NEW YORK STATE | Department of Health

Review of Chemicals Used in Nail Salons

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Introduction

As part of the work of the NYS Nail Salon Task Force, the NYS Department of Health (DOH) conducted a review of chemical agents used in nail salons by reviewing relevant scientific literature and consulting with partners in other state and federal health and environmental agencies. The review focused on the types of chemicals found in nail products, the potential adverse health effects associated with exposure to nail-product chemicals, evidence of chemical exposures in nail salon workers, and evidence supporting actions to reduce chemical exposures in nail salons.

Many different types of products are used when providing nail specialty services. These products contain a large variety of chemical ingredients. Many nail-product ingredients evaporate easily producing vapors and odors that may be inhaled or contact eyes and mucus membranes of nail salon workers and clients. Also, certain procedures during nail care generate dust which may be inhaled. Skin contact is also inherent in the use of nail-care products. Some types of chemicals commonly found in nail salon products are known to be associated with adverse health effects at relatively high exposure levels. Hence, concern has been raised about whether nail salon workers and clients could be at risk for such adverse health effects.

The scope of this review is focused on summarizing existing information on the types of chemical ingredients found in nail salon products and in the nail salon indoor environment, the potential hazards of chemicals in nail salon products, and the effectiveness of interventions to reduce potential hazards. Peer-reviewed scientific literature and information sources from authoritative health and environmental agencies were reviewed, along with existing laws, regulations, and governmental policies related to nail salon chemicals. In addition to published sources, DOH staff consulted with subject-matter experts at other state and federal health and environmental agencies. The information obtained from these reviews and consultations was evaluated and is synthesized in the following summary sections. More detailed technical assessment supporting the summary sections is found in the report appendices. The findings from this review were used to inform DOH recommendations by considering whether measures beyond current regulatory requirements are needed to protect nail salon workers and clients.

Chemicals used in nail salon products

We evaluated information sources including product labels, product safety data sheets (SDS[1]), nail salon industry literature, online toxicology databases, existing nail salon product information from other local, state, and federal agencies, and US and international regulatory information related to chemicals in nail salon products and other cosmetics. Based on review of all of these information sources, there are many different chemicals that can be found in nail product formulations. For example, a report supported by the Toxics Use Reduction Institute at University of Massachusetts, Lowell, identified approximately 100 chemicals potentially found in

[1] Safety data sheets are required elements of the OSHA hazard communication standard, and are intended to communicate information on the potential hazards of exposure to each chemical in a product.

nail salon products.[2] Moreover, our review of product SDSs showed that a single nail polish, for example, can contain dozens of chemical constituents.[3]

We found that while products within a single category (such as nail polishes or artificial nails) can share some common constituents (e.g., acetates, phthalates, methacrylates), the list of ingredients can vary between products and can potentially be influenced by individual product characteristics such as polish color, texture, drying time or other product features. Thus, chemical ingredients common now or in the past may not be used in the future, while other chemicals, not currently in use, may become common in the future as fashion trends (and, as a result, product characteristics) change over time. For example, a nail specialty trade association publication issued a report on nail industry statistics that showed an increase in use of brush-on-gel polishes – which may include some different chemical ingredients from other types of polish[4] – from 2013 to 2014. Gel treatments were also the most frequently added service among the surveyed nail salons in 2014.[5]

There can also be nail product misbranding (e.g., discrepancies between the chemicals listed on nail product labels and the actual chemicals present in the product), leading to further challenges developing a list of known nail product chemicals. Sampling of nail salon products in 2012 by the California Environmental Protection Agency (CA EPA), for example, detected toluene in 10 out of 12 products with labeling claims that the products were "toluene-free".[6]

Given the uncertainties associated with nail salon product information, developing a list of nail product chemical ingredients that will be comprehensive and remain accurate over time is not feasible. Nevertheless, based on our review, a listing of chemicals and chemical categories that are most commonly reported in current nail salon products and, in some cases, have been detected in air-monitoring studies in nail salons has been developed (Appendix 1, Table A1). There are about 30 chemicals or chemical categories that appear to be commonly used in nail products. Additional product ingredients that were identified in a limited review of product Safety Data Sheets, but had less supporting information from other sources, are also presented in Appendix 1.

[2] New Ecology Inc., 2006. Toxicity, Safety and Performance Evaluation of Alternative Nail Products. http://www.turi.org/Our_Work/Business/Small_Businesses/Nail_and_Hair_Salons/Nail_Salons/Reports
[3] Toxnet Household Product Database, 2015
[4] According to an article by Nail Magazine (2011), gel nail polishes use the same types of solvents as traditional nail polishes, but can also have other chemical constituents used to lower the viscosity of the product so that application is similar to that of a polish.
[5] Nail Magazine, 2015
[6] Guo et al., 2012. Summary of data and findings from testing of a limited number of nail products. CA EPA, Department of Toxic Substance Control.

Potential health effects of exposure to chemicals in nail salon products

We reviewed available information describing potential health effects that could occur if there was substantial exposure to the chemicals listed in Table A1. The different bodies of scientific, technical, and industry literature researched for this review, included:

- summaries of toxicology information developed by other authoritative state, federal, and non-governmental sources[7]
- product ingredient information from safety data sheets (SDSs) available via online searches[8]
- peer-reviewed literature on environmental epidemiology and industrial hygiene studies conducted in nail salons

Many of the chemicals listed in Table A1 are associated with similar short-term effects (e.g., reversible central nervous system effects such as headache, dizziness, and drowsiness; and irritation of the skin, eyes and respiratory system). Potential health effects that could be associated with long-term exposure to the listed chemicals include skin sensitization, cancer, and chronic non-cancer effects affecting various organs or systems (e.g., reproductive, developmental, central nervous system, liver, kidneys).

The potential health effects information presented in Table A1 does not imply that these health effects are known or are likely to occur with routine use of nail salon products. The risk or likelihood of a nail salon worker or client experiencing any adverse health effect would depend on many factors such as the exposure concentration, how often exposure occurs, for how long, the route of exposure (ingestion, inhalation, or direct contact), and factors related to individual susceptibility, general health status, pre-existing health conditions, and so on.

Likewise, Table A1 does not provide an exhaustive list of potential health effects for the listed chemicals because, for some, the toxicity database may not be complete. Also the available information reflects only the results of toxicity testing performed on individual chemicals, whereas exposure is generally to mixtures of chemicals that have not been evaluated for their combined toxic effects. Given these uncertainties, the risk of short-term and long-term health effects due to routine product use can be best minimized by adequately controlling exposures to chemicals in nail salon products.

