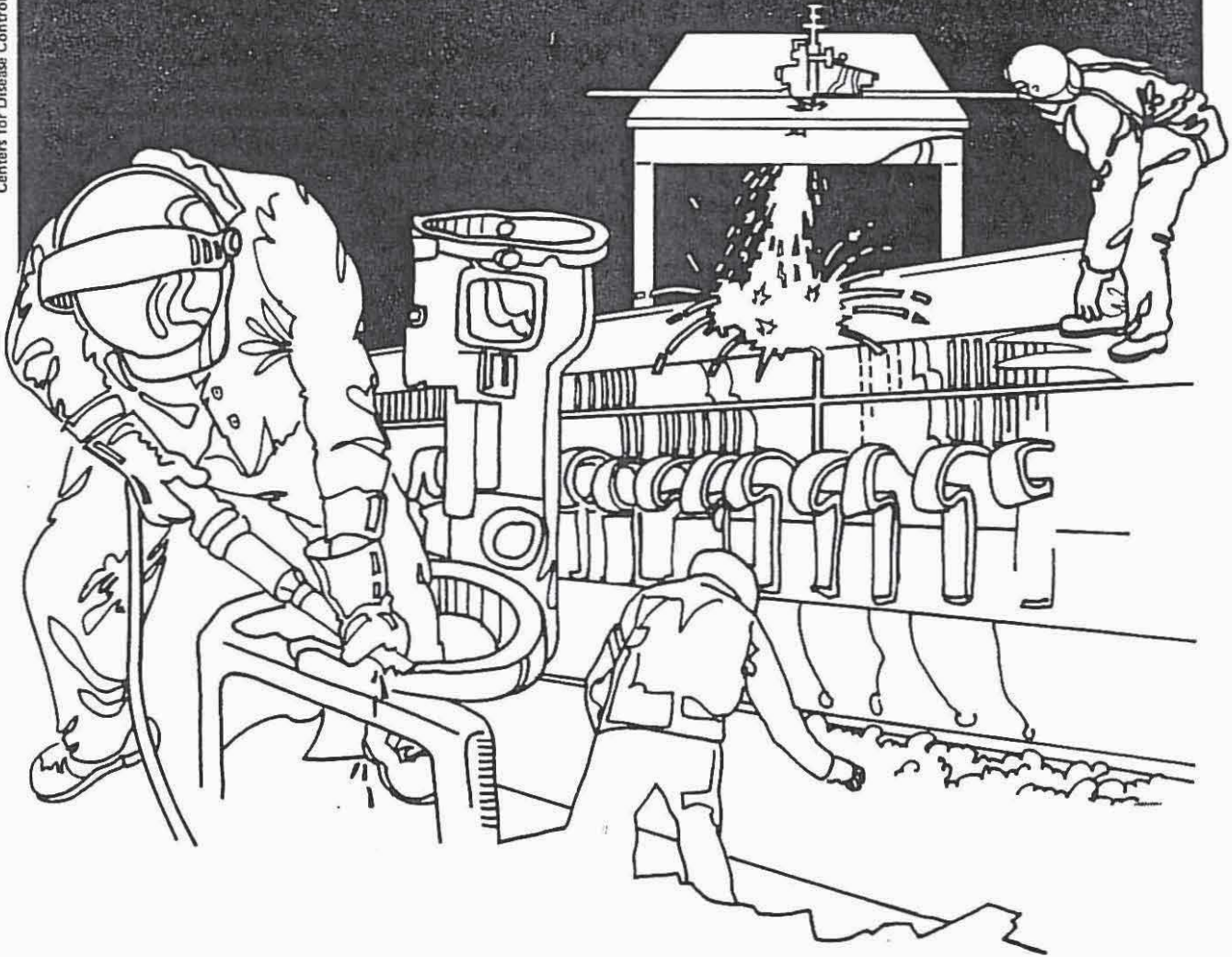


NIOSH



Health Hazard Evaluation Report

HETA 84-230-1528
RUBBERMAID INCORPORATED
WOOSTER, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 84-230-1528
NOVEMBER 1984
RUBBERMAID INCORPORATED
WOOSTER, OHIO

NIOSH INVESTIGATORS:
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I. SUMMARY

On March 20, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposures to cadmium and respirable dust in the thermoplastic injection molding department at the Akron Road facility of Rubbermaid, Inc. in Wooster, Ohio. The request was a follow-up to a previous NIOSH Health Hazard Evaluation conducted in 1982, at which time the company had initiated efforts to reformulate pigments used in their products with the objective of eliminating heavy metal (including cadmium) compounds. During the previous NIOSH study cadmium exposures had been documented exceeding the NIOSH recommended exposure limit of 0.04 milligrams per meter cubed (mg/m^3).

