTS COMPANY
WARREN, MICHIGAN

SEPTEMBER 1973

I. SUMMARY DETERMINATION

A. 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 any 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 exposure of plastic machine operators and plastic leaders to fumes produced when DuPont Delrin polymer was processed in plastic injection mold machines at the Robin Products Company, 27027 Groesbeck, Warren, Michigan.

B. Federal Standards

The occupational permissible noise exposures promulgated by the U. S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Section 1910.95) are as follows:

Duration per day, hours	Sound Level dBA slow response[a]
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115 ceiling value

The occupational health standard promulgated by the U.S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G. Section 1910.93, Table G-2) applicable to the substance of this evaluation is as follows:

Substance	8-hour time[b] weighted average	Acceptable[b] ceiling concentration	Acceptable maximum peak above[b] the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum Duration
Formaldehyde	3 ppm	5 ppm	10 ppm	30 minutes

Occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

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[a] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + ... + C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

[b] Parts of vapor or gas per million parts of contaminated air by volume.

C. Environmental Evaluation Results

Noise measurements were conducted in the injection mold area on May 17-18, 1973. The full results of this survey may be seen in Table I. Noise levels in excess of those recommended by NIOSH, 85 dBA, and the present Federal Standard, 90 dBA, for an 8-hour exposure were measured at numerous operator stations in this area. Large contributors to the noise levels are the grinders located in this area. The majority of readings made while grinders processed scrap were greater than 90 dBA slow response.

Results of continuous samples for formaldehyde obtained on May 17-18, 1973 in the breathing zone of workers ranged from 0.01 to 0.10 ppm while static samples in the area ranged from 0.01 to 0.53 ppm. Detector tubes were used to measure peak exposures of formaldehyde in operators' breathing zones, and only one measurement of a total of 28 indicated a measurable level which was 1 ppm.

Three detector tubes were used to measure formaldehyde concentrations at the grinder resulting in levels of 2-4 ppm. Complete formaldehyde measurements are contained in Tables II, III and IV of the Full Report.

D. Medical Evaluation Results

On April 16, 1973, an initial walk-through survey was undertaken. At that time no Delrin or Celcon was being utilized in the manufacturing process. Occupational and medical histories were obtained from nine workers. All the workers questioned stated that when Delrin and to a lesser extent, Celcon, were processed into molded plastic parts, they suffered from burning of the eyes, dryness of the nose, irritation of the throat and tightness in the chest. None of the workers have ever missed work due to the alleged hazard.

On May 17-18, 1973, the process was re-inspected. At this time two extruder molding machines were in operation using Delrin and Celcon. Ten other machines were processing Zytel (nylon). This represented a typical production day. Seldom are there more than two machines in operation using Delrin or Celcon. Occupational and medical histories plus physical examinations (concentrating on the eyes, nose and throat) were performed on the 12 women machine operators prior to and after their eight hour work shift.

In inspecting the extruder molding machines using Delrin and Celcon, the medical investigator could, subjectively, detect traces of the characteristically harsh, pungent odor of formaldehyde.

While interviewing and examining the workers, the following information was obtained: The employee operating the machine which was processing Delrin stated that both before and after the work shift she experienced no adverse symptomatology. Clinical examination at these times revealed no abnormalities of the eyes, nose, and throat. The employee operating the machine which was processing Celcon stated that she felt well in the morning, but after the work shift she complained of hoarsenss and nasal dryness. It was noted that her eyes, nose and pharynx were within normal limits in the morning. In the afternoon, on follow-up examination, her conjunctiva were slightly injected, the nasal mucous membranes extremely dry and the pharynx within normal limits.

The women using Zytel on the day of our investigation all gave a rather similar story. They all felt well prior to the work shift but at the end of the shift complained of dryness of the nose, varying degrees of burning of the eyes, and hoarseness in the throat. Six of ten employees examined at the end of the shift had dry nasal mucous membranes. Three others had slightly injected conjunctiva and one or two had mildly erythematous pharynx.

E. Toxicity Determination

It is concluded by the investigators that toxic exposure to formaldehyde does not exist at the concentrations found in this work environment. However, conditions can occur which might cause unnecessary worker discomfort and lead to insidious adverse health affects. More specifically, prolonged dryness of the nasal mucous membranes may retard or prevent the normal filtering mechanism of airborne pollutants. This determination is based upon (1) medical histories (2) physical examination of workers and (3) environmental measurements of formaldehyde concentrations. In addition a large number of workers in this production facility are exposed to excessive noise for protracted periods of time based upon noise measurements made in the injection mold area.

