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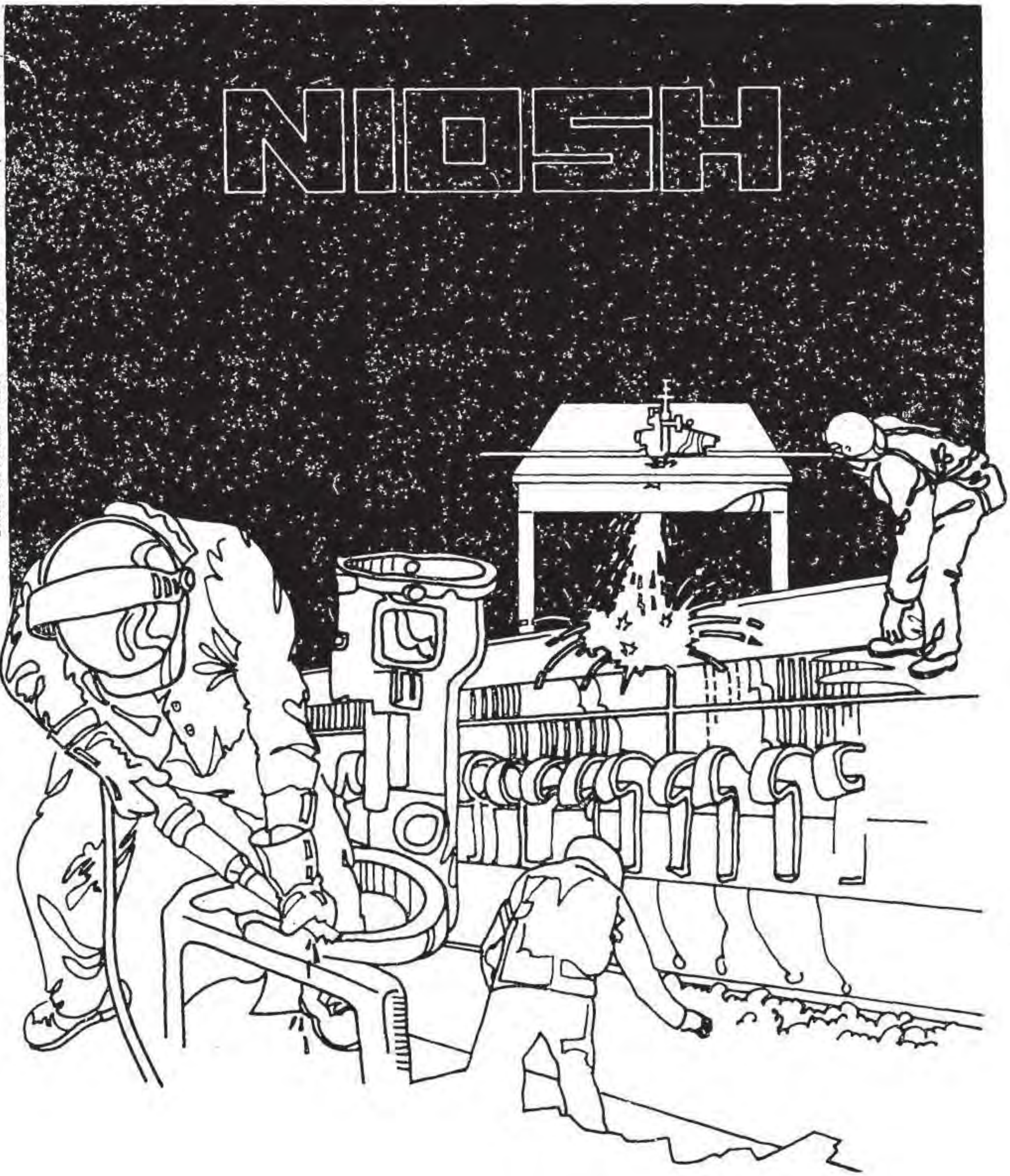

Health Hazard Evaluation Report

HETA 85-159-1827
BLACKMAN UHLER CHEMICAL COMPANY
(SYNALLOY CORPORATION)
SPARTANBURG, SOUTH CAROLINA

PREFACE

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

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

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BLACKMAN UHLER CHEMICAL COMPANY
(SYNALLOY CORPORATION)
SPARTANBURG, SOUTH CAROLINA

NIOSH INVESTIGATORS:
John N. Zey, MS, CIH
Mitchell Singal, MD
A. Blair Smith, MD
Paul E. Caplan, PE, CIH, MPH

I. SUMMARY

On January 30, 1985 the National Institute for Occupational Safety and Health (NIOSH) received a request to assess the incidence of bladder cancer and existing working conditions at Blackman Uhler Chemical Company (a division of the Synalloy Corporation), Spartanburg, South Carolina. NIOSH had previously documented an excess of bladder cancer at a separate Synalloy dye manufacturing facility in Augusta, Georgia.

NIOSH investigators visited the Spartanburg facility on April 18-19, 1985 and September 2-5, 1986 to conduct medical and environmental assessments.

The environmental investigation consisted of collecting short-term air samples for dimethyl formamide (DMF), ortho-dianisidine (ODA) and chromium IV. An assessment was also made of the existing engineering controls, work practices and chemical handling procedures. Concentrations in all air samples were low. Of the air samples collected - one for DMF, four for ODA and one for chromium VI - only the sample for DMF, a 26 minute sample, had a detectable air concentration, 15.6 mg/m^3. This is approximately 50% of the current OSHA PEL of 30 mg/m^3 (as an 8-hour TWA). As the employee had no further exposure to the chemical that day, his 8-hr TWA was 0.83 mg/m^3.

Deficiencies were noted for the company's chemical handling procedures, work practices, engineering controls, and employee training and education.

The medical evaluation consisted of a review of the company's bladder cancer screening program of 919 current and former employees; 689 (75%) had not participated in the program. As of April 1985 the program had identified one case of bladder cancer.

The NIOSH investigators have concluded that while air sample values in the few samples collected were low, improvements are needed in the bladder cancer screening program, as well as in engineering controls, work practices, chemical handling procedures, and employee training and education. Recommendations to improve these programs are made in Section VIII of this report.

Keywords: SIC 286 (Industrial organic chemicals) beta napthylamine, BNA, ortho-dianisidine, dimethlyformamide, DMF, bladder carcinogen, work practices, chemical handling procedures, respiratory protection.

II. INTRODUCTION

On January 30, 1985 the National Institute for Occupational Safety and Health received a confidential request to evaluate chemical exposures at Blackman-Uhler Chemical Company, Spartanburg, South Carolina. The request concerned assessing current working conditions as well as evaluating the incidence of bladder cancer among plant employees. NIOSH had previously documented an excess of bladder cancer in a separate dye manufacturing facility owned by the Synalloy Corporation - parent company for the Spartanburg facility.[1,2]

NIOSH investigators visited the facility on April 18-19, 1985 to conduct an indepth walk-through to assess the potential for chemical exposures and evaluate the company's bladder cancer screening program. A follow-up visit on September 2-5, 1986 was conducted to collect air samples and evaluate existing engineering controls and work practices.

An interim report discussing and making recommendations regarding the bladder cancer screening program was distributed on May 23, 1986. Letters presenting results, recommendations and/or providing status reports were distributed on April 25 and July 19, 1985; April 2 and November 4, 1986; and April 27, 1987.

