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JAGS BEAUTY SALON
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 Jags Beauty Salon, Norman, Oklahoma, to conduct a health hazard evaluation (HHE). The requestor was concerned about the potential for chemical exposures which may result from working with hair care products.

On October 24, 1991, an environmental evaluation was conducted. Samples were collected to qualitatively screen and identify volatile organic chemicals (VOCs) present in the general workroom air. Additionally, long-term and short-term air samples were collected specifically for the following chemicals or groups of chemical compounds: ammonia, formaldehyde, alcohols, and carbon dioxide (CO_2). Temperature and relative humidity readings were also collected to evaluate thermal comfort and an evaluation of the ventilation system was conducted.

The airborne concentrations of all chemical substances evaluated during this health hazard evaluation were all below their respective evaluation criteria. Airborne ethanol concentrations were less than 3% of the environmental criteria and airborne ammonia concentrations were less than 2% of the environmental criteria. Although formaldehyde was detected at a concentration of 0.027 parts per million (ppm) this is not considered unusual as similar concentrations have been found in many indoor environments.

An inspection of the heating and cooling system revealed that there are no provisions for the introduction of outside air into this building. Accordingly, some of the CO_2 concentrations exceeded the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) recommendation of 1000 ppm. All temperature and relative humidity readings recorded were within the ASHRAE comfort zone.

The ventilation evaluation revealed that there are no provisions for the introduction of outside air into this building, nor is there an exhaust fan in the dispensary (or any part of the building) to exhaust 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. An adequate amount of outside air should be provided to meet the American Society of Heating, Refrigerating, and Air-Conditioning Engineers recommendation of 25 cfm/person of outside air for beauty salons.

KEYWORDS: SIC 7231 (Beauty Shops), ammonia, beauty salons, cosmetology, cosmetologists, hairdressers, hairsprays, permanent wave products, ventilation.

II. INTRODUCTION AND BACKGROUND

On November 7, 1989, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owner/operator of Jags Beauty Salon, Norman, Oklahoma, to conduct a health hazard evaluation (HHE). The requestor was concerned about the potential for chemical exposures, which may result from working with hair care products.

On October 24, 1991, an environmental evaluation was conducted. Samples were collected to qualitatively screen and identify volatile organic chemicals (VOCs) present in the general workroom air. Additionally, long-term and short-term air samples were collected specifically for the following chemicals or groups of chemical compounds: ammonia, formaldehyde, alcohols, and carbon dioxide (CO_2). Temperature and relative humidity readings were also collected to evaluate thermal comfort and an evaluation of the ventilation system was conducted. The preliminary results of the CO_2, temperature and relative humidity measurements, and ventilation evaluation were transmitted verbally at the closing conference on October 24, 1991.

A previous NIOSH HHE focused on exposures to hairsprays and permanent wave products and/or decomposition products of permanent wave products. A review of the MSDSs prior to that investigation indicated that **permanent wave products** generally contain thioglycolic acid in concentrations ranging from 1% to 10%, and many contain ammonia thioglycolate and various hydroxides (e.g., sodium, potassium). Thioglycolic acid readily decomposes to acetic acid and hydrogen sulfide; therefore, air sampling was conducted during that survey to measure airborne concentrations of these two chemical substances, as well as ammonia, which is often present in permanent wave products. The results of environmental air sampling for ingredients and decomposition products of **permanent wave products**, during that NIOSH HHE, showed that ammonia was the only airborne chemical found in quantifiable concentrations; hydrogen sulfide was not detected, while acetic acid was detected but not at quantifiable levels. Furthermore, the airborne concentrations of these three chemical substance were all below their respective evaluation criteria.[(1)]

Review of MSDSs for **aerosol hairsprays** revealed that these products generally contain alcoholic solutions of polymers, minor ingredients, and propellants in a pressurized container. Environmental sampling at the salon previously-mentioned measured total particulate and respirable particulate at concentrations less than 0.1 mg/m^3. Ethanol and isopropanol were less than 3% and less than 1%, respectively, of the environmental criteria. Short-term air samples collected during hairspray application showed ethanol concentrations at 10% - 12% of the applicable long-term environmental criteria (1000 ppm); sample results were compared to the long-term criteria because there is no short-term exposure criteria for ethanol.[(1)]

III. PROCESS DESCRIPTION

Jags Beauty Salon is a hair styling and hair cutting salon located in a detached single-story brick building. The present business owner leases the building. The building

layout includes a waiting area at the front of the building, three hair styling rooms, a restroom, and a dispensary. Two of the three hair styling rooms were being utilized at the time of the NIOSH survey. All hair styling products are stored in the dispensary and most hair care products are mixed in the dispensary. At the time of the NIOSH survey the salon employed one full-time and one part-time cosmetologist, and was open for business from 9:00 a.m. to 9:00 p.m.