F. Distribution

Copies of this Summary Determination are available 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) Robin Products Company
b) Plant Chairman, Local No. 189, UAW
c) U. S. Department of Labor - Region V
d) NIOSH - Region V

For purposes of informing the approximately 65 affected employees of the results of this investigation, the employer shall post a copy of this Summary Determination for a period of 30 calendar days at or near the work places of affected employees.

II. 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 any 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 exposure of plastic machine operators and plastic leaders to fumes produced when DuPont Delrin polymer was processed in plastic injection mold machines at the Robin Products Company, 27027 Groesbeck, Warren, Michigan.

The Robin Products Company is engaged in the manufacture of metal and plastic parts with most of the production consumed by the automobile industry. In the plastic production area of the plant a plastic resin is received as pellets in bags or drums, the appropriate resin is injected into a mold with the waste being ground up for reuse, the molded parts are audited, and the finished parts are packaged for shipment to the customer. Several polymer raw materials are used depending upon the characteristics desired in the end product. There are approximately 65 employees who potentially could be exposed to fumes produced during processing in the molding area of the plant. Technical information obtained from DuPont warns against heating the Delrin polymer above 450° F since decomposition to formaldehyde can occur under this condition. The polymer should not be heated above 347° F for prolonged periods.

III. BACKGROUND HAZARD INFORMATION

A. Federal Standards

The occupational permissible noise exposures promulgated by the U. S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Section 1910.95) are as follows:

Duration per day, hours	Sound level dBA slow response[a]
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115 ceiling value

The occupational health standard promulgated by the U.S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Section 1910.93, Table G-2) applicable to the substance of this evaluation is:

Substance	8-hour time[b] weighted average	Acceptable[b] ceiling concentration	Acceptable maximum peak above[b] the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum Duration
Formaldehyde	3ppm	5 ppm	10 ppm	30 minutes

Occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on a 8-hour per day, 40-hour per week basis over a normal working lifetime.

B. Toxic Effects

Noise

Exposures to intense noises may lead to a loss in hearing which may be temporary or permanent. Loss of hearing will be noted by a measured shift in the hearing threshold. When recovery to normal hearing thresholds occurs, the shift is known as "temporary". When full recovery does not

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[a] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + \ldots + C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

[b] Parts of vapor or gas per million parts of contaminated air by volume.

occur, the shift is known as "permanent". Not all persons are susceptible to hearing loss at the same noise level. Therefore, it is not possible to set up a simple relation between hearing loss and noise level. However, standards have been established to protect the majority of the people.

Formaldehyde

Formaldehyde is a colorless gas with an irritating odor that is perceptible at less than one ppm.

The principal hazard in industrial use is from the vapors of formaldehyde. Irritation of the membranes of the eyes and upper respiratory passages results from excessive exposure. Repeated exposures may result in inflammation of the eyelids. Chronic irritation to the eyes, nose and upper respiratory tract may result from repeated exposures to the vapors. Inhalation of high concentrations can cause laryngitis, bronchitis, and broncho-pneumonia.

Repeated contact with the skin has a hardening or tanning effect and causes irritation. Prolonged or repeated contact may produce cracking of the skin and ulceration, particularly around the fingernails. Skin sensitization or dermatitis has been a common occurrence from prolonged and repeated contact with formaldehyde solutions or with products containing free formaldehyde.

A threshold limit value of 5 ppm by volume in air has been set by some agencies as the safe concentration for an eight hour exposure, but few workers will be comfortable at such concentrations. The American Conference of Governmental Industrial Hygienists (ACGIH) has set the TLV at a 2 ppm ceiling.

IV. HEALTH HAZARD EVALUATION

A. Observational Survey

On April 16, 1973 NIOSH representatives Messrs. Paul Caplan, Robert Rosensteel and Dr. Phillip Polakoff arrived at the Robin Products Company, Warren, Michigan to conduct an initial visit in response to a request for a health hazard evaluation. A meeting was held with company officials in which the "Official Notice", 1970 Occupational Safety and Health Act, and Hazard Evaluation regulations were presented. An explanation of Section 20(a)(6) of the Act was given as well as the necessity for subsequent visits and the report mechanisms of a hazard evaluation.

