HETA 90-048-2253
SEPTEMBER 1992
HAUTE NAILS
NORMAN, OKLAHOMA

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I. SUMMARY

On November 7, 1989, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owner/operator of the Haute Nails Salon, Norman, Oklahoma, to conduct a Health Hazard Evaluation (HHE) at her artificial nail sculpturing and tanning salon. The requestor was concerned about the potential for chemical exposures resulting from the use of nail sculpturing products.

On October 23, 1991, long-term general-area air sampling for volatile organic chemicals (VOCs), formaldehyde, and methacrylates was conducted, along with personal breathing-zone (PBZ) air sampling for methacrylates. An evaluation of the ventilation system was also conducted including CO_2, temperature and relative humidity (RH) measurements.

Qualitative VOC sample results indicated that the major chemical compounds present in the air were acetone, *n*-butyl acetate, ethyl acetate, ethyl methyacrylate, toluene, and 1,1,1-trichloroethane. Quantitative samples collected alongside qualitative samples showed that the highest airborne concentrations ranged from 0.3% to 5.3% of the applicable environmental criteria. Discussions with the employees indicated that they did not have any symptoms related to the use of the nail products.

Analyses of bulk material samples showed that the nail sculpturing products contained methyl and ethyl methacrylate and another unspecified methacrylate ester that was quantitated against isobutyl methyacrylate.

Samples collected specifically for airborne methacrylates detected ethyl methacrylate on all nine samples collected; methyl and isobutyl methacrylate were not detected. Long-term samples collected at the two nail sculpturing tables showed ethyl methacrylate concentrations ranging from 10.3 milligrams per cubic meter (mg/m^3) to 14.1 mg/m^3; the combined time-weighted average (TWA) concentrations at Table #1 was 10.7 mg/m^3 and 12.5 mg/m^3 at Table #2. Short-term PBZ air samples collected during the application of acrylic monomer liquid and polymer powder showed ethyl methacrylate concentrations of 128 mg/m^3 (7-minute sample) and 78.9 mg/m^3 (14-minute sample). Currently their are no standards for exposure to ethyl methyacrylate; however, ethyl and methyl methacrylate are chemically similar and thought to have similiar toxicities. All sample results were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for methyl methacrylate of 410 mg/m^3 as an 8-hour TWA, and the NIOSH recommended exposure limit (REL) of 410 mg/m^3 for up to a 10-hour TWA.

Sampling for airborne formaldehyde showed a trace concentration of formaldehyde indoors. The concentration found was above the analytical limit of detection (LOD), but below the analytical limit of quantitation (LOQ), and is estimated to be about 0.014 parts per million (ppm). The outdoor formaldehyde concentration in the courtyard of the adjoining building was below the LOD (<0.003 ppm).

An inspection of the heating and cooling system serving this salon revealed that there is no mechanical exchange of air (exhaust or intake) for this salon. The results of CO_2 measurements showed that indoor CO_2 concentrations exceeded the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) guideline of 1000 ppm. All temperature and RH readings recorded in the salon were within the ASHRAE comfort zone.

The ventilation evaluation showed that there is no provision for the mechanical introduction of outside air to this business, nor is there an exhaust fan in any part of the business to remove contaminated air. The air sampling data obtained during this evaluation found no overexposures to ethyl methyacrylate (when compared to the methyl methacrylate evaluation criteria); however, an outside air supply duct should be added to the heating and cooling system to provide mechanical ventilation for the building. Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends that 25 cubic feet per minute per person (cfm/person) of outside air be supplied to beauty salons. Recommendations for installing an outside air supply duct to the existing system are presented in Section IX of this report (please see pages 13-14).

KEYWORDS: SIC 7231 (Beauty Shops), acrylic nails, artificial nails, sculptured nails, nail salons, methacrylates, ventilation.

II. INTRODUCTION

On November 7, 1989, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owner/operator of the Haute Nails Salon, Norman, Oklahoma, to conduct a Health Hazard Evaluation (HHE) at her artificial nail sculpturing and tanning salon. The requestor was curious about the potential for chemical exposures resulting from the use of nail sculpturing products.

