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. 78-104-565

UNIVERSAL PRINTING COMPANY
ST. LOUIS, MISSOURI 63110

FEBRUARY 1979

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at Plant No. 2 of the Universal Printing Company; St. Louis, Missouri, on July 18-20, 1978. The evaluation methodology consisted of (a) medical interviews of 30 employees and a limited physical examination and/or follow-up of some selected employees; (b) environmental sampling of known air contaminants; (c) laboratory determinations; (d) literature review of known chemicals and their physiological effects; and (e) inspection of the workplace and personal observations.

Results of the hazard evaluation indicate the following:

A. Several employees had skin dermatitis (e.g., dry, cracked skin on the hands and arms) at the time of the survey which is attributed to direct contact of organic solvents with the skin. These solvents were in common use in the press areas.

B. Employees had irritation of the eyes which included two cases of current eye irritation and two other individuals with a past history of eye irritation. The workers attributed their eye irritation to the blanket wash solvents. Exposures were via splashes as well as visible airborne contaminants.

C. Employees may be exposed to airborne concentrations of mineral spirits which could be considered as potentially toxic if employees worked overtime or were involved in more cleanup or changeover operations than occurred at the time of the survey.

D. Employees were not exposed to airborne toxic concentrations of the major organic chemicals (i.e., mineral spirits, toluene, ethyl benzene, m-xylene, cumene, and trimethyl benzene) considered at the time of this evaluation.

E. Employees were not exposed to airborne toxic concentrations of the secondary chemicals (i.e., total and respirable nuisance dusts, oil mists, chromium VI, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, free benzidine (3,3'-dichlorobenzidine), 2-nitropropane, lead, cadmium, copper, nickel, nitric oxide, nitrogen dioxide, formaldehyde, phenol, triethylamine, and carbon monoxide) considered at the time of this evaluation.

Detailed information concerning the above items plus pertinent observations concerning work practices and other items are contained in the body of this report. Recommendations are included in this report which are designed to reduce employee exposure to a minimum.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies of this report have been sent to:

a) Universal Printing Company
b) Authorized Representative of Graphic Arts International Union Local No. 505
c) U.S. Department of Labor - Region VII
d) NIOSH - Region VII

For the purpose of informing the approximately 30 "affected employees", the employer shall promptly "post" for a period of thirty calendar days, this Determination Report in a prominent place(s) near where exposed 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 received such a request from an authorized representative of the Graphic Arts International Union Local No. 505 regarding worker exposure to various chemical products (e.g., blanket wash, roller wash, petro gum, copper activator solution, silicone emulsion, and fountain solution). These

exposures resulted in worker symptoms of irritation of the eyes such as reddening of the eyes, burning of the eyes, and tearing of the eyes.

IV. HEALTH HAZARD EVALUATION

A. Description of Process

There were approximately 30 full-time employees who are about equally distributed among all three shifts for five, sometimes six, and occasionally seven days a week. Some employees were on 12-hour shifts due to a shortage of personnel. There are two large Webb Offset Printing Presses -- the Harris Cottrell Press No. 801 (4 printing units) was installed in 1967 and the Hantscho Press No. 802 (5 printing units) was installed in 1970. The printing units are preceded by pasters and the infold and followed by a drier or gas oven (operated at 300-475°F) and a folder or sheeter. Each press is manned by a first pressman, second pressman, first assistant, second assistant, and press tender. Each press uses a wide variety of heat setting inks and paper furnished by several different firms. Other products used are polysiloxanes, blanket washes, hand cleaners, roller washes, silicone spray, copper activator, plate kleen, petro gum, fountain solutions, inks, and other similar products in common use in offset lithography operations. These products contain a wide variety of chemicals such as toluene, aliphatic solvents, xylene, naphthas (high and low boiling points), naphthenic and paraffinic oils, gilsonite, rosin gum, and other varied compounds. Several bulk samples of various products were obtained and sent to the NIOSH laboratories for analysis of potential contaminants which may become airborne. In addition, each of the manufacturers of the many products were contacted concerning the specific compounds involved in their formulations of these products. As these products are of a proprietary nature, only the known major compounds of these formulations which may present a health hazard are discussed in this report. There were two different types of papers used at the time of the survey. Both papers are acceptable for use with food contact application and are consistent with the requirements of the 1958 Pure Food and Drug Act with subsequent amendments. The papers are also within the requirements of the Toxic Substances Control Act of 1977 and are considered as exempt material by the Food and Drug Administration.

