HEALTH HAZARD EVALUATION REPORT 72-29-28
HAZARD EVALUATION SERVICES BRANCH
DIVISION OF TECHNICAL SERVICES

Establishment : Modern Industrial Plastics Division
Duriron Company, Dayton, Ohio

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

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HEALTH HAZARD EVALUATION REPORT 72-29
MODERN INDUSTRIAL PLASTICS DIVISION
(DURIRON COMPANY)
DAYTON, OHIO

FEBRUARY 1973

I. SUMMARY DETERMINATION

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 to dusts and decomposition products of polytetrafluoroethylene (Teflon) at the Modern Industrial Plastics Division, Duriron Company, Dayton, Ohio.

The substance used or found in the workplace with its most appropriate exposure standard as promulgated by the U.S. Department of Labor (Federal Register, Volume 37, §1910.93, October 18, 1972) is listed below. The potentially hazardous "physical agent" found in the workplace and its exposure standard as promulgated by the U.S. Department of Labor (Federal Register, Volume 37, §1910.93, October 18, 1972) is also listed below.

SUBSTANCE	STANDARD LEVEL OR CONCENTRATION
Teflon Dust (Inert or Nuisance)	15 mg/M^3 (Total Dust)*
PHYSICAL AGENT	**STANDARD LEVEL**
Noise	90 dBA**

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* Unit of Measurement based on eight-hour time weighted average: mg/M^3 milligrams of substance per cubic meter of air.

**dBA-permissible noise level exposure in decibels (A-weighting network) based on an eight-hour time weighted average. Higher noise levels are permissible with shorter duration of exposure than eight hours as calculated by a standard curve and up to a ceiling level of 115 dBA.

The results of an evaluation conducted during the months of August and September 1972 by NIOSH investigators have indicated that a significant hazard at this time does not exist to the health and well being of the approximately one hundred (100) workers at the Modern Industrial Plastics Division, however the "potential" for a less serious hazard to health may exist. The basis for this conclusion is the evaluation of the environmental and medical data obtained by the authors.

Environmental and biological data indicate that worker exposures to Teflon dust are not excessive based upon research data reported in the literature on the subject. Total dust air concentration levels obtained from twenty-three (23) personnel and four (4) general area samples ranged from 0.0 - 5.5 mg/M^3 (Standard of 15 mg/M^3).

Toxic pyrolysis products from Teflon may be given off at temperatures 300°C and higher. Processes employing teflon at elevated temperatures in the plant (370°C) are well controlled utilizing closed and exhaust ventilation techniques of operation.

The urine soluble fluoride level ranged from 0.098 - 2.19 mg/liter in the seventy-seven (77) worker samples collected. A good indicator of toxic levels of fluoride exposure is approximately 3.0 mg/liter and above.

Yet episodes of polymer fume fever continue to occur in the plant although less frequently with improvement made in the engineering control methods over the last few years. Two recommendations from official agencies in the State of Ohio have been consistently neglected: (1) the level of housekeeping throughout the plant needs much improvement and (2) smoking should be prohibited in areas where Teflon is cut, machined, or processed and dust or chips may be produced. Unless these recommendations are followed, it is impossible to conclude other than the fact that the Teflon can be handled safely with proper precautions.

Environmental measurements for noise indicated that in several areas of the plant (Blending Room, Delco Room, Machine Shop), noise levels and exposure times were reached where permanent hearing damage can be expected. Other areas of the plant had noise levels which require further study. Approximately 15-20 employees are at risk of being adversely affected by the noise levels.

The following summary of recommendations made in the Full Report are suggested to alleviate hazardous or potentially hazardous conditions:

1. An improved housekeeping program should be instituted throughout the plant to keep dust sources to a minimum.

2. Smoking should be prohibited in areas where Teflon is cut, machined, or processed where dust or chips are produced.

3. Where feasible noise levels should be reduced to fall within Federal standards by instituting engineering controls.

4. A hearing conservation program should be established including audiometric testing of employees and mandatory use of personal protective devices where excessive noise levels persist.

Copies of the Summary Determination as well as the Full Report of the evaluation 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 of both have been sent to:

a) Modern Industrial Plastics Division
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region V

For purposes of informing "affected employees," the employer will promptly "post" the Summary Determination in a prominent place(s) near where affected employees work for a period of 30 calendar days.

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 to dusts and decomposition products of polytetrafluoroethylene at the Modern Industrial Plastics Division, Duriron Company, Dayton, Ohio.