III. BACKGROUND

Blackman Uhler Chemical company began production in the mid-1950s. The plant consists of 12 buildings, including the office and a canteen (Figure 1). The Canteen includes showers and clean/dirty lockers. Employees are required to wear work uniforms, which they can change into at work or take home and wear the following day. Each employee is provided 11 changes of clothing for a two-week (10-day) work schedule. At the time (1972) of a previous NIOSH walk-through survey of this facility, the plant employed 90 production workers.[3] The number of production workers was down to about 25 during the NIOSH visits in 1985 and 1986. The company currently makes azoic dyes and pigments for the textile industry. They also make special-order water treatment chemicals "Water Chem Division", and just prior to the 1986 visit the company began production of proprietary pesticides. Between 1968 and 1972 the company used beta-napthylamine (BNA), a proven bladder carcinogen, which they received from their Augusta, Georgia facility. During the 1972 NIOSH visit, NIOSH investigators noted that 10-12 employees at the spartanburg plant, were involved in handling BNA.[3] According to the company BNA was never manufactured at the Spartanburg plant.

This plant, as with many chemical plants uses batch production. Due to the type of production, the number of chemicals they can produce, and the cyclic demand of many of the products, the company has used hundreds of chemicals over the years. A list of chemicals supplied to NIOSH included over 700 raw materials, intermediates, and finished products.

Specific areas evaluated as part of the environmental investigation included:

1. Building 2 - Warehouse 1, Repackaging Area

   This warehouse building is divided into three bays, as shown in Figure 2A. The building (approximately 200 ft x 200 ft x 16.5 ft) has a total volume of approximately 660,000 cubic feet. General (dilution) mechanical ventilation is provided to the three bays by means of six ceiling fans, as shown in Figure 2A. Additional mechanical exhaust ventilation is provided by a canopy hood in Bay 1, as shown in Figure 2B.

   In the dumping area, under the canopy hood, various materials, such as naphthals, are packaged and formulated. At the time of the NIOSH visits, no dumping operations were in progress.

   Potential air contamination may be created, in this building, both by dusts, during repackaging operations and by exhaust gases, including carbon monoxide, from the two operating butane fork trucks. These trucks are provided with catalytic convertors, which, if properly maintained, should keep toxic exhaust gas concentrations at a minimum.

2. Building 3 - Department 12 - Print Color Mixing Tanks

   On the ground floor of Building 3, three mix tanks are used to formulate and mix solutions of print colors, as shown in Figure 3A. All colors and emulsifiers (liquid) are manually added to the mix tanks from drums or by overhead tank hoses. Batch mixtures may contain chemicals such as: naphthal (as a powder), liquid caustic soda, soluble dye colors, such as PRTG black, and water. Batching is conducted by a 2-man crew. One batching cycle normally requires 2 hours of mixing.

3. Building 9 - Department 38 - Upstairs Batching Area

In this manufacturing area, seven batch mix tanks are located in parallel, along the west wall, as shown in Figure 4. The room volume (82 ft x 60 ft x 12 ft) is approximately 59,000 cubic feet. Exhaust fans are located in three of the five windows. Solutions, consisting of aqueous ammonia and powdered materials such as titanium dioxide, alto white TE clay, SYN FAC-8210, and dispersing agents, such as ethoxylated phenolic compounds, are mixed with water in these tanks, then filtered to form solutions.

Aqua ammonia is carried in open buckets from a 55-gallon drum to batch mixers as needed. Bags of powdered material, such as the TiO_2 and the TE clay, are removed from a pallet, slit either on the top or along the side of the bag, at the mixer and dumped into a batch mix tank. Empty bags are placed in a waste drum for final disposal. After all ingredients are added to the batch, it is mixed, with a motor driven mixer for approximately 1-1/2 hours.

4. Building 10 - Department 42 - Blue Dispersal Dye Area (Main Floor) and Brown Dispersal Dye Area (Mezzanine Floor)

Blue Dispersal Area - On the mezzanine, liquid dispersal dyes are mixed in six mix tanks. Since dry powders are used only in one tank, it alone is provided with mechanical exhaust ventilation, as shown in Figure 5A. Wet grinding of dye mixtures, using silica sand, produces a slurry, which is screened and sieved to separate the ground dye product from the grinding sand. Dry silica sand (20 to 30 mesh) is added to this wet grinder as needed.

Brown Dispersal Area - On the mezzanine of Building 10, three mixing tanks are used to formulate brown dyes, as shown in Figure 5B. One of these tanks is mechanically exhausted; and a shrouded area is also exhausted where dry dusts are dumped.

IV. METHODS

A. Environmental

During the initial site visit the NIOSH investigator conducted a walk through survey of the various process areas, collected detector tube air samples for ammonia, and asked for information on the identity and amount of chemicals used.

Subsequently a decision was made to return to the facility to conduct limited air monitoring while concentrating on existing engineering controls, work practices, and chemical handling procedures. This decision was based on the following factors.

1. Observations during the initial walk-through survey indicated that physical contact with most chemicals was short-term during activities like adding raw materials to process vessels. This is often the case for batch production operations.

2. Many process areas conduct a wash-down after making a batch. Such practices tend to reduce the build-up of loose material in the upper building structures. Visual observation during the initial visit revealed minimal dust build-up in the upper structure (rafters) of the process areas.

3. Results of a concurrent OSHA investigation during which air samples collected for two suspect carcinogens showed nondetectable levels.

4. Many of the chemicals used at the plant can be absorbed via the skin while others can cause severe skin problems.

5. Usually only 1-2 employees worked in any specific area.

In selecting chemicals for air monitoring, the NIOSH investigators reviewed the list of chemicals and a list of the 15 main chemicals by pounds used per year. Those chosen were selected based on the known toxicity, the relative amount used, the likelihood of exposure, and plant production schedules. Air samples were collected by attaching the sampling media of choice to a battery operated pump. NIOSH sampling and analytical techniques were used for all chemical samples. Table 1 presents sampling and analytical techniques used for the chemicals selected for air monitoring.

Work practices/chemical handling procedures were assessed by spending time in the production areas and observing employee activities.

Quantitative evaluations were made of the engineering controls at several locations in the plant. Air flow velocities and patterns were measured using a Kury Air Velocity meter, model 441, an Alnor Velometer, Jr. and Draeger Smoke Tubes. These locations were:

a. Building 2 - Warehouse/Repackaging Area

b. Building 3 - Department 12 - Print Color Mix Tanks

c. Building 9 - Upstairs Batching Area for Product 38

d. Building 10 - Department 42 - Blue Disperse Area (main floor) and Brown Disperse Area (mezzanine).

Additional qualitative observations were made at other Building work areas, including:

a. Building 6 - Quality Control Lab for testing dye products

b. Building 7 - Bulk Storage Tanks - a closed system where spent nitrating acid (a sulfuric/nitric acid mixture) and 2 ethyl hexanol are processed to make fertilizer (2 ethyl hexyl nitrate) and fuel additives.

c. Building 8 - the Filter Press Room, where alkaline solutions, buffered with muriatic acid, are processed to produce sodium acetate in solution for packaging in 55-gallon plastic drums.

B. Medical

The purpose of the medical investigation was to assess the company's bladder cancer screening program. Specific issues to be addressed included (a) the adequacy of the current screening protocol, (b) the population that should be included in the program, and (c) whether cystoscopy should be used for routine screening. (This procedure was not routinely done, but its inclusion in the screening program had been advocated by some worker representatives).

The evaluation of the company's bladder cancer screening program utilized cytology screening records, obtained during the current investigation, and personnel records obtained during the 1972 survey.

V. EVALUATION CRITERIA

A. Environmental Criteria

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

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Recommended Exposure Limits (REL's) 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards.[5-8] Often, the NIOSH REL's and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

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

B. Specific Chemicals

1. Ortho-Dianisidine

Ortho-dianisidine (ODA) is an analogue of benzidine, a chemical which has been linked to bladder cancer in humans. Clear evidence that ODA causes cancer in humans has not been found. Investigators have observed a carcinogenic effect in rats and hamsters following oral administration of ODA.[9-13] Subsequently, the International Agency for Research on Cancer considered ODA for its carcinogenic potential.[14]

In a Health Hazard Alert released in December, 1980 NIOSH and OSHA on the basis of available information concluded that ODA had the potential to cause cancer in humans.[15]

2. Dimethylformamide (DMF)

Exposure of humans to DMF can result in a variety of effects, including nausea, abdominal pain, diarrhea, nervousness, eye and skin irritation, liver abnormality, headache, and dizziness.[16] The OSHA PEL and the ACGIH TLV for DMF are 30.0 mg/m^3 as a TWA.[6,7] NIOSH currently has no REL for DMF.