B. Evaluation Progress and Methods

1. Progress

The Occupational Safety and Health Administration (OSHA) had previously conducted an inspection of this facility and obtained information on the chemicals used at this facility. Sufficient background information was obtained from OSHA, representatives of the company, and manufacturers of various products that an initial walk-through survey as well as a

combined environmental-medical survey was conducted on July 18-20, 1978, by a NIOSH team consisting of two industrial hygienists and a physician's assistant. Separate exit interviews were held with appropriate representatives of union and management to discuss any preliminary observations and findings, and to answer any questions concerning this evaluation and subsequent reports. An interim summary report of observations and findings was sent to management and union representatives on August 3, 1978.

The primary emphasis concerned employee exposure to various organic solvents used (a) during normal production runs where employees clean various pieces of equipment on an intermittent basis to assure good copy; and (b) between different production runs where employees have intensive cleanup operations of the press for about one hour to assure good copy. Appropriate personal samples were obtained on employees to establish exposure levels of employees to various organic compounds during the normal production run and cleanup operations which occurred at the time of the survey.

2. Environmental Design and Methods

Personal air samples were used to evaluate employee exposures to various organic solvents. The personal samples were obtained by attaching the pump to the workers belt with the sampling media in a holder attached to the lapel of the worker to obtain a representative sample of air in the breathing zone of the worker. Samples were collected by absorbing vapors onto charcoal contained in glass sampling tubes at a sampling rate of 0.05 to 0.2 liters per minute (lpm). The sampling tubes were submitted to the laboratory for analysis by gas chromatography according to a modified NIOSH Method P&CAM No. 127 contained in the NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 77-157, Cincinnati, Ohio 1977. These samples were analyzed for total naphtha and for toluene, ethyl benzene, m-xylene, cumene, 1,3,5-trimethyl benzene, 1,2,4-trimethyl benzene which are either additives or impurities to the various products in use at this facility. The results of these samples are discussed in detail in Section IV-D-1 of this report.

General area air samples were obtained at various locations and were analyzed for other suspect contaminants which may be a part of various products but which were of a secondary consideration as far as this evaluation is concerned. These samples are summarized below.

a. Two respirable dust and two total dust samples were obtained in the vicinity of the sheeters and/or folders on Presses 801 and 802. These samples were obtained on FWSB filters using a MSA Model "G" Pump at a flow rate of 1.7 lpm. These samples were analyzed gravimetrically for tare weight which would be representative of the dust and oil mist loading at the time of the survey. The maximum results were reported as 0.5 mg/M^3 (mg/M^3 - milligrams of contaminant per cubic meter of air sampled) for total dust or oil mist and 1.1 mg/M^3 for respirable dust. These levels are ten percent or less of the more

restrictive environmental criteria of 5 mg/M^3 for oil mists and respirable nuisance particulates or dusts. These samples were also analyzed for "free silica" as quartz and cristobalite and no "free silica" (less than 0.03 mg per sample) was detected on the filters using the NIOSH Method P&CAM No. 109.

b. Three total dust samples were obtained in the vicinity of the paint table of Press 802 and the sheeter and/or folders of Presses 801 and 802. These samples were obtained on DM-800 filters using a MSA Model "G" Pump at a flow rate of 1.5 lpm and analyzed gravimetrically for tare weight. The maximum result was 2.4 mg/M^3 for total particulate which is less than twenty-five percent of the environmental health criteria of 10 mg/M^3 for total nuisance dusts or particulates. These samples were also analyzed for chromium VI and no chromium VI (less than 0.0002 mg per sample) was detected on the filters using the NIOSH Method P&CAM No. 169.

c. Five samples were obtained using a glass fiber filter followed by a silver impregnated membrane filter using a MSA Model "G" Pump at a flow rate of 1.5 lpm. Four samples were obtained at the exit and entrance to the ovens of both presses and on the solvent table of Press 801. These samples were analyzed for fluoranthene (detection limit of 0.04 µg/sample), pyrene (detection limit of 0.20 µg/sample), benzo(a)anthracene (detection limit of 0.04 µg/sample), chrysene (detection limit of 0.10 µg/sample), and benzo(a)pyrene (detection limit of 0.02 µg/sample). It is noted that 1 µg is equal to 0.001 mg. These samples were analyzed by reversed-phase high pressure liquid chromatography procedures. Results were all less than detectable levels for these compounds.

d. Two glass fiber filter samples were obtained on both pigment tables and two glass fiber filter samples were obtained on both presses. These samples were obtained using a MSA Model "G" Pump at a flow rate of 1.5 lpm. These samples were analyzed for free benzidine (3,3'-dichlorobenzidine) using an "Analytical Procedure for Benzidine in Azodyes (HPLC)" which is available upon request to the authors of this report. Results were all less than the detectable level of 1 µg per sample for benzidine.

