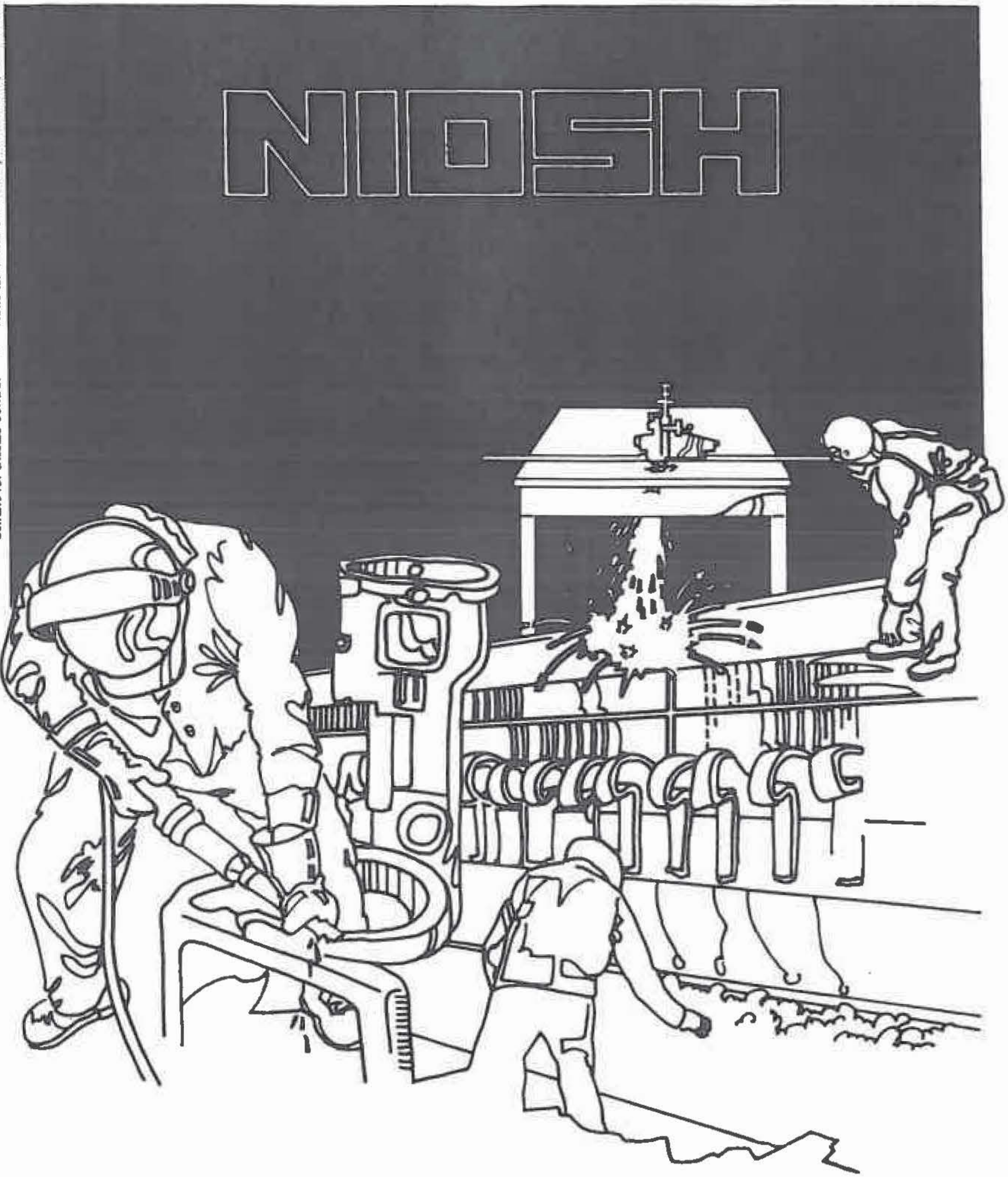
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HHE 80-196-957
RUBBERMAID, INC.
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.

HE 80-196 - 957
September 1981
Rubbermaid, Inc.
Wooster, Ohio

NIOSH INVESTIGATOR:
William N. Albrecht, IH

I. SUMMARY

In July, 1980, Rubbermaid, Inc. requested the National Institute for Occupational Safety and Health (NIOSH) provide a comprehensive evaluation of present working conditions and exposures in all phases of their manufacturing processes. The work force of 1820 manufactures thermoplastic and molded rubber goods for home uses.

Environmental surveys were conducted July 29 - August 1 and December 8-12, 1980, and March 30-31, 1981. During the first site visit, noise and illumination surveys were performed as well as area sampling for metals, silica, and nuisance particulates. Sound pressure levels throughout the facility were below the 85dbA NIOSH recommended level. Similarly, the current illumination scheme was satisfactory when compared to the intensities recommended by the Illumination Engineering Society. Area sample levels for lead, chromium, and titanium were below detectable limits. Zinc (as metal) in the compounding area averaged 17 ug/M^3. Personal exposures are to be limited to 5000 ug/M^3. Cadmium levels for the five area samples taken in the Plastics I averaged 28 ug/M^3. NIOSH recommends personal exposure limits of 40 ug/M^3. Since the area samples taken are an estimate of a 'worst case' situation, and because cadmium is not in use on a daily basis, no health hazards associated with the limited cadmium exposure are anticipated. Free silica was not found in any of the area samples for respirable nuisance dust. Dust levels were all below 1 mg/M^3.

The following two surveys emphasized sampling for nitrosamines in the press area of the Compression Molding department. Personal samples taken over four shifts on the press operators showed exposures which ranged from 29 to 212 parts per trillion (ppt) for N-dimethylnitrosamine (NDMA) with an average of 74 ppt. The other nitrosamine found in measurable quantities was N-nitrosomorpholine (NMOR). Exposures for NMOR ranged from 95 to 1124 ppt with an average exposure of 404 ppt. If ingested or inhaled in sufficient quantities, nitrosamines are capable of causing irreversible liver damage. Some nitrosamines have also been demonstrated in animal feeding experiments to cause cancers. The levels of nitrosamines measured in the compression molding department are lower than, or comparable to amounts found in other rubber industries.

On the basis of the data examined from the environmental surveys performed during the period July 1980 to March 1981, there appear to be no health hazards associated with any of the materials or processes in use at Rubbermaid, Inc. Recommendations addressing the improvement of ventilation capabilities for certain processes in the facility are included in the report. Management at Rubbermaid is encouraged to continue to maintain nitrosamine levels as low as practicable in the compression molding press area.

KEYWORDS: SIC 2820 (Plastics and Synthetic Resins), nitrosamines, synthetic rubber, rubber products.

II. INTRODUCTION

In July, 1980, Rubbermaid, Incorporated (SIC 2820) requested the National Institute for Occupational Safety and Health (NIOSH) to perform a health hazard evaluation at their facility in Wooster, Ohio. The nature of the request was for NIOSH to provide, in consultation, an evaluation of present working conditions and practices in all phases of their manufacturing processes.

An opening conference was conducted at Rubbermaid on July 29, 1980. Present at the meeting were representatives of Rubbermaid, United Rubber Workers Local 302, and NIOSH. Discussion centered about the general protocol for the conduct of the hazard evaluation, and various concerns of labor and management.