3. Chromium VI

Chromium compounds (chromic acid and the chromates) are oxidizing agents; they are irritating to the mucous membranes, skin, and eyes. Chromates have long been recognized for their primary irritant effects on skin, and ability to produce allergic contact dermatitis. Chromium can exist in bivalent, trivalent, and hexavalent (chromium VI) forms. Bivalent forms can produce chrome ulcers of the skin ("chrome holes"). Chromium VI has also been associated with an increase in the incidence of respiratory cancer. Hexavalent chromium compounds have been divided into noncarcinogenic (monochromates and dichromates of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, plus chromium VI oxide). Carcinogenic Chromium VI compounds include all others.[17-19].

VI. RESULTS

A. Environmental

1. Air Samples

Four ammonia air samples collected with Draeger detector tubes during the initial survey, ranged from less than 5 ppm to 10 ppm. The samples were collected in Building 9 - Department 38. The NIOSH REL for ammonia is 50 ppm as a ceiling value and the OSHA PEL is 50 ppm as a TWA. Results of short-term air sampling for DMF, ODA and chromium VI, conducted during the follow-up survey were all well below corresponding exposure criteria. Of the six air samples collected - one for DMF, four for ODA and one for chromium VI, only DMF was detected at an air concentration of 15.6 mg/m^3. This short-term sample (26 minutes) represented this employee's entire exposure for his 8-hr shift. Thus, his TWA was 0.83 mg/m^3. The current OSHA PEL for DMF is 30 mg/m^3.

2. Engineering Controls, Work Practices, Chemical Handling Procedures

a. Building 2 - Warehouse 1, Repackaging Area

General (Dilution) Ventilation

As shown in Figure 2A, the six mechanical ceiling fans (in recessed walls - 4 ft x 2.5 ft) exhaust a total air volume of approximately 36,200 cubic feet per minute (cfm). Since the canopy hood, in Bay 1, removes approximately 4,300 cfm additionally, a total air volume of approximately 40,500 cfm (24.3×10^5 cubic feet per hour) is mechanically moved through the building. Thus, approximately 3.7 air changes per hour are provided. This air movement should help maintain air concentrations of chemicals such as CO (from fork lifts) at acceptable levels.

Local Exhaust Ventilation

As shown in Figure 2B, the 4 ft x 6 ft canopy hood, at the east wall of the building, is used during the transfer of materials, including naphthals, from bulk containers to smaller packages. The hood-to-floor distance is 5.75 feet. The average air velocity at the face of the hood is approximately 180 feet per minute (fpm); the air volume through the hood is 4320 cfm. Since the total open area, below the canopy hood to the floor, (periphery of 20 ft x 5.75 height) is 115 ft^2, an average "control" velocity, at any point under the hood, is approximately 38 fpm (4320/115). This low control velocity would probably not be sufficient, at all times, to completely capture dusts emitted from drums or bins, particularly, if cross drafts, due to activity in the room, exceed this value.

A simple modification of this system, to improve its capture "effectiveness," would be to install overlapping, transparent, plastic strips, e.g., 2 inches wide by 6 ft long, around 3 sides of the hood - from the canopy to the floor. This addition would reduce the "effective" open area to approximately 35 ft^2 and increase the average control velocity to about 123 fpm. This, undoubtedly, would be sufficient to overcome extraneous drafts and puffs of emitted product powder. It, also, would not interfere with transport or visibility through the three curtained sides of the canopy.

b. Building 3 - Department 12 - Print Color Mixing Tanks

Chemical emissions from each of the three mix tanks are controlled by a three-slot exhaust system, which exhausts from the front side of an open tank, as shown in Figure 3B. At any time, the exhaust systems of two of the three tanks are closed off, by slot dampeners, so that all of the exhaust ventilation is provided to the one tank in operation at that time.

The average velocity through the three slots is approximately 3900 fpm, and the combined area of the slots (7/8 in/12 x 12 ft = .87 ft^2) is .87 ft^2. Thus, the total exhausted air flow rate is approximately 3400 cfm. Since the back side of the mix tank is open and not controlled by the slot exhaust system (and access to it is not needed during normal charging of the tank), it should be covered by a removable cover. Additionally, the movable cover on the exhausted side of the tank in use should be closed whenever possible, during mixing, to minimize evolution of vapors and gases.

Flexible plastic strips, down the sides of the slot hood would also improve the effectiveness of the slot exhaust system, by reducing the open area of air movement.

Work Practices

Skin exposure to the caustic solutions, constitutes a most probable source of hazard in this area. Thus, good work practices and personal hygiene are stressed by management, and were observed during this study. Workers are instructed to wash three or four times per day and to shower daily at the end of their shift.

Workers are provided clean caps, shirts, and pants daily; new rubber work gloves (with chemical resistant gauntlets) are provided weekly, and safety goggles are provided as needed. Disposable dust masks (3M Model 8710) are used when dry powders are added to the mix tank by shovel. High efficiency dust and mist respirators (effective against lead dust and asbestos) are also available when needed.

Spills on floors were washed down the drain with water immediately after their occurrence.

c. Building 9 - Department 38 - Upstairs Batching Area

Dust and Vapor Control

Air is exhausted through windows 2, 3, and 5 at the following rates:

Window No.	Window Area ft^2	Air Movement: Velocity (average) fpm*	Air Movement: Flow Volume cfm**
2	4.28	920	3950
3	8.73	375	3275
5	10	300	3000
Total Air Movement			10,225

*fpm = feet per minute
**cfm = cubic feet of air per minute

Additional air is removed through two exhaust ventilators at the rate of 11,600 cfm (8,000 cfm + 3,600 cfm). Since the total room volume is approximately 59,000 cubic feet, approximately 22 changes of air per hour are provided. At each of the motorized mixers, the air cooling fans create local air turbulence with velocities from 500 to 1500 fpm, in random directions, at the top and bottom of the motor housing. This turbulence dissipates approximately 1 foot away from the motor housing. Although no excessive dust was observed during this study, we suggest that shrouds over the fans, with outlets closer to the wall exhaust fans, would more effectively control any stray dust emissions.

Work Practices

Several work practices were observed which could be modified to reduce the potential for dust and vapor emission into the general work environment, and subsequent worker exposure both by inhalation and skin absorption.

1) Protective Clothing - Both men in the area should be required to wear full protective clothing during batching operations. One man was observed to be wearing a work shirt, trousers, gloves, an apron, and a respirator, while the second man did not wear either the gloves or apron. Since skin contact is a major potential source of hazard, skin protection is very necessary.

2) The pallet, loaded with bags of powder, was located about 15 feet upwind of the mixer and away from the wall fan. If feasible, the loaded pallet should be located closer to one of the wall fans, so that stray dust would be exhausted from the room more effectively.

3) The bags, to be emptied, should be slit (preferably on the end) as close to the west wall fans as possible for optimum dust control. The worker should orient himself so that he stands upwind of the opening location, so that dust is drawn away from him toward the fan.

4) The waste disposal drum was also located away from the wall fans. If this drum were located close to the wall, the folded, empty bags (emitting dust) would evolve less dust into the general work area.