A walk-through inspection was conducted by the NIOSH investigators accompanied by plant and union officials. The storage, extrusion, auditing, packaging and shipping areas of the plant were observed. The walk-through was concentrated in the extrusion area of the plant. The DuPont Delrin polymer which had caused initiation of the request was not being processed during the inspection. The Delrin polymer is processed for 2-3 days out of every two weeks. Waste plastic produced during extrusion is reground so it may be reused. The grinders caused noise levels in the extrusion area which required shouting in order to be heard when attempting to speak in this area. During the walk-through a Celanese product called Celcon was being processed on No. 9 and No. 15 machines. This polymer is similar to Delrin. Six detector tubes were used to measure formaldehyde levels in the areas near these machines, but no color change was noted on any tubes. The lowest measurable limit of the tubes used was two ppm, but a color change can be seen at a lower level.

On two occasions minor nose and eye irritation was noted near one of the grinders by the investigators and the characteristic formaldehyde odor was easily distinguishable at several locations. The present production rate of Delrin and Celcon is about 8000 pounds per month. Upon completion of the walk-through the National Surveillance Network questionnaire was completed.

On April 6, 1973, an initial walk-through survey was undertaken by NIOSH medical officer, Dr. Phillip L. Polakoff. Occupational medical histories were obtained from nine workers. All the workers questioned stated that when Delrin and to a lesser extent, Celcon, are being processed they noted burning of the eyes, dryness of the nose, irritation of the throat and tightness in the chest. None of the workers have ever missed work due to the alleged hazard.

B. Environmental Evaluation

The environmental evaluation was directed at determining the exposure of workers to formaldehyde vapors in the injection mold area of the plant. In addition, noise levels in this area were suspected of being excessive on the basis of observations made by the NIOSH investigators during the conduct of the initial visit.

It has been determined that "substances" as presently defined in Section 20(a)(6) of the Act do not include physical agents. However, for completeness of our overall responsibilities for acknowledging any occupational hazards we encounter during the course of our evaluation in the worksite in question, noise levels are reported in this evaluation.

A noise survey of the injection mold area of the plant was made on May 16 and 18, 1973. Sound pressure levels were made with a General Radio Company Type 1565-B Sound Level Meter on the A-weighting network at slow response. The results of these measurements are contained in Table I. Large contributors to excessive noise levels in the injection mold area are the grinders located at various positions in the area, generally one grinder per two injection mold machines.

Measurements were made while grinders were operating under various conditions. The approximate location of grinders in relation to the injection mold machines at the time of the survey may be seen by referring to Figure 1.

The high noise levels measured when scrap was not actually being ground show other sources of excessive noise also exist in this area. Of special note is the pnuematic press used at Machine No. 8 for separating finished parts which exposes the operator to high noise levels for a significant part of the work period. The present intention expressed by management to replace the existing grinders with sound deadened grinders should help lower overall noise levels in this area. If equipment is modified or new equipment is purchased careful consideration should be given to engineering controls to reduce noise levels for such equipment. NIOSH has recommended a lowering of the noise standard for new installations to a level of 85 dBA slow response which would also apply to established installations following a feasibility study by the Secretary of Labor in consultation with the Secretary of Health, Education, and Welfare.[1] Engineering controls which are applied should be accomplished with the recognition of the possibility of a lower standard applying in the future.

Formaldehyde was sampled in the breathing zone of injection mold operators and at stationary locations (area samples) using a sampling train composed of two all glass, midget impingers in series equipped with fritted glass tips, each containing 15 ml of distilled water. The impingers were connected with a short piece of plastic tubing, and the outlet of the second impinger was connected to a MSA Model G personal sampling pump. No tubing was connected to the inlet of the first impinger. The flow rate was controlled by observing the pump's rotometer and adjusting the flow to one liter per minute. Each pump was checked periodically and the flow was corrected when necessary.

The absorbing solution was transferred to sealed bottles for return to the NIOSH Cincinnati laboratory. The absorbing solution was reacted with chromatropic acid - sulfuric acid solution to form a purple color complex. The absorbance of the solution was then determined at 580 nm with a spectrophotometer, and the amount of formaldehyde determined from an absorbance versus concentration relationship.[2]

The concentrations of the continuous formaldehyde samples were calculated, and the results are presented in Tables II and III. Table II contains the results of samples which were obtained using personal sampling devices which aspirated the air sample from the workers' breathing zones. Table III contains the results from sample devices which were located at a static position in the room during the sampling period.

The concentrations of formaldehyde as determined by all the continuous samples were very low. The samples obtained in workers' breathing zones are well below even the most restrictive limit which has been suggested for protection of workers from irritation of eyes and respiratory tract.[3] The concentrations obtained with the static area samples were also low and as expected higher levels of formaldehyde were measured at the machines processing the acetal polymers. A rapid drop off to negligible levels occurred at the other extrusion machines in the area.