The chemical toxicity information presented in Table A1 derives mainly from summaries published by authoritative sources of chemical-specific toxicity testing studies, as well as chemical-specific hazard information presented in safety data sheets. In contrast, our review of environmental epidemiology studies focused on health outcomes in nail salon workers. The literature in this area is sparse, but we did not find clear evidence of associations between nail salon work and chronic health outcomes such as reproductive effects. Also, epidemiology studies were not found that attempted to investigate whether specific chemical ingredients or specific products used during nail specialty work were associated with particular health outcomes. While limited, the epidemiology literature suggests that working in the nail salon environment may be associated with various respiratory, musculoskeletal, and neuropsychological symptoms (Appendix 2).

[7] A complete reference list is appended to Table A1.
[8] Online search engines were used to identify nail salon product SDSs using search phrases like “nail polish,” “nail salon product,” “nail polish remover,” “artificial nails” etc.

Chemical exposure in nail salon workers

Published studies that we reviewed of air sampling in nail salons found that several types of volatile organic compounds (VOCs) were commonly detected in nail salon air (Appendix 3). In particular, acetone, toluene, alcohols, and several acetates were reported from nail salons at higher levels than typically found in non-industrial indoor air. Two studies reporting a measure of total VOCs also reported levels in nail salons somewhat higher than levels typically expected in non-industrial indoor settings.

Two studies conducted by researchers from the DOH Wadsworth Center laboratories investigated the presence of phthalates and siloxanes in various indoor settings, including nail and hair salons. Overall, phthalates and siloxanes from all sampled environments were detected at much lower levels than other VOCs reported from nail salons. However, the mean phthalate and siloxane concentrations were higher in salons than in other settings investigated (e.g., homes, office, laboratories, and schools.[9] Of particular note, dibutyl phthalate was detected in all nail salon samples, but at very low levels (less than 0.5 micrograms per cubic meter [ug/m^3]), and somewhat below levels found in hair salons.

Formaldehyde was reported from nail salon air samples in some studies. Formaldehyde concentrations reported from nail salons were generally below concentrations reported for air in new housing or buildings with extensive wooden surfaces. Building materials such as wood products and adhesives are known to contribute to formaldehyde levels inside buildings, and the limited information from nail salons suggests that contributions of formaldehyde to indoor air from nail salon products may be low compared to building materials.

Methyl methacrylate was detected in air samples from three studies that analyzed for it (two in California, one in Utah). Since background levels of methyl methacrylate are generally very low, products used in the nail salons likely contributed to these detections. However, the sale, use, or application of monomeric methyl methacrylate to any person by appearance enhancement businesses was prohibited in New York State in 2001 (Article 27, Section 404-a of the General Business Law). Therefore, these results are not likely to be relevant to nail salons in New York State.

Interventions to reduce potential chemical exposures in nail salons

As discussed above, nail specialty work entails the use of many different products containing potentially dozens of different chemical ingredients that can change over time. Most of the chemicals of interest identified in Table A1 can readily evaporate when exposed to the air, and people can be exposed to the chemicals through inhalation of vapors from the salon air. Direct contact with chemicals in nail salon products is also a potential exposure route for nail-salon workers and clients and includes skin contact or eye contact from splashes.

In general, protection of workers from chemical exposures in the workplace relies on recognizing potential hazards, assessing exposure potential, and developing appropriate control strategies to reduce or eliminate potential exposures. The concept of hierarchy of controls is commonly used in workplace settings as a systematic way to consider alternative strategies for reducing potential chemical

[9] Tran TM and Kannan K, 2015. Occurrence of Phthalate Diesters in Particulate and Vapor Phases in Indoor Air and Implications for Human Exposure in Albany, New York, USA. Arch Environ Contam Toxicol. v68:489–499. Tran TM, and Kannan K. 2015. Occurrence of cyclic and linear siloxanes in indoor air from Albany, New York, USA, and its implications for inhalation exposure. Science of the Total Environment 511: 138-144.

exposures.[10] The range of controls to reduce exposure for workers and clients is dependent on the route of exposure, the degree of risk posed by the exposure, and the feasibility of implementation. Controls that do not require active implementation by each employee provide the greatest degree of protection, and are therefore preferred whenever possible. Hence, complete elimination of the hazard, if possible, is the most preferred category of control in the hierarchy. Additional hierarchy options in decreasing order of protectiveness include:

- product substitution – if possible, identify and use inherently less toxic products or ingredients.
- engineering controls – for example, the use of enhanced exhaust ventilation to remove volatile chemicals from the air before it is inhaled by workers or clients.
- administrative controls – for example, written policies and training to encourage proper procedures for handling chemicals in the workplace and to encourage personal work habitats that reduce the opportunity for chemical exposure.
- personal protective equipment (PPE) – protective clothing, gloves, respiratory protection, etc.; PPE requires active diligence on the part of the employee and supervisor to ensure equipment is always available, used when needed, and used correctly.

Chemical elimination has been applied to a limited degree in the appearance-enhancement industry. Many states, including New York,[11] have statutory or regulatory bans in place on the use of monomeric methyl methacrylate by appearance enhancement businesses. Additional chemical bans apply to the broader category of cosmetic products in the United States and internationally. Voluntary programs such as the California Healthy Nail Salons Cooperative program endorse avoiding products that contain other chemicals including toluene, formaldehyde, dibutyl phthalate, ethyl acetate, butyl acetate, and methyl ethyl ketone.[12] If chemicals of greater toxicity concern are effectively removed from products use in nail salons, the exposure concern related to those particular chemicals is eliminated. The range of regulatory controls that relate to nail salon products is discussed further in the following section.

Substituting less hazardous chemicals in products, when feasible, is another preferred strategy to reduce potential health risks associated with the use of these products. Clearly, however, the products used in nail salons, and the ingredients in those products can change frequently. Therefore, it may not be feasible to identify an ingredient substitution approach that would be robust over time. It is also often challenging to determine whether potential substitutes are, in fact, less hazardous than the ingredient they are replacing. Absent effective ingredient substitution, the next preferable approach to keeping workplace exposures low is to implement effective engineering controls.

Engineering controls protect workers by removing hazardous conditions or by placing a barrier between the worker and the hazard. Ventilation is a commonly used engineering control to reduce workplace exposure to airborne chemicals including vapors and dust. There are two main categories of ventilation control systems: local exhaust ventilation and dilution ventilation. Local exhaust ventilation (LEV) systems, such as downdraft tables, are intended to capture contaminants at or near their source of release and to remove them from the area before they can be inhaled by a worker or other occupant. Local exhaust ventilation systems that capture air contaminants at the point of generation and discharge them to the outdoor air are the preferred ventilation method for toxic materials. By contrast, dilution

[10] See, for example, Weinberg, J. L., Bunin, L. J., & Das, R. (2009). Application of the Industrial Hygiene Hierarchy of Controls to Prioritize and Promote Safer Methods of Pest Control: A Case Study. *Public Health Reports*, *124* (Suppl 1), 53–62.
[11] NYS General Business Law, Article 27, Section 404-a.
[12] http://www.cahealthynailsalons.org/what-is-hns/about-healthy-nail-salons/

ventilation systems reduce the general concentration of contaminants within the room or area, but do not remove the contaminant at its source. Dilution ventilation is primarily used to provide conditioned air to the area for general comfort and odor control.