Environmental sampling has been performed previously by state and private agencies. NIOSH evaluated several concerns regarding changes in processes, situations which have not been previously examined, and hazards posed by exposure to physical agents at Rubbermaid.

A preliminary environmental study was conducted July 29 - August 1, 1980. Area sampling was done in the compression molding department. A cursory illumination and noise survey was performed throughout the facility. An Interim Report was issued October, 1980. Follow-up surveys were performed December 8-12, 1980, and March 30-31, 1981, with sampling focusing on the compression molding department.

III. BACKGROUND

Rubbermaid, Inc. manufactures a wide variety of plastic and synthetic rubber items primarily for household applications; especially in the kitchen and bathroom.

The complex employs 1820 people; 33% in administrative capacities, 59% in production, and the remainder in maintenance. Of the 1220 production employees, 58% are female. There are 3 shifts per day, 5 days a week. Compression molding is the most labor intensive department utilizing about 130 employees per shift. Average length of service plant-wide for males is 15 years and 11 years for females.

Production and warehousing at the site occupy over 1,000,000 sq. ft. of floor space. Four areas may be conveniently designated to describe the facility; injection molding, compression molding, Bowman Street operations, and warehousing.

A. Injection Molding

Injection molding (IM) is a technique used in the Plastics I and II departments to form semi-rigid thermoplastic objects of polyethylene and polypropylene. There are 83 injection molding machines of various manufacture, most of which are operating continuously. They are fed resin in the form of beads by a vacuum system. Colorants are added manually into hoppers which feed the process. The resin-color mixture is melted by a heated screw which directs the glob into the injector. Plastic now at 400°F is then injected into the mold where it solidifies upon cooling. Waste and scrap from IM is estimated at 2 1/2%. This plastic is shredded, reextruded, and reused. Items are ejected onto a conveyor which transports them to an assembly and packaging module. A module consists of a group of 5 or 6 employees around a circular, rotating conveyor, at which the products are inspected, labeled, and stacked or packaged. Up to eight machines supply a given module.

These modules are well removed from the heat and noise of the machines. Workers are allowed to rotate tasks to reduce monotony. Since the nature of the work is repetitive, the conviviality afforded by this arrangement helps to alleviate potential boredom.

B. Compression Molding

Compression Molding (CM) is a method of pressing synthetic rubber formulations into appropriate shapes. A mixture of synthetic rubber, in this case styrene-butadiene (SBR), clays, colorant, accelerators, retardants, and miscellaneous ingredients are compounded in the 'lodige' area. Batch size ranges from 2000-2700 lbs (909-1227 kg).

Commonly used accelerators include: 2-benzothiazyl disulfide (MBTS), a blend of 90% N-oxydiethylene benzothiazole-2-sulfenamide and benzothiazyl disulfide (NOBS #1), and tetramethylthiuram disulfide. A representative retardant would be N-cyclohexylthiophthalamide.

A 1000 lb portion of the batch is dispensed into a 1 cu yd plasticized cloth bag called a "Gaylord". The bag is funnel shaped and is set above a Farrell continuous mixer. This mixer also operates on the heated screw principle. Batch mix is gravity fed into a continuous screw which fuses it by friction. The 'rubber biscuit' is conveyed to the press for cure and final forming.

Two types of mold-curing presses are used at Rubbermaid. McNeil presses are electrically operated and the remaining presses are hydraulic. After molding, the articles are placed in a ventilated chamber to off-gas and cool prior to packaging.

Miscellaneous assembly and packaging operations are intermittently located throughout the plant. During one NIOSH visit a set of ultrasonic welders were in operation. Other situations included high-speed packaging and decal application.

C. Warehousing

Warehousing comprises the bulk of the facility. Sophisticated material transfer/handling systems are in use. It is beyond the scope of this report to describe the situation in detail. There were no industrial hygiene related problems observed to be associated with the warehousing practices.

D. Bowman Street Plant

The Bowman Street facility was the initial location of the Rubbermaid manufacturing operation. Presently it houses a variety of processes; plastic shelf paper is formed from low-density polyethylene and printed with designs, wire dish draining baskets are covered with a vinyl plastisol, placemats receive applique, non-slip flowers for the bottom of bathtubs are cut and packed, etc.

III. MATERIALS AND METHODS

Metals were collected on mixed cellulose ester (AA) filters. All metal samples were analyzed according to NIOSH Method No. P&CAM 173. Perchloric acid was used in all samples to aid in the wet ashing of the filters.

NIOSH Method No. P&CAM 259 was used to analyze the bulk and filter samples for free silica. The preweighed 'M5' filters were equipped with stainless steel cyclones to isolate the respirable fraction of 10 um and less particle size diameter. A flow rate of 2 lpm was used. Filters were dissolved in tetrahydrofuran rather than being ashed in a furnace. Standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than using the suggested normalization procedure. Two polymorphs of silica, quartz and cristobalite were examined.

Particulate weights were determined by preweighing sample filters and later reweighing them. The difference in filter weight from the previously tared weight is the dust weight. The instrumental precision of weighings done at one sitting is 0.01 mg.

Nitrosamine air sampling cartridges (Thermosorb/N) were used for the evaluation of ambient N-nitroso compund levels in the workplace air. Analyses requested were for N-nitrosodimethylamine (NDMA), N-nitroso-diethylamine (NDEA), N-nitrosodipropylamine (NDPA), N-nitrosodibutylamine, N-nitrosomorpholine (NMOR), N-nitrosodiphenylamine (NDPhA), and N-nitrosopyrrrolidine (NPYR).

The Thermosorb cartridges were eluted with 1.67 ml of methylene chloride: methanol; 75:25, as specified by Thermal Electron Corporation. The samples were then analyzed using a liquid chromatograph interfaced with a Thermal Energy Analyzer (LC/TEA). An HC Pellosil guard column and u Bondpack NH_2 analytical column with a flow rate of 0.5 ml/min was used. The solvent system consisted of isooctane:acetone; 97:3.

Additionally, four samples were analyzed for NDMA by a gas chromatograph interfaced with a TEA. The NMOR present was in relatively high amounts and obscured the NDMA during LC/TEA analysis. Dilution to analyze NMOR reduced the NDMA concentration to below instrumental detection limits. Recoveries for NDMA averaged 102% and for NMOR 86%.

Sound pressure levels were taken with a General Radio 1565-B Sound Level Meter. Illumination measurements were obtained with a General Electric #213 light meter. Ionizing radiation from the ^{85}Kr source of the thickness gauge was measured with a Dosimeter Corporation of America radiation contamination monitor which registers all ionizing radiations except x-ray.

IV. EVALUATION CRITERIA

Noise

NIOSH recommends that exposure to continuous noise be limited to 85 dbA for an eight hour shift (1).

Illumination

Recommended illumination levels are listed with the measured levels in Table I. The recommending body is the Illumination Engineering Society (2).

Nitrosamines

N-nitroso compounds are common environmental contaminants. As limits of detection become lower because of advances in analytical technology, more sources of nitrosamines are being discovered. A brief listing of common products which have been shown to contain nitroso-compounds include: foodstuffs, cosmetics, herbicides, liquor (both distilled and fermented), cutting fluids, etc.