The industrial hygiene survey consisted of personal exposure monitoring for cadmium, lead, and total chromium. Personal and process sampling for respirable dust at equipment using granular polyethylene resin was also conducted. The survey was conducted June 12-14, 1984 over the course of three workshifts. Both short-term and full-shift sampling was conducted for metals.

Evaluation of personal exposures to metals found lead and chromium levels below detectable limits. Cadmium levels ranged from below detectable limits up to $0.02 \text{ mg}/\text{m}^3$, this highest value obtained from a short-term sample. (NIOSH recommended exposure limit: $0.04 \text{ mg}/\text{m}^3$ full-shift; $0.2 \text{ mg}/\text{m}^3$ ceiling) A total of 7 of 34 (21%) samples had detectable quantities of cadmium present. All respirable dust exposures were negligible. Thirteen samples had no quantifiable weight gain, six had trace amounts (less than $0.11 \text{ mg}/\text{m}^3$). (OSHA PEL: $5 \text{ mg}/\text{m}^3$ respirable nuisance dust).

Sampling results obtained during this survey for cadmium exposures associated with pigment handling in the injection molding areas did not indicate the existence of a health hazard. Additionally, exposure levels had been reduced from levels seen during a previous NIOSH evaluation through reduction and elimination of cadmium content in the pigments. No respirable dust hazard was identified in areas where granular polyethylene was used. Recommendations address work practices, housekeeping, and respirator use.

KEYWORDS: SIC 3079 (Miscellaneous Plastic Products), injection molding, pigments, cadmium, CAS # 7440-43-9, cadmium sulfoselenide, CAS # 12626-36-7, granular polyethylene, CAS # 9002-88-4

II. INTRODUCTION

On March 20, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from Rubbermaid management to conduct an industrial hygiene survey for cadmium exposures in the Plastics Division at their Akron Road plant in Wooster, Ohio. The company requested the study as a follow-up to a NIOSH Health Hazard Evaluation (HETA 82-223-1340¹) conducted at the facility in 1982. The purpose of the survey was to reevaluate workers handling pigments for cadmium exposures now that the company had completed a reformulation of their pigments, eliminating heavy metals, such as cadmium, to the maximum extent possible.

NIOSH investigators conducted an industrial hygiene survey in the Plastics I and II departments June 12-14, 1984. During NIOSH's preparation for the survey, the company requested that sampling for respirable dust, associated with an increased use of granular polyethylene, also be conducted during the survey. Union representation was provided by Local 302 of the United Rubber Workers of America.

III. BACKGROUND

A. Background of Request

NIOSH investigators, in the 1982 evaluation, documented cadmium exposures of Plastics II workers to be at or above the recommended NIOSH action level of 20 micrograms per meter cubed ($\mu\text{g}/\text{m}^3$) and in some cases above the recommended NIOSH exposure limit of 40 $\mu\text{g}/\text{m}^3$. The company undertook a program to reformulate the pigments used in the Plastics I and II areas with the purpose of eliminating all heavy metals currently present in the pigments. Therefore, as a follow-up to reformulation of the pigments, they requested that NIOSH return to conduct exposure monitoring for cadmium, a compound to which workers had previously encountered higher exposures (as compared to lead and chromium). The company had also proceeded with their expansion of granular polyethylene use, and since the material produced some visible dust when — compared to pelletized polyethylene, they requested further sampling to determine if a respirable dust hazard to press operators and workers on the production floor existed under routine operating conditions. At the request of the union representative several samples were analyzed for additional metals, specifically lead and chromium.

The reader is referred to HETA reports 80-196-957² and 82-223-1340¹ if further information on past surveys and the subsequent findings are desired.