In 2000, NIOSH investigators published a case study evaluating a new manicure table that was developed for applying artificial nails at a cosmetology school in Trinidad, Colorado.[13] The manicure table evaluated in this study was 19 feet long and 2 feet wide, and had 6 work stations. Each station consisted of a 15 x 15 inch grill with downdraft ventilation where customers rest their hands during the application of artificial nails.

Personal breathing-zone air samples were collected from cosmetology students during the time they applied artificial nails and taught new students how to apply artificial nails. Samples were collected while nails were applied on tables without local exhaust ventilation, as well as when using the new manicure table with the downdraft ventilation system in operation. Four breathing-zone samples for ethyl methacrylate were collected without local exhaust ventilation, and five samples were collected while using the downdraft table.

Exposure concentrations of ethyl methacrylate among four persons applying and teaching the application of artificial finger-nails ranged from 1.0 to 11 parts per million (ppm). Five cosmetology students using the new table with local exhaust ventilation were exposed to ethyl methacrylate concentrations ranging from non-detectable to 0.16 ppm. Observations using smoke tubes[14] indicated that effective capture zones existed up to 10 inches above each station.

The authors concluded that “The new manicure work table was effective in reducing exposure to ethyl methacrylate among cosmetology students. Smoke tube observations showed that the LEV system effectively kept contaminants out of the manicurists’ breathing zones.” The authors noted however that the air sampling results obtained from before and after the LEV system was installed are not directly comparable due to differences in the skill levels of the students and the number of nails they applied during air sampling.

In 2012, NIOSH conducted a research project to examine the effectiveness of different portable source capture ventilation systems (SCVS, a form of LEV) with the potential for use in nail salons.[15] Several different SCV system configurations were tested under controlled laboratory conditions and, on average, were found to reduce exposures by at least 50%. The highest collection efficiency achieved was 61.7%. The investigators reported that additional testing could be used to determine configurations that would improve collection efficiency, and that practical testing in nail salons would be necessary to determine if this arrangement would be accepted by nail technicians.

Although limited, these data indicate that LEV systems have the potential to reduce personal breathing-zone exposures of nail salon workers to chemicals in products they are using by more than 50%. A significant limitation of these NIOSH studies is that they were conducted under a limited set of operational conditions, and the results are not necessarily generalizable to all nail salons. Each nail salon will have unique attributes such as size, occupancy, positions of windows and doors, location relative to neighboring stores or buildings, workstation layout, etc., that can affect the design and performance of a LEV system. Additional data are needed to better understand how the many different

[13] Lee S, McCammon J, McGlothlin C, Phillips J. 2000. A new manicure table for applying artificial fingernails. Appl Occup Environ Hyg. 15(1):1-4.
[14] Smoke tube observation is a method for visualizing air movement.
[15] Marlow DA, Looney T, and Reutman s. 2012. An Evaluation of Local Exhaust Ventilation Systems for Controlling Hazardous Exposures in Nail Salons. NIOSH EPHB Report No. 005-164.

variables related to the nail salon building environment, and the design of LEV systems themselves affect their performance.

One important benefit of control strategies based on chemical elimination, product substitution, and engineering controls is that no active decision is required on the part of the worker or client to implement these controls. The controls are automatically applied to all workers, assuming they are not accidentally or purposely circumvented. Administrative controls and the use of PPE depend on active implementation by the worker and employer on a continual basis. For example, written manuals and training can emphasize that mixing chemicals should only be done in designated locations with adequate exhaust ventilation, or that hands should be properly washed with soap and water between client procedures. However, barriers may exist that limit access to the proper facilities, or workers may choose to deviate from the policies for other reasons such as convenience or comfort. Similarly, the protective benefit of PPE use will be lost if the appropriate equipment is not used when indicated. The effective use of administrative controls and PPE requires additional diligence on the part of workers and supervisors to ensure that all equipment and facilities needed to comply with protective policies are made available and properly maintained at all times, and that they are consistently and correctly used when indicated.

Chemical elimination or substitution in nail salon products

Implementing voluntary or mandatory programs that regulate chemical use and product formulation is an approach to reducing chemical exposures associated with products used in nail salons based on chemical elimination or product substitution. We researched existing regulatory documentation from a selection of local, state, and federal agencies (in the U.S. and internationally), and independent third-party standards-setting organizations. We also consulted with technical expert counterparts in some agencies regarding existing programs. The review was primarily intended to explore the range of existing regulatory approaches to chemical elimination from nail salon products implemented by other jurisdictions (Appendix 4), not to evaluate program effectiveness.

With the exception of state bans on the use of methyl methacrylate,[16] we did not find examples of strict statutory or regulatory prohibitions against chemicals in nail salon products themselves. Several examples of regulations prohibiting or restricting the use of certain chemicals in the broader category of cosmetic products or personal care products were identified, including regulations of the European Commission, Health Canada, the Japanese Ministry of Health and Welfare, and the U.S. Food and Drug Administration (see Table A8).

Voluntary certification programs exist that are administered by state or local governments, or by private third-party organizations. Programs exist that certify either products used in salons or nail salons as a whole. In general, these labor intensive certification programs establish a set of criteria that have to be met by a manufacturer or a nail salon owner in order to receive certification endorsement under the program. Voluntary programs for nail salons and cosmetic products include prohibitions on the use of certain chemical ingredients as a program component.

The least stringent type of control program applied to chemicals in nail salon products is guidance or recommendations developed by local, state, and federal agencies. Many health and environmental agencies recommend avoiding products containing certain chemical ingredients such as phthalates or formaldehyde. In California, products containing ingredients identified by the state as carcinogens or reproductive/development toxicants are labeled with statements to that effect.[17] The labeling acts as a

[16] Including the NYS ban that applies to appearance enhancement businesses.
[17] The California Proposition 65 program: http://oehha.ca.gov/prop65/background/p65plain.html

form of guidance to the consumer regarding the presence of potentially hazardous ingredients, but does not make specific use or avoidance recommendations.

The regulatory and guidance programs reviewed here vary substantially in the number and types of chemicals that are prohibited in products or for which avoidance is recommended. Nevertheless, restrictions or prohibitions against some chemicals or chemical classes are common to many of the programs. Common recommendations in guidance and voluntary certification programs include avoiding products containing toluene, formaldehyde, and dibutyl phthalate. Other ingredients for which avoidance is frequently recommended include methacrylic acid; methyl-, ethyl-, and butyl-acetates; and ketones including methyl-ethyl ketone and acetone. Voluntary certification programs for the broader category of cosmetics and personal-care products include larger lists of prohibited ingredients (see Tables A6 and A7).