On October 23, 1991, environmental air samples were collected and a ventilation assessment was performed. Long-term general-area air sampling for volatile organic chemicals (VOCs), formaldehyde, and methacrylates was conducted, along with personal breathing-zone (PBZ) air sampling for methacrylates. An evaluation of the ventilation system was also conducted including carbon dioxide (CO_2), temperature and relative humidity (RH) measurements. Preliminary CO_2, temperature, and RH results were verbally transmitted at the closing conference on October 23, 1991.

III. PROCESS DESCRIPTION

Haute Nails is an artificial nail sculpturing and tanning salon located on the first floor of a two-story brick building. Other businesses located in the building include a beauty salon, and offices on the second story. The nail salon layout includes a waiting room, two nail tables, four tanning booths, a products display area, and restrooms. The restrooms are located in a common area shared with the neighboring beauty salon. At the time of the NIOSH survey the salon employed two full-time nail sculpturers and four part-time receptionists for the tanning beds. Business hours were from 9:00 a.m. to 9:00 p.m.

This nail and tanning salon is served by an air-conditioning system which provides heating and cooling for the business. The system does not provide for the mechanical exchange of outside air and no exhaust fans are located in the area served by the system. The air-handling unit (AHU) is located in a furnace closet at the rear of the business, and is equipped with a fan, a filter, a natural-gas-fired burner and heat exchanger, and a cooling (evaporator) coil (which is provided with refrigerant from an electric-powered mechanical compressor). The system has a network of supply-air ducts (located above the ceiling) which feed supply-air diffusers mounted in the ceiling, a return-air duct located at the furnace closet near the back of the business (below the closet door is an entry grille for the returning air), and the necessary controls and other hardware. The surrounding businesses and offices are served by separate systems and were not evaluated.

Nail sculpturing procedures performed include: 1) the application of a full set of nails, 2) "fill-ins" - as the natural nail under the artificial nail grows out a fill-in is required about every two weeks, and 3) fixing broken acrylic nails. The amount of time required for each of the three procedures varies; application of a full set of nails required approximately 30 to 40 minutes, fill-ins required approximately

15 to 20 minutes, and fixing a single broken nail takes about 5 minutes. Application of a full set of nails requires: removal of old nail polish with a low acetone remover; clipping back loose acrylic nails; filing the nail; applying a primer with disinfectant; applying new acrylic nail using an acrylic polymer powder and an acrylic monomer liquid; filing the newly applied acrylic nails; buffing the nails; and applying new polish (one base coat, two coats of color, one top coat, and a coat of "nail dry" to help the nails dry quicker).

IV. EVALUATION DESIGN AND METHODS

A. Industrial Hygiene Sampling

To determine the types of air contaminants that may be present, Material Safety Data Sheets (MSDSs) of the nail sculpturing products used at this salon were obtained and reviewed prior to the environmental air sampling survey. Potential sources of chemical exposures include methacrylates from the acrylic monomer liquid and powdered acrylic polymer, dusts from sanding of the acrylic nails, and solvents contained in the nail polishes and nail polish removers used in the salon.

On October 23, 1991, long-term air samples were collected to determine the airborne concentrations of chemical contaminants generated during the application of artificial nails. Several air sampling pumps, along with the appropriate sampling media, were placed at the two nail sculpturing tables, as close as possible to the breathing-zone of the nail sculpturists. Each sample group included sampling media for qualitative and quantitative screening for VOCs and methacrylates. Short-term PBZ air samples were collected to evaluate personal exposures to methacrylates during the application of acrylic nails; samples were collected during the entire 30-45 minute procedure and also during the 10-12 minute portion of the procedure when the acrylic monomer liquid and polymer powder were being applied to the nails of the customer. Bulk material samples of the acrylic nail sculpturing substances (liquid and powder) used at this salon were also collected for chemical analysis. The heating and cooling system was visually inspected and CO_2, temperature, and RH measurements were collected inside the salon, and for comparison, outdoors.

Qualitative and quantitative samples for VOCs were collected on charcoal tubes connected via Tygon® tubing to battery-powered sampling pumps calibrated to provide a volumetric airflow rate of 0.05 liters per minute (ℓpm) and 0.1 ℓpm, respectively. These samples were analyzed via gas chromatography/mass spectrometry (GC/MS). Qualitative samples were screened for organic chemical compounds and quantitative samples were analyzed for specific compounds as indicated by the results of the qualitative analyses.