The Modern Industrial Plastics Division is a manufacturer and fabricator of corrosion resistant parts for automobiles, appliances, and the chemical industry. The plant utilizes approximately 25,000 pounds of polytetrafluoroethylene which is commonly fabricated into numerous corrosion resistant products. The company employs approximately 130 people at the plant (100 in production and 30 in administration) during two full shifts and a skeletal third shift.

III. BACKGROUND HAZARD INFORMATION

A. Standards

The occupational health standards promulgated by the U.S. Department of Labor most applicable to the substances of this evaluation are as follows:

Inert or Nuisance Dust (Total Dust)............15 mg/M^3*
(Federal Register, Part II, Vol. 37, No. 202, Table G-3)

Noise......................................See Table III
(Federal Register, Part II, Vol. 37, No. 202, Table G-16)

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*Units of Measurement: mg/M - milligrams of dust per cubic meter of air

B. Toxic Effects

Teflon is a trade name for fluorocarbon resins obtained by the fluorination of unsaturated low molecular weight hydrocarbons. One type which has been used extensively in industry is obtained by the ploymerization of tetrafluoroethylene (polytetrafluoroethylene). The toxicity of polytetrafluoroethylene (PTFE) depends upon the state of the compound.

The unheated resin of PTFE has been shown to have a low order of oral toxicity based on animal feeding experiments. The United States Food and Drug Administration has reported that PTFE resins, when in contact with food during processing or cooking, do not present any problems under the Food Additives Amendment. Inhalation of resin dust at room temperature and containing no decomposition products is not reputed to be extremely hazardous although cases of a condition typical of metal fume fever have been associated with the cutting and grinding of fabricated parts of Teflon with high-speed tools. The etiologic agent for this temporary influenza-like condition (known as polymer fume fever) has not been determined but it is generally believed that smoking Teflon-contaminated cigarettes in work areas may give rise to the malady. The toxic reaction is marked by chills, nausea, vomiting, and body and joint pains following several hours after exposure. Profuse sweating, weakness, and dry cough may ensue. The syndrome is self-limited and clears spontaneously within 48 hours and there is no evidence that serious or permanent injury has resulted from polymer fume fever. Polytetrafluoroethylene does not damage normal skin when used at ordinary temperatures.

The first indication that toxic materials were being evolved from PTFE at elevated temperatures came during the development of molding techniques for this polymer. It was observed that around sintering temperatures (350°C), proximity to the compound could result in the onset of polymer fume fever. At temperatures below 275°C, there does not appear to be any hazard from the pyrolysis products of Teflon. At 300-360°C, tetrafluoroethylene, hydrogen fluoride, silicon tetrafluoride, and an incompletely characterized waxy sublimate have been isolated. Above 380°C, small amounts of the toxic gases hexafluoropropylene and octafluoroisobutylene have been found in the pyrolysate. As use temperatures increase above 400°C, pyrolysis occurs more rapidly, and the principle toxic compounds found are perfluoroisobutylene and carbonyl fluoride. Some of the toxic breakdown products have produced delayed pulmonary edema in experimental animal situations. There have never been any clearly documented reports of pulmonary edema in human lungs from exposure to PTFE pyrolysis gases and there is no substantiation to rumors of fatal reactions. In animal experiments, all of the toxic gases can cause death if the concentrations of these compounds are high enough. At industrial use temperatures, human response to PTFE seems to be limited to episodes of polymer fume fever.

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 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 correlation between hearing loss and noise level. However, after extensive research, permissible noise levels have been established to protect the majority of the people.

IV. HEALTH HAZARD EVALUATION

A. Initial Visit - Observational Survey

On August 22, 1972, NIOSH representatives Phillip L. Polakoff, M.D., and Mr. Melvin T. Okawa presented themselves to the management of Modern Industrial Plastics Division of the Duriron Company, Dayton, Ohio. The purpose of the visit was explained to [redacted], Plant Superintendent, who assisted us in arranging the details for our survey of the plant. After completion of the preliminary meeting, a walk-through survey of the manufacturing areas of the plant was made. [redacted], Union President (United Steelworkers of America Local 6046), accompanied us during the observational survey. The processes in the plant and the surveyors' observations are described in the paragraphs to follow.

The initial mixing and formulating of raw materials is completed in the Blending Room. The various fluorocarbon resin powders are mixed with such other materials as fiberglass, coke flour, graphite, and polydisulfide as called for in specific formulas. All the materials described are handled manually. A mixer, shaker, and mill are located in the Blending Room. Overhead canopy hoods are provided for the shaker and mill. One workers handles all operations but receives some part-time help from another employee. The mill, shaker, and mixer generally run for 4 hours per day but were not in operation during our survey.