Nitrosamines have been shown to cause a type of irreversible liver damage if sufficient amounts are fed to experimental animals or ingested by humans. Other feeding experiments have caused various cancers to form. Nitrosamines are definitely potent animal carcinogens when administered orally and in appropriate amounts. Little work has been done on the effects of inhaling nitrosamines, and no conclusive evidence exists for determining if workplace exposures cause the same effects as seen in experimental animals. Based on available data, nitrosamines are currently considered by NIOSH as 'suspect human carcinogens' and exposures should be controlled as such.

The Food and Drug Adminstration's action level for dimethylnitrosamine in beer is 5 ppb. A person drinking three cans of beer per day incurs a relative lifetime risk of 1 in 1000 in developing an 'excess' cancer.

Inhaling the smoke from a blended U.S. cigarette has been shown by Hoffman, etal. (3) to contain about 0.084 ug NDMA and 0.140 ug of N-nitrosonornictotine (NNN). A daily consumption of one pack would therefore constitute an inhalation dosage of approximately 1.5 ug NDMA and 3.0 ug of NNN, if the entire dose is absorbed.

A prudent recommended level in an occupational situation therefore must be weighed against exposures encountered during daily existence. Exposures should be maintained at levels as low as practicable in the workplace, and exposures should be docmented so that decisions regarding the need for control measures can be formed.

V. RESULTS

Except for some minor modifications in illumination levels, the noise and illumination survey did not reveal any marked problems either in lighting levels, or noise levels generated by the manufacturing equipment. The illumination between the aisles in general stores was measured at 2 L/ft^2 (lumens per square foot) and should be increased to 5 L/ft^2. See Table I for a summary of the noise and illumination survey results and the recommended levels for both.

The thickness gauge was evaluated by electrically forcing the shutter door of the gauge open and positioning it nearest the operator station, thereby achieving a greatly exaggerated exposure situation which will never occur if the machine is operating properly. Radiation levels were at background levels two feet from the open shutter door.

Metal levels in general were at or near the limit of detection. In the Plastics I area, two area exposures (85 and 2 ug/M^3) on lift-trucks averaged 44 ug/M^3 of cadmium (as metal), but the area-wide average level during the day NIOSH sampled was 28 ug/M^3. Since the area samples taken are an estimate of a 'worst case' situation, and because cadmium containing colorants are not used consistently in the Plastics operations, no health hazards associated with the limited cadmium exposures are anticipated. See Tables II and III for a summary of the metals survey results.

The summarized results of the sampling for nitrosamines are presented in Tables IV and V. The personal exposures to dimethylnitrosamine ranged from a high of 641 to a low of 87 ng/M^3 (212 to 29 ppt, i.e. part per trillion), while the values for nitrosomorpholine were a high of 5341 to 450 ng/M^3 (1124 to 95 ppt). The average personal exposures were 224 ng/M^3 NDMA and 1919 ng/M^3 (74 and 404 ppt). Area samples for NMOR behind the presses tended to have values about twice as high as the personal samples.

The personal exposures for all operators are uniform throughout the compression molding area. Area samples taken behind one of the presses gave values 38% higher for NDMA and 52% higher for NMOR. This demonstrates the effectiveness of the ventilation system currently in place in compression molding in reducing nitrosamine exposures.

In all cases, the area samples for respirable and total nuisance dust levels are well below the personal exposure criteria level of 10 mg/M^3. Additionally, there were no respirable quantities of any form of free silica. See Table VI for a summary of the dust sampling results.

VI. DISCUSSION AND CONCLUSIONS

The precursor sources of the nitrosamines are materials which comprise the rubber batch. Tetramethylthiuram disulfide, an accelerator, may be decomposed under heat and reformed with available NO_x to form dimethylnitrosamine. Likewise, a component of the NOBS #1 accelerator can be nitrosated to N-nitrosomorpholine.

Although a potential nitrosating agent has not been identified, the oxidation of a secondary or tertiary amine under heat and acidic conditions is a likely mechanism of the nitrosating reaction; similar to the 'Sandmeyer reaction'. Because of the inability to find the environmental source of the nitrosating agent, recommendations toward the reduction of levels cannot be made from the viewpoint of a process modification; except the obvious replacement of the accelerators which provide the amine portion of the nitrosated amines. This recommendation is not currently justified based on the measured environmental levels.

VII. RECOMMENDATIONS

1. Personal hearing protection should be worn at all times when operating or working near the shredder.

2. Employees operating sonic welders should close the door on the enclosure when welds are made.

3. Illumination between the aisles in the general stores should be at least 5 L/ft^2.

4. NIOSH approved respirators of proper type and fit should be worn at all times when handling pigments and solvents in the color blending room. A dust and particulate type is suggested for blending in the Harshaw mixer. An organic vapor/air purifying type should be used when the mixer is cleaned.

5. The primary hoppering room located on the roof above compression molding should be vacuum-cleaned periodically, and routinely if there is frequent activity inside. A dust/particulate mask must be worn at all times until clean-up is accomplished.

6. The Vaqua Processing Unit/Sandblaster should be inspected periodically for grit leaks. Optimally it should be modified to more closely model the cabinet suggested in VS-101.1 (Figure 1). The cloth recirculation duct on the present machine was observed to have grit leaking when the machine was in operation.

7. Welding should be performed with ventilation as suggested in VS-416, VS-416.1 (Figs. 2 and 3).

8. Recommendations for improvement in caustic dip and open dip tanks are not made at this time, but refer to VS-502, VS-503, and VS-504 for examples of such systems (Figs. 4, 5, and 6).

9. Solvent storage upstairs at Bowman Street is unsatisfactory. Solvents no longer needed should be disposed of properly. Solvents which must be stored should be maintained outdoors in a metal explosion proof building with adequate ventilation and grounding.

10. A ventilation scheme should be devised for drawing vapors and particulates out of the breathing zone of those employees who fuse the nibs on the bottom of the plasticized dish draining racks. At present, the placement of the fans dilute the contaminants but also push it into the breathing zone of the workers as demonstrated by smoke tube. Local exhaust ventilation is optimal although a drastic improvement in general ventilation may be acceptable (VS-602, Fig. 7).

11. Eating, drinking, smoking, or the application of cosmetics should be allowed only in designated areas.

12. Bowman Street Operations/ Wire Division:

i.) Once the ventilation system for the addition to the facility has been installed, it would be desirable to upgrade and/or retrofit the existing exhaust ventilation system of the Organosol dip/oven to increase the air flow. This would complement and enhance natural ventilation patterns which exist in the building. Until this addition can be affected, the current practice of stationing fans for worker-cooling and contaminant dispersal should emphasize the concept of drawing contaminants away from the breathing zones of the workers. Therefore, all fans should be oriented from back to front in the wire basket work area, so that the flow originates at the back of the area and is directed toward the exhaust fans situated above the take-off end of the Organosol oven. This will decrease the amount of stagnant air and up-welling of contaminants; situations which were observed during the NIOSH visits.

ii.) Although it was not possible to measure contaminants suspected to exist from the fusing of Organosol nibs on the bottom of the wire baskets, or from the decomposition of the silicone lubricant used to maintain plastic-free soldering iron tips, it is recommended that all soldering irons be rewired to 220V. By decreasing the voltage requirement by one- half, the iron tip temperature will be decreased from about 855°F (457°C) to 428°F (229°C). Unless there is a need for the higher tip temperature, the lower tip temperature will be below the temperature at which the silicone lubricant decomposes or burns (550°F).