Detector tubes were used to evaluate peak formaldehyde levels occurring near the machines processing acetal resins. The only operation at which measurable formaldehyde levels were observed was associated with charging the grinder or emptying regrind from the grinder. The detector tubes used measure formaldehyde levels of 2 ppm or higher although levels below 2 ppm can be estimated. Samples DT8, DT11, and DT15 were taken at the inlet chute of the grinder which is not in the operators' breathing zone (BZ), but did result in formaldehyde levels of 2 ppm, 4 ppm, and 3 ppm respectively. All other detector tube measurements were made in the operator's BZ and resulted in levels which were not detected with one exception that occurred when the operator emptied the grinder and was exposed to a level of about 1 ppm formaldehyde. All measurements were considerably below the Federal Standard of 10 ppm which is the acceptable maximum peak above the ceiling concentration for an 8-hour shift.

C. Medical Evaluation

On May 17-18, 1973, the process was re-inspected. At this time two extruder molding machines were in operation using Delrin and Celcon. The other ten machines were processing Zytel (nylon). This represents a typical production day. Seldom are there more than two machines in operation using Delrin or Celcon. Occupational and medical histories were taken and physical examinations (concentrating on the eyes, nose and throat) performed on the 12 women machine operators prior to and after their eight hour work shift.

In inspecting the extruder molding machines using Delrin and Celcon, the medical investigator could, subjectively, detect traces of the characteristically harsh, pungent odor of formaldehyde.

While interviewing and examining the workers, the following information was obtained: The employee operating the machine which was processing Delrin stated that both before and after the work shift she experienced no adverse symptomatology. Clinical examination at these times revealed no abnormalities of the eyes, nose and throat. The employee operating the machine which was processing Celcon stated that she felt well in the morning, but after the work shift complained of hoarseness and nasal dryness. It was noted that her eyes, nose and pharynx were within normal limits in the morning. In the afternoon, on follow-up examination, conjunctiva were slightly injected, the nasal mucous membranes extremely dry and pharynx within normal limits.

The women using Zytel on the day of our investigation all gave a rather similar story. They all felt well prior to the work shift but at the end of the shift complained of dryness of the nose, varying degrees of burning of the eyes, and hoarseness in the throat. Six of the ten employees examined at the end of the shift had dry nasal mucous membranes. Three had slightly injected conjunctiva and one or two had mildly erythematous pharynx.

In conclusion, it is the belief of the investigators that a toxic exposure to formaldehyde does not exist. However, conditions can exist which would cause unnecessary worker discomfort and might lead to insidious adverse health effects. More specifically, prolonged dryness of the nasal mucous membranes may retard or prevent the normal filtering mechanism of airborne pollutants.

D. Conclusions

1. A large number of the workers in this production facility are exposed to excessive noise for protracted periods of time.

2. A toxic exposure to formaldehyde does <u>not</u> exist. However, conditions can exist which would cause unnecessary worker discomfort and might lead to insidious adverse health effects.

3. The original request and worker medical histories obtained during the initial visit identified the acetal resins as the cause of worker symptoms and complaints. However, the findings of the follow-up medical evaluation show general effects among workers indicating other polymer resins being processed in the area may contribute to the observed effects.

V. RECOMMENDATIONS

1. Personal protective equipment should be provided to protect the hearing of personnel from exposure to excessive noise levels in the injection mold area. Such equipment should be used until engineering controls have been implemented to control noise levels.

2. The applicable Section and page number is cited below from "Criteria for a Recommended Standard - Occupational Exposure to Noise", U. S. Department of Health, Education, and Welfare, HSMHA, NIOSH, HSM 73-11001, 1972.

a. Section 4, page IV-5. A medical surveillance program as outlined should be instituted for employees working in the injection mold area.

b. Section 6, page VI-8. A sign should be appropriately located to warn workers of the existence of excessive noise at the injection mold area.

c. Section 7, page VII-9. Personal protective equipment which is used by personnel should meet the requirements of this section.

d. Section 8, page VIII-10. This information concerning hazards, relevant symptoms, proper conditions and precautions should be accessible to all workers.

e. Section 9, page IX-10. The appropriate monitoring and recordkeeping should be instituted as outlined.

3. A thorough study of the sources of excessive noise generation should be made and where possible noise should be controlled by engineering methods.

4. The program of replacing the present grinders with sound proofed grinders should be continued based on the demonstrated effectiveness of the sound proofed grinder in operation at the time of the survey. However, it should be recognized other engineering controls may be necessary to bring noise levels down to acceptable levels for protection of workers' hearing.