There are some dust accumulation due primarily to the poor housekeeping and the mill and shaker seemed noisy when they were turned on for our survey. Improved housekeeping and a regular ventilation maintenance program should be adequate to keep dust levels at a minimum. Further noise studies are needed to make the determination whether a noise hazard exists and if so what controls are needed to reduce the noise levels in the Blending Room.

The General Molding section of the plant houses several molding operations and contains most of the sintering ovens. One employee works in the Paste Extrusion Room. He blends fluorocarbon resins with petroleum naphtha to make a "pre-form" for an extrusion operation. The mixture is molded and extruded under pressure into the desired part. The extruded part is sintered at 700°F (371°C) and put on a mandril for shaping. The sintering oven is equipped with local exhaust ventilation and a hood. Other than general housekeeping, no occupational health problems were noted.

The Molding Room is located in the General Molding section. Two or three people work on a pressure molding process. The "preform" is shaped by applying pressure to the part and is sintered at 700°F. The molded part is then put on a "coining" die which holds the part to tolerances while it is modified to final specifications. The sintering oven is equipped with local exhaust ventilation. No serious occupational health problems were observed.

Nine sintering ovens are located in the General Molding section outside of the Molding and Paste Extrusion Rooms. In the past, fumes from the ovens had accumulated in the area and cases of polymer fume fever were reported. About a year ago, all of the ovens were enclosed in cabinets and equipped with local exhaust ventilation. Since that time, no problems in this area have been reported and we do not anticipate any under normal operating conditions.

Teflon gaskets are manufactured in the Ring Room. Generally, four employees work in the area. The "pre-form" powder is added by hand to an automatic ring machine where the rings are molded by pressure. The rings are shuttled by conveyor belt to a sintering oven located outside of the Ring Room. The rings are conveyed back into the Ring Room where the workers hand-clean them with compressed air hoses. Local exhaust ventilation is provided for each ring machine. However, dust tends to accumulate in the area from two sources. First, the constant use of compressed air hoses to clean rings and blow dust off of machines and clothing adds dust to the area and keeps it airborne. Second, the local exhaust ventilation for the ring machines is not very effective since enclosure of the operation is not complete and dust escapes into the room. There is a potential hazard from exposure to fluorocarbon resin dust. However, improved housekeeping and better engineering controls should be adequate to keep dust levels at a minimum.

After the rings are produced in the ring room, they are brought to the ring grinding machines where they are finished to final specifications. One employee usually handles both of the ring machines. Two tumbling machines are also located in this part of the plant. After the rings are finished, they are placed in the tumblers to be cleaned. One worker operates both of the tumblers. The housekeeping should be improved in the area and noise from the machinery seemed to be high.

Approximately five persons work in the Glow Mold area. A Teflon part is placed in an iron mold or a casting and sintered at 610 or 710°F. The potential occupational health hazard was observed to be possible short-term exposure to Teflon pyrolysis products when oven doors are opened to remove parts. All ovens are equipped with local exhaust ventilation and under normal conditions, pyrolysis products should not accumulate in the area. Adequate general ventilation in the Glow Mold area should disperse the small amounts of pyrolysis products which may escape when molds are removed from ovens.

One worker operates the machinery in the Delco Room. In this area, small pistons are coated automatically with Teflon. When all of the machinery was operating, the noise level seemed high. No other occupational health problems were noted.

A large and separate area of the plant is the Machine Shop. Approximately 20 people work in the shop with various pieces of machinery such as lathes, grinders, mills, and automatic screw makers. The machinery is standard with the only difference being that Teflon is machined rather than metal. Most of the machinery is supplied with a local exhaust ventilation system which is used to reclaim scrap pieces of Teflon. The system was observed to be extremely efficient in picking up the Teflon scrap as it came off of the tool. Unless cases of polymer fume fever appear among the workers in the Machine Shop, the ventilation system should be adequate. Again, housekeeping in the area should be improved. Additionally, with all of the machinery running, the area around the automatic screw makers seemed noisy.

An observational survey of the manufacturing areas of the Modern Plastics Division was conducted. In general, it was noted that certain areas were dusty or noisy and that overall housekeeping at the plant was poor. All Teflon parts are sintered at 610 - 710°F (321 - 376°C), and all of the sintering ovens are equipped with local exhaust ventilation. The more toxic pyrolysis products do not form readily until use temperatures increase above 400°C, and since the etiologic agent for polymer fume fever is unknown, it would be difficult to select a single pyrolysis compound to sample in an environmental survey. It was decided, therefore, that fluorocarbon resin dust levels would be sampled for during the environmental survey to pinpoint areas where housekeeping should be improved. Further environmental sampling would be contingent upon results of the medical survey of the plant. Additionally, sound level readings would be taken in the noisy areas to determine whether a health hazard from noise is present.