13. Resin Reclamation Area

i.) When plastic decomposes at elevated temperatures, certain unpleasant odors and possibly irritating emissions are generated. Two sources of odors in the resin reclamation area have been identified; the extruder head and the sand bath.

ii.) The present exhaust ventilation system for the extruder is poorly designed and installed. To improve the efficiency and efficacy of the present system, utilizing the existing air-moving equipment, it is desirable to decrease duct diameter thus increasing capture velocity, center the exhaust inlet over the extruder head, and lower the hood height 4 to 6 inches.

iii.) The sand bath exhaust is also poorly constructed. Duct joints should be such that leaks do not occur. The air-mover should be upgraded, depending upon the future of the existing duct-work.

iv.) Because air-flow charcteristics over flat-roofed buildings tend to cause a layer of semi-impermeable strata immediately above the roof, exhaust stacks are generally recommended to be raised one and one-half the height of the building. The exhaust for the extruder head is at roof level, below the confining layer of air. When prevailing winds blow in the appropriate direction, odors vented onto the roof from the extruder head exhaust are conceivably being entrained by the air intake house which supplies Module 61. The same is true of the exhaust for the sand bath, although that exhaust is elevated. Suggestions offered by the engineering staff at Rubbermaid are in accordance with those made by NIOSH. The exhaust stacks are to be combined for the extruder head and sand bath, and are to be elevated at least an additional ten feet above the roof of the penthouse.

14. Compression Molding Area

i.) Employees working in the batch color blending area should be equipped with properly fitting, NIOSH approved air-purifying respirators when using 1,1,1 trichloroethane to clean the mixers.

ii.) The existing vacuum system in the blending area should be used for all dust retrieval.

iii.) A respirator program should be enacted to ensure proper fit on employees, and adequate cleansing and storage procedures.

iv.) It is the opinion of the NIOSH investigator that the ventilation measures now in effect at Rubbermaid, Inc. are the most feasible and efficacious method for controlling the nitrosamine exposure situation. (At this time, recommendations for the reduction of nitrosamine levels cannot be made, since no well-defined criteria exists for such exposures.)

15. Plastics I and II

i.) Concern has been expressed regarding the colorants used in the Plastics I and II area. Although the materials do contain metals which are considered toxic and/or hazardous at excessive levels, as used and measured in the area, they do not appear to present a problem. Lift-truck operators that handle tote-bins should exercise sound work practices when dumping large volumes of materials. In the interest of providing an additional margin of safety to the workers who perform the color changes, and because actual physical contact with the colors is intermittent, particulate masks and cotton or rubber gloves should be worn by employees when they do the color changing operation. Additionally, after the color change, workers are encouraged to wash thoroughly with an appropriate cleanser.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Supervisor for Safety and Security, Rubbermaid, Inc., 1147 Akron Road, Wooster, Ohio 44691.

2. Safety Committee Chairman, Local 302 URW.

3. U.S. Department of Labor - OSHA Region V.

4. NIOSH Region V

For the purposes of informing employees of Rubbermaid, Inc., the employer shall post a copy of this report in a prominent place so that it may be examined by the employees near a place where they work.

REFERENCES

1. Occupational Exposure To Noise. NIOSH Publication No. 73-11001 (1972).

2. IES Lighting Handbook, 5th ed., Illuminating Engineering Society, New York (1972).

3. Hoffman, D., etal. Chemical Studies on Tobacco Smoke XXVI. On the isolation and identification of volatile and non-volatile N-nitrosamines and hydrazines in cigarette smoke. In: Bogovski, P. and E.A. Walker eds. "N-nitroso compounds in the environment." IARC Pub. No. 9, Lyon (1974).

TABLE I
NOISE and ILLUMINATION SURVEY

Rubbermaid Incorporated
Wooster, Ohio
14 AUG 80

Work Station/Location	Noise Levels Measured (dBA)	Noise Levels Recommended[1] (dBA)	Illumination Measured (L/Ft²)	Illumination Recommended[2] (L/Ft²)	Category for Illumination Recommendation
Plastics I					
In front of shredder	92		20	30	Milling
Module 52	77	85	39-41	50	Materials handling - wrapping, packing, labeling
Color bins	79-81	85	11	10	Storage room - active rough bulky
Tumblers	84	85	18	20	Rubber goods - mechanical stock preparation
Module 27	81	85	64	50	Materials handling - wrapping, packing, labeling
Module 212	76	85	55	50	Materials handling - wrapping, packing, labeling
Plastics II					
Area 624	82	85	51	50	Materials handling - wrapping, packing, labeling
Machine B9 side	81	85	10	10	
Machine B5	85	85	52	50	Materials handling - wrapping, packing, labeling
Warehousing/Packing					
Racetrack packer	73	85	10	10	Warehouse - active rough bulky
Central stores					
Aisle shelves 8-21	68	85	2	5	Storage rooms - inactive
Assembly/Packaging					
Ultrasonic welder #1					
Bkgd	77	85	24	30	Assembly - rough easy seeing
Weld w/door closed	86				
Ultrasonic welder #3	70	85	50	30	Assembly - rough easy seeing
Bkgd					
Weld w/door closed	90				
Amscomatic 500	87-88	85	30	30	Assembly - rough easy seeing
A&D Amsco	77	85	42	30	Assembly - rough easy seeing

TABLE I (Continued)
Noise and Illumination Survey

Work Station/Location	Noise Levels Measured (dBA slow)	Noise Levels Recommended (dBA)	Illumination Measured (L/Ft^2)	Illumination Recommended (L/Ft^2)	Category for Illumination Recommendation
Compression molding					
Rotary federal press #7				50	Machine shop - rough work
Bkgd	76	85			
Impact	98	127/impact			
@ 380/hr, 3040/day					
Hydraulic #14 front	82	85	120	50	Rubber goods - molded products
Hydraulic #16 front	80	85	110	50	Rubber goods - molded products
Press #5 (not operating)	74	85		50	Machine shop - rough work
Compounding deck (auger off)	80	85	16	30	Rubber goods - stock preparation

References:

1. Occupational Exposure to Noise. NIOSH Publication 73-1101 (1973).

2. IES Lighting Handbook, Fig. 9-80. Illuminating Engineering Society, New York (1972).

TABLE II

METAL LEVELS - INJECTION MOLDING AREA - PLASTICS I
(in micrograms per cubic meter)

Rubbermaid, Inc.
Wooster, Ohio

10 DEC 80

Location	Sampling Time(min)	Cadmium	Lead	Titanium
mixer lift-truck	275	2	n.d.	n.d.
mixer lift-truck	255	85	n.d.	n.d.
tumblers	371	10	n.d.	n.d.
misc. tumblers	369	43	n.d.	n.d.
scale in front of womens room	364	1	n.d.	n.d.
(limit of detection in ug/filter)		1	4	25

n.d. means not detected

TABLE III

METAL LEVELS - COMPRESSION MOLDING AREA
(in micrograms per cubic meter)

Rubbermaid, Inc.
Wooster, Ohio

30 JUL 80

Job Category/Location	Sampling Time(min)	Zinc	Chromium	Lead
Lodige weigh station (1)	432	20	ND	ND
Lodige weigh station (2)	396	34	ND	ND
Compounding station (1)	423	30	ND	ND
Compounding station (2)	400	7	ND	ND
Lift truck driver*	420	5	ND	ND
Bag loading station	407	3	ND	ND
(limit of detection in ug/filter)		2	3	4
NIOSH Recommended Exposure Levels in ug/M3		5000	100	50
OSHA Permissible Exposure Levels in ug/M3		5000	100	50