5. The installation of local exhaust ventilation at injection mold machines would help protect workers from the vapors and fumes produced during the processing of polymer resins.

VI. REFERENCES

1. Occupational Exposure to Noise, U. S. DHEW, HSMHA, NIOSH, HSM 73-11001, 1972.

2. Health Lab. Sci., Vol 7, No. 1, Supplement - January, 1970, p. 87.

3. Documentation of the Threshold Limit Values, ACGIH, 3rd Ed., Cincinnati, Ohio, 1971, pp. 118-119.

VII. TABLES, FIGURES, AND PHOTOGRAPHS

TABLE I

NOISE LEVEL SURVEY - INJECTION MOLD AREA
May 16 - 18, 1973

Location - Machine	Description of Operation	Noise Level dBA - Slow Response
Op. Station-Stokes #15	Grinder #5 running empty	85-88
Op. Station-Stokes #15	Grinder #5 at time scrap loaded into grinder	97-99
Op. Station-Stokes #15	Grinder #5 grinding scrap	92-98
Op. Station-Stokes $15	Grinder #5 grinding scrap	93-97
Op. Station-Stokes #15	Grinder #5 grinding scrap	89-91
Op. Station-Stokes #16	Grinder #11 running empty	87-90
Op. Station-Moslo #4	Grinder #11 running empty	85-90
Op. Station-Moslo #4	Grinder #11 running empty	88-91
Op. Station-Moslo #3	Grinder #11 at time scrap loaded into grinder	85-87
Op. Station-Moslo #7	Grinder #11 grinding scrap	86-89
Op. Station-Stokes #13	Grinder #9 running empty	86-90
Op. Station-Stokes #13	Grinder #9 at time scrap loaded into grinder	90-94
Op. Station-Stokes #13	Grinder #9 at time scrap loaded into grinder	92-102
Op. Station-Van Dorn #11	Sound proofed grinder grinding scrap	86-89
Op. Station-Van Dorn #11	Sound proofed grinder at time scrap loaded into grinder	86-91*
Op. Station-New Britain #12	Grinder #8 at time scrap loaded into grinder	92-108
Op. Station-New Britain #12	Grinder #8 running empty	86-87
Op. Station-New Britain #12	Grinder #8 at time scrap loaded into grinder	92-104
Op. Station-New Britain #12	Grinder #8 at time scrap loaded into grinder	93-97
Op. Station-New Britain #12	Grinder #8 at time scrap loaded into grinder	90-91
Op. Station-New Britain #12	Grinder #8 at time scrap loaded into grinder	88-90
Op. Station-New Britain #12	Grinder #8 at time scrap loaded into grinder	90-97
Op. Station-New Britain #10	Grinder #6 grinding scrap	85-90
Op. Station-New Britain #10	Grinder #6 at time scrap loaded into grinder	93-95
Op. Station-New Britain #8	Pnuematic press used to separate parts	85-103
Op. Station-New Britain #9	Grinder #3 running empty	86-88
Op. Station-New Britain #9	Grinder #3 at time scrap loaded into grinder	88-94
Op. Station-Stokes #13	Background noise level	86-88
Op. Station-Stokes #16	Background noise level	89-90

* Instanteneously at 91 dBA with very rapid drop off to the 86 dBA level.

TABLE II

CONCENTRATION OF FORMALDEHYDE DETERMINED BY CONTINUOUS SAMPLES IN WORKERS' BREATHING ZONES

Date	Sample Length (min.)	Machine #	8-Hour Time Weighted Average Exposure Concentration (ppm)
5/17	102	4	0.01
5/17	170	6	0.03
5/17	347	9*	0.10
5/17	314	10*	0.03
5/17	210	13	0.01
5/17	122	15	0.01
5/18	305	8	0.03
5/18	341	9*	0.08
5/18	239	10*	0.03

TABLE III

CONCENTRATION OF FORMALDEHYDE DETERMINED BY CONTINUOUS SAMPLES FROM AREA LOCATIONS

Date	Sample Length	Machine #	Concentration (ppm)
5/17	418	9*	0.38
5/17	429	10*	0.50
5/18	303	9*	0.53
5/18	206	10*	0.05
5/18	239	11	0.01
5/18	239	12	0.03
5/18	80	14	0.01
5/18	55	16	0.05

