This Survey Report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved. Additional NIOSH Survey Reports are available at http://www.cdc.gov/niosh/surveyreports.

SENTINEL EVENT NOTIFICATION SYSTEM
FOR OCCUPATIONAL RISKS (SENSOR)

IN-DEPTH SURVEY REPORT

CONTROL OF ETHYL METHACRYLATE EXPOSURES DURING THE APPLICATION OF ARTIFICIAL FINGERNAILS

at

Moore's University of Hair Design
Cincinnati, Ohio

REPORT WRITTEN BY
Amy Beasley Spencer
Cheryl Fairfield Estill
Jane B McCammon*
R Leroy Mickelsen
Ova E Johnston

*Colorado Department of Health

REPORT DATE
August 1994

REPORT NO
ECTB 171-22a

U S DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
Engineering Control Technology Branch
4676 Columbia Parkway, Mail Stop R5
Cincinnati, Ohio 45226-1998

FACILITY SURVEYED	Moore's University of Hair Design 6011 Montgomery Road Cincinnati, Ohio 45213
SIC CODE	7231 - Beauty Culture Schools
SURVEY DATES	March 23-26 and March 30-31, 1993
SURVEY CONDUCTED BY	Amy Beasley Spencer Cheryl Fairfield Estill
EMPLOYER REPRESENTATIVES CONTACTED	Carol Smith, Director
EMPLOYEE REPRESENTATIVES CONTACTED	No Union
ANALYTICAL WORK PERFORMED BY	Fred Rejali Data Chem Laboratories 960 West LeVoy Drive Salt Lake City, Utah 84123 Ardith A Grote Measurements Research Support Branch Division of Physical Science and Engineering, NIOSH, Cincinnati, Ohio
MANUSCRIPT PREPARED BY	Debra A Lipps

DISCLAIMER

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal organization engaged in occupational safety and health research Located in the Department of Health and Human Services (DHHS), NIOSH was established by the Occupational Safety and Health Act of 1970 This legislation mandated NIOSH to conduct a number of research and education programs These programs are separate from the standard setting and enforcement functions carried out by the Occupational Safety and Health Administration (OSHA), which is located in the Department of Labor (DOL) An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical, biological, and physical hazards The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering (DPSE) has been given the lead within NIOSH to study the engineering aspects of health hazard prevention and control

This study was conducted under the Sentinel Event Notification System for Occupational Risks (SENSOR) program In 1987, NIOSH initiated the SENSOR program, a cooperative effort between federal and state governments designed to develop local capabilities to recognize, report, and prevent designated occupational disorders The Colorado Department of Health is participating in the SENSOR program for occupational asthma In 1990, three cases of asthma in cosmetologists working with fingernails prompted Colorado to request the assistance of NIOSH researchers in the evaluation and control of nail salon technician exposure Artificial nail application appears to be a common factor in these three occupational asthma cases The primary objective of this study was to reduce the risk of hazardous exposure to nail salon technicians After examining various controls, it was decided a downdraft manicure table was the best control option The objective at that point was to examine ethyl and methyl methacrylate exposures during application of artificial fingernails when using an unventilated manicure table compared to a modified ventilated manicure table By use of the modified manicure table, NIOSH researchers hope to reduce the risk of hazardous exposures to nail technicians

The technique for application of artificial fingernails started perhaps as early as the late 1950s, but became popular in the early 1970s when manicurists began applying methyl methacrylate dental acrylic to fingernails to strengthen natural nails or create artificial nails [1] Since then, artificial nail application has grown tremendously In 1993, there were 33,000 salons exclusively for nails, up 14 percent from 1992 This number does not count the many other salons which perform artificial nail services in addition to offering other services (hair, massages, etc) In 1993, there were 190,000 nail technicians, up 9 percent from 1992 The projected dollars spent for artificial nails and extensions are projected to reach almost three billion dollars, more than double the total dollars spent for these services in 1989 [2]

PRESENT CONTROLS

Present controls vary from shop to shop There are many methods used by salons to control emissions/dust from artificial fingernails The following are some of the methods used alone or in conjunction with another method (1) general building ventilation systems, (2) general room fans exhausting air outside or into a general ventilation system, (3) general room air-purifying systems, (4) local exhaust fans, (5) local air-purifying systems, (5) placement of towels on the manicure tables to collect dust (which do not capture vapors or respirable dusts), or (6) use of no controls

Many control systems currently being used do not follow basic industrial ventilation principles For general ventilation systems, the worker must be far enough away from the contaminant source so that an exposure will not be excessive For local ventilation systems, the location of the air inlet should be near the source of contaminant generation The location of the worker should not be between the contaminant and the contaminated air inlet, because the worker would breathe contaminated air

NIOSH researchers observed several recirculating downdraft tables with charcoal filters during the walk-through evaluations A number of problems with these manicure tables were noted Leaks were detected around the charcoal filter, thereby allowing contaminated air to escape before reaching the filter There was no indicator on the charcoal filter to notify the operator when the filter needed replacing, nor was there a backup filter There was uneven air flow across the face of the downdraft ventilation, and the volume of air was not adequate to overcome room air currents

It was also observed during walk-through evaluations that in some of the salons, the salon air purifiers were located in out-of-the-way places, usually not near the generation source Even if the purifiers were completely effective in removing the contaminants, the workers would be exposed to high local concentrations of contaminants This exposure would occur before the contaminants could diffuse into the room and subsequently be removed by the purifier The air purifier may have an effect on the removal of the low level background contamination in the room, but the purifier will have little or no effect on reducing worker exposure near the generation source For these reasons, general room air purifiers were not evaluated The study focused on the evaluation of local exhaust controls that properly use industrial ventilation principles