Conclusions

The scientific literature and other documentation reviewed and evaluated here clearly indicate that a wide variety of chemicals can be found in nail salon products. Many are volatile organic chemicals that can readily evaporate into the air, and could be present in indoor air of nail salons at substantial levels if engineering controls and appropriate product-handling procedures are not appropriately implemented. Air monitoring and analytical methods employed in the studies we reviewed would not be expected to detect all potential nail salon product ingredients. So the list of chemicals of primary interest is likely not exhaustive, but it does represent common product ingredients, and ingredients identified by many different authorities as potentially contributing to worker and client exposure in nail salons.

Studies of health outcomes in nail salon workers (Appendix 2) are suggestive that working in the nail salon environment can be associated with various respiratory, musculoskeletal, and neuropsychological symptoms. The number of studies investigating health outcomes in nail salon workers is small, and some studies did not include adequate control groups or are limited in their ability to account for errors due to bias and confounding. Nevertheless, there is some consistent evidence that nail salon workers are more likely to report non-specific symptoms such as mucous-membrane (eye, nose, throat) irritation, skin irritation, and headache than comparison groups. More limited data suggest working in a nail salon could be associated with small decreases in performance on some standardized neurobehavioral tests. No studies were identified that specifically looked at reproductive outcomes among nail salon workers. Whether studies have simply not investigated reproductive outcomes in this population, or negative results have not been published due to publication bias is unknown. However, one published study[18] that investigated reproductive outcomes among the broader population of cosmetologists (who are licensed to perform a variety of appearance enhancement tasks, including nails) did not find an association between performing nail services daily and having a low birthweight child.

Air sampling in nail salons clearly indicates that levels of some volatile organic chemicals related to nail products can be elevated compared to indoor environments where nail products are not being used. Chemicals commonly detected at elevated levels in these studies include solvents such as acetone and toluene, alcohols, and several acetates. Total VOC levels surveyed in some studies also indicated elevated levels compared to typical indoor background. Formaldehyde data are limited, but do not show levels in nail salon samples different from background levels in other settings that are not affected by new construction materials. Other types of volatile chemicals that can be components of nail

[18] Herdt-Losavio ML, Lin S, Druschel C, Hwang SA, Mauer MP, and Carlson GA. 2011. A nested case-control study of low birthweight among cosmetologists. International Archives of Occupational and Environmental Health. 84(6):601-608.

salon products, including phthalates and siloxanes, were detected in salon air in two recent studies, but at much lower levels than the chemicals mentioned above. Health Hazard Evaluations conducted by NIOSH in the 1990s[19] identified lack of adequate fresh-air ventilation as a common problem in nail salons. The air-sampling evidence from much more recent studies showing elevated VOC levels in nail salons may indicate that lack of adequate fresh-air ventilation is still a challenge in these facilities.

Regulation of nail salon products generally falls under the broader regulatory category of cosmetics. Different jurisdictions take different approaches to regulating the ingredients used in cosmetic products, including nail products. Our review of regulatory approaches for the broad category of cosmetics and personal-care products in selected jurisdictions (local, state, federal, and international) found that programs vary from requirements for pre-market safety assessment and enforceable regulatory prohibitions on specific ingredients, to guidance suggesting that use of certain ingredients be limited. Voluntary programs also exist that certify products or nail salons as meeting certain criteria related to product ingredient use. Nail salon products represent only a small segment of the much larger category of cosmetics and personal-care products. In the US, the only chemical bans that appear to apply primarily to nail products are state and local bans on methyl methacrylate. Recommendations from several local, state, and federal programs suggest avoiding nail products containing other chemical ingredients including toluene, formaldehyde, dibutyl phthalate, and certain acetates and ketones.

Some types of chemicals commonly found in nail salon products are associated with adverse health effects at exposure levels that are likely much higher than typical levels in nail salons (primarily in laboratory animal studies). As a result, concerns have been raised that nail salon workers and clients may be at risk for such adverse health effects due to conditions in nail salons. Studies at high exposure levels provide information on the types of health effects a particular chemical can cause (e.g., neurotoxicity or reproductive toxicity), but do not predict whether those health effects are likely to occur in other circumstances where the exposure conditions are different. Whether or not exposure to a chemical is likely to cause an adverse health effect depends not only on the chemical's inherent toxic properties, but on a number of exposure-related factors including the route of exposure (inhalation, ingestion or dermal contact), how large the exposure is, how often exposure occurs, and whether or not the exposure is repeated over a long a period of time. Many other factors such as a person's age, sex, existing health conditions, activity levels, and inherent differences in susceptibility to toxic effects within and between species when extrapolating evidence from animal studies can also affect the likelihood of a chemical exposure causing an adverse health effect. The existing information base needed to understand all these factors is unavailable or very limited for many types of chemicals used in commercial products such as nail-salon products. In the absence of a complete understanding of the exposure potential and toxicity properties of the variety of chemicals found in nail salon products, actions to minimize chemical exposures should be emphasized.

[19] NIOSH. 1998. Health Hazard Evaluation Report 97–0153–2694. NIOSH. 1992. Health Hazard Evaluation Report No. 90-048. NIOSH. 1992. Health Hazard Evaluation Report No. 92-128.

Recommendations

A primary goal in any workplace setting where chemicals are being used is to implement workplace policies and control measures aimed at reducing chemical exposures as much as possible. Implementing the following actions as quickly as is feasible is recommended to reduce risks from workplace chemical exposures in nail salons:

- Source Capture Exhaust Ventilation: Ventilation is a preferred measure under the hierarchy of controls concept as it does not require active diligence on the part of the employee if it is correctly implemented. Current NYS and NYC mechanical codes have ventilation specifications for nail salons. These specifications include 50 CFM exhaust ventilation per workstation (on an intermittent basis), capturing contaminants and odors at their source. The International Code Council 2015 Mechanical Code includes additional specification for source-capture exhaust inlets to either be factory installed in manicure tables and pedicure stations, or to be located no more than 12 inches horizontally and vertically from the point of chemical application.[20] Workstation source capture exhaust units should be designed so that there is sufficient air velocity at the point of generation to efficiently capture vapors or dusts being released. The outdoor supply airflow rate should equal the exhaust airflow rate to maintain a neutral air pressure balance. Exhaust vents on building exteriors should be located to avoid affecting neighboring fresh-air intakes or outdoor air quality where people are likely to be present.

