U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-158 -299

FEDERAL PRODUCTS CORPORATION
PROVIDENCE, RHODE ISLAND
JUNE 1976

I. TOXICITY DETERMINATION

Exposures of employees to airborne concentrations of ammonia, beryllium, chromic acid, lead, methyl ethyl ketone, fumes, nitric acid, nuisance dusts, oil mists, sodium hydroxide, toluene diisocyanate, 1,1,1-trichloroethane, 1,1,2-trichloro 1,2,2-trifluoroethane, welding fumes, mahogany wood dust, and wood dust, and operations in the print shop, dark room, and lapping area are not believed to be toxic to employees under the conditions observed by the NIOSH Hazard Evaluation personnel during the visits of October 22-24, 1975, and January 27-29, 1976. It was determined that employee exposure to free silica at the vacu-blast operation was potentially toxic on January 28, 1976. Recommendations are presented within this report to reduce the dermatitis experienced by employees in the Air Machine Department and other areas.

These determinations are based upon measurements of workplace concentrations of airborne chemicals, physical inspection of process operations and control measures, private interviews with exposed employees, and a review of the current knowledge of the toxic effects of the chemicals evaluated.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) Federal Products Corporation, Providence, Rhode Island
b) Authorized Representative of Employees
c) U. S. Department of Labor - Region I
d) NIOSH - Region I

For the purpose of informing the approximately 480 "affected employees", the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where affected employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the employer regarding the exposure of employees to "lead dust, fumes, 1,1,1-trichloroethane, methyl ethyl ketone, oil mist, dust, lapping compound, welding operation, wood dust, paint, degreaser, plating, polyurethane, anhydrous ammonia, 3M Scotchcal® Fin. Clear, 3M Scotchcal® Developer, glacial acetic acid, developer fluid, deletion fluid, plate cleaner, and black printers ink" at the Federal Products Corporation plant in Providence, Rhode Island.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

The Providence, Rhode Island location of the Federal Products Corporation is involved in the manufacture of precision linear instruments and their accessories (sic code 3821). The activities at this location include design work, machining and finishing of gage components, and gage assembly. Most of the employees involved in these activities could be described as "skilled workers." While no formal employees group exists for the purpose of collective bargaining, an "employees agent" functions on-behalf of the employees. The total number of employess at the Providence facilities, according to work status classification are: administrative/professional, 80; production/maintenance, 400. There is effectively one eight hour work shift per day, five days of the week.

Seven separate Requests, each identifying a particular operation/area, were submitted and will be discussed in this report according to the designations assigned at the time of Request Receipt.

75-158A

Catalog Gage Division: The Request for Health Hazard Evaluation identified lead dust and fumes, 1,1,1-trichloroethane, and methyl ethyl ketone as hazardous substances. The forty employees working in this area are involved in gage assembly. This Division is located on the second level of the 1139 Eddy Street location. (The second level has dimensions of approximately 380 feet by 115 feet with a twelve foot high ceiling. Only the metal finishing area is a physically separated operation on this level.)

Automated soldering of printed circuit boards is performed at a "wave soldering" operation located along the south wall of this area. The wave soldering apparatus includes a conveyor belt which carries the circuit board through a heated liquid flux and a heated (500°F) solder/oil "wave." After the board has passed through the solder wave, the operator removes it from the conveyor and washes it in a pan of 1,1,1-trichloroethane. The solder is composed of 63% tin and 37% lead. The solder wave reservoir is locally exhausted by an overhead hood. The wave soldering process is new and its use will be expanding in the future. Presently, the wave soldering is performed by one operator, one day per week (about 150 circuit boards per week). Approximately six hours is required for the operator to set up the process and solder 150 circuit boards.

1,1,1 Trichloroethane is used at numerous assembly stations in this area. The gage assembly process does not require the handling of large quantities of any material. Each assembler has a pint container of 1,1,1-trichloroethane, observed to be covered the majority of the time, which is used for cleaning the gage components. A water-jacketed degreaser containing 1,1,1 trichloroethane is also used in this area for cleaning larger parts. Observation of work practices indicated sporadic use of the degreaser and the practice of covering the degreaser when not in use. A freon (DuPont-Freon TF, trichlorotrifluoro ethane, B.P. 47.6°C) degreaser is also located in the Indicator Assembly area. This degreaser is covered except during the periodic dipping of small parts by the assemblers. It was stated that about 16 gallons of the freon is ordered each year, some of which is disposed of when contaminated. While this degreaser unit is equipped with a heating coil for use when cleaning, it has not been used in this way for a year, nor is this type of usage planned in the future.

Methyl ethyl ketone is occasionally added to a rubber-type cement as a thinning agent. Approximately two ounces of methyl ethyl ketone is used for this purpose each week. The rubber-type cement is used in relatively small quantities for gage assembly by one employee.

75-158B

Catalog Machine Division: The Request for Health Hazard Evaluation identified oil mist, dust, lapping compound, fumes and 1,1,1 trichloroethane as the hazards. This division is located on the 1st level of the 1139 Eddy Street address. The approximately nineteen workers in this division are located in two areas: the Hand Screw and Automatic Screw Machine Departments (Departments 48 and 49), and the Grinding and Lapping Department. These two departments are adjacent to each other in an area with combined dimensions of 160 feet by 115 feet.

Departments 48 and 49 are involved in the machining of brass and iron gage parts. The equipment operated in this area includes punch presses, drill presses, lathes and grinders. The machining operations are highly variable because of daily changes in work orders. Unfinished brass and iron gage parts are machined using water soluable and oil based coolants/cutting fluids. An exhausting hood is located above one lathe in this area. A water-jacketed 1,1,1trichloroethane degreaser is located in this area and is used to clean the machined parts. Most workers in this area use the degreaser for less than one-half hour per day. The machining operations in the Grinding and Lapping Department are again dependent on the work order for the day. Small gage parts are machined on several surface grinders which use water soluable coolants. Pedestal grinders are also used to finish small gage parts. The grinding operations usually involve small quantities of materials which are machined to close specifications. Lapping operations are performed in a temperature controlled room by hand and automated lapping machines. An oil based lapping compound, containing an abrasive, is used in about five gallon quantities per year. The automated lapping machines are locally exhausted for housekeeping and quality control purposes. There is a 1,1,1-trichloroethane degreasing tank in this area which is used to clean the machine and parts. The workers use the degreaser as needed, several times per shift.

75-175C

Special Gage Division: The Request for Health Hazard Evaluation identified a welding operation as the hazard. This Division is located at the 1139 Eddy Street address on the first level. The physical area is in a large room which includes the Catalog Machine Division. The eight employees in this Division are involved in the machining and assembly of gages and their components. Physical inspection of this Division disclosed a heli-arc welding operation, drill presses, a radial drill, belt sanders, lathes, and grinders. The non-production line assembly process results in variable work tasks with no standard measure of production.