FACILITY DESCRIPTION

Moore's University of Hair Design is a school with approximately 50 students The students can choose their course of study ranging from manicures, pedicures, hair services, artificial nails, facials, or a combination of the above After the students have passed a certain point in the curriculum, they are allowed to practice on customers who come to the school who receive the services at a reduced fee After graduation, the students are required to take a test to obtain a state license to perform the services for which they are trained

The area where artificial nails were applied was 22 by 13 feet with a ceiling 9 feet high The nail application area also served as an area for hair drying stations, and was connected to the hair styling area A diagram of the facility is shown in Figure 1 During normal operation, the students used

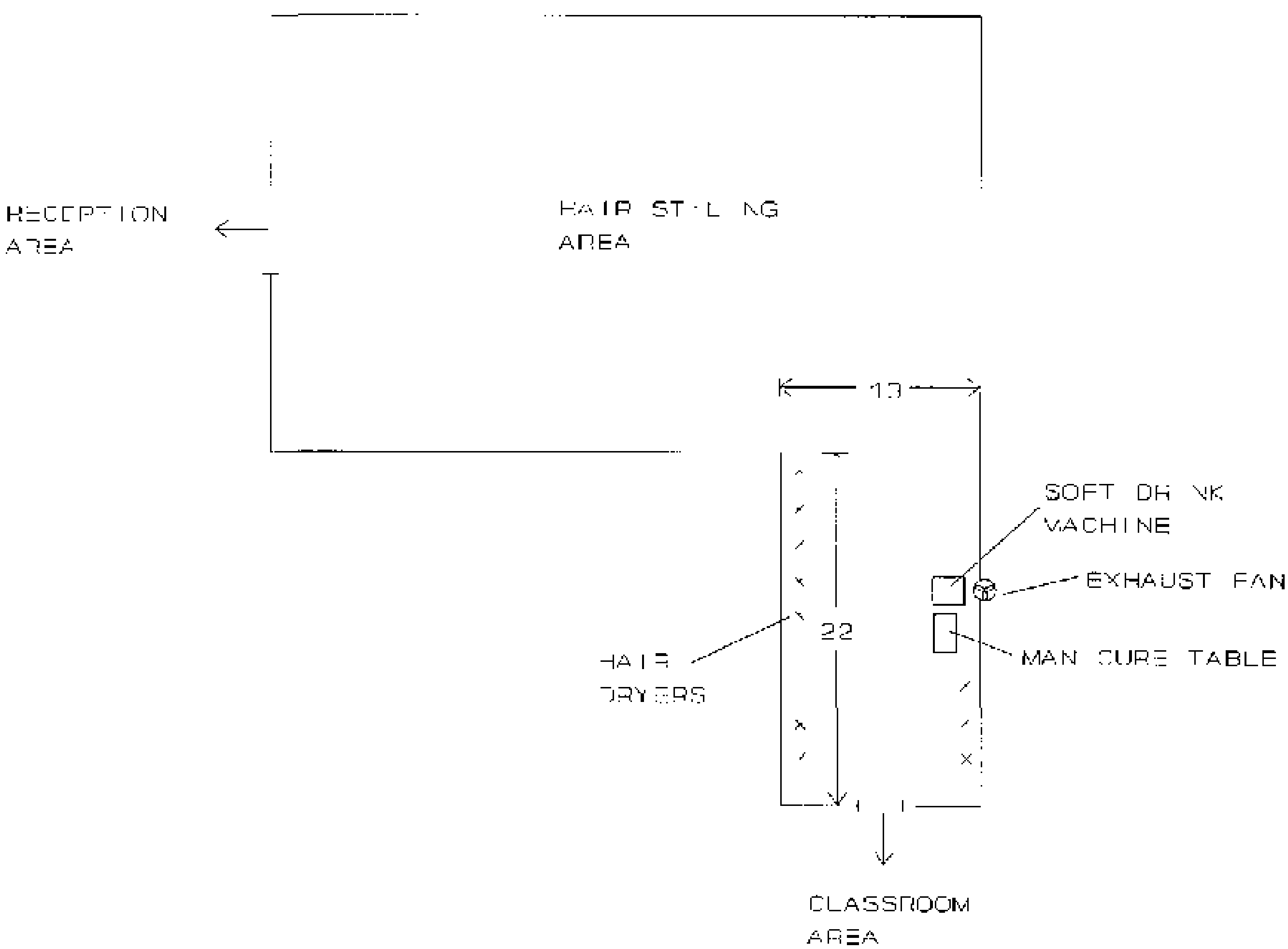

Figure 1 Moore's University of Hair Design

commercially available unventilated tables for manicures and artificial nail application Cloth towels were placed on the table to capture dusts and liquids There was general room ventilation in the form of a fan mounted in the wall, exhausting outside There was no additional ventilation during artificial nail application

PROCESS DESCRIPTION

There are two general types of artificial nails applied Both techniques involve removing old color coats, and filing down the natural nail surface to create a rougher surface for better adhesion The natural nail surface is then sanitized, a dehydrating liquid and a primer are applied to the nail to promote adhesion After the preparation of the natural fingernail, there are two major types of artificial nail applications

- Sculptured nails often are preferred if a client's natural nails are very short These are formed over the natural nail, and the artificial portion is created over a removable form From two large bottles of the liquid monomer and powdered polymer, a small amount of each is placed into two individual glass containers, so as not to contaminate the larger bottles Also, the smaller amounts of the substances are easier to work with These small containers usually contain approximately 30 mL, and can be open to the air Another type of container commonly used for the monomer has a small opening for an application brush to enter when pressure is applied by the technician The nail is formed entirely by this small brush applicator, which is dipped into a liquid monomer, then dipped into the powdered polymer The polymer contains a peroxide accelerator The nail technician then forms the nail into the general shape before curing (hardening) fully takes place