The building is served by a residential-type air-conditioning system with heating and cooling capabilities. Its air handling unit (AHU) is located in the attic of the building, 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 located outside at the rear of the building). 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 is located in a closet near the front of the building (the closet door has an entry grille for the returning air), and the necessary controls and other hardware. This system does not have any provision for the induction of outside air, nor is the building equipped with any exhaust fans.

IV. EVALUATION DESIGN AND METHODS

A. Industrial Hygiene Sampling

Conversations with the requester indicated the most-frequently used products at this salon are hairsprays and permanent wave products. Based on this information and air sampling data from the previous NIOSH HHE (detailed earlier), it was determined that this evaluation would focus on ammonia and alcohol exposures resulting from the use of these two types of products, and evaluating the ventilation system serving the salon. Additionally, screening for VOCs was conducted to determine if other chemical substances were present. Because many beauty products and building products contain formaldehyde, airborne sampling for formaldehyde was also conducted.

On October 24, 1991, environmental sampling was conducted to assess general workroom concentrations and personal exposures to ammonia from permanent wave products and alcohols from hairsprays. Formaldehyde sampling was also conducted to assess indoor and outdoor formaldehyde concentrations. A group of four sampling pumps were placed in styling room #1 and included sampling media for qualitative and quantitative samples for volatile organic chemicals (VOCs), ammonia, and alcohols.

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 0.1 liters per minute (ℓpm) and 0.2 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.

Ammonia samples were collected using a modification of NIOSH Method No. S347.[2] Samples were collected on sulfuric acid-treated silica gel solid sorbent tubes connected via Tygon® tubing to battery-powered sampling pumps calibrated to provide a volumetric airflow rate of 0.1 ℓpm for long-term general area samples and 0.2 ℓpm for short-term personal breathing zone (PBZ) air samples. Alkaline phenol and sodium hypochlorite were added to the samples to form indophenol in proportion to the ammonia concentration and analyzed by visible spectrophotometry. The intensity of the blue colored indophenol was measured at 630 nanometers.

Alcohol samples were collected on solid sorbent charcoal tubes connected via Tygon® tubing to battery-powered sampling pumps calibrated to provide a volumetric airflow rate of 0.02 ℓpm for long-term general-area samples and 0.2 ℓpm for short-term PBZ air samples. Based on the result of qualitative samples collected for VOCs, these samples were analyzed for both ethyl alcohol and *n*-butyl alcohol via gas chromatography according to NIOSH Method No. 1400.[3]

Formaldehyde samples (one inside the building and one outdoors) 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.[3]

B. Evaluation of Ventilation System

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 relative humidity readings in the styling room #1, styling room #2, and the reception/waiting room.

Airborne CO_2 concentrations were measured using a Gastech direct reading Portable CO_2 Monitor (Model RI411), set in the 60–sec average mode. Indoor CO_2 concentrations were obtained at three locations throughout the Salon and ambient CO_2 samples were collected outdoors for comparison. The air temperature and relative humidity were measured using a hand-held, direct-reading, electronic Vaisala HM34 Humidity and Temperature Meter.

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),[4] 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[5] and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards.[6] 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. Ammonia

Ammonia, NH_3, is a colorless, strongly alkaline, and extremely soluble gas with a characteristic pungent odor.[7] Ammonia is a severe irritant of the eyes, respiratory tract, and skin.[8] The NIOSH REL for ammonia is 25 ppm as a TWA for up to a 10-hour workday and 35 ppm as a 15-minute STEL.[9] The ACGIH TLV is 25 ppm as an 8-hour TWA and 35 ppm as a 15-minute STEL, and the OSHA PEL is 35 ppm as a 15-minute STEL.[5,6]

C. Ethanol (ethyl alcohol)

Ethanol is a 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.[7] The OSHA PEL for ethanol is 1000 ppm averaged over an 8-hour work shift.[6] The NIOSH REL is 1000 ppm averaged over a work shift of up to 10 hours per day.[9]

D. Formaldehyde

Formaldehyde is a colorless gas with a strong, pungent odor detectable at low concentrations;[10,11] its odor threshold is approximately 0.8 ppm.[12] It is commonly utilized as formalin, an aqueous solution containing 37-50% formaldehyde by weight.[10] It is widely used in the production of resins, in the manufacture of many other compounds, as a preservative, as a sterilizing agent, and as an embalming fluid.[13] 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).[14,15]

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.[10]