- Access to a Sufficient Supply of Appropriate Personal Protective Equipment (PPE): Having PPE available to workers encourages an additional means to minimize exposures beyond that provided by the use of dilution and source capture exhaust ventilation. PPE also provides additional protection against direct contact with chemicals and infectious agents. Appropriate PPE for nail specialty work includes N95 or N100 respirators for use during any dust-generating procedure, nitrile gloves (or other material as appropriate) for use during procedures involving direct skin contact with clients and when handling chemicals, and goggles for eye protection when chemical handling could result in splashes. An adequate supply of all PPE should be provided that allows PPE to be replaced as needed (e.g., between each client for gloves; when dirty, wet, or damaged for particulate respirators). DOS regulations (19 NYCRR §§160.11; 160.20) regarding PPE have been adopted on a permanent basis.

  It is important that nail specialists understand that N95 and N100 respirators are only designed to protect against dust and aerosol exposures. They are not designed to protect against exposures to gases or vapors. Dilution and source capture exhaust ventilation and good workplace practices (see below) provide the primary controls for these exposures.

  The choice of an appropriate glove depends on the potential exposure situation. Nitrile gloves are protective against potential infectious-disease transmission from direct skin contact, and are also appropriate for handling most chemicals. However, nitrile gloves provide limited protection for extended exposure to acetone. If acetone is applied with a cotton applicator and there is no prolonged direct contact between the acetone on the applicator and the nail specialist's glove when handling the applicator, nitrile gloves can provide adequate protection. Alternative glove materials (e.g., latex or butyl) should be considered for situations (such as bulk chemical mixing) where prolonged direct contact with acetone is likely. Latex can cause allergy in some people, so the use of latex gloves should be limited to handling acetone.

- Implementation of Appropriate Administrative Controls: Nail salon workers should be trained in best practices for personal hygiene, use and handling of bulk chemicals and nail salon products,

[20] International Mechanical Code sections 403.3.1.1 and 502.20; http://codes.iccsafe.org/app/book/toc/2015/I-Codes/2015%20IMC%20HTML/index.html

and appropriate use of PPE. Best practices such as proper hand-washing, changing towels and gloves between clients, and keeping chemical storage and waste containers closed between uses reduce the chances of chemical or infectious-disease exposure. Use of best practices by nail salon workers is already reflected in existing DOS appearance enhancement regulations (19 NYCRR 160), but should be a renewed point of emphasis in guidance to business owners, in employee training programs, and during inspections and enforcement. Appropriate facilities should be provided to enhance compliance with administrative controls; e.g., ready access to hand-washing facilities with soap and running water, separate break or kitchen area for food consumption, language- and literacy-appropriate training materials. Nail salon employers must comply with OSHA's Hazard Communication standard (1910.1200) including requirements for product Safety Data Sheets, product labeling, and employee training.

In addition to these recommendations, further consideration could be given to the following policy options aimed at reducing potential exposure to certain chemical ingredients in nail salon products:

- Chemical elimination: The most-common elimination recommendations relate to toluene, formaldehyde, and dibutyl phthalate. A number of jurisdictions have already taken some form of action to eliminate or minimize use of products containing these three chemicals. As a result, alternatives are available in the marketplace. Therefore, if chemical elimination is to be considered, legislative action to phase out the use of products containing toluene, formaldehyde, and dibutyl phthalate in nail salons (or in appearance enhancement businesses as is the case with the statutory methyl methacrylate ban) might be more likely to be successful than other chemical elimination proposals. All chemicals have the potential for adverse health effects under conditions that cause sufficiently-large exposures, and there is often significant uncertainty about both toxic potency and exposure potential for many product ingredients. As a result, controlling all exposures through methods such as exhaust ventilation is expected to be a more reliable approach to reducing health risks than targeting single chemicals for elimination.

- Voluntary Certification: Establishing and administering a certification program patterned after the California Healthy Nail Salons program, although worth considering, is unlikely to yield significant changes in the industry. These programs entail an ongoing workload and would necessitate significant additional agency resources in order to establish recognition criteria, review applications, and implement endorsement decisions. Although salons benefit from the onsite consultation services these programs provide, they can be provided in a more efficient manner through existing regulatory programs. An alternative approach would be to use stakeholder engagement to encourage the industry to develop, and implement, its own voluntary certification program with Department of State oversight as a form of compliance monitoring rather than full agency implementation.

APPENDICES

Appendix 1

Table A1. Common chemicals in nail salon products. The table presents chemicals that are commonly found in different categories of nail salon products. Information is presented that summarizes what is known about potential health effects that could occur if a person is exposed to the chemical at high levels for either a short period of time (short-term effects, usually hours or a few days), or repeatedly over a long period of time (long-term effects, usually daily or continuously for years). The potential health effects summaries consider exposure by inhaling or ingesting the chemical, or by having direct contact with the chemical.

Chemical Name[21]	**Potential health effects or affected body systems under different exposure conditions**	
	Short-term Effects (single exposure or a few days)	**Long-term Effects (repeated exposure, usually for years)**
Solvents, thinners, glues, nail polish removers		
acetone[1,39]	headaches, lightheadedness, dizziness, unsteadiness, nausea, and irritation of the eyes, skin and respiratory system	effects on the kidneys, blood, liver and nervous system
acetonitrile[39,40,41]	irritation of the skin and respiratory system, nausea, vomiting, weakness and exhaustion	effects on the central nervous system
butyl acetate[39]	headaches, dizziness, confusion, drowsiness, and irritation of the eyes, skin, nose, mouth and throat	irritation of the eyes and dryness, redness and scaling of the skin
ethyl acetate[16,39]	irritation of the eyes, stomach, skin, nose, mouth and throat, confusion	dermatitis[a]
ethyl cyanoacrylate[42]	irritation of the eyes, mucous membranes and skin	skin sensitization[b]
isopropyl acetate[22,39]	respiratory irritation, sleepiness, irritation or burning of skin and eyes	dermatitis
methanol[7,31,35]	irritation of the eyes, skin and respiratory tract, nausea, confusion, headache, dizziness, blurred vision and the inability to coordinate muscle movement	developmental[c] and ocular effects, dermatitis, and effects on the central nervous system
methyl ethyl ketone[42,43]	irritation of the eyes, skin, respiratory tract, headache, dizziness, drowsiness, vomiting	developmental effects, dermatitis
toluene[3,7,18,39,42]	headaches, confusion, dizziness, numbness, muscle fatigue, irritated eyes, nose, throat and lungs	effects on the nervous system, liver, and kidneys, developmental effects and dermatitis

[21] Superscript numbers following each chemical name indicate the sources cited for each chemical. A numerical citation list for Table A1 follows immediately after the table.