5) Aqueous ammonia was transferred from a 55-gallon drum, on the north side of the room, into two open buckets and then carried to the mixer tanks. Although only low levels of ammonia vapor may normally be emitted, they can be extremely irritating, as demonstrated by the workers' need to wear ammonia respirators (3M disposable chemical cartridge respirator, Model 8727; NIOSH/MSHA approved for ammonia). Closed containers, for transport of the aqueous ammonia, would greatly reduce vapor emission during transport across the room.

d. <u>Building 10 - Department 42 - Brown Dispersal Area</u>

Dust Control

In the Brown Dispersal Area (mezzanine), the one tank is ventilated with a Y exhaust duct system above the tank, as shown in Figure 5B. Air is moved at the rate of approximately 300 cfm through each arm of the system, totaling 600 cfm. This exhausted air is filtered through an AAF bag filter. The filtered exhaust air is vented into the general room environment. It is recommended that the exhaust of this bag filter be redirected through the roof, to the outside of the building.

Additionally, the open sides of the shrouded area, Figure 5B, should be closed off with flexible plastic strips, with all dumping and disposal of empty bags performed inside the shrouded area. The exhausted air from this area is filtered through a Cyclonaire fume scrubber (packed with interlocked saddles), and then exhausted through the roof.

e. <u>Building 10 - Department 42 - Blue Disperse Area</u>

Vapor Control

Vapors from the 78 inch tank in this area are controlled by a 5-1/2" air exhaust duct above this tank. Approximately 200 cfm of air is moved through this duct.

Work Practices in the Brown and Blue Dispersol Areas

Excellent work practices were observed in these two areas. Hard hats and safety glasses were required and were used. When bags are dumped, the shroud is moved over the tank so bags or drums are dumped inside the shroud.

3. Other

Problems were noted regarding respiratory protection program, employee training and education, and eye washes/deluge showers. Problems with the respirator program included outdated canisters (TC 146-93) on ammonia respirators, bearded employees wearing respirators, employees who reported they wore respiratory protection, stated that they had not been fit tested, and the company has no written respiratory protection program at the time of the first NIOSH visit (April 1985). Problems with emergency eye washes were insufficient water pressure such that the double streams of water did not join and cracks in the main pipe such that no water cleared the nozzles. Problems with employee education were that many employees were unaware of the chemicals they work with or the hazards the chemicals presented. As noted by other investigators, some of the employees cannot read or write.

There was also a problem in afixing warning labels to some process tanks. Due to rust or chemical spill-over some labels would not adhere to the corresponding tank.

B. Medical

The company's screening program provided for cytologic (Papanicolaou) examination of a single urine specimen once a year. Workers with abnormal findings were referred for further evaluation. According to the company, the program was available to all current and former employees.

Based on the available records, there were at least 919 current and former employees of the Spartanburg plant as of April 1985. Of these 919, 230 (25%) had participated in the bladder cancer screening program. As of April 1985, the program had identified one case of bladder cancer.

VII. DISCUSSION AND CONCLUSION

A. Environmental

Based on these results the NIOSH investigators have concluded that air concentrations of DMF and ammonia were low and of ODA and CR VI were below the limit of detection, but improvements are needed in the medical screening program, engineering controls, work practices, chemical handling procedures, and Employee Training and Education programs.

B. Medical

As of 1968, in a screening program for workers exposed to para-aminodiphenyl prior to 1955, 35 cases of histologically confirmed bladder cancer were found, a cumulative incidence rate of 7%.[20] Additionally, there were 8 cytologically conclusive cases and 16 cases of suspicious cytologic findings, potentially raising the rate to 8.5% or 12%. In a recent bladder cancer screening program among workers from a plant in Augusta, Georgia, that formerly used and made beta-naphthylamine,[1] three cases of bladder cancer were found among 655 participants,[2] a rate of 0.5%. In the total cohort of 1,385 there were, including the cases detected by the screening program, 14 known cases of bladder cancer, an overall rate of 1.0%*.

Since some workers had jobs with greater exposure than others (indeed, some had no apparent exposure), the overall rate underestimates the risk among workers who had high-exposure jobs. Six of the cases occurred among the 118 workers nominally classified as "exposed" on the basis of the company's records (unpublished NIOSH data), a cumulative incidence rate of 5.1%.

If the overall risk of bladder cancer among the 919 Blackman-Uhler Spartanburg workers is similar to that at the Augusta plant, one might expect at least nine cases. This may be an overestimate, however. Since the Spartanburg plant, unlike the Augusta plant, never manufactured BNA, exposures at the Spartanburg plant may not have been as high or as widespread. Most of the cases among workers from the Augusta plant were diagnosed prior to the screening program, which began 9 years after the last exposures to beta-naphthylamine. By analogy, since 689 (75%) of the 919 Spartanburg workers have not participated in the company's screening program, cases of bladder cancer (perhaps unknown to the company) may have already been diagnosed among them, and others may occur in the future.

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*Since the publication of the results of the project, additional members of the cohort were screened, for a total of approximately 800. As of May 1986, one additional case of bladder cancer was detected. Thus, the rate of bladder cancer in the screening program participants remained at 0.5%, and that of the total cohort rose to 1.1% (unpublished NIOSH data).

A number of biochemical and immunologic markers of bladder cancer have been considered for screening purposes. Some have been found to be impractical or unreliable; others have not yet been adequately evaluated.[21,22] Thus, as an initial screening test for bladder cancer in a high-risk population, the preferred procedure is voided urine cytology in combination with routine microscopic examination for red blood cells and an inquiry about symptoms. For detection of high-grade tumors (those that are, or are likely to become, invasive), the sensitivity of cytology can exceed 90%.[23] The specificity can exceed 95%, but this depends on how marginal abnormalities are reported.[24] For a screening program for bladder cancer, it may be preferable to sacrifice some specificity for a gain in sensitivity. (That is, it may be better to find an abnormal test result in a person without disease than a normal test result in a person with disease.) Quantitative fluorescence image analysis[25] (QFIA) may prove to be a better method of examining the urine sediment cells than routine (Papanicolaou) techniques,[26] so if QFIA is available it should be considered in addition to routine cytology.

In the case of asymptomatic tumors, non-negative cytologic findings typically occur 1-3 years prior to cystoscopic evidence.[20] Examination of only a single urine specimen, however, may miss 20% of persons who actually have abnormal cytology.[23] Analyzing another specimen would detect about 2/3 of those, and a third specimen would detect the rest. Though annual screening that includes urine specimens from three different days might theoretically be adequate, twice-a-year screening, as is done in England,[27,28] would be more prudent, especially if three separate specimens are not obtained at each screening.

VIII. RECOMMENDATIONS

A. Environmental

1. All plant employees should be provided with better training and education (T & E) about the chemicals they work with. The T and E program should include the potential acute and chronic health effects, and techniques for reducing exposure. For employees who cannot read, training must be entirely visual and verbal.

2. Work practices should be modified as outlined in the Results section.

3. The respiratory protection program should be improved with emphasis on proper selection, cleaning and maintenance, fit-testing, and proper storage.

4. All emergency eye wash and showers should be inspected at least once per month and adjusted as needed.

5. Labels should be properly affixed to tanks, vessels, etc. Tanks with coating such as rust should be cleaned so that the label can be attached.

B. Medical

1. The screening program should continue to be available to all current and former workers who were potentially exposed to beta-naphthalamine or other bladder carcinogens. All such workers should be informed of their increased risk of bladder cancer. They should be advised that this increased risk continues after assignment to a different job or termination of employment, even though exposure has ceased, and that they should continue indefinitely to have periodic screening. The screening program should actively maintain contact with eligible workers; former employees, especially, are more likely to participate if given pertinent, understandable information and timely reminders.

2. The best available screening procedure for bladder cancer is urine cytology in combination with microscopic examination of the urine for red blood cells and an inquiry about urinary tract symptoms. Each screening session should ideally include three separate urine specimens. Semi-annual screening is preferable to annual screening in that it provides a margin of safety in case all three specimens are not obtained at each session. (For workers no longer at the plant or near the screening site, collecting two specimens a few hours apart may be more practical than collecting specimens on two or three different days.)