Formaldehyde is present in many cosmetic products (e.g., shampoos) as a preservative and is also present in many construction materials, so

sampling for formaldehyde was conducted to assess airborne formaldehyde concentrations in the salon. Two formaldehyde samples were collected; one indoors, at the front center of the nail salon and one outdoors, in the courtyard of the adjoining building. Formaldehyde samples were collected using impingers (containing an aqueous 1% sodium bisulfite solution) connected via Tygon® tubing to battery-powered sampling pumps calibrated to provide a volumetric airflow rate of 1 ℓpm. Sodium bisulfite solutions were analyzed for formaldehyde by reaction with chromotropic acid and subsequent visible absorption spectrophotometry in accordance with NIOSH Method No. 3500.[1]

Bulk material samples of the acrylic nail sculpturing liquid and powder used at this salon were collected and analyzed. Bulk samples were extracted with carbon disulfide, screened by GC, and then analyzed by GC/MS.

B. Ventilation evaluation

NIOSH investigators visually inspected the heating and cooling system serving the salon. The system's performance was further evaluated by collecting CO_2, temperature, and RH measurements in the nail sculpturing room, at the reception desk, and outdoors for comparison.

Airborne CO_2 concentrations were measured using a Gastech direct reading Portable CO_2 Monitor (Model RI411) set in the 60–sec average mode. The air temperature and RH were measured using a hand-held, direct-reading, electronic Vaisala HM34 Humidity and Temperature Meter.

We intended to collect airflow measurements to determine the amount of outside air being introduced to the facility for comparison to the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) recommendations, but visual inspection of the system and discussions with the architect indicated that there was no provision for outside air exchange.

V. EVALUATION CRITERIA

A. Environmental Evaluation Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed 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 (RELs),[2] 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[3] and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards.[4] The OSHA standards may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is required by the Occupational Safety and Health Act of 1970 (29 USC 651, et seq.) 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 limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures.

B. Heating Ventilating and Air-Conditioning (HVAC) Systems

The outside air ventilation criteria recommended by NIOSH investigators are those published by ASHRAE in the ASHRAE Standard on Ventilation for Acceptable Indoor Air Quality (ASHRAE 62-1989).[5] Table 2 of that document specifies outdoor air requirements for ventilation in commercial facilities. ASHRAE recommends an outdoor air ventilation rate of 25 cubic feet per minute per person (cfm/person) for beauty shops.

C. Temperature and Relative Humidity

The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ASHRAE has published guidelines describing thermal environmental conditions for comfort (ASHRAE Standard 55-1981, Thermal Environmental Conditions for Human Occupancy).[6] These guidelines are intended to achieve thermal

conditions that will be found acceptable or comfortable by at least 80% of the population. The temperatures range from 68°F to 74°F in the winter, and from 73°F to 79°F in the summer. The difference between the two is largely due to seasonal clothing selection. ASHRAE recommends that RH be maintained between 30% and 60%.[5] Excessive humidity can support the growth of pathogenic and allergenic microorganisms.[5]

D. Carbon Dioxide

Carbon dioxide (CO_2) is a normal constituent of exhaled breath and, if monitored, may be useful as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cfm/person for office spaces and conference rooms, 15 cfm/person for reception areas, 25 cfm/person for beauty shops, and 60 cfm/person for smoking lounges, and provides estimated maximum occupancy figures for each area.[5]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration [range 300-350 parts per million (ppm)]. When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased.

E. Methacrylates

The methacrylates are methacrylic esters and are 2-methyl derivatives of acrylic esters. Chemically, they are of the general structure CH_2:C(CH_3)COOR, where "R" represents an organic hydrocarbon group. Biologically, the methacrylates resemble the acrylates, except for their lower reactivity and thus decreased toxicity. This is probably due to steric hindrance by its methyl group and, in turn, decreased rates of membrane transport and systemic translocation.[7] However, relatively, the methacrylates are mild to moderate irritants; thus, inhalation and skin and eye contact should be avoided.[7]

Methyl, ethyl, and isobutyl methyacrylate have been used in various artificial nail sculpturing products. Methyl methacrylate is an irritant of the eyes, skin, and mucous membranes. The toxic effects are due to the monomer; the polymer appears to be inert.[8] The OSHA PEL, NIOSH REL and ACGIH TLV for methyl methacrylate are 100 ppm as an 8-hour TWA.[3,4,9]

