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HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT NO. TA 78-33

WILLIAM T. BURNETT COMPANY
BALTIMORE, MARYLAND

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Study Requested By:
Eula Bingham, Ph.D.
Assistant Secretary of Labor
Occupational Safety and Health Administration
Washington, D.C.

Report Prepared By:
Gary L. White, M.S.
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Cincinnati, Ohio

James P. Keogh, M.D.
NIOSH Contract Medical Investigator
Division of Occupational Medicine
Baltimore City Hospitals
Baltimore, Maryland

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I. SUMMARY

NIOSH investigated an epidemic of urinary dysfunctions and neurological disorders among polyester urethane workers at the William T. Burnett Company, Baltimore, Maryland, on the dates of April 7 through May 5, 1978. It was determined, based on medical and epidemiological evidence, that employees were exposed to toxic concentrations of NIAX® Catalyst ESN and suffered from adverse health effects resulting from the exposures.

Urinary retention was the most common symptom reported by questionnaire, affecting 85 of the 141 employees (60 percent) at one facility of the company and 6 of 75 (8 percent) at a second facility. Follow-up studies of 65 employees still having urinary retention included the administration of pyelograms; 17 (26 percent) had abnormalities which may have been occupationally related. Four were diagnosed as having neurogenic bladders which were associated with the catalyst. Neurological signs and symptoms were reported among the employees at both facilities and are further discussed in the text of this report. Sexual dysfunctions (decreased frequency and ability) were reported by 49 (35 percent) and 6 (8 percent) employees in the respective facilities. No new cases of neurological, urological or sexual dysfunctions have been reported since the ESN usage stopped in March 1978. Many employees have reported improvements since ESN exposures have ceased.

Other adverse health effects where found, which were not related to the catalyst, but could be related to other substances in the environment, and include skin, eye and respiratory symptoms. Definitely abnormal pulmonary function tests were recorded for 25 percent and 19 percent of the workers at the respective facilities. The decrease in pulmonary function in the study population may be due to cigarette smoking, occupational exposures, or to other causes. However, the cause was not determined in this study.

Environmental sampling, conducted to characterize the airborne contaminants, revealed that toluene diisocyanate (TDI), n-ethylmorpholine (NEM), dimethyl piperazine (DMP), formaldehyde, propionaldehyde (PA), cyclopentanone (CP), methylene chloride, n-methyl morpholine (NMM), and acetone were present in the work environment. Several TDI concentrations exceeded NIOSH recommended criteria on the first day of sampling; on the second sampling occasion, TDI was not detected. Employees were experiencing visual problems (cloudy vision and halos), which might be related to NEM exposures although the exposures were below existing criteria. All other contaminants were measured in quantities below recommended exposure criteria if such exist for certain substances, or in relatively trace amounts. Bis(2-(dimethylamino) ethyl ether (A99), dimethylamino propionitrile (DMAPN) and NEM were identified as offgases of the curing/stored polyurethane at the Dorsey Road warehouse. Other airborne contaminants including aliphatic hydrocarbons, trichloroethane (TCE), tetrachloroethylene (TCEE), and toluene were identified in trace amounts in the Dorsey Road warehouse environment. No occupational exposure criteria exist for DMP, CP, NMM, PA, or DMAPN.

Recommendations to improve the facilities' ventilation, respiratory protection and medical programs are included in this report to assist in ensuring worker safety and health. At the time of this report, the company has reported to have implemented several of the NIOSH recommendations.

II. INTRODUCTION

At the request of the Assistant Secretary of Labor, Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), conducted a combined environmental-medical investigation at the William T. Burnett Company, Baltimore, Maryland. The purpose of the study was to determine if reported employee health problems of bladder dysfunction and neuropathies were present and related to exposures to a polyurethane catalyst known as NIAX® Catalyst ESN. NIOSH was already evaluating a second facility whose employees were experiencing similar health problems and were exposed to the same catalyst system. The evaluation was conducted during the dates of April 7 through May 5, 1978.

III. EVALUATION

A. Facility Description

1. 1500 Bush Street

The William T. Burnett Company began operations at 1500 Bush Street, Baltimore, Maryland in about 1923. The main product was cotton batting. The facility is an old brick warehouse-style building which is subdivided into several distinct departments. It is heated by steam heaters, and there are eleven ceiling and wall exhaust fans.

The company began producing polyester urethane, a German development, just after World War II, and was one of the first urethane manufacturers in the United States. (Polyester urethane is a "firmer" type polyurethane made from polyester resins, whereas polyether urethanes are a "soft" type made with polyols). The Bush Street facility employs approximately 57 hourly and seven salaried workers, all of whom work an 8-hour day, 40-hour week. Approximately ten of the hourly and two of the salaried employees are female. The plant presently operates one shift per day. The facility currently produces a variety of "specialty" urethane products, in numerous colors and degrees of fire resistance, in addition to cotton batting. The plant also contains quality control and experimental urethane laboratories, administrative offices, a maintenance shop, and restroom facilities.

2. Jessup

In about 1971-1972 the company expanded its operations to a second facility at Jessup, Maryland. This new facility produces only bulk polyester urethane. The facility is heated with vented gas heaters and contains both recirculating and general exhaust ventilation. There are twenty-three ceiling and wall exhaust fans and a few local exhaust systems. The Jessup facility employs approximately 138 hourly and 13 salaried employees and operates three shifts per day, five days per week. Three of the salaried, but none of the hourly employees are female. Most of the employees work an 8-hour day, 40-hour week, except the bridge personnel (foam line) who work a 10-12 hour day. The Jessup facility contains a lunchroom, with vending machines, maintenance shop, administrative offices, and restroom facilities. There are also two storage buildings located at Jessup and a warehouse located on Dorsey Road. The production employees at both facilities are represented by the United Furniture Workers of America, AFL-CIO.

B. Process Description

1. Bush Street

There is one urethane foaming line. The front of the line with the foam head is called the 'Bridge' and the end of the line is designated as the 'lower end.' (See Appendix A). Chemicals are stored in an area below the bridge in tanks and drums. Batches of chemical additives* (surfactants, fire resistants, blowing agents, dyes, catalysts, etc.) are mixed together in the 'activation room' by an activator and assistant, (compounders), and pumped to the bridge, in a closed system, to combine with toluene diisocyanate (TDI) and a polyester resin.* All the ingredients mix and flow through the foamer head onto a plastic coated paper conveyor system which is controlled by the foamer operator who maintains the rate and density of foam application. The foam reacts, exothermically, as the process flows towards the lower end. The conveyor system is partially enclosed and is ventilated. As the reacting foam solidifies (polymerizes), into flat slabs, it passes a series of heat lamps which can be used to facilitate skin formation for certain batches of product. At the lower end the paper is removed, ('paper take off'), and the solid polyurethane moves onto a roller system which transports it to a cutting process, ('saw'). The continuous band saw is operated by a 'cutter' who adjusts the machine to achieve specified lengths of foam and also labels each piece as it is cut. The cut pieces are then removed from the roller conveyor and stacked, by color, for ambient curing. Cured foam slabs are cut to desired thicknesses by the 'duplex' operation and then are restacked for shipment. Some of the polyurethane is processed on-site for specialty products such as gaskets, shoulder pads, and hair curlers. Overall, the foaming process is a batch operation.

2. Jessup

There is one urethane foam process line similar to that at Bush street. The chemical additives are mixed in the activation room, pumped to the Bridge foaming/pouring head where the mixture combines with TDI and resin, and is metered through the pouring head onto a conveyor covered with a continuously

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* The chemical additives and the foam composition were designated as trade secret, not to be released for public knowledge. However, substances identified by environmental air sampling are presented in Tables I-V.

fed plastic coated paper. The paper in this process however is slowly curled up on the sides so that the reacting foam becomes cylindrical in shape upon solidification (polymerization). The reacting foam proceeds along the partially enclosed, exhaust-ventilated, conveying system, through the 'paper take off' station and onto a roller system leading to the cutting station. As the urethane cylinder is cut to specified lengths, it is labeled and stacked, in the 'backroom' for a four hour minimum ambient cure. The urethane cylinders are placed on a core borer which bores a hole through the cylinder's horizontal center (core) and the cylinder is mounted onto a machine which peels it into sheets of specified thickness and length. (Longer sheets can be made by heat-sealing two peeled cylinder ends together.) The peeling room is called the 'main room'. rewinds the cut sheets into a cylinder which is placed into a polyethylene bag, which is then compressed either by vacuum or mechanically, wrapped, taped, weighed and readied for shipment. Excess scraps of urethane are fed into a shredder which feeds a baler, via a roof cyclone. The baled urethane scraps are loaded by a fork lift truck into railroad cars for shipment.

The foam process is a continuous 10 to 12-hour operation, whereas the foam peeling process is an 8-hour shift, three shifts per day operation. Second shift peels the most fresh foam, with a third shift peeling a lesser amount than the second. The first shift peels mostly 1-day-old (cold) foam. A limited amount of foam is peeled at Bush street too.

C. Chronology of Events

In April 1976 the Burnett Company began formulation experimentation with a new urethane catalyst known as NIAX® Catalyst ESN. [The catalyst, is a mixture of dimethylamino propionitrile (95 percent) and bis (2-(dimethylamino) ethyl) ether (5 percent)]. The new catalyst was recommended to the Burnett Company as a substitute for the NEM Catalyst. In August 1976 the new catalyst was introduced into production, in a limited quantity* at both facilities, and within a month it was increased ten fold* at the Jessup facility. The new catalyst not only produced a better quality product, but employee odor complaints were also less frequent than with the other catalysts used. By August 1977, however, Jessup was using twice* the quantity as the year before and ten times more than Bush Street when the first employee nonformal complaint of a urinary problem surfaced.

In September/October 1977 increasing production and usage of the catalyst peaked, except for certain days in January and March 1978; also, employee complaints of fumes prompted a complaint to be filed with the Maryland Occupational Safety and Health Administration (MOSH) at about the same time. The complaint concerned fumes and indicated blurred vision, nausea, and dizziness; hence, the MOSH investigation centered around TDI and

*The lbs/month usage data was designated as confidential, not to be released for public information.

n-ethyl morpholine (NEM). The company at this time issued respirators to all backroom, saw, and bridge personnel and instituted a 4-hour minimum ambient cure. MOSH's investigation indicated that exposures to TDI and NEM were not in violation of any existing standards, based on environmental sampling results. Over the next five months the health problems and complaints, to both MOSH and Federal OSHA, began to multiply. In March 1978 complaints of skin and bladder problems, in addition to the previous complaints, prompted another MOSH survey. The survey indicated that over 50 percent of the interviewed employees (69 of 101) reported bladder/urinary problems (many had been experiencing urinary dysfunctions for some months) in addition to numerous other complaints, including dizziness, weakness, paresthesia, impotence, hair loss, cloudy vision, hematuria, and dermatitis. MOSH personnel met with a physician from Baltimore City Hospitals (BCH) and a neurologist from John Hopkins Hospital (JHH). The neurologist noted that a component of the NIAX® Catalyst ESN (dimethylaminopropionitrile) was similar to other propionitriles which are known neurotoxins. (At approximately the same time, similar health problems surfaced at a polyurethane plant in Massachusetts which was using the same catalyst, and that company requested NIOSH to evaluate the problem. The NIOSH investigators initiated literature searches on March 28, 1978 and began the on-site evaluation in April 4, 1978.) The JHH neurologist began laboratory evaluations of the catalyst and its components, in rats, and the BCH physician began designing a study to evaluate the Burnett employees' medical problems. The company discontinued use of the catalyst on March 29, 1978, and MOSH issued a news release on March 30, 1978 of it's survey findings. Federal OSHA requested NIOSH to conduct an evaluation at the Burnett facilities, and NIOSH contracted with the BCH physician to conduct the medical evaluation. NIOSH began the evaluation on April 7, 1978. Subsequently, OSHA issued a health hazard alert, and NIOSH and OSHA issued a joint Current Intelligence Bulletin[1] regarding the health hazards associated with NIAX® Catalyst ESN. (Both NIOSH and OSHA had received information that other facilities using the catalyst had an excessive number of employees who had or were experiencing some urological or neurological problems.)

