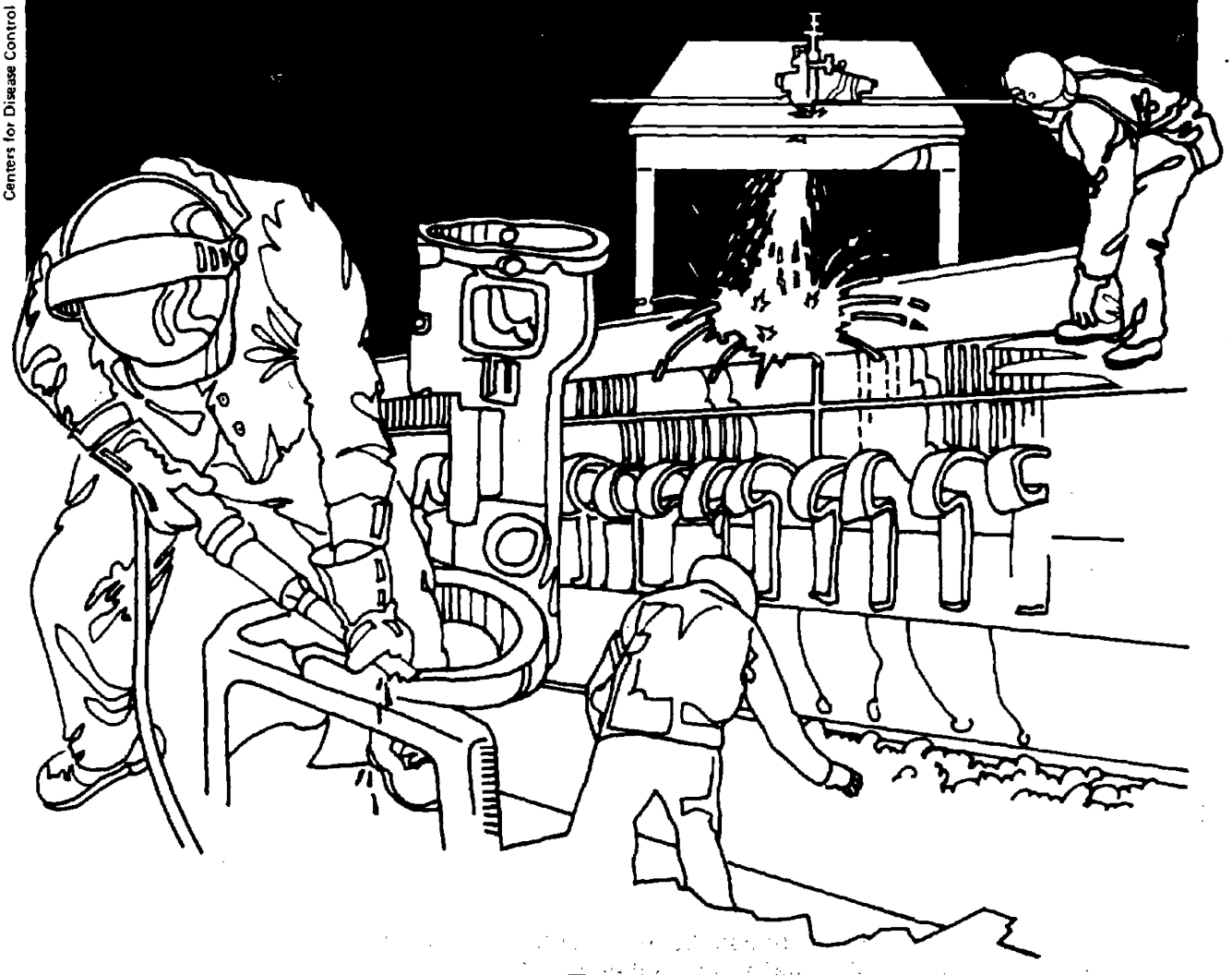
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 81-143-1041
ARMCO COMPOSITES
HARTFORD CITY, INDIANA

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 81-143-1041
February 1982
Armco Composites
Hartford City, Indiana

NIOSH Investigators:
James M. Boiano, I.H.
Arthur Watanabe, Pharm. D.
Daniel J. Habes, I.E.

I. SUMMARY

In January 1981, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a health hazard evaluation to assess occupational exposures to cured resin particulates, styrene monomer and ergonomic stresses at Armco Composites, Hartford City, Indiana. This facility manufactures fibrous glass reinforced plastic products and employs approximately 120 production workers.

NIOSH conducted a preliminary screening survey on March 11-12 and a follow-up survey on July 20-21, 1981. During the initial survey NIOSH collected air samples to characterize workroom contaminants. Medical interviews were conducted with 29 employees. During the follow-up survey NIOSH conducted environmental sampling for cured resin particulates and styrene. An ergonomic evaluation was performed and consisted of a work methods assessment of repetitive hand tasks. Photographs and movies were taken to aid in this portion of the evaluation. Informal interviews were conducted with 26 employees to determine the extent of symptoms associated with the use of hand tools.

Personal breathing-zone time-weighted average (TWA) concentrations of cured resin particulates (evaluated as nuisance particulates) for finisher/assemblers ranged from 1.8 to 20.1 milligrams per cubic meter (mg/M^3). Three of 14 personal samples exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) recommended level of 10 mg/M^3. Two of these samples exceeded the Occupational Safety and Health Administration (OSHA) standard of 15 mg/M^3. Styrene TWA concentrations for the 10 mold press operators ranged from 31.5 to 150 mg/M^3. All values were below the ACGIH recommended criteria of 215 mg/M^3 and the OSHA standard of 435 mg/M^3.

Eighteen of 26 employees interviewed in July exhibited early signs of carpal tunnel syndrome (CTS). Reported symptoms included nocturnal numbness of the fingertips, swelling of the hands, stiffness of the joints, and general pain in the hands and wrist.