B. Process Description

Plastics I and II are exclusively injection molding departments. A variety of polyethylene items for household use (e.g. wash baskets, trash cans, pitchers, bowls, canisters, pails, etc.) are produced, assembled, and boxed in these areas. The polyethylene resin is fed into the machines either through a pneumatic resin handling system or from a hopper located directly above the injection molding machine. The company has switched over to granular polyethylene resin for the bulk of their products. Reground material may also be added to the system. Pigments are added to the resin in one of two ways. Colortronic units on pneumatically fed machines automatically mix pigments with the resin at the raw material inlet of the machine. Workers (primarily set-up) must periodically replenish the pigment supply in these units.

Plastics I has numerous machines which are fed raw material from totes (large metal containers) unlike Plastics II where all machines are pneumatically supplied. The totes are filled separately and then used to fill hoppers atop machines. Pigments are added to this system by weighing out specified amounts on a scale, dumping them into the tote with the resin, and then placing the tote in a tumbler which permits mixing of the tote's contents. Material Service workers in Plastics I have the primary responsibility for making up resin/pigment mixtures to keep the hoppers filled. Set-up workers tend the machines in Plastics I having colortronic units. The totes system is not used at all in Plastics II. These two departments operate 24 hours-a-day, five days per week and seven days per week if product sales dictate the necessity.

Granular polyethylene in use at the plant, per the manufacturer's material safety data sheet, has an average particle size of 6350 micrometers (0.25 inches). Finer particles also appear to be present but the pneumatic resin handling system is equipped with dust collection equipment. At the injection molding machines a fine mesh sleeve surrounds the pneumatic resin system point of discharge into the small machine hopper, located before the pigment/resin blending unit into which the resin feeds.

C. Pigments

During the previous surveys, numerous dry colorants in use contained metals such as lead, chromium, and cadmium, in addition to less toxic compounds such as titanium dioxide and iron oxide. Cadmium-containing colorants were in common use. A review of Material Safety Data Sheets for the pigments in use during the current survey indicates that only two of the 15 colorants used contained cadmium. A yellow and a dark almond pigment, both in use during the survey, contained cadmium in the form of cadmium sulfoselenide (cadmium selenide sulfide, CAS # 12626-36-7).

IV. METHODS AND MATERIALS

A. Metals

Personal exposure monitoring for cadmium, chromium, and lead was conducted using portable sampling pumps (DuPont P-2500®) precalibrated at a flow rate of two (2) liters per minute with a 0.8 micrometer pore size mixed cellulose ester membrane filter as the collection medium. Sample duration was intended to be full-shift but this was not possible in all cases. In these latter instances sampling was conducted only during the period of actual pigment handling or until the worker left or was reassigned to another job. Samples analyzed for cadmium alone used NIOSH Method 7048.³ Filters for cadmium, chromium, and lead were processed using NIOSH method 7300.³ These methods involve wet ashing of the filters and analysis by flame atomic absorption spectrometry. The analytical limit of detection for the cadmium-only samples was one (1) microgram (ug) per filter. Samples analyzed for cadmium, chromium, and lead had respective analytical limits of detection of 2 ug/filter, 5 ug/filter, and 5 ug/filter.

B. Respirable Dust

Personal and process monitoring for respirable dust levels was conducted using portable sampling pumps (DuPont P-2500's®) with 10 millimeter nylon cyclones and pre-weighed polyvinyl chloride filters as the collection medium. The flow rate used was 1.7 liters per minute. Weights of samples were determined by weighing the samples plus filters on an electrobalance and subtracting the previously determined tare weight of the filters. The tare and gross weighings were done in duplicate. The instrumental precision of weighings done at one sitting is 0.01 milligrams. Due to variable factors such as overloading, hygroscopicity of sample, humidity, and the physical integrity of the filter itself, the actual precision can be considerably poorer and occasional slight net negative particulate weights are to be expected.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

1. Cadmium

Cadmium is a toxic heavy metal which may enter the body either by inhalation (breathing) or by ingestion (swallowing) of cadmium metal or oxide. Once absorbed, cadmium accumulates in organs throughout the body, but major depositions occur in the liver and kidneys. Acute inhalation exposure to high levels of cadmium can cause pneumonia or pulmonary edema, as well as liver and kidney damage.⁴ Chronic exposure may lead to emphysema and kidney disease. The possibility that cadmium exposures may cause cancer of the prostate has been expressed, but this issue remains questionable.⁵

A recently completed follow-up mortality study among cadmium workers by Thun et al⁶ found an increase in deaths from lung cancer among workers exposed to cadmium at levels exceeding the NIOSH recommended full-shift exposure limit. An association of cadmium with nonmalignant gastrointestinal disease was also observed. Previous findings of prostatic cancer among exposed workers were somewhat weakened.