D. Environmental Evaluation

NIOSH industrial hygienists obtained background information from MOSH, OSHA, management and labor representatives. Information regarding employee demography, products, raw materials, formulations, usage data and dates, process descriptions, ventilation, health and safety policies, and medical programs were obtained from management for both of its facilities. On-site observations of the work place, employee work practices, safety equipment usage and hygiene were made at both plant locations.

Bulk samples of many of the chemicals in use were obtained in glass scintillation vials with Teflon®-lined caps, and samples of different foam products, produced on different dates both with and without the catalyst, were obtained in plastic sealable bags. Photographs of the operations and sketches of the facilities were obtained. Qualitative ventilation measurements were made utilizing a Sierra* hot wire anemometer and Gastec* smoke tubes. Qualitative measurements for airborne organic vapor contaminants were made with an Organic Vapor Analyzer (OVA) to facilitate identification/characterization of contaminants generation sources. Swipe samples for surface contamination were obtained with Whatman* filter swipe pads. The samples were placed in glass scintillation vials with Teflon®-lined caps. Relative humidity and temperature measurements were made with a battery operated psychrometer.

1. Environmental Sampling

General area and personal samples for qualitative and quantitative assessment of exposures to airborne organic vapor contaminants were taken at both production facilities and the warehouses. Calibrated battery operated MSA* model G and Sipin* personal monitoring pumps were utilized in combination with six different collecting media, both liquid absorbents and solid absorbents, to characterize the airborne contaminants. The cotton batting area was not evaluated because it was beyond the scope of the evaluation, which was focused on NIAX® Catalyst ESN.

a. Liquid Absorbents

(1) Marcali Solution

General area samples for TDI were obtained utilizing midget impingers with 15 milliliters (ml) of modified Marcali solution, (sampling data sheet 18.01)[2] and MSA* model G sampling pumps operated at air flows of approximately 1.0 liter per minute (lpm). Samples at Jessup were obtained in the chemical storage areas and in the backroom downstream of the hot foam cutting station.

Personal samples for TDI were obtained utilizing spill-proof impingers containing 15 ml absorption media and MSA* pumps operated at air flows of approximately 1.0 lpm. The impingers were pinned to the workers' clothes, on the chest, to simulate their breathing zone. The pumps were hung on belts around their waists and connected to the impinger with tygon tubing. Samples were obtained of most job classifications expected to have the highest potential exposure for TDI.

(2) 1 percent Sodium Bisulfite[2]

One area sample for aldehydes was obtained in two midget impingers hooked in series, each containing 15 ml of 1 percent sodium bisulfite absorption solution and a MSA* pump operated at an air flow of approximately 1.0 lpm.

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*Mention of a manufacturer's name does not constitute a NIOSH endorsement.

The sample was taken at the cutting station to determine if aldehydes were present in the off-gases of the plume evolving from the fresh hot foam.

(3) Distilled Water

One area sample for water soluble contaminants was obtained in two midget impingers, hooked in series, each containing 15 ml of double-distilled water. The samples were obtained with an MSA* pump operated at an air flow of approximately 1.0 lpm. This sample was obtained to characterize the hot-foam plume at the cutting station.

b. Solid Adsorbents

(1) Charcoal[2]

General area samples for characterization of airborne organic vapors were obtained with 150 milligram (mg) activated charcoal tubes attached to MSA* and Sipin* pumps operated at air flows of 1.0 lpm and 0.2 lpm, respectively. Samples were obtained throughout the Jessup facility and warehouses.

Personal samples were also obtained utilizing Sipin* pumps operated at air flows of approximately 0.2 and 0.05 lpm. The charcoal tubes were clipped to the workers' collars to simulate their breathing zone. Most job classifications were surveyed.

(2) Silica Gel[2]

General area samples for airborne organic amines were obtained with 150 mg silica gel tubes attached to air pumps operated at air flows of 1.0 and 0.2 lpm. Samples were located throughout the Jessup facility and warehouses, side-by-side, with the charcoal tube samples.

Personal samples were obtained in the same manner as were the personal charcoal tube samples.

(3) Porous Aromatic Polymer

Both general area and personal samples for organic vapors were obtained utilizing 150 mg porous aromatic polymer tubes. The samples were taken in the same manner as were both the charcoal and silica get samples.

A sample set using each type of solid adsorbent was taken in the warehouse, side by side, to identify off-gases and determine if DMAPN was present. At the time of the sampling there was no available sampling or analytical method for DMAPN.

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2. Environmental Sample Analysis

a. Liquid absorbents

(1) Samples obtained for TDI were analyzed by a colorimetric method, NIOSH P&CAM #141[3].

(2) 1 percent Sodium Bisulfite

The sample for aldehydes was analyzed by two methods. Formaldehyde analysis was via a colorimetric procedure, NIOSH P&CAM #125[3]. Other aldehydes were screened for by GC using a 12-foot four percent carbowax on carbopack B glass-column at 130°C, NIOSH P&CAM #127[3]. (Some interfering unknown peaks eluted; thus, the detection limits were not as low as in most determinations.)

(3) Distilled Water

A qualitative analysis of the water sample was performed by liquid chromatography.

b. Solid Adsorbents

(1) Activated Charcoal Tubes

The charcoal tube samples (plus the front glass-fiber plug) were desorbed in 1.0 ml of carbon disulfide (CS_2) and analyzed by gas chromatography (GC) using a 20 foot stainless steel 10 percent SP1000 column.

(2) Silica Gel Tubes

The samples (including the front plug) were desorbed in 1 ml of an 0.5 percent aqueous cupric chloride in acetone solution.*

A two-hour sonification aided desorption. The solutions were then analyzed by GC using a 6 foot one-fourth-inch glass column containing 4 percent carbowax 20M with 0.8 percent Carbopack B. The GC was run isothermically at 200°C and an 0.1 N KOH solvent flush was run after each sample to prevent column deactivation.

(3) Porous Aromatic Polymer Tubes

The tubes media was desorbed and analyzed in the same manner as the silica gel sample except sonification was not required for desorption.

(4) Swipe Samples and Bulk Urethanes

The swipe samples were desorbed (extracted) with 2 ml, and bulk samples with 20 ml, of the 0.5 percent aqueous cupric chloride in acetone solution and analyzed the same as (2) and (3).

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*The analytical method used was supplied by Union Carbide Corporation which had specifically developed it for analysis of the A-99 component, bis(2-(dimethylamino) ethyl) ether. The method was adaptable for analysis of DMAPN and NEM.

GC/Mass Spectrometry (MS) was performed on selected samples for identification of unknown eluted compounds. (See Appendix B). Desorption studies were conducted for some compounds on some of the solid adsorbents. (See Appendix C).

E. Medical Evaluation

The medical evaluation was made available to all current employees at both facilities, including management, and was conducted on site. Management provided the necessary time and space for the evaluation. Informed consent was obtained from each participant prior to being evaluated. The evaluations consisted of both a self- and an investigator administered questionnaire, complete physical examination, urinalysis, blood tests, and spirometry. (Some employees declined certain tests but were included in the data analysis for the parts they did complete).

A self-administered questionnaire was used to elicit responses to questions concerning current and prior jobs, age, sex, race, personal safety equipment usage, and whether or not any medications were being used. An investigator administered questionnaire asked questions about smoking and alcohol use, and the presence or absence of selected symptoms. The questions asked about dermatitis, throat and upper respiratory tract irritation, cloudy or distorted vision, pulmonary symptoms, central nervous system symptoms, symptoms of peripheral neuropathy, symptoms of urinary retention, frequency and dysuria, sexual dysfunction, and constipation.

Physical examination was recorded on a standardized form and included a brief neurological examination. This consisted of testing cranial nerves II through XII, motor strength, deep tendon reflexes (DTR's), vibratory sensation at the ankles, gait and balance (presence or absence of Romberg's sign).

Pelvic and rectal examinations were not performed on women. Rectal examinations were declined by some of the men. Abnormalities were grouped as respiratory, urological, neurological, hypertension, and other.

Pulmonary function tests were performed on a calibrated Collins* survey spirometer and were repeated after bronchodilators. (Three trials were performed per test). Forced vital capacity (FVC) and one-second forced expiratory volume (FEV_1) were determined.

Because of concern that workers might have urinary tract infections, urinalysis (dipstick and microscopic) was performed on-site at the Jessup plant during the examination. At the Bush Street plant urine specimens were sent for examination to a commercial laboratory. All abnormal urines were cultured.

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Venous blood was drawn for evaluation of electrolytes, calcium, phosphorous, blood urea nitrogen (BUN), creatinine, glucose, protein, albumin, globulin, bilirubin, serum transaminase enzymes (SGOT, SGPT). alkaline phosphatase, lactate dehydrogenase (LDH), cholesterol, triglycerides, iron, G-glutamyl, transpeptidase, complete blood count (CBC) with differential, uric acid, antistreptolysin O titer (ASO), latex fixation, antinuclear antibody, and prothrombin time. The tests were part of a "Chem Screen 26."

D. Evaluation Criteria

1. Environmental

The following occupational exposure criteria were used in evaluating the environmental contaminants found at the time of the survey: (1) National Institute for Occupational Safety and Health (NIOSH), Recommended Criteria for Occupational Exposures, (2) American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values for Substances and Physical Agents in the Workroom Environment and supporting Documentation, and (3) U. S. Department of Labor, Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1910.1000, Tables Z1 and Z3). As the table indicates there are several substances with no existing occupational exposure criteria or standard.

Substance	(1) NIOSH (mg/M^3)*	(2) ACGIH (mg/M^3)*	(3) OSHA (mg/M^3)*
Acetone	--	2400	2400
Aliphatic Hydrocarbons	--	--	--
bis (2-(dimethylamino) ethyl)ether	--	--	--
Cyclopentanone	--	--	--
Dimethylamino propionitrile	--	--	--
Dimethylpiperazine	--	--	--
Formaldehyde	1.2[2]	3[2]	4.5[2]
Isopropyl Alcohol (skin)**	980	980	984
n-Ethyl Morpholine (skin)**	--	94	94
n-Methyl Morpholine	--	--	--
Methylene Chloride	261	360[1]	1740
Propionaldehyde	--	--	--
Toluene (skin)**	375	375	750
Toluene Diisocyanate	0.036	0.014[1]	0.14
Tetrachloroethylene	6.87	670	678
1,1,1-Trichloroethane	1910	1900	1900

*Approximate milligrams of substance per cubic meter air, as an 8-hour time weighted average (TWA) daily exposure.
**Notation indicates that substance is known to be adsorbed through intact skin.
1. Intended changes for 1978 (lowered to value indicated).
2. Ceiling value, for a 15-minute exposure, not to be exceeded.

These criteria are designed to protect most workers for an eight to ten hour day, forty-hour week, during a normal working lifetime. However, there are numerous factors that may influence an individual's response to a particular substance, such as age, sex, health status, smoking and alcohol habits, etc. Also, these criteria are based on single substance exposures; thus, effects from exposures to combinations of substances may be additive or synergistic when the substances elicit similar physiological responses.

2. Medical Criteria

Discussion of the health effects of every substance identified in this survey is beyond the scope of the medical evaluation, which was directed towards employee health problems associated with NIAX® Catalyst ESN exposures; thus, they are not presented in this report. (Included in the Reference Section are sources which can be consulted for health effects information on the substances not discussed here. It should be noted that some of the identified substances have little, if any, health effects noted in the literature.)

a. Toxicity Data

(1) NIAX® Catalyst ESN[4,5]

The catalyst is a light-yellowish, water-soluble liquid mixture containing 3-(dimethylamino propionitrile (95 percent) and bis(2-(dimethylamino) ethyl) ether. It has an amine type odor and may contain trace contaminants of acrylonitrile and dimethylamine.