While there are no standards for exposure to ethyl and isobutyl methacrylate it has been suggested that the industrial hygiene recommendations for methyl methacrylate can also be applied to these methacrylates.[7]

F. Ethanol (ethyl alcohol)

Ethanol is an mild irritant of the eyes and mucous membranes. The primary route of exposure is through inhalation; but, it can also affect the body if it comes in contact with the eyes or skin, or by ingestion. The liquid can defat the skin, producing a dermatitis characterized by drying and fissuring.[10] The OSHA PEL for ethanol is 1000 ppm averaged over an 8-hour work shift.[4] The NIOSH REL is 1000 ppm averaged over a work shift of up to 10 hours per day.[9]

G. Formaldehyde

Formaldehyde is a colorless gas with a strong, pungent odor detectable at low concentrations;[11,12] its odor threshold is approximately 0.8 ppm.[13] It is commonly utilized as formalin, an aqueous solution containing 37-50% formaldehyde by weight.[11] It is widely used in the production of resins, in the manufacture of many other compounds, as a preservative in many beauty products, as a sterilizing agent, and as an embalming fluid.[14] In some states, the use of formaldehyde cabinet fumigants is required in beauty salons. These fumigants are generally in the form of solid paraformaldehyde tablets or are prepared with formalin solutions (37% formaldehyde).[15,16]

Exposure to formaldehyde can occur through inhalation or skin absorption.[8] The primary non-carcinogenic effects associated with formaldehyde exposure are irritation of the mucous membranes of the eyes and respiratory tract, and allergic sensitization of the skin. Dermatitis due to skin contact with formaldehyde solutions and formaldehyde-containing resins is a well-recognized problem. Both primary skin irritation and allergic dermatitis have been reported.[11]

NIOSH recommends that formaldehyde be handled as a potential occupational carcinogen and that appropriate controls be used to reduce worker exposure to the lowest feasible level. This recommendation is based primarily on a study in which nasal cancers developed in rats and mice following repeated inhalation exposures of approximately 15 ppm formaldehyde.[17]

On May 27, 1992, OSHA amended its existing regulation for occupational exposure to formaldehyde to take effect on June 26, 1992. The final amendments lowered the 8-hour PEL for formaldehyde from 1 ppm to an 8-hour TWA of 0.75 ppm.[18,19] The amendments also added medical removal protection provisions to supplement the existing medical surveillance requirements for those employees suffering significant eye, nose, or throat irritation; and for those suffering from dermal irritation or sensitization from occupational exposure to formaldehyde. Additional hazard labeling, including a warning that formaldehyde presents a potential cancer hazard, is required where formaldehyde air concentrations, under reasonably foreseeable conditions of use, may potentially exceed 0.5 ppm.

The final amendment also provides for annual training of all employees exposed to airborne formaldehyde concentrations of 0.1 ppm or higher.[19]

VI. RESULTS

A. Industrial Hygiene Sample Results

Qualitative samples collected at the two nail sculpturing tables were screened for VOCs and quantitative samples were analyzed for specific VOCs as indicated by the results of the qualitative analyses. Qualitative sample results indicated that the major chemical compounds present were acetone, *n*-butyl acetate, ethyl acetate, ethyl methyacrylate, toluene, and 1,1,1-trichloroethane. Acetone is found in nail polish removers; ethyl acetate, *n*-butyl acetate and toluene are found in nail polishes; ethyl methacrylate is found in the liquid and powdered acrylic nail products; and 1,1,1-trichloroethane is contained in many cleaning compounds. The results of quantitative air samples collected showed that the highest concentrations of acetone, *n*-butyl acetate, ethyl acetate, ethyl methacrylate, toluene, and 1,1,1-trichloroethane, detected ranged from 0.3% to 5.3% of the applicable criteria.

Analyses of the bulk material samples showed that the nail sculpturing products (liquid and powder) used at this salon contained methyl and ethyl methacrylate and an unspecified methacrylate ester that was quantitated against isobutyl methyacrylate.