The types of postures that were of interest in this evaluation and have been linked to CTS included wrist flexion and extension, ulnar and radial deviation of the wrist, and open hand pinch. All of these hazardous postures were assumed to some degree by the finisher/assemblers while filing and sanding typewriter parts.

On the basis of the information collected during the investigation NIOSH determined that a health hazard did exist from tasks involving repetitive hand/wrist movements. Exposures to cured resin particulates exceeded the nuisance dust criteria. Concentrations of styrene were below the recommended occupational exposure limit. Recommendations for decreasing the incidence of CTS in the workforce and for reducing employee exposure to cured resin dusts are presented in Section VII of this report.

KEYWORDS: SIC 3079 (Miscellaneous Plastic Products), cured resin particulates, nuisance dust, repetitive hand tasks, styrene, carpal tunnel syndrome, ergonomics, musculo-skeletal disorders, cumulative trauma.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, NIOSH investigates the effects on human health of substances found in the workplace. On January 12, 1981 NIOSH received a confidential request from employees of Armco Composites, Hartford City, Indiana regarding exposure of employees to cured resin particulates, styrene, and tasks requiring repetitive hand/wrist movements. The request stated that employees were experiencing headache, dizziness, lightheadedness, sore throats, chest pain, and muscle cramps.

In May 1981, following an initial visit to the plant on March 11-12, NIOSH distributed Interim Report #1 for this evaluation. Union and company representatives were provided with recommendations for reducing chemical exposures and the incidence of carpal tunnel syndrome in the Interim Report and in subsequent correspondence. Most of these recommendations are also included in this report.

III. BACKGROUND

A. Plant Description

Armco Composites, a division of Armco Incorporated, manufactures a variety of thermoformed fibrous glass reinforced plastic products including typewriter housings, basketball backboards, outboard motor covers, and other products with most of the production involving the typewriter housings. The plant has been in operation since 1978 and employs approximately 120 hourly workers. Major job classifications include finisher/assemblers (85), mold press operators (18); punch press operators (7); and quality control inspectors (4). It is common practice that new workers start as finisher/assemblers and move to mold/punch press operator and then to quality control inspector with increasing seniority at the plant.

B. Process Description

All products are manufactured from a preblended polyester-base molding compound which contains approximately 10% styrene monomer as a reactive diluent. Other major constituents include limestone and coarse fibrous glass. Additives including pigments, catalysts and release agents comprise approximately 0.5% of the compound by weight.

The molding compound is received in 48" wide sheets at thicknesses of 1/4 - 3/4 inches and is sandwiched between a thin nylon layer to prevent sticking. The nylon also suppresses styrene vaporization. During the process the molding compound is stripped of the nylon sheets, cut, weighed, preheated in some applications, and then molded by compression and heat into the desired product. All molded products except for the typewriter housings are finished at their respective mold press stations by a press operator or finisher assembler. Finishing may include trimming, drilling, touch up and/or sanding. Following inspection these products are manually packaged and stored for shipment.

The typewriter housing consists of two individually molded plastic sections called "center" and "tops". (The center is the main body of the typewriter; the top is the movable lid.) Both parts are machine fabricated, i.e., punch pressed, drilled, or routed and then manually finished by about 25 finisher/-assemblers stationed at tables along the finishing line. Finishing tasks involved the use of pneumatic orbital sanders and steel files. The centers required considerably more finishing than the tops since the former is larger and more complex of the two pieces. Small amounts of epoxy and methylene chloride were used for touch-up. The pieces are inspected, then assembled and packaged for shipment.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

During the initial survey, NIOSH collected bulk air samples at the mold presses for qualitative and quantitative analyses of organics using gas chromatographic/mass spectrographic techniques. Direct reading detector tubes were also used to screen for styrene, methylene chloride and carbon monoxide. Styrene vapor concentrations varied from 40-300 mg/M^3 in the mold press area. The highest levels were obtained directly above the uncured molding compound. Carbon monoxide levels ranged to 5 ppm (NIOSH criteria: 35 ppm). Methylene chloride vapor was not detected. Based on the results of this preliminary sampling survey, NIOSH concluded that the follow-up environmental evaluation should focus on assessing worker exposure to styrene monomer and cured resin particulates.

On the follow-up survey NIOSH collected full-shift personal breathing zone samples on 14 finisher/assemblers and 10 mold press operators for cured resin dusts and styrene, respectively. These samples were collected during the second and first shifts on July 21 and 22, respectively. Total cured resin particulates including both respirable and non-respirable particulates were collected on tared polyvinyl chloride acrylonitrile copolymer M5 filters using calibrated personal sampling pumps at a flowrate of 1.7 liters per minute (lpm). The amount of particulate was determined by weight difference. The instrumental precision of weighings was $\pm$ 0.01 mg.

Styrene was collected on a standard charcoal tube using personal sampling pumps calibrated at 0.05 lpm. Analysis of the charcoal tubes was conducted in accordance with NIOSH Method P&CAM S-30 which is a gas chromatographic method using carbon disulfide as the sample desorbant and a flame ionization detector. The lower limit of detection for styrene was 0.1 mg/sample.

B. Medical

During the initial survey in March, NIOSH administered a health questionnaire to 25 mold press and punch press operators on all three shifts. The interviews were conducted in these worker groups because their work history included finish/assembly work. Four workers who worked as finisher/assemblers and had a history of carpal tunnel syndrome (CTS) were also interviewed. The information collected during the evaluation provided a basis for a follow-up comprehensive ergonomic evaluation.

During the follow-up study, informal interviews with 26 employees were held for purposes of determining the extent of symptoms of cumulative trauma and to determine the extent of classic Raynaud's or "white finger" symptoms associated with vibration from the disc or orbital sanders.

C. Ergonomics

On July 21, 1981, the NIOSH investigators observed the second shift in the press, finish assembly, and quality control areas. The first shift was observed on the following day. A work methods assessment for purposes of documenting work postures and types of motions which could contribute to the occurrence of such symptoms. Still pictures and movies were taken to assist in this portion of the evaluation.