There is a very limited amount of toxicological information on this urethane catalyst mixture. The only known information available is Union Carbide Corporation's Material Safety Data Sheet and Toxicology Information Sheet. The toxicology data indicates that skin penetration, in rabbits, is a definite hazard. (LD_{50}= 0.445 mg/kilogram body weight). The compound is classified as moderately hazardous in rats via both oral (LD_{50}= 2.46 ml/kilogram body weight) and inhalation routes of entry. Skin irritation is listed as a slight hazard and eye injury, to a 15 percent or more solution, a serious hazard. (All data is based on single exposure animal tests.) The sheet also states that patch testing with human volunteers using cured polyester foams made with the catalyst were not irritating or sensitizing. Other information addressed the properties of the substance and general precautions. (Labels on drums, located at facilities evaluated, contained less information.)

A preliminary animal study conducted by medical investigators at Harvard School of Public Health revealed the following toxicological action of the catalyst substance. "A 20 percent solution of ESN was administered to rats at a dose of 10 mg/kilograms (kg) by the intraperitoneal route (IP) (actual dose 2 ml/kg). Several rats were used and the following observations notes. Within 30 to 60 seconds the animal appeared to be depressed, its stance became low to the tabletop on which it stood; within an additional 15 to 20 seconds clonic convulsions occurred, and within one minute the animal died. A smaller dose of a 20 percent solution, 1 ml/kg by the IP route produced depression of activity, an apparent right rotation of the body (the animal began to circle its cage). It recovered completely after five to 10 minutes.

Further experiments were undertaken with three control rats and at two dose levels of ESN (1 ml and 0.5 ml of a 20 percent solution using three rats per dose level). Gross necropsy of these animals showed a large hematoma of the bladder in the region of the neck of the bladder in the treated rats. The lesion appeared to be on the abdominal side of the bladder and resulted in an apparent division of the bladder into what appeared to be two horns. Depending on the extent of the lesion or erosion the urine was tinged with blood. Whether the urinary output was altered in these latter experiments was not determined since urine was not collected nor volume measured. However, the size of the gross lesions suggests that the potential exists for a mechanical obstruction to occlude the urinary exit from the bladder."[6]

(2) 3-(dimethylamino) propionitrile[7-27] (DMAPN)

The only known toxicological information available for this substance is the Union Carbide Corporation toxicology sheet. The data, based on single exposure animal studies, indicates that the substance is only a definite hazard to the eyes, via direct contact. The hazards, by route of entry (inhaling, oral, skin contact) are described as moderate to slight. There is, however, information concerning similar propionitriles which are known neurotoxins and can cause skeletal system defects, teratogenesis, and other adverse biological effects.[7] Imino dipropionitriles are used experimentally to cause peripheral neuropathy in rats. Amino acid nitriles, present in certain plants and particularly in species of sweet peas of the genus Lathyrus, play a role in causing neurolathyrism, a degenerative spinal cord disease related to a diet of such peas. The neurological disorders include clinical descriptions of bowel and bladder dysfunctions, tingling sensations, and impotence.

Osteolathyrism, a syndrome of bone deformity and hind limb paralysis, can be caused by beta-amino propionitrile (BAPN). In addition, BAPN can cause the syndrome of angiolothyrism both in young rats and rat fetuses. Feeding BAPN to pregnant rats can result in offspring that are still-born or that die shortly after birth from aneurysms of great vessels that rupture (e.g. aortic aneurysms). Numerous other adverse effects, including teratogenesis have also been reported. The effects appear to be associated with an inhibition of the fibroblast cells and collogen and elastin enzymes.

(3) bis(2-(dimethylamino)ethyl)ether (A99)[28]

Again, the only available information for this substance is Union Carbide's toxicology study sheet. The data indicates that the substance is moderately to slightly hazardous by each route of entry, based on single exposure animal data.

Both the John Hopkins neurologist and Union Carbide are currently conducting toxicological studies on each of the substances and the results will be available at some time in the future.

It should be noted that DMAPN was listed as moderately hazardous, via skin penetration, and the ether as slight to moderately hazardous, but the catalyst mixture as definitely hazardous. The difference in the skin penetration hazard may be that the ether component facilitates or potentiates skin absorption of DMAPN.

(4) Dimethyl piperazine (DMP)[29]

The only information found on this substance was Texaco Inc.'s material safety data sheet. The substance, a component of a urethane catalyst, is a clear, amber-colored corrosive liquid with an ammoniacal odor. It is described as extremely irritating and slightly toxic via inhalation, oral and dermal routes of entry. It's sensitizing properties were listed as unknown but all personal contact is to be avoided.

Other piperazine derivatives are used in veterinary and human medicines as anthelmintics. Many piperazine derivatives are pharmacologically active[30] and there is literature that describes T-lymphocyte depletion[31] and choroid plexus epithelium degeneration.[31] The literature mainly addresses the effects of tertiary amines but numerous articles discuss nitrosamine-formation reactions and effects.[33]

(5) N-Ethyl morpholine (NEM)[34-36]

NEM is a liquid mixture with an ammoniacal odor. It is used as a urethane catalyst. The literature describes it as irritating and it produces drowsiness, headaches and most notably "halos" and foggy vision. Eye contact is to be avoided because it may cause sloughing of the cornea and edema. No literature was found that describes the chronic low level effects, and it is unknown if the repeated eye effects produce other adverse effects. The effects can pose a safety hazard, particularly in night driving.

(6) Toluene Diisocyanate (TDI)[37-40]

The health effects and properties of this substance are well documented in literature. The substance is a light-yellow liquid and is classified as a Class B poison. It is a strong irritant, especially to the eyes and upper and lower respiratory tract. Acute exposure to the liquid produces chemical burns, and eye contact produces severe conjunctival irritation. Acute exposures can be fatal.

Chronic low level exposures to vapors cause burning or smarting of the eyes and gastrointestinal reactions of nausea, vomiting, and abdominal pains. Of all the adverse effects, the most notable are those involving the respiratory tract.

(a) Primary irritancy - at sufficient concentrations of TDI, all exposed individuals are susceptible to effects on the respiratory tract, resulting in burning of the nose and throat, a choking sensation, dry or productive cough, and general chest pains. These effects are often mistaken for "colds" or upper respiratory tract infection. Exposure to higher concentrations can lead to severe irritation of the respiratory tract, mimicking an asthmatic attack, and may produce a chemical pneumonia. Additional symptoms include headache, sleeplessness, ataxia, and euphoria.

(b) Allergic sensitization - TDI can produce an immunological sensitization and very low concentrations may thus elicit various symptoms. Nocturnal shortness of breath and cough as well as symptoms and signs of asthma may appear in sensitized individuals (such asthmatic reactions have been reported to be fatal). A stuffy headed feeling, similar to hay fever, are often signs of sensitization.

A third type of respiratory effect, from chronic low level exposure, is that of obstructive airways disease.

E. Results and Discussion

1. Environmental

The results of environmental sampling are contained in Tables I-V. In general, the results should be considered as the minimum concentrations present because most samples were not full 8-hour samples and there may be competitive binding of the substances on the medias. Sampling results for airborne TDI, (Tables I and II) indicate that exposures were highly variable and at times potentially toxic exposures did exist. The highest exposure to TDI, at Jessup, was found at the quality control peeler which peels fresh "hot" ($\approx 140^{o}$-204^{o}F) foam. However, the operator wore a respirator during the operation thus his actual exposure would be less. The operation also only runs for approximately 10-15 minutes each hour. The operator of the peeler next to this operation, however, was exposed to a concentration of TDI just below the ACGIH TLV exposure limit in only a 1 hour period. The criteria is an eight hour limit, thus the operator may well have been exposed to excessive TDI over the entire day. (The calculation of the 8-hour TWA assumed zero exposure for any time not sampled which is mathematically correct but not actually representative of the real situation.)

Other TDI samples at Jessup which exceeded the ACGIH TLV exposure criteria were the material handler and saw operator. The material handler wore respiratory protection during the TDI unloading operation. The saw operator intermittently wore a respirator as did many backroom employees. They were not properly instructed in respiratory protection usage, limitations, maintenance, etc., thus the protection was judged to be inadequate. (Medical data indicates that some employees are experiencing adverse respiratory effects (Table XIV) which may be related to TDI exposures.) The differences in the sampling data on the separate dates (Table I and Table II), could be related to process variability (which could include; variations in raw material composition, differences in reaction completion with the varying additives, operator variability, compounding variations, metering pump fluctuations and varying homogeneity of the reacting mixture in the foamer head) and possible TDI concentration differences in the varying product runs. On the second sampling (Table II), most of the loading dock doors were open, (including the doors at the paper take off area a few feet away), whereas on the first sampling most of the doors were closed. With the open doors, additional makeup air was entering (visibly demonstrated with smoke tubes) thus decreasing the resistance to the exhaust fans in the air hood etc., which would improve the efficiency of the fans.

Samples 31A-39, (Table I), were obtained at Bush Street. They also indicate highly variable exposures, but the bridge and lower end (paper take off and saw area) do appear to have the highest exposures, as would be expected. The operator's were not properly instructed in the use and maintenance of their respirator, thus the protection was not judged to be adequate. Three of the seven personal samples for TDI exceeded the ACGIH TLV and two samples exceeded the NIOSH recommended exposure criteria.

It should be noted that most samples were not full 8-hour samples; thus exposures could be higher than indicated. Also, many Jessup workers on the bridge and saw area work more than eight hours per day; thus, their actual exposures could be higher.

Additional environmental evaluation of the TDI exposures would be necessary to more accurately determine the employee exposures and the variability in the process by foam type, particularly at the Bush Street plant where the operation is more variable because of the batch procedure.

Improper use, maintenance and storage of respiratory protection was observed at both plants. Also, there was no detailed written respirator program.

A number of airborne organic compounds were identified (Tables IIIA-IVA), but based on the single substance occupational exposure criteria there did not appear to be excessive exposures on the dates sampled. However, some of the substances do not have exposure criteria; thus, evaluation of these exposures is not certain. The exposures measured for DMP are the only human exposure data known to exist. Also, although NEM and aldehyde exposures were not found to be excessive based on existing criteria, numerous employees had experienced and complained of effects that would be attributable to NEM and/or the aldehydes identified, i.e. cloudy vision, halos, irritation, etc.). This could be the result of inadequate collection of the substance on the various adsorption media used, exposure criteria set too high, or some additive or synegistic effect from combinations of substances present was eliciting the effects.

Samples taken in the Dorsey Road warehouse (Table IIIA and IVA) revealed that there were several substances evolving from the stored foam produced with NIAX^R Catalyst ESN, including its components.

The sampling data for DMAPN's is the only known data to exist and it was somewhat surprising to find the substance, particularly since its use was terminated at least one week before sampling. The second sampling results indicate that DMAPN airborne concentrations are decreasing with time, as would be expected. DMAPN was also found (Table IVB) as a contaminant at the saw area. This sample was taken of dirt "film" buildup along the exhaust hood over the cutting operator's station. Also, unbound DMAPN was extractable from the cured foam (Table V). The results indicate that employees could have been exposed to DMAPN via inhalation and/or contact. It should be noted that although DMAPN is 95 percent of the catalyst mixture, the five percent component is less volatile; thus, finding it on higher concentration in the swipe sample and less in the air is not surprising. It is likely that it will persist longer than DMAPN.

Readings taken with the OVA (Table V) reveal that the saw area has the highest organic vapor concentrations. This would be expected because the hot (240+^{o}F) fresh foam leaves the partially enclosed exhaust ventilated conveyor system just ahead of the saws. Overall, the backroom, which includes the saw area, has the highest concentrations of organics. The concentrations will vary according to how much fresh foam is made and stacked for curing. There could be localized pockets of high concentrations between curing stacks or fresh foam (buns). The concentrations drop whenever foam is not handled or where it is already "cold" (cured). The visible plume evolving from the fresh foam, or foam that is peeled before complete curing, appears to be composed of primarily water vapor with aldehydes and NEM, and may contain, at varying times, excess TDI and traces of other organics.