e. Four glass tube samples (containing chromosorb 106 absorbent) were obtained on both solvent tables (Presses 801 and 802) and both paint tables. These samples were obtained using a Sipin pump at a flow rate of approximately 0.2 lpm. These

samples were analyzed by gas chromatography using NIOSH Method P&CAM No. 272 and by gas chromatography/mass spectrometry for 2-nitropropane. All results were less than the minimal detectable amount of 0.005 mg per sample for 2-nitropropane.

f. Two AA filter samples were obtained over both paint tables and two AA filter samples were obtained in the vicinity of the sheeter and/or folder of both presses. These samples were obtained using a MSA Model "G" Pump at a flow rate of 1.5 lpm. These samples were analyzed for lead, cadmium, copper, and nickel with a minimum detectable level of 5 µg/sample for lead, and 2 µg/sample for cadmium, copper and nickel.

g. Several detector samples (using Bendix, MSA or Draeger pumps) were obtained at appropriate locations for carbon monoxide, formaldehyde, phenol, triethylamine, nitric oxide, and nitrogen dioxide. Carbon monoxide was detectable at 5.5 mg/M^3 which is less than 15 percent of the environmental health criteria of 38.5 mg/M^3. Formaldehyde, phenol, triethylamine, nitric oxide and nitrogen dioxide were not detected at the time of the survey.

The airborne levels of total and respirable nuisance dusts, oil mists, chromium VI, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, free benzidine (3,3'-dichlorobenzidine), 2-nitropropane, lead, cadmium, copper, nickel, nitric oxide, nitrogen dioxide, formaldehyde, phenol, triethylamine, and carbon monoxide were found to be well below the evaluation criteria for these compounds and are not considered as toxic from an inhalation standpoint. Therefore, air concentrations of these compounds are not discussed further in this report.

3. Medical Design and Methods

The thirty persons who participated in this study did so because of their proximity to various print shop substances, i.e., stoddard solvent solutions and silicone emulsions. These thirty persons comprised all available personnel in the print shop at the time this survey took place. Each person was questioned regarding any pertinent past medical history, or as regards specific symptoms known to be associated with excessive exposure to the above mentioned substances. In addition to the history, a physical examination was performed on each person. Detail was paid to mucous membranes, eyes, and the epidermis. Permission was obtained from three workers to review their private medical records. Two of these workers evidenced eye irritation and the other was under treatment for a dermatitis condition.

C. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in this report are: (a) NIOSH Criteria Documents with recommended standards for occupational exposure; (b) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation; and (c) Federal Occupational Health Standards as promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor (29 CFR 1910.1000). For the substances evaluated during this study, the primary environmental criteria considered most appropriate are:

TABLE OF ENVIRONMENTAL CRITERIA

SUBSTANCE	STANDARD OR GUIDE mg/M^3*
Mineral Spirits (e.g., stoddard solvent, etc.)	350 (a)** (maximum concentration of 1,800 mg/M^3 for 15 minute sampling period)
Toluene	375 (a,b) (750 mg/M^3 for 10 minute sampling period)
Trimethyl benzene	120 (b)
Xylene (skin)	435 (a,b,c)
Ethyl benzene	435 (b,c)
Cumene (skin)	245 (b,c)

*Approximate milligrams (mg) of substance per cubic meter (M^3) of air sampled.

**Reference letters in parentheses refer to the source(s) from the above discussion from which the standard or guide was obtained.

Occupational health limits for individual substances are generally established at levels intended to protect workers occupationally exposed during an 8 or 10 hour work day, 40 hour work week, over a normal working lifetime. The above air concentrations should be reduced accordingly if the worker is exposed over 40 hours per week. For instance, the levels for mineral spirits would be 280 mg/M^3 [(40 hours ÷ 50 hours) x 350 mg/M^3] for an employee working 50 hours a week and 233 mg/M^3 for an employee working 60 hours a week.

2. Biological Criteria - Review of Literature

Biological criteria are based on the observable health effects of exposure to the work environment usually in reference to a biologically normal condition. Exposures include not only the breathing concentrations but

also direct skin contact with solvents, cleaning agents, and other chemicals. Absorption via the skin of various chemicals as well as absorption via the gastrointestinal tract from hands contaminated with various chemicals are major areas of concern but areas where there is only limited data and information. General information on the major compounds considered in this evaluation are discussed below.