3. The role of routine cystoscopy in screening persons at high risk of bladder cancer is currently under debate. Although cystoscopy may, on occasion, detect a tumor missed by the other screening tests, it is an uncomfortable, invasive procedure with risks of injury, infection, and adverse reactions to the anesthetic or other accompanying medications. At the present time, then, there is insufficient justification to recommend cystoscopy as a routine screening procedure for persons without symptoms or other findings suggestive of a consequential, persistent urinary tract disorder. Fewer persons will experience the untoward side effects and complications of cystoscopy (or any other procedure), and the risks are justifiable, when the procedure is done on patients selected for medical reasons (symptoms, microhematuria [red blood cells in the urine], or non-negative cytologic findings) rather than on large numbers of asymptomatic persons in a screening program.

4. Anyone with urinary tract symptoms, microhematuria, or non-negative cytology should have further medical evaluation. This might include repetition of the screening tests, additional diagnostic tests or procedures, and/or observation of the effect of treatment or time. Not all symptoms or test abnormalities are due to bladder cancer, and invasive diagnostic procedures are not always necessary. Since the screening program participants are presumably at increased risk of bladder cancer, however, invasive procedures, such as cystoscopy, are appropriate when cytologic abnormalities, microhematuria, or urinary tract symptoms are not otherwise readily explained.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report prepared and survey conducted by:	John N. Zey, M.S., C.I.H. Industrial Hygienist Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch
	Mitchell Singal, M.D., M.P.H. Supervisory Medical Officer Medical Section Hazard Evaluations and Technical Assistance Branch
	A. Blair Smith, M.D., M.S. Chief Medical Section Hazard Evaluations and Technical Assistance Branch
	Paul E. Caplan, P.E., C.I.H., M.P.H. Research Industrial Hygienist Engineering Control Technology Branch
Analytical Evaluation:	Tanya Cheklin Steven A. Billas Fred Rejali Chemists UBTL, Inc. Salt Lake City, Utah
Report Typed by:	Linda Morris Clerk-Typist Industrial Hygiene Section

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2. OSHA, Region IV
3. South Carolina Dept. of Labor
4. South Carolina Dept. of Health

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I

Sampling and Analytical Techniques
HETA 85-159

Blackman-Uhler Chemical Company
Spartanburg, South Carolina

Chemical	Flow Rate (LPM)	Media	Analytical Technique
DMF	1	Silica gel tubes	A and B sections of the tube were separated and analyzed by GC according to NIOSH method No. 2004.[29] Samples were desorbed in methanol for 1 hr. Oven conditions were 100°C, isothermal.
ODA	2-2.5	Filters	Filter samples were analyzed for ODA according to NIOSH method No 5013 - modified.[29] Samples were desorbed in 2 ml of water and sonicated for 15 min. Then 1 ml aliquots were added to 1 ml of a reducing solution and each sample was let stand 1-hr and injected into an HPLC system.
Cr VI	2.5	Filters	Samples analyzed via visible spectroscopy per NIOSH method 7600.[29] Filters were extracted in 5 ml 2% NaOH - 3% Na-carbonate solutions. Color was developed by adding 1.9 ml 6 N H_2SO_4 and 0.5 ml diphenylcarbazide to the flasks. Samples then diluted to final volume of 25 ml with distilled H_2O.
Ammonia	NA	Sorbent tube	Visual - direct reading.

DMF = dimethyl formamide, ODA = ortho-dianisidine, Cr VI = Chromium + 6, ml = milliliter, H_2O = water.

Figure 1
Facility Diagram
Blackman Uhler Company
Spartanburg, South Carolina
HETA 85-159

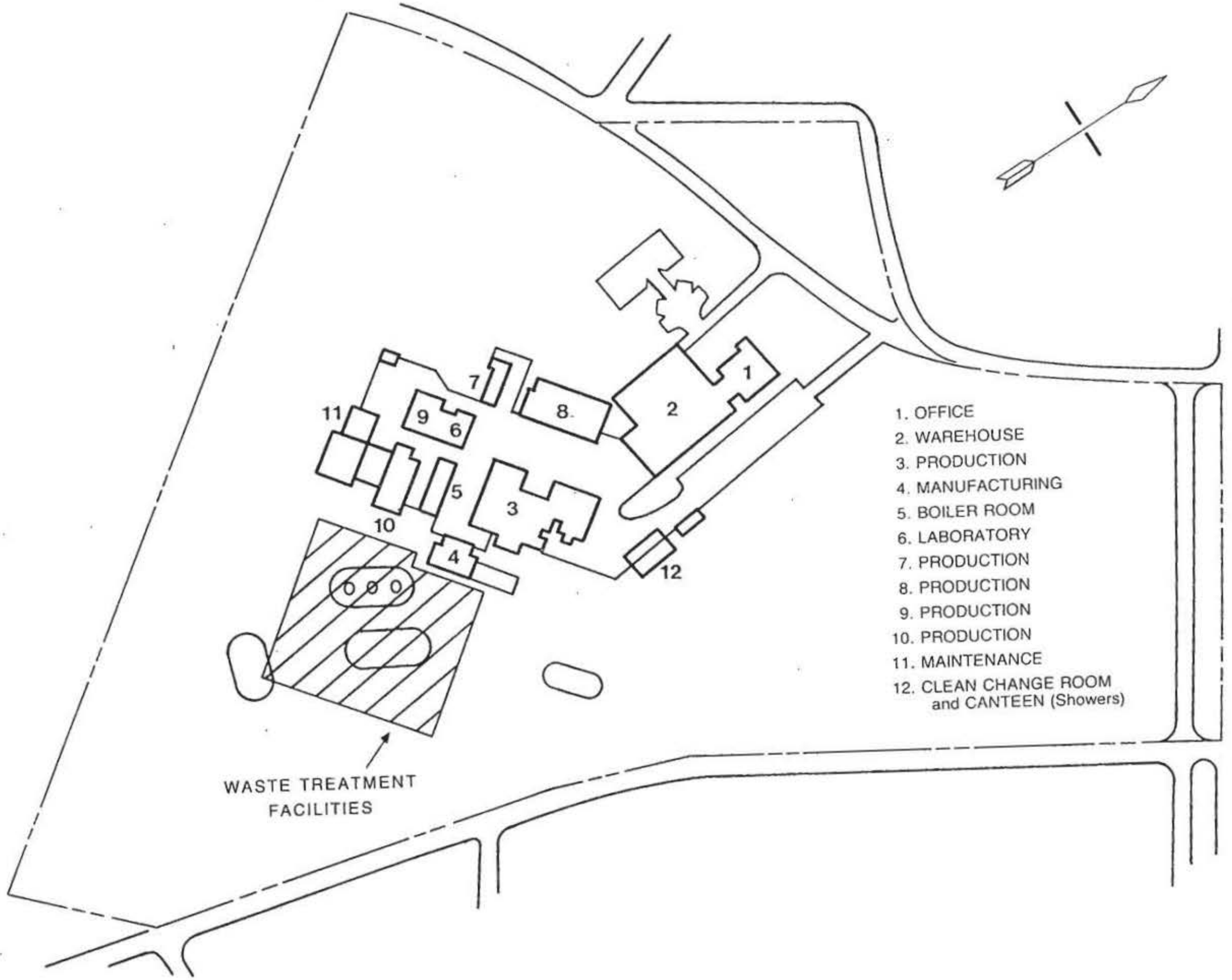
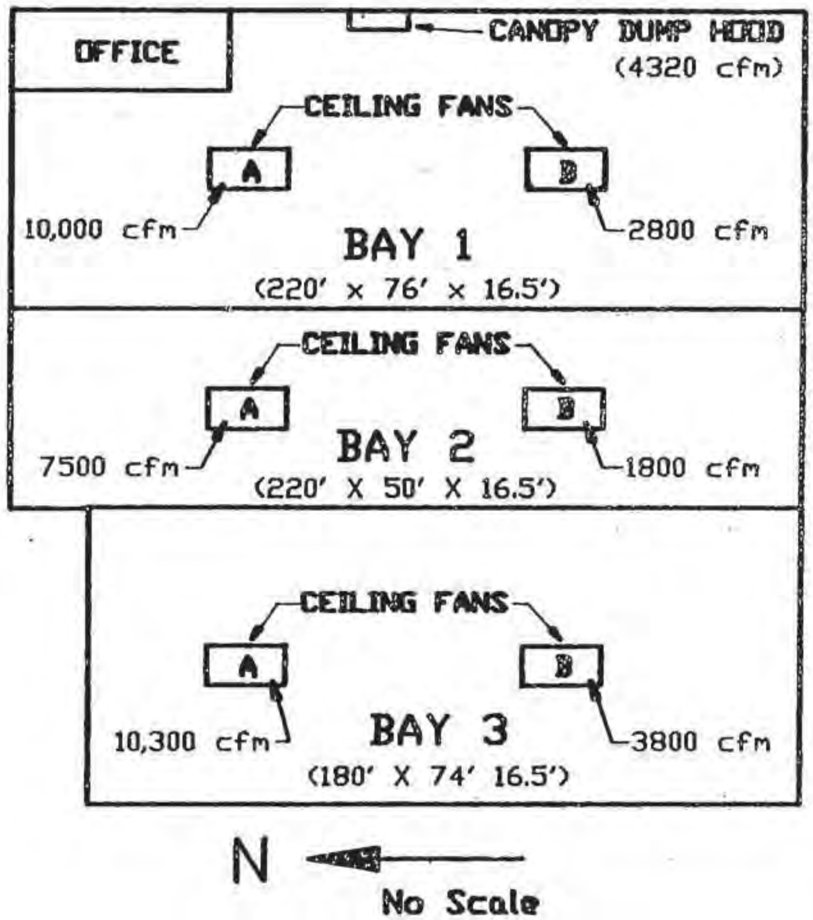