Nail polishes		
benzene[5,7]	drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion	increased risk of certain cancers, effects on the hematological, immune and nervous systems
dibutyl phthalate[4,7,39]	nausea, irritation of the eyes, skin, nose, mouth and throat	reproductive[d] and developmental effects and effects on the liver and kidneys
di(2-ethylhexyl) phthalate[7,26]	irritation of the eyes and the respiratory tract	reproductive and developmental effects, cancer
butyl acetate[39]	headaches, dizziness, confusion, drowsiness, and irritation of the eyes, skin, nose, mouth and throat	irritation of the eyes and dryness, redness and scaling of the skin
ethyl acetate[16,39]	irritation of the eyes, stomach, skin, nose, mouth and throat, confusion	dermatitis
formaldehyde[7,39]	difficulty breathing including coughing, asthma-like attacks, and wheezing, allergic reactions, irritation of the eyes, skin and throat	cancer, effects on the respiratory system, and contact dermatitis
isopropyl acetate[22,39]	respiratory irritation, sleepiness and contact can irritate or burn skin and eyes.	dermatitis
toluene[3,7,18,39,42]	headaches, confusion, dizziness, numbness, muscle fatigue, irritated eyes, nose, throat and lungs	effects on the nervous system, liver, and kidneys, developmental effects and dermatitis
Nail hardeners, artificial nails		
tosylamide formaldehyde resin[10,42]	irritation of the skin and eyes	skin sensitization
benzoyl peroxide[20,41]	irritation of the eyes, skin, nose, mouth, throat and lungs	skin sensitization
butyl methacrylate[41,23]	irritation of the eyes, skin, nose, mouth, throat, and lungs; loss of appetite; inability to sleep and concentrate; depression	skin sensitization
dimethyl p-toluidine[7,15,27]	methemoglobinemia and associated symptoms that result from reduced ability of the blood to carry oxygen to tissues	effects on the liver, kidney, respiratory system, digestive system, spleen, and cancer
ethylene dimethacrylate[28]	irritation of the eyes and the respiratory tract	skin sensitization
ethyl methacrylate[12,39,42]	irritation of the eyes, skin, nose and mouth; difficulty breathing; dizziness.	skin sensitization
2-hydroxyethyl acrylate[13,29]	irritation of the eyes, skin and respiratory tract	skin sensitization

2-hydroxyethyl methacrylate[14,30,37]	dizziness, irritation of the eyes, skin and respiratory tract	skin sensitization
2-hydroxypropyl acrylate[21,25]	irritation eyes, skin, respiratory system, eye and skin burns, cough, dyspnea	skin sensitization
hydroquinone[24,42]	irritation and inflammation of the eyes, irritation of the skin, nausea, dizziness, rapid breathing, muscle contraction, central nervous system excitement and green or brownish-green urine.	skin sensitization, dermatitis
isobutyl methacrylate[17,42]	irritation of the eyes, skin, nose, mouth, throat and lungs	skin sensitization
methacrylic acid[11,39]	skin burns and irritation of the eyes, skin, nose, mouth and throat, difficulty breathing.	effects on the respiratory system
methylene chloride[2,7,32]	irritation of the eyes, skin and respiratory tract, lowering of consciousness, methemoglobinemia	effects on the central nervous system, liver and kidneys; dermatitis and cancer
methyl methacrylate[e] 39,44,45	asthma, irritation of the eyes, skin, nose and mouth. Difficulty concentrating and loss of smell	skin sensitization, respiratory effects
phthalic anhydride[8,34,38]	irritation of the eyes, skin and respiratory tract	skin and respiratory sensitization, eye and respiratory irritation, asthma and bronchitis
Disinfectants		
ortho-phenyl phenol[7,9,33]	irritation of the eyes, skin and respiratory tract. Abdominal cramps and pain	cancer and effects on the kidneys
quaternary ammonium compounds[19,39]	irritation of the nose and skin, skin burns nausea, vomiting, and abdominal pain. May cause asthma.	irritant contact dermatitis; skin sensitization

[a] A localized inflammation of the skin, characterized by redness, heat, swelling, pain.

[b] The development of an allergic skin reaction after repeated exposure to a chemical.

[c] Adverse effects (such as structural abnormality, altered growth and functional deficiency) on the developing organism that may result from exposure to a chemical prior to conception (either parent), during prenatal development (i.e., fetal effects), or postnatally until the time of sexual maturation.

[d] Adverse effects on the reproductive systems of females or males that may result from exposure to a chemical

[e] §404-a. of the New York State General Business Law prohibits the sale, use or application of Monomeric methyl methacrylate by any owner or operator of an appearance enhancement business.

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Safety Data Sheets (SDSs) for nail products were also reviewed for additional product ingredient information. These documents are developed by product manufacturers and contain information on product ingredients present above a *de minimis* level (generally 1% by weight, or 0.1% for carcinogens). They also provide information on the potential health effects of exposure to the listed ingredients. This review provided additional qualitative information regarding potential chemicals present in products likely to be used in nail salons.

Thirty-six SDSs were reviewed. Based on product labels, the products included polishes, gels, lacquers, glazes, one cuticle oil, top coats, base coats, nail strengtheners/hardeners, nail ridge fillers, one polish remover, and one all-in-one product. The most common category of chemical ingredients in these products (31/36) was acetates (primarily ethyl-, propyl- or butyl-acetate). Next most common were alcohols (29/36; mostly isopropyl alcohol or denatured ethyl alcohol), nitrocellulose (24/36), tosylamide/formaldehyde epoxy resin (21/36), and trimethyl-pentanyl diisobutyrate (21/36). At least one color additive ingredient was reported in 17/36

products. Toluene was reported as present in 2 of 36 products; di-butyl phthalate in 1/36; free formaldehyde in 6/36; methyl-ethyl ketone in 1/36; acetone in 1/36; and methacrylates (ethyl-, hydroxyethyl-, or hydroxypropyl-methacryclate) in 3/36. Twelve of 36 products reported containing acrylate polymers or co-polymers, and 15/36 contained a substituted benzophenone.

We cannot establish how representative the SDSs reviewed here are of nail salon products used in NYS. Nevertheless, this informal product survey is suggestive that ingredients with potentially greater concern for chronic health effects (e.g., toluene, di-butyl phthalate, formaldehyde, methyl-ethyl ketone) or sensitization (ethyl methacrylate) are relatively uncommon in current products.

Appendix 2

Environmental epidemiology studies

Introduction

The products used in nail salons contain many different chemicals. This results in a complex mixture of exposures to employees and patrons. It is very difficult to determine the separate effects of each chemical. A review of the epidemiological literature was conducted so that the health effects reported by nail salon technicians or associated with the working environment of the nail salon could be summarized. Health outcomes identified in these studies as potentially of concern are generally associated with working in the nail salon environment as a whole – and therefore potentially experiencing exposures to a mixture of chemicals that changes over time – rather than being associated with exposure to a specific chemical or product.