V. EVALUATION CRITERIA

Cured Resin Particulates

The dusts generated by the filing and sanding tasks primarily contained cured polyester resin, limestone, and ground glass. Currently, no exposure criteria exist for these compounds as a conglomerate. The available toxicity data would indicate that they would be categorized as nuisance particulates.[3,4,5] Lung tissue reaction, if any, to nuisance type dust is characterized by the following histological features: (1) the architecture of the air spaces remains intact; (2) collagen (scar tissue) is not formed to a significant extent; and (3) the tissue reaction is potentially reversible.

Excessive concentrations of nuisance-type dusts may cause skin, eye and upper respiratory tract irritation, bronchitis, and safety hazards such as decreased visibility.

The American Conference of Governmental Industrial Hygienists (ACGIH) currently recommends that occupational exposure to nuisance particulates be limited to 10 milligrams per cubic meter (mg/M^3) of total dust as an 8-hour time-weighted average (TWA).[6] The current OSHA standard for nuisance particulate, by comparison, is 15 mg/M^3.[7]

Styrene

Acute exposure to styrene is known to cause irritation to the eyes and mucous membranes and depressive effects on the central nervous system. Eye and respiratory tract irritation have been reported in humans exposed to vapor concentrations in excess of about 800 mg/M^3.[8] Humans exposed to 1636 mg/M^3 have experienced eye and nasal irritation within 15 minutes; after one hour at this concentration effects were headache, nausea, decreased dexterity and coordination.[9] While early reports indicate that styrene is readily absorbed through the skin,[10] a recent study suggests that cutaneous absorption is not a significant exposure route in the plastic industry.[11] The fact that styrene binds to the polyester resin molecules and therefore prevents absorption through the skin was offered as a possible explanation of this phenomena.

The odor threshold of styrene is approximately 0.43 mg/M^3; the disagreeable odor and upper respiratory tract irritation would normally prevent the inhalation of acute toxic quantities, although the warning properties may not be sufficient for prolonged exposures.

The long-term or chronic toxicity of styrene is not well defined. However, there is growing concern over its potential carcinogenicity.[12,13,14,15,16]

The current ACGIH recommended standard for styrene is 215 mg/M^3 as an 8-hour TWA with a 15 minute ceiling limit of 425 mg/M^3.[6] This standard was set approximately ten times below the lowest concentration possibly causing lymphoid or hematopoietic tumors in rats.[15] The OSHA standard for styrene is 435 mg/M^3 for an 8-hour TWA with a 15 minute ceiling of 870 mg/M^3 and a 5 minute peak limit of 1305 mg/M^3 within any 3 hour period.[7]

Of the criteria presented for each substance, those which are the most stringent and thus afford the best health protection for the worker, will be applied.

Ergonomics

The specific types of postures that were of interest in this evaluation included: wrist extension and flexion, ulnar and radial deviations and open hand pinches. There are few quantitative criteria such as frequency, total number and extent of these postures that clearly delineate hazards. Jobs requiring the repetitive use of these postures, particularly in conjunction with high muscular force demands of the hand and wrist have been linked to common cumulative trauma disorders such as carpal tunnel syndrome, tendonitis and tenosynovitis.[2] Currently, the extent of the hazard is based on analysis of the distribution and type of postures with application of professional judgement and comparison with available literature.

VI. RESULTS AND DISCUSSION

A. Environmental

Personal samples collected on 14 finisher/assemblers for cured resin particulates indicated TWA concentrations over the 7-8 hour sampling period ranging from 1.8-20.1 mg/M^3 (Table I). Three workers were exposed to particulate levels in excess of the 10 mg/M^3 ACGIH recommended criteria; two were above the OSHA standard of 15 mg/M^3.

In reviewing the data, the apparent wide range in exposures was probably due to a combination of the following factors: (1) reintrainment/dispersion of settled and tool-generated particulates by air currents produced by the portable upright fans; (2) the amount of filing vs. sanding done by a worker; and (3) personal work practices. It must be noted that there is variability in the degree to which each of these factors contributed to a workers' total exposure.

The use of fans along the finishing line appeared to increase the particulate exposures of some of the finisher/assemblers. At two of the work tables the mean dust concentration was 4-5 times higher for the two workers facing the fan versus their counterparts across the table. NIOSH investigators observed that the air currents produced by the fans exposed the workers facing the fans to dusts generated by their cohorts across the table in addition to dusts generated by their own work.

Sanding/filing regimens may have also influenced the amount of employee dust exposure. It appeared that workers toward the end of the finishing line where sanding was more common had higher exposures than their counterparts who predominately filed. The fact that more particulates were generated with the use of the pneumatic sander may explain the difference.

Work practices also appeared to affect the extent of exposure. For example, NIOSH observed one employee who positioned her head directly above the workpiece during filing and sanding operations. This individual had the third highest dust exposure which was not unexpected considering the proximity of her breathing zone to the contaminant source. Workers also were observed "blowing off" sanded workpieces which unnecessarily contributed to airborne dust levels.

Styrene monitoring results appear in Table II. Vapor concentrations in the breathing zone of 10 mold press operators ranged from 28.8 to 150 mg/M^3 (average: 71.5 mg/M^3). These levels, by comparison, were below the occupational exposure limit of 215 mg/M^3 recommended by ACGIH and the OSHA standard of 425 mg/M^3.

B. Medical

1. Initial Survey

(a) Questionnaire Results

A total of 29 employees were interviewed: 19 press operators, 6 punch press operators, and 4 other (See Table III for demographic data). The last four workers all were reported to have a history or carpal tunnel syndrome. There were no reports of any liver or kidney disease nor any reports in females of miscarriages. Acute symptoms are reported by job category in Table IV. Union representatives reported seven workers have a history of carpal tunnel syndrome.