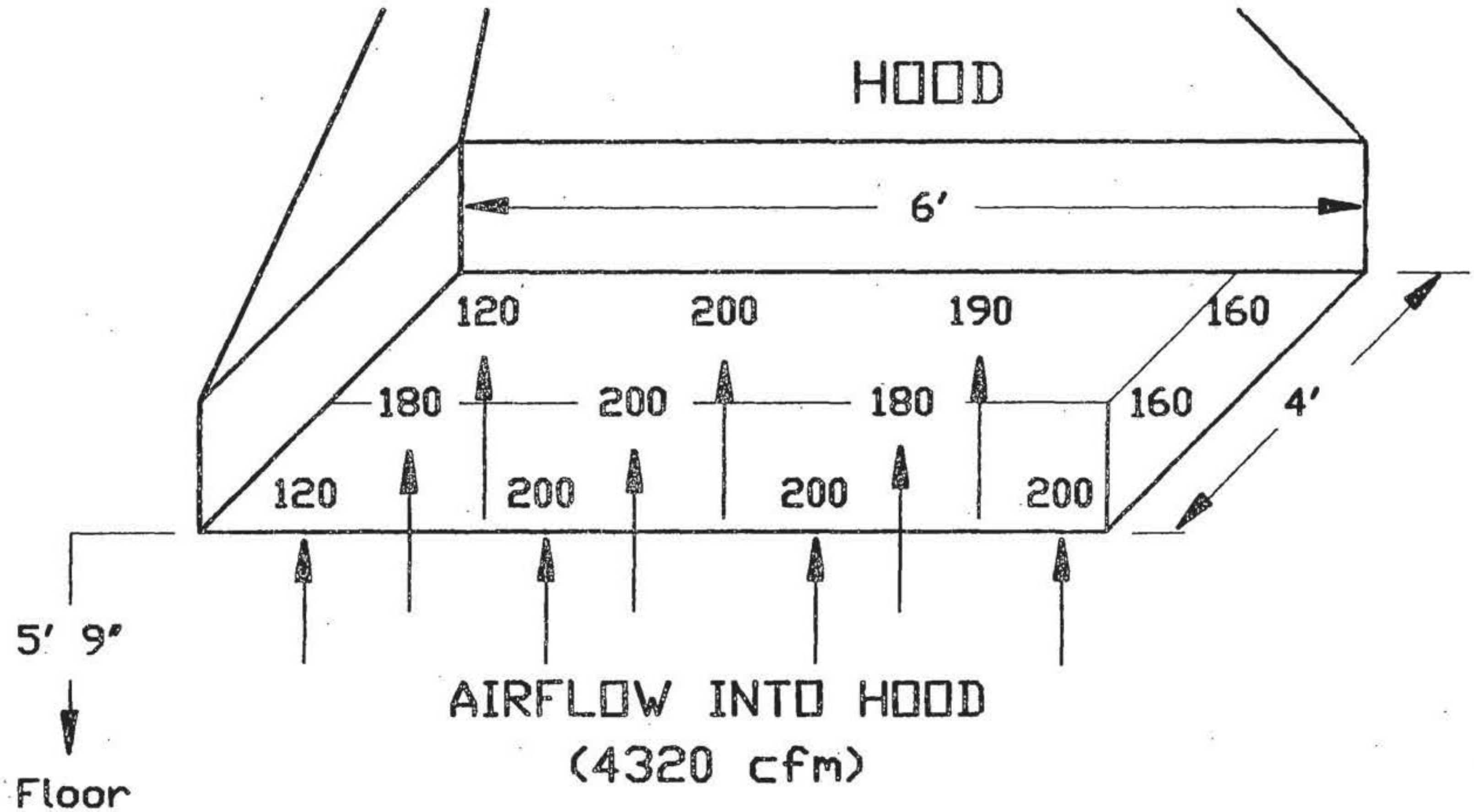
Figure 2A



BUILDING 2, WAREHOUSE MAIN FLOOR

REPACKAGING AREA

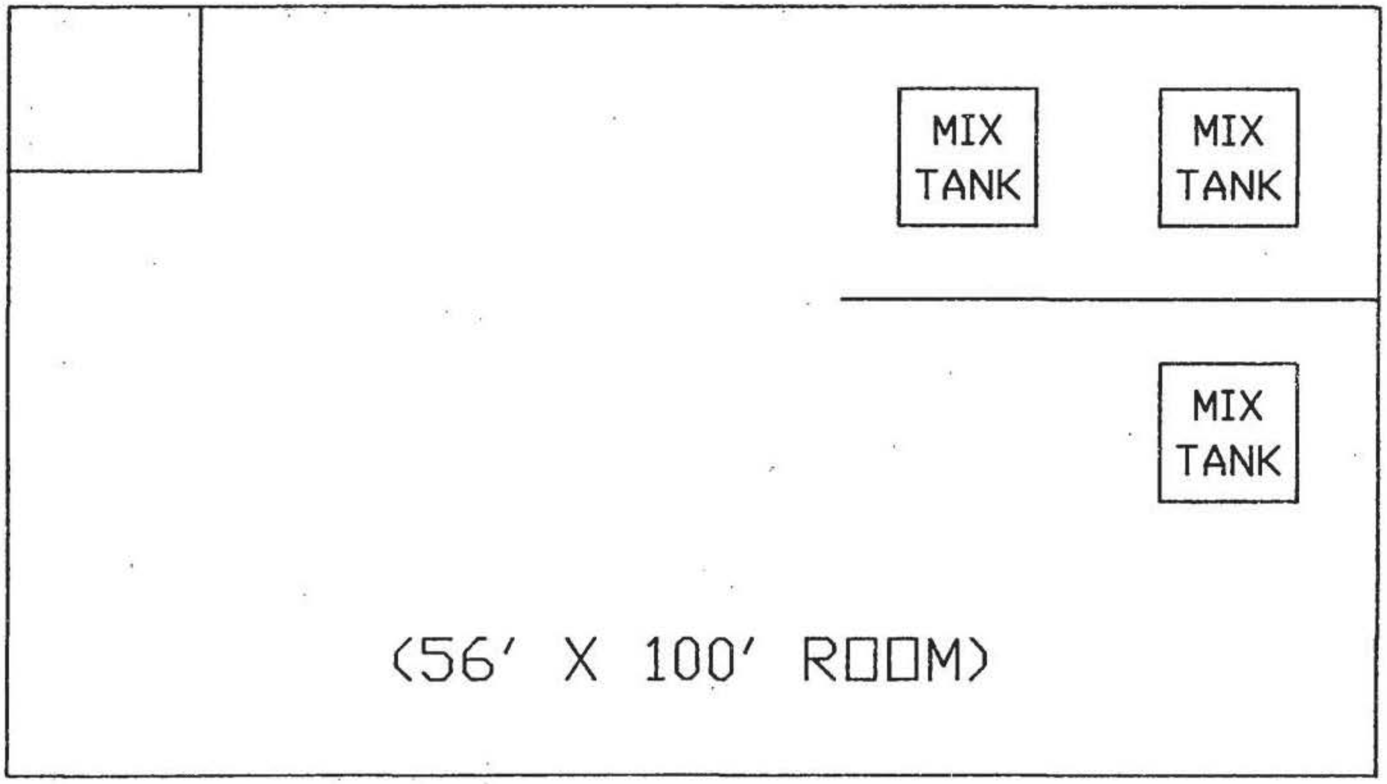
Figure 2B



CANOPY HOOD DUMP STATION

BUILDING 2