* Personal sample
ND means not detected

TABLE IV

NITROSAMINE LEVELS -- COMPRESSION MOLDING DEPARTMENT -- RUBBERMAID, INC.
WOOSTER, OHIO 10 DEC 80

Job/Location	time (min)	vol (1)	NDMA(i) corrected ng/M3-ppt	NMOR(ii) corrected ng/M3-ppt	NBNA(iii) corrected ng/M3-ppt
Personal/Operator McNeil 3&4	353	706	93/31	794/167	*
Personal/Operator Hydr 10	372	744	139/46	1870/394	9/1
Personal/Operator McNeil 13&14	356	712	145/48	450/95	35/5
Personal/Operator McNeil 5&6	358	716	121/40	1108/233	23/3
Personal/Operator McNeil 7&8	343	686	87/29	709/149	*
Personal/Operator Hydr 16	423	846	143/47	1214/256	*
Personal/Operator Hydr 15	430	860	127/42	2536/534	*
Personal/Operator Hydr 10	421	842	233/77	5341/1124	*
Personal/Operator McNeil 2	419	838	132/44	2753/580	*
Personal/Operator McNeil 7	416	832	177/58	649/137	23/3
Blank			12/4	*	*
			n=10 X=140/46 sd=42/14	n=10 X=1742/367 sd=1496/315	n=4 X=23/3

i) NDMA : N-dimethylnitrosamine 98% recovery
ii) NMOR : N-nitrosomorpholine 86% recovery
iii) NDBA : N-dibutylnitrosamine 96% recovery
ND : not detected

TABLE V

NITROSAMINE LEVELS -- COMPRESSION MOLDING DEPARTMENT -- RUBBERMAID, INC.
WOOSTER, OHIO 30 MAR 81

Job/Location	time (min)	vol (l)	NDMA(i) corrected ng/M3-ppt	NMOR(ii) corrected ng/M3-ppt	NPYR(iii) corrected ng/M3-ppt	
Personal/Operator Hydr 13	394	788	355/117	2304/485	*	
Personal/Operator Hydr 29&30	392	784	641/212	2843/599	70/17	
Personal/Operator Hydr 31&32	390	780	374/123	2635/555	*	
Personal/Operator McNeil 7&8	382	764	224/74	1569/330	*	
Personal/Operator McNeil 9&10	379	758	269/89	1401/295	*	
Personal/Operator Hydr 13	446	892	197/65	2305/485	*	
Personal/Operator Hydr 29&30	dead	(iv)	218/72	2514/529	*	
Personal/Operator Hydr 31&32	442	884	239/79	2089/440	*	
Personal/Operator McNeil 7&8	439	878	327/108	1909/402	*	
Personal/Operator McNeil 9&10	436	872	232/77	1378/290	*	
		n=10	X=308/102 sd=132/44	X=2095/441 sd= 519/109		
area behind Hydr 19 next to extruder	337	674	412/136	5038/1061	ND	*
same area	358	716	524/173	4765/1003	ND	*
same area	325	650	533/176	3170/667	ND	*
			X=490/162	X=4324/911		

i) NDMA : N-dimethylnitrosamine 98% recovery
ii) NMOR : N-nitrosomorpholine 86% recovery
iii) NPYR : N-nitrosopyrrolidine 99% recovery
iv) estimated volume
ND : not detected

TABLE VI

FREE SILICA AND RESPIRABLE NUISANCE DUST LEVELS
(in milligrams/cubic meter)

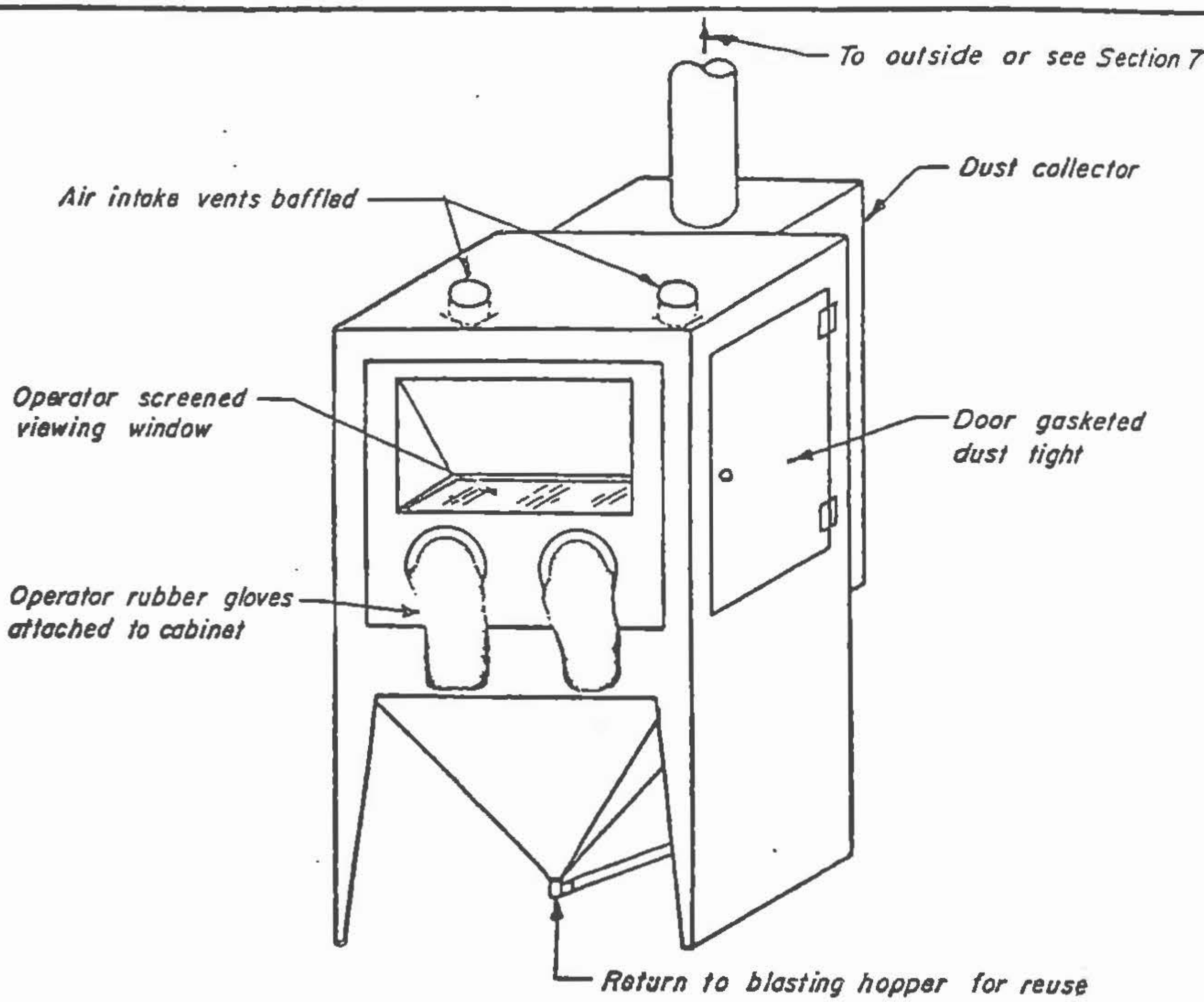
Rubbermaid Inc., Wooster, OH.
1 AUG 81

Area	Dust	free silica as quartz
Compounding weigh station	0.41	ND*
Compounding weigh station	0.37	ND
Lodige weigh station	0.31	ND
Lodige weigh station	0.32	ND
Bag loading area	0.77	ND
Bag loading area	0.29	ND
Aisle bewteen presses	3.26 (Total dust)	0.07
Lower limit of quantitation	0.03	0.03

* ND means not detected.