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.[16]

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.[17,18] 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 levels, under reasonably foreseeable conditions of use, may potentially exceed 0.5 ppm. The final amendments also provide for annual training of all employees exposed to formaldehyde at levels of 0.1 ppm or higher.[18]

ACGIH classifies formaldehyde as a Suspected Human Carcinogen (i.e., a chemical substance associated with industrial processes, which are suspect of inducing cancer, based on either limited epidemiological evidence or demonstration of carcinogenesis in one or more animal species by appropriate methods).[5] The recommendation of ACGIH concerning a Suspected Human Carcinogen is that worker exposures by all routes be carefully controlled to levels as low as reasonably achievable below its TLV.[5] On June 2, 1992, ACGIH adopted a ceiling limit TLV of 0.3 ppm. A ceiling limit is a concentration that should not be exceeded during any part of the working exposure. ACGIH formerly recommended an 8-hour TLV-TWA of 1 ppm and a 15-minute STEL of 2 ppm for formaldehyde. The revised TLV was adopted to further reduce sensory irritation for workers handling formaldehyde or formaldehyde-containing products. Moreover, ACGIH stated that because of the reported dose-dependent carcinogenic effect in the rat and mouse and the inadequate epidemiologic data on the cancer risk in man, it was advisable to reduce formaldehyde workplace exposure to the lowest possible level.[13]

E. Heating Ventilating and Air-Conditioning Systems

The outside air ventilation criteria recommended by NIOSH investigators are those published by the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) in the ASHRAE Standard on Ventilation for Acceptable Indoor Air Quality (ASHRAE 62-1989).[19] Table 2 of that document specifies outdoor (fresh) air requirements for ventilation in commercial facilities. ASHRAE recommends an outside air ventilation rate of 25 cfm/person for Beauty Shops.

F. 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).[20] 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 relative humidity be maintained between 30% and 60%.[19] Excessive humidity can support the growth of pathogenic and allergenic microorganisms.[19]

G. 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 cubic feet per minute per person (cfm/person) for office spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges, and provides estimated maximum occupancy figures for each area.[19]

Indoor CO_2 concentrations are normally higher than the generally-constant ambient CO_2 concentration (range 300-350 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.

VI. RESULTS

A. Industrial Hygiene Air Sampling Results

The results of general area and personal breathing zone (PBZ) air samples collected on October 24, 1991, are summarized below.

Qualitative and Quantitative Sampling for VOCs

Long-term general area air samples collected for qualitative screening for volatile organic chemicals (VOCs) via GC/MS identified ethanol, siloxanes, butanol, toluene, and numerous aliphatics as the major compounds present in the general workroom air of styling room #1. Other compounds identified include 1,1,1-trichloroethane, ethyl methacrylate, xylenes, butane, and dimethyl ether. These chemical compounds are present in many of the products used in the salon including hairsprays, nail polishes, nail polish remover, and other products.

Based on qualitative screenings for VOCs, the quantitative sample for VOCs was analyzed for ethanol and total hydrocarbons. The ethanol concentration detected on this sample agreed with the concentration detected on samples collected specifically for the alcohols, as discussed below. Quantitative results showed an airborne ethanol concentration of 23 ppm, or less than 3% of the environmental criteria of 1000 ppm. Total airborne hydrocarbon concentrations were 1.7 mg/m^3. While there is no specific criteria for which to compare this value, Molhave notes that concentrations of VOCs higher than 1.7 mg/m^3 have resulted in complaints of irritation in indoor environments.[21]

Hairsprays

Samples collected specifically for alcohols were analyzed for ethanol and *n*-butanol based on the results of the qualitative samples for VOCs. Both alcohols are commonly found in hairsprays. Ethanol was found on the two samples collected for alcohols, but *n*-butanol was not detected on either sample. An ethanol concentration of 22 ppm was detected on a long-term general-area air sample collected in styling room #1; and an ethanol concentration of 24 ppm was detected on a short-term PBZ air sample collected on the hair stylist while applying a hairspray.

Permanent wave products

Ammonia is present in most permanent wave products and is released during their application. All three samples showed concentrations less than 2% of the NIOSH and ACGIH criteria of 25 ppm. Long-term sample results showed that the hair stylist was exposed to a TWA concentration of 0.27 ppm and that the long-term general-area TWA concentration in styling room #1 was 0.20 ppm. A short-term PBZ air sample collected during the application of a permanent wave product showed a detectable concentration of ammonia, but it was less than the analytical limit of quantitation, the approximate concentration present was calculated to be 0.24 ppm.