Samples collected for airborne methacrylates were analyzed for methyl, ethyl, and isobutyl methacrylate based on the results of bulk material analyses of the nail sculpturing products. Ethyl methacrylate was detected on all nine air samples collected for the methacrylates as shown in Table I. Methyl methacrylate and isobutyl methacrylate were not detected on any of the samples collected. Six long-term samples collected at the nail sculpturing tables (three at each table) showed ethyl methacrylate concentrations ranging from 10.3 milligrams per cubic meter (mg/m^3) to 14.1 mg/m^3. The combined TWA concentration for the area sample collected at nail sculpturing table #1 was calculated to be 10.7 mg/m^3 and the full-shift TWA concentration for the area sample collected at table #2 was 12.5 mg/m^3.

Short-term PBZ air samples showed that the nail sculptor at table #1 was exposed to an ethyl methacrylate concentration of 128 mg/m^3 during a 7-minute time period when the acrylic liquid and powder was being applied; and, the nail sculptor at table #2 was exposed to an ethyl methacrylate concentration of 78.9 mg/m^3 during a 14-minute period when the acrylic liquid and powder was being applied. One sample collected during an entire nail sculpturing procedure, from start to finish (37 minutes), showed a minimum airborne ethyl methacrylate concentration of 18.9 mg/m^3. It must be emphasized that the reported concentration is a minimum concentration

because a portion of the sample was lost and the actual concentration is likely higher. Currently their are no standards for exposure to ethyl methyacrylate; but, when compared to the criteria for methyl methacrylate all sample results were below the OSHA PEL and ACGIH TLV of 410 mg/m^3 as an 8-hour TWA, and the NIOSH REL of 410 mg/m^3 for up to a 10-hour TWA.

Sample results showed a trace concentration of airborne formaldehyde indoors. The sample was collected near the front center of the nail salon and the concentration found was above the analytical limit of detection (LOD) but below the limit of quantitation (LOQ) and is estimated to be about 0.014 ppm. The outdoors formaldehyde concentration in the courtyard of the adjoining building was below the LOD (<0.003 ppm).

B. Ventilation Evaluation Results

An inspection of the heating and cooling system serving this salon revealed that there is no provision for the mechanical induction of outside air for this salon, nor is any air exhausted to the outside. Further inspection indicated the air filters had been incorrectly installed and the condensate drain traps overflowed in the past. Many items were stored in the area immediately in front of the return air grille leading to the air-handling unit (AHU) closet; thus, restricting the return airflow.

At the time of the survey the salon was occupied by eight to 12 persons at most times; two full-time nail sculptors, plus one client for each nail sculptor, one to two receptionists, and one to four tanning customers at most times. The results of CO_2 measurements showed indoor CO_2 concentrations of 1200 ppm to 1500 ppm and indicate the indoor CO_2 concentrations rose during the day. The CO_2 concentrations measured indoors exceeded the ASHRAE guideline of 1000 ppm. Outdoor CO_2 concentrations were within the normal range for outdoor environments and ranged from 275 ppm to 300 ppm.

Indoor temperature and RH readings were collected at two locations in the salon; one near the reception desk and the other between the two nail sculpturing tables. All indoor air temperatures were between 75°F and 76°F with relative humidities of 42% to 44%. The outdoor temperature was 81°F to 83°F with relative humidities readings of 51% to 58%. All temperature and RH readings recorded in the salon were within the ASHRAE comfort zone.

VII. DISCUSSION

Products used for sculptured nails and manicures contain chemical ingredients which can have toxic effects at high levels. Acetone is found in nail polish removers; ethyl acetate, *n*-butyl acetate and toluene are found in nail polishes;

and ethyl, methyl, and isobutyl methacrylate have been identified in various brands of liquid (monomer) and powdered (polymer) acrylic nail products.

The nail sculpturing technique was developed in the early 1970s. The first sculptured nail products marketed in the United States contained methyl methacrylate monomer, which manicurists began applying to fingernails to strengthen and lengthen them.[20,21] The use of these products resulted in consumer complaints of allergic contact dermatitis of the nail beds and fingers, nails dystrophy, and inflammation of the tissue surrounding the nail (paronychia).[20,21] Subsequently, the U.S. Food and Drug Administration (FDA) banned the use of the methyl methacrylate monomer in nail products in 1974.[20,21] Since then other methacrylates (i.e., ethyl, butyl, isobutyl) have been substituted in these artificial nail products. There are indications; however, that methyl methacrylate continues to be used despite the FDA ban.[21]