B. Environmental Evaluation

An environmental survey for fluorocarbon resin dust levels and noise was conducted at the Modern Industrial Plastics Division plant on August 24, 1972, by NIOSH investigators Melvin T. Okawa, Raymond L. Ruhe, and Jerome P. Flesch.

Personnel breathing zone and general area samples were collected with the same type of instrument. MSA Model G battery powered vacuum pumps were used to draw air through Millipore type AA filters. The filters were 37-millimeter size and were weighed before the survey. The filters were placed in open face holders which were attached to the worker's lapel or collar. General area samples were taken with the same instrument set-up. The sampling rate was maintained at 2.0 liters per minute and the sampling times ranged from 40 - 117 minutes. Noise levels were measured with a General Radio Company sound level meter (Model 1565-B).

Results (Teflon Dust):

The filter samples were returned to NIOSH laboratories in Cincinnati, Ohio. The filters were reweighed to obtain the weight of the dust and the dust was analyzed by a mass spectrometer for Teflon content. The weight of the Teflon dust was divided by the total volume of air sampled to obtain Teflon dust concentrations in milligrams of dust per cubic meter of air (mg/M^3). These results are contained in Table I of this report.

Eight personnel breathing zone samples were taken in the Glow Mold area. The Teflon dust levels ranged from 0.0 - 2.4 mg/M^3. The figure (0.0) was reported but may not be exact. Weighing variation and limits on the analytical method resulted in zero concentrations of Teflon dust when, in fact, small quantities may have been present. Four general area samples were collected on top of the Michigan ovens in the Glow Mold area of the plant. The Teflon dust levels ranged from 0.0 - 3.2 mg/M3. Eight personnel breathing zone samples were collected in the Ring Room. The Teflon dust concentrations ranged from 0.4 - 5.5 mg/M^3. Three personnel breathing zone samples were taken on the worker operating the ring grinding machines. The Teflon dust level ranged from 2.5 - 2.9 mg/M^3. In the Machine Shop, four personnel breathing zone samples were collected. The Teflon dust levels were between 0.2 and 2.9 mg/M^3.

Nuisance dusts are termed "inert" but this concept is not entirely correct in that all particles result in some reaction in the lungs. The American Conference of Governmental Industrial Hygienists (ACGIH) recommended threshold limit value (TLV) for nuisance dust is 10.0 mg/M^3. The mandatory occupational health standard for nuisance dust is 15.0 mg/M^3 as promulgated by the U.S. Department of Labor. These levels are based on a total dust sample (time-weighted average for an eight-hour day). At the present time, a mandatory occupational health standard specifically for Teflon dust does not exist, but current research seems to indicate that the nuisance or inert dust standard of 15.0 mg/M^3 is adequate for protection. None of the samples taken showed levels which were more than approximately one-third the Federal standard or one-half the TLV. However, this fact does not preclude the possibility that some people can suffer adverse effects at these lower dust concentrations. As expected, the dustiest area was the Ring Room where levels ranged from 0.4 - 5.5 mg/M^3. Other areas in the plant were less dusty as can be seen from Table I.

There are several types of Teflon fluorocarbon resins in commercial use, each differing in thermal stability and therefore in the amounts of the decomposition products evolved at various elevated temperatures. Although much is known about the toxicity of several of the decomposition products, no practical way has been devised to express a safe level for a mixture of these compounds. This fact is particularly true when polymer fume fever is of concern since the etiologic agent for the malady is unknown. The most practical approach to the problem is measure the maximum use temperature and make adjustments in the ventilation and protective equipment to obviate the potential hazard. It is generally believed that a "safe" use temperature without controls is 275°C (527°F).

Results (Noise):

Noise does not fall under the "substance" category established as the basis for a health hazard evaluation under Section 20(a)(6) of the Act. However, NIOSH, for completeness of its overall responsibility for acknowledging any occupational health hazards, makes it a policy to report excessive noise levels in evaluations.

Noise levels were measured in decibels (dBA) on the A-weighting network with a sound level meter. Several locations were chosen on the basis of the observational survey. These noise measurements are contained in Table II as well as the permissible noise exposure in hours per day for the average noise level measured. The worker exposure times were obtained from the affected employee and the permissible noise levels were taken from the mandatory standard promulgated by the U.S. Department of Labor (Table III).