The heli-arc welding operation has been in use for about a year and is performed by one individual for a maximum of two hours per day. Most of this work is performed on a work bench which is locally exhausted by a fixed position skirted-hood. Materials worked with in the welding operation include beryllium (2 pounds of rod used per year - 2-1/4% beryllium, 0.35% cobalt, 97% copper), aluminum (about five pounds of rod used per year), stainless steel, and sheet steel (about 15 pounds of filler rod used per year). Welding with the beryllium alloy has been performed on three occasions in the last year. Subsequent to the initial survey visit, the extent of beryllium use in other areas of the plant was investigated. A gage part called an "air fork", is the only beryllium alloy gage component processed at Federal Products. The air fork is a component of a specialized gage used to measure races on ball bearings. The air fork is initially received as a forge carting of 2% beryllium and 97% copper composition. A total of 600-700 air forks are processed per year. It is estimated that 90% of this 600-700 figure are returned air forks requiring repair work. The processing rate of the air forks is consequently dependent on work orders. The damaged air forks are first handled in the Receiving Department and in turn forwarded to the foreman in the Air Machine Department. One employee spends the majority of a ten hour work period processing these air forks. Essentially all of the repair jobs require brazing (using a silver-copper alloy solder), induction brazing, light milling, grinding, and polishing. The silver-copper brazing, milling and grinding is performed in the Air Machine Department in an area set aside from other operations in this Department. The induction brazing process is performed in Department 46. The process is locally exhausted with small quantities of materials handled. Polishing is presently performed in the Metal Finishing area. Heli-arc welding has been attempted in place of the brazing. The results were not acceptable and no further heli-arc welding on these air forks is planned. About 10% of the air forks processed must be manufactured from forge castings. Once received in the Air Machine Department, the forge castings are machined to specifications using the equipment and work area used in air fork repair work. The finished air fork is forwarded to the Inspection Department where the invoice is compared with the packaged item. The packaged air fork is then forwarded to the Shipping Department and sent to the purchaser.

75-158D Maintenance Welding and Carpenter Shop Department

The Request for Health Hazard Evaluation identified wood dust and welding as the hazard. This Department is located in a building adjacent to the 1139 Eddy Street Building. Dimensions of the work area are approximately 50 feet by 35 feet with a 15 foot high ceiling. The major activity in this Department involves the

production of mahogany instrument boxes. As many as three carpenters are involved in instrument box production and all use a belt sander, lock box corner machine, radial saws, a band saw, and other woodworking tools. The belt sander, lock box corner machine and table saw are locally exhausted with a shaker bag type filtration of the exhausted air.

Maintenance welding is performed at the west end of the shop by one worker. The acetylene gas welding is performed sporadically on iron materials. There is a wall-mounted exhaust fan located in the area of welding.

75-158E Instrument Component Division

The Request for Health Hazard Evaluation identified paint, degreaser, plating, 1,1,1-trichloroethane, and polyurethane as hazards. The operations conducted by the 14 employees in this area include plating, polishing and painting. The work area is separated from the other second level work areas by permanent walls. Dimensions of this area are about 65 feet by 60 feet.

A chrome plating process is the main activity in the plating area. The plating area is arranged in three rows of plating and cleaning tanks with a total of about fifty tanks. The various metal parts are first plated with copper (a ten second electroplating), then nickel (a three minute electroplating), and finally chrome (a five minute electroplating). The plating is preceded and followed by various cleaning and rinsing baths. The chromic acid tanks and selected other tanks are locally exhausted. The chromic acid tanks are heated and air agitated. The nickel tanks and a "blackening" tank (containing a concentrated sodium hydroxide solution) are also heated. The current densities depend on the size of the parts being electroplated and range from 10 to 500 amps per square foot. A 1,1,1-trichloroethane degreaser is located in this and is used for dip cleaning parts. The six employees directly involved in the plating operations spend a variable amount of time at each plating operation, dependent on the work order for the day.

Adjacent to the plating area is a polishing and grinding area. Two employees are involved in polishing and grinding in this area, each for eight hours/day. This polishing is performed on automated and standard polishing wheels. Two "vacu-blast" units (glove box type cabinets which are used for sandblast cleaning of small parts) are located in the polishing area. Also in this area are three "vibro millers" which are used about seven hours per day. These are large vibrating tubs filled with an abrasive "media" (usually jade stone, plastic beads or ceramic material) into which the metal parts are placed for deburring, etc.

A metal cleaning and spray painting area are also located in the metal finishing area. These two areas are separated by walls (with entrances to each other) from the plating and polishing areas. Two painters prepare metal parts for painting in the metal cleaning room. The metal parts are cleaned by dipping racks of parts into various cleaning solutions which include: Oakite Q5 (a caustic paint stripper which is heated and air agitated), Oakite Deoxidizer LNC (a deoxidizing solution for aluminum, composed of 15% nitric acid), and Unichrome Strip Salts (a heated phosphate solution). Following the cleaning of parts, the racks of parts to be painted

are suspended from an overhead rail located in front of the spray booths (a filtration and water curtain type of booths). About 80% of the painting is with a white polyurethane enamel (with xylene as the main solvent). About eight gallons per year of a zinc chromate containing paint (7.8% zinc chromate by weight) is used.

75-158F Reproduction Department

The Request for Health Hazard Evaluation identified anhydrous ammonia, 3M Scotchcal® Finishing Clear and Scotchcal® Developer as hazards. This Department is located on the second floor of the 1144 Eddy Street address, adjacent to a large room where design work is performed by the engineering staff. The three employees working in this Department are responsible for the reproduction of blue prints and the construction of visual aides (e.g., signs, displays, etc.).

A Bruning Ozalid Printer is used to reproduce blueprints. The image developer in this type of machine is ammonia, which in this case is metered from a pressurized tank located in the same room. The darkness of the image is controlled by the amount of ammonia exposing the paper. The meter setting for the ammonia requires little attention and is reportedly seldom altered. The printer is vented by a fan located inside the printer, exhausting to the outside environment. The printer is normally run continuously during the morning with about 150 prints (of varying size) produced in a day.

A photosensitive paper and developing liquid are used in making various types of prints. The developer (3M Scotchcal® Developer No. 8500) is applied to the paper from a "squirt" container. About one quart per month is used.

3M Scotchcal® Finishing Clear No. 3900 is applied from an aerosol can, within an exhausted hood, as a protective coating to graphic displays. About three one-pint aerosol cans are used per month.

75-158G Print Shop and Dark Room

The Request for Health Hazard Evaluation identified glacial acetic acid, developer fluid, 1,1,1-trichloroethane, deletion fluid, plate cleaner, and black printers ink as hazards. The printing shop is located on the first floor of the 1144 Eddy Street Building in a room with dimensions of 50 feet by 20 feet. The activities in this area include offset printing and gage dial printing with two employees involved. The offset printing is a small scale operation with about 35 pounds of black printers ink used per year. A number of solvents are used to clean this printing press. Plate deletion fluid is used with a cotton swab in four ounce quantities per year. About one quart per month of 1,1,1-trichloroethane is used to clean the printing press. A stoddard solvent (Blanket and Roller Work K-11) is used in two gallon quantities per month to clean parts of the printing press.

The dark room/photo lab is located adjacent to the printing area and has dimensions of approximately 25 feet by 12 feet. Photographs and offset plates are processed by a photographer using standard processes, equipment and

techniques. About 100 black and white prints per week are processed. The row of tanks used for developing and washing prints is locally exhausted. Glacial acetic acid is occasionally mixed to provide a 5% acetic acid solution. This solution is used as a "fix batch" in the processing of prints.