The airborne concentrations of ethyl methacrylate found in this salon were all below the evaluation criteria for methyl methacrylate. The evaluation criteria for methyl methacrylate was used for comparison because there are no existing standards for ethyl methacrylate, and it has been suggested that the toxicity of the two methacrylates are similar, so the evaluation criteria for methyl methacrylate may be applicable to ethyl methacrylate and isobutyl methacrylate.[7,20,21]

VOC air sampling results indicated that the concentrations detected were below the applicable environmental criteria, and employees did not report any symptoms related to the use of the nail products. However, an inspection of the ventilation system indicated that there was no provision for the mechanical induction of outside air to the salon. ASHRAE recommends that 25 cfm/person of outdoor air be supplied to beauty salons. The introduction of outdoor air to this salon would aid in further diluting the airborne concentration of chemical ingredients contained in the products used.

VIII. CONCLUSIONS

The ventilation evaluation showed that there is no provision for the induction of outside air to this business, nor is there an exhaust fan in any part of the business to remove potentially-contaminated air. While the air sampling data obtained during this evaluation indicated that no exposures occurred that were higher than existing industrial evaluation criteria, an outside air supply duct should be added to the heating and cooling system to provide mechanical ventilation for the building.

IX. RECOMMENDATIONS

1. An outside air supply duct should be added to the heating and cooling system to provide for the mechanical introduction of outside air to the salon. The total quantity of outside air supplied to the salon should be based on

the ASHRAE recommendation of 25 cfm/person, using the maximum number of customers and employees expected in the salon at any given time. The building owner should retain the services of a qualified mechanical contractor to design and install this feature; to avoid over-pressurizing the salon it may be necessary to add exhaust fans (the contractor should evaluate whether mechanical exhaust fans are needed to compensate for the outside air inducted). After the modifications are complete, the air-conditioning system fan control (and those for the exhaust systems employed) must be placed in the "on" position whenever the salon is occupied. If the air-conditioning system fan control is left in the "auto" position, the fan will cycle off and on with the burner or air-conditioning compressor based on thermostat demand, and ventilation (outside air exchange) will be intermittent.

2. The heating, ventilating, and air-conditioning systems serving the other spaces of the building (i.e., the adjacent beauty salon and the office spaces above the nail salon) should be considered by the mechanical contractor along with the system in Haute Nails to assure that the modifications recommended above do not lead to the migration of air contaminants from Haute Nails to the other spaces. Although it is desirable for the salons to be maintained under slight "positive pressure" with respect to the outdoors (that is, with the outside-air intake rate slightly exceeding the exhaust-air flowrate), the offices must then be maintained under somewhat greater positive pressure so that they are "positive" with respect to the salons. In general, the recommendations which have been offered in regard to the nail salon also apply to the beauty salon located in the building. The beauty salon should also have an outside air supply of 25 cfm/person as recommended by ASHRAE, and the offices' spaces should meet the ASHRAE requirement of 20 cfm/person for office spaces.

3. Cleaning of the AHUs within the salon should be performed on a regular maintenance schedule. The filters should be changed regularly, and the evaporator coils and condensate drains should be cleaned routinely to prevent the accumulation of standing water, which could provide a medium for the growth of microorganisms that could enter the airstream and affect the indoor air quality. A record of all cleaning performed should be kept and any potential problems promptly corrected.

4. The area immediately in front of the return air grille leading to the AHU closet should not be used as a storage area.

5. An inventory of all products used in the salon should be conducted and Material Safety Data Sheets (MSDSs) of all products used should be obtained from the manufacturer or distributor. An assessment of the toxicity of the individual products should then be conducted and the employees informed of the potential hazards involved.

6. Nail sculptors should receive regular and repeated education about the potential hazards associated with the use of these products and the proper

precautions necessary when using these products. Nail sculptors should remain aware of work practices, such as handwashing and the wearing of protective gloves or barrier creams, to minimize exposure to chemical compounds.[22] Good personal hygiene should be practiced, such as washing of the hands with mild soap and water to remove potentially irritating dusts prior to taking breaks. Additionally, smoking, eating, or drinking should be prohibited at nail sculpturing tables, and smoking should be prohibited anywhere in the salon.

X. REFERENCES

1. NIOSH [1984]. NIOSH manual of analytical methods. 3rd Edition. 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. 84-100.

2. CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. MMWR 37 (suppl S-7).

3. ACGIH [1991]. 1991-1992 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

4. Code of Federal Regulations [1989]. OSHA Table Z-1. 29 CFR 1910.1000. Washington, D.C. U.S. Government Printing Office, Federal Register.

5. ASHRAE [1989]. Ventilation for acceptable indoor air quality. Atlanta, Georgia: American Society of Heating, Refrigerating, and Air conditioning Engineers. ANSI/ASHRAE Standard 62-1989.

6. ASHRAE [1981]. Thermal environmental conditions for human occupancy. Atlanta, Georgia: American Society of Heating, Refrigerating, and Air Conditioning Engineers. ANSI/ASHRAE Standard 55-1981.

7. Sandmeyer EE, Kirwin CJ [1981]. Ester. Chapter 33. In: Clayton GD, Clayton FE, eds. Patty's Industrial Hygiene and Toxicology. 3rd rev. ed. Vol. 2A, Toxicology. New York, NY: Wiley-Interscience Publishers, pp 2298-2302.

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

9. NIOSH [1988]. NIOSH testimony on the Occupational Safety and Health Administration's proposed rule on air contaminants, August 1, 1988, OSHA Docket No. H-020. 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).

10. NIOSH [1977]. Occupational diseases a guide to their recognition. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-181.

11. NIOSH [1977]. Criteria for a recommended standard--occupational exposure to formaldehyde. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control,

National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-126.

12. NIOSH [1988]. Occupational safety and 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, DHHS (NIOSH) Publication No. 89-104, Supplement II-OHG.

13. Amoore JE, Hautala E [1983]. Odor as an aid to chemical safety: odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. J Appl Tox 3:272-290.

14. ACGIH [1990]. 1989 Supplementation documentation-formaldehyde. American Conference of Governmental Industrial Hygienist (ACGIH), Appl Occup Environ Hyg *5*:383-389.

15. NIOSH [1990]. Hazard evaluation and technical assistance: Buckeye Hills Career Center, Rio Grande, 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. 88-153-2072.

16. NIOSH [1991]. Hazard evaluation and technical assistance: Northwest Vocational School, Cincinnati, 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. 88-153-2072.

17. NIOSH [1986]. Current Intelligence Bulletin 34: Formaldehyde: evidence of carcinogenicity. 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. 86-122).

18. Code of Federal Regulations [1987]. Amended formaldehyde standard. 29 CFR 1910.1048. Fed Reg 52 (233). Washington, D.C.: U.S. Government Printing Office, Federal Register.

19. 57 Fed. Reg. 22290 [1992]. Occupational Safety and Health Administration: occupational exposure to formaldehyde; final rule. (To be codified at 29 CFR 1910.1048.)

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

21. Froines JR, Garabrant DH [1986]. Quantitative evaluation of manicurists exposure to methyl, ethyl, and isobutyl methacrylate during production of synthetic fingernails. Appl. Ind. Hyg. 2:70-74.

22. Code of Federal Regulations [1991]. OSHA general industry standards: hazard communication. 29 CFR 1910.1200. Washington, D.C: U.S. Government Printing Office, Federal Register.

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1. Haute Nails, Norman, Oklahoma
2. OSHA, Region VI

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

Ethyl methacrylate concentrations

Haute Nail and Tanning Salon
Norman, Oklahoma
HETA 90-048

October 23, 1992

SAMPLE LOCATION	SAMPLE TYPE	SAMPLE PERIOD BEGIN END	CONCENTRATION (mg/m^3)
Nail Table #1	General-area (GA)	8:33am - 10:55am	10.3
	GA	1:07pm - 4:10pm	10.5
	GA	4:14pm - 6:34pm	11.4
		Combined TWA	10.7
	Short-term PBZ	1:28pm - 1:35pm	128
	Short-term PBZ	3:09pm - 3:46pm	18.9*
Nail Table #2	GA	9:14am - 1:01pm	12.9
	GA	1:31pm - 4:29pm	10.8
	GA	4:38pm - 7:16pm	14.1
		Full-shift TWA	12.5
	Short-term PBZ	2:26pm - 2:40pm	78.9
Environmental Criteria:		NIOSH REL	410
		OSHA PEL	410
		ACGIH TLV	410

Abbreviations:
TWA - time weighted average
PBZ - personal breathing-zone

* - this value is considered a minimum sample concentration, actual sample concentration may be higher because a portion of the sample was lost.