At the Modern Industrial Plastics Division plant, workers were exposed to excessive noise levels in the Blending Room, Delco Room, and parts of the Machine Shop. Noise levels in other areas of the plant exceeded the 90 dBA eight-hour limit, but the estimated durations of exposure were within permissible time limits. More indepth study of the noise problem is needed and some general recommendations to obviate the noise hazard are included in Section V of the report.

C. Medical Evaluation

The Modern Industrial Plastics Division plant was visited on two separate occasions by NIOSH physicians. On August 22, 1972, Dr. Phillip Polakoff took part in the observational survey of the plant. Dr. Polakoff spent extended amounts of time in the areas where the alleged hazards existed. Workers were questioned throughout the production process as to whether they suffered from any occupational ill effects including occupational dermatoses, chills, fever, altered mental status, and upper respiratory symptomatology. No medical examinations except personal observations were performed at that time.

On September 20, 1972, NIOSH physicians, James B. Lucas and Phillip L. Polakoff, returned to the plant. Medical questionnaires (see Appendix A) were administered to 77 employees (71 production and 6 office staff). A like number of individuals gave a urine sample which was to be analyzed for fluoride level.

Results (Observational Survey):

In regard to occupational preventive medicine procedures, the following information was obtained. The Duriron Company requires pre-employment physical examinations on its employees but does not require periodic check-ups. All employees receive a chest X-ray once a year. The company employs no occupational health nurse at the Modern Plastics Division, but one is located at the headquarters five miles away. A formal safety committee exists within the plant. None of the employees, whether in the administrative or production branch of the operation, are specifically trained in first aid. Two first aid stations are present in the plant. In cases of a more severe accident, the company refers the worker to the company physician in Dayton. The company has set no firm policy requiring the use of respirators in areas where Teflon is fabricated. Smoking is allowed in these same areas. Safety shoes are not required but the wearing of safety glasses is encouraged.

Since 1961, no less than six requests have been submitted to the State of Ohio Department of Health or the Industrial Commission of Ohio. Two reports summarizing the results of two separate investigations were completed by the Industrial Commission. These reports dealt primarily with the industrial hygiene aspects of Teflon fabrication and recommendations were made to improve the industrial hygiene control measures at the plant. No medical input was provided in either of these investigations. During the two visits to the plant, no one was observed to be suffering from an acute episode of polymer fume fever, although during the first visit it was reported that two individuals had gone home during the previous week with symptoms compatible of the malady.

Results (Medical Questionnaire):

From the questionnaire presented to workers on the first and second shifts and to a small group of administrative personnel, the following information was obtained. The questionnaire was completed by 77 individuals (about 75% of the total work force in the plant) composed of 40 workers from the first shift, 30 from the second, and 7 from the administrative staff. Seventy percent of these individuals had been employed on the job for greater than one year with 55% being employed for greater than five years. Greater than 60% of the workers engaged in smoking while on the job.

Eighty-six percent (60/70) of the workers stated that they had experienced polymer fume fever somtime in the past, but of this same group, only 50% acknowledged that they had experienced symptoms of polymer fume fever in the past year. Fourteen percent of the workers reported that they had greater than three episodes of the malady in the preceeding 12 months. A third of the workers, at one time or another, had stayed home from work because of alleged polymer fume fever. Only 10% of those debilitated with polymer fume fever deemed it necessary to seek the aid of a physician.

Results (Urine Analysis):

Each individual who completed the questionnaire also provided a urine sample to be analyzed for fluoride level. Seventy-seven samples were collected and the results are contained in Table IV. The following is Donald E. Richards' (Research Chemist, NIOSH) report on his analyses of these samples:

"All urine samples were analyzed in accordance with the method of Frant and Ross [Clin. Chim. Acta 21, 216-218 (1970)]. Briefly, this procedure involves the dilution of the urine sample with an equal volume of commercially available total ionic strength adjustment buffer (TISAB) and the measurement of the fluoride ion concentration of the resulting mixture with a fluoride ion activity electrode. As determined by this method, the urinary fluoride levels ranged from 0.098 mg/liter to 2.19 mg/liter. The average fluoride content of two samples of drinking water taken in Dayton was 0.19 mg/liter.