Observations and qualitative spot check measurements of the ventilation systems indicated that there is an inadequate air flow through and to the Jessup facility. The backroom is particularly in need of additional makeup air. The ventilation system ratings appear to be overrated to the actual air movement, and the backroom bun stacking scheme interferes with the designed airflow. The local exhaust systems in the activator room, which had recently been modified and improved, appeared to be working adequately.

There are improperly located ventilation systems at Bush Street. The systems pull contaminated air across the operators' breathing zones. The bridge and paper take-off areas are particularly poor. Overall, Bush Street appears to be the most inadequately ventilated of the two facilities. The housekeeping at Jessup appeared good, and most equipment was well maintained. The eyewash fountain water, however, was too hot, and the shower facilities were located too close to a contaminated area (i.e. chemical storage tanks). Bush Street was not as well kept. It is, however, a much older facility, and the eye wash was in need of repair.

2. Medical

The results of the medical evaluation are contained in Tables VI-XVI. Tables VI and X contain the questionnaire results by facility and job area. (Work area, job codes and descriptions are contained in Appendix A). In two cases date of birth was not recorded. Length of employment (date of hire) was not obtained from a number of salaried personnel. Persons hired during the first two months of 1978 were distinguished from those hired in March 1978. (ESN usage was decreased in the beginning of March 1978). Date of birth, date of hire, sex, whether or not participant worked in the 'backroom' of the Jessup plant and the number of months spent in areas 2 through 6 (greatest exposure to freshly made foam) were tabulated. Also recorded were responses to questions about symptoms, grouped by category. (Tables VII, VIII, XI & XII) In analysis, responses were grouped by category, and a participant was judged to have a positive response to that category if he or she answered yes to any of the questions in that category.

a. Urological Symptoms

Urinary retention was the most common symptom reported by questionnaire. Eighty-five of the 141 (60 percent) workers at Jessup and six of 75 (8 percent) at Bush Street had been affected. Only two workers at Jessup and one at Bush Street had primary complaints of increased frequency. Thirteen (9 percent) at Jessup and eight (11 percent) at Bush Street had abnormal urinalysis with the presence of red cells and/or white cells. None of the urine cultures were positive, and all of these workers had followup examinations. All of those seen by urologists have had negative repeat urinalysis and the abnormalities were probably due to inadequate cleansing of the meatus or to urethitis. Two of the workers from Jessup have since been treated for nonspecific urethritis. Sexual dysfunction ranging from decreased libido to impotence was reported in 49 (35 percent) at Jessup and six (8 percent) at Bush Street.

To examine the relationship between symptoms and exposure, workers at Jessup were grouped by whether or not they had worked in the backroom, where exposure to warm foam was the greatest. Results are shown in Table XVI A. The relation of symptoms and exposure to warm foam in handling and cutting foam in the backroom and peeling operations in the main room are shown in Table XVI B. None of the recently hired workers gave symptoms of urinary retention. To determine if this was related to the decreased usage of ESN or to length of employment, those hired in March 1978 were compared to those hired previously. As can been seen in Table XVI C, those hired in January or February had at least as great a likelihood of symptoms, while those hired in March, including new employees in the backroom, had no symptoms of urinary retention. Such an abrupt transition is more likely to relate to a sudden decrease in exposure than to an effect from shortened length of employment.

Follow-up examinations were offered to all workers still having symptoms of urinary retention. The examinations included an intravenous pyelogram (IVP) with post-voiding films, history review, genitalia and prostate examinations, and as indicated, catherization and cystometrograms. Sixty five workers had the intravenous pyelograms with post-voiding films. Seventeen° (26 percent) had abnormalities which were possibly occupationally related. Five had minimally increased post void residual on IVP. Nine had moderate amounts of residual, and three had larger amounts. Three workers had catherization and cystometrograms (CMG's), two of those with moderate retention had definite neurogenic bladders confirmed by catherization and cystometrogram (CMG), and one of those with minimal retention had a normal CMG. Three of these seventeen had other abnormalities which were considered unrelated to occupational exposure. One had medullary sponge kidney; one had multiple calculi; and one had a renal cyst. One of the 48 workers with normal IVP's had an enchondroma of the iliac crest which had been present for years.

Because of the noninvasive approach of looking for post-voiding residual, an IVP is sensitive but not specific, so these numbers may exaggerate the number of "abnormalities." However, in those two participants who were catheterized bladder dysfunction was confirmed. (Fortunately neither was felt to be in danger of developing hydronephosis). Thus these two clear-cut cases and the previous two cases (diagnosed before the evaluation began) bring the total of such cases to four from the same plant. All are being carefully followed and one is receiving Urocholine*. The vast majority of those workers symptomatic during April were able to demonstrate adequate bladder emptying on IVP's done some weeks later. In summary, symptoms of urinary retention and sexual dysfunction were much more common at Jessup than at Bush Street. They seem to correspond to the degree of exposure to warm foam and were particularly likely to be present among those who worked in the "backroom."

No new cases were reported after ESN usage was discontinued.

b. Skin and Upper Respiratory Symptoms

Skin problems were reported as common problems at both Jessup (65 percent) and Bush Street (43 percent). A common problem was dryness of the hands and loss of hair on the forearms. Some workers reported that they commonly balanced lengths of foam across their heads and shoulders and that their hair seemed increasingly brittle. Hoarseness or sore throats were reported in 39 percent at Jessup and 19 percent at Bush Street.

c. Eye

Irritation and cloudy vision were reported by 113 (80 percent) of the Jessup workers and 36 (49 percent) of those at Bush Street. Cloudy vision, when reported, was almost always described as having its onset while at work, clearing about an hour after work. Many workers also reported "halos" around lights. One worker had a visibly cloudy cornea during the exam and some had conjunctivitis. Visual acuity was not tested.

d. Respiratory

Sixty (43 percent) at the Jessup plant and 17 (23 percent) at Bush Street reported wheezing or chest tightness that became worse at work. However, 10 (13 percent) of the Bush Street workers had abnormalities on chest exam as opposed to 7 (4 percent) at Jessup.

One hundred and thirty nine of 151 workers (92 percent) at the Jessup facility and 75 of 83 (90 percent) at Bush Street had pulmonary function tests. Pulmonary function tests were considered definitely abnormal if the forced vital capacity (FVC) was less than 70 percent predicted or if the forced expiratory volume in one second (FEV_1) divided by FVC (FEV_1/FVC) was less than 70 percent predicted. Thirty five (24 percent) of the workers at Jessup and 14 (19 percent) of Bush Street workers had definitely abnormal pulmonary function (Table XIV B). No relationship to length of time or area of work was found, but pulmonary function testing was done at different times of the day and of the week. If there is an acute effect

*Urocholine is a trade name; generic name is bethanechol chloride.

of exposure to TDI or cotton dust, both known to be present, this would overshadow and confuse any effect of chronic exposure. The general decrease in pulmonary function in the study population may be due to cigarette smoking, occupational exposures, or to other causes. A more sophisticated pulmonary function study would be necessary to determine the primary reasons for the abnormal findings.

e. Neurological Symptoms

Weakness and paresthesias were reported as common problems at Jessup (22 and 26 percent respectively), but considerably less at Bush Street (5 and 1 percent respectively). These findings do parallel the urological findings. (Table VIII and XII). At Jessup (11 percent) and at Bush Street (4 percent) had some neurological abnormality in examination.

f. Other Findings on Examination

Dry mouth and bad taste were more common at Jessup (41 percent) than at Bush Street (23 percent), where they were rare among batting department, laboratory, and office workers. Hypertension was rare (6 percent Jessup and 10 percent Bush Street). Forty-three percent of those at Jessup and 28 percent of those at Bush Street had some abnormality on physical exam other than those mentioned above. These were most commonly conjunctivitis, skin problems and other minor abnormalities.

g. Laboratory Tests

At Jessup 29 percent and at Bush Street 24 percent had some abnormality on blood tests. Almost all of these were judged to be insignificant. A number of workers were found to have elevated triglycerides, but samples were not drawn fasting. Some had slight elevation of one or more liver function tests, which is not surprising in any population. Only one worker had significantly elevated liver function tests. A number of workers had elevated ASO titers, and some had positive tests for ANA and latex fixation.

h. Intercurrent Illnesses

Some workers had illnesses requiring acute care. These were referred for therapy. One worker was hospitalized for severe weakness. He was thyrotoxic, and his nerve conduction studies and bladder function were normal on examination.

One worker died during the study. He had signs of peripheral neuropathy but also had a history of alcoholism. At the request of the investigators the Medical Examiner's office took custody of the body and an autopsy was performed. Cause of death was reported to be coronary artery disease and was not considered related to the ESN exposure. Pathological examination of brain, cord, and bladder have not yet been reported to the investigators.

All workers were notified, in writing, of their individual test results and advised as appropriate to seek follow-up evaluations. Personal physicians were also notified if the employees had indicated such on their consent forms.
forms.

IV. CONCLUSIONS/RECOMMENDATIONS

A. Conclusions

Based on the results of medical and environmental evaluations and comprehensive literature reviews it was determined that NIAX® Catalyst ESN was the probable causative agent of employee urological and neurological disorders and possibly the sexual dysfunctions too. The specific substance which probably elicited the toxic effects was the dimethylamino propionitrile component. Further toxicological testing is underway, but the results were not available for this writing.

The evaluation revealed numerous other health problems, skin, eye, respiratory, etc., which may be the result of occupational exposures. However, this study was not designed to determine the causes of those effects.

Many of the affected employees are improving since the ESN usage was discontinued.

B. Recommendations

1. Employees must exercise strict personal hygiene and adhere to good work practices. They are encouraged to continue cooperating with the medical investigator, who will attempt to maintain a surveillance program for them in the future.

2. Management is encouraged to develop detailed written health and safety programs and instruct all employees of the hazards associated with the chemicals used in the respective facilities and with proper usage of personal protective equipment. The programs should include emergency spill, decontamination and clean-up procedures. A respiratory protection program as specified in 29 CFR 1910.134 should be established. Approved type respirators must be worn during TDI transfer/unloading operations, spills, maintenance on chemical tanks, lines, and exhaust ducts. Clean, sanitized, NIOSH approved respirators should be available each day for those who want to use them, particularly saw/paper take-off personnel and backroom runners. (The sampling data did not indicate excessive exposures; thus, mandatory respirator usage cannot be fully justified. However, if health problems or complaints develop, the usage must be mandatory until the situation is re-evaluated or until ventilation modifications can be instituted.) Employees who enter the Dorsey Warehouse must wear respirators until the DMAPN concentrations have been further diluted. "Airing" out the warehouse will expedite the removal of the contaminants.

3. Complete sets of Material Safety Data Sheets and supplemental toxicology information should be acquired and maintained on each substance and first-aid procedures outlined.

4. Institution of a preplacement and periodic medical evaluation program, as outlined in the NIOSH criteria documents for TDI and cotton dust, should be established. Of particular importance are the following:

a. Medical history - paying particular attention to any respiratory symptoms and allergies.

b. 14" X 17" chest roentgenogram.

c. White blood cell count with differential and an absolute eosinophil count.

d. Pulmonary function testing which includes forced vital capacity (FVC) and forced expiratory volume at one second (FEV).

5. Clear plexiglass®, (or other similar material) hinged covers (panels) could be added to the foam line canopy hoods along the entire process, including downstream of the saws. Each piece should seal at its side intersections. This would facilitate containment of vapors and help the exhaust ventilation function more adequately, and yet the product flow could be observed and, when necessary access, would not be impeded. The plexiglass® panels must be kept clean. Also the exhaust duct work should have the "Y"-branches higher and the ducts attached to every other canopy section; thus, an even distribution of exhaust would be achieved.

6. Additional makeup air should be added to the backroom and saw area. The air supplied could be distributed through a slotted plenum, and in the saw area should be located behind the operator. Consult an industrial ventilation manual or consultant prior to any major modifications. (See Figure 1 for an example of possible solutions.) Also the bun stacking scheme should be changed to facilitate air flow and prevent pocketing of contaminants.