- The preformed tips are preferred if the client has a sufficient nail length with which to attach the tips This technique involves the use of already formed artificial nail tips that are attached over the natural nail with an ethyl cyanoacrylate glue, and then shaped These tips are made of acrylics, gel, fiberglass, or porcelain The tip is then covered with a liquid monomer and powdered polymer, using the same procedure used to form sculptured nails

After the artificial nails are formed, filing is performed to refine the nail shape Filing is performed by using a nail file manually, or a drill with a special tip Cuticle oil is applied over the nail surface and cuticle, and the nail is buffed A base coat of primer is applied, followed by a color coat topped with a clear protective coat Application time is generally 1 to 2 hours Exposures result from the off-gassing of organic solvents, methacrylate monomers, and dust generated when filing the artificial or natural nails

The products used at Moore's University of Hair Design were NSI nail products (Nail Systems International, West Conshohoken, Pennsylvania) Both the NSI liquid and powder are composed primarily of ethyl methacrylate There were trace levels of methyl methacrylate detected in both the NSI liquid and powder The NSI primer was mainly composed of methacrylic acid, and contained trace amounts of methyl methacrylate, and the dehydrating liquid (NSI NailPure) was mainly composed of methyl ethyl ketone

POTENTIAL HAZARDS

There are many products used during the application of artificial nails, including the color coat remover, the liquid and powder of the artificial nails, the adhesives, primers, and color coats Many of these products contain chemicals causing negative health effects [3]

HEALTH EFFECTS - METHYL METHACRYLATE

Some artificial nail products contain the liquid monomer and powdered polymer of methyl methacrylate The monomer is an irritant of the eyes and mucous membranes, and has been found to cause dermatitis [4] High concentrations may cause central nervous system depression and unconsciousness [5] The polymer appears to be inert [6] Although methyl methacrylate was banned by the U S Food and Drug Administration (FDA) in 1974[7] for use in all nail products, there are still some nail products that contain this chemical Methyl methacrylate was banned for use in nail products because it caused deterioration of nail plates, nail dislocation, and/or allergic dermatitis in both customers and nail technicians [7] However, in 1982, a study reported that methyl methacrylate was found in 8 of 29 bulk samples of nail products [3] Researchers from NIOSH obtained 25 random bulk samples of the powder and liquid components used for the creation of artificial fingernails, 15 contained at least trace amounts of methyl methacrylate Many manufacturers of other artificial nail products have substituted ethyl methacrylate as the main component Both methyl and ethyl methacrylate are flammable, methyl methacrylate is classified as a class 1B flammable liquid [8]

HEALTH EFFECTS - OTHER SOLVENTS

Ethyl methacrylate is the main ingredient for many artificial nail products There is evidence that ethyl methacrylate is toxicologically similar to the liquid monomer and powdered polymer of methyl methacrylate [9] Industrial hygiene recommendations for ethyl methacrylate are the same as recommended for methyl methacrylate [10]

Ethyl cyanoacrylate is used in the adhesives that are often used during artificial nail application Ethyl cyanoacrylate causes symptoms of irritation to the eye and mucous membrane, upon exposure to tissue, the glues are toxic due to heat generation and degradation to formaldehyde and cyanoacetate [11] Ethyl cyanoacrylate exposure also can cause dermatitis and asthma [11,12,13]

EVALUATION CRITERIA

As a guide to the evaluation of the hazards resulting in workplace exposures, NIOSH field staff employ evaluation criteria for assessment of many 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, preexisting medical conditions, and/or hypersensitivity (allergy) In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medication or personal habits of the workers to produce adverse 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 these multiple routes of entry potentially increase the overall dose Previous studies have shown that technicians' exposures during artificial nail application are below recommended levels for several potentially hazardous substances [14,15,16] It is possible that reported asthma cases may be a result of exposures in which the concentrations are below the recommended exposure levels

There are currently no Threshold Limit Values (TLV), Permissible Exposure Levels (PEL), or Recommended Exposure Levels (REL) for ethyl methacrylate or for ethyl cyanoacrylate For methyl methacrylate, the NIOSH REL and the Occupational Health and Safety Administration (OSHA) PEL, are 410 mg/m^3 (100 ppm) as an 8-hour TWA [8] OSHA recommends a TWA of 15 mg/m^3 of total dust and 5 mg/m^3 of respirable dust [17]

The Colorado Board of Cosmetology previously required an air purification system with specific air exchange rates, a charcoal filter, and a particulate filter [18] These air purification system requirements were later deemed possibly inadequate, the requirements were too specific, and the Board was unsure if these particular requirements were sufficient for worker health The new requirements allow for any means to be used that reduce the level of toxic substances to an acceptable level [19] This new rule is a broader, less defined performance standard, and is similar to many other states' Cosmetology Board requirements

STUDY METHODS

COMMERCIALLY AVAILABLE MANICURE TABLE

After examining various controls, a commercially available recirculating downdraft manicure table with charcoal filters was purchased and evaluated (Model #0592M, Professional Fabricators, Inc , Cypress, California) This manicure table is shown in Figure 2 It appeared that there were several manufacturers with similar designs The table was 3 4 feet long by 1 5 feet wide and 2 6 feet high On the client's side of the table, a 5 2-inch wide padded arm rest was extended from the table The client's side of the table was 2 6 inches higher than the technician's working surface, so the client's hands would extend over the downdraft face The downdraft air exhausted through a perforated plate which was located 6 5 inches from the technician's side of the table The perforated plate was 13 inches long, and 4 2 inches wide, with 67 3 percent void space The air for the downdraft ventilation entered the table through the perforated plate A small centrifugal fan was