FIGURE 1

SPECIFIC OPERATIONS



20 air changes per minute
At least 500 fpm inward velocity at all openings
Entry loss = 1 VP plus collector

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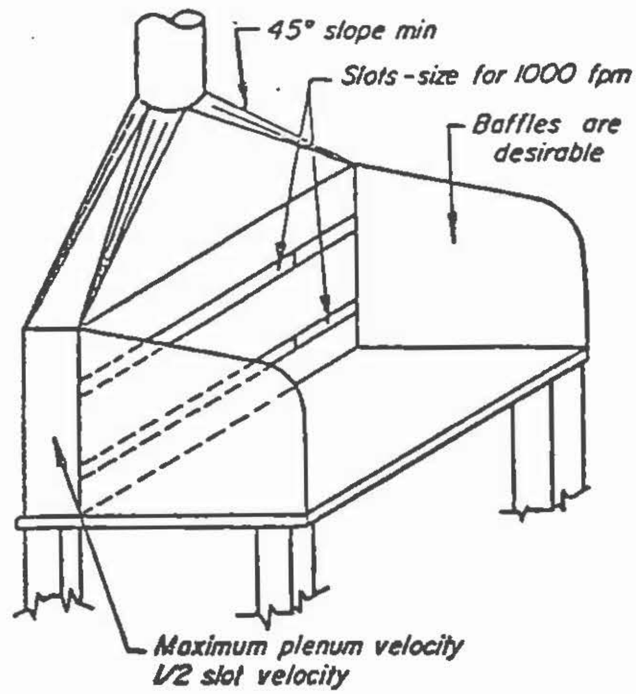
ABRASIVE BLASTING CABINET	
DATE 1-78	VS-101.1

FIGURE 2

SPECIFIC OPERATIONS



Q = 350 cfm/lineal ft of hood
Hood length = required working space
Bench width = 24" maximum
Duct velocity = 1000 - 3000 fpm
Entry loss = 1.78 slot VP + 0.25 duct VP

GENERAL VENTILATION, where local exhaust cannot be used:

Rod, diam	cfm/welder*
5/32	1000
3/16	1500
1/4	3500
3/8	4500

OR

A. For open areas, where welding fume can rise away from the breathing zone:
cfm required = 800 x lb/hour rod used

B. For enclosed areas or positions where fume does not readily escape breathing zone:
cfm required = 1600 x lb/hour rod used

*For toxic materials higher airflows are necessary and operator may require respiratory protection equipment.

OTHER TYPES OF HOODS

Local exhaust: See VS-416.1
Booth: For design See VS-415, VS-604
Q=100 cfm/sq ft of face opening

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WELDING BENCH

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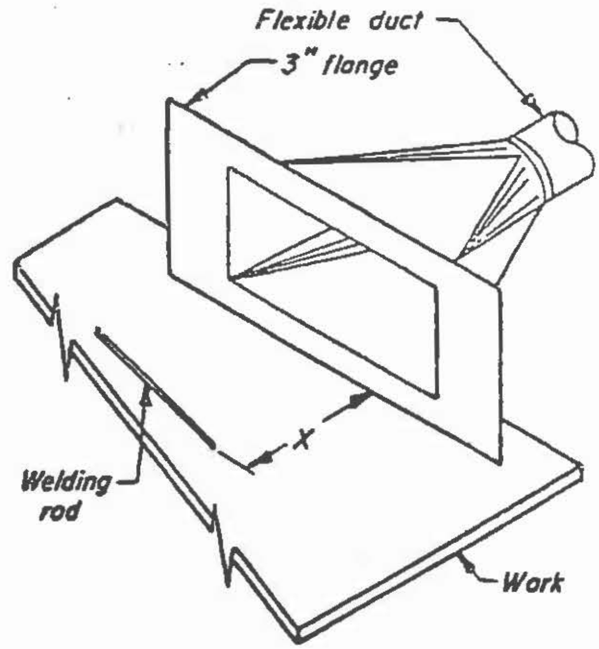
FIGURE 3

INDUSTRIAL VENTILATION



PORTABLE EXHAUST

X, inches	Plain duct cfm	Flange or cone cfm
up to 6	335	250
6 - 9	755	560
9 -12	1335	1000

Face velocity = 1500 fpm
Duct velocity = 3000 fpm minimum
Plain duct entry loss = 0.93 duct VP
Flange or cone entry loss = 0.25 duct VP

GENERAL VENTILATION, where local exhaust cannot be used:

Rod, diam	cfm/welder
5/32	1000
3/16	1500
1/4	3500
3/8	4500

OR

A. For open areas, where welding fume can rise away from the breathing zone:
cfm required = 800x lb/hour rod used

B. For enclosed areas or positions where fume does not readily escape breathing zone:
cfm required = 1600 x lb/hour rod used

For toxic materials higher airflows are necessary and operator may require respiratory protection equipment.