Search Methods

Searches were conducted on the following terms: “nail salons”; “manicurists”; “pedicures”; “nail technicians”; and “nails.” A total of 38 articles, written in English, were found, seven of which were relevant. The outcomes of interest here are limited to those associated with chemical exposures, as opposed to infectious agents. Three studies were conducted in the United States (in Boston Massachusetts, Oregon, and California) among Vietnamese populations, two were conducted in the United States (Michigan) on predominantly white populations, one was conducted in the United Kingdom (race/ethnicity/ country of origin were not noted), and one was conducted in Korea.

Summary

The epidemiologic literature on health effects in nail technicians is very sparse. Musculoskeletal, skin, respiratory, neurologic, and cognitive problems have been reported by nail technicians. A study of Vietnamese-American nail technicians in California found that over one-quarter of participants reported nose, throat, lung, skin, or eye irritation.[22] A study of Vietnamese nail technicians in Boston, Massachusetts found that musculoskeletal and skin problems, as well as respiratory irritation and headaches were commonly reported among these workers.[23] A study of Vietnamese nail technicians in Oregon (94% women), found that almost one-quarter of the nail technicians reported nose irritation.[24] Since none of these studies included a comparison group, it cannot be determined if the reported symptoms are more or less common among nail salon technicians than in another working group that did not have the exposure of working in a nail salon. Therefore, due to this limitation, these studies are only

[22] Quach T, Gunier R, Tran A, et al. Characterizing workplace exposures in Vietnamese women working in California nail salons. Am J Public Health 2011;101:S271-S276.
[23] Roelofs C, Azaroff LS, Holcroft C, Nguyen H, and Doan T. Results from a community-based occupational health survey of Vietnamese-American nail salon workers. J Immigr Minor Health 2008;10:353-361.
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presented to provide background on what proportion of nail salon technicians report these symptoms. These studies are not discussed further.

A significant potential health outcome identified by studies of nail salon workers is respiratory concerns. A Korean study found a very strong elevated risk for nose irritation among nail technicians, in addition to increased risks for throat irritation and cough after adjusting for age, marital status, hours worked, exercise, smoking, and alcohol use.[25] A study in the United Kingdom (UK) found that nasal symptoms were significantly elevated among nail salon technicians, but did not find an elevated risk of cough after adjusting for age, smoking, and hours worked.[26] Both studies attempted to ascertain whether wheeze and chest tightness (symptoms that could indicate asthma exacerbation) were associated with nail salon work, but neither study found a significant association.

Due to routine contact with various substances and the presence of detectable levels of several compounds in air in nail salons, eye and skin irritation are commonly reported among nail technicians. The study conducted in Korea surveyed for eye irritation and skin irritation, finding an elevated risk for both after adjusting for potential confounders. In addition, they found a borderline elevated risk for eczema. However, the UK study did not detect a risk for eye irritation and could not calculate an effect estimate for eczema. The UK study did not ask about skin irritation.

Headaches were found to be associated with working in a nail salon in both the Korean and British studies. In addition, two slightly older studies conducted in Michigan looked at neuropsychological symptoms and performance in nail technicians compared to demographically similar controls from the local community with no known chemical exposures. A small significant difference in neurologic complaints, cognitive efficiency, memory, verbal learning, and academic skills was found between the two groups. Overall, nail technicians reported more complaints in these areas.[27] Additionally, nail technicians did worse than controls in the areas of attention and processing speed.[28]

Musculoskeletal health outcomes are unlikely to be related to chemical exposures, but rather may occur due to the often awkward positions and repetitive movements used when performing nail services. Musculoskeletal effects reported by nail technicians included back, neck, shoulder, wrist/hand, and leg/foot problems. The Korean study found a statistically significant elevated risk of neck, shoulder, upper back, arm, and wrist/hand problems among nail technicians compared to office workers. Consistent with that study, statistically significant elevated adjusted odds ratios were found among nail salon workers in the UK study for neck, shoulder, and wrist/hand problems compared to office-based controls.

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[25] Park S-A, Gwak S, and Choi S. Assessment of occupational symptoms and chemical exposures for nail salon technicians in Daegu City, Korea. J Prev Med Public Health 2014;47:169-176.
[26] Harris-Roberts J, Bowen J, Sumner J, et al. Work-related symptoms in nail salon technicians. Occup Med 2011;61:335-340.
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[28] LoSasso GL, Rapport LJ, Axelrod BN and Whitman RD. Neurocognitive sequelae of exposure to organic solvents and (meth)acrylates among nail-studio technicians. Neuropsychiatry Neuropsychol Behav Neurol 2002;15:44-55.

Overall the epidemiologic literature is limited in this area, but it suggests that working in the nail salon environment may be associated with various respiratory, musculoskeletal, and neuropsychological symptoms. The exposure variable related to health outcome data in each of these studies was working in a nail salon. Only two studies[29] measured chemical compounds in air in nail salons, but the authors did not attempt to relate measurements of specific chemicals to health outcomes. Because these authors did not use these measurements as the exposure in their analyses, these studies do not inform us about specific chemical exposures that might be contributing to particular observed outcomes. The air-sampling results from these two studies are included in the section summarizing salon air monitoring data below.

Several interventions and policy change recommendations were made by these authors based on their work. Several authors recommended that there be regulatory changes regarding the products used in nail salons. Recommendations were also made for appropriate ventilation and ergonomic equipment in nail salons. Other suggestions included updating occupational exposure limits and improving training to include health concerns.

In addition to published epidemiology studies, we reviewed health and safety investigations conducted in nail salons by two federal agencies (the National Institute of Occupational Safety and Health [NIOSH], and the Occupational Safety and Health Administration [OSHA]).

NIOSH conducted three on-site worker health-and-safety investigations (Health Hazard Evaluations or HHEs) in nail salons in the 1990's. NIOSH undertakes HHEs at the request of workers, worker representatives, or employers to help learn whether health hazards are present in workplace environments. The results of these three HHEs are summarized in Table A2. All three HHEs were prompted by complaints or concerns related to chemical exposures or odors associated with the use of nail salon products. Although chemical exposure levels in all the investigations were not high enough to exceed regulatory limits, NIOSH noted that, in each case, the salon's ventilation system did not provide fresh outdoor air into the salon. Providing adequate outdoor-air ventilation is important to reduce the accumulation of chemical contaminants in occupied indoor spaces, especially when products containing volatile chemicals that readily evaporate into the indoor air are in routine use. NIOSH also recommended improvements in other workplace practices – for example prohibiting smoking, eating, and drinking in the workplace; providing appropriate written health and safety materials to employees; and providing training on the safe handling and use of chemicals – to reduce the potential for worker and client chemical exposure.

NIOSH analyses of bulk material samples collected during the HHEs showed that some nail products used at the time contained methyl and ethyl methacrylate, another "unspecified methacrylate ester," dimethyl toluidine isomer, and methacrylic acid. Small amounts of an unknown aromatic nitrogen compound and octabenzone were also detected. Chemical analyses of bulk samples of the acrylic polymer powder used during the application of artificial nails showed that the powder did not contain detectable amounts quartz (a form of crystalline silica) or cristobalite (a form of asbestos).