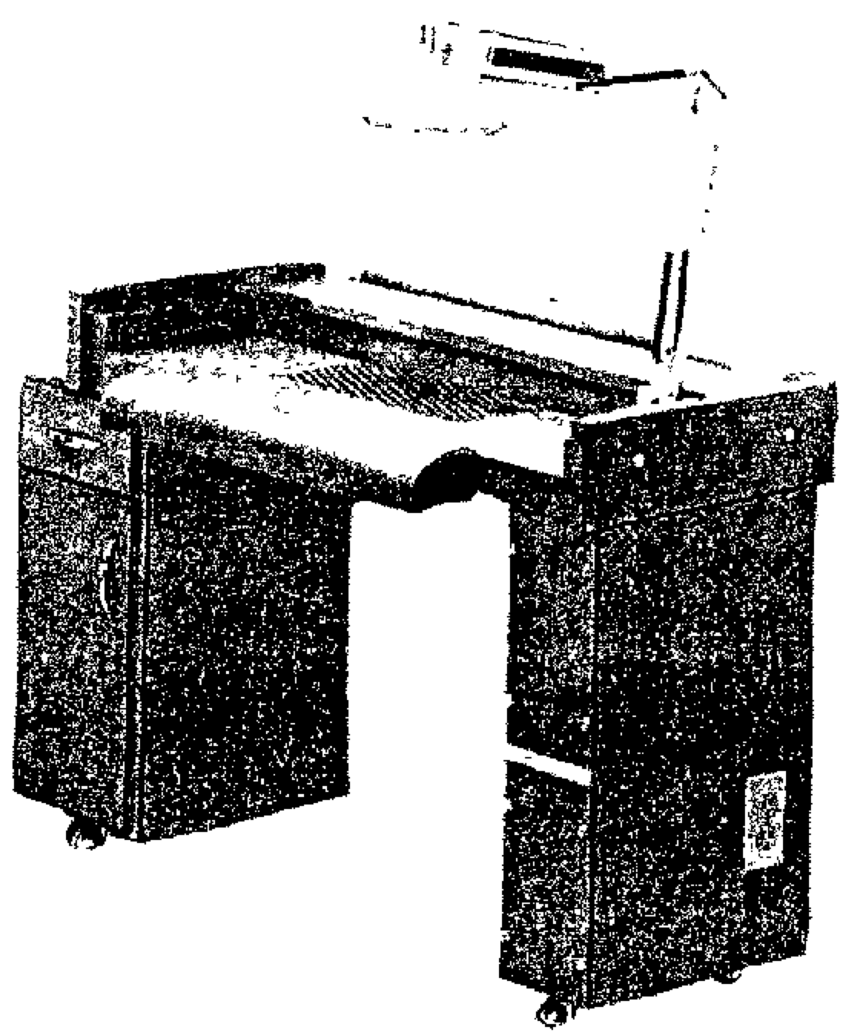

Figure 2· Commercially available downdraft manicure table used for the downdraft flow The measured average flow of downdraft air through the table as purchased was 62 cfm, the average face velocity was measured at 160 ft/min The air passed through a carbon filter, and exited the table though the bottom

The ventilation of the manicure table was deemed inadequate due to the following factors (1) leaks were detected around the charcoal filter, thereby allowing potentially contaminated air to escape before reaching the filter, (2) there was no indicator to notify the operator when the filter needed replacing, nor was there a backup filter, (3) there was uneven air flow across the face of the downdraft opening, and (4) the volume of air was not adequate to overcome room air currents

MODIFICATIONS TO THE COMMERCIALLY AVAILABLE MANICURE TABLE

The following modifications were made to the commercially available manicure table (1) The downdraft air volume was increased from 62 to 235 cfm by using a larger fan, (2) The plenum was enlarged such that the plenum velocity equaled half the perforated plate velocity for more consistent air flow rates at the face of the table, (3) The charcoal filters were removed and an exhaust system to the outdoors was incorporated, and (4) An extension around the duct leading to the perforated plate at the face of the table was added The extension brought the duct (downdraft plenum) on the technician's side up to the height of the client's side of the table, up approximately 2 6 inches

The added outdoor exhaust system incorporated approximately 8 feet of flexible corrugated duct The duct connected the downdraft exhaust from the manicure table to an opening in an outside wall which was previously an exhaust for the building

AIR SAMPLING STRATEGY

The evaluation was performed using two configurations the modified manicure table with downdraft ventilation, and an unventilated manicure table The same table was used throughout the study for consistency, the ventilation was turned off to represent a common unventilated table, and was turned on to represent a ventilated table

There were three full days of sampling for each of the two configurations, the order of the configurations was random Four different technicians applied nails using the same product throughout the testing period The technicians applied as many nail sets as possible each day, the number of nail sets applied ranged from two to four sets per day

Air sampling for methyl and ethyl methacrylate was performed according to NIOSH Method 2537 [20] The samples were collected with XAD-2 solid sorbent tubes (SKC #226-30-06) using Gilian® air sampling pumps at flow rates of 20 mL/min to 50 mL/min After sampling, the sorbent tubes were stored on dry ice until analysis Air samples were taken in the technician's PBZ at a flow rate of 50 mL/min for each set of nails Air samples were also taken for the entire day (around 6 hours) at a flow rate of 20 mL/min at three locations (1) in the technician's personal breathing zone (PBZ), (2) in the manicure table area, approximately 1 5 feet from the technician, and (3) in the extended area, approximately 10 feet from the technician