B. Evaluation Design and Methods

In response to the request for a Hazard Evaluation, an initial industrial hygiene survey was conducted on October 22-24, 1975. During this initial visit NIOSH investigators performed a walk-through survey to identify operations of potentially high exposure, collected information on materials and their conditions of use, performed preliminary environmental measurements, and conducted confidential medical interviews with the employees associated with the potentially high exposure operations. Subsequent to the initial visit, information on product components was collected and a follow-up survey protocol was developed. A follow-up industrial hygiene survey was conducted on January 27-29, 1976. Accomplishments during the follow-up survey included air sampling to determine worker exposures to various chemical substances, observation of work practices, and additional medical interviews with employees to elicit adverse symptomatology related to occupational exposures. Many operations at this facility are very intermittent due to the nature of gage production and variations in demand for these products. Arrangements were made prior to the follow-up survey for the accumulation of the intermittently performed operations so that they could be evaluated during the survey. Our evaluation may have missed some operations but every attempt was made to evaluate particular operations under normal operating conditions.

1. Air Sampling Methods

Airborne Dust Total airborne dust was measured by drawing air at 2.0 liters per minute through a pre-weighed polyvinyl chloride (Gelman VM-1) filter in a closed face cassette and weighing the amount of collected dust. Airborne respirable dust was measured by drawing air at a rate of 1.7 liters per minute through a 10-mm nylon cyclone (a size selective device) and weighing the amount of collected dust on the filter.

Ammonia Worker breathing zone levels of ammonia were measured using a NIOSH Certified Gas Detector Tube Unit (Drager). These Units are certified to have an accuracy of ±35% at 1/2 the exposure limit and an accuracy of ±25% at 1 to 5 times the exposure limit.

Beryllium Worker exposures to beryllium were measured by both personal and general area air samples. Total airborne beryllium was measured by drawing air through a cellulose ester filter (Millipore HA) mounted in a three piece closed face cassette. Respirable airborne beryllium was measured by drawing air through a cyclone preselector and cellulose ester filter. The filters were analyzed for collected beryllium by atomic absorption spectrophotometry.

Chromic Acid Chromic acid mist was measured by drawing air at 2.0 liters per minute through a PVC filter and analyzing the filter for hexavalent chrome by the colorimetric method.

Free Silica Free silica inhalation exposures were estimated by both personal and area air sampling. Personal breathing-zone total free silica was measured by drawing air at 2.0 liters per minute through a PVC filter. Personal breathing-zone respirable free silica was measured by drawing air at 1.7 liters per minute through a cyclone pre-selector and a PVC filter. Collected free silica on the filters was estimated by the X-ray diffraction method of analysis.

Lead Airborne lead was measured by drawing air at 2.0 liters per minute through a cellulose ester filter. The collected lead was analyzed by atomic absorption spectrophotometry.

Nitric Acid Nitric acid mist was measured by drawing air at 1.0 liters per minute through an impinger bubbler containing 0.1N NaOH as a collecting media. The collecting solution was then analyzed for nitric acid by a colorimetric method.

Oil Mist Oil mist was measured by drawing air at 2.0 liters per minute through a cellulose ester filter and analyzing the filter for oil content by the fluorescence spectrophotometric method.

Sodium Hydroxide NaOH mist was measured by drawing air at 2.0 liters per minute through a cellulose ester filter and analyzing the filter for collected sodium by atomic absorption spectrophotometry.

1,1,1-Trichloroethane Worker exposures were estimated by personal and area air sampling using low-flow vacuum pumps with activated charcoal as the collecting media. Sample analysis was performed by gas chromotography.

1,1,2-Trichloro -2,2,1-trifluorethane Personal air sampling was performed using low-flow vacuum pumps with activated charcoal as the collecting media. Sample analysis was performed by gas chromatography.

Welding Fumes Welding fumes were measured by drawing air at 2.0 liters per minute through a PVC filter and weighing the weight gain of the filter.

Xylene and Paint Solvents Worker exposure to xylene and paint solvent vapors was estimated by drawing air through tubes containing activated charcoal, and analyzing the tubes for xylene and paint solvents by the gas chromatographic method.

2. Private Employee Interviews

During the initial survey of October 22-24, 1975, and during the follow-up visit of January 27-29, 1976, a number of employees in the various plant areas were administered a questionnaire privately by NIOSH industrial hygienists to find out if the employees felt that they might have health problems related to their work. Employees were also asked whether they had experienced any symptoms or irritation in the past when performing their job duties, and if so, what the symptoms were, when they occurred, and when they disappeared.

C. Evaluation Criteria

1. Health Effects

The following discussion describes the toxicologic effects that may occur in workers exposed to the chemical substances evaluated during this study. The effects are described so that workers may know the symptoms and potential health consequences of excessive exposure. The effects described here depend upon a number of factors such as airborne concentrations, length of exposure, individual susceptibility, and possible additive or synergistic effects of two or more substances in combination. If airborne concentrations of these substances are maintained below the limits listed on the following pages, it is believed that employees will suffer no adverse health effects as a result of their work exposures.

Ammonia[1] Acute and chronic health effects as a result of inhalation exposure to ammonia are rare because of its irritant properties. Eye, nasal, and throat irritation result from exposure to ammonia at levels below those believed to pose any health problems. Direct skin or eye contact with concentrated ammonia will result in damage to tissues.

Beryllium[2,3,4,5] The toxic effects of exposure to beryllium can occur in both the acute and chronic form. Acute effects on the skin include contact dermatitis and beryllium ulcers. Ulcerations occur as a result of crystal implantation of soluble or insoluble materials in cutaneous areas previously injured as a result of cuts or abrasions. Beryllium-induced acute respiratory effects range from a mild inflammation of the nasal mucous membranes and pharynx, to tracheobronchial involvement and severe chemical pneumonitis. Recovery from acute pneumonitis may be prolonged and in severe cases may be fatal.

Chronic beryllium disease is characterized by a 5-20 year period between exposure to beryllium particulate and the appearance of detectable evidence of disease. The most common signs and symptoms of chronic beryllium lung disease is a persistant inflamatory process with its accompanying cough, chest pain, general weakness, dyspnea, anoxeria and cyanosis especially in advanced cases.

On the basis of many animal experiments, beryllium is a carcinogen capable of inducing malignant bone and lung tumors. Although the questions may not yet be conclusively answered to the satisfaction of some experts, it is NIOSH's current position that beryllium is a human carcinogen.

Chromic Acid[6,7] Experience in the chrome-plating industry has shown that employees working in uncontrolled operations develop damage to the nasal tissues. Ulceration and perforation of the nasal septum frequently develops as a result of excessive exposure. Dermatitis, upper respiratory tract irritation and dental erosion have also been reported to result from work in chrome-plating operations. Good personal hygiene, in addition to ventilation and other process controls is considered to be a factor in preventing these health problems.

Free Silica[8] The chief concern of excessive free silica exposure is the development of a disease termed silicosis. This form of pneumoconiosis usually occurs only after a number of years of exposure, although with severe exposure silicosis can occur in a short time. Early silicosis (termed "simple silicosis") is usually first diagnosed by chest X-ray examination. At this stage there is usually little if any functional impairment, and there are often no associated symptoms and signs. Symptoms occur when silicosis advances and becomes complicated by infection and emphysema.