There are a wide variety of refined petroleum products[1] (e.g. mineral spirits, stoddard solvent, naphthenic and paraffinic oils, toluene, ethyl benzene, etc.) which are used as additives and solvents in various formulations or products - the most common being mineral spirits and/or stoddard solvent which are relatively high boiling point petroleum oils. Repeated or prolonged contact with the skin may lead to a dermatitis. Solvents dissolve the natural protective oils from the skin resulting in a loss of skin hydration. This leads to redness, drying, and cracking of the skin. Once the skin barrier is broken, it is easily infected by common bacteria and also deeper penetration with subsequent absorption of chemicals through the affected skin areas. Persons with dry, senile, or sensitive skin are particularly prone to solvent actions. The other major toxic effects from mineral spirits and other solvents are irritation of the skin, eyes, throat, and nose and the feeling of sleepiness, light headedness, headache, and possibly some incoordination from breathing excessive amounts of the vapors. These symptoms of the central nervous system may be intensified or first noted at the moment of entry into an uncontaminated atmosphere after a solvent (e.g., mineral spirits, toluene, etc.) over-exposure.[2] In some refined petroleum products there are also impurities which involve other considerations. These considerations may include, but are not necessarily limited to, such impurities as trimethyl benzene, cumene, and ethyl benzene. They have shown that they can affect the blood (e.g., leukocytosis, hyperemia, etc.) of animals such as rats and rabbits. However, these chemicals have not been shown to produce the severe leukopenias found in benzene-dosed rats. Benzene may also be an impurity in mineral spirits, stoddard solvent, toluene, and other solvents or refined petroleum products. The most significant toxic effect of benzene is insidious and often irreversible injury to the blood-forming tissues, resulting most commonly from repeated low-level chronic exposures. Route of entry to the body is by inhalation and skin absorption. Excessive human exposure may cause headache, weariness, loss of appetite and lassitude with incipient blood effects including decreased red cell counts and unusual white cell configurations. Leukemia is a possibility. NIOSH is currently investigating the teratogenicity of ethyl benzene.

A recently completed inhalation study indicates that 2-nitropropane[3], a widely used solvent in industrial coatings and printing inks, causes liver cancer in rats. Although this study suggests that 2-nitropropane is carcinogenic, its carcinogenic potential in man has not yet been researched. Contact with manufacturers of various products as well as environmental air samples did not indicate any 2-nitropropane. However, previous products used at this facility may have contained (note no confirmation that products did contain) 2-nitropropane.

There are a few silicone products used interchangeably. These products are primarily composed of dimethylpolysiloxane fluid with traces of emulsifiers and water. Eye contact via exposure to aerosol mist/splashes may cause tissue irritation and transient corneal damage with recovery in a few days unless there is continued repeated insults to the eyes. Silicones are also used as filler or body to various products including paper.

Printing inks which may have been or are in current use involve an extremely wide variety of formulations and products. In particular, there is a wide variety of inks which contain various components such as carbon black, pigment yellow 12 (derived from 3,3'-dichlorobenzidine), pigment blue 15, pigment red 57 (litho rubine), phthalo cyanine blue and dyes containing metals such as lead and chromium VI. Some of these compounds are considered as toxic from a chronic, long-term exposure to low airborne concentrations of the substances and may be absorbed by the skin. For instance, chromium VI is known to produce lung cancer, skin ulcers and lung irritation. Lead is well-known to cause lead poisoning which affects the kidney, blood and nervous system. Some inks in use at this facility and throughout the industry contain benzidine yellows, also known as diarylide yellows. Some benzidine derived dyes have been shown to be a animal and human cancer-causing agent.[4] These are diazotized from the suspect carcinogen 3,3'-dichlorobenzidine which has been shown to cause bladder cancer in animals[5]. While benzidine yellow inks have not been shown to be carcinogenic[6,7], it has been claimed[8] that when ingested benzidine yellow is broken down by metabolic processes in the body to its original 3,3'-dichlorobenzidine. Studies on related azo dyes have shown that benzidine dyes are metabolized by Rhesus monkeys[9] into their aromatic components. There is some evidence from mortality data on record[10] that newspaper pressmen experience an unusual incidence of cancer of the buccal cavity and pharynx which is experienced in the early and middle years. These studies did not find bladder cancer to be a significant factor.

Environmental and epidemiological studies conducted by Golstein[11,12] et al. have shown that newspaper pressmen working in areas with ink mist concentrations 2 to 4 times the 5 mg/M^3 TLV showed no apparent acute or chronic health effects. On the other hand, mortality data from a recent study by Lloyd[13] et al. has shown that newspaper pressmen experience an unusual incidence of cancer of the buccal (cheek) cavity and pharynx which is experienced in the early and middle working years. NIOSH recently completed a retrospective survey of cancer in relation to health[14] and found that the relative risk of developing buccal cavity and pharynx cancer was 2.33 for print workers. This increased risk was considered statistically significant (p less than 0.05).