OTHER TYPES OF HOODS

Bench: See VS-416

Booth: For design See VS-415, VS-604
Q=100 cfm/sq ft of face opening

"Granite Cutting" VS-909

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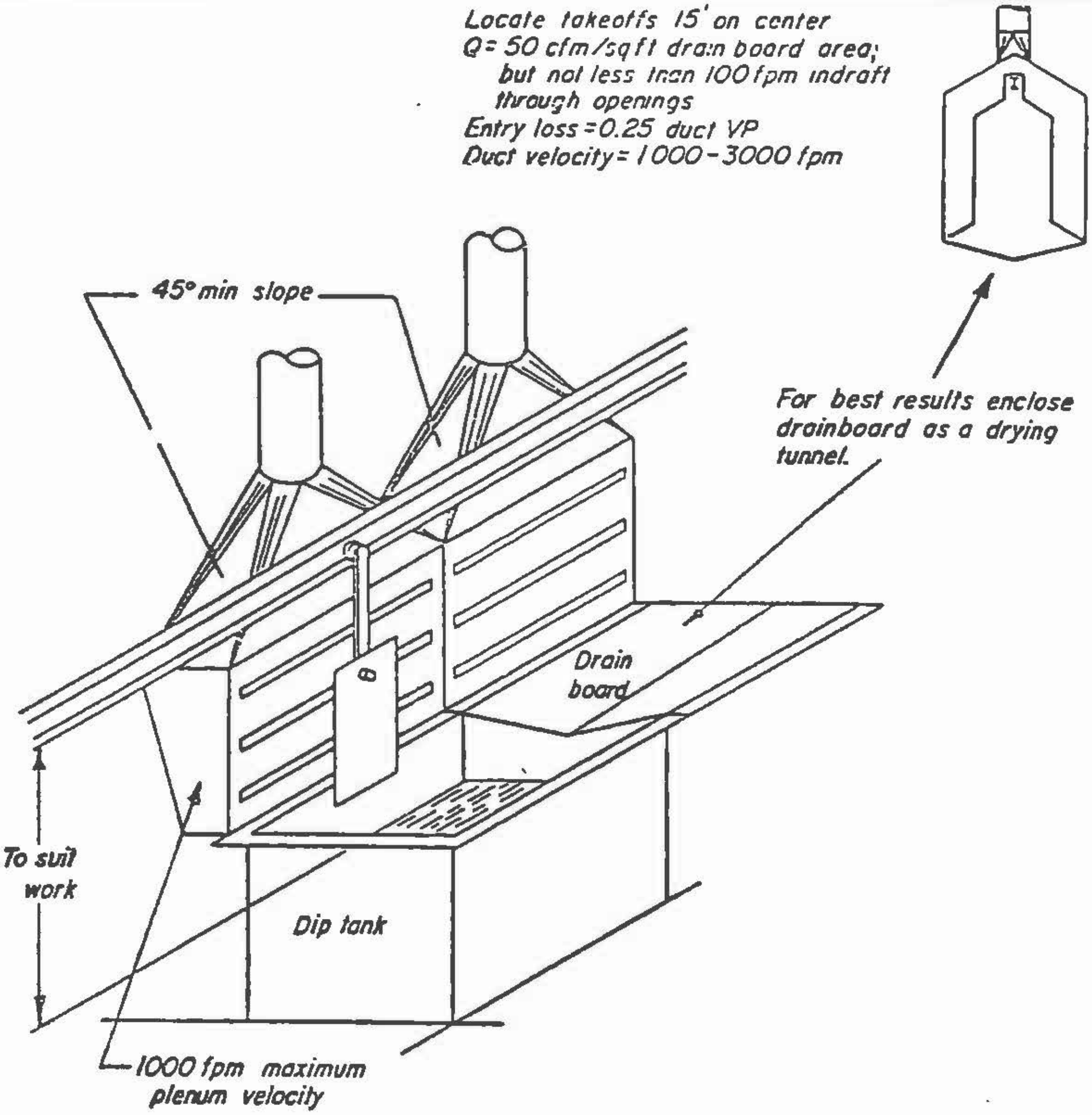
WELDING BENCH

DATE 1-78 | VS-416.1

FIGURE 4

SPECIFIC OPERATIONS



Q = 125 cfm/sq ft of tank and drainboard area
Slot velocity = 2000 fpm
Entry loss = 1.78 slot VP + 0.25 duct VP
Duct velocity = 1000-3000 fpm

NOTE: For details on drying oven, See VS-602

For air drying in a room or enclosure, see Section 2 for dilution ventilation required.

For construction and safety, consult NFPA.[113]

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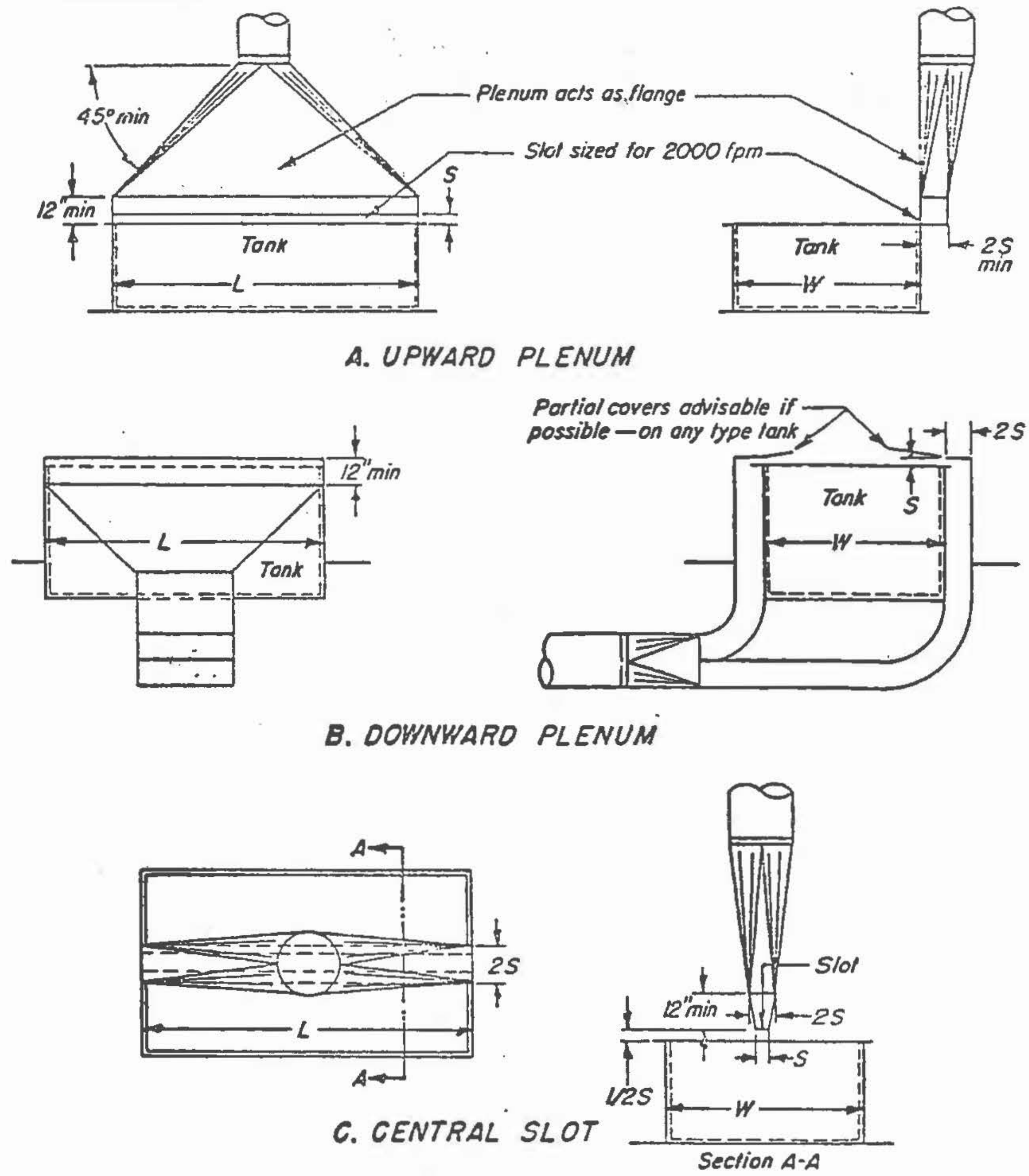
DIP TANK