The deposition of crystalline free silica in the lungs in sufficient amounts over a period of years may produce fibrous nodules. These nodules cause many individual alveoli (air sacs within lung) to be compressed and collapsed, thus reducing the function of the lungs. Continuous exposure to elevated concentrations of dust containing free silica may produce increased debilitating effects. These changes are marked by intolerance to exertion, episodes of coughing and production of thick purulent sputum. When silicosis has progressed to this point, the chest X-ray is usually read as "conglomerate silicosis". Conglomerate silicosis many times progresses in spite of termination of exposure and becomes incapacitating to affected workers.

Lead[9] The effects of lead poisoning have been described as loss of appetite, constipation, anemia, pallor, malaise, weakness, insomnia, headache, muscle and joint pains, fine tremors, and colic. The effects of lead exposure are dependent on the form of exposure, previous lead exposure (e. g., non-occupational), and an individual's characteristic metabolism. Absorption of lead is primarily by the routes of ingestion and inhalation. Absorption as a result of ingestion may occur from drinking lead contaminated beverages (illicitly distilled whiskey, acidic beverages stored in improperly fired lead-glazed containers, etc.), and food contamination due to not washing hands before eating. Absorption of lead by the inhalation route can be the result of industrial operations which generate a dust or fume, or from contamination of smoking materials with lead. Because of the various factors which can influence lead absorption it is generally suggested that a biologic, as well as environmental, index of exposure be used to prevent excessive lead exposure. Blood lead is generally felt to be a good index of recent lead absorption.

Methyl Ethyl Ketone[10] The vapor is highly irritating to the eyes and mucous membranes and will generally give this warning before dangerous concentrations develop. Exposure to high concentrations will cause vomiting and nausea. Both the liquid and vapor have been known to cause dermatitis. The effects of methyl ethyl ketone vapor is additive to the effects from exposure to other solvent vapors.

Nitric Acid[11,12] Solutions of nitric acid are highly corrosive and will produce damage to the skin, eyes, and mucous membranes, the severity of which is dependent on the duration of contact and the acid concentration. Continued exposure to nitric acid vapor and mist has reportedly brought about chronic bronchitis, bronchial irritation, and dental erosion.

Nuisance Dusts[6] The "nuisance" dusts are those which have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. Excessive concentrations of nuisance dusts in the work room air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages, or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by the rigorous skin cleansing procedures necessary for their removal.

Oil Mist[13,14,15] Dermatitis is the most frequent health problem resulting from work with cutting and lubricating oils. In addition to the skin drying effects of these oils, oil acne and folliculitis (inflammation of hair follicles) frequently develops from the mechanical blockage of the follicular openings. Experimental animal studies of the inhalation toxicity of white mineral oil mist indicate minimal toxicity. While the potential health hazard of an oil mist is also dependent on the oil additives and thermal decomposition products, a review of industrial experiences indicate few illnesses related to oil mist inhalation. Excessive inhalation exposure to petroleum distillate mists would be expected to produce upper respiratory tract irritation.

Photographic Processing Operations[16] A number of potential hazards exist in photographic processing. The most common hazards are a result of skin contact with the developer solutions and the need to carry out many operations in darkness (thus increasing accident potential). Dermatitis may be due to an irritation caused by the alkaline solutions or in some cases to a skin allergy or sensitivity to the developing agents (amino phenol). Skin problems can be minimized by wearing gloves and immediate flushing with water whenever chemicals come into contact with skin areas.

Sodium Hydroxide[17] Sodium hydroxide (caustic soda) will produce tissue damage by virtue of its alkaline nature. The hazards associated with the use of sodium hydroxide include: contact with the eyes, contact with the skin, ingestion and inhalation of sodium hydroxide aerosol. Inhalation of sodium hydroxide can result in irritation and damage to the tissues of the respiratory system.

Toluene Diisocyanate[18] Toluene diisocyanate (TDI) has been studied intensively and has been discussed in a NIOSH criteria document. TDI is a primary irritant of the mucous membranes of the eyes, nose, throat and bronchial tree. In addition, it may cause a progressive, allergic sensitization of the respiratory tract, ultimately resulting in severe asthmatic attacks after exposure to even minute traces of TDI. The sensitizing effect appears related to the number of available isocyanate groups, which if fully reacted no longer elicit the allergic or irritative response. Presumably if the isocyanate were partly reacted, thus reducing the number of available isocyanate groups, the response would also be reduced.

1,1,1-Trichloroethane[19,20] Excessive inhalation exposure to 1,1,1-trichloroethane will result in central nervous system depression manifested as drunkeness and incoordination. Frequent skin contact will cause a defatting of the skin and resulting dermatitis. It is generally felt that 1,1,1-trichloroethane is the least hepatotoxic (toxic to the liver) of the common chlorinated hydrocarbon solvents.

1,1,2-Trichloro, 1,2,2-trifluoroethane[6] The chief effects from excessive exposure to vapors of this freon product would be depression of the central nervous system and irritation of the respiratory tract. Excessive skin contact will cause a defatting of the skin with resulting dermatitis.

Welding Fumes[21,22] Worker exposures to toxic materials at welding operations are dependent on the materials used, the type of welding, work practices and the extent of fume control. Welding with iron, mild steel and aluminum produces the least toxic metal-oxides. Welding with zinc, copper, nickel, chromium, manganese, or beryllium materials can evolve highly toxic metal fumes and should be carefully controlled. Toxic gases such as ozone (especially with arc welding of aluminum) and oxides of nitrogen are commonly produced. The use of electrodes whose coatings contain fluorides offers a definite hazard from the fluoride fumes or gases.

Irritation of the eyes and throat is commonly experienced as a result of welding operations. This irritation can be caused by excessive exposure to ozone, oxides of nitrogen, and the fluoride fumes and gases.

Exposure to metal fumes can result in various diseases. Iron oxide is considered relatively non-toxic. Prolonged excessive exposure to iron oxide may result in siderosis (a benign pneumoconiosis); which is simply an iron pigmentation. Exposure to cadmium, chromium, beryllium, manganese, lead, nickel and other metal fumes can result in more serious lung and general systemic diseases.

Metal fume fever is a possibility upon exposure to welding fumes; however, this is highly dependent on the metals and concentrations involved. Some of the symptoms of metal fume fever include chills and fever, which rarely exceeds a temperature of 102°F., upset stomach and vomiting, dryness of the throat, cough, weakness, and aching of the head and body. Such symptoms often occur some hours later and usually last only a day.

Wood Dust[23-30] The most common health problems experienced in the woodworking industry are dermatitis, conjunctival irritation, and respiratory disease. While some woods are reported to be cutaneous sensitizers, mahogany is not considered to be allergenic. Dermatitis resulting from contact with mahogany would presumable be caused by the primary irritant effects upon the skin. A study of woodworkers in the furniture industry reported impairment of nasal mucociliary clearance. Researchers in Britain have established a significant correlation between adenocarcinoma of the nasal cavity and sinuses and occupational exposure in the furniture industry. While the level, duration and types of exposures are not documented, it is assumed that wood dust is at least a contributing factor in the development of adenocarcinoma. A recent study of mortality patterns in a large wood-exposed population supports the hypothesis that wood contains cancer causing agents. Other researchers have suggested that alveolar (deep lung) deposits result from long term exposures in environments heavily saturated with wood dust.