It is important to note that previous studies by Lippmann[11] and Goumas[15] were mainly concerned with measuring only the respirable ink mist fraction (ink mist droplets less than 3 microns in diameter), since non-respirable droplets (droplets larger than 3 microns) would not pass through the upper

respiratory tract and be deposited in the lower respiratory passageways of the lung. The droplet size of pressroom ink mist will range between 9-30 microns[12]. Therefore, when collecting only the respirable ink mist fraction it is understandable that samples will contain only small quantities of ink (results well below the 5 mg/M^3 TLV for oil mist). A review of the literature[12,13,14] indicates that newspaper pressmen do not experience an increased risk of lung cancer.

Some of the products used at the facility contain various types of rosins (phenanthrene nucleus), gum arabic (not considered as toxic--polysaccharide), gilsonite (solid asphaltic material--bitumens), carbon black, and asphaltum gum emulsions. Some of these substances contain polynuclear aromatic hydrocarbons or PNAs such as pyrene and anthracene. Several PNAs have been identified as potential carcinogens. Although asphalt and many of its products contain PNAs, NIOSH believes that asphalt fumes should be somewhat more hazardous than a nuisance dust[16] and recommends a level of 5 mg/M^3. NIOSH recommends a level of 3.5 mg/M^3 for carbon black[17] and is also considered as somewhat more hazardous than nuisance dust and asphalt. Asphalt and gilsonite have strong pigmenting properties and are considered as an irritant and skin sensitizer for sensitive individuals. It is known that roofers and other trades using copious quantities of asphalt and pitch suffer from photosensitization reactions on the skin from direct contact with the materials[18,19] and exposure to sunlight.

In this study, acute effects on the skin, eyes, and respiratory tract as a result of the printing operations were evaluated. This study was not designed to examine whether printers suffer from an incidence of chronic skin, eye and respiratory disease(s) or of cancer. Such studies would demand more employees who have been exposed over longer periods of time than available at Plant No. 2 in order to be a credible or statistically significant study. Therefore, the authors felt it necessary to summarize some of the considerations and previous studies on this matter and not ignore this which was evidently an area of concern from employee interviews. NIOSH has previously recognized this problem and is currently conducting an industry-wide epidemiologic research study of occupational carcinogenesis of "printing tradesmen". The biological response under investigation is malignant and non-malignant diseases which includes assessment of contaminant levels, worker exposures, work practices and environmental controls. The study is exploratory research into the association between on-the-job exposures and disease manifestation. The epidemiology is a retrospective cohort study utilizing life-table method to examine cause-specific mortality. The results of this study should be available in the near future (hopefully within a year) and should be of particular interest to management and union respresentatives, as the results of the health hazard evaluation does not contain adequate information on occupational carcinogenesis or diseases of "printing pressmen" as discussed above.

D. Evaluation Results and Discussion

1. Environmental Results and Discussion

Tables IA and IB show the results of the personal air samples obtained during normal operations of Presses 802 and 801, respectively. The results for toluene, ethyl benzene, m-xylene, cumene and trimethyl benzene were all well below the respective environmental criteria for these compounds and are not considered further in this report. The results varied from 8 to 60 percent of the environmental criteria of 350 mg/M^3 for mineral spirits on a 40-hour work week basis and from 10 to 75 percent of the environmental criteria of 280 mg/M^3 for mineral spirits on a 50-hour work week basis. There were more cleanup operations on Press 801 than on Press 802, although this is not always the case. No complete changeover operations occurred on either press on day shift.

Maximum exposures occur during changeover operations (change one print job to a different print job) where the pressmen cleanup the presses (e.g., fountains, ink wells, rollers, etc.) and change solutions. Table IC shows the results of one hour personal air samples obtained during changeover operations involving Press 802 on swing shift. All sample results were 50 percent or less of the environmental criteria for short-term samples of 1800 mg/M^3 for mineral spirits and 750 mg/M^3 for toluene. Assuming that airborne levels of mineral spirits are the same order of magnitude for changeover operations involving both presses and the changeover operations were conducted on both presses during the day shift, then one may consider the exposures in Table IC as additive to these levels in Tables IA and IB. Assuming changeover operations on both presses during the day shift would result in exposures ranging from a minimum of 21 percent to a maximum of 76 percent (average of 48 percent) of the environmental criteria of 350 mg/M^3 for mineral spirits (40-hour work week), and between 27 and 94 percent (average 60 percent) of the environmental criteria of 280 mg/M^3 (50-hour work week). In evaluating the data, it should be noted that each press averages approximately 80 changeover operations per month.