Although the high prevalence of symptoms reported by the workers on the questionnaire were consistent with a high level acute exposure to styrene vapors, the concentration of styrene vapors measured in March (40-300 mg/M^3) and in July (29-150 mg/M^3) were not consistent with these symptoms. Many of the symptoms reported including eye and upper respiratory tract irritation are known to occur at a much greater airborne concentration. This concentration is documented to be in excess of about 800 mg/M^3.[8]

Skin irritation (skin redness, itchiness, rash), particularly on exposed skin surfaces, was also reported by a large proportion of workers and was associated with the dust generated from sanding plastic parts. These effects are consistent with fibrous glass-resin dust exposure.[17,18]

Seven workers had histories of carpal tunnel syndrome. In these workers it is possible that the repetitive hand, wrist and arm motions from filing and sanding the plastic parts are the cause of their problems. In addition to these seven workers, a high proportion of workers also reported the occurrence of hand pain, numbness and tingling in the past when they had previously worked on the finish/assembly line.

2. Follow-up Survey

(a) Questionnaire Results

In all, 26 employees were informally interviewed, 11 on the second shift and 15 on the first shift. A total of 18 workers were judged to be symptomatic. Two of three press operators on the day shift were symptomatic. All others were finisher/assemblers. This information is summarized below.

INFORMAL INTERVIEWS

	Men	Symptomatic	Women	Symptomatic
Second Shift July 20	4	2	7	5
First Shift July 21	3	2	12	9

The most common symptom noted was that of nocturnal numbness of the fingertips, a classic early sign of carpal tunnel syndrome. Remarkably, workers reported this symptom in their own words without need for suggestion by the NIOSH investigators. Other symptoms reported included swelling of the hands, stiffness of joints, and general pain in the hands and wrist.

A review of company medical records indicated 15 women had cumulative trauma disorders since January 20, 1981 with 13 accounting for lost time. All were diagnosed as numbness and/or swelling of the hands. This information is summarized below.

LOST TIME INJURIES RESULTING FROM CUMULATIVE TRAUMA

Job Type	No. Of Injuries	Average No. Of Lost Days
Finisher/Assembler	9	14.6
Punch Press	2	17.0
Press Operator	1	5.0
Quality Control	1	9.0

Three of four of those injured who were not finisher/assemblers had previously worked in that area. The average number of lost days per case was 13.8. However, it should be noted that one of those injured for whom there was no lost time accounted quit work on the day of the injury and another quit after 24 days of lost time. Conversations with Union representatives indicated that there have been seven operations for carpal tunnel decompression among their union workers since March, 1979.

(b) Work Methods

NIOSH medical investigators observed that while employees were filing and sanding the typewriter centers and tops, all of the hazardous postures described earlier (in Section IV B) were assumed in some fashion and for varying amounts of time by every employee working along the finishing/assembly line. These positions are illustrated in Figure 1. Figure 2 shows the different types of files and the type of sander which are used by the finisher/assemblers.

The job procedures studied were so unstructured that it was difficult to characterize them in terms of required movements and postures. Each worker seemed to have developed his or her own style of performing the work. Some moved the part around quite often and made frequent tool changes; others would simply leave the top or center in one position and move the hand to wherever finishing was required. Some workers changed hands while filing while others used only one hand. Regardless of the work method, however, the movements and postures required are complex and nearly constant. Studies of movies taken of work practices revealed that while filing and sanding the center, by far the more complicated and demanding of the two pieces, movements ranged from 700 to over 1000, posture changes from 45 to 70, and tool changes ranged from 3 to 10 per piece. Since the observed hourly rate at the time was about six centers per person, between 4200 and 6000 movements were made per hour per worker. One classic study has shown an occurrence of cumulative trauma disorders associated with jobs where 2000 manipulations per hour were required in a tobacco packing plant.[19]

The vibration resulting from the use of the orbital sanders in the finishing area appeared not to be excessive. Although no measurements were made, it is most likely that the repetitive motions of the type described earlier which are required while using these sanders is more of a contributory factor to the hand and wrist problems than is the vibration. The disc sander, however, rated at 17000 rpm, which was used in the glove box operation, did appear to be a potential vibration hazard. No measurements were made to substantiate this inference.

Very little time was spent in the press area, but some jobs were observed and a few people were interviewed. Some of the molding jobs required repetitive motions, but not nearly those required in finishing. One job of concern, however, was the cutting of the molding compound. Sheets of this compound, which is very tough and reinforced with fibrous glass, are cut from a roll using a single edge razor mounted in a handle, much like that used to open cardboard boxes. The material is cut by repeatedly scoring it with the razor tool until it can be separated from the roll. The hand force required to make these cuts seemed high and the wrist was flexed while doing so. Interviews with employees supported this observation and several claimed to have hand and wrist problems.

VII. RECOMMENDATIONS

Since the development of carpal tunnel syndrome in workers was the most significant finding of this study, ergonomic recommendations will be presented first.

1. The type and complexity of movements and postures observed appeared to contribute most to the hand and wrist problems of workers along the finishing line. The highly unstructured nature of the work complicates the situation. Therefore, the first and most important recommendation that can be made is to standardize the work in such a way that the number of hazardous work postures such as wrist extension and flexion, ulnar and radial deviation and pinch grips is minimized. It is reasonable to believe that such a reduction would be effective because there seemed to be fewer injuries and complaints by workers finishing the top piece, a less complex job than the finishing of the center.

2. A fixture (as illustrated in Figure 5a) should be provided at the finishing line tables so that all of the work surfaces in a given plane can be filed/sanded with the wrist in a neutral (straight) position. The fixture should be adjustable in height and have a swivel capability which would allow easy access to the underside of the assembly. This recommendation is based on the observation that a greater number of wrist extensions and deviations are required by workers sanding/filing the workpiece while it is "flat" on the work table (Figure 4) versus when the workpiece is in a tilted position (Figure 3).

3. The method and order of filing should also be standardized. As shown in Figure 5b, each side of the assembly should be labelled and the order of which side to file first and which windows to file in what order should be standardized and documented in the form of an operation description. Figure 6 is an example of how such a description should be written.