Xylene:[31] Excessive exposure to xylene vapor will result in irritation of the eyes, nose, and throat. Narcotizing effects are experienced at concentrations above that required to produce irritation to the nose and throat. These narcotic effects range from light headedness and giddiness to unconsciousness at extreme exposure conditions. While liver and kidney damage have been reported to result from high exposures to xylene vapors, it is generally believed that the damage is reversible. Skin contact can be a significant route of xylene absorption. The irritant and narcoticizing effects of xylene may be additive to the effects of other hydrocarbon solvent exposures.

2. Environmental Evaluation Criteria

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by several sources. These limits are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from three sources:

a. NIOSH Recommended Standards - airborne exposure limits which NIOSH has recommended to OSHA for occupational health standards.

b. Threshold Limit Values (TLV's) - guidelines for airborne exposures recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1975.

c. OSHA Standards - the air contaminant standards enforced by the U.S. Department of Labor as found in Federal Register, Vol. 39, 23540-23543, June 27, 1974.

The criteria used in this investigation to assess potential health hazards from airborne exposures are listed below:

Source	Substance	8-Hour Time-Weighted Average Concentration
NIOSH Criteria Document	Ammonia	50 ppm[a]
NIOSH Criteria Document	Beryllium	0.002 mg/M^3 [b]
NIOSH Criteria Document	Chromic Acid	0.025 mg/M^3
NIOSH Criteria Document	Free Silica	0.05 mg/M^3
NIOSH Criteria Document	Lead	0.15 mg/M^3
OSHA Standard	Methyl Ethyl Ketone (2-butanone)	590 mg/M^3
NIOSH Criteria Document	Nitric Acid	5 mg/M^3
OSHA Standard	Oil Mist	5 mg/M^3
OSHA Standard	Respirable Dust	5 mg/M^3
NIOSH Criteria Document	Sodium Hydroxide	2 mg/M^3
1975 TLV	Total Dust	10 mg/M^3
OSHA Standard	1,1,1-trichloroethane	1,900 mg/M^3
OSHA Standard	1,1,2-trichloro 1,2,2-trifluoroethane	7,600 mg/M^3
1975 TLV (proposed)	Welding Fumes	5 mg/M^3
1975 TLV	Wood Dust	5 mg/M^3
NIOSH Criteria Document	Xylene	435 mg/M^3

a - parts of ammonia per million parts of contaminated air by volume, as determined by a 5-minute sample
b - approximate milligrams of contaminant per cubic meter of air.

NIOSH Recommended Standards and Threshold Limit Values are only recommended exposure limits whereas the OSHA Standards are those set and enforced by the U. S. Department of Labor.

D. Results

Catalog Gage Division The initial walk-through survey performed in this area disclosed potential health hazards at the wave soldering and parts degreasing operations. The work performed in this area involves the assembly of gages and does not require the handling of large quantities of materials.

The use of methyl ethyl ketone was investigated. One employee uses about two ounces per week to thin a glue. Informal questioning with this person failed to elicit health complaints related to the use of the methyl ethyl ketone. No further evaluation was conducted because of the low health risk with the quantities used.

Due to the intermittent nature of the wave soldering operation, air sampling was possible on only one occasion. The personal air sample for airborne lead was of 2.9 hours duration and of a volume of 0.35 cubic meters of air. Analysis of the filter sample showed collected lead not to exceed the limit of detection (0.001 mg lead). This corresponds to airborne lead levels of less than 0.003 mg/M^3, (the NIOSH recommended level is .15 mg/M^3). Evaluation of the exhaust hood located over the lead reservoir indicated the ability for partial emmission control. This hood could be made more effective by attaching flanges or skirts. A complaint of minor throat irritation in association with the use of the liquid flux was elicited from the wave solder operator. Future use of the wave soldering operation will increase. Worker exposures should be evaluated when such process changes occur.

1,1,1-Trichloroethane ("Chlorothene VG") is used by most workers in this Division to clean gage parts. Most work areas have covered pint-containers in which the gage parts are dipped. A degreasing tank, with a water jacket, is used periodically by most workers to dip clean the larger gage parts. Measurements performed during the initial survey with length of stain detector tubes indicated that worker exposures to 1,1,1-trichloroethane did not exceed 50 ppm (about 270 mg/M^3). Personal and general area air sampling was performed to estimate worker exposures to 1,1,1-trichloroethane. Results from this air sampling are presented in Table I and indicate that worker exposures were well within the OSHA standard of 1,900 mg/M^3. Medical questionnaires failed to elicit health complaints related to working with the 1,1,1-trichloroethane.

A freon (1,1,2-trichloro 1,2,2-trifluoroethane) degreaser is located in the indicator assembly area of this Division. This degreasing tank has a water jacket and remains covered except while dip cleaning parts. Worker exposures to freon vapors were evaluated by personal air sampling. Results from this air sampling are presented in Table II and indicates that worker

exposures were well within the OSHA standard of 7,600 mg/M^3. Administration of medical questionnaires to workers in the general area elicited a complaint of eye irritation from the freon vapors. This eye irritation was mentioned in the context that the worker had "tested" to see if the vapors were irritating.

75-158B Catalog Machine Division During the initial walk-through survey of this Division, potential health hazards were recognized at the machining operations in Departments 48 and 49 (oil mist), at grinding operations (airborne dust), and at degreasing operations. Air sampling was performed and medical interviews were administered to evaluate any adverse health effects from work at these operations. The Request identified "fumes" as a hazard. No fume generating operations were identified during this evaluation.

The use of lapping compound was identified by the Requestor as presenting a hazard. The lapping is performed intermittently in a controlled temperature room using an oil-based lapping compound. The lapping boards are locally exhausted for quality control purposes. Observation of the lapping operation and an interview with the worker performing the lapping operations indicated that the potential health hazard was minimal. No further evaluation of this operation was conducted.

This Division was evaluated for dust generating operations. Most observed operations which have the potential for generating a small particle use an oil or water based coolant. While there were about twelve pedestal-type wheel grinders and several surface grinders in the Grinding Department, investigation of the materials used and observation of the intermittent grinding failed to indicate a health hazard from dust. Measurements of capture velocities at the locally exhausted pedestal grinders showed poor system balance with negligible air flow at some grinders. The results of air sampling (Table III) at the E1b and pedestal grinders indicate that worker exposures to airborne dust, assuming the dusts to be "nuisance" type, were within the 1975 TLV (mg/M^3 total dust) and OSHA standards (5 mg/M^3 respirable dust, 15 mg/M^3 total dust).

Worker exposures to oil mist was evaluated by medical interviews and air sampling. Emission of an oil mist was observed, and personal air samples were obtained, at several machining operations in Department 48 and 49. The results presented in Table IV indicate that worker exposures were within the OSHA standard of 5 mg/M^3. It was mentioned that certain operations which were not currently in operation would result in a greater oil mist emission. While most lathes were not locally exhausted, general observations indicated adequate process control. Two of eight workers which were administered medical questionnaires complained of occasional dry throat during periods when an "oil haze" was present. The operation which causes this high oil mist emission should be identified and controlled to eliminate these complaints.