* Machines processing acetal resins on day of investigation

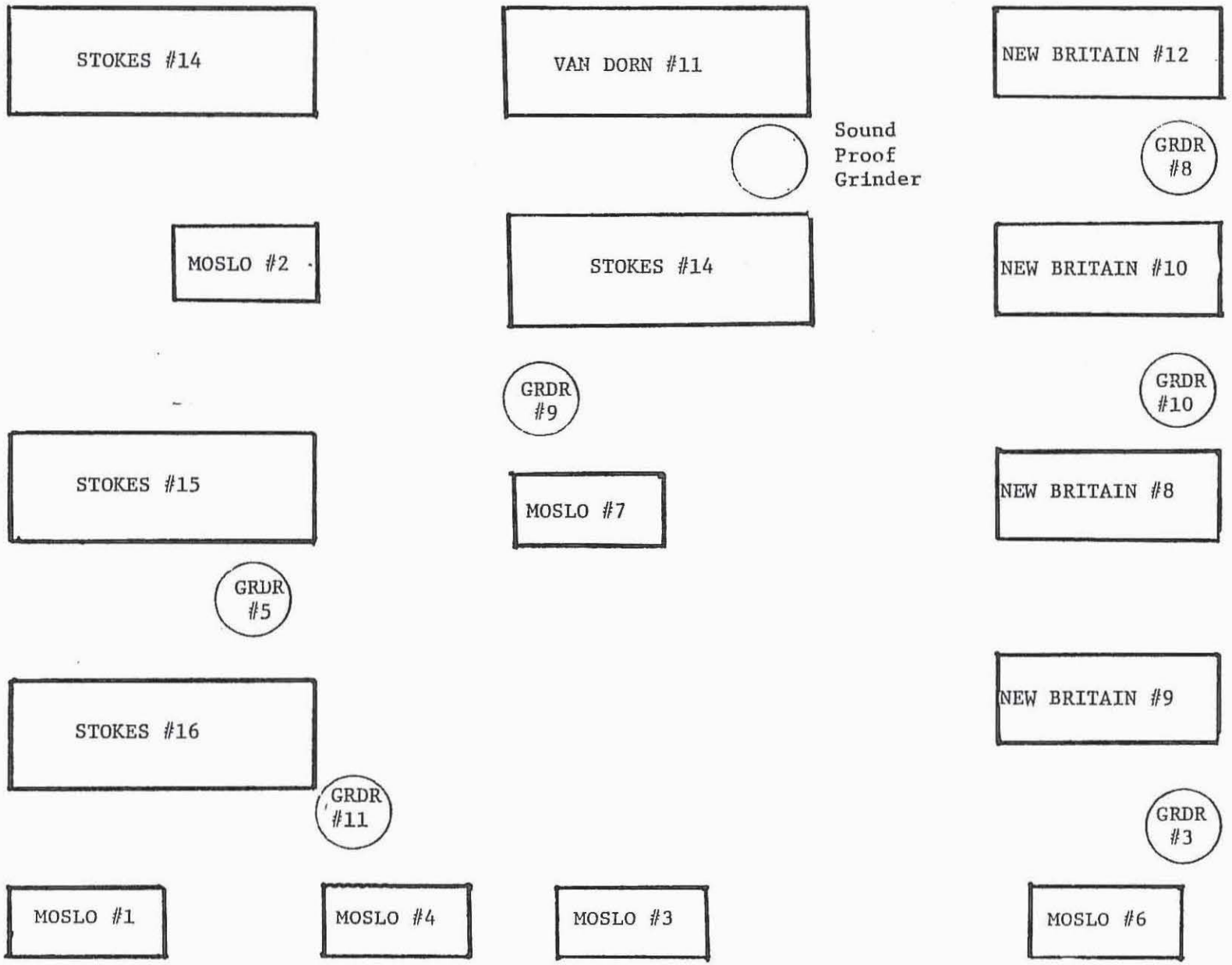
TABLE IV

DETECTOR TUBE SAMPLES OF FORMALDEHYDE CONCENTRATIONS

Date	Sample #	Time	Location*	Concentration (ppm)**
5/17	DT1	0814	Op. BZ Mach. #9	N.D.
5/17	DT2	1052	Op. BZ Mach. #9	N.D.
5/17	DT3	1055	Op. BZ Mach. #9	N.D.
5/17	DT4	1059	Op. BZ Mach. #10	N.D.
5/17	DT5	1100	Op. BZ Mach. #10	N.D.
5/17	DT6	1104	Op. BZ Mach. #10	N.D.
5/17	DT7	1105	Op. BZ Mach. #10	N.D.
5/17	DT8	1108	Grinder hopper-freshly charged Mach. #9	2 ppm
5/17	DT9	1115	Op. BZ Mach. #9	N.D.
5/17	DT10	1118	Op. BZ emptying grinder Mach. #9	N.D.
5/17	DT11	1122	Grinder hopper-freshly charged Mach. #9	4 ppm
5/17	DT12	1343	Op. emptying grinder Mach. #9	N.D.
5/17	DT13	1350	Op. BZ Mach. #9	N.D.
5/17	DT14	1352	Op. BZ Mach. #9	N.D.
5/17	DT15	1358	Grinder hopper-freshly charged Mach. #9	3 ppm