4. Modifications should also be made to the tools that are used. Figure 2a shows the typical style of files that are used by most of the workers. They are all straight and have no handles except for the one that has a piece of rubber hose which, from interviews, we found is usually put on by the worker in a makeshift fashion. A handle like the one in Figure 7a is recommended. It should be about 1.5 inches in diameter[20] and angled about 45 to 60 degrees. The optimum angle would depend on the angle at which the wooden holder for the assembly, described above, is inclined.

5. The orbital sander should also be redesigned. As it is now (Figure 2b), it is too large to be held comfortably in the hand. Constant pressure must be maintained with the hand spread wide in order to control it while sanding. Additionally, in these types of air driven tools, air blowing onto the hand while using, and in this case perhaps some vibration, tends to anesthetize the fingertips so that sensory feedback is reduced. This results in the tendency to grasp the tool even more forcefully. Grasping forces are also increased by designs such as the one used here where the air hose is parallel to the tool at the point of attachment which increases the torque on the tool. The air line should be perpendicular to the sander base at this point. Figure 7b is a recommended orbital sander design. Like the recommended file design, this tool should have a 1.5 inch diameter handle with the angle of the handle depending on the inclination of the assembly being sanded. The handle should also be positioned so that air does not blow on the hand. Textured rubber gloves should also be provided to minimize grasping forces.

6. Each finisher/assembler should be provided with a file organizer. A simple wooden holder where each file could be placed vertically would clean up the work area and allow for easy access to any file. This would be an important factor if the order of the sanding and filing was standardized.

7. The glove box sanding operations for the 19" center should be automated as has been done for the 15" center. As noted earlier, the high rpm of the disc sander used in this operation makes it a potential vibration hazard.

8. A shear should be used to cut the molding compound. As discussed previously, cutting this compound with a hand held razor device appeared to require excessive muscular force and caused the wrist to be repeatedly flexed.

9. It is unlikely that any of the above recommendations would be successful without the proper administration. Training sessions should be conducted so that the workers can become familiar with and appreciate the types of movements and postures which precipitate cumulative trauma disorders. If done in a constructive manner, the workers will accept the need for work method standardization and they will be more aware of these movements and postures as they work. Supervisors should also be educated to recognize situations in which these disorders are produced and should be aware of what can be done to remedy them.

A more immediate administrative practice which could be implemented is job rotation. This should be done at least between the top and center finishing jobs and ideally on jobs throughout the entire plant if a compromise concerning entry level and seniority jobs can be agreed upon. Even if finishers could be placed in the press area 1 or 2 days a week or 1 or 2 hours a day, there would be a reduction in the trauma to which they are subjected.

10. Local exhaust ventilation (i.e. downdraft hoods) should be provided at the finishing tables to reduce exposure to cured resin particulates.

11. The portable upright fans used for comfort ventilation should be positioned so that they do not reintrain and/or disperse particulates in the work area.

12. Good work practices and good personal hygiene should be stressed with the goal of preventing or minimizing inhalation, ingestion, skin and eye contact with cured polyester resin particulates. Included in this program should be: (1) hand washing before eating, drinking, and smoking; (2) continued abstinence from eating, drinking and smoking in the production area; (3) discontinuing practice of "blowing off" sanded work pieces by employing vacuum removal; and (4) use of long sleeves or protective clothing when sanding/filing plastic parts. Similarly, styrene exposures can be reduced by utilizing good work practices and procedures.[21]

13. Although styrene exposures were below the acceptable health standards the company should provide local exhaust ventilation for the compound tables and preheating units in light of the recent information implicating styrene as a carcinogen.

14. A housekeeping program should be established whereby equipment, work tables and floors are vacuumed at the end of each day.

VIII. REFERENCES

1. National Institute for Occupational Safety and Health, Manual of Analytical Methods, 2nd Edition, Vol. 2, U.S. Dept. of Health, Education & Welfare, NIOSH Method P&CAM S-30, National Institute for Occupational Safety and Health, Cincinnati, Ohio. Publication No. 77-167B, April 1977.

2. Armstrong T. and Chaffin D. Carpal Tunnel Syndrome and Selected Personal Attributes" J. Occup. Med. 21:481-486, 1979.

3. Schepers G. The Pulmonary Reaction to Sheet Fiberglass Plastic Dust. AIHA J. 20:73, 1959.

4. Schepers G. The Pathogenicity of Glass-Reinforced Plastics. Arch. Env. Health 2:620, 1961.

5. Schepers G. The Biological Action of Fiberglass Plastic Dust. Arch. Ind. Health 18:34, 1958.

6. American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1981. American Conference of Governmental Industrial Hygienists, Inc., Cincinnati, Ohio, 1981.

7. Occupational Safety and Health Administration. Code of Federal Regulations, 29 Labor, Parts 1900 to 1910, Revised July 1, 1980. Washington, D.C., 1980.

8. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, U.S. Department of Health and Human Services and U.S. Department of Labor, 1981. (DHHS publication no. (NIOSH) 81-123).

9. Stewart RD, Dodd HEC, Baretta ED, and Schaffer AW. Human Exposure to Styrene Vapor. Arch. Env. Health 16:656-62 (1968).

10. Dutkiewicz T and Tyras H. Skin Absorption of Toluene, Styrene, and Xylene in Man. Brit. J. Ind. Med. 25:243 (1968).

11. Brooks SM, Anderson L, Emmet E, et al. The Effects of Protective Equipment on Styrene Exposure in Workers in the Reinforced Plastic Industry. Arch. Env. Health 35:287-293 (1980).

12. Lilis R and Nicholson WJ. Cancer Experience Among Workers in a Chemical Plant Producing Styrene Monomer. In: Proceedings of NIOSH Styrene-Butadiene Briefing, National Institute for Occupational Safety and Health, Cincinnati, Ohio, pp. 22-27, 1977.