7. Institute longer curing times. A full eight hours should be adequate.

8. Consider the other recommendations outlined in the NIOSH, SHEFS 2 Report April 27, 1978. (Attached as Appendix D)

9. The vacuum compressor exhaust should be piped outside. This will eliminate a contamination generation site.

10. Environmental sampling should be conducted if ESN produced foam is peeled. Such operations should be done on a limited basis to characterize and limit possible exposures to residual DMAPN. Employees must wear gloves and NIOSH approved respirators during the trial runs until it is determined if DMAPN is present.

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VI. ACKNOWLEDGMENTS

Originating Office:	Jerome P. Flesch, Act. Chief Hazard Evaluations and Technical Assistance Branch Cincinnati, Ohio
Environmental Evaluation:	Richard J. Costello, C.I.H., P.E. James P. Price, M.S. Industrial Hygienists Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch Cincinnati, Ohio
	John Love Chemical Engineering Student Trainee Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch
NIOSH Medical Monitor:	Theodore W. Thoburn, M.D. Medical Officer Medical Section Hazard Evaluations and Technical Assistance Branch Cincinnati, Ohio

Medical Coordinator:	Elizabeth Allen Baltimore City Hospitals Baltimore, Maryland
Medical Evaluation:	Debra Wertheimer, M.D. John Burton, M.D. Matthew Fine, M.D. Jack Nissim, M.D. Gary Paxton, C.P.P.A. Edward Schafer, M.D. Frank Chatham, M.D. Franca Freedman Baltimore City Hospitals Baltimore, Maryland
	Surry Kent Geri Reath Susan Bietila, R.N. John Molinaro Vicki Loden Donald Milton John Hopkins University Baltimore, Maryland
Laboratory Analysis:	Ardith Grote Spencer Ball Joe Lebrizzi Carole Perry Christine Dorsey Chemists Measurement Support Section Measurement Support Services Branch Cincinnati, Ohio
Technical Information Assistance:	Robert M. Delmage Technical Information Specialist Information Retrieval and Analysis Section Cincinnati, Ohio
Report Typed By:	Marie A. Holthaus Clerk Typist Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch Cincinnati, Ohio

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Table I

Results of Air Sampling for TDI*

Wm. T. Burnett Company
Jessup, Md.

April 13, 1978

TA 78-33

Environmental Conditions - Indoors - Temperature 60-77°F, Relative Humidity = 35% Time 2256-2345

Sample No.	Time	Description	Results (mg/M3)[1] Total TDI*	TWA[2]
TDI-2	0830 - 1125	Foam Operator Personal Sample (P.S.)	0.022	0.009
TDI-3	1325 - 1331	Breathing Zone No. 9 Peeler Quality Control	3.840	0.048
TDI-4	0835 - 1540	Saw Operator P.S.	0.004	0.003
TDI-5	0837 - 1542	Holeborer Backroom P.S.	0.003	0.003
TDI-6	1235 - 1340	Peeler #8 P.S.	0.092	0.013
TDI-8	0845 - 1145	Run Crew Poleman Backroom P.S.	0.010	0.004
TDI-9	1030 - 1537	Peeler #3 P.S.	0.005	0.003
31A	0753 - 1550	Foam Operator P.S.	0.005	0.005
32A	0757 - 1535	Activator Man P.S.	0.011	0.010
33A	0748 - 1600	Area Sample Drum Area Near Bridge	0.012	
34A	0810 - 1557	Paper Take-off P.S.	0.212	0.206
35A	0820 - 1608	Saw Operator P.S.	0.015	0.014
36A	0825 - 1605	Duplex Machine Operator P.S.	0.003	0.003
39	0835 - 1555	Paper Starter P.S.	0.050	0.046
TDI-100	0830 - 1647	General Area Sample by TDI Tanks in Bridge Area	0.002	
TDI-101	0830 - 1201	Material Handler - Tank Truck Unloader P.S.	0.034	0.015
TDI-102	0841 - 1636	Quality Control Man P.S.	0.004	0.004
TDI-103	0843 - 1150	Saw (Cutter) Man P.S.	0.036	0.014

*Toluene Diisocyanate

1 Approximate milligrams of substance per cubic meter of air sampled

2 Calculated eight hour time weighted average based on sample period and assuming no other exposure.

The NIOSH Recommended Criteria for Occupational Exposure to TDI is 0.036 mg/M^3 as an 8-hour TWA daily exposure or 0.14 mg/M^3 as a twenty minute ceiling.

Table II

Results of Air Sampling for TDI*

Wm. T. Burnett Company
Jessup, Md.

May 5, 1978

TA 78-33

Environmental Conditions: Indoors, Temperature 71°F, R.H. = 50%, 1223 Hour

Sample No.	Time	Description	Results (mg/M^3)[1] TDI
TDI-200	0845-1655	Personal Sample (P.S.) Quality Control Peeler Operator	N.D.[2]
TDI-201	0830-1647	P.S. Peeler Operator #8	N.D.
TDI-202	0847-1649	P.S. Peeler Assistant #8	N.D.
TDI-203	0850-1635	P.S. Quality Control Helper	N.D.
TDI-204	0950-1534	P.S. Paper Take Off - Miscellaneous Task	N.D.
TDI-205	0957-1522	P.S. Cutter Operator	N.D.
TDI-206	1017-1518	General Area Backroom	N.D.
TDI-207	1001-1008	Breathing Zone Quality Control Peeler	N.D.
TDI-208	1157-1204	Breathing Zone Quality Control Peeler	N.D.
TDI-258	1540-1735	P.S. Cutter Operator	N.D.

*Toluene Diisocyanate
1. Approximate milligrams of substance per cubic meter air
2. Not Detected: The limit of detection for these samples was 0.2 ug TDI/ml absorption media.

The NIOSH Recommended Standard for Occupational Exposure to TDI is 0.036 mg/M^3 as an 8-hour TWA daily exposure or 0.14 mg/M^3 as a twenty minute ceiling.

Table III A

Results of Air Sampling for Organic Vapors

Wm. T. Burnett Company
Jessup, Md.

April 12-13, 1978

TA 78-33

Environmental Conditions: Indoors, Temperature 60-77°F, R.H. = 35%, Time: 2256-2345

			Results (mg/M³)												
Sample Number	Time	Description	A-H[9]	TCE[10]	TCEE[11]	Acetone	C.P.[1]	M.C.[2]	IPA[3]	NEM[4]	NMM[5]	Toluene	DMP[6]	DMAPN[7]	A-99[8]
CT-1	0830-1673	General Area (G.A.) Compounding	-	-	-	-	-	-	1.1**	21	-	0.43	1.5	-	-
CT-68	0803-1557	Personal Sample (P.S.) Backup Activator (Bush)	-	-	-	4.2	-	28	-	-	-	-	-	-	-
CT-101	0850-1636	P.S. Activator	-	-	-	-	-	-	-	25	-	-	21	-	-
CT-200	0905-1647	G.A. Chemical Storage Tank Area	-	-	-	-	0.43	-	-	10	0.43	0.22	2.0	-	-
CT-100	0840-1646	G.A. Foam Cutting Area	-	-	-	-	-	-	0.43**	17	+***	0.21	9.1	-	-
CT-400	1737-2043	G.A. 2nd Shift Backroom	-	-	-	-	-	-	-	3.8	-	-	2.8	-	-
CT-104	0843-1535	P.S. Backroom Runner	-	-	-	-	-	-	-	35	-	-	5.7	-	-
CT-402	1828-2332	P.S. Backroom Holeborer Operator	-	-	-	-	-	-	1.6	5.0	-	-	-	-	-
CT-201	0901-1703	G.A. Vacuum Compressor Area	-	-	-	-	-	-	-	2.7	-	-	0.21	-	-
CT-401[12]	1800-2347	P.S. Peeler #22 Operator	-	-	-	-	-	-	-	3.0	-	-	-	-	-
CT-102[12]	0838-1325	P.S. Peeler #7 Operator 84"	-	-	-	-	-	-	-	25	-	-	2.1	-	-
CT-103	0847-1210	P.S. Quality Control Helper	-	-	-	-	-	-	-	12	-	-	-	-	-
CT-300	1023-1813	G.A. Dorsey Road Warehouse	2.8	0.64	2.1	-	0.43	-	-	26	-	0.43	-	11	-
SG-300	1023-1813	G.A. Dorsey Road Warehouse	-	-	-	-	0.32	-	-	17	-	-	-	9.1[7]	-
PP-300**	1023-1813	G.A. Dorsey Road Warehouse	-	-	-	-	-	-	-	1.8	-	-	-	1.6	0.07

*Approximate milligrams of substance per cubic meter of air
**Minimum amount present due to possible breakthrough on backup section of tube
***Trace detected

1. Cyclopentanone
2. Methylene Chloride
3. Isopropyl Alcohol - Estimated concentration
4. n-Ethyl Morpholine
5. n-Methyl Morpholine - Estimated concentration
6. Dimethyl Piprazine
7. Dimethyl Amino Propionitrile - No desorption efficiency determined for substance on silica gel, so value must be taken as minimum concentration present.
8. Bis(2-(dimethylamino)ethyl) ether
9. Aliphatic Hydrocarbons
10. 1,1,1-Trichloroethane
11. Tetrachloroethylene
12. Pump failed

TABLE III B

Results of Air Sampling for Organic Vapors
Sampling Medium: Silica Gel

Wm. T. Burnett Company
Jessup, Md

April 12-13, 1978

TA 78-33

Environmental Conditions: Temperature 60-77°F, R.H. = 35%, Time 2256-2345

Sample Number	Time	Description	Results (mg/M³)* Cyclopentanone	NEM[1]	Form[2]	Prop[3]
SG-2	0830-1125	Personal Sample (P.S.) Foam Operator (Bridge)	0.57	4.6		
SG-100	0840-1646	General Area (G.A.) Foam Cutting Area	1.2	26		
SG-200	0905-1647	G.A. Chemical Storage Area	1.2	16		
SG-10	0840-1615	G.A. Backroom First Shift	1.1	14		
SG-5	0837-1542	P.S. Backroom Hole Borer	1.2	13		
SG-8	0845-1527	P.S. Backroom Running Crew - Poleman	1.2	19		
SG-104	0843-1536	P.S. Backroom Runner	1.2	27		
SG-400	1737-2330	G.A. Backroom	1.1	12		
SG-402	1825-2343	P.S. Hole Borer Operator	N.D.[5]	12		
SG-201	0901-1703	G.A. Vacuum Compress Area	--	--		
SG-401	1802-2342	P.S. Peeler #8 Operator	N.D.	9.2		
SG-103	0840-1534	P.S. Peeler #4 Operator	N.D.	6.1		
SG-102[4]	0843-1150 1325-1559	P.S. Saw Operator	N.D.	6.7		
SG-101	0841-1636	P.S. Quality Control Operator	1.2	26		
SG-4	0835-1540	P.S. Saw Operator	1.1	12		
NaS	1606-1737	G.A. Fresh Urethane Plume Saw Area			0.52	3.6

* Approximate milligrams of substance per cubic meter air

1 n-Ethyl Morpholine

2 Formaldehyde

3 Propionaldehyde

4 Pump off during medical examination

5 Not detected - the limit of quantification for these samples was 0.05 mg/sample

TABLE IV A

Pesults of Air Sampling for Organic Vapors

Wm. T. Burnett Company
Jessup, Md.