"According to F.F. Heyroth (Industrial Hygiene and Toxicology, second revised edition, Vol. II, F.A. Patty, ed., Interscience, New York, N.Y., p. 841), a mean daily urinary output of 4 mg of fluorides reflects the maximum permissible fluoride exposure. Thus, based on an average urinary output of 1.235 liters/day [19 ml/kg/day x 65 kg (average body weight), Magee, H.E., J. Hyg., Vol. 37, p. 30, 1937], the results of these analyses show that the employees from whom the urine specimens were collected have not been exposed to toxic levels of soluble fluorides."

The urine samples proved negative as far as a biological indicator of excess fluoride exposure. However, these samples only reflect the fluoride exposure at the time the samples were collected. From the medical questionnaires, the majority of persons interviewed had experienced episodes of polymer fume fever with 50% having been symptomatic in the past year. Therefore, it is not possible to rule out the fact that a health hazard does not exist. On the other hand, the majority of workers smoke on the job, and smoking cigarettes contaminated with Teflon has been hypothesized as being a major contributor to the cause of polymer fume fever. Possibly, the experiences of workers in the future after some adjustments in the handling of the product will give a clearer picture.

D. Conclusions

Polytetrafluoroethylene, after extensive medical and environmental research, has been found to be a relatively safe chemical compound to work with and if proper precautions are taken, it should be unlikely that any worker will demonstrate in himself detrimental health effects. At the Modern Industrial Plastics Division, worker experience seems to conflict with this statement. Numerous improvements in engineering controls have been made and these changes have helped. However, two recommendations from official agencies in past reports have been neglected: (1) improved housekeeping throughout the plant and (2) no smoking in areas where Teflon is cut, machined, or processed where dust and chips are produced. Unless employees work for a time period with improved plant housekeeping and no smoking in areas where cigarettes can become contaminated, we cannot but agree with the position that Teflon can be processed safely with the proper precautions. Some general recommendations on the safe handling of Teflon will be included in Section V and Appendix B of this report.

Noise levels are high enough in certain areas of the plant to warrant a hearing conservation program to monitor and obviate the health hazard from noise. General recommendations on noise are included in Section V of this report.

V. RECOMMENDATIONS

1. An improved housekeeping program should be instituted throughout the plant to keep dust sources to a minimum.

2. A periodic maintenance program for the existing ventilation systems should be mandatory.

3. The ring machines should have more enclosure to make maximum use of the existing ventilation. If feasible, cleaning of rings with compressed air hoses should be eliminated (vacuum cleaning) or done in such a manner that dust is not blown about.

4. Smoking should be prohibited in areas where Teflon is cut, machined, or processed where dust or chips are produced.

5. Urine sample bottles should be available at all times to obtain urine samples from workers complaining of polymer fume fever. Samples should then be analyzed for urine fluoride levels.

6. An improved first aid program should be established with two or three individuals on each shift given advanced training in first aid.

7. Appendix B contains a list of precautionary measures which should be followed in the use of Teflon.

8. A hearing conservation program for employees in the Blending Room, the Delco Room, the Machine Shop, and the ring grinder and tumbler areas should be established. The hearing conservation program should include audiometric testing of employees. In those sections of the plant, high noise sources should be lowered by engineering methods whenever possible and ear protection made mandatory for employees in areas where noise levels cannot be lowered to meet Federal standards.

9. The NIOSH publication (HSM 73-11001), criteria for a recommended standard....Occupational Exposure To Noise, should be followed in implementing the hearing conservation program.

VI. REFERENCES

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Table I. Personnel Breathing Zone And General Area Samples For Teflon Dust Levels Collected At The Modern Industrial Plastics Division

Sample#	Location	Type	Sample Vol(liters)	Teflon Dust Conc. (mg/M³*)
29	Glow Mold	Personnel	114	0.0
21	"	"	234	0.6
5	"	"	105	0.1
30	"	"	204	0.0
10	"	"	100	0.7
9	"	"	230	0.6
15	"	"	94	2.4
3	"	"	170	0.4
25	Mich. Ovens	Gen. Area	90	3.2
13	"	"	166	0.0
14	"	"	88	0.8
8	"	"	166	0.1
20	Ring Room	Personnel	92	1.7
24	"	"	90	0.4
7	"	"	174	3.2
27	"	"	116	3.0
19	"	"	84	5.5
12	"	"	170	4.4
6	"	"	122	4.3
22	"	"	104	1.8
18	Ring Grinder	Personnel	80	2.6
23	"	"	176	2.9
4	"	"	126	2.5
26	Lathe	"	120	0.2
16	Screw Maker	"	118	2.6
17	Machinist	"	118	2.9
2	Bridgeport Mill	"	116	1.6