13. Ponomarkov V and Tomatis L. Effects of Long-term Oral Administration of Styrene to Mice and Rats. Scand. J. Work Env. Health 4:127-135 (1978).

14. Vainio H, Paakkonen R, Ronnholm K, Raunio V and Pelkonen O. A Study on the Mutagenic Activity of Styrene and Styrene Oxide. Scand. J. Work Env. Health 2:147-151 (1976).

15. Loprieno N, Abbondandolo A, Barale R, et al. Mutagenicity of Industrial Compounds: Styrene and Its Possible Metabolite Styrene Oxide. Mut. Res. 40:317-324 (1976).

16. American Conference of Governmental Industrial Hygienists, Documentation of the Threshold Limit Values, Fourth Edition, American Conference of Governmental Industrial Hygienists, Inc., Cincinnati, Ohio, pp. 373-374 1980.

17. Committee on Industrial Medical Practice, Industrial Medical Association, Fiberglass Resin Dust, J. Occup. Med. 14:331, 1972.

18. Vandervort R and Thoburn T. Health Hazard Evaluation. Goodyear Aerospace Corporation, Coimmercial Plastics Division, Jackson, Ohio. Report No. 73-194-153, Cincinnati, Ohio: NIOSH, 1974.

19. Hammer A. Tenosynovitis. Medical Record, 353-355, 1934.

20. Chaffin D, Miodonski R, Stobbe T, Boydstun L and Armstrong T. An Ergonomic Basis for Recommendations Pertaining to Specific Sections of OSHA Standard 29 CFR Part 1910, Subpart D, Walking and Working Surfaces. Industrial and Operations Engineering, The University of Michigan, Ann Arbor, MI, 48109. NTIS Number PB 284 370.

21. National Institute for Occupational Safety and Health, Behavioral Procedures for Reducing Worker Exposure to Carcinogens, Final Report, NIOSH Contract No. 210-77-0040, National Institute for Occupational Safety and Health, Cincinnati, Ohio, 1981.

IX. AUTHORSHIP/ACKNOWLEDGEMENTS

Report Prepared By:

James M. Boiano
Industrial Hygienist
Industrial Hygiene Section

Arthur S. Watanabe, Pharm. D.
Medical Officer
Medical Section

Daniel J. Habes
Industrial Engineer
Division of Biomedical and Behavioral Science

Acknowledgement:

Thomas G. Wilcox, M.D.
Medical Officer
Medical Section

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
Cincinnati, Ohio

Report Typed By:

Marlene Hoffmann
Jackie Woodruff

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia.

Copies of this report have been sent to:

1. Confidential Requestors
2. Armco Composites
3. Armco, Inc.
4. United Paperworkers International Union, Local 1293
5. NIOSH, Region V
6. OSHA, Region V

For the purpose of informing the 110 "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
PERSONAL BREATHING ZONE AIRBORNE CONCENTRATION OF CURED RESIN PARTICULATES FOR FINISHER/ASSEMBLERS WORKING ON THE FINISHING LINE

ARMCO COMPOSITES, HARTFORD CITY, INDIANA
HETA 81-143
July 20-21, 1981

Date	Sample Location	Sample Duration (min)	Sample Volume (M^3)	Cured Resin Particulate Concentration mg/M^3	Comments
7/20/81	Middle of finishing line	417	0.71	4.30	
"	3/4 down finishing line	419	0.71	4.61	
"	3/4 down finishing line	426	0.72	4.41	
"	thermwood/glove box	431	0.73	2.48	
"	3/4 down finishing line	422	0.72	20.1	
"	3/4 down finishing line	426	0.72	18.6	
"	auto disc sander	430	0.73	4.49	
7/21/81	auto disc sander	451	0.77	3.73	
"	1/2 down finishing line	439	0.75	1.80	
"	3/4 down finishing line	450	0.77	6.70	
"	1/4 down finishing line	441	0.75	10.7	
"	thermwood/glove box	455	0.77	1.85	disc sander in glove box used sparingly
"	1/2 down finishing line	419	0.71	2.57	
"	1/2 down finishing line	443	0.75	2.07	Wore dust respirator
Mean $\pm$ Standard Deviation:				6.31 ± 6.00	
Evaluation Criteria (ACGIH):				10	

TABLE II

PERSONAL BREATHING ZONE CONCENTRATION OF STYRENE FOR MOLD PRESS OPERATORS

ARMCO COMPOSITES
HARTFORD CITY, INDIANA
HETA 81-143

July 20-21, 1981

Date	Sample Location Mold Press #	Sample Duration (min)	Sample Volume (liters)	Styrene Concentration (mg/M^3)
7/20/81	Verson 3	430	20.5	28.8
"	Moline 6	446	7.9	105
"	Hannefin 4	435	24.1	116
"	Erie 5	440	23.5	63.8
"	Moline 7	451	14.9	31.5
7/21/81	Erie 5	459	10.1	99.0
"	Verson 3	465	26.6	45.1
"	Moline 6	467	22.4	37.5
"	Hannefin 4	462	8.0	150
"	Verson 2	472	26.4	37.9
Mean $\pm$ Standard Deviation:				71.5 ± 42.8
Evaluation Criteria (ACGIH)				215

TABLE III

DEMOGRAPHIC DATA BY JOB CLASSIFICATION

ARMCO COMPOSITES
HARTFORD CITY, INDIANA
HEAT 81-143

March 11-12, 1981

Job Classification	Age (Mean)	Job Duration (Mean)
Mold Press Operator (n=19 of 21)	31.1 years	1.5 years
Punch Press Operators (n=6 of 7)	27.3 years	0.6 years
Other*	32.3 years	1.6 years

*Category includes 4 workers with carpal tunnel syndrome.