Air sampling was performed to estimate exposures to 1,1,1-trichloroethane ("chlorothane VG") vapors as a result of the degreasing operations. Results (Table I) indicate that worker exposures were within OSHA Standards (1,900 mg/M^3). Degreasing is conducted periodically by most workers in

this Division with no person at the degreaser for longer than thirty minutes in a day. The degreasing tanks appeared to have good vapor control with the combination of water jackets and lids. One of eleven individuals interviewed complained of chapped skin from use of the 1,1,1-trichloroethane and coolants. A reduction in hand contact with the solvents and the use of barrier creams should be encouraged in this situation.

75-158C Special Gage Division A welding operation was identified as the hazard in this area. One employee is directly involved in the welding operations. Welding was performed at only one time during our presence, at which time a personal air sample for welding fume particulate was obtained (outside of hood). The welding operation in this case was performed on mild steel materials. The sample duration was 1.5 hours. Analysis indicates a worker exposure of 1.36 mg/M3 to welding fume particulate. This compares to the Proposed 1975 TLV of 5 mg/M^3. Evaluation of the exhaust ventilation at the welding operation showed capture velocities of about 150 feet per minute at the work surface. Use of low toxicity materials and good work practices at this operation should not present a health hazard. Questioning failed to elicit any work-related health problems or complaints.

Air sampling was conducted to determine worker exposures to beryllium during the brazing, grinding and other typical machining operations in the Air Machine Department. One employee is primarily responsible for the production of the "air forks" from the beryllium-copper alloy. Approximately ten other employees work in the general area where the air forks are produced. No type of personal protective equipment (e.g. gloves or respirator) was utilized. A total of five personal (total and respirable fractions) and five area air samples were collected during "normal" operating conditions on January 27-29. Analysis of the sample filters did not find quantities of beryllium in excess of the limit of detection (1.0 ug Be). Evaluation of the existing ventilation indicated poor control of any emissions that might result from these operations. Three of the approximately twelve employees in the Air Machine Department reported dermatitis as a result of work with methyl chloroform degreaser and oil based coolants. These individuals reported no direct contact with the beryllium alloy. The individual who works with the beryllium alloy reported no health problems related to work.

75-158D Maintenance Welding and Carpenter Shop The maintenance welding is intermittent and we were unable to observe this operation during the course of the evaluation. The gas welding work is generally performed on steel materials. The area is ventilated by a wall-mounted exhaust fan with a measured capacity of 3,000 cubic feet per minute. Repair work with materials such as stainless steel, beryllium or galvanized iron may result in excessive accumulations of toxic substances and should not be conducted in this area. No work-related health problems were reported by the welder.

Exposures to wood dust were evaluated by air sampling and medical interviews. The results from air sampling for airborne dust presented in Table III indicate that the worker exposures to wood dust was within that proposed in 1975 by the ACGIH. In view of new information which suggests that wood dust may be a contributing factor in adenocarcinoma of the nasal

cavity, ways to reduce exposures to wood dust should be investigated. A complaint of upper respiratory tract irritation during the use of the belt sander was elicited from one carpenter. Evaluation of the ventilation at the belt sander, the lock box corner machine, and a table saw showed inadequate capture velocities for effective dust control. The existing system appeared to be poorly designed and maintained. Unit collectors may provide adequate control for those operations not presently ventilated.

75-158E Instrument Component Division/Metal Finishing Air sampling and medical interviews were conducted to evaluate the health effects of the painting operations. Two area air samples for nitric acid mist were collected in the metal preparation area directly above the aluminum deoxidizing tank. Sampling and analytic results indicated that the air levels ranged from 0.014 to 0.027 milligrams of nitric acid per cubic meter of air. (The OSHA standard is 5 mg/M^3.) The painters exposure to paint solvent vapors (xylene and methyl ethyl ketone) was estimated by personal air sampling. Results of this air sampling (Table V) indicate that worker exposures were within the NIOSH Recommended Standard and the OSHA Standards for xylene and methyl ethyl ketone (OSHA Standards: xylene, 435 mg/M^3; methyl ethyl ketone, 590 mg/M^3). Subsequent to the air sampling it was discovered that the catalyst used for the polyurethane paint ("Polane") contains 0.4% free toluene diisocyanate. No air sampling was conducted to determine the painters exposures to toluene diisocyanate. However measurement at the work areas in front of the spray booths indicated that capture velocities met recommended velocities.[34] Medical questionnaires administered to the painters failed to elicit any health complaints.

Evaluation of the chrome plating operation included air sampling, ventilation measurements and administration of medical questionnaires. Air sampling was performed when a cleaning or plating solution was heated or air agitated. Three personal and two general air samples for chromic acid mist failed to find chromic acid in excess of the limit of detection. The chromic acid tanks were fitted with fold down shields and mist suppressant . Ventilation evaluation at the chromic acid tanks indicated adequate control velocities. One area and four personal air samples for sodium hydroxide mist were obtained and failed to show sodium hydroxide levels in excess of the analytic lower limit of detection. Evaluation of the exhaust ventilation at the caustic soda tanks indicated adequate control except at the "Jetal" tank, probably due to poor maintenance of the plenum and ductwork. Personal air samples for 1,1,1-trichloroethane were also obtained for those employees working around the parts degreaser in the plating area. The results in Table I indicate that exposure levels were well within the OSHA Standard (1,900 mg/M^3). This degreaser had a water jacket for control of solvent vapors. Medical questionnaires administered to four of the platers failed to elicit any job related health problems.

Bulk analysis of the abrasive media used at the "vacu-blast" operation disclosed that it contained 98% quartz. Exposures to free silica dust were evaluated by personal air sampling. The method of analysis will detect the quartz, tridymite, and cristobalite forms of crystalline silica. Air sampling results (Table VI) indicated that during the periods of air sampling the vacu-blast operator had exposures to respirable free silica

which exceed NIOSH recommendations (0.050 mg/M^3). Analysis of the other three air samples showed levels below the analytic limit of detection for free silica, thus indicating exposures within NIOSH recommendations. Analysis of other materials used in this area (polishing media used at the polishing wheels) failed to indicate the presence of crystalline silica. Visual examination of the area around the vacu-blast unit disclosed media spillage. Improved work practices, or preferably the substitution the presently used abrasive media with an abrasive free of silica should reduce worker exposures to acceptable levels.

75-158F Reproduction Department Administration of medical questionnaires to the three employees in this department elicited complaints of eye and nasal irritation associated with the ammonia vapors from the blue print operation. No health complaints related to use of other materials was elicted. Worker exposures to ammonia were estimated by breathing-zone grab air samples using length of stain detector tubes on October 23, 1975 and January 28, 1976. A total of nine air samples were obtained and indicated exposures ranging from 5 to 20 ppm of ammonia. While complaints of irritation were unanimous, the measured levels of ammonia did not reach the NIOSH exposure limit (50 ppm as determined by a five minute sample).

Scotchcal® Developer No. 8500 is used in processing photosensitive paper. Information provided by the supplier indicates that the most hazardous material in this product is n-propyl alcohol. The use of Scotchcal No. 8500 appeared to present no health hazard due to the quantities (one quart per month) and methods of use. No health complaints related to the use of this product were elicited.

About three one-pint aerosol cans of Scotchcal® Finishing Clear No. 3900 are used each month as a protective coating for visual displays. The coating is applied in a hood. Information provided by the supplier indicates that this product contains methylene chloride, cyclohexanone, amyl acetate, n-butyl acetate, acetone, toluene, alphatic petroleum distillates, and a freon propellant. No health complaints related to the use of this product were elicited. Health effects as a result of using this product will be minimized by continued use in the hood.