*Units of Measurement: mg/M³ - milligrams of dust per cubic meter of air

Table II. Noise Level Exposures Of Workers In Selected Areas At The Modern Industrial Plastics Division Plant

Area/Occupation	Ave. Noise Level (dBA)	Ave. Worker Exposure (hours)	Permissible Exposure* (hours)
Blending Room(Fitz-patric mill running)	106 - 107	2	3/4 - 1
Ring Room	82 - 84	8	8
Tumblers(full)	95 - 97	2 - 3	3 1/2
Ring Grinders (near hoppers)	95 - 96	2	3 1/2 - 4
Delco Room	91 - 95	8	5 - 5 1/2
Machine Shop(near screw makers)	88 - 95	8	6 - 7
Machine Shop (general area)	88 - 90	8	8

*See Table III

TABLE III

PERMISSIBLE NOISE EXPOSURES*

Duration Per Day, Hours	Sound Level dBA Slow Response
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

*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 on each. If the sum of the following fractions: C1/T1+C2/T2 +Cn/Tn exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

TABLE IV

2 October 1972

Determination of Urinary Fluoride Levels of Workers

Engaged in the Manufacture of Teflon

Sample No.	Fluoride Concentration mg/liter*	Sample No.	Fluoride Concentration mg/liter*
1	0.779	17	0.266
2	0.437	18	0.209
3	1.29	19	0.437
4	0.304	20	0.446
5	0.760	21	0.760
6	0.741	22	0.428
7	0.627	23	0.256
8	0.969	24	0.656
9	0.608	25	0.475
10	0.399	26	0.608
11	0.684	27	0.285
12	0.182	28	0.570
13	0.646	29	0.256
14	0.608	30	0.817
15	0.494	31	1.10
16	0.437	32	0.304

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2 October 1972

TABLE IV

Determination of Urinary Fluoride Levels of Workers

Engaged in the Manufacture of Teflon

Sample No.	Fluoride Concentration mg/liter*	Sample No.	Fluoride Concentration mg/liter*
33	0.589	62	1.65
34	0.504	63	0.788
35	0.722	64	0.665
36	0.332	65	0.314
37	0.361	66	0.428
38	0.370	67	0.137
39	2.19	68	0.589
40	0.608	69	0.428
41	0.399	70	0.294
42	0.399	71	1.52
43	0.931	72	1.63
44	0.475	73	1.22
45	0.788	74	0.788
46	0.323	75	0.504
60	0.098	76	0.437
61	0.931	77	1.37

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TABLE IV

2 October 1972

Determination of Urinary Fluoride Levels of Workers

Engaged in the Manufacture of Teflon

Sample No.	Fluoride Concentration mg/liter*
78	0.988
79	0.874
80	0.361
81	0.238
82	0.323
83	0.342
84	0.276
85	0.475
86	0.532
87	0.361
88	0.228
89	0.361
90	0.513
91 (44)	0.437
92 (83)	0.338
93 (88)	0.276
94 (37)	0.361
95 (68)	0.428
96 (38)	0.361
Drinking Water	0.190

* Fluoride concentration represents an average of five determinations with a relative standard deviation of ± 2.2%.

APPENDIX A

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
HEALTH SERVICES AND MENTAL HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
518 POST OFFICE BUILDING
CINCINNATI, OHIO 45202

Teflon Products Workers Study
Medical Questionnaire

CONSENT

I hereby voluntarily agree to participate in a study of "Teflon" workers to exposure to polytetrafluoroethylene (teflon) and its by-products to be conducted by the U. S. Public Health Service. I agree to answer questions about my health which have a bearing in this study.

I agree to give a sample of my urine to determine whether I have had a significant exposure to "Teflon" fumes. I am aware that medical information will be used for statistical purposes only unless I authorize otherwise. I am also aware that I may withdraw from the study at any time.

DATE____________________ SIGNATURE__________________________

- -

AUTHORIZATION FOR RELEASE OF MEDICAL INFORMATION

I hereby request that the Public Health Service inform my personal physician

Dr.______________________________

Street____________________________ City____________________

and the company physician of

Company Name________________________ City____________________

of any significant medical findings from this study.

SIGNATURE__________________________

Note: Strike out the words "and the company physician Company Name__________ City________", if the worker prefers that the significant medical findings from this study be sent <u>only</u> to his personal physician.

Information obtained in this study will be kept confidential in accordance with U.S. Public Health Service Regulation (42 DFR Part 1).