Relative levels of organic compounds were examined using a Photovac MicroTIP™ (Photovac Inc , Thornhill, Ontario, Canada) This instrument recorded the total ionizable solvents present in volts (the term "ionizable" means gases which can be photoionized by a miniature lamp inside the instrument) The MicroTIP™ reported the output (in volts) which was then recorded by a Rustrak Ranger™ data logger (Gulton Industries, Inc , E Greenwich, Rhode Island) Before each set of nails, the MicroTIP™ was calibrated with 100 ppm isobutylene This data was collected to qualitatively analyze how work practices are related to exposures The MicroTIP was located approximately 1 foot from the technician

RESULTS

Methyl methacrylate levels were nondetectable for all the sorbent tube samples taken This was expected since there were only trace levels of methyl methacrylate in the bulk artificial nail application products The ethyl methacrylate data were lognormally distributed, and are shown in Appendix I

For purposes of statistical analysis, the ethyl methacrylate sample results which were reported as ND (nondetectable) were calculated to be the LOD (limit of detection) This results in obtaining the most conservative estimate of the ND value The LOD reported in the lab results was 0 01 mg/sample of ethyl methacrylate

A comparison of the ethyl methacrylate PBZ sample results for both configurations during application of the individual nail sets indicated that exposures were statistically different as a function of configuration (p=0 0054) This value indicated there was less exposure to ethyl methacrylate during application with the modified ventilated table versus the standard unventilated table

When using the unventilated table, the ethyl methacrylate PBZ geometric mean was 10 6 ppm per day when analyzing the data taken for each set of artificial nails applied The geometric standard deviation was 1 4 When using the modified ventilated table, the PBZ ethyl methacrylate geometric mean was 0 8 ppm per day when analyzing the data taken per set of nails, the geometric standard deviation was 2 1 These data are summarized in Table 1

When all the samples taken during the application of one nail set were pooled and examined, it was found that there was no statistical difference among the four technicians that applied nails during the survey (p=0 1219) There was also no statistical difference between the days that nails were applied (p=0 2379) Therefore, neither the technician nor the day was considered to be a variable

A comparison of the ethyl methacrylate PBZ sample results taken for the entire day indicated that exposures were statistically different as a function of

<table>
<tr><th colspan="7">TABLE 1
Breathing Zone Sample Results - 1 Nail Set</th></tr>
<tr><th rowspan="2">Configuration</th><th rowspan="2">Day</th><th rowspan="2">n</th><th rowspan="2">Time (min)</th><th colspan="3">Ethyl Methacrylate</th></tr>
<tr><th>TWA (ppm)</th><th>Geometric Mean (ppm)</th><th>Geometric Standard Deviation</th></tr>
<tr><td rowspan="3">Unventilated</td><td>3</td><td>4</td><td>327</td><td>7 7</td><td rowspan="3">10 6</td><td rowspan="3">1 4</td></tr>
<tr><td>4</td><td>3</td><td>375</td><td>14 5</td></tr>
<tr><td>6</td><td>3</td><td>333</td><td>10 7</td></tr>
<tr><td rowspan="3">Ventilated</td><td>1</td><td>3</td><td>340</td><td>0 9</td><td rowspan="3">0 8</td><td rowspan="3">2 1</td></tr>
<tr><td>2</td><td>3</td><td>376</td><td>1 5</td></tr>
<tr><td>5</td><td>2</td><td>287</td><td>0 3</td></tr>
<tr><td colspan="7">Unventilated = Commercially available unventilated table
Ventilated = Modified commercially available ventilated table
TWA = Time Weighted Average</td></tr>
</table>

configuration (p=0 0054) This value indicated there was less exposure to ethyl methacrylate during application with the modified ventilated table versus the unventilated table

When using the unventilated table, the PBZ sample results showed a geometric mean of 9 4 ppm during the entire day of applying artificial nails, with a geometric standard deviation of 1 4 When using the modified ventilated table, the worker had an exposure with a geometric mean of 0 7 ppm during the entire day of application, with a geometric standard deviation of 2 0 These results are summarized in Table 2

A comparison of the ethyl methacrylate manicure table area sample results taken for the entire day indicated that exposures were statistically different as a function of configuration (p=0 0001) This value indicated there was less exposure to ethyl methacrylate during application with the modified ventilated table versus the unventilated table

When using the unventilated table, the table area had a concentration with a geometric mean of 1 7 ppm for a day applying artificial nails, with a geometric standard deviation of 1 2 When using the modified ventilated table, the table area concentration had a geometric mean of 0 4 ppm per day of application, with a geometric standard deviation of 1 1 These data are summarized in Table 3

A comparison of the ethyl methacrylate extended area sample results that were taken for the entire day indicated that exposures were not statistically different as a function of configuration (p=0 2959)

TABLE 2 Breathing Zone Sample Results - Entire Day					
Day	Configuration	Time (min)	Ethyl Methacrylate		
			Concentration (ppm)	Geometric Mean (ppm)	Geometric Standard Deviation
3	Unventilated	330	7 0	Unventilated 9 4	Unventilated 1 4
4	Unventilated	381	12 8		
6	Unventilated	368	9 3		
1	Ventilated	345	0 4	Ventilated 0 7	Ventilated 2 0
2	Ventilated	376	1 5		
5	Ventilated	327	0 7		

Unventilated = Commercially available unventilated table
Ventilated = Modified commercially available ventilated table