May 5, 1978

TA 78-33

Environmental Conditions: Indoors, Temperature 71°F, R.H. = 50%, Time 1223

Sample Number	Time	Description	Results (mg/M³)* DMAPN[1]	DMP[2]	NEM[3]	NEM & DMP[4]
PP-200A**	1017-1328	General Area - Backroom fresh foam line	--	0.68	1.3	--
PP-200B**	1130-1518	General Area - Backroom fresh foam line	--	1.1	3.8	--
SG-26A	1017-1328	General Area - Backroom fresh foam line	--	--	--	13
SG-26B	1129-1518	General Area - Backroom fresh foam line	--	--	--	5.0
SG-28	1331-1518	General Area - Backroom fresh foam line	--	--	--	6.2
SG-30	1333-1519	General Area - Backroom fresh foam line	--	--	--	7.6
PP-203	0831-1641	Personal Sample (P.S.) Saw group leader	--	3.5	6.2	--
PP-204**	0835-1528	P.S. Hole Borer Operator	--	1.8	5.5	--
PP-205	0840-1722	P.S. Saw Operator	--	8.0	13	--
PP-206	0836-1553	P.S. Backroom hot foam stacker	--	2.5	4.2	--
PP-207**	0845-1554	P.S. Backroom hot foam stacker runner	--	3.6	6.2	--
PP-208**	0846-1550	P.S. Backroom hot foam stacker runner	--	4.0	6.0	--
SG-200[5]	0856-1552	P.S. Backroom hot foam stacker runner	--	--	--	12
PP-200	0847-1655	P.S. Quality control operator	--	12	28	--
PP201[5]	0825-1226 1316-1649	P.S. Peeler #8 Operator (rewinding)	--	2.1	1.6	--
PP-202	0826-1647	P.S. Peeler #8 helper	--	3.3	1.9	--
PP-209**	1401-1558	G.A. Dorsey Road Warehouse	1.7	N.D.[6]	2.9	--
SG-209	1401-1558	G.A. Dorsey Road Warehouse	5.7	--	--	14
PP-210	1401-1558	G.A. Dorsey Road Warehouse	6.2	N.D.[6]	11	--
PP-500	1622-1703	G.A. Jessup Warehouse #2	--	N.D.[6]	N.D.[6]	--

			Methylene Chloride
CT-300	1333-1709	G. A. Activator Room (Jessup)	1.1

* Approximate milligrams of substance per cubic meter air.

** Values must be considered as minimum since breakthrough may have occurred.

1 Dimethylamino propionitrile,

2 Dimethyl piperazine: No desorption efficiency was determined on porous aromatic polymer so values must be considered as minimum.

3 n-Ethyl Morpholine.

4 GC column failed and did not separate NEM from DMP. Since GC/MS analyses showed the major component desorbed from silica gel was NEM, results are reported based on NEM. No desorption efficiency for DMP on silica gel was determined.

5 Pump failed.

6 Not Detected: The limit of quantification for these samples was 0.02 mg/sample.

TABLE IV B

Results of Swipe Samples for Surface Contamination

Wm. T. Burnett Company
Jessup, Md.

May 5, 1978

TA 78-33

Environmental Conditions: Indoors, Temperature 71°F, R. H. = 50%, Time 1223

Sample Number	Time	Description	(mg/filter)* A99[1]	DMAPN[2]	DMP[3]	NEM[4]
SS-100	1136	Conveyor along back wall - backroom	<0.02	<0.02	<0.02	0.03
SS-101	1137	Rollers at corner between saw and backwall	<0.02	<0.02	<0.02	0.05
SS-102	1139	Conveyor between cutter #2 and rollers at corner	<0.02	<0.02	<0.02	0.03
SS-103	1142	Conveyor between cutter #1 and cutter #2	<0.02	<0.02	--	--
SS-104	1350	Hood over area where fresh foam labeled (after saw #1)	1.9	0.04	0.18	0.04
SS-105	1400	Side of ventilation duct above foam stream (bridge area)	<0.02	<0.02	<0.02	<0.02

* Approximate milligrams of substance per swipe filter.

1 Bis (2-(dimethylamino)ethyl)ether

2 Dimethylamino propionitrile.

3 Dimethyl piperazine.

4 n-Ethyl Morpholine.

Table V

Results of Organic Contaminant Analysis

Wm. T. Burnett Company
Jessup, Md.

TA 78-33

A. Organic Vapor Monitor Analysis

Location	Time	Reading(ppm)*
Cafeteria	1652	6.8-8
Compounding Room	1657	10
Activator Area - Bridge	1659	8
Cleaning Area - Background	1700	20-30
Chemical Storage - By Foaming Line	1702	10-15
Saw Area - Fresh Cut Foam	1704	30-60(peak)
Saw Area - Background	1705	20-25
Back Room - Fresh Cut Black Foam	1706	180
Back Room Area - Blue White Foam	1707	20-25
Peeler - Black Foam (Warm)	1715	15-20
Peeler - Background	1716	12-14
Vacuum Compressor - Black Foam	1718	12-14
Back Room - Baler	1720	14
Back Room - Fresh Blue Foam Stacked	1720	25-40
Back Room - Cold Black Foam Stacked	1721	20
Back Room - Background	1722	12-14

B. Urethane Bulk Samples

Sample Type	Description	DMAPN[1]	A-99[2]	NEM[3]
Foam Lot 284	Unpeeled Foam Sample Produced 3/28-29/78	+[4]	--	--
Foam Lot 281	Unpeeled Foam Sample Produced 3/28-29/78	+[4]	--	--
Foam Lot 284, #37	57" White 100 Foam Peeled 1200 noon 4/18/78 Produced 3/28-29/78	+[4]	--	--
Bulk #1000	Random Sample Cut From Bulk Foam Lot #284 #37	+[5]	--	--
Bulk #1000A	Random Sample Cut From Bulk Foam Lot #284 #37	+[5]	--	--
Bulk #1000B	Random Sample Cut From Bulk Foam Lot #284 #37	+[5]	--	--
Bulk Green	Green 319 Lot #204 Block #228 Produced 1/1/78-2/24/78	+[5]	--	--

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* Approximate parts per million total organics - not used to identify specific substances.

1 Dimethylamino propionitrile

2 Bis(2-(dimethylamino)ethyl) ether

3 n-Ethyl Morpholine

4 Detected via extraction - not quantitated

5 Liquid extraction from foam - considerably less than 50 ug/sample with a limit of detection of ≈ 10 ug/ml desorption solution.

Table VI

Examined Employee Demography Data by Job Area

Wm. T. Burnett Company
Jessup, Md.

TA 78-33

Jessup	# Examined	Average Year of Birth*	S.D.	Year of Hire	S.D.	Female	#Who Had Been in Back Room	Average Time Exposed to Warm Foam	S.D.	Average Amount of Alcohol Consumed	S.D.
Job Area 1	7	46.7	10.1	73	5.1	-	0	5.2	8.2	4	1.8
Job Area 2	7	46.4	11.8	71.1	7.5	-	3	15.4	12.1	5	3.6
Job Area 3	13	44.5	11.6	75.9	2.1	-	10	13.5	10.5	3	1.7
Job Area 4	7	53.5	6.9	77.2	0.9	-	3	7	9.7	1.7	2.1
Job Area 5	63	47.5	9.4	76.4	7.21	-	2	17.8	7.05	2.4	2.9
Job Area 6	5	44.6	15.5	71	10.0	-	0	24.2	1.7	2.6	1.5
Job Area 7	5	46.6	12.1	76.4	1.5	-	0	3.2	6.6	3.6	2.7
Job Area 8	9	51.6	4.6	68.2	23.4	-	0	5.7	8.6	2.6	2
Job Area 9	6	40.4	9.9	73	2.5	-	0	0	0	2.8	1.6
Job Area 10	3	39	13	72	4.5	-	2	14	12.7	1.6	1.1
Job Area 11	16	41.5	13.5	73.2	8.6	2	1	3.3	1.8	1.8	1.3

*Average year of birth - i.e., 46.7 = 1946.7

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Table VII

Medical Questionnaire Results

Wm. T. Burnett Company
Jessup, Md.

TA 78-33

Jessup	Total # in Area	Skin		Throat		Eye		Bronch.[1]		Cough		Wheezing		Tightness		Work Related[2]		Dyspnea		Bad Taste in Mouth	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Job 1	7	7	100	4	57	7	100	1	14	3	43	6	86	6	86	5	71	1	14	5	71
Job 2	7	6	86	6	86	7	100	0	0	2	29	4	57	5	71	5	71	0	0	4	57
Job 3	13	7	54	7	54	13	100	0	0	2	15	6	46	10	77	9	69	1	8	4	31
Job 4	7	3	43	1	14	7	100	0	0	3	43	1	14	2	29	2	29	0	0	4	57
Job 5	63	43	68	22	35	55	87	1	2	17	27	30	48	35	56	25	40	4	6	25	40
Job 6	5	4	80	3	60	5	100	0	0	3	60	4	80	3	60	3	60	0	0	1	20
Job 7	5	2	40	2	40	4	80	0	0	1	20	1	20	1	20	1	20	0	0	3	60
Job 8	9	7	78	1	11	8	89	1	11	4	44	3	33	4	44	2	22	0	0	4	44
Job 9	6	2	33	1	17	5	83	2	33	2	33	2	33	3	50	1	17	0	0	1	17
Job 10	3	2	67	0	0	2	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Job 11	16	9	56	6	37	11	68	0	0	5	31	7	43	10	60	7	43	0	0	8	50
Total	141	92	65	55	39	113	80	5	4	42	30	64	45	79	56	60	43	5	4	58	41

1. Bronchitis
2. Work Related Symptoms

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Table VIII

Medical Questionnaire Results

Wm. T. Burnett Company
Jessup, Md.

TA 78-33

Jessup	Total # in Area	CNS 1 #	CNS 1 %	Weak 2 #	Weak 2 %	Par. 3 #	Par. 3 %	Head 4 #	Head 4 %	Sleep 5 #	Sleep 5 %	Retention #	Retention %	Frequency #	Frequency %	Sex #	Sex %	Constip. 6 #	Constip. 6 %
Job 1	7	5	71	1	14	2	28	1	14	2	28	5	71	0	0	5	71	0	0
Job 2	7	5	71	0	0	3	42	2	28	3	42	6	85	0	0	4	57	0	0
Job 3	13	9	69	4	31	4	31	2	15	5	38	10	76	0	0	4	31	3	23
Job 4	7	3	42	1	14	0	0	1	14	1	14	3	42	0	0	0	0	1	14
Job 5	63	32	50	15	23	13	29	22	34	17	26	39	61	2	3	21	33	6	10
Job 6	5	3	60	2	40	2	40	2	40	3	60	4	80	0	0	3	60	1	20
Job 7	5	1	20	1	20	0	0	1	20	0	0	1	20	0	0	1	20	0	0
Job 8	9	3	33	1	18	1	18	3	33	3	33	5	55	0	0	3	33	0	0
Job 9	6	3	50	3	50	2	33	2	33	3	50	3	50	0	0	0	0	0	0
Job 10	3	0	0	0	0	0	0	1	33	0	0	1	33	0	0	0	0	0	0
Job 11	16	7	43	4	25	5	31	3	18	7	43	7	43	0	0	6	37	2	12
Total	141	71	50	32	22	37	26	40	28	44	31	85	60	2	1	49	35	13	9

1. Central Nervous System
2. Weakness
3. Paresthesia
4. Headache
5. Sleeplessness
6. Constipation

Table IX

Abnormal Medical Findings Among Employees Examined

Wm. T. Burnett Company
Jessup, Md.