75-158G Print Shop Worker exposures in the print shop and dark room were evaluated by air sampling and medical interviews. A stoddard solvent based roller wash (Blanket and Roller Wash K-11) is used in two gallon per month quantities. Information provided by the supplier stated that no toluene, benzene, xylene or chlorinated hydrocarbons were present in this product. No further evaluation of worker exposures to this product were conducted. About four ounces per year of plate deletion fluid (3M Deletion Fluid) is used by cotton swab application. Product information provided by the supplier indicates that the deletion fluid contains 2-methoxyethanol, 2-ethoxyacetate and ammonium fluoride. While skin contact or ingestion of this product presents a health hazard, the conditions of use are not expected to present a health hazard. No further evaluation of the press operators exposure to this product was conducted. About 35 pounds of black printers ink is used per year with the offset printer. This ink has a paste-like consistency which minimizes problems of ink mist generation. About one quart per month of 1,1,1-trichloroethane is used by the operator to clean parts of the press. Personal

and area air samples indicated that the press operators exposure to 1,1,1-trichloroethane was within the OSHA standard of 1,900 mg/M^3 (Table I). Administration of a medical questionnaire failed to elicit any job related health problems.

A visual inspection of the dark room and discussion with the photographer disclosed a standard dark room operation where about 100 black and white photographs are processed each week. The products utilized in the development of black and white photographs are standard to the process. While the potential exists for dermatitis as a result of skin contact with the fix bath (5% acetic acid) and developer fluid (aminophenol), questioning failed to elicit any job related health problems. The work bench is locally exhausted and appeared to reduce the possibility of contaminant accumulation.

V. RECOMMENDATIONS

Catalog Gage Division

Although it was not indicated that worker exposures to airborne lead at the wave soldering operation were excessive, the performance of the existing hood can be easily improved by attaching flanges or skirts. Due to complaints possibly caused by the flux at the wave soldering operation, local exhaust ventilation at the flux reservoir should be provided. Ventilation with a lateral exhaust hood may be one way of controlling this operation without causing work interference. Design procedures for ventilating such operations are described in the ACGIH industrial ventilation manual.

Catalog Machine Division

1) Identify the operation in the Catalog Machine Division which has on occasion produced the oil mist "haze" and control these oil mist emissions to reduce the complaints of dry throat.

2) Because of several reported cases of dermatitis associated with the use of the coolants and 1,1,1-trichloroethane degreaser, protective gloves should be used when practical, or the accelerated use of barrier creams is to be encouraged.

3) Many operations in this Division are exhaust ventilated although no health hazard exists. While this is commendable from a health standpoint, and desirable for housekeeping purposes, evaluation of most ventilation indicated that there would be essentially no contaminant control. This appears to be due to a combination of poor maintenance practices, and poor design (e.g. overloading systems by trying to ventilate too many operations, etc.). A regular maintenance and performance evaluation program of the ventilation system should be established. Performance criteria for various operations are available.[33]

Special Gage Division and Air Machine Department

1) Due to the high potential toxicity of beryllium products, any operation which has the potential for generating a beryllium dust or fume should be ventilated. The air fork brazing, polishing, grinding and milling operations should be locally exhausted. Air sampling results do not indicate that extreme control measures, such as a glove hood, are necessary to protect workers from excessive beryllium exposures.

Section 5 of the Industrial Ventilation Manual[27] presents design criteria for ventilating specific operations (Print No. VS-207, VS-209, VS-406, VS-416). Exhaust air from these operations should not recirculated.

2) Due to the high frequency of reported dermatitis problems in the Air Machine Department, it is recommended that:

a) Employees in this area be encouraged to report skin problems and have them treated before they become more severe.

b) Work practices be developed which reduce coolant/degreaser contact with the skin.

c) Protective gloves be used if possible, otherwise, accelerated use of barrier creams should be encouraged.

Maintenance Welding and Carpenter Shop

1) Repair welding on hazardous materials such as beryllium, stainless steel, galvanized steel, and manganese should not be performed with the existing ventilation.

2) A regular evaluation and maintenance program of the ventilation system must be practiced in order to control the wood dust from the box making operations. Design and evaluation criteria for ventilating woodworking operations are presented in Section 5 of the "Industrial Ventilation Manual".[32]

Painting/Metal Finishing

1) Due to the use of polyurethane paint with free TDI, it is recommended:

a) Educate the painters and any other exposed personnel to the hazards and proper work practices for this paint. These persons should be able to recognize the signs of TDI allergy and recognize that such an allergy can develop at any time.

b) Evaluate spray booth performance on a regular basis. Criteria are presented in the Industrial Ventilation manual.[34]

c) Install an automated filter changer for the dry-filter spray booth.

2) Because of air samples indicating excessive worker exposures to free silica, it is recommended that:

a) Work practices and control measures at the vacu-blast operation be changed to prevent the escape of the quartz abrasive media. Air sampling should be conducted to confirm acceptable exposure levels, or preferably

b) Substitute a less toxic abrasive media for the quartz media in present usage.

3) A regular evaluation and maintenance program of ventilation at the plating operation should be practiced.

Reproduction Department

Only partial control of ammonia emissions from this operation are possible with the existing exhaust ventilation. The general area ventilation should therefor be increased. A wall mounted exhaust fan located near the printer may help control the movement of ammonia vapors into other areas of the building.

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VII. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By:

Jack O. Geissert
Industrial Hygienist
Hazard Evaluation and
Technical Assistance Branch

Originating Office:

Jerome P. Flesch
Acting Chief
Hazard Evaluation and
Technical Assistance Branch

Acknowledgments

Environmental Evaluation:

Walter J. Chrostek
Industrial Hygienist
Region III, NIOSH

Bruce A. Hollett
Industrial Hygienist
Hazard Evaluation and
Technical Assistance Branch

Irving Kingsley
Industrial Hygienist
Region II, NIOSH

Laboratory Analyses:

Staff, Agricultural Research and
Analytical Laboratory
Western Area Laboratory for Occupational
Safety and Health
Salt Lake City, Utah