Figure 3A



FIRST FLOOR AREA

BUILDING 3, DEPARTMENT 12

Figure 3B

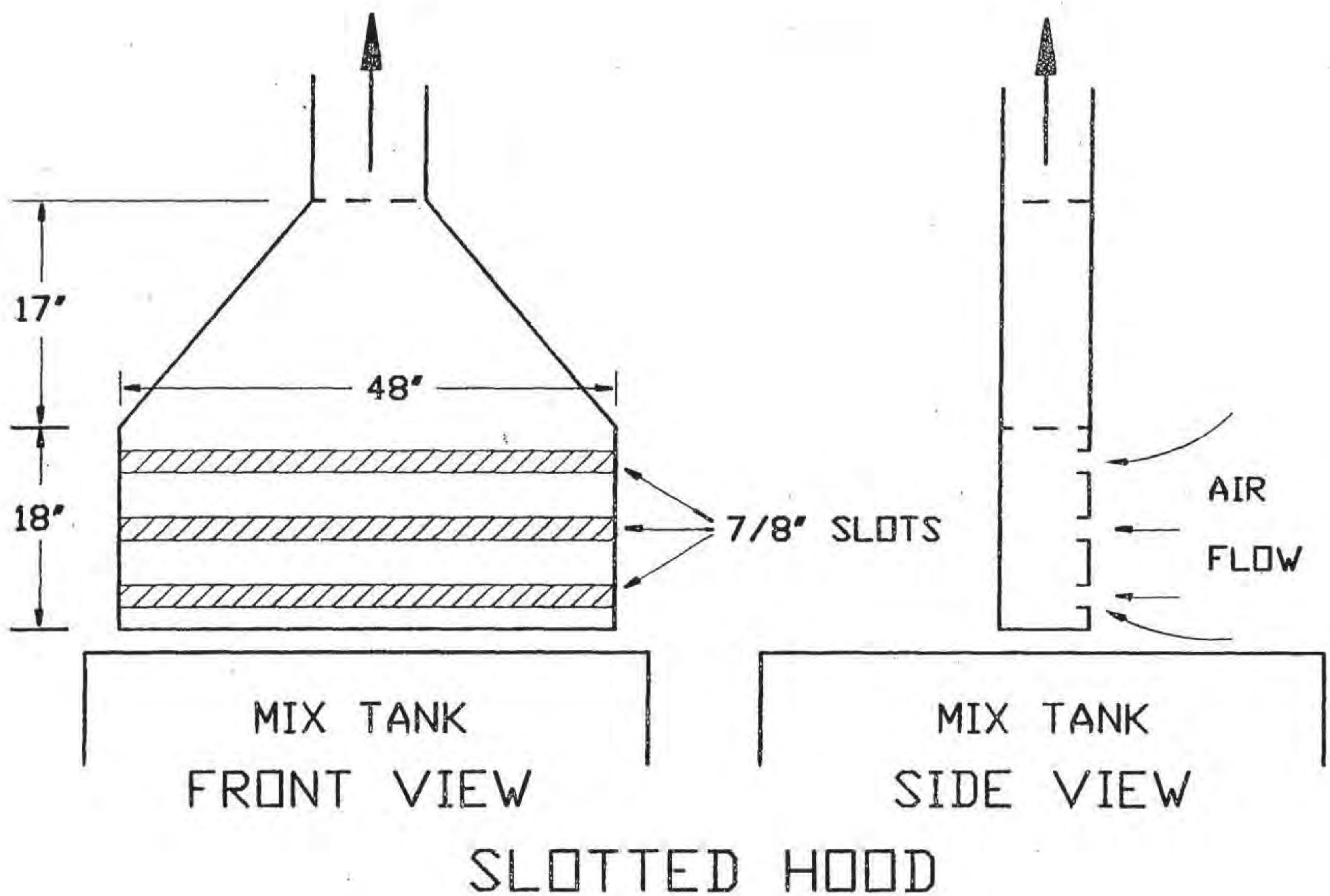
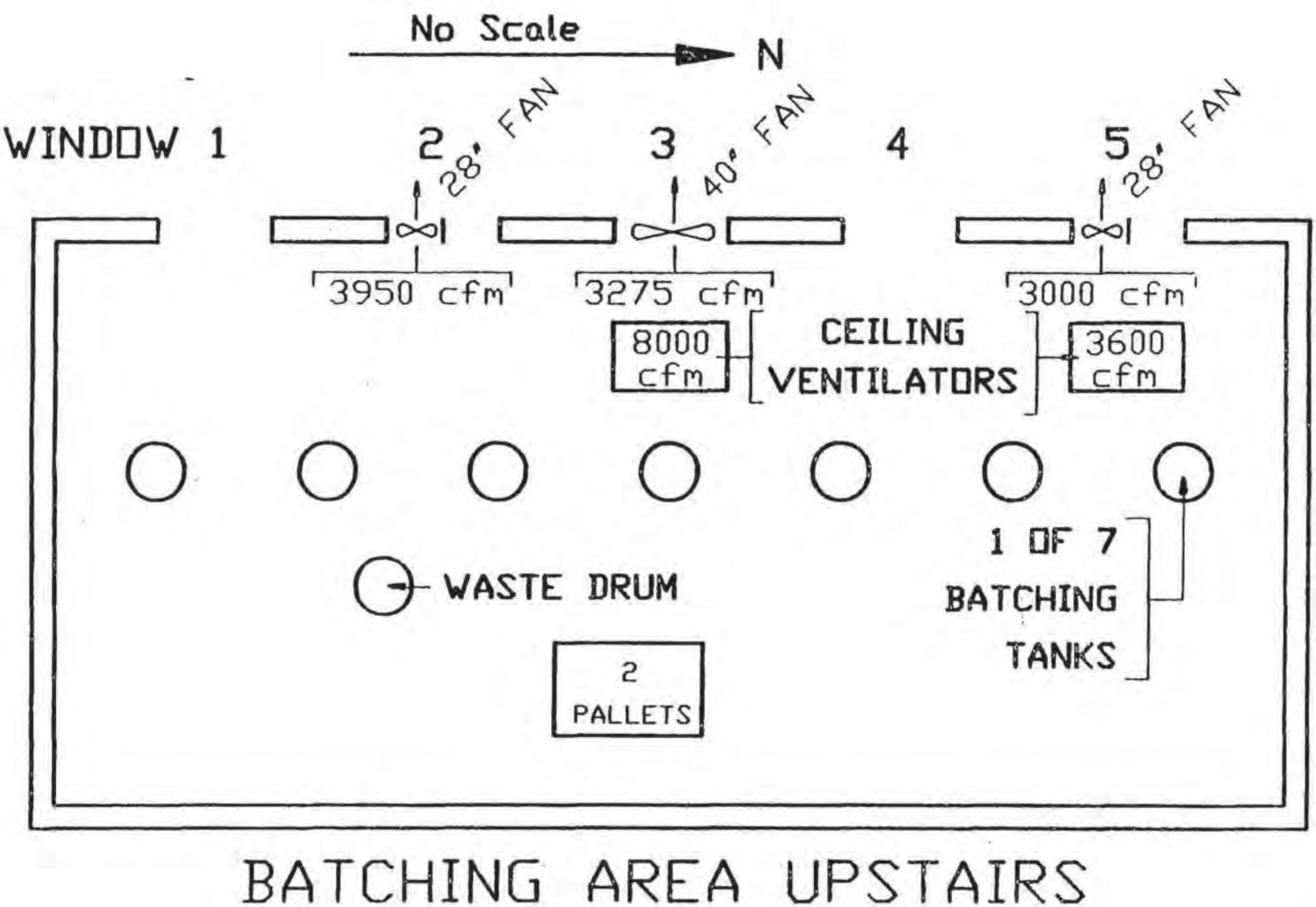
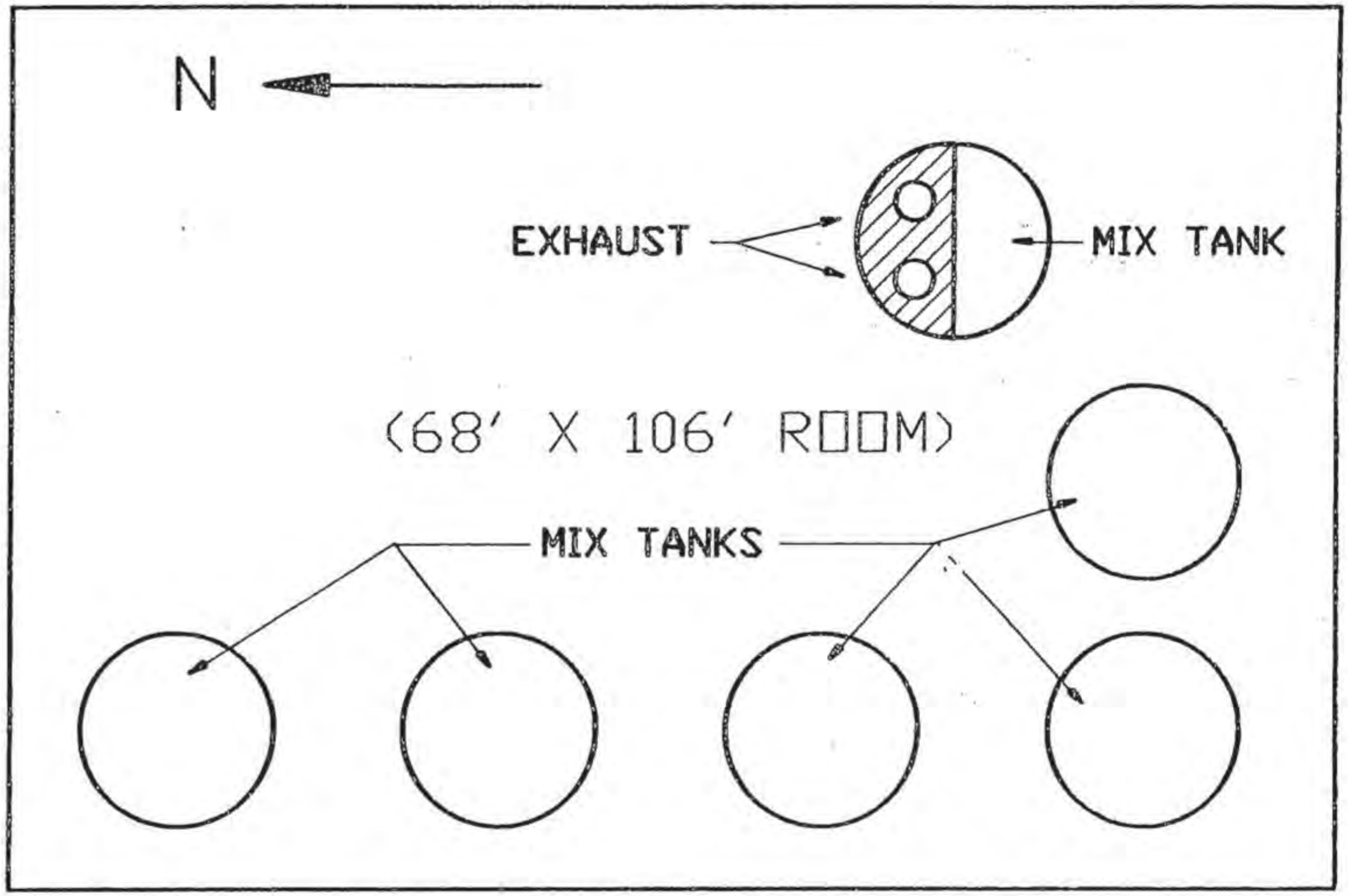