TA 78-33

Job #	# Examined	Respiratory #	Respiratory %	G. U.[1] #	G. U.[1] &	Neurological #	Neurological %	Hypertension #	Hypertension %	Other #	Other #
1	7	1	(14)	1	(14)	1	(14)	0	0	2	(28)
2	7	0	0	1	(14)	0	0	0	0	5	(71)
3	13	0	0	3	(23)	2	.15	1	(08)	7	(54)
4	7	0	0	1	(14)	0	0	0	0	3	(42)
5	63	1	2%	6	(10)	2	3	1	2	20	32.7
6	5	0	0	0	0	1	20	1	20	3	60
7	5	0	0	1	20	1	20	0	0	2	40
8	9	1	11	1	11	3	33	0	0	6	66
9	6	1	16	0	0	0	0	0	0	1	16
10	3	1	33	0	0	0	0	0	0	2	66
11	16	1	6	4	25	2	12	3	18	5	31
TOTAL	141	7	4%	20	14%	16	11%	9	6%	60	43%

1. Genito-Urinary

Table X

Examined Employee Demography Data by Job Area

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

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Bush Street	# In Area	Average Year of Birth*	S. D.	Year of Hire	S.D.	Female	# of Months in in Back Room	Average Time Exposed to Warm Foam	S.D.	Average Amount Alcohol Consumed	S.D.
Job I	8	48.1	12.9	72.5	6.9	0	0	3.7	1.9	3.1	1.2
Job II	3	40.5	6.3	66	8.1	0	0	13	35	1	1
Job III	6	50.7	7.1	76.4	8.7	0	0	13.2	3.6	3.6	1.9
Job IV	14	41.4	6.4	70.7	8.4	7	0	19	4.3	3.3	1.8
Job V	10	53.8	7.3	75.4	8.6	0	0	14.7	3.8	5.9	2.4
Job VI	2	53	7.3	77	8.8	0	0	0	0	5	2.2
Job VII	8	38.8	6.2	70	3.4	0	0	0	0	2.1	1.5
Job VIII	9	41.6	6.4	[illegible]3.5	7.9	0	0	0	0	3.6	1.9
Job IX	5	50.2	7.1	77	8.8	0	0	0	0	2.5	1.6
Job X	10	35.8	5.9	67.1	8.2	1	0	0	0	4.3	2.1

*Average year of birth - i.e., 48.1 = 1948.1

Table XI

Medical Questionnaire Results

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

Bush Street	Number Examined	Skin		Throat		Eyes		Chronic Bronchitis		Cough		Wheeze		Tightness		Work Related		Severe Dyspnea		Bad Taste	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	8	4	50	2	25	5	62	0	0	4	50	1	12	2	25	3	37	0	0	1	12
2	3	1	33	1	33	2	66	0	0	0	0	0	0	0	0	0	0	0	0	1	33
3	6	2	33	0	0	5	83	0	0	3	50	2	33	2	33	2	33	0	0	3	50
4	14	11	78	2	14	10	71	3	21	4	29	6	42	6	42	5	35	1	7	6	42
5	10	3	30	5	50	5	50	0	0	2	20	3	30	2	20	2	20	0	0	3	30
6	2	0		0	0	2	100	0	0	1	50	2	100	1	50	1	50	0	0	1	50
7	8	1	12	1	12	2	25	0	0	0		4	50	3	37	2	25	0	0	1	12
8	9	1	11	0	0	1	11	0	0	2	22	2	22	1	11	0		0	0	0	0
9	5	4	80	1	20	1	20	0	0	1	20	1	20	2	40	1	20	0	0	0	0
10	10	5	50	2	20	3	30	1	10	4	40	3	30	4	40	1	10	0	0	3	30
TOTALS	75	32	43	14	19	36	48	4	5	21	28	21	28	23	31	17	23	1	1	17	23

Table XII

Medical Questionnaire Results

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

Bush Street	Number Examined	CNS[1]		Weakness		Paresthesia		Headache		Sleep		Retention		Frequency		Sex		Constipation	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	8	1	12	0	0	0	0	1	12	0	0	0	0	1	12	1	0	0	12
2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	6	1	16	0	0	0	0	3	50	0	0	1	16	0	0	2	33	2	33
4	14	3	21	1	7	0	0	5	35	1	7	1	7	0	0	0	0	0	0
5	10	4	40	0	0	0	0	2	20	1	10	0	0	0	0	0	0	0	0
6	2	1	50	0	0	0	0	0	0	0	0	0	0	0	0	1	50	0	0
7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	9	0	0	1	11	0	0	2	22	0	0	1	11	0	0	0	0	0	0
9	5	1	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	10	4	40	2	20	1	10	1	10	1	10	3	30	0	0	2	20	1	10
TOTAL	75	16	21	4	5	1	1	14	19	3	4	6	8	1	1	6	8	3	4

1. Central Nervous System

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Table XIII

Abnormal Medical Findings Among Employees Examined

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

Bush Street	# Examined	Respiratory		G.U.[1]		Neurological		Hypertension		Other	
		#	%	#	%	#	%	#	%	#	%
1	8	1	12	0	0	1	12	1	12	3	37
2	3	0	0	0	0	0	0	0	0	1	33
3	6	0	0	1	16	0	0	1	16	0	0
4	14	3	21	1	7	1	7	3	21	7	50
5	10	3	30	0	0	0	0	0	0	3	30
6	2	0	0	0	0	0	0	0	0	1	50
7	8	3	37	0	0	0	0	1	12	1	12
8	9	0	0	1	11	0	0	1	11	1	0
9	5	0	0	0	0	0	0	0	0	1	20
10	10	0	0	1	10	1	10	0	0	6	60
TOTAL	75	10	13	4	5	3	4	7	10	21	28

1. Genito-Urinary

Table XIV

Laboratory and Pulmonary Function Test Results

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

A. Number of Workers with Abnormal Laboratory Findings

		# Examined	# Abnormal[1]	%
Blood Tests	Jessup	118	35	29%
	Bush Street	70	17	24%
Urinalysis	Jessup	155	13	9%
	Bush Street	70	8	11%

B. Number of Workers with Definitely Abnormal Pulmonary Function Tests (PFT's)

Plant Location	Number of Workers in Plant	Number Participating in Study		Abnormal PFT's	
	#	#	%	#	%
Jessup	151	139	92	35	25
Bush Street	83	75	90	14	19
Total	234	214	91	49	23

1. Not considered significant or occupationally related.

Table XV

Results of Medical Findings by Date of Hire

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

	1977	1978 Jan, Feb	1978 March	Total
Affected[1]	32	4	1	37
Not Affected	91	4	9	104
Total	123	8	10	
	26%	50%	10%	26%

1. Reported or diagnosed urological effects.

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Table XVI

Comparison of Medical Results, Work Area, and Employment Period

Wm. T. Burnett Company
Baltimore, Md.

TA 78-33

Table XVI A Number Who Had Worked in Back Room During 2/76 through 2/78

	In Back Room	Not In Back Room	Total
Affected[1]	18	67	85
Not Affected	3	53	56
Total	21	120	141
% Affected	85%	55%	60%

Table XVI B Number Who Had Worked in an Area with Exposure to Warm Foam

	In Areas 2 - 6	Not In Areas 2-6	Total
Affected	73	12	85
Not Affected	27	29	56
Total	100	41	141
% Affected	73%	29%	60%

Table XVI C Number Hired During Each Time Period

Date of Hire	≤ 77	Jan. & Feb. 1978	March 1978	Total
Affected	79	6	0	85
Not Affected	44	2	10	56
Total	123	8	10	141
% Affected	64%	75%	0%	60%

1. Reported or diagnosed urological effects.

APPENDIX A

Workplace Job Code Numbers and Descriptions

Wm. T. Burnett Company
Baltimore, Maryland

TA 78-33

I. JESSUP, MARYLAND

Job Area	Code Number	Job Classification
Activation Area - Bridge	1	Activator, Ass't. Activators, Chemical Handler, Foamer Operator, Ass't. Foamer Operators
Lower End - Saw	2	Paper Take-off, Saw Operator, Ass't(s) Saw Operator
Hole Borer - Back Room	3	Hole Borer Machine Operator
Material Handler - Back Room	4	Material Stackers, Poleman, Run Crew Foreman
Peeling Area	5	Large and Small Peeler Machine Operators, Ass't(s) Large & Small Peeler Machine Operators
Quality Control Peeling Operation	6	Quality Control, Ass't(s) Quality Control
Compressing Area	7	Mechanical & Vacuum Compress Operator, Ass't(s) Mechanical & Vacuum Compress Operator
Shipping & Handling Area	8	Shipper, Ass't(s) Shipper
Maintenance	9	Maintenance Personnel
Baler Operation - Back Room	10	Baler & Lift Truck Operator
Other	11	Janitor, Office Personnel, & Other Company Personnel

APPENDIX A (CONTINUED)

II. BUSH STREET BUILDING

Job Area	Code Number	Job Classification
Bridge	1	Activator, Ass't Activator(s), Foamer Operator, Ass't Foamer Operator(s), Chemical Handler
Duplex	2	Duplex Machine Operator, Ass't Duplex Machine Operator(s)
Lower End	3	Paper Take-off, Saw Operator, Ass't Saw Operator(s)
Fabricating	4	Punch Press Operator, Ass't Punch Press Operator(s)
Peeler	5	Large & Small Peeler Machine Operator, Ass't Large & Small Peeler Machine Operator(s)
Machine Shop	6	Maintenance Personnel, Machine Operator
Batting, Cotton	7	Machine Operator, Ass't Machine Operator(s)
Offices	8	Various Office Personnel
Labs	9	Laboratory Personnel, Ass't Laboratory Personnel, Laboratory Technician(s)
Other	10	Janitor, and Other Company Personnel

APPENDIX B

Compounds Identified by GC*/MS**

Wm. T. Burnett Company
Baltimore, Md.

TA-78-33

Sample	Compounds Identified
SG-209	NEM[1], DMAPN[2]
PP 200B	NEM[1], 1,4-dimethylpiperazine
PP 210	NEM[1], DMAPN[2]
SG-26A	NEM[1], 1,4-dimethylpiperazine
SS-104	NEM[1], 1,4-dimethylpiperazine, A-99[3]
Bulk NEM	(Run to obtain mass spectrum for comparison)
CT-1 (back)	NEM[1], Isopropanol
CT-68	Acetone, Methylene Chloride
CT-100	Toluene, N-methylmorpholine, 1,4-dimethylpiperazine, NEM[1]
CT-104	1,4-dimethylpiperazine, NEM[1]
CT-200	Toluene, 1,4-dimethylpiperazine, NEM[1], Cyclopentanone, n-methyl morpholine
CT-300	1,1,1-trichloro ethane, cyclopenthanone, toluene, tetrachloroethylene, 1,4-dimethylpiperazine, NEM[1], aliphatic hydrocarbons
SG-300	NEM[1], DMAPN[2]
SG-200	Cyclopenthanone, NEM[1], 1,4-dimethylpiperazine

* Gas chromatography

** Mass Spectrometry

1. n-ethyl morpholine
2. dimethylamino propionitrile
3. bis(2-(dimethylamino)ethyl) ether

APPENDIX C

Desorption Efficiency Studies

Wm. T. Burnett Company
Jessup, Md.

TA 78-33

NEM* Desorption Efficiencies

Media/Desorption Solution	No. of Samples	mg Spiked on Tube	Average Desorption(%)	Range(%)
Charcoal/CS_2	4	2.8	97	94-100
	4	0.03	87	86-89
Silica Gel/Aq.	4	0.02	80	76-88
$CuCl_2$-Acetone	4	0.18	78	76-82
	4	1.8	88	84-93
Porous Polymer/	4	0.02	94	91-96
Aq.$CuCl_2$-Acetone	4	0.18	98	96-99

* n-Ethyl Morpholine

Charcoal Tubes - Carbon Disulfide

Compound	No. of Samples	mg Spiked on Tube	Average Desorption(%)	Range(%)
DMAPN[1]	4	2.6	94	92-97
DMAPN[1]	4	0.03	58	57-59
A-99*[2]	4	2.7	58	53-64
A-99*[2]	4	0.03	Not Detected	

* Peak tails on GC column used for sample analyses

Porous Aromatic Polymer - Aq.$CuCl_2$ - Acetone

Compound	No. of Samples	mg Spiked on Tube	Average Desorption(%)	Range(%)
DMAPN[1]	3	0.02	92	90-94
DMAPN[1]	4	0.04	96	92-98
A-99**[2]	4	0.02	81	70-92
A-99[2]	4	0.05	93	91-96

** Low amount close to detection limit of method (10-20 ug)

1 Dimethylamino propionitrile

2 Bis(2-(dimethylamino) ethyl) ether

APPENDIX D

MEMORANDUM

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

TO : Director, DSHEFS
Through: Acting Chief, HETAB
Chief, IHS, HETAB
Chief, MS, HETAB

DATE: April 27, 1978

FROM : Industrial Hygienist, IHS, HETAB

SUBJECT: SHEFS 2 REPORT: HETAB Project 78-33
William T. Burnett Company

Location #1 - 2112 Montevideo Road
Jessup, Maryland

Location #2 - 1500 Bush Street
Baltimore, Maryland

I. INTRODUCTION/BACKGROUND STATEMENT OF REQUEST

A NIOSH initial medical-environmental evaluation is currently being conducted at the William T. Burnett Company, Baltimore, Maryland, (see SHEFS 1 Report TA 78-33). The company operates two separate facilities which produce polyester urethane.