TABLE 3 Table Area Sample Results - Entire Day					
Day	Configuration	Time (min)	Ethyl Methacrylate		
			Concentration (ppm)	Geometric Mean (ppm)	Geometric Standard Deviation
3	Unventilated	333	1 4	Unventilated 1 7	Unventilated 1 2
4	Unventilated	384	1 8		
6	Unventilated	358	1 9		
1	Ventilated	344	0 4	Ventilated 0 4	Ventilated 1 1
2	Ventilated	376	0 3		
5	Ventilated	327	0 4		

Unventilated = Commercially available unventilated table
Ventilated = Modified commercially available ventilated table

When using the unventilated table, the extended area had a concentration with a geometric mean of 0 4 ppm for a day applying artificial nails, with a geometric standard deviation of 1 5 When using the modified ventilated table, the extended area concentration had a geometric mean of 0 3 ppm per day of application, with a geometric standard deviation of 1 1 These data are summarized in Table 4

As expected, the highest readings from the Photovac MicroTIP™ were in the beginning of the application of the nail set - during the removal of nail polish, sanitization, and the actual application of the artificial nail product Readings were also high near the end of the process, during the application of the color coat (color polish) For sanitation reasons, between clients, the technician used a square piece of gauze to soak up the remaining nail liquid monomer (primarily ethyl methacrylate) stored in a small open glass container, approximately 30 mL It was then thrown away in a covered trash can beside the manicure table Elevated readings occurred as the monomer was absorbed by the gauze, and whenever the trash can was opened

TABLE 4
Extended Area Sample Results - Entire Day

Day	Configuration	Time (min)	Ethyl Methacrylate		
			Concentration (ppm)	Geometric Mean (ppm)	Geometric Standard Deviation
3	Unventilated	334	0 4	Unventilated 0 4	Unventilated 1 5
4	Unventilated	384	0 3		
6	Unventilated	358	0 7		
1	Ventilated	344	0 4	Ventilated 0 3	Ventilated 1 1
2	Ventilated	374	0 3		
5	Ventilated	427	0 3		

Unventilated = Commercially available unventilated table
Ventilated = Modified commercially available ventilated table

DISCUSSION

The modified ventilated manicure table is clearly better than the unventilated manicure table for lowering exposures to ethyl methacrylate during artificial nail application, personal exposures were reduced more than tenfold The exposures to methyl methacrylate measured during this study and others[14 16] were well below the current NIOSH REL and OSHA PEL of 100 ppm as an 8-hour TWA The levels observed in the present study seem to indicate that PBZ results for ethyl methacrylate can be achieved down to 0 7 ppm on an 8-hour TWA with the modified ventilated table, as compared to a range of 7 to 14 ppm with the unventilated table

The technicians and clients preferred to use the modified ventilated table to control the odor of the nail application products With the exception of the extended area samples, all sampling results reveal that the modified ventilated manicure table is better to lower exposures to ethyl methacrylates than the unventilated table The extended area sample results are lower for the modified ventilated table, although not statistically lower, than for the unventilated table Since the exposures in the extended area were detectable, the results show that people in surrounding areas are also potentially exposed to ethyl methacrylate, and other chemicals The surrounding area exposures would especially be a factor when several technicians apply nails concurrently

The downdraft technique is a good control option for this process since placement of a duct for ventilation elsewhere would be awkward or not as effective The technician uses both sides of the table for tool and material storage, so ventilation on the side of the manicure table would not be the best option A ventilation duct from above would have to be close to the process to be effective, this placement would interfere with client/technician interaction Also, this type of system could potentially pull contaminants up through the PBZ of the technician/client

In previous walk-through evaluations of other salons, technicians commented that when they used the tables with downdraft ventilation, the additional air flow caused the nail product to crystallize too quickly during application The accelerated and uneven crystallization (curing of the polymer) reduced the time in which the technician had to form the product into the proper shape The technicians at Moore's University did not believe that the additional ventilation caused the nail application products to evaporate more quickly, or cause the nails to dry faster However, this difference in opinion could be due to product or application technique variations between the different facilities A foot-controlled, multispeed fan or built-in damper system may accommodate the needs of most technicians A higher volume would be used for dust collection during filing and to help dry the color coat, the lower volume would be used for nail application during the curing of the polymer while the technician is forming the nail

Exposures are reduced because of the location of the local exhaust system with respect to the source of exposure and the location of the technician's PBZ Good ventilation techniques included distributing the capture potential evenly over the perforated plate near the client's hands, and a design which moved the vapors away from the PBZ In addition, the modified, ventilated table was versatile and practical for the needs of most manicure processes

The real-time readings from the Photovac MicroTIP™ indicated that when the covered trash can located beside the manicure table was opened, there were slightly elevated readings This was intuitive since the odor was much stronger when the trash can was opened The technicians believed the stronger odor was due to the same plastic bag being reused day after day for the trash

The technicians' practice of throwing away gauze pads saturated with liquid monomer nail product adds to the potential ethyl methacrylate exposure

Since the facility was a school, the student technicians used other students' hands to practice applying nails The students were required to perform a predetermined number of hours applying artificial nails Many students would choose to apply artificial nails for 1 or 2 hours at a time However, during this study, the technicians applied nails during the entire day During the three days that the unventilated table was used, the customers complained of the odor accompanying the nail application, there were no comments during the three days of application using the ventilated table The customers were unaware that the ventilation was changed during the study The technicians also noted a major reduction of odor when using the ventilated table

The technicians did not use any personal protective equipment The need for personal protective equipment was evident when artificial nails were being removed, as the acrylic was clipped, chips often flew through the air The technicians noted that this is a common hazard Technicians complained about dust, they also noted that after applying nails for a few hours, headaches often developed Also, there was a soft drink machine located in the manicure area, the technicians and their clients often drank during artificial nail application