The current OSHA Standard for cadmium dust is 0.2 mg of cadmium dust per meter cubed of air (mg/m^3) averaged over an eight-hour work shift, with a ceiling level of $0.6 \text{ mg}/\text{m}^3$.⁷ NIOSH recommends that the permissible exposure limit be reduced to $0.040 \text{ mg}/\text{m}^3$ of cadmium averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of $0.2 \text{ mg}/\text{m}^3$ averaged over a 15-minute period.⁸ The ACGIH has recommended elimination of the $0.2 \text{ mg}/\text{m}^3$ short-term exposure limit for cadmium dusts and salts in the Notice of Intended Changes in the 1984-85 TLV® booklet.⁹ The eight hour TWA TLV® of $0.05 \text{ mg}/\text{m}^3$ has been retained.

2. Respirable Dust

The evaluation criteria applied to respirable dust data gathered during this survey, presumed to be primarily polyethylene dust, is that of nuisance dusts. The ACGIH definition considers "nuisance" dusts to be those having a long history of little adverse effect on lungs and which do not produce significant organic disease or toxic effect when

exposures are kept under reasonable control. The "nuisance" dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amount.⁹ The limit recommended by ACGIH⁹ and the OSHA⁷ permissible exposure limit for respirable nuisance dusts is 5 mg/m³.

VI. RESULTS AND DISCUSSION

Table I presents the sampling results for cadmium exposures obtained in Plastics I and II. Concentrations ranged from below detection limits up to 0.02 mg/m³ for all samples obtained - both short-term and full shift. All cadmium levels were below the NIOSH recommended exposure limit. The highest cadmium level occurred during the colortronic pigment replenishment at the beginning of the work shift. No individual worker performed more than one color changeover during a workshift and many did not have any color changeovers.

Table II presents the breathing zone and process sampling results for respirable dust in Plastics I and II. Respirable dust concentrations for all 19 samples collected were negligible. The maximum amount collected on any one sample was calculated to be less than 0.11 mg/m³ with 13 of the 19 samples (68%) having no reportable weight gain.

The elimination of cadmium compounds from most of the colorant formulations appears to have significantly reduced the cadmium exposures of workers handling the colorants. The maximum cadmium exposure in the June 1982, NIOSH survey was 0.043 mg/m³ (which included 1 color changeover), and 0.025 mg/m³ in a January 1983, NIOSH survey (which did not include any color changeover). Whereas cadmium was present in all Plastics II metal exposure monitoring conducted previously, during this survey only 2 of 15 (13%) had detectable cadmium exposures. No previous personal exposure monitoring for cadmium had been conducted in Plastics I. Limited process samples for cadmium conducted in the past in this area intended to demonstrate a worst case averaged 0.028 mg/m³ (HETA 80-196-957²).

The reduction in cadmium exposures remains even though the company discontinued vacuum clean up and returned to dry sweeping during color changeovers. The fact that cadmium compounds remain in at least two currently used colorants and that low level cadmium exposures were documented in a few samples emphasizes the need for continued good work practices and housekeeping in order to avoid higher cadmium exposures. The amount of the cadmium-containing pigments used can also offer increased exposure potential, should production demands require greater use of these pigments than occurred during the NIOSH survey.

No lead or chromium was detected in any of the seven samples analyzed for these contaminants. Table I indicates the samples analyzed for these additional metals.

Respirator use by some of the workers handling the colorants was observed, however, at the cadmium levels observed here respiratory protection for cadmium is optional. Workers indicated that they had been qualitatively fit-tested and instructed in the care and use of their respirators. The use of respiratory protection was generally limited to colorant replenishment or color changeovers. These procedures constituted only a portion of the work shift (generally less than 1.5 hours).

In summary, the reduction in cadmium content of most of the colorants appears to have substantially reduced worker exposure. The recommendations issued previously concerning Plastics II and pigment handling (See Section VII Recommendations) are offered again, at this time as a part of good industrial hygiene and housekeeping practices.