The urethane operations are similar at both facilities except that the Bush Street plant produces batch specialty foams, gaskets, hair curlers, shoulder pads, etc., from flat slabs of urethane, whereas the Jessup facility produces "cylinders" of urethane foam which are machine peeled, foaming long sheets of urethane of varying thicknesses and colors.

The alledged health problems, reported to the Maryland Occupational Safety and Health Administration (MOSH), included; urinary retention and incompetence, hesitancy and intermittency of urinary stream, painful urination, hematuria, dermatitis, respiratory, visual, neurological and other health complaints. MOSH's initial screening indicated that 69 of 101 interviewed workers, reported bladder/urinary problems.

II. ACTIONS TAKEN TO DATE

An opening conference and walk through survey was performed on April 7, 1978. Numerous literature search requests for suspect chemicals including propionitriles were submitted to NIOSH's Information Retrieval and Analysis Section. On April 11, 1978, the NIOSH medical/environmental evaluation began. The medical evaluation is under the direction of Dr. James Keogh of Baltimore City Hospital.

Information regarding employee demography, products/materials, formulations, ventilation, health and safety policies, etc. have been gathered at both facilities. Chronologies of events and other background information was also obtained from MOSH, the union and Federal OSHA.

Bulk samples of many of the presently used chemicals were obtained in glass scintillation vials. Bulk samples of different foam products, made on different dates with and without ESN were also obtained in sealable plastic bags. A bulk sample of NIAX Catalyst ES was obtained for identification. (Note: This substance was received by the company after all the ESN was eliminated. The ES may be a new formulation of ESN or a mislabeled drum.)

A block of urethane produced with ESN was peeled and a sample obtained from the "core" on April 18, 1978. (This sample simulates how the urethane was normally handled and sold, thus analysis for contamination may help to determine if the material is safe to handle, particularly since the product is used in fabric lamination operations in other industries.)

Both facilities and the warehouse were evaluated environmentally on April 11-14, 1978. Bulk air and personal samples for TDI, amines, morpholines, organic vapors and aldehydes were obtained. Work practices, safety equipment usage, hygiene, etc. were observed. Qualitative ventilation measurements were performed and photographs of each facility's operations were obtained. Organic vapor contamination was qualitatively assessed throughout the Jessup facility with an Organic Vapor Analyzer. A sketch of the Jessup facility was drawn (see attachment).

Medically, as of April 18, 1978, approximately 80 percent of the employees had been evaluated at the Jessup facility. (The medical evaluation has progressed slower than at a similar Massachusetts plant (see SHEFS 1 Report HE 78-68) due to a more prolonged physical examination, interviewer administered questionnaires and pulmonary function tests). All other tests (i.e. bloods, urines) are basically similar to those performed at the Massachusetts facility.

Initial arrangements were made for the medical evaluation of the Bush Street facility.

Maagement and labor were given copies of NIOSH publications, training course schedules, fact sheets, etc.

III. FINDINGS TO DATE

The Burnett Company, located at 1500 Bush Street, originally produced cotton batting. It started producing urethanes, a German development, just after World War II. The company was the first urethane manufacturer in the U.S. and expanded its operations, in approximately 1971, to the Jessup facility. The Bush Street facility first used ESN experimentally in the spring of 1976, on a limited basis before it was used at the Jessup facility. A primary reason for using ESN was that it made a better white foam product and was less irritating than N-ethyl morpholine, which was causing numerous employee complaints.

In September/October, 1977, respirators were issued to employees at Jessup, to help reduce odor/irritation complaints arising from increased production. A four hour ambient temperature cure time for the fresh foam was also instituted. At Jessup, the second and third shifts peel more of the fresh foam and more foam in total than does the first shift. Bush Street peels only a limited quantity of foam, which is produced at Jessup.

The Jessup facility employs 138 hourly and 13 salaried employees, plus one part time office clerk. All the hourly and all but three of the salaried personnel are males.

The Bush Street facility employs 57 hourly and 7 salaried workers. Approximately 10 of the 57 hourly employees and 2 of the salaried employees are female.

All environmental samples have been submitted for analysis. Numerous observations of improper safety equipment usage/storage, work practices and ventilation were noted. Many of the deficiencies were addressed on-site and interim recommendations offered.

The medical team , as of April 18, 1978, had completed approximately 111 employee evaluations. Approximately 30-35 of those examined have been referred, by Dr. Keogh, for follow-up medical evaluations at John Hopkins and/or Baltimore City Hospitals. No other medical findings were available to date.

IV. FUTURE ACTIONS/RECOMMENDATIONS

Upon completion of the medical evaluation at the Jessup facility, the medical team will set up at the Bush Street facility and begin those evaluations. It is anticipated that Jessup will be completed by April 20, 1978, and Bush Street by April 25-26, 1978.

The following interim recommendations are offered to help improve the health and safety conditions of the facility.

1. The Jessup eye wash and safety shower water temperature is too hot. The hot water valve to the mixing chamber should be turned down or off.

2. The eye wash fountain at Bush Street should be cleaned and repaired to improve its performance.

3. The new wall fan in the back room at Jessup should exhaust rather than supply air. Additional makeup air will be required.

4. The shop at Jessup needs exhaust ventilation installed to control welding fumes. The exhaust unit should be used whenever welding is done. Consult a ventilation manual such as NIOSH's Recommended Industrial Ventilation Guidelines Manual.

5. There should not be any recirculating air units in high air contamination areas, as is the case at Bush Street in the Bridge area.

6. A written emergency/spill program should be instituted and employees trained, on each shift, periodically in decontamination/clean-up operations. The program must include proper safety equipment usage procedures.

7. The change room in the chemical storage area should be relocated to an area of less potential contamination. The present shower could be revamped as a second safety shower and left in its present location. The new change room should have shower facilities and lockers and all workers should be encouraged to shower and change clothes after work.

8. Continue enforcing the usage of respirators until the sampling results are received. A decision in respirator usage and additional ventilation will depend on the sampling results. Respirators are needed for spills, thus a comprehensive respirator program as specified in 29 CFR 1910.134 should be established.

9. Rubber and/or plastic impervious gloves and aprons should be provided the activators, tank truck unloader, bridge foamer operators and saw operators. Rubber boots and safety goggles should be provided the activators and tank truck unloader. The back room people should also wear impervious gloves for the present. Neoprene type rubber should be adequate.

10. Materials for TDI decontamination should be located in the storage area and the bridge area. The materials needed are 5-10% aqua ammonia with 10% isopropanol neutralizing solutions and an adsorbent material such as vermiculite. Any wastes from a spill should be dumped into clean barrels with loose fitting lids and placed outside. Any safety equipment used during decontamination procedures will need to be decontaminated and washed after usage.

11. Obtain the NIOSH Criteria Document for TDI for reference and recommendations. (Enclosed is a NIOSH Publications Catalog for information on how and where to order NIOSH publications.)

12. Develop written health and safety programs and instruct all employees of the hazards associated with chemicals used in the facility. Stress personal hygiene and good work practices.

13. The medical employment examination should screen for allergic conditions which may be aggravated by TDI.

14. A member of management responsible for health and safety and a union health and safety representative should attend NIOSH training courses. The courses recommended would be:

    (a) Recognition, Evaluation and Control of Occupational Hazards #549
    (b) Occupational Respiratory Protection #593
    (c) Industrial Ventilation

15. Continue to present voluntary curtailment of ESN usage.

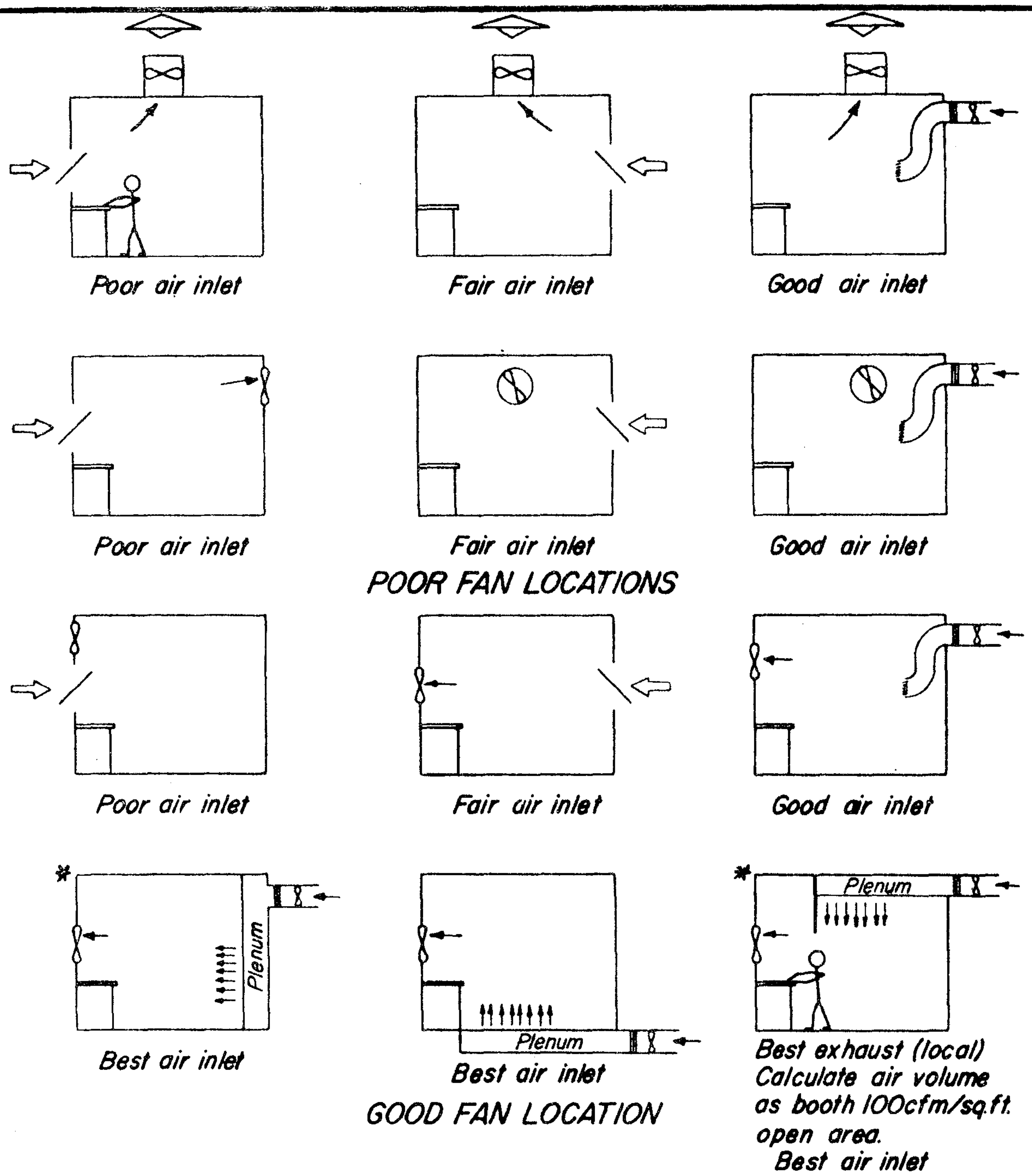
16. Consider a one shift cure time for fresh foam before peeling.

54.

17. Obtain complete sets of Material Safety Data Sheets for each substance used in the facilities.

Gary L. White

Figure I
Excerpted from the American Conference of Governmental
Industrial Hygienists - Industrial Ventilation Manual
TA 78-33



Note:
Inlet air requires tempering during winter months. See Section 7

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

PRINCIPLES OF DILUTION VENTILATION

DATE 1-66 | Fig. 2-1