TABLE IV

ACUTE SYMPTOMS BY JOB CATEGORY

ARMCO COMPOSITES
HARTFORD CITY, INDIANA
HETA 81-143

March 11-12, 1981

Job Category	CNS	MM	RESP	GI	N-M	SKIN
Mold Press Operator (n = 19)						
Number Reporting Symptom:	13	15	12	7	11	12
Percent:	68%	79%	63%	37%	58%	63%
Punch Press Operator (n = 6)						
Number Reporting Symptom:	6	3	3	2	6	6
Percent:	100%	50%	50%	33%	100%	100%

KEY: CNS (Central Nervous System) = Lightheadedness, dizziness, sleepiness
MM (Mucous Membrane) = Irritation of eyes, nose, throat
RESP (Respiratory) = Shortness of breath, difficulty breathing
GI (Gastrointestinal) = Nausea, stomach upset
N-M (Neuromuscular) = Numbness, tingling, weakness of hands, forearms
SKIN (skin) = Redness, itching, irritation, rash

1(a) Wrist Flexion

1(b) Wrist Extension

1(c) Ulnar Deviation

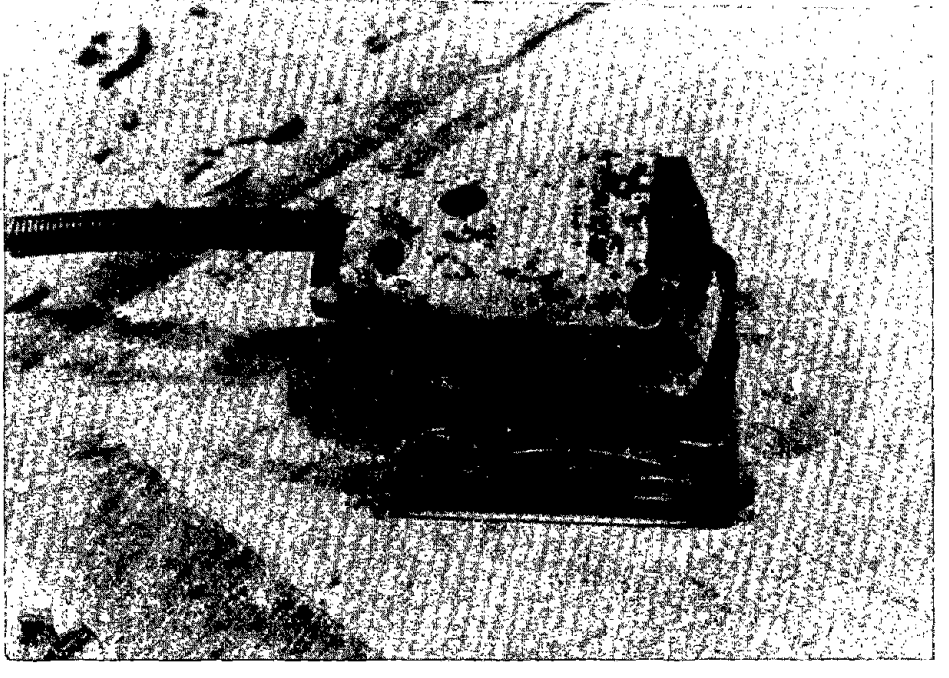
Figure 1(a-e): Illustration of Wrist Postures During Typewriter Finishing Tasks

1(d) Radial Deviation

1(e) Pinch

Figure 1(a-e): Continued

2(a) Files



2(b) Pneumatic Orbital Sander

Figure 2(a-b): Tools Used to Finish Typewriter Centers and Tops

Figure 3: Illustration of Neutral Wrist Positions When the Typewriter Center is Tilted

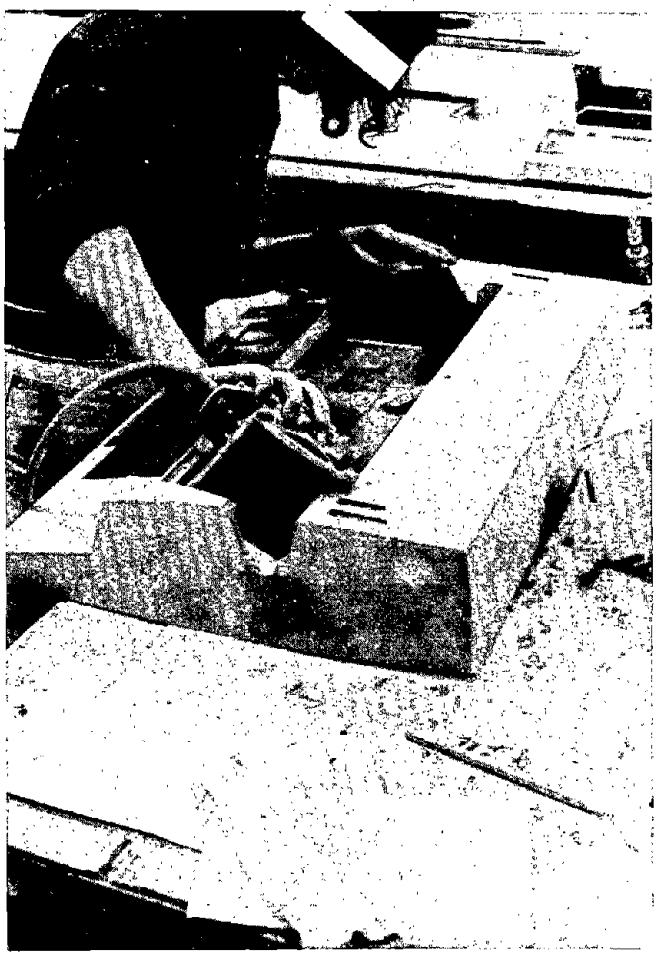
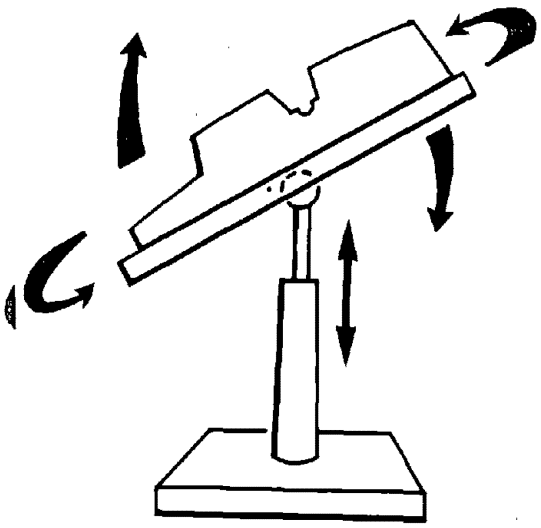
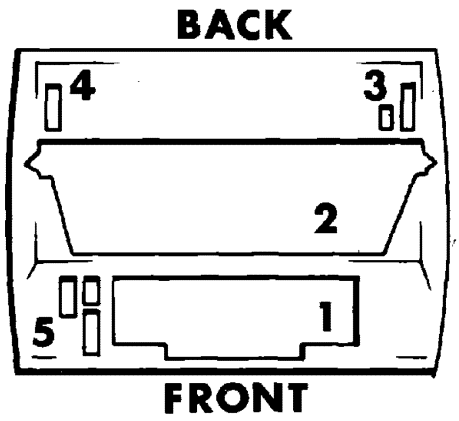