It is our understanding that most employees were working five 8-hour shifts during the week of the survey, and some employees had worked 12-hour shifts due to a lack of personnel. No overtime was scheduled for the weekend. The data indicates the first pressman is the least exposed employee with the second pressman and feeders being the most exposed. The results show that no employee was exposed to concentrations of mineral spirits which exceeded the environmental criteria at the time of the survey.

2. Medical Results and Discussion

A total of thirty workers (all male) were interviewed and examined. The workers' age range was 21-57 years with a mean age of 32. Their average

employment span in the printing industry was 10.7 years. Symptomatology elucidated from the respondents yielded one common complaint from several employees. Hand and arm irritation (dry, cracked skin) was evident in 12 workers, nearly 40% of the total worker population. Nearly 1/3 of all the employees stated they seldom wore, or had available, impervious gloves.

Two cases of eye irritation were discerned on physical examinations. Two other individuals gave a past history of eye irritation. All persons with the above mentioned physical findings felt their maladies were the result of exposure to various compounds in their immediate work vicinity. Splash goggles were unavailable in the shop. Twelve employees, nearly 40%, complained of occasional transient dizziness during "blanket washing". This complaint is consistent with the environmental levels of mineral spirits found during changeover operations.

E. Observations and Conclusion

Although employee exposure to airborne contaminants was not considered as toxic at the time of the survey, employees may be exposed to airborne concentrations of contaminants which could be considered as potentially toxic if employees worked overtime or were involved in overtime and more cleanup or changeover operations than occurred at the time of the survey. The reader is cautioned that several additional evaluations under different operational conditions (e.g., overtime, changeover, etc.) as well as environmental conditions (e.g., hot, cold, average temperature; winter-summer-spring-fall) need to be accomplished before a more definitive conclusion can be reached. At the time of the survey, several employees had skin dermatitis (e.g., dry, cracked skin on hands and arms) which is attributed to direct contact of organic solvents with the skin.

During the survey, it was noted that several employees' hands and portions of their clothing were contaminated with various products such as blanket wash and printing inks. Absorption of chemicals by the skin and uptake by the gastrointestinal tract via hand to mouth (e.g., cigarettes, food, etc.) activities are important considerations in assessing the potential exposure of employees. It appears evident that mere air sampling will not by itself provide an adequate measure of the occupational exposure to various chemicals, although that method is the only readily quantifiable measure of exposure.

There were several work practices which were considered as marginal at best. These practices include, but are not necessarily limited to: (1) allowing eating, drinking and smoking in work areas; (2) limited or unavailability of protective clothing such as impervious gloves and splash goggles; (3) open trays of solvents such as blanket wash, soaked cleaning rags on tables, equipment, and open 55 gallon barrels of various printing inks; (4) inadequately supplied first aid kit in the main work area; and (e) smoke tube tests indicated several areas in and around the presses where the smoke was not readily dispersed.

Skin cleaners and barrier creams vary widely in their effect on the skin due to several factors such as alkalinity, buffering, and liquid versus granular formulations. To some extent it will be necessary to leave the worker some leeway as to how strong a hand cleaner is needed under any particular set of circumstances. It may be necessary for the company to have available more than two types of barrier creams and hand cleaners in order to meet the needs of employees.

F. Recommendations

In view of the above information as well as the lack of toxicological information on various chemicals, particularly printing inks, it is prudent to minimize potential exposures. The following recommendations are offered to provide a more desirable working environment for all personnel:

1. Engineering controls such as improved ventilation in and around the presses should be considered to lower concentrations of airborne contaminants. For instance, perhaps man-cooling fans could be used to disperse the airborne mineral spirits during changeover operations.

2. Direct skin contact with the mineral spirits, inks, and other chemicals should be avoided wherever possible. Gloves should be readily available and of adequate size and length to prevent the solvent from entering at the cuff, and should have some sort of washable and changeable lining to prevent excessive moisture build up inside from sweat.

3. The waterless hand cleaners should prove much less harsh than the granular cleansers. The granular cleanser should only be used when exceptionally heavy cleaning is needed, and then as infrequently as possible. Barrier creams may afford some protection to the hands from the action of the solvents and cleansers and are worth a trial. Appendix A lists three barrier creams which may prove helpful. Equivalent barrier creams and cleansers could also be tried.