VII. RECOMMENDATIONS

A. Workpractices

1. Cadmium-containing pigments should be kept in closed containers, especially once a sack has been opened. Additionally, the transfer of the powder should be kept to a minimum and done in a manner to minimize dust generation.
2. All dry sweeping should be discontinued and preferably replaced with vacuuming, or at least wet mopping. The company should continue efforts to eliminate toxic metals from the pigments in favor of less toxic substitutes and to devise a more dust-free system of handling powdered materials. Spilled pigments should be cleaned up promptly.

B. Personal Hygiene

1. Food storage, handling, and consumption should be prohibited in cadmium work areas. Smoking or carrying uncovered tobacco or tobacco products in cadmium work areas should also be prohibited.
2. Workers should wash their hands before eating or before using tobacco to prevent their absorbing additional amounts of cadmium compounds. This practice should be followed for all pigments.

3. Work clothing and street clothing should be exchanged at the beginning and end of each workday to prevent the wearing of contaminated clothing outside the workplace.

C. Respiratory Protection

1. The respirators in use by set-up workers should be equipped with high efficiency particulate air (HEPA) filters. Single-use respirators should not be used for cadmium dust, and cartridges provide better protection than the approved dust pre-filter clipped onto half-mask respirators without cartridges. Qualitative fit testing should be done when issuing respirators, as well as at periodic intervals, and workers issued respirators should not be permitted to have beards that interfere with respirator fit.
2. Employees individually issued respiratory protection should be instructed in the proper inspection and maintenance of their equipment as well as being provided proper storage for the unit when not in use. Additionally, workers to whom respirators are issued should have received a medical evaluation to determine their ability to use a respirator.

VIII. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Rubbermaid Incorporated, Wooster, Ohio
2. United Rubber Workers of America, Local 302
3. United Rubber Workers of America, International
4. NIOSH, Region V
5. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I

Breathing Zone Exposures to Cadmium of Workers Handling Pigments in Plastics I and II

Rubbermaid Incorporated
 Wooster, Ohio
 HETA 84-230

June 13-14, 1984

Date	Shift (sample period)	Sample Description*		Duration (minutes)	Cadmium Concentration in mg/m ³ **	NOTES ⁺
		Location	Job			
6/13	07:00-15:00	Plastics I	Set-up	436	N.D.	A, C
	07:15-10:50		Set-up	155	N.D.	B, C
	07:15-08:30		Set-up	75	N.D.	B, C
	10:52-14:24		Set-up	212	N.D.	B, C
	07:22-12:50		Material Service	328	N.D.	B
	07:05-10:30		Material Service	205	0.01	B
	11:04-14:48		Material Service	224	0.005	B
	07:06-14:23		Utility Person	437	N.D.	
	07:01-14:43	Plastics II	Set-up	462	0.007	A, C
	07:03-08:05		Set-up	62	0.02	C
	09:51-10:19		Set-up	28	N.D.	C
	07:05-14:49		Set-up	464	N.D.	C
	07:06-12:40		Set-up	334	N.D.	B, C

(Continued)

Sample Description*						
Date	Shift (sample period)	Location	Job	Duration (minutes)	Cadmium Concentration in mg/m ³ **	NOTES ⁺
	15:00-22:18	Plastics I	Set-up	438	N.D.	C
	15:01-22:33		Set-up	452	N.D.]	C, D
	15:01-15:13		Set-up	12	N.D.]	B, C
	14:49-22:22		Material Handler	453	0.004	A
	14:54-18:45		Material Handler	231	0.004]	
	19:04-22:24		Material Handler	200	N.D.]	
	15:02-22:20	Plastics II	Set-up	438	N.D.	A, C
	15:05-22:21		Set-up	385	N.D.	C
	15:08-15:24		Mold Technician	16	N.D.	B, C
	15:10-15:45		Mold Technician	35	N.D.	B, C
	15:00-22:25		Utility	390	N.D.	
6/14	07:10-14:27	Plastics I	Set-up	437	N.D.	C
	07:05-10:17		Material Service	192	0.003	B
	07:03-13:00		Material Service	327	N.D.]	A, B
	07:03-08:10		Material Service	67	N.D.]	B
	10:53-14:20		Material Service	207	N.D.	A, B
	07:07-10:38		Utility	211	N.D.	B

(Continued)

Table I
Continued

Sample Description*						
Date	Shift (sample period)	Location	Job	Duration (minutes)	Cadmium Concentration in mg/m ³ **	NOTES ⁺
	06:59-14:44	Plastics II	Set-up	465	N.D.]	A, C
	07:00-07:43		Set-up	43	N.D.]	B
	07:04-14:41		Set-up	457	N.D.	C, E
	07:02-14:38		Set-up	456	N.D.	C, E
	07:00-14:38		Utility	458	N.D.	