Formaldehyde

Formaldehyde is often present in various hair care products and in construction materials. Therefore, background sampling for formaldehyde was conducted. The results of long-term sampling for formaldehyde showed a concentration of 0.027 ppm

inside the salon in styling room #1 and no detectable concentration (<0.008 ppm) in the outside air.

B. Ventilation Evaluation

An inspection of the heating and cooling system serving this salon revealed that there is no mechanical supply of outside air to this salon. At the time of the survey the salon was occupied by one full-time cosmetologist the entire workday, one part-time cosmetologist during the afternoon hours, plus one to two customers at most times.

The results of CO_2 measurements showed that indoor CO_2 concentrations ranged from 775 ppm to 1200 ppm. The outdoor CO_2 concentrations ranged from 275 ppm to 325 ppm and were all within the normal range for outdoor environments. These data showed the indoor CO_2 concentrations rose during the day to their highest measured levels at around 6:15 pm, and then dropped to the same levels as the early afternoon hours. Several of the measured concentrations exceeded the ASHRAE guideline of 1000 ppm for indoor CO_2.

Indoor temperature and relative humidity readings were collected at three locations in the salon. Indoor temperatures ranged from 72.3°F to 72.8°F with relative humidities ranging from 49% to 50%. The outdoor temperature was 87°F with a relative humidity of 53%. All temperature and relative humidity readings recorded in the salon were within the ASHRAE comfort zone.

VII. DISCUSSION

A. Exposures to Chemical Agents

Services performed by hairdressers include haircutting, cleansing, conditioning, and corrosive treatments for the hair and scalp, as well as treatments designed to hold the hair in place or change its shape, configuration or color.[22] Cosmetologists also perform other beauty services such as massaging the face and neck with creams and oils, coloring eyebrows and lashes, manicuring fingernails and toenails, and hair removal by various techniques.[23]

Many chemical compounds contained in beauty products (e.g., hairsprays, permanent wave products, dyes, bleaches, etc.) are capable of causing skin irritation, respiratory problems including bronchial irritation and occupational asthma, and other adverse symptoms through inhalation and dermal absorption.[22-25] Epidemiological evidence also suggests an elevated risk of cancer at several sites (particularly bladder and lung) for hairdressers with exposure to hair care products.[22,26,27]

Contact dermatitis is a well-recognized, and possibly the most-frequent, occupational disease among cosmetologists. Dermatitis can seriously inhibit the effectiveness and ability of a beautician to perform the basic services of the profession.[28,29] Many of the products used by beauticians, including permanent wave solutions and oxidation-

type hair coloring preparations, contain both dermal irritants and sensitizers. Oxidation-type hair coloring preparations may also be carcinogenic.[22]

Asthma, a lung disorder characterized by reversible obstruction of the lung airway system (bronchial tubes) causes intermittent respiratory symptoms, including shortness of breath, wheezing, chest tightness, and cough. In occupational asthma, airway obstruction is caused or made worse by workplace exposure to dusts, fumes, gases, or vapors.[30] In the U.S., asthma occurs in about 5% of the general population; 2% of these cases are thought to be occupational.[31] Occupational asthma among hair stylists has been associated with persulphate salts used in hair bleaches, henna, and other hair dyes containing paraphenylenediamine.[24,25] In addition to shortness of breath, cough, wheezing, and chest discomfort, other symptoms including irritation of the mucous membranes of the eyes, nose, and throat, headache, nausea, and vomiting following exposure to various aerosols have been recorded.[24,32,33,34] Peak flow meters have been used to demonstrate reversible airway obstructions associated with the work environment.[24,35,36] Frequently, additional testing such as pulmonary function tests and various immunological tests are included in such studies.

This HHE focused on assessing chemical exposures of beauticians through inhalation of alcohols contained in hairsprays, ammonia released during the application of permanent wave products, airborne formaldehyde released from beauty products and construction materials, and an evaluation of the ventilation system. The airborne concentrations of each individual chemical substance evaluated during this health hazard evaluation were all below their respective evaluation criteria. Airborne ethanol concentrations were less than 3% of the environmental criteria and airborne ammonia concentrations were less than 2% of the environmental criteria. The airborne formaldehyde concentration found (0.027 ppm) is not considered unusual as similar levels have been found in many indoor environments.[37]

Formaldehyde cabinet fumigants were not used at this beauty salon and are not required by the State of Oklahoma, but are required in other states. Two previous NIOSH HHE investigations at beauty schools within the vocational program of two public school systems focused on the use of formaldehyde cabinet fumigants and showed that the use of cabinet fumigants contributed to the overall formaldehyde concentrations found at these schools.[14,15] Any products or fixtures containing formaldehyde can contribute to airborne formaldehyde concentrations within the work environment. Therefore, the use of all products containing formaldehyde or any suspected or confirmed carcinogen should be discontinued where possible. In instances where this is not feasible, personnel should be protected by the use of engineering controls.

The basic principles for controlling airborne contaminants in the occupational environment consist of substitution, isolation, and ventilation. Product substitution and/or ventilation are the two choices best suited for controlling airborne contaminants in beauty salons. Product substitution (i.e., elimination) is the first and most effective method of controlling airborne contaminants and should be used if possible. In instances where product substitution is not feasible, local exhaust or dilution ventilation should be used to remove chemical contaminants generated from the various beauty products used.

B. Ventilation Evaluation

An inspection of the heating and cooling system showed that there was no provision for induction of outside air for this building. The busiest times at this salon were from about 1:00 p.m. to 6:00 p.m., when both the full-time and part-time stylist were working with customers. During this survey, CO_2 measurements were highest when both stylists were present and had customers, CO_2 concentrations at about 6:15 p.m. exceeded the ASHRAE recommendation of 1000 ppm.

It should be emphasized that CO_2 concentrations are only one of the parameters used for assessing the effectiveness of ventilation systems and indoor air quality in office building environments. Elevated CO_2 concentrations can be used as an indicator of insufficient outside air being introduced to beauty salons; however, CO_2 concentrations alone cannot be used to indicate that enough outside air is being introduced to a salon for two reasons: 1) office building environments generally do not have the major contaminant sources that are present in beauty salons; 2) ASHRAE recommends higher outside air rates for beauty salons than for office spaces, therefore CO_2 concentrations would likely be diluted to a greater extent by the higher rates required for beauty salons. ASHRAE recommends that outside air be provided at a rate of 25 cfm/person for beauty salons, as compared with their recommendation of 20 cfm/person for office spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges. It should be further noted that these recommendations are only guidelines and if additional outside air is needed to control odors and contaminants, it should be provided.

A more appropriate measurement for assessing the effectiveness of the ventilation systems would be to determine the amount of outside air being introduced to the salon. When determining outside air intake rates, actual airflow measurements should be collected rather than estimating the flowrate based on the position of the outside air intake damper.

The ventilation system at this salon should be designed to provide outside air at a rate based on the maximum number of cosmetologists and patrons expected in the salon at any given time and the ASHRAE recommendation of 25 cfm/person. To prevent airborne contaminants from stagnating, air in the salon should be distributed as evenly as possible. An air velocity of 25-50 feet per minute is recommended for the occupied zone (from the floor to 6 foot in height).[38] The exact recommended velocity is dependent upon the temperature and relative humidity of the air in the space.

Most of the chemical products used in this salon are mixed in the dispensary. The dispensary should be under negative pressure relative to the other areas of the salon to prevent odor migration, should a spill occur. To accomplish this, an exhaust fan should be installed in the dispensary and should be exhausted above the roof of the building. Exhaust airflow from the dispensary should be at least 10% greater than the supply flow to the dispensary. When feasible, the mixing of permanent wave solutions and all other chemical products used in the salon should be done in the dispensary.

VIII. CONCLUSIONS

The ventilation evaluation showed that there is no outside air induction for this building, nor is there an exhaust fan in the dispensary or any part of the building to exhaust 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. A exhaust fan should be installed in the dispensary. Ducting for the exhaust fan should be run through the roof of the building and potentially-contaminated air should be exhausted directly to the outdoors.

2. An outside air supply duct should be added to the heating and cooling system to provide an outside air supply rate of about 200 cfm, sufficient for sustained occupancy of eight persons under ASHRAE guidelines of 25 cfm/person for beauty salons. If a possibility of expanding the business exists (i.e., hiring more cosmetologists) a larger air supply should be considered.

3. Cleaning of all AHUs within the building should be performed on a regular maintenance schedule. A record of all cleaning performed should be kept by the building management, and any potential problems corrected.

4. The return plenum in the front closet should not be used as a storage area.

5. An inventory of all products used in the salon should be compiled and Material Safety Data Sheets (MSDSs) of all products used should be obtained from the manufacturer or distributor and made accessible by all employees.

6. Hairdressers should receive regular and repeated education about the potential hazards in the workplace. When possible, products that contain known chemical allergens should be substituted for those that do not. Hairdressers should remain aware of work practices, such as handwashing and the wearing of protective gloves, to minimize exposure to chemical compounds.[39]

7. Hairdressers with a history of asthma or allergic reaction to chemicals, or who experience respiratory or skin irritation problems should inform their physicians about their exposures at work.

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