17"
48"
18"
7/8" SLOTS
AIR
FLOW
MIX TANK
FRONT VIEW
MIX TANK
SIDE VIEW
SLOTTED HOOD

Figure 4A



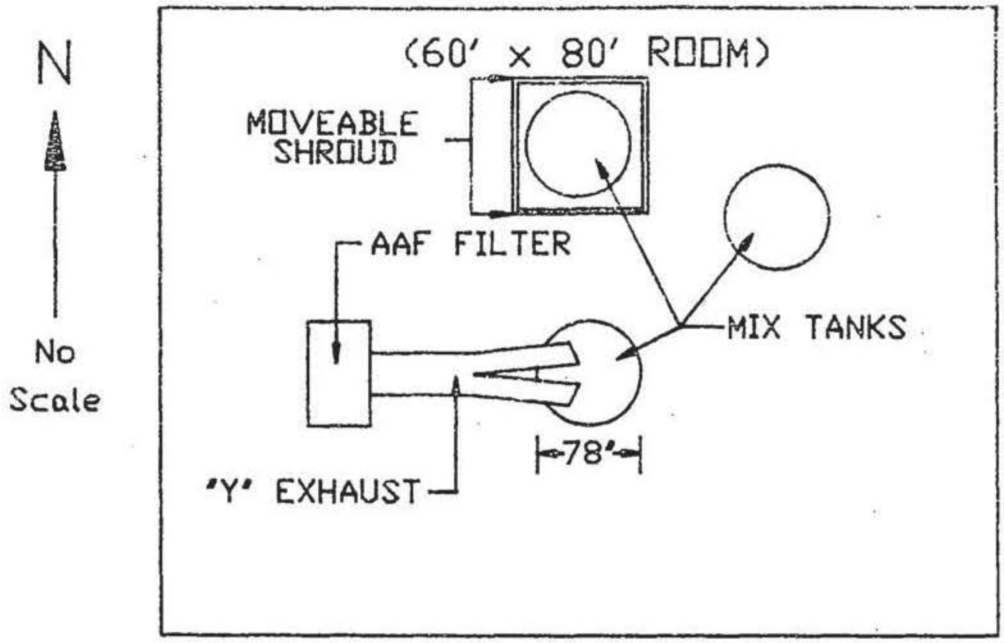
Building 9, Department 38

Figure 5A



BLUE DISPENSE AREA
MAIN FLOOR, BLDG. 10, DEPT. 42

Figure 5B



BROWN DISPENSE DYE AREA

2nd FLOOR, BLDG 10, DEPT 42