A wall exhaust fan was located in the nail application area, as well as in other areas of the school The exhaust fan in the nail application area was located in the outside wall approximately 8 feet high, and was equipped with outdoor louvers When this exhaust fan was turned on, the outside louvers did not open Assuming the fan was the correct size when installed, it was assumed that the louvers were too heavy to open due to dirt, or excess paint layered on the louvers throughout the years One of these outside exhaust openings could be utilized by the facility to exhaust downdraft table contaminants, as was done by NIOSH researchers during this evaluation

During the preliminary walk-through evaluations, it was noted that technicians or clients frequently ate or drank at the manicure table At the facility visited in this study, the area where nails were applied also served as a smoking area

RECOMMENDATIONS

Although exposure concentrations observed in this and other studies indicate that methyl methacrylate levels are below OSHA PELs and NIOSH RELs, it appears that some technicians are still adversely affected by the chemical exposures associated with artificial nail application It is recommended that this facility use the modified ventilated manicure table design If a salon owner wishes to construct their own manicure table using the general modified ventilated table design, there are many considerations When choosing an adequate exhaust volume, one should consider the other costs which may be associated with adding ventilation There will be more air exhausted which will increase the cost to heat or cool the makeup air The downdraft table design should be low noise so as not to interfere with client comfort or conversation The system should have a system to control the volume of air (either a multispeed fan, or a damper on a high volume fan) Also, the system should have a filter to capture dust This filter should be properly maintained according to manufacturer's instructions

The technicians' practice of soaking up the remaining nail product liquid with a gauze pad and placing in the trash can should be eliminated The technician should place the gauze pad in a sealed bag before placing it in the trash can, the trash can liner should be changed daily Also, the technician should not pour out an excess of the liquid into the small glass container from which they work These containers are open to the air, these containers should be replaced with containers that have a small opening for an application brush to enter when pressure is applied by the technician These containers would result in less evaporation of the product, thereby reducing potential exposures to methacrylates

This facility should provide personal protective equipment to the technicians such as gloves, safety glasses, and dust masks as appropriate Technicians should wash hands and other exposed areas with mild soap and water several times throughout the day to remove potentially irritating dust, long-sleeved garments should be worn to help to avoid this dust Eating or drinking should not be permitted in the work areas, since unintentional contact of methacrylates on the face could cause dermatitis, or accidental ingestion Also, there are many other chemicals located in a salon that if ingested could cause health problems Smoking should be eliminated from the entire salon, because many chemicals in a salon, including nail products, are very flammable This would also eliminate the hazards of exposure to second-hand smoke Very often a room is set aside as a smoking area, rarely is this room on a separate ventilation system, therefore, second-hand smoke is distributed throughout the facility

The general ventilation system should be examined As recommended by ASHRAE, the ventilation system should provide at least 25 cfm of outside air per person The outdoor louvers for the exhaust fans in the facility should be maintained to ensure that they are opening properly when the exhaust fans are operating Cleaning of the louvers of excess paint and dirt should allow for proper operation If proper cleaning does not remedy the problem, either lighter louvers or larger capacity fans are necessary, the solution would depend on the amount of ventilation desired Makeup air would also have to be provided to account for the air exhausted An inadequate volume of makeup air would result in negative pressure areas, perhaps resulting in drafts However, adequate makeup air is often provided through outside entries, windows, etc

Use of these recommendations should help this facility toward the goal of maintaining exposures to ethyl methacrylate and other volatile organic chemicals as low as feasible Effective engineering measures, good work practices, and appropriate personal protection should be implemented and maintained in order to maintain exposures to the lowest feasible levels

REFERENCES

1 Gorton A [1993] The history of nail care Nails Magazine, Bobit Publishing Company, Redondo Beach, CA, *February* 42-44

2 Drummey C, ed [1993] Nails magazine 1993 fact book Redondo Beach, CA Bobit Publishing Company, pp 10-12

3 HESIS [1989] Artificial fingernail products a guide to chemical exposures in the nail salon Berkeley, CA Hazard Evaluation System and Information Service, California Occupational Health Program

4 Rycroft RJ [1977] Contact dermatitis from acrylic compounds British Journal of Dermatology *96* 685-687

5 NIOSH/OSHA [1988] NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health/U S Department of Labor, Occupational Safety and Health Administration, DHHS (NIOSH) Publication No 81-123

6 Proctor NH, Hughes ML [1988] Chemical hazards of the workplace 2nd ed Philadelphia, PA J B Lippincott Co

7 U S District Court Decision U C vs C E B Products, Inc 380 Federal Suppl 664 (N D III , 1974)

8 NIOSH [1990] NIOSH pocket guide to chemical hazards Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No 90-117

9 Oberly R, Tansy MF [1985] LC50 values for rats acutely exposed to vapors of acrylic and methacrylic acid esters J Tox Environ Health *16*(6) 811-822

10 Sandmeyer EE, Kirwin CJ [1981] Toxicology In Clayton GD, Clayton FE, eds Patty's industrial hygiene and toxicology 3rd rev ed Vol 2A New York, NY Wiley-Interscience Publishers, pp 2298-2302

11 Kopp SK, McKay RT, Moller DR, Cassedy K, Brooks SM [1988] Asthma and rhinitis due to ethyl cyanoacrylate instant glue Ann Int Med *102*(5) 613-5

12 Shelley, DE [1988] Nail dystrophy and periungual dermatitis due to cyanoacrylate glue sensitivity [letters] J Amer Acad Derm *19*(3) 574-5