[29] Quach T, Gunier R, Tran A, et al. Characterizing workplace exposures in Vietnamese women working in California nail salons. Am J Public Health 2011;101:S271-S276.
Park S-A, Gwak S, and Choi S. Assessment of occupational symptoms and chemical exposures for nail salon technicians in Daegu City, Korea. J Prev Med Public Health 2014;47:169-176.

A review of the OSHA regulatory compliance and inspection database from January, 2004 through June, 2015 for citations relating to nail salons found 191 citations issued during 126 total OSHA inspections. Four inspections in NYS resulted in a total of five citations. Consistent with the observations reported in the NIOSH HHEs, most OSHA citations associated with chemical hazards were for violations of the OSHA Hazard Communication Standard (29 CFR 1910.1200), including lack of a written health and safety program, lack of safety data sheets, and lack of proper worker training.

Table A2. Summary of health and safety investigations and inspections conducted by federal agencies

Type of Investigation	Main Findings	Recommendations	Agency Location Date
HHE[30] Worker complaint for exposures to salon chemicals	No overexposures to sampled chemicals[31] No outdoor air supply from ventilation system	Redesign ventilation system to provide outdoor air Prohibit smoking in the workplace Establish a written Hazard Communication Program Obtain MSDSs for all products Maintain an occupational injury and illness log Provide appropriate gloves[32] to protect skin from chemical hazards	NIOSH Chicago, IL 1998
HHE Request from owner on chemical exposures to nail sculpting products	No overexposures to sampled chemicals No outdoor air supply from ventilation system No exhaust fan	Redesign ventilation system to provide outdoor air Obtain MSDSs for all products Provide information and training to workers on safe use of chemicals	NIOSH Norman, OK 1992
HHE Request from local health department to evaluate odor complaint from	No overexposures to sampled chemicals No outdoor air supply from ventilation system	Install ventilation system to provide outdoor air and to control odors Prohibit eating and drinking in the salon to protect from unintentional	NIOSH Springdale, OH 1992

[30] Health Hazard Evaluation

[31] Air sampling results were compared to existing occupational exposure limits including OSHA Permissible Exposure Limits (PELs), NIOSH Recommended Exposure Limits (RELs), and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs). PELs are legally-enforceable standards; RELs and TLVs are generally more restrictive than PELs, but are not developed as regulatory standards.

[32] Workers were wearing latex gloves which NIOSH reported as "not appropriate protection against the potential skin hazards when mixing bleaches, permanent wave solution, and other chemicals."

adjacent business in same building		contact of lips and face with methacrylate-containing nail liquids Prohibit smoking in the salon due to the presence of flammable chemicals	
Regulatory compliance inspections of nail salons (NAICS code 812113) 126 total inspections 4 inspections in NYS	191 total citations issued 5 citations in NYS Primary chemical-related citations were for violations of the Hazard Communication Standard (29 CFR 1910.1200), including lack of: written program MSDSs worker training	correct deficiencies to come into regulatory compliance	OSHA Inspection database January 2004 – June 2015

Appendix 3

Air monitoring results from nail salons

We identified publications in the peer-reviewed literature that reported data for a wide variety of volatile organic compounds in indoor air, area air, or personal air[33] at U.S. nail salons (Table A3). The salons were located in several locations throughout California,[34] Alameda County, California,[35] Salt Lake City, Utah,[36] Boston, Massachusetts,[37] and San Francisco, California.[38]

In addition to these general air-monitoring studies, two peer-reviewed publications by researchers at the NYS DOH Wadsworth Center reported data from investigations targeting two specific classes of chemicals: phthalate diesters (hereafter, phthalates) and siloxanes. Indoor air concentrations of phthalates were measured in several settings, including two kinds of salons in Albany, New York.[39] Data provided by the authors allowed us to summarize indoor air phthalate levels reported for nail salons and hair salons separately (Table A4). Selected siloxanes were measured in indoor air at four hair salons and two nail salons.[40] Differences between mean indoor air siloxane levels for the two types of salons did not achieve statistical significance, so the authors summarized the combined data (Table A5).

Among the individual analytes reported at particularly high concentrations in air were several volatile organic compounds that are components of nail products, including acetone (up to 13 ppm in area air), ethyl acetate (up to 5.5 ppm in personal air), isopropyl alcohol (up to 2 ppm in area air), and toluene (up to 1 ppm in personal air). In comparison, a US EPA review[41] of multiple studies indicated that these analytes are either not commonly detected in residential indoor air, or are reported present in indoor air at concentrations generally below 0.1 ppm.

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[33] "Indoor air" is air that is sampled in nail salons but at a substantial distance from where nail specialist work, "area air" is air that is sampled near where nail specialist work, and "personal air," also known as "breathing zone air," is air that is intended to be representative of what an exposed individual (e.g., nail specialist or client) actually inhales.

[34] McNary JE, Jackson EM. 2007. "Inhalation exposure to formaldehyde and toluene in the same occupational and consumer setting." Inhalation toxicology 19.6-7: 573-576.

[35] Quach T, Gunier R, Tran A, Von Behren J, et al. 2011. Characterizing workplace exposures in Vietnamese women working in California nail salons. Am J Public Health. Dec;101 Suppl 1:S271-6.

[36] Alaves VM, Sleeth DK, Thiese MS, Larson RR. 2013. Characterization of indoor air contaminants in a randomly selected set of commercial nail salons in Salt Lake County, Utah, USA. Int J Environ Health Res. 23(5):419-33.

[37] Goldin LJ, Ansher L, Berlin A, et al. 2014. Indoor air quality survey of nail salons in Boston. J Immigr Minor Health. Jun;16(3):508-14.

[38] Garcia E, Sharma S, Pierce M, Bhatia S, Argao ST, Hoang K, Quach T. 2015. Evaluating a county-based healthy nail salon recognition program. Am J Ind Med. Feb; 58(2):193-202.

[39] Tran TM, Kannan K. 2015a. Occurrence of phthalate diesters in particulate and vapor phases in indoor air and implications for human exposure in Albany, New York, USA. Arch Environ Contam Toxicol. Apr;68(3):489-99.

[40] Tran TM, and Kannan K. 2015b. Occurrence of cyclic and linear siloxanes in indoor air from Albany, New York, USA, and its implications for inhalation exposure. Science of the Total Environment 511: 138-144.

[41] US EPA. 2011. United States Environmental Protection Agency. Background Indoor Air Concentrations of Volatile Organic Compounds in North American Residences (1990–2005): A Compilation of Statistics for Assessing Vapor Intrusion. Publication No. EPA 530-R-10-001.

In the two NYS studies, mean phthalate and siloxane concentrations were higher in salons than in other settings investigated (e.g., