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RUBBERMAID, INC.
REYNOLDS, INDIANA

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I. SUMMARY

On January 16, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from a management representative of Rubbermaid, Inc., Reynolds, Indiana. Rubbermaid manufactures thermoset microwave cookware and other molded plastic products at this facility. NIOSH evaluated potential worker exposure to airborne **formaldehyde** in the Press Department and **total and respirable dust** in the Compounding Department. NIOSH was also requested to collect air samples to identify other airborne organic chemicals in these departments.

On February 19 and 20, 1992, NIOSH investigators conducted a health hazard evaluation at Rubbermaid to assess potential worker exposure to airborne **formaldehyde** and **total and respirable dust**. Personal breathing zone (PBZ) airborne **formaldehyde** concentrations for nine press operators in the Press Department ranged from 0.52 to 1.75 parts per million (ppm) with a mean of 1.10 ppm. Seven of these samples exceeded the Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL) of 0.75 ppm. Area airborne **formaldehyde** samples collected at 15 locations in the Press Department ranged from 0.23 to 1.98 ppm with a mean of 1.15 ppm (n=33). Two area samples collected in the Bipel booth yielded airborne **formaldehyde** concentrations of 0.08 and 0.32 ppm.

Six area air samples were collected in the Bipel booth in the Compounding Department to assess potential worker exposure to **total and respirable dust**. **Total dust** concentrations within the booth were 2.25 and 2.47 milligrams per cubic meter (mg/m^3) and were 0.05 mg/m^3 just outside the booth. **Respirable dust** concentrations within the Bipel booth were 0.69 and 0.56 mg/m^3 within the booth and 0.01 mg/m^3 just outside the booth. The difference in dust concentrations within the booth and just outside the booth indicate that the booth effectively contains the dust that is generated at that operation.

Air samples collected throughout the plant were analyzed for various organic compounds. Styrene, isopropanol, toluene, and 1,1,1-trichloroethane were detected in very low quantities on some of these samples.

Based on the results of this evaluation, it was determined that press operators' formaldehyde exposures were a health hazard at this plant. Engineering controls and compliance with the OSHA formaldehyde standard (CFR 29 part 1910, §1910.1048) are recommended.

KEYWORDS: SIC 3089 (Plastics Products), styrene, formaldehyde, melamine, polyester resin, dust, thermoset cookware, ventilation.

II. INTRODUCTION

On January 16, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from a management representative of Rubbermaid, Inc., Reynolds, Indiana. Rubbermaid manufactures thermoset microwave cookware and other molded plastic products at this plant. NIOSH was requested to evaluate airborne concentrations of formaldehyde in the Press Department and airborne particulates in the Bipel booth in the Compounding Department. No health effects were reported in the request.

On February 19 and 20, 1992, NIOSH investigators conducted an industrial hygiene survey in the plant. Personal breathing zone (**PBZ**) and area samples for formaldehyde, area samples for dust, and area samples for volatile organic compounds were collected in the Compounding and Press Departments.

III. BACKGROUND

The Rubbermaid, Inc., facility in Reynolds, Indiana is a single-story building where about 175 people are employed, of whom 150 work in production areas. Rubbermaid manufactures thermoset (irreversibly hardened) plastic cookware products at this facility.

The production area is divided into three departments (Figure 1). In the Compounding Department, melamine-formaldehyde powder is compressed into small pellets which are placed in crates for transport to the Press Department, where they are molded into the desired shape. Pieces are then sent to the Product Process Department where parts are trimmed and packaged. The office area (adjacent to production) is used by about 25 employees for administrative and research purposes.

The greatest potential for exposure to airborne formaldehyde was in the Press Department where melamine-based tablets are compressed with heated dies into desired products. Formaldehyde gas is evolved as a product from the breakdown of melamine during this process. None of the presses had local exhaust ventilation. Before the melamine tablets were placed in the press they were preheated for about a minute in small ovens near the presses. When these ovens were opened there was also the potential for exposure to airborne formaldehyde. None of the preheat ovens were equipped with local exhaust ventilation.

The melamine-based tablets were formed automatically by a machine in an enclosed room (Bipel booth) in the Compounding Department, equipped with a plastic curtain at the entrance to prevent dust from escaping to the rest of the Compounding Department. The machine operator worked inside the Bipel booth. Melamine-formaldehyde powder was fed to a press from a bin in the room through a vacuum apparatus on the roof of the room. After the powder was compressed into tablets, they were taken by the operator and stacked into crates for transport to the Press Department. A protective suit and respirator were provided for this press operator.

IV. EVALUATION DESIGN AND METHODS

Airborne formaldehyde concentrations were measured using two different methods. A liquid-filled impinger method and a solid sorbent tube method were used. The impinger method is more sensitive than the sorbent tube method in detecting airborne formaldehyde, but the impinger uses a liquid which can be spilled during PBZ sampling. For these reasons, and to compare the results from the two methods, both methods were used. To assess airborne formaldehyde concentrations, 25 full-shift samples were collected using a sorbent tube (16 general area and nine personal exposure) and 19 full-shift general area samples were collected using an impinger. Ten of the impinger samples were collected side-by-side with sorbent tube samples at the locations presented in Table 2. These side-by-side samples were collected in order to compare the two air sampling methods. Six general area dust samples were collected (three total dust and three respirable dust). Six general area samples were collected on charcoal tubes to assess airborne concentrations of other volatile organic contaminants.

Formaldehyde samples were collected on solid sorbent tubes (treated XAD-2) connected via Tygon™ tubing to battery-powered vacuum pumps calibrated at a flow rate of 0.07 liters per minute (**ℓpm**). These sorbent tubes were analyzed using gas chromatography (**GC**) and a flame ionization detector (**FID**) according to NIOSH method 2541.[2] The analytical limit of detection (**LOD**) was 3.0 micrograms (µg) per sample, which equates to a minimum detectable concentration (**MDC**) of 0.01 ppm for a 28-ℓ sample.

Formaldehyde samples were also collected by drawing air through a glass impingers containing 20 milliliters (**ml**) of 1.0% aqueous sodium bisulfite solution. The glass impingers were connected to battery-powered pumps that were calibrated at a flow rate of 750 ml per minute. At the laboratory, this solution was then analyzed by reaction with sulfuric acid and chromotropic acid and then quantitated by visible absorption spectrophotometry in accordance with NIOSH method 3500.[3]

Area and personal samples for total and respirable dust were collected on tared 37-mm filters connected via Tygon™ tubing to battery-powered pumps. The total dust pumps were calibrated at a flow rate of 2.0 ℓpm. Sample weights were determined by weighing the samples and filters on an electrobalance and subtracting the tare weights of the filters (NIOSH method 0500[4]). The air samples for respirable dust were collected on filters mounted in 10-mm Dorr-Oliver nylon cyclones, which remove the non-respirable particles (particles >10 microns (**µm**) mass median diameter) from the sample air stream (NIOSH method 0600[5]). The sampling train for the respirable fraction was calibrated at 1.7 ℓpm. The LOD for both methods was 0.01 milligrams (**mg**) per sample (0.014 milligrams per cubic meter [mg/m³] for a 700-ℓ sample).

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH investigators 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).

Three primary sources of environmental evaluation criteria are used in judging workplace exposures: 1) NIOSH Criteria Documents and Recommended Exposure Limits (**REL**), 2) the American Conference of Governmental Industrial Hygienists' (**ACGIH**) Threshold Limit Values (**TLV**), and 3) the Occupational Safety and Health Administration (**OSHA**) Permissible Exposure Limits (**PEL**).[6,7,8] The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; in contrast, the NIOSH-recommended exposure limits are primarily based upon the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing those levels found in this report, it should be noted that employers are legally required to meet those levels specified by an OSHA PEL.

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 (**STEL**) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

A. Formaldehyde

Symptoms of exposure to low concentrations of formaldehyde include irritation of the eyes, throat, and nose; headaches; nausea; congestion; asthma; and skin rashes. It is difficult to ascribe particular health effects to specific concentrations of formaldehyde to which people are exposed, because of variability in subjective responses and complaints. Irritation symptoms may occur in people exposed to formaldehyde at concentrations as low as 0.1 parts per million (ppm), but more frequently in exposures of 1.0 ppm and greater. Some sensitive children or elderly, those with preexisting allergies or respiratory diseases, and persons who have become sensitized from prior exposure may have symptoms from exposure to concentrations of formaldehyde between 0.05 and 0.10 ppm. Formaldehyde-induced asthma and bronchial hyperreactivity developed specifically to formaldehyde are uncommon.[9]

Formaldehyde vapor has been found to cause a rare form of cancer in rats. Whether these results can be extrapolated to human exposure is the subject of considerable speculation in the scientific literature. Studies of long-term human occupational exposure to formaldehyde have not detected an increase in nasal cancer. Nevertheless, the animal results have prompted NIOSH to recommend that formaldehyde be considered a potential occupational carcinogen and that workplace exposures be reduced to the lowest feasible limit.[10]

OSHA has recently reduced its PEL for formaldehyde to 0.75 ppm as a TWA during an 8-hour shift, with a 0.5 ppm action limit. In addition, a 15-min STEL was set at 2.0 ppm.[8] The ACGIH has given formaldehyde an A2 designation, indicating that ACGIH considers formaldehyde a suspected human carcinogen. The ACGIH TLV/TWA for formaldehyde is 1.0 ppm and the TLV/STEL is 2.0 ppm.[7] The ACGIH has issued a Notice of Intended Change for formaldehyde of 0.3 ppm for a TLV-ceiling.[7] If, after two years, no evidence comes to light that questions the appropriateness of the proposed change, the value will be considered for adoption into the TLV listing.

B. Total and Respirable Nuisance Particulate

The material safety data sheet (MSDS) supplied by the manufacturer of the granular melamine-formaldehyde molding compound indicates that the material is a nuisance dust and that the dust from the resin does not produce the toxicity hazards of formaldehyde. Nuisance particulates refer to a number of non-fibrogenic dusts or particulates which are common air contaminants and, as such, are normally found in the occupational environment. The human respirable range for particulate matter is generally considered to extend from 0.5 to 5.0 µm; only a few dust particles greater than 5.0 µm in diameter will be deposited in the respiratory tract, while particles less than 0.5 µm leave the lung without producing local adverse health effects. Inhalation of nuisance particulates normally will not cause adverse effects in the lung; however, excessive airborne concentrations may reduce visibility in the work environment and may also promote irritation of the eyes, nose, throat, and lungs.

NIOSH currently supports the ACGIH 8-hour TWA/TLV of 10 mg/m³ for total dust containing no asbestos and less than 1% crystalline silica.[6] The present OSHA standard is 15 mg/m³ for total dust, or 5 mg/m³ for respirable dust and is also expressed as an 8-hour TWA exposure.[8]

C. Formaldehyde on Dust

Although the manufacturer of the melamine-formaldehyde molding compound stated on the MSDS that the resin dust does not produce the toxicity hazards of formaldehyde, it was not clear from the MSDS if formaldehyde exposure could occur as a result of being exposed to airborne dust. Reaction of the dust with the mucous membranes of the workers could result in worker exposure to formaldehyde. It is not clear if such a reaction could take place with the melamine-formaldehyde dust. Although there are no evaluation criteria for formaldehyde on dust, previous studies have suggested an excess of cancers in the upper respiratory passages among workers exposed to formaldehyde and formaldehyde-containing dusts (garment manufacture).[11,12] It has been hypothesized that upper respiratory areas may be receiving additional formaldehyde exposure from the deposition of formaldehyde-containing particulate material in addition to the vapor phase formaldehyde which evolves from these materials.[13]

VI. RESULTS

PBZ and area sample results for formaldehyde, dust, and volatile organic contaminants are presented in Tables 1-6. The respective NIOSH RELs, ACGIH TLVs, and OSHA PELs are referenced at the bottom of each table.

Table 1 presents PBZ air sampling results for airborne formaldehyde concentration for nine press operators in the Press Department. These ranged in concentration from 0.52 to 1.75 ppm with a mean of 1.10 ppm. Seven of the nine samples were above the OSHA PEL of 0.75 ppm. All nine exceeded the 0.5 ppm OSHA action level, which triggers activities from the Standard which must be complied with (CFR 29, Part 1910, §1910.1048).[7] These include periodic employee monitoring, notification of workers of monitoring results, and the right for an employee representative to observe employee monitoring.

Table 2 presents area air sampling results for airborne formaldehyde at 15 locations in the Press Department and at one location in the Compounding Department. Results from both the impinger and sorbent tube methods of air sampling are presented in this table. Formaldehyde concentrations (measured with sorbent tubes) in the Press Department ranged from 0.23 to 1.96 ppm with a mean of 1.05 ppm (n=15). Formaldehyde concentrations (measured with impingers) in the Press Department ranged from 0.32 ppm to 1.98 ppm with a mean of 1.23 ppm (n=18). Airborne formaldehyde concentrations in the Bipel booth in the Compounding Department were 0.08 and 0.32 ppm. The sample times and air volumes for all of the formaldehyde samples are presented in Table 3.

A statistical comparison was made for the data from the two sampling methods. At 10 Press Department locations (see bold text, Table 2), air samples were collected side-by-side using both the sorbent tube and the impinger methods. The impinger results were paired with the sorbent tube results from the same sampling site and a two-tail paired t-test was performed on this data set to see if there was any statistical difference between the two sampling methods. The p-value for the two-tailed t-test was 0.099, which means that there was no statistically significant difference between the two methods of air sampling for formaldehyde.

Tables 4a and 4b present area and PBZ air sampling results for airborne formaldehyde during industrial hygiene surveys conducted at Rubbermaid on June 19, 1990, and August 2, 1990, respectively. Sampling locations for Tables 4a and 4b are shown in Figure 2. The data in Table 4a were collected using the impinger method.[3] Airborne formaldehyde concentrations ranged from 0.5 to 0.9 ppm with a mean of 0.6 ppm. The data in Table 4b were collected using the sorbent tube method.[2] Airborne formaldehyde concentrations ranged from 0.1 ppm in the Bipel booth to 0.8 ppm near the presses. The mean PBZ exposure in the Press Department was 0.5 ppm. The data suggests that worker exposures in 1990 (mean 0.5 ppm) were lower than in the current evaluation (mean 1.10 ppm). During the earlier surveys, local exhaust ventilation ducts were installed around the presses. By the time of the later survey (February 1992) the local exhaust ventilation systems had been removed.

Table 5 presents exposure concentrations for total and respirable dust in the Compounding Department. These samples were collected at two locations inside the Bipel booth [A & B] and on the cabinet just outside the booth [C]. The total dust

concentrations within the booth were 2.25 and 2.47 mg/m^3, while the respirable dust concentrations within the booth were 0.69 and 0.56 mg/m^3. The dust concentrations measured just outside the Bipel booth were 0.05 mg/m^3 (total) and 0.01 mg/m^3 (respirable). None of the six measurements exceed the ACGIH TLV or OSHA PEL for total or respirable dust. A machine operator worked inside the Bipel booth during the time of sampling. No one worked directly outside the booth, but the general area of the Compounding Department was used by a few workers throughout the day.

Tables 6a and 6b present the results of qualitative and quantitative analysis of the six other air samples for volatile organic compounds (VOCs). Table 6a shows that styrene was detected on all five of the qualitatively analyzed samples. Isopropanol and 1,1,1-trichloroethane were detected on three samples, and toluene was detected on two of the qualitative samples. Sample CT-6, which was collected in the maturation room, was analyzed quantitatively for styrene, toluene, and 1,1,1-trichloroethane. This sample was selected for quantitation due to management concern about VOCs in the maturation room. An airborne styrene concentration of 0.31 ppm was measured on this sample. This concentration is well below the established criteria for occupational exposure. The ACGIH TLV and NIOSH REL for styrene are both 50 ppm, while the OSHA PEL is 100 ppm.[6,7,8] Toluene and 1,1,1-trichloroethane were not detected on this sample.

VII. DISCUSSION

Results of PBZ air samples indicate that press operators in the Press Department were overexposed to formaldehyde at both the presses and the pre-heat ovens. There was no local exhaust ventilation for the presses or pre-heat ovens. During preheating and pressing of the melamine-formaldehyde pellets, the formaldehyde gas that was produced was not exhausted from the work space. The press operators were subsequently exposed to these elevated airborne formaldehyde concentrations. A NIOSH health hazard evaluation at this facility in 1990 (HETA 90-261), at which time the presses were equipped with local exhaust ventilation, found that all of the PBZ airborne formaldehyde concentrations for the press operators were less than the current PEL of 0.75 ppm.[4] It is likely that removal of these engineering controls has created an environment in which the workers are overexposed to formaldehyde.

Area airborne formaldehyde concentrations were also elevated. Most of the air samples showed formaldehyde concentrations above the PEL. The area samples were collected in the work area of each press operator. Consequently, the area airborne formaldehyde concentrations were very similar to the PBZ formaldehyde levels. Once again, removal of the local exhaust systems has allowed elevated formaldehyde concentrations to occur in the Press Department. Two area air samples were collected in the maintenance area adjacent to the Press Department. Airborne formaldehyde concentrations measured in the maintenance area were both higher than the PEL.

Two area air samples collected in the Bipel booth in the Compounding Department showed airborne formaldehyde concentrations that were well below the PEL for total and respirable dust. The potential for exposure to formaldehyde gas in the Bipel booth is low because the resin is in a granular form at that stage in the process. However, airborne particulates are generated during the formation of the melamine-formaldehyde

pellets. Therefore, the worker in the Bipel booth could be exposed to formaldehyde via these airborne particulates. Although the total and respirable airborne particulate concentrations were relatively low, it is possible that worker exposure to formaldehyde could occur as a result of exposure to the dust. Hydrolysis of chemically-bound formaldehyde from the inhaled dust could result in formaldehyde release in the upper respiratory tract after inhalation.[15] The difference between the total and respirable dust concentrations within the booth and just outside the booth indicate that the booth is effective at containing the dust that is generated during the manufacture of the melamine-formaldehyde pellets.

The results of one quantitative and five qualitative screen samples for organic compounds at the facility showed very low concentrations of styrene, isopropanol, toluene, and 1,1,1-trichloroethane, which do not represent a health hazard.

VIII. RECOMMENDATIONS

The following recommendations are made to help reduce the potential for exposure to formaldehyde, and to help ensure the safety of the workers at Rubbermaid, Inc. These recommendations are based on the environmental sampling results and observations made during the evaluation.

1. Engineering controls, including local exhaust ventilation systems should be installed at all of the presses and pre-heat ovens in the Press Department to remove airborne formaldehyde at the source, and minimize worker exposures.

2. Until engineering controls are implemented to reduce airborne formaldehyde concentrations, respiratory protection should be used by the press operators. A respiratory protection program, as described in CFR 29, part 1910, §1910.134 will be required. NIOSH recommends that workers exposed to potential occupational carcinogens be provided the most reliable and protective respirators; either supplied-air respirators with a full facepiece operated in pressure demand or other positive pressure mode, or self-contained breathing apparatus with a full facepiece operated in pressure demand or other positive pressure mode.

3. Previously existing local exhaust systems for the presses were often clogged with flashing from the production process. The exhaust systems should be designed to minimize debris accumulation and, once they are in place, they should be kept clear of plastic trimmings and other debris to ensure optimum performance.

4. Further monitoring of airborne formaldehyde concentrations should be conducted after engineering controls to reduce formaldehyde concentrations have been implemented.

5. Because of the high formaldehyde concentrations, Rubbermaid, Inc., must comply with the provisions of the OSHA formaldehyde standard as described in CFR 29, part 1910, §1910.1048. This standard requires that the employer, Rubbermaid, Inc., do the following:

- provide exposure monitoring
- establish regulated areas where the concentration of airborne formaldehyde exceeds the PEL
- institute engineering and work practice controls to reduce and maintain employee exposures to formaldehyde
- provide protective equipment and clothing to the workers
- provide change rooms for employees who are required to change from work clothing into protective clothing to prevent skin contact with formaldehyde
- provide housekeeping to reduce the chance of formaldehyde exposure
- adopt proper emergency procedures
- provide medical surveillance
- provide the workers with information regarding the hazard associated with formaldehyde

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY

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Copies of this report have been sent to:

1) Rubbermaid; Reynolds, Indiana
2) Rubbermaid; Wooster, Ohio
3) OSHA
4) Others as requested

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 1
Airborne PBZ* Formaldehyde Exposure Concentrations
Rubbermaid, Inc.
Reynolds, Indiana
February 19, 1992
HETA 92-117

Job/location	Sample Time (minutes)	Sample Volume (liters)	Concentration (ppm)**
Operator press 3 (front)	385	27.0	1.75
Operator press 12	392	27.4	1.34
Operator press 3 (preheat oven)	423	29.6	1.32
Operator press 4 (preheat oven)	421	29.5	1.16
Operator press 7	415	29.1	1.15
Operator press 10	414	29.0	1.12
Operator press 5 (front)	376	26.3	0.87
Operator press 2 (preheat oven)	427	29.9	0.71
Operator press 2 (preheat oven)	381	26.7	0.52
Overall average			1.10
Minimum Detectable Concentration (for a 28.0 liter sample)		28.0	0.01

Evaluation Criteria (ppm):		
	NIOSH REL	LFL***
	OSHA PEL	0.75
	ACGIH TLV (ceiling****)	0.3

* Personal Breathing Zone
** parts per million averaged over the duration of the sampling period
*** Lowest Feasible Level
**** Concentration that should not be exceeded during any part of the working exposure.

Table 2
Area Airborne Formaldehyde Exposure Concentrations (**ppm**)*
Rubbermaid, Inc., Reynolds, Indiana
February 19 & 20, 1992
HETA 92-117

Sample location	2/19/92 Sorbent tubes	2/19/92 Impingers	2/20/92 Impingers	Impinger mean value
Press 3 (back)	**1.96**	**1.72**	1.85	1.79
Press 6	**1.94**	**1.88**	1.70	1.79
Press 4 (back)	**1.93**	**1.88**		1.88
Press 4 (front)	**1.38**	**1.98**		1.98
Press 3 (front)	**1.35**	**1.57**		1.57
Press 7	**1.21**	**1.23**		1.23
Press 8 (workbench)	0.97		0.32	0.32
Press 2 (back)	0.88			---
Press 5 (front)	**0.84**	**1.33**	1.44	1.39
Press maintenance area	0.84		0.88	0.88
Press 13	**0.78**	**1.36**		1.36
Press 2 (front)	**0.54**	**0.46**	0.68	0.57
Press 9 (front)	0.52			---
Press 10	**0.43**	**0.71**	0.66	0.69
Press 12	0.23		0.57	0.57
Bipel booth (Compounding Dept.)	0.08		0.32	0.32
Press Department average	1.05	1.41	1.01	1.23
MDC****	0.01	0.002	0.002	

Evaluation Criteria (ppm):		
	NIOSH REL	LFL**
	OSHA PEL	0.75
	ACGIH TLV (ceiling ***)	0.3

* Parts per million over the duration of the sample time
** Lowest Feasible Level
*** Concentration that should not be exceeded during any part of the working exposure.
**** Minimum Detectable Concentration
Bold text: paired results used to compare methods

Table 3
Area Airborne Formaldehyde Sample Durations and Volumes
Rubbermaid, Inc., Reynolds, Indiana
February, 19 & 20, 1992
HETA 92-117

Sample location	2/19/92 Sorbent tubes		2/19/92 Impingers		2/20/92 Impingers	
	Sample time (minutes)	Volume (liters)	Sample time (minutes)	Volume (liters)	Sample time (minutes)	Volume (liters)
Press 3 (back)	457	32.0	394	299	440	334
Press 6	463	32.4	393	299	437	297
Press 4 (back)	458	32.1	394	299		
Press 4 (front)	457	32.0	395	300		
Press 3 (front)	455	31.9	395	300		
Press 7	461	32.3	393	299		
Press 8 (workbench)	421	29.5			442	336
Press 2 (back)	452	31.6				
Press 5 (front)	460	32.2	394	307	440	334
Press maintenance area	430	30.1			427	325
Press 13	449	31.4	393	299		
Press 2 (front)	451	31.6	393	299	423	288
Press 9 (front)	425	29.8				
Press 10	460	32.2	393	299	440	334
Press 12	441	30.9			436	331
Bipel booth	448	31.4			429	326

Table 4a
Airborne Formaldehyde Exposure Concentrations*
Rubbermaid, Inc.
Reynolds, Indiana
June 19, 1990
HETA 90-261

Sample location	Sample type	Sample time (minutes)	Sample volume (liters)	Concentration (ppm)
Press 401	Area	371	297	0.9
Press H-3	Area	350	280	0.6
Press H-3	Area	352	282	0.6
Press 402	Area	373	298	0.6
Melamine preform room (Bipel booth)	Area	371	297	0.6
Press G-3	Area	373	298	0.5
Press D-1	Area	342	274	0.5

Evaluation Criteria: NIOSH REL LFL**
OSHA PEL 1.0***
ACGIH TLV 1.0***

* These samples were collected using impingers according to NIOSH method 3500.[3]
** Lowest Feasible Level
*** The OSHA PEL and ACGIH TLV given here are the levels that were current at the time of the 1990 survey. These were changed to 0.75 ppm and 0.3 ppm (ceiling) in 1992. See evaluation criteria in Table 1.

Table 4b
Airborne Formaldehyde Exposure Concentrations*
Rubbermaid, Inc.
Reynolds, Indiana
August 2, 1990
HETA 90-261

Sample location	Sample type	Sample time (minutes)	Sample volume (liters)	Concentration (ppm)
Presses 403 & 404	Area	443	22.2	0.8
Press D-3 operator	PBZ	457	22.9	0.6
Press D-3 operator	PBZ	455	22.8	0.5
Press D-3 preheat oven	Area	443	22.2	0.5
Press D-1 operator	PBZ	469	23.5	0.5
Press 404 operator	PBZ	462	23.1	0.4
Press 403 operator	PBZ	461	23.1	0.3
Press 404	Area	455	22.8	0.2
Melamine preform (Bipel booth) operator	PBZ	454	22.7	0.2
Melamine preform room (bipel booth)	Area	458	22.9	0.1

Evaluation Criteria: NIOSH REL LFL**
OSHA PEL 1.0***
ACGIH TLV 1.0***

* These samples were collected using sorbent tubes according to NIOSH method 2541.[2]
** Lowest Feasible Level
*** The OSHA PEL and ACGIH TLV given here are the levels that were current at the time of the 1990 survey. These were changed to 0.75 ppm and 0.3 ppm (ceiling) in 1992. See evaluation criteria in Table 1.

Table 5
Area Airborne Exposure Concentrations for Total and Respirable Airborne Particulates
Rubbermaid, Inc.
Reynolds, Indiana
February 19 & 20, 1992
HETA 92-117

	Sample Time (minutes)	Sample Volume (liters)	Total Dust Concentration* (mg/m^3)	Respirable Dust Concentration* (mg/m^3)
[A] Inside Bipel booth	435	870	2.47	---
[A] Inside Bipel booth	436	741	---	0.69
[B] Inside Bipel booth	410	800	2.25	---
[B] Inside Bipel booth	410	697	---	0.56
[C] Outside booth on cabinet	416	811	0.05	---
[C] Outside booth on cabinet	416	693	---	0.01
Evaluation Criteria:		OSHA PEL	15.0	5.0
		ACGIH TLV	10.0	

*Averaged over the duration of the sample time

Table 6a
Results of Qualitative Analysis of Charcoal Tubes for Organic Compounds
Rubbermaid, Inc., Reynolds, Indiana
February 20, 1992
HETA 92-117

Sample #	Location	Compounds			
		Styrene	Isopropanol	1,1,1-Trichloroethane	Toluene
CT-1	Outside Bipel booth	✓			✓
CT-2	Finishing/packing area	✓	✓		
CT-3	Press room	✓	✓	✓	
CT-4	Press room	✓	✓	✓	✓
CT-5	Maturation room	✓		✓	

✓ Indicates that the compound was detected on the charcoal tube.