13 Belsito DV [1987] Contact dermatitis to ethyl-cyanoacrylate-containing glue Contact Dermatitis *17*(4) 234-6

14 Hiipakka D, Samimi B [1987] Exposure of acrylic fingernail sculptors to organic vapors and methacrylate dusts Am Ind Hyg Assoc J 48(3) 230-237

15 NIOSH [1992] Hazard evaluation and technical assistance Haute Nails, Norman, OK Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No HHE 90-048-2253

16 NIOSH [1992] Hazard evaluation and technical assistance Tina and Angela's Nail Salon, Springdale, OH Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No HHE 92-128-2241

17 CFR [29 CFR 1910 1000 (1989)] Code of Federal regulations Washington, DC U S Government Printing Office, Office of the Federal Register

18 Colorado Board of Barbers and Cosmetologists [1982] Rules and regulations, Section 2(11)A, effective June 1, 1982 to September 30, 1990

19 Colorado Board of Barbers and Cosmetologists [1990] Rules and regulations, Section 6, effective October 1, 1990

20 NIOSH [1984] Methyl methacrylate Method 2537 (supplement issued 5/15/89) In Eller PM, ed NIOSH manual of analytical methods, 3rd rev ed Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Pub 84-100

APPENDIX I

APPENDIX I Moore's University of Hair Design March 23-26 and March 30-31, 1993

									Ethyl Methacrylate		
Tech	Configuration	Day	Sample Location	Sample number	Flow (L/min)	Air Vol (L)	Time (min)	Analyte (mg)	Conc (mg/m3)	Conc (ppm)
3	Unventilated	6	Personal 1 set	MU42	0 05	4 0	79	0 25	63 3	15 5
3	Unventilated	6	Personal 1 set	MU41	0 05	5 2	104	0 24	46 2	11 3
3	Unventilated	6	Personal 1 set	MU36	0 05	7 5	150	0 24	32 0	7 8
2	Unventilated	4	Personal 1 set	MU21	0 05	7 6	152	0 66	86 8	21 2
2	Unventilated	4	Personal 1 set	MU27	0 05	6 7	133	0 19	28 6	7 0
2	Unventilated	4	Personal 1 set	MU26	0 05	4 5	90	0 26	57 8	14 1
2	Unventilated	3	Personal 1 set	MU20	0 05	5 1	101	0 19	37 6	9 2
2	Unventilated	3	Personal 1 set	MU30	0 05	3 5	69	0 09	25 5	6 2
1	Unventilated	3	Personal 1 set	MU13	0 05	6 5	129	0 23	35 7	8 7
2	Unventilated	3	Personal 1 set	MU25	0 05	1 4	28	<0 01	<7 1	<1 7
3	Ventilated	5	Personal 1 set	MU33	0 05	6 5	131	<0 01	<1 5	<0 4
3	Ventilated	5	Personal 1 set	MU35	0 05	7 8	156	0 01	1 3	0 3
2	Ventilated	2	Personal 1 set	MU19	0 05	3 3	65	0 01	3 1	0 8
4	Ventilated	2	Personal 1 set	MU10	0 05	8 7	173	0 10	11 0	2 7
2	Ventilated	2	Personal 1 set	MU11	0 05	6 9	138	0 01	1 4	0 4
1	Ventilated	1	Personal 1 set	MU4	0 05	6 5	130	<0 01	<1 5	<0 4
1	Ventilated	1	Personal 1 set	MU2	0 05	4 8	95	<0 01	<2 1	<0 5
1	Ventilated	1	Personal 1 set	MU5	0 05	5 8	115	0 04	7 3	1 8
3	Unventilated	6	Personal day	MU37	0 02	7 4	368	0 28	38 0	9 3
2	Unventilated	4	Personal day	MU22	0 02	7 6	381	0 40	52 5	12 8
-	Unventilated	3	Personal day	MU15	0 02	6 6	330	0 19	28 8	7 0
3	Ventilated	5	Personal day	MU31	0 02	6 5	327	0 02	3 1	0 7
-	Ventilated	2	Personal day	MU8	0 02	7 5	376	0 05	6 0	1 5
1	Ventilated	1	Personal day	MU3	0 02	6 9	345	<0 01	<1 5	<0 4
3	Ventilated	5	Table area	MU32	0 02	6 5	327	<0 01	<1 5	<0 4
-	Ventilated	2	Table area	MU18	0 02	7 5	376	<0 01	<1 3	<0 3
1	Ventilated	1	Table area	MU6	0 02	6 9	344	<0 01	<1 5	<0 4
3	Unventilated	6	Table area	MU38	0 02	7 2	358	0 06	7 8	1 9
2	Unventilated	4	Table area	MU24	0 02	7 7	384	0 06	7 6	1 8
-	Unventilated	3	Table area	MU14	0 02	6 7	333	0 04	5 9	1 4
3	Ventilated	5	Extended area	MU29	0 02	8 6	427	<0 01	<1 2	<0 3
-	Ventilated	2	Extended area	MU12	0 02	7 5	374	<0 01	<1 3	<0 3
1	Ventilated	1	Extended area	MU7	0 02	6 9	344	<0 01	<1 5	<0 4
3	Unventilated	6	Extended area	MU39	0 02	7 2	358	0 02	2 8	0 7
2	Unventilated	4	Extended area	MU28	0 02	7 7	384	0 01	1 3	0 3
-	Unventilated	3	Extended area	MU16	0 02	6 7	334	<0 01	<1 5	<0 4
-	-	-	Blanks	(1-6)	-	-	-	ND	ND	ND

NOTE LOD = 0 01 mg/sample