4. It would probably prove valuable to have hand cream available for use after cleaning up for the day to return oils to the skin. Eucerin or its equivalent is a non-medicated, non-prescription hand cream available through drug stores. Cold cream, Vasoline Intensive Care Lotion, Noxema, or any of several other commercially available formulations would also be suitable.

5. Workers who frequently come in contact with the colored inks should be cautioned and instructed in proper hygienic practices. Emphasis should be placed on the thorough washing of hands before smoking or eating. Under no circumstances should food, drink, or cigarettes be stored or consumed in the work room. The

workers should be reminded that such habits as nail biting are not acceptable behavior on the job.

6. Chemical goggles should be available and worn by employees during those operations which may involve splashes or airborne droplets of contaminants.

7. As a minimum, an emergency dual water stream eye wash basin, preferably with an overhead shower, should be easily accessible to employees in the work area.

8. Employee education and personal hygiene of employees (e.g., washing, hands, changing clothes, etc.), contamination control, and use of protective clothing (e.g., gloves, splash goggles, etc.) should be stressed. Employees should be instructed not to eat, drink or smoke at work stations due to potential contamination to skin, mouth, and gastrointestinal tract of employees. Blanket wash should not be used for cleaning hands. Employees should be instructed in the chemicals used in the workplace and their associated hazards.

9. The first aid station kit in the main work area should be kept well stocked with supplies approved by a consulting physician and be readily available.

10. Containers with various chemicals should have tight-fitting lids in place when not in use and should be appropriately marked with contents of the container. Also, open trays of solvents such as blanket wash should not be allowed. Perhaps small or large liquid spray pump bottles or plunger cans could be used in lieu of open trays. Other work practices should be evaluated towards minimizing potential exposure of employees.

V. REFERENCES

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3. NIOSH Current Intelligence Bulletin No. 17; 2-Nitropropane April 25, 1977.

4. NIOSH Current Intelligence Bulletin No. 24; Benzidine Derived Dyes April 17, 1978.

5. Suspected Carcinogens - A Subfile of the NIOSH Toxic Substances List 1975. NIOSH Publication No. 75-188.

6. Technical Bulletin #136, United States Printing Ink Corporation, April 25, 1974 with attached Graphic Arts Technical Foundation letter subject: Benzidine Yellow Pigments, dated April 1974.

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VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared and Survey Conducted By:

Raymond L. Hervin
Regional Industrial Hygienist
Kansas City, Missouri

Michael T. Donohue
Physician Assistant
Cincinnati, Ohio

Raymond L. Ruhe
Industrial Hygienist
Cincinnati, Ohio

Originating Office : Jerome P. Flesch, Acting Chief
Hazard Evaluation and Technical Assistance Branch
Cincinnati, Ohio

Laboratory Analyses : Stephen Billets, Ph.D.
John Holtz
Richard Kupel
Research Chemists
M.D.S. Laboratories-NIOSH
Cincinnati, Ohio

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JULY 19, 1978

TABLE IA
CONCENTRATIONS OF ORGANIC SOLVENTS FOUND DURING NORMAL PRINTING OPERATIONS

Job and/or Area Classification	Sample Number	Time of Sample	Mineral Spirits mg/M^3*	Toluene mg/M^3*	Ethyl Benzene mg/M^3*	m-Xylene mg/M^3*	Cumene (isopropyl benzene) mg/M^3*	Trimethyl Benzene		
								1,3,5-trimethyl benzene (mesitylene) mg/M^3*	1,2,4-trimethyl benzene (pseudocymene) mg/M^3*	Total Trimethyl Benzene mg/M^3*
Employee A	CT-4	732-1355	88	43	ND	1	ND	1	2	3
Employee A	CT-5 (replaced with CT-19)	732-1050	41	19	ND	ND	ND	ND	ND	ND
Employee A	CT-19	1116-1355	146	75	1	2	ND	1	3	4
Employee B	CT-2	727-1355	38	17	ND	ND	ND	ND	1	1
Employee C	CT-9	717-1355	44	21	ND	1	ND	ND	1	1
Employee C	CT-3	717-1355	76	34	ND	1	ND	1	2	3
Employee D	CT-11	729-1355	28	12	ND	ND	ND	ND	ND	ND
Employee D	CT-12	729-1355	19	8	ND	ND	ND	ND	ND	ND
Employee E	CT-7	730-1355	105	51	ND	1	ND	1	2	3
Employee E	CT-1	730-1355	105	45	ND	1	ND	1	2	3
General Area-Solvent Table	A-3	1125-1441	123	57	1	2	ND	2	4	6
Environmental Criteria for 40-hour workweek			350	375	435	434	245			120

*mg/M^3 -- approximate milligrams of substance per cubic meter of air.

NOTE: The concentrations reported for mineral spirits is the total of all organic compounds detected and includes toluene, ethyl benzene, m-xylene, cumene, and trimethyl benzene.

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TABLE IB
CONCENTRATIONS OF ORGANIC SOLVENTS FOUND DURING NORMAL PRINTING OPERATIONS

Job and/or Area Classification	Sample Number	Time of Sample	Mineral Spirits mg/M^3 *	Toluene mg/M^3 *	Ethyl Benzene mg/M^3 *	m-Xylene mg/M^3 *	Cumene (isopropyl benzene) mg/M^3 *	Trimethyl Benzene		
								1,3,5-trimethyl benzene (mesitylene) mg/M^3 *	1,2,4-trimethyl benzene (pseudocumene) mg/M^3 *	Total Trimethyl Benzene mg/M^3 *
Employee F	CT-15	704-1420	207	86	1	2	ND	2	5	7
Employee F	CT-16	704-1420	210	92	1	2	ND	2	4	6
Employee G	CT-18	710-1420	140	59	ND	1	ND	1	3	4
Employee G	CT-10	710-1420	137	53	ND	2	ND	2	4	6
Employee H	CT-13	712-1420	131	55	1	2	ND	1	3	4
Employee I	CT-8	714-1420	196	83	1	2	ND	2	4	6
Employee I	CT-17	714-1420	173	77	1	2	ND	2	4	6
Employee J	CT-6	707--220	67	28	ND	1	ND	1	2	3
Environmental Criteria for 40-hour workweek			350	375	435	434	245			120

*mg/M^3 -- approximate milligrams of substance per cubic meter of air.

NOTE: The concentrations reported for mineral spirits is the total of all organic compounds detected and includes toluene, ethyl benzene, m-xylene, cumene, and trimethyl benzene.

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TABLE IC
CONCENTRATIONS OF ORGANIC SOLVENTS FOUND DURING CHANGEOVER OPERATIONS

Job and/or Area Classification	Sample Number	Time of Sample	Mineral Spirits mg/M^3 *	Toluene mg/M^3 *	Ethyl Benzene mg/M^3 *	m-Xylene mg/M^3 *	Cumene (isopropyl benzene) mg/M^3 *	Trimethyl Benzene		
								1,3,5-trimethyl benzene (mesitylene) mg/M^3 *	1,2,4-trimethyl benzene (pseudocumene) mg/M^3 *	Total Trimethyl Benzene mg/M^3 *
Employee K	CT-20	1456-1557	291	143	1	3	ND	2	5	7
Employee K	CT-21	1456-1557	205	99	ND	1	ND	2	4	6
Employee L	CT-22	1502-1600	244	106	1	3	ND	3	6	9
Employee L	CT-27	1502-1600	258	116	ND	3	ND	2	5	7
Employee M	CT-23	1500-1601	715	349	2	7	2	6	15	21
Employee M	CT-24	1503-1558	659	330	2	6	1	6	14	20
Employee N	CT-26	1458-1559	709	357	2	7	1	5	13	18
Employee N	CT-29	1458-1559	741	377	2	7	1	6	14	20
Employee O	CT-28	1503-1558	425	208	2	4	ND	3	9	12
Employee O	CT-25	1503-1558	408	199	2	4	ND	4	10	14
Environmental Criteria for Short Term Sample			1800		750					

*mg/M^3 -- approximate milligrams of substance per cubic meter of air.

NOTE: The concentrations reported for mineral spirits is the total of all organic compounds detected and includes toluene, ethyl benzene, m-xylene, cumene, and trimethyl benzene.

APPENDIX A

RECOMMENDATIONS OF SKIN CLEANSERS & BARRIER CREAMS WHICH COULD BE TRIED

The following barrier creams and cleaners are suggested to protect against the effects of stoddard solvent:

(1) Betadine® Skin Cleanser, Purdue Frederick Company, 50 Washington Street, Norwalk, Connecticut 06856

(2) Phisoderm®, Winthrop Laboratories, 90 Park Avenue, New York, New York 10016

(3) Kerodex No. 51. Ayerst Laboratories, Special Products Department, 685 3rd Avenue, New York, New York 10017 Barrier Cream

(4) PLY No. 9. The Milburn Company, 4246 E. Woodbridge, Detroit, Michigan 48207 Barrier Cream

(5) West Protective Cream No. 411. West Chemical Products, Inc., 42-16 West Street, Long Island City, New York 11101 Barrier Cream

It is recognized that there may be other equally effective products on the market. Mention of these companies or products names, therefore, is not to be considered an endorsement by NIOSH.