Table 6b
Area Airborne Concentrations of Organic Compounds
Rubbermaid, Inc., Reynolds, Indiana
February 20, 1992
HETA 92-117

Sample #	Location	Sample volume (liters)	Styrene (ppm*)	1,1,1-Trichloroethane (ppm)	Toluene (ppm)
CT-6	Maturation room	41.2	0.31	n.d.**	n.d.
	MDC***	41.2	0.06	0.04	0.06

* parts per million
** not detected
*** Minimum Detectable Concentration for a 41.2 liter air sample.

Figure 1
Rubbermaid, Inc., Reynolds, IN
HETA 92-117
2/20/92

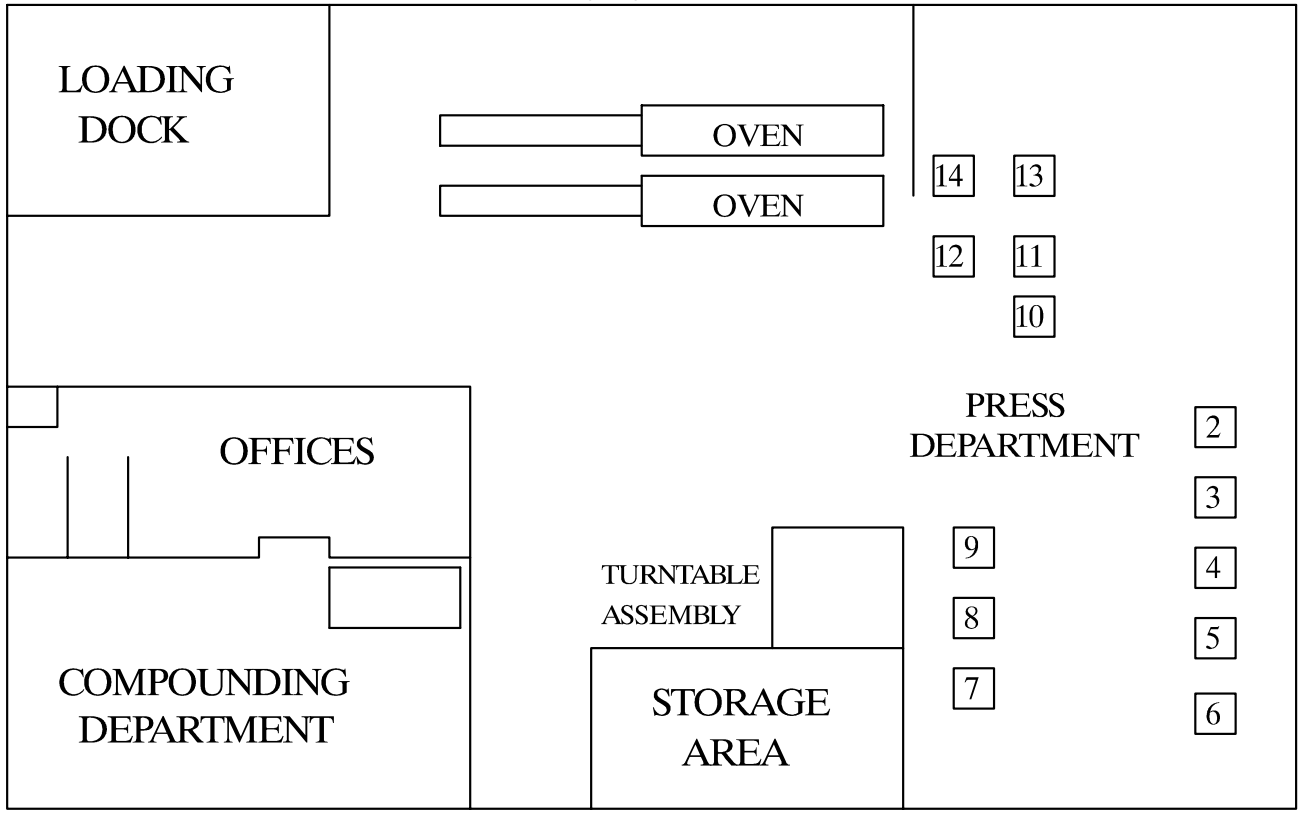

Figure 2 RUBBERMAID, INC. REYNOLDS, IN

HETA 90-261

6/19/90