5/17	DT16	1403	Op. BZ Mach. #10	N.D.
5/17	DT17	1406	Op. BZ Mach. #10	N.D.
5/17	DT18	1408	OP. BZ Mach. #10	N.D.
5/17	DT19	1410	Op. BZ Mach. #10	N.D.
5/17	DT20	1415	Op. BZ Mach. #9	N.D.
5/17	DT21	1417	Op. BZ Mach. #9	N.D.
5/18	DT22	1055	Op. BZ Mach. #9	N.D.
5/18	DT23	1338	Op. BZ Mach. #9	N.D.
5/18	DT24	1340	Op. BZ Mach. #9	N.D.
5/18	DT25	1343	Op. BZ Mach. #9	N.D.
5/18	DT26	1345	Op. BZ Mach. #9	N.D.
5/18	DT27	1347	Op. BZ Mach. #10	N.D.
5/18	DT28	1348	Op. BZ Mach. #10	N.D.
5/18	DT29	1350	Op. BZ Mach. #10	N.D.
5/18	DT30	1352	Op. BZ Mach. #10	N.D.
5/18	DT31	1354	Op. BZ emptying grinder Mach. #9	1 ppm

* Op. BZ - Operator's breathing zone
** N.D. - Not detected

FIGURE I. LAYOUT OF INJECTION MOLD AREA - APPROXIMATE
(No Scale)



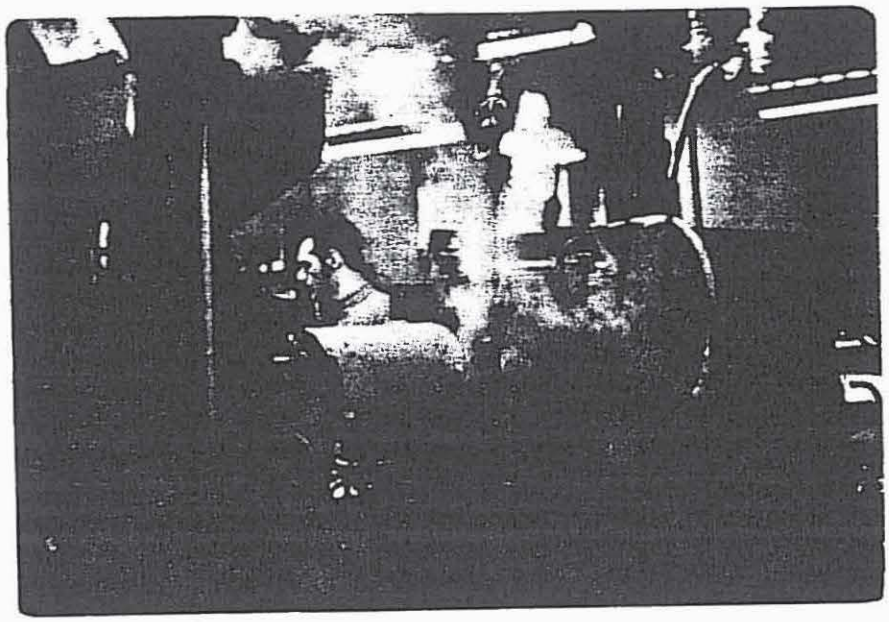


Photo 1. Fumes Produced at an Injection Mold Machine During Product Change.