TABLE I

SUMMARY OF AIR SAMPLING FOR 1,1,1-TRICHLOROETHANE*
AT FEDERAL PRODUCTS CORPORATION ON
JANUARY 27-28, 1976

Person/Location	Sample Type, Personal (P) or Area (A)	Sample Period	Air Concentration of 1,1,1-trichloroethane (mg/m^3)
Catalog Gage Division		**January 27, 1976**	
Dial Printer - Dept. 32	P	0920 - 1125	190
Dial Printer - Dept. 32	P	1125 - 1225	194
Dial Printer - Dept. 32	P	1225 - 1326	252
Dial Printer - Dept. 32	P	1327 - 1432	140
Dial Printer - Dept. 32	P	1432 - 1525	305
Gage Assembler #1 - Dept. 60	P	0930 - 1127	135
Gage Assembler #1 - Dept. 60	P	1232 - 1330	156
Gage Assembler #1 - Dept. 60	P	1330 - 1427	59
Gage Assembler #1 - Dept. 60	P	1427 - 1520	79
Testmaster Repair - Dept. 60	P	1130 - 1235	333
Testmaster Repair - Dept. 60	P	1235 - 1333	148
Testmaster Repair - Dept. 60	P	1333 - 1430	211
Testmaster Repair - Dept. 60	P	1430 - 1523	149
Indicator Repair - Dept. 32	P	0925 - 1126	18
Indicator Repair - Dept. 32	P	1126 - 1231	311
Indicator Repair - Dept. 32	P	1231 - 1334	46
Indicator Repair - Dept. 32	P	1334 - 1425	52
Indicator Repair - Dept. 32	P	1425 - 1520	51
		January 28, 1976	
Gage Assembler #2 - Dept. 60	P	1320 - 1417	46
Gage Assembler #2 - Dept. 60	P	1417 - 1522	116
Area Near Degreaser	A	1315 - 1415	79
Area Near Degreaser	A	1415 - 1515	141
Catalog Machine Division		**January 27, 1976**	
Rack Machine Operator	P	0910 - 1055	169
Rack Machine Operator	P	1055 - 1156	162
Rack Machine Operator	P	1234 - 1352	148
Rack Machine Operator	P	1354 - 1525	101
Near Degreaser - Dept. 48	A	0906 - 1048	251
Near Degreaser - Dept. 48	A	1048 - 1217	257
Near Degreaser - Dept. 48	A	1237 - 1342	309
Near Degreaser - Dept. 48	A	1350 - 1526	142

TABLE I (Continued)

FEDERAL PRODUCTS CORPORATION

Person/Location	Sample Type, Personal (P) or Area (A)	Sample Period	Air Concentration of 1,1,1-trichloroethane (mg/m^3)
		January 28, 1976	
Rack Machine Operator	P	0756 - 0934	16
Rack Machine Operator	P	0934 - 1149	135
Rack Machine Operator	P	1237 - 1521	87
Drill Press Operator-Dept. 48	P	0753 - 0936	30
Drill Press Operator-Dept. 48	P	0936 - 1148	13
Drill Press Operator-Dept. 48	P	1238 - 1520	80
Metal Finishing		January 27, 1976	
Plater #1	P	0940 - 1135	105
Plater #1	P	1135 - 1237	118
Plater #1	P	1237 - 1337	69
Plater #1	P	1337 - 1440	147
Plater #1	P	1440 - 1520	78
Plater #2	P	0945 - 1135	429
Plater #2	P	1135 - 1200	480
Plater #2	P	1225 - 1340	69
Plater #2	P	1340 - 1438	360
Plater #2	P	1438 - 1528	178
Printing Shop		January 28, 1976	
Printer	P	0904 - 1200	16
Printer	P	1344 - 1528	89
General Area	A	0904 - 1200	8
General Area	A	1344 - 1528	87

*OSHA Standard 1,900 mg/m^3

a - approximate milligrams of contaminant per cubic meter of air

TABLE II

SUMMARY OF PERSONAL AIR SAMPLING FOR 1,1,2-TRICHLORO 1,2,2-TRIFLUOROETHANE* (FREON TF)
AT FEDERAL PRODUCTS CORPORATION ON
JANUARY 27-28, 1976

Person/Location	Sample Period	Air Concentration of 1,1,2-trichloro 1,2,2-trifluoroethane (mg/m^3)[a]
	January 28, 1976	
Indicator Assembler #1	0755 - 0955	178
Indicator Assembler #2	1155 - 1355	102
Indicator Assembler #1	1355 - 1520	164
Indicator Assembler #2	0755 - 1155	126
Indicator Assembler #2	1155 - 1355	51
Indicator Assembler #2	1355 - 1520	50
	January 28, 1976	
Indicator Assembler #1	0705 - 0905	203
Indicator Assembler #1	0905 - 1207	175
Indicator Assembler #1	1207 - 1405	227
Indicator Assembler #1	1405 - 1520	331
Indicator Assembler #2	1205 - 1520	92

*OSHA Standard 7,600 mg/m^3

a - approximate milligrams of contaminent per cubic meter of air

TABLE III

SUMMARY OF AIR SAMPLING FOR AIRBORNE DUST*
AT FEDERAL PRODUCTS CORPORATION ON
JANUARY 27-28, 1976

Person/Location	Sample Type	Sample Period	Airborne Dust Concentration (mg/m^3)[a]
Catalog Machine Division		January 27, 1976	
Elb Grinder Operator	Personal, Total	0835-1154, 1236-1524	2.02
	Personal, Respirable	0835-1154, 1236-1524	0.70
		January 28, 1976	
Pedestal Grinder Operator	Personal, Total	1335-1435	0.70
	Personal, Respirable	1335-1435	0.80
Wood Shop		January 27, 1976	
Carpenter #1	Personal, Total	0911-1151, 1235-1548	3.26
Carpenter #1	Personal, Respirable	0911-1151, 1235-1548	0.48
Carpenter #2	Personal, Total	0915-1149, 1233-1548	2.30
Carpenter #2	Personal, Respirable	0915-1149, 1233-1548	0.49
		January 28, 1976	
Carpenter #1	Personal, Total	0739-1153, 1253-1526	1.35
Carpenter #1	Personal, Respirable	0739-1153, 1253-1526	0.43
Carpenter #2	Personal, Total	0740-1152, 1255-1526	4.52
Carpenter #2	Personal, Respirable	0740-1152, 1255-1526	0.74

*OSHA Standard for Respirable Dust - 5 mg/m^3
1975 TLV for Total Dust - 10 mg/m^3
1975 TLV for Wood Dust - 5 mg/m^3

a - approximate milligrams of contaminant per cubic meter of air

TABLE IV

SUMMARY OF AIR SAMPLING FOR OIL MIST*
AT FEDERAL PRODUCTS CORPORATION ON
JANUARY 27-29, 1976

Person/Location	Sample Type, Personal (P) or Area (A)	Sample Period	Air Concentration of Oil Mist (mg/m^3)[a]
		January 27, 1976	
Waddell Machine	A	0822 - 1540	0.37
#3 Universal Turret Lathe Operator	P	0821 - 1046	0.07
#6 Hardinge Lathe Operator	P	0932 - 1156	0.45
		January 28, 1976	
#6 Hardinge Lathe Operator #1	P	0729 - 0927	0.68
Hardinge Lathe Operator #2	P	0728 - 1158, 1236 - 1524	0.31
		January 29, 1976	
#6 Hardinge Lathe Operator	P	0754 - 1157, 1250 - 1520	2.35

* OSHA Standard 5.0 mg/M^3

TABLE VI

SUMMARY OF PERSONAL AIR SAMPLING FOR RESPIRABLE FREE SILICA*
AT FEDERAL PRODUCTS CORPORATION ON
JANUARY 27-29, 1976

Person/Location	Sample Period	Air Concentration of Free Silica (mg/m^3)[a]
	January 27, 1976	
Polisher #1	0820 - 1520	N.D.[b]
Vibra-Miller Operator	0815 - 1520	N.D.
	January 28, 1976	
Vacu-Blast Operator	0803 - 1158, 1240 - 1513	0.167
	January 29, 1976	
Polisher #2	0730 - 1211	N.D.

*Free silica is defined here as the quartz and cristobalite forms of SiO_2.
The NIOSH recommended exposure limit for respirable free silica is 0.050 mg/m^3.

a - Approximate milligrams of contaminant per cubic meter of air.

b - N.D. - None detected where the analytic lower limit of detection for quartz for cristobalite is 0.01 mg.