Evaluation Criteria: NIOSH Full-shift Time Weighted Average: 0.04 mg/m³ 15 minute ceiling: 0.2 mg/m³++

+ Notes

A - Sample was also analyzed for total chromium and lead. Neither contaminant was present at detectable levels.

B - Some samples did not run for the entire shift because worker left early, was reassigned, or finished pigment handling (i.e. color changes) for his assigned shift. Short-term samples would also be the this category.

C - Sample included replenishment of colortronic unit with pigment at the start of a shift and/or a color change over.

D - Sample had evidence of tampering.

E - Wore dust respirator during pigment handling.

* Sample Description: The shift (or sample period) designates the time during which the sample was collected. Most pigment handling activity took place during the first one half hour to forty-five minutes of the shift when colortronic units were replenished. In Plastics I, Material Service workers had occasion to handle pigments throughout the shift when mixing pigments with resins.

(Continued)

Table II

Breathing Zone and Process Sampling Results for Respirable Dust in Plastics I and II

Rubbermaid Incorporated
 Wooster, Ohio
 HETA 84-230

June 13-14, 1984

Sample Description			
Date	Location and Type*	Duration (minutes)	Respirable Dust Concentration in mg/m ^{3**}
6/13	Plastics I		
	Presses 611 & 612, BZ, Product Processor	409	Trace
	Presses 611 & 612, BZ, Product Processor	407	Trace
	Press 612, Area, Edge of Granular Polyethylene Hopper	449	N.D.
	68 Module, BZ, Product Processor	395	Trace
	Area, Edge of Press Hopper with Granular Polyethylene	445	Trace
6/13	Plastics II		
	Presses A1 & A3, BZ, Product Processor	379	N.D.

(Continued)

** Bracketed values are for one job that was split up among more than one worker for reasons noted in B above; or to designate a short term sample obtained during a peak exposure period for which there is also a corresponding full-shift or longer term sample.

++ The ACGIH has proposed in their Notice of Intended Changes for 1984-85 that the short term exposure limit for cadmium dusts and salts of 0.2 mg/m^3 be deleted. See reference 9.

Table II
Continued

Sample Description			
Date	Location and Type	Duration (minutes)	Respirable Dust Concentration in mg/m ^{3**}
	Press A3, Area, Edge of Granular Polyethylene Hopper	451	Trace
	Presses B1-B4, BZ, Product Processor	364	N.D.
	Press B5, Area, Edge of Granular Polyethylene Hopper	434	N.D.
6/14	Plastics I		
	68 Module, BZ, Product Processor	416	N.D.
	Press 612, Area, Edge of Granular Polyethylene Hopper	429	N.D.
	Press 610, Area	374	N.D.
	Press 68, Area, Edge of Granular Polyethylene Hopper	385	N.D.
	Press 69, Area	434	Trace
6/14	Plastics II		
	Press B5, BZ, Product Processor	449	N.D.

(Continued)

Table II
Continued

Sample Description		
Date	Location and Type	Respirable Dust Concentration in mg/m ^{3**}
	Press B5, Area, Edge of Granular Polyethylene Hopper	452
	Press B9, Area, Edge of Granular Polyethylene Hopper	435
	Press B11, BZ, Product Processor	429
	Press B11, Area, Edge of Granular Polyethylene Hopper	436
Evaluation Criteria: ACGIH Respirable Nuisance Dust		5 mg/m ³

* BZ = Breathing Zone; Product Processor is the job title of workers stationed at the machines.

** Concentration given in milligrams per meter cubed (mg/m³)

Trace denotes that a slight weight gain was measured and in this sample set the concentration would be less than 0.11 mg/m³.

N.D. = No weight gain reported other than for that attributable to hygroscopicity of the sample, humidity, and precision in weighing.

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