TEFLON PRODUCTS WORKERS STUDY
MEDICAL QUESTIONNAIRE

EMPLOYEE STUDY NUMBER: ________________

Name ____
Last   First   Middle

Social Security Number: _______/_______/_________

Date of Birth: ______________________________
Month   Day   Year

USE THE ACTUAL WORDING OF EACH QUESTION. PUT "X" IN APPROPRIATE SQUARE AFTER EACH QUESTION. WHEN IN DOUBT RECORD "NO".

---

1. Do you work in the actual production of "Teflon" products Yes ☐ No ☐

2. How long have you worked with "Teflon" products:

   0-1 years ☐

   1-5 years ☐

   5-10 years ☐

   10 years ☐

3. Do you work in the molding part of the operation? Yes ☐ No ☐

4. Do you work in the manufacturing part of the operation? Yes ☐ No ☐

5. Do you smoke while working on the job? Yes ☐ No ☐

6. Have you ever experienced "Teflon" fume fever? (i.e., Chills, Flu-like Symptoms)

   Yes ☐ No ☐

7. How many times have you experienced "Teflon" fume fever in the past year?

   0 ☐

   1-2 times ☐

   3-5 times ☐

   Greater than 5 times ☐

8. Have you ever stayed home from work because of "Teflon" fume fever?

   Yes ☐ No ☐

9. Have you ever seen a physiciana because of "Teflon" fume fever?

   Yes ☐ No ☐

10. Have you ever had:

	Yes	No
Back problems requiring an x-ray	☐	☐
Bronchitis	☐	☐
Bronchial Asthma	☐	☐
Occupational dermatitis (skin rash)	☐	☐

APPENDIX B

Precautionary Measures

The following precautionary measure should be followed in the use of Teflon or any synthetic resin.

1. Temperature Limitations

   a. The upper limits of chemical stability should be ascertained from the manufacturer. Do not merely accept a salesman's statement but secure copies of the appropriate literautre from the manufacturer.

   b. Different types of Teflon-TFE-Fluorocarbon resins are available and apparently with different upper temperature limitations of use. For example, Teflon labware for chemical laboratories is claimed to be heat-resistant continuously to 600°F. In a recent advertisement on Teflon bearings, it is stated that Teflon resins are rated for continuous use from -450°F. to 500°F.

   c. Unless information from a competent source dictates otherwise, we recommend 500°F. as the limiting temperature except when mechanical ventilation is afforded for fume removal.

2. Handling of Formed Teflon

   a. No precautions are necessary.

3. Ventilation Requirements

   The DuPont Company recommends ventilation when Teflon is subjected to elevated temperatures on a somewhat continuous basis. The following rates apply upon the basis of per pound of Teflon decomposed.

Temperature °F.	Required Ventilation - CFM/lb. Teflon 1,5,7,x	Teflon 6,30
600	5	15
700	15	100

   It is obvious to an engineer that these are quite small ventilation rates and roughly equivalent to the normal air movement found in most large areas, such as mill buildings, laboratories, etc. Therefore, if one can keep his face from being directly in the fume rising directly from the process, the existing ventilation of such areas should be adequate, unless a few pounds of Teflon is burned.

4. Maintenance - Flame Cutting

   a. Insofar as practical, other measures than burning or cutting should be used to disassemble equipment or elements containing Teflon.

   b. Burning off a pipe section close to a flange which may have a Teflon gasket, or burning any metal containing a Teflon element, (i.e. pump, etc.) should be done under conditions with mechanical ventilation to disperse the fumes, if there is the possibility of the Teflon element being burned.

   c. Burning in highly confined spaces, such as valve pits, should be conducted only with local exhaust ventilation to remove the fumes.

5. Smoking

   Smoking should be prohibited in areas where Teflon is cut, machined, or processed where dust or chips are produced.

6. Chemical Laboratory Use

   Teflon labware, used under conditions of direct applied heat, such as hot plates or flames, should be placed in fume hoods.

7. Disposal

   a. Teflon scrap should not be disposed of by burning in incinerators, furnaces, etc. unless the fumes are vented to the outside and mechanical draft is provided.

   b. The disposal of Teflon scrap should preferably be done by burial in the ground when an appreciable quantity of scrap is involved.

8. Storage and Flammability

   a. Teflon is non-flammable and will not propagate a flame but will decompose under heat with development of noxious and toxic gases and fumes. This is characteristic of many non-flammable materials. Therefore, the only storage restriction which need be applied is to prevent storage with flammable materials, such as oils, gases, solvents, etc. This type of restriction applies equally well to rubber belting, insulated wires and plastics.