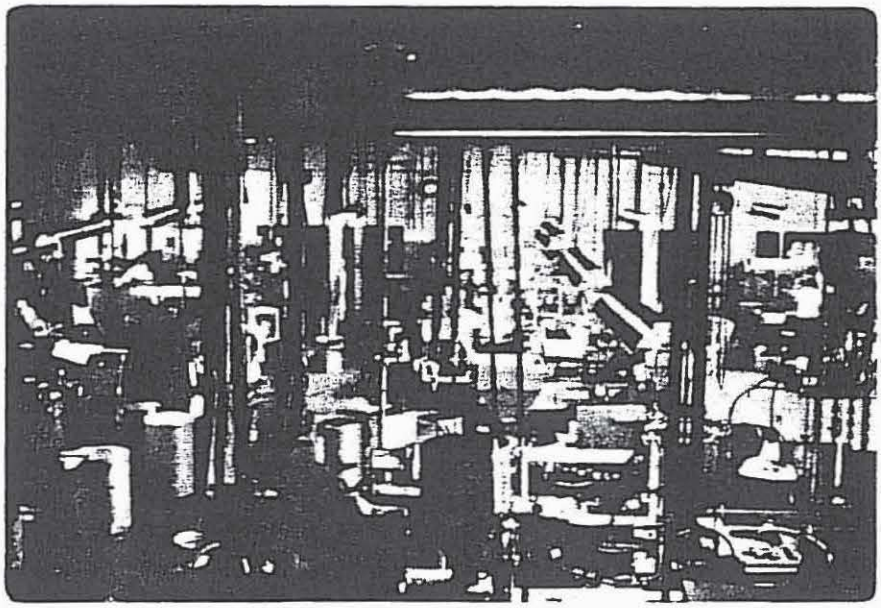


Photo 2. View of the Injection Mold Area of Plant.

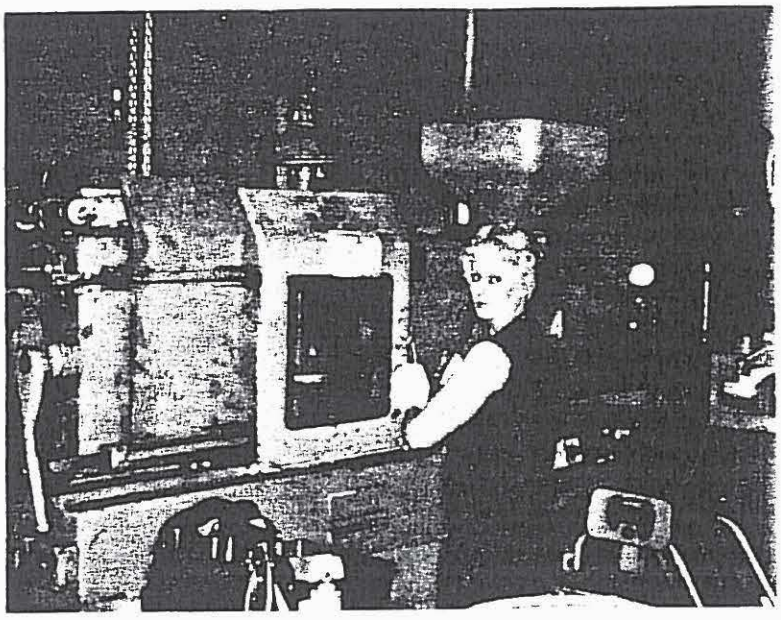


Photo No. 3. Worker Operating an Injection Mold Machine

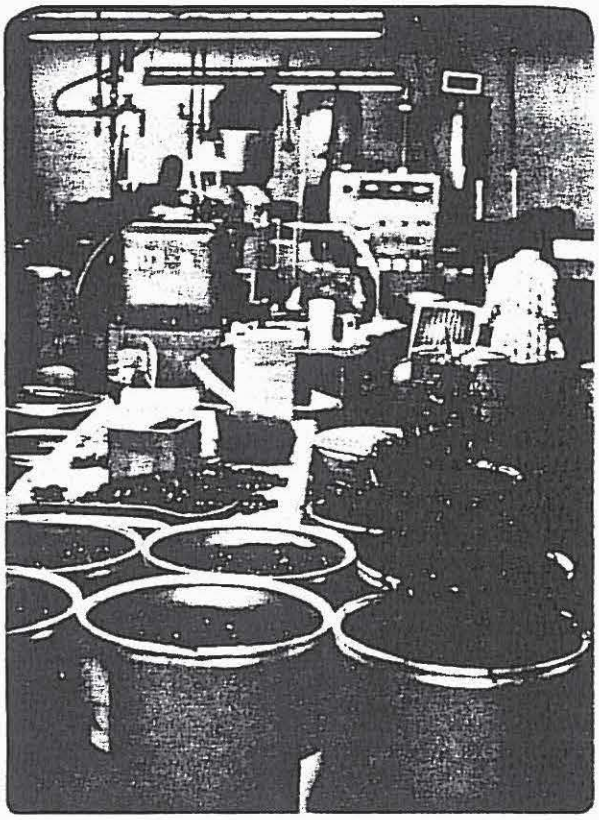


Photo No. 4. Finished Parts Being Packaged in Preparation for Shipment