Figure 4: Illustration of Wrist Extension and Deviation Needed to File and Sand When the Typewriter Center is Left Flat on the Work Table

Figure 5: Workplace Modifications for the Typewriter Center During Finishing Tasks.

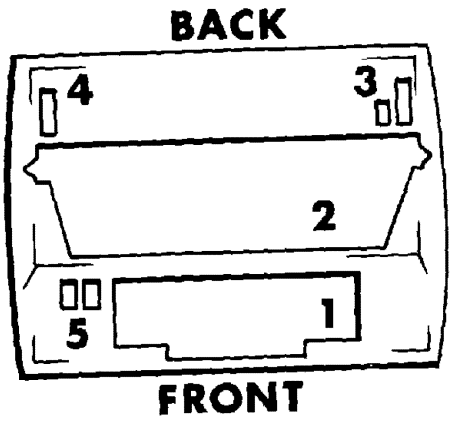


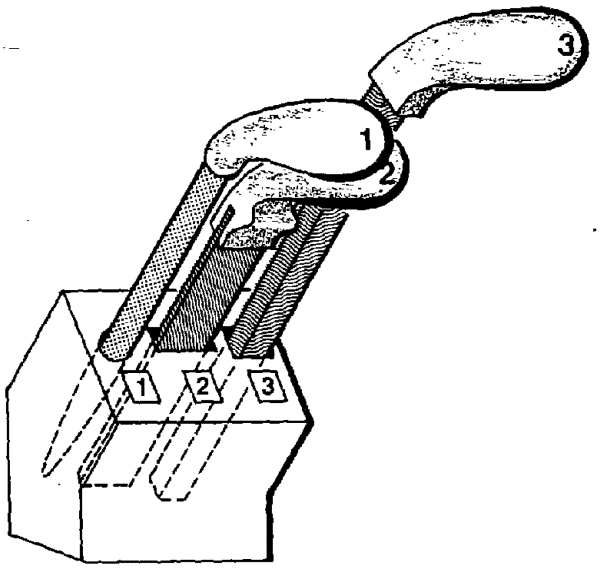
(a) Recommended inclined fixture design for the typewriter center.



(b) Recommended standard orientation for the typewriter center.

JOB TITLE: IBM CENTER FINISHING STANDARD
JOB PROCEDURE





JOB ELEMENTS

A. Position center on fixture with front facing operator. Adjust fixture height and title angle.

B. Get file #2, remove flashing from windows 1 and 2.

C. Get file #3, remove flashing from windows 3, 4, and 5.

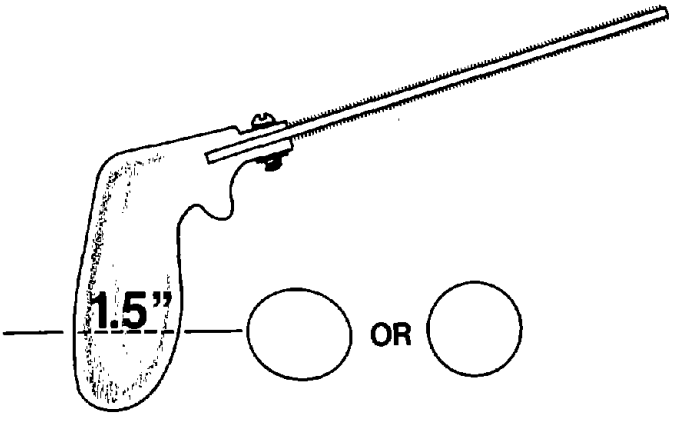
D. Position center on fixture with right side facing operation. Adjust fixture height and tilt angle.

E. Get file #2, remove flashing from windows 1 and 2.

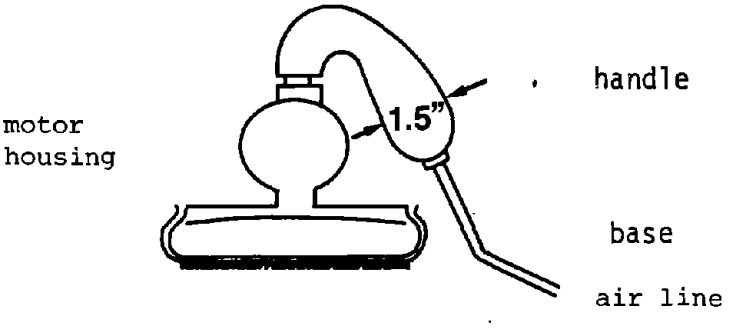
F. Get file #3, remove flashing from windows 3, 4, and 5.

Figure 6: Suggested Format Type for Recommended Job Procedure Standardization

Figure 7: Recommended Tool Modifications



(a): Recommended file with angled handle.



(b): Recommended sander with angled handle.

B282/13

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396