DATE 1-73 | VS-502



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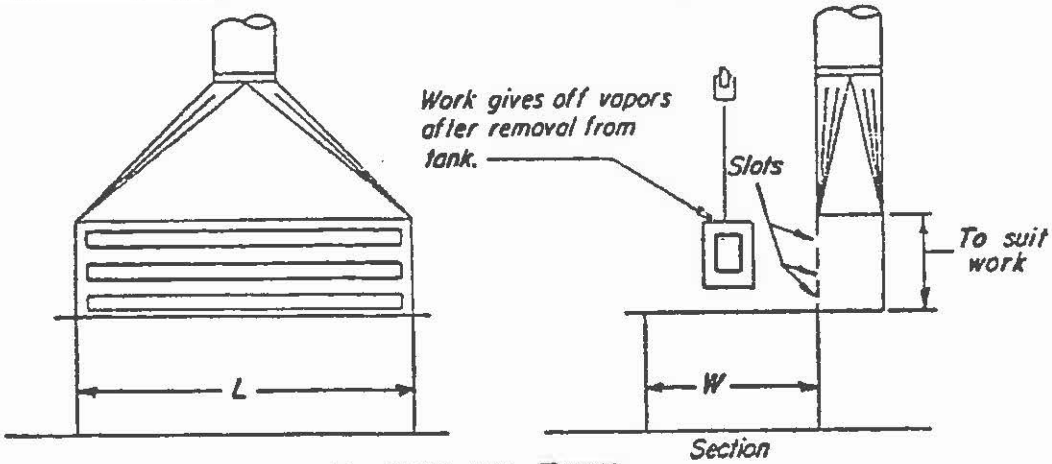
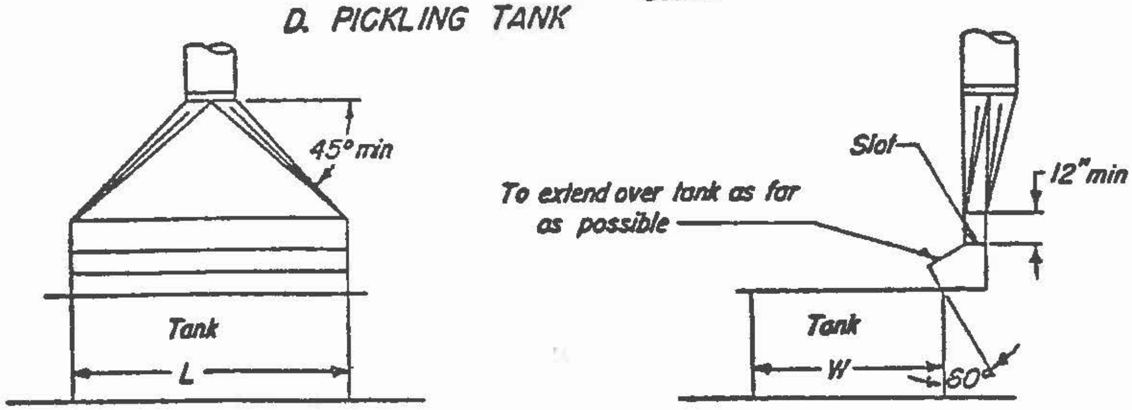
OPEN SURFACE TANKS		
DATE	1-64	VS-503

FIGURE 6

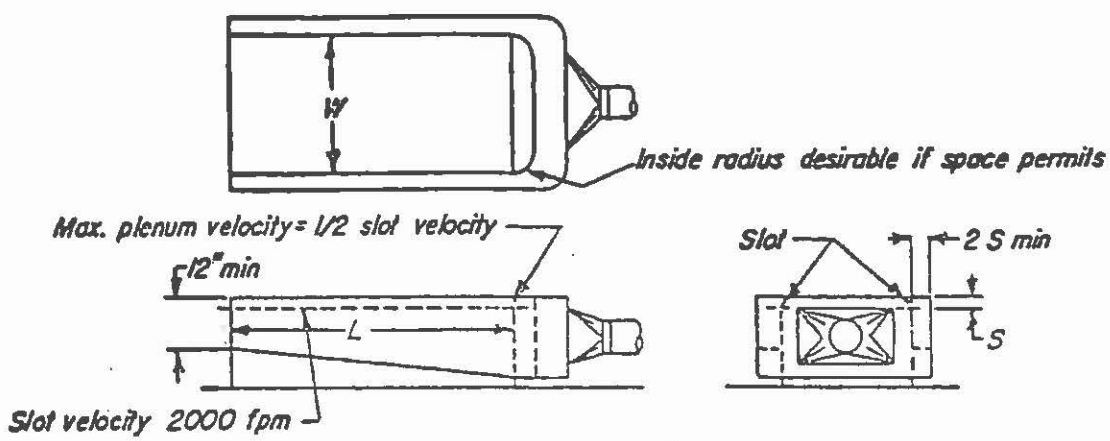
SPECIFIC OPERATIONS



D. PICKLING TANK



E. SEMI-LATERAL



F. END TAKE-OFF

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OPEN SURFACE TANKS	
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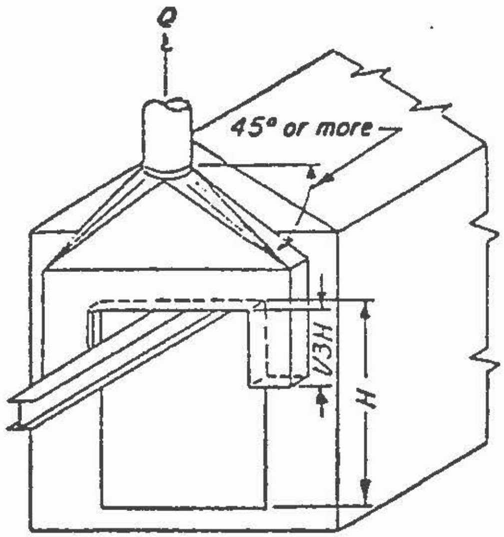
FIGURE 7

SPECIFIC OPERATIONS

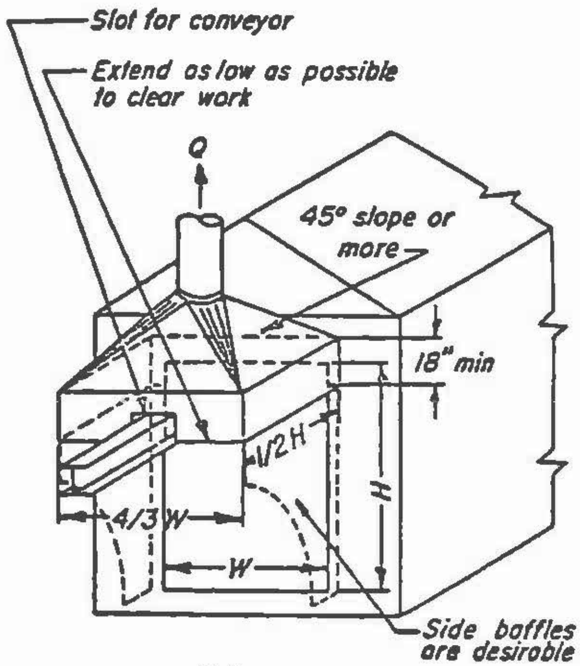


SLOT TYPE

Q = 100 cfm/sq ft door plus 1/2 products of combustion
Entry loss = 1.0 slot VP plus 0.25 duct VP
Duct velocity = 1000-3000 fpm

Size plenum for 500 fpm maximum

Slot on three sides size for 1000 fpm
Locate on inside or outside of door.



CANOPY TYPE

Q = 200 cfm/sq ft of hood face plus 1/2 products of combustion
Entry loss = 0.25 VP
Duct velocity = 1000-3000 fpm

Note:
For dryers, include volume of water vapor liberated.
For flammable solvent drying refer to Section 2, "Dilution Ventilation for Fire and Explosions".

Note:
Hoods at each end of oven. Reduce size of doors as much as possible. Separate vent must be added for products of combustion.

For construction and safety, consult NFPA(1/3)

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DRYING OVEN VENTILATION	
DATE 1-78	VS-602

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