U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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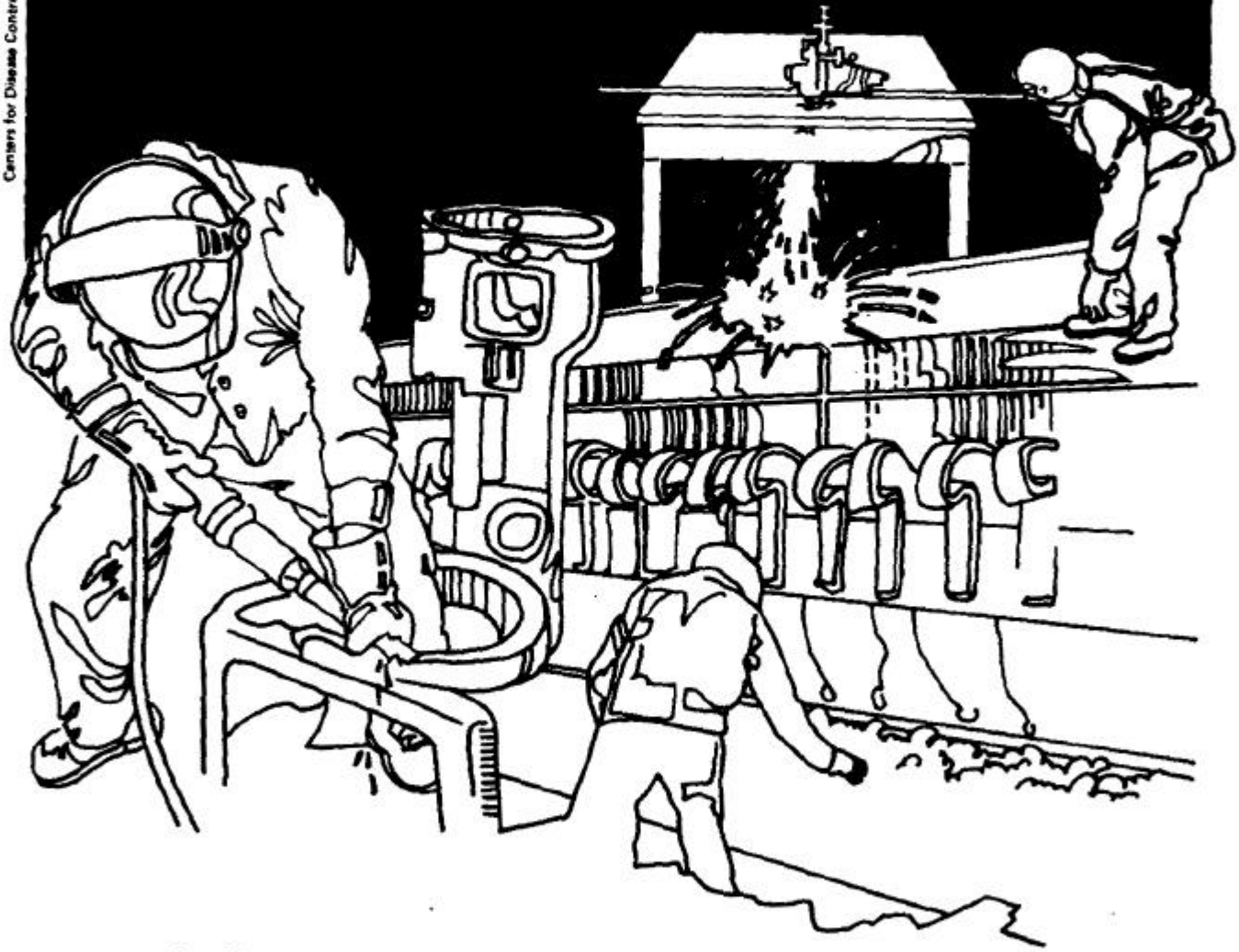
NIOSH



Health Hazard Evaluation Report

HETA 88-346-2030
GRAPHIC CREATIONS, INC.
WARREN, RHODE ISLAND

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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GRAPHIC CREATIONS, INC.
WARREN, RHODE ISLAND

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I. SUMMARY

On July 14, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the management of Graphic Creations, Inc., Warren, Rhode Island to evaluate employee exposures to hydroquinone and printing press cleaning solvents which contained benzene.

Sheet-fed press operators' isopropyl alcohol exposures ranged from non-detected (ND) to 31.4 mg/M^3 (12.8 PPM). The NIOSH Recommended Exposure Limit (REL) is 980 mg/M^3 (400 PPM). Personal breathing zone naphtha exposures ranged from 81.74 to 914.8 mg/M^3; REL = 350 mg/M^3. The personal breathing zone samples for 2-butoxyethanol (2-BE) ranged from ND to 2.56 mg/M^3 (0.53 PPM). NIOSH recommends that exposure to glycol ethers be reduced to the lowest extent possible. Personal breathing zone exposures to benzene ranged from 0.98 to 1.10 PPM. This exposure exceeded the OSHA permissible exposure limit (PEL) of 1.0 PPM. NIOSH recommends that benzene exposures be at the "lowest feasible level," based on carcinogenicity, and in no case shall exposures to benzene exceed 0.1 PPM-TWA. Hydroquinone was not detected in any of the personal breathing zone samples or area samples.

On the day of the NIOSH survey, a health hazard existed from employee exposure to naphtha, benzene and 2-butoxyethanol in excess of established criteria. Employee exposures to isopropyl alcohol and hydroquinone were below the evaluation criteria. Recommendations have been presented in the body of this report to further minimize, or in the case of benzene and 2-BE exposure, eliminate worker exposures to these solvents.

KEYWORDS: SIC 2752 (commercial printing, lithographic), naphtha, benzene, alcohols, butyl cellosolve, 2-butoxyethanol, hydroquinone, letter-press, off-set printing

II. INTRODUCTION

On July 14, 1988, NIOSH received a request for a Health Hazard Evaluation from the management of Graphic Creations, Inc., doing business as East Bay Printing Company, 458 Main Street, Warren, Rhode Island. The request concerned potential employee exposures to hydroquinone and printing press cleaning solvents, which contained benzene. Furthermore, NIOSH was requested to comprehensively evaluate the general indoor air quality at this facility.

An initial site visit and walk-through survey was conducted on August 1, 1988, by a NIOSH Regional Industrial Hygienist. During the initial walk-through evaluation, an indoor air quality (IAQ) survey was conducted. On September 14, 1988, a more comprehensive industrial hygiene air monitoring survey was conducted to assess employee exposures to hydroquinone and printing press cleaning solvents.

III. BACKGROUND

Graphic Creations is an offset printing establishment located in a 50-year old, single-story, brick structure. The company is a "general commercial printer," utilizing offset and letterpress processes, and has been in operation at this location since 1974. The maximum size of sheets processed is 17.5 by 22.5 inches, and a maximum of two colors are used on any job. The company specializes in business cards, invitations and specialty printing. There are no roller-fed presses at the establishment. There are seven sheet-fed presses, one sheet-fed letter-press and one automated folder. All presses are fully automated.

The printing process involves photographing art work, producing a negative, making a plate, exposing the plate in an exposure frame, and then installing this plate on the printing press.

Printing processes also involve moistening the plate with a solvent called "fountain solution," (a glycerin based product), which allows ink to adhere only to those surfaces to be reproduced. If a color change is required, the rollers are washed with a "roller-wash" and the new color scheme is applied.

All office areas are carpeted; the press room has a vinyl-tiled floor with painted sheet rock walls. The company occupies a total floor space of 3,100 square feet. The are twelve full-time employees representing secretaries, administrative personnel, artists and pressmen.

The only ventilation system is an air-conditioning unit which was installed in 1972. This unit cools and recirculates existing room air. There are five LP gas powered forced hot air ceiling-mounted heating units. There is no fresh air input or make-up air. Natural ventilation occurs when windows or doors are opened.

IV. EVALUATION DESIGN AND METHODS

On August 1, 1988, an initial indoor air quality survey was conducted. Temperature and relative humidity data were collected, using a Cole-Palmer, LCD Digital Hygrometer, Model 3900-50. Carbon dioxide concentrations were also measured in all areas where temperature and relative humidity data were obtained, using a Draeger bellows pump with direct reading colorimetric detector tubes.

The environmental air monitoring evaluation on September 14, 1988, consisted of monitoring employee exposures to hydroquinone, isopropyl alcohol, naphtha, benzene, and 2-butoxyethanol (butyl cellosolve).

There is one 8-hour work shift, and employee exposures were monitored while they were performing routine printing operations. Area air monitoring for hydroquinone was conducted in the stat/dark room. Worker exposures to organic solvents used in printing operations were measured using standard air sampling techniques. Full-shift personal breathing zone (PBZ) samples were collected by drawing a known volume of air through glass tubes containing activated coconut shell charcoal (150 mg), using battery-powered sampling pumps, at a nominal flow rate of 100 milliliters per minute (ml/min) for the organic solvent samples and 50 ml/min for the isopropanol samples. For PBZ samples, the pump was attached to the worker's belt and the charcoal tube was clipped to the collar or lapel in the worker's breathing zone. Full-shift PBZ samples for isopropanol, naphtha, benzene, and the hydroquinone area samples were split into two sampling periods to conform to the standard sampling method.

A bulk sample of the cleaning solvent (Blanket Wash, #106) was obtained for qualitative analysis to complement the analysis of the air samples.

Personal monitoring for full-shift employee exposures and short-term (task dependent) exposures were conducted. Workers in the press areas were monitored for their entire work shift. All press areas were operating in normal fashion and this evaluation was designed to characterize current conditions at this facility. While exposure monitoring was being conducted, employees were interviewed regarding their work practices and health status.

Isopropyl Alcohol

Isopropyl alcohol is used to clean the Letterflex equipment at the end of the shift and to prepare the surface of the photographic negatives. Two samples were quantitatively analyzed for isopropyl alcohol. The analysis was performed according to NIOSH method 1400, [1] with modifications. The samples were divided into front and back sections, and desorbed with 1.0 milliliter (ml) of CS_2 which contained 1.0 microliter (ul) of toluene, as an internal standard, and 1% sec-butanol as an aid in desorption. The samples were then analyzed by gas chromatography-flame ionization detection (GC-FID). The limit of detection (LOD) for this mixture was 0.03 mg/sample, and the limit of quantitation (LOQ) was 0.09 mg/sample.

Hydroquinone

Hydroquinone is used in the stat/dark room in the photographic negative developing process. Employees conducting these operations do not wear face or eye protection or gloves, even though these personal protection articles are provided by the employer. Employees stated that splashes have occurred which have resulted in eye and skin irritations.

Two PBZ air samples were collected on mixed cellulose-ester filters (MCEF). These two samples were obtained during the photo-negative imaging process, which is approximately 10 minutes in duration. An additional personal sample was obtained during hydroquinone reservoir cleaning and refilling. Also, two 8-hour area samples were taken for hydroquinone in the stat/dark room. The stat/dark room is the only work area at this facility where hydroquinone is used or stored. All employee and area samples were analyzed by high performance liquid chromatography according to NIOSH Method 5004,[1] with modifications.

2-Butoxyethanol - (Butyl Cellosolve)

Butyl cellosolve is one of the chemicals in Glaz-a-Way. Since some press rollers are made of rubber, and inks frequently adhere to these rollers during printing operations, Glaz-a-Way, a cleaning solvent, is manually applied to these rollers after every three or four runs, to remove accumulated ink, or when an ink color is being changed. After Glaz-a-way has been applied and allowed to set for five minutes, Blanket Wash #106 is applied and manually removed by wiping. This operation occurs six to eight times a day during an 8-hour work shift, or sometimes more frequently if required.

Two PBZ air samples were collected on activated charcoal to evaluate butyl cellosolve exposure. These samples were analyzed by gas chromatography according to NIOSH method 1403,[1] with modifications.

Benzene/Naphtha

Benzene and naphtha are two of the chemicals found in Blanket Wash #106. This product is used to clean press rollers after Glaz-a-Way application, and assists in the removal of accumulated ink. Blanket Wash #106 is either applied directly to the rollers or put on a rag and then wiped over the rollers. All cleaning operations are performed manually. Employees do not wear protective gloves when conducting these operations. Protective gloves are, however, supplied by the employer.

Four PBZ air samples were quantitatively analyzed for the benzene/naphtha mix. The charcoal tubes were divided into a front and back section and analyzed according to NIOSH method 1501.[1] The samples were first desorbed with 1.0 ml CS_2, prior to their analysis. The LOD for this mixture was 0.03 mg/sample, and the LOQ was 0.06 mg/sample.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed for up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage of workers may experience adverse health effects because of individual susceptibility, a pre-existing medical condition and/or by a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medication, or the personal habits of the worker, and produce adverse health effects even if the occupational exposures are controlled at the level set by the evaluation criteria. Many industrial environments are complex and varying and the potential for illness or injury changes from day to day, shift to shift, and even from hour to hour. Individual exposures are difficult and sometimes impossible to estimate or predict because of this variability. When this environmental variability is combined with an employee's mobility which can produce a different degree of exposure with each area he visits, the investigator's task of assessing total employee exposures and predicting related adverse health effects becomes extremely difficult. These issues are frequently not considered in the above-mentioned evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thereby potentially increase an employee's overall exposure.[12] Lastly, evaluation criteria change as new information on a chemical compound's toxic effects become available.

The primary sources of environmental evaluation criteria considered for this study were: 1) NIOSH criteria documents and Recommended Exposure Limits (RELs);[7] 2) the American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs);[3] and, 3) the U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), Federal Permissible Exposure Limits (PELs) (29 CFR 1910).[2] Often, the NIOSH RELs and ACGIH TLVs are lower than the corresponding OSHA PELs. Both NIOSH RELs and ACGIH TLVs usually are based on more recent information than are OSHA standards. The OSHA PELs also take into account the economic feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing the levels reported here, it should be noted that industry is legally required to meet and comply with those levels specified by a specific OSHA standard.

A time-weighed average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8-10 hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from short-term exposures.

Table IV presents the NIOSH, OSHA and ACGIH evaluation criteria and a brief summary of the primary adverse health effects associated with exposure to these airborne contaminants.

A. Toxicology

1. Hydroquinone[4]

Hydroquinone is a reducing agent, and is used as a photographic developer and as an antioxidant or stabilizer for certain materials which polymerize in the presence of oxidizing agents. Hydroquinone, as a solid, is colorless, and exists as hexagonal prisms. Many of its derivatives are used as bacteriostatic agents, and others, particularly 2,5-bis(ethyleneimino)hydroquinone, have been reported to be good antimitotic and tumor-inhibiting agents. The NIOSH REL for hydroquinone is 0.44 PPM (2.0 mg/M^3) ceiling (15 minutes). The OSHA PEL and the ACGIH TLV for hydroquinone is 2 mg/M^3.

Skin sensitization to the dry solid is very rare but does occur on occasion from contact with its alkaline solution. The skin may be depigmented by repeated applications of ointments of hydroquinone, but this virtually never occurs from contact with dust or dilute water solutions. Following prolonged exposure to elevated dust levels, brownish conjunctiva stains may appear. These may be followed by corneal opacities and structural changes in the cornea which may lead to loss of visual acuity. The early pigmentary stains are reversible, while the corneal changes tend to be progressive.

Oral ingestion of large quantities of hydroquinone may produce blurred speech, tinnitus, tremors, a sense of suffocation, vomiting, muscular twitching, headache, convulsions, dyspnea and cyanosis from methemoglobinemia, and coma and collapse from respiratory failure. The urine is usually green or brownish green. No systemic symptoms have been found following inhalation of hydroquinone dust. Oxidation of hydroquinone may produce quinone vapor which is highly irritating.

2. Benzene[4,5]

Benzene is a clear, volatile, colorless, highly flammable liquid, with a characteristic odor. The most common commercial grade contains 50-100% benzene, the remainder consists of toluene, xylene, and other constituents which distill below 120 ^{o}C.

The NIOSH REL is 0.1 PPM (0.32 mg/M^3), 8-hour TWA; 1 PPM (3.2 mg/M^3) ceiling (15 minutes). The OSHA Permissible Exposure Limit for benzene is 1 part per million (PPM) for an 8-hour TWA, with 5 PPM as a maximum peak above the acceptable ceiling for a maximum duration of 15 minutes.

The inhalation of benzene vapors may be supplemented by percutaneous benzene absorption; however, this syngeristic action seldom occurs since benzene is actually very poorly absorbed through intact skin.

Exposure to liquid and vapor may produce primary irritation to skin, eyes, and upper respiratory tract. If the liquid is aspirated into the lung, it may cause pulmonary edema and hemorrhage. Erythema, vesiculation, and dry, scaly dermatitis may also develop from defatting of the skin.

Acute exposure to benzene results in central nervous system depression. Headache, dizziness, nausea, convulsions, coma and death may result. Death has occurred from large acute exposures as a result of ventricular fibrillation, probably caused by myocardial sensitization to endogenous epinephrine. Early reported autopsies revealed hemorrhages (non-pathognomonic) in the brain, pericardium, urinary tract, mucous membranes, and skin.

Chronic exposure to benzene is well documented and is known to cause blood changes. Benzene is basically a myelotoxic agent. Erythrocyte, leukocyte, and thrombocyte counts may first increase, and then aplastic anemia may develop with anemia, leukopenia, and thrombocytopenia.

Recent epidmiologic studies along with case reports of benzene related blood dyscrasias and chromosomal aberrations have led NIOSH to conclude that benzene is leukemogenic. The evidence is most convincing for acute myelogenous leukemia and for acute erythroleukemia, but a connection with chronic leukemia has been noted by a few investigators.

Recent work has shown increases in the rate of chromosomal aberrations associated with benzene myelotoxicity. These changes in the bone marrow are both stable and unstable and may occur several years after exposure has ceased. "Stable" changes may give rise to leukemic clones and seem to involve chromosomes of the G-group.

3. Naphtha[4,5,6]

Naphthas are derived from both petroleum and coal tar. Petroleum naphthas are composed principally of aliphatic hydrocarbons and are termed "close-cut" fractions. Further designations which have been applied to petroleum naphthas are "medium-range" and "wide-range" fractions which are made up of 40 to 80 percent aliphatic hydrocarbons, 25 to 50 percent naphthenic hydrocarbons, 0 to 10 percent benzene, and 0 to 20 percent other aromatic hydrocarbons.

The OSHA PEL for petroleum naphtha is 500 PPM (2,000 mg/M^3). The ACGIH TLV for naphtha is 300 PPM or 1370 mg/M^3. The NIOSH REL for naphtha is 350 mg/M^3.

Inhalation of naphtha vapor is the primary route of entry. Percutaneous absorption of liquid naphtha is probably not important in the development of systemic effects unless benzene is also present.

The naphthas are irritating to the skin, conjunctiva, and the mucous membranes of the upper respiratory tract. Skin "chapping" and photosensitivity may develop after repeated contact with liquid naphtha. If confined against the skin by clothing, the naphthas may cause skin burns.

Petroleum naphtha has a lower order of toxicity than naphtha derived from coal tar, where the major hazard is due to aromatic hydrocarbons. Sufficient quantities of both naphthas cause central nervous system depression. Symptoms include inebriation, followed by headache and nausea. In severe cases, dizziness, convulsions, and unconsciousness occasionally result. Symptoms of anorexia and nervousness have been reported to persist for several months following an acute overexposure, but this appears to be rare. One fraction, hexane, has been reported to have been associated with peripheral neuropathy. If benzene is present, naphtha may produce blood changes such as leukopenia, aplastic anemia, or leukemia. The kidneys and spleen have also been affected in animal experiments.

4. Isopropyl Alcohol[7,8]

Isopropyl alcohol is considered to be of low toxicity by any route of exposure. Like other alcohols, it has mild central nervous system depressant properties. At 400 PPM it has been found to cause mild irritation of the eyes, nose and throat.

The NIOSH REL for isopropyl alcohol is 984 mg/m3 (400 PPM) TWA exposure for up to a 10-hour work shift, 40-hour work week. In addition, a ceiling (15 minutes duration) concentration of 1968 mg/m3 (800 PPM) is recommended. The ACGIH TLV-TWA for isopropyl alcohol is also 984 mg/m3 (400 PPM). The TLV-STEL is 1225 mg/m3 (500 PPM). The OSHA PEL is 984 mg/m3 (400 PPM) for an 8-hour TWA exposure.

Short-term exposure to high airborne concentrations of isopropyl alcohol may cause mild irritation of the eyes, nose and throat. Drowsiness, headache and incoordination may also occur. Swallowing isopropyl alcohol may cause drowsiness, unconsciousness and in excessive concentrations death has been reported. Gastrointestinal pain, cramps, nausea, vomiting and diarrhea may also result from swallowing isipropyl alcohol. Long-term exposure causes drying and cracking of the skin. Epidemiological investigations have established that a carcinogenic substance is present during isopropyl alcohol manufacturing, but these studies have not implicated isopropyl alcohol as a carcinogen.

The most apparent toxic effect of isopropyl alcohol is narcosis, which occurs in mice at vapor concentrations of 3,000 PPM. The adverse health effects increase with the duration of exposure. Exposure to higher concentrations results in ataxia, followed by deep narcosis and death. Reversible changes occurred in the hepatic fat of mice, which were repeatedly exposed to high concentrations of vapor.

Isopropyl alcohol is metabolized fairly rapidly, and acetone may be detected in the urine following heavy exposures. Human volunteers reported mild irritation of the eyes, nose and throat after three to five minutes exposure to vapor at 400 PPM; at 800 PPM the results were not severe, but most subjects found the atmosphere to be objectionable.

Accidental, extensive wetting of the skin could occur in industrial situations and because isopropyl alcohol is absorbed readily through the skin, the additive effect of inhalation and skin absorption could have serious results. Similarly, there is a risk of deliberate ingestion of isopropyl alcohol as a substitute for ethyl alcohol, which would add to the effects of inhalation. The defatting action of isopropyl alcohol can

cause mild skin irritation, and a small percentage of the exposed workers may develop contact dermatitis of a serious nature. No chronic systemic effects have been reported for isopropyl alcohol exposure in humans.

5. Glycol Ethers: (2-butoxyethanol or butyl cellosolve)[8,9]

2-Butoxyethanol can affect the body if it is inhaled, swallowed, or comes in contact with the eyes or skin. It can enter the body through intact skin. Overexposure to high airborne levels of 2-butoxyethanol may cause irritation of the eyes, nose and throat. It may also cause the production of dark red urine.

The current OSHA PEL for 2-butoxyethanol is 240 mg/M^3 (50 PPM) averaged over an 8-hour work shift. The American Conference of Governmental Industrial Hygienists has issued a Notice of Intended Change to their recommended Threshold Limit Value for 2-butoxy ethanol from 50 PPM to 25 PPM with a skin notation. Based on toxicological data, NIOSH recommended in Current Intelligence Bulletin (CIB) No. 39 The Glycol Ethers, with Particular Reference to 2-Methoxyethanol and 2-ethoxyethanol: Evidence of Adverse Reproductive Effects that glycol ethers be regarded in the workplace as having the potential to cause adverse reproductive effects in male and female workers. Also noted were embryotoxic effects, including teratogenesis, in the offspring of the exposed pregnant females [NIOSH 1983]. The current NIOSH REL is therefore "reduction of workplace levels to the lowest extent possible."

2-Butoxy ethanol is metabolized to butoxyacetic acid, which appears in the urine of animals and man promptly following exposure; both are hemolytic agents. This substance penetrates the skin readily, and this may account for more absorption than does inhalation in some cases. The liquid is damaging to the eye, producing pain, conjunctival irritation, and transitory injury to the cornea.

B. Indoor Air Quality - (IAQ) Criteria

1. Thermal Environmental Conditions

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published guidelines (Figure 1) describing thermal environmental conditions that at least 80% of the occupants will find acceptable or "comfortable" (ASHRAE Standard 55-1981, Thermal Environmental Conditions for Human Occupancy). The operative temperature for thermal acceptability (comfort zone) of sedentary or slightly active persons in the summer season at 50% relative humidity is 73° to 79°F. If the operative temperature is outside of this range, more than 20% of the healthy people occupying the area are likely to experience some degree of discomfort.

The perception of comfort is related to one's metabolic heat production, the transfer of the heat to or from the environment, physiological adjustments, and body temperatures. Heat transfer between the body and the environment is influenced by environmental factors such as temperature, humidity, radiative effects, and air movement, as well as personal factors such as activity and clothing.

ASHRAE 55-1981, Section 5.1.2, also recommends that the dew point temperature in occupied space not be greater than 62°F or less than 35°F. This recommendation is based partially on structural preservation of the building itself, i.e., prevention of moisture condensation on building materials.

2. Carbon Dioxide

Measurement of carbon dioxide (a normal byproduct of human respiration) is useful in assessing whether adequate quantities of fresh air are being introduced into a building. Carbon dioxide levels are used as a surrogate measuring tool. The outdoor ambient concentration of carbon dioxide is typically 200 to 350 PPM. Levels of carbon dioxide above the ambient level are common indoors, even in buildings with no reported health complaints. However, if the indoor air carbon dioxide concentration is at 1,000 PPM or greater, or 3 to 4 times the ambient level, inadequate ventilation is suspected.[10,11] Carbon dioxide levels above 1,000 PPM do not constitute a health hazard, but may indicate that the air concentration of other contaminants which are normally present in offices and related work areas are also be elevated to a point where, individually or in combination, they may be contributing to employee complaints.

Currently, neither NIOSH nor OSHA have developed ventilation evaluation criteria for general offices. Many design engineers use the guidelines published by ASHRAE, "Ventilation for Acceptable Indoor Air Quality" (ASHRAE Standard 62-1989), which now calls for 20 CFM/occupant in non-smoking areas. In this guideline (62-1989), the requirement for a smoking area is 60 CFM/person. All of these guidelines require a continuous supply of fresh air during times of building occupancy.

VI. RESULTS

A. Isopropyl Alcohol

Two sheet-fed press workers were monitored for full-shift isopropyl alcohol and N-propyl alcohol solvent exposures. Replenishing the dampening system for the sheet-fed presses with isopropyl alcohol is a potentially high-exposure task. This is done twice per shift and takes five to fifteen minutes. Depending upon the press

operating conditions there may be other additives with the alcohol, but these are in small quantities. Included as additives may be "subtractive plate gum" and/or "fountain solution."

The only isopropyl alcohol exposure recorded was for one press operator, at 12.8 PPM, (31.4 mg/M^3). This personal exposure is below the evaluation criteria established by NIOSH, ACGIH, and OSHA. N-propyl alcohol was not detected in any of the personal breathing zone samples collected.

B. Benzene

Personal breathing zone samples were collected for two sheet-fed press operators who were monitored for full-shift benzene and naphtha solvent exposures. Blanket Wash #106 contains benzene and naphtha and is used to clean press rollers when ink changes are mandated or there is excessive ink residue on press rollers. Sheet-fed press operators may perform 6 to 8 blanket and roller washes per shift using this solvent mixture. This procedure takes about two to five minutes. Typically, a rag is dipped into a solvent bucket, or the solvent is applied to the rag from an application bottle, then the roller surfaces are wiped several times. Sometimes solvent is applied to the surfaces using a squirt bottle while the rollers are spinning; then they are wiped down. Benzene concentrations ranged from 0.98 to 1.10 PPM. These results exceed both the OSHA and NIOSH criteria for worker exposures.

C. Naphtha

Personal breathing zone air samples were collected for the two sheet-fed press operators during their 8-hour work shift to assess petroleum naphtha exposures. Blanket Wash #106 contains naphtha in addition to benzene and is used in cleaning press rollers.

Naphtha concentrations ranged from 76 mg/M^3 to 946 mg/M^3. One of the two personal exposures exceeded the evaluation criteria established by NIOSH of 350 mg/M^3.

D. Hydroquinone

Two personal breathing zone air samples were collected from one employee who was performing two task-oriented procedures using hydroquinone solution. The first personal sample was for a duration of 10 minutes and involved photographic plate developing techniques. The second task of 15 minutes duration, involved hydroquinone reservoir emptying, cleaning and refilling.

Two area samples of 8-hour duration were collected during this air-monitoring survey in the stat/dark room.

Hydroquinone was not detected in any of the personal or area air-monitoring samples.

E. 2-Butoxyethanol (Butyl Cellosolve)

Three breathing zone samples were collected for two pressmen who performed roller washing techniques with Glaz-a-Way, a cleaning compound which contains butyl cellosolve. Each roller washing procedure takes between 5 and 10 minutes to perform. For one pressman a butyl cellosolve exposure of 0.53 PPM was recorded.

NIOSH does not recommend a specific exposure limit for 2-butoxy ethanol, but recommends that exposure be reduced to the lowest extent feasible. This personal exposure concentration is below the OSHA standard.

F. Indoor Air Quality

In the various office and work areas evaluated on 7/12/89, air temperatures ranged from 75 to 78 degrees F. and the average relative humidities were between 50 and 55%. These temperature and relative humidity values are within the thermal comfort range established by ASHRAE, in their standard on "Thermal Environmental Conditions for Human Occupancy", (ASHRAE Standard 55-1981) (see Figure 1). The thermal conditions documented during this survey were all within the range where more than 80% of the occupants would be expected to be comfortable.

Carbon dioxide concentrations were measured in all areas where temperature and relative humidity data were obtained. Carbon dioxide values of 1,000 PPM and higher were found in several areas, suggesting that there is a lack of fresh air being introduced to these employee work areas. These results are presented in Table I. Carbon dioxide concentrations ranged from 1,300 to 1,600 PPM.

VII. DISCUSSION

The environmental sampling results indicate that during the time period of this evaluation, isopropyl alcohol exposures were generally less than one percent (1%) of the NIOSH REL. However, benzene, naphtha and 2-butoxyethanol exposures exceeded the evaluation criteria. For benzene and 2-BE, any measurable exposure would be considered excessive according to the NIOSH criteria. Percutaneous absorption of these solvents was likely, but could not be measured. The greatest potential for acute, high inhalation and cutaneous exposures are during the replenishing and dampening procedures which employ isopropyl alcohol, and the set-up, washup, and job changeover tasks which employ benzene/naphtha (Blanket Wash #106). Personal protective clothing and respirator usage at these times would diminish this potential.

However, substitution of these solvents with less toxic materials is the preferred method of controlling the potential hazards. The uncontrolled use of these solvents presents the potential for unnecessary employee exposures.

Although employees reported that no adverse health effects are currently being experienced, this response, even in conjunction with employee histories indicating no adverse health effects, does not eliminate the possibility of adverse health effects resulting from potential future exposures because the solvents are used with no ventilation, and skin contact with solvents is commonplace.

The environmental data obtained during the visit indicates that thermal conditions are within the recommended thermal comfort guidelines established by ASHRAE. The levels of carbon dioxide provide evidence that additional fresh air is necessary to effectively ventilate office areas.

VIII. CONCLUSIONS

Based on the results of this survey it was determined that a health hazard due to employee exposure to benzene, 2-butoxyethanol and naphtha existed at the time of this investigation.

IX. RECOMMENDATIONS

For the employer to effectively control employee exposures at this establishment the following recommendations are presented:

1. To eliminate benzene exposure, substitute with another blanket wash solvent which does not contain benzene as a vehicle. This recommendation was implemented by the employer prior to the writing of this report.

2. Provide ventilation in the stat/dark room where hydroquinone is used and stored. Although hydroquinone could not be detected in the sampling media it is still recommended that this room be mechanically ventilated. Furthermore, the employer should ensure that employees performing photographic development procedures using hydroquinone, and preforming the hydroquinone reservoir cleaning and refilling operations, wear gloves impervious to the hydroquinone solutions (natural rubber, neoprene, nitrile rubber, or polyvinly chloride). Since hydroquinone is a severe eye irritant, it should also be made mandatory that safety glasses and/or face shields and other necessary personal protective articles be worn by employees developing, emptying, cleaning and refilling the hydroquinone reservoir in the stat/dark room.

3. Management should enforce the mandatory use of gloves impervious to solvents containing 2-butoxyethanol (butyl rubber or saranex laminated), which is used in the press roller washing and cleaning operations. Butyl cellosolve has an OSHA skin notation and is one of the ingredients of Glaz-a-Way. The skin notation for this compound indicates skin exposure is the primary route of entry into the body. The use of this product, in conjunction with isopropyl alcohol, a defatting agent, will facilitate bodily entry through the skin. An alternative recommendation is to find a substitute for Glaz-a-Way, which does not contain 2-BE.

4. Although ingestion is not a major route of absorption of solvents, eating at the worksite should be discouraged. Furthermore, smoking at the worksite is often even more important in its potential for increasing the absorption of solvents, since it increases inhalation of these chemical substances.

   Management should regulate employee smoking by developing and implementing a smoking policy. Eliminating or reducing cigarette smoke is a recognized method of improving the indoor environment. Restricting smoking to designated areas (preferably with separate air supply and exhaust to the outside environment) is a means to attain this end.

   Smoking should be prohibited in all work areas where isopropyl alcohol is either stored or in use, such as where press rollers are cleaned. Flammable vapors may accumulate and can cause a potential fire or explosion hazard.

5. Management should develop a Hazard Communication Program in accordance with OSHA Standard 29 CFR 1910.1200. The Hazard Communication Program will inform and train employees about the hazards associated with the chemicals used and stored at the work place. Containers of hazardous chemicals should also be appropriately labeled as required by the OSHA 1910.1200 Hazard Communication Standard. In particular, containers (5-gallon) of isopropyl alcohol should be properly labeled and also bear a flammable liquid designation.

6. The employer should obtain a flammable liquid safety cabinet to store and dispense isopropyl alcohol. Currently this flammable liquid is stored in an unprotected, unsecured area of this facility in the press room.

7. The employer should install a mechanical ventilation system, since the only source of fresh air supply to office areas and the pressroom work areas is by passive or natural diffusion, accomplished by opening doors or windows. Mechanical ventilation is mandated by OSHA standards in flammable storage areas.

8. Current work practices permit the application of "Blanket Wash" to spinning press rollers. This method of application produces excessive misting and splattering of this cleaning solvent, thereby increasing potential employee exposure. Blanket wash should only be applied to press rollers when the press has been shut off.

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to the following:

1. Graphic Creations, Inc., doing business as East Bay Printing Company, Warren, R.I.
2. OSHA, Region I, Boston, MA.
3. NIOSH Regional Offices/Divisions

In accordance with the requirements of NIOSH regulations (CFR, Title 42, Part 85), this letter must be posted for a period of 30 days. For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Mention of company or product names does not constitute endorsement by NIOSH.

TABLE I

Indoor Air Quality Data
Graphic Creations, Inc.
Warren, Rhode Island
August 1, 1988

HETA 88-345

Area	Carbon dioxide (PPM)	Tempera-ture (Deg. F)	Relative Humidity (%)	Employee Number (in area)
Paper folding area	1500	75	55	-2-
Main press area (5 presses in operation)	1200	77	52.5	-5-
Finish work area	1500	77	51.4	-2-
Art dept.	1600	78	50.9	-3-
Main office area	1300	78	50.5	-2-
Outside air values (11:00 AM 8/1/88)	250	75	48.0	-0-

TABLE II

Hydroquinone Exposure Data
Graphic Creations, Inc.
Warren, Rhode Island
September 14, 1988

HETA 88-345

Job Classification	sample time (minutes)	sample volume (liters)	Concentration mg/M^3
stat camera area (1,2) (PERSONAL SAMPLES)	25	33.8	ND
	10	13.5	ND
Stat/Dark Room (AREA SAMPLES)	230	529	ND
	225	517.5	ND

Limit of detection was 0.04 mg/M^3

1) all samples were collected on MCEF - Cellulose Ester Membrane Filter

2) employee air-monitoring samples were collected within the employee's breathing zone

TABLE III
Organic Solvent Exposure Data
Graphic Creations, Inc. - Warren, Rhode Island
September 14, 1988
HETA 88-345

Job classi-fiction	sample time (min.)	sample volume (liters)	contaminant	concentra-tion	TWA
operator of press, A. B. Dick # 385	245	11.7	2-butoxy ethanol	0.53 ppm	N/A
	180	8.6	isopropyl alcohol	12.8 ppm	N/A
	180	8.6	N-propyl alcohol	N.D.	N/A
operator multigraph single-copy Press #1250	240	27.5	naphtha	946 mg/M^3	915 mg/M^3
	180	20.6	naphtha	874 mg/M^3	
	240	27.5	benzene	1.37 ppm	0.98 ppm
	180	20.6	benzene	0.47 ppm	
operator A.B.DICK Press #360	250	27.7	naphtha	87 mg/M^3	82 mg/M^3
	225	24.9	naphtha	76 mg/M^3	
	225	24.9	benzene	0.31 ppm	1.1 ppm
	250	27.7	benzene	1.81 ppm	
operator A.B.DICK multi-graph Press #1250	320	14.4	2-butoxy ethanol	-N.D.(1)	
	95	3.7	isopropyl alcohol	-N.D.(2)	
	95	3.7	N-propyl alcohol	-N.D.(2)	

(1) Limit of Detection was 0.7 mg/M^3
(2) Limit of Detection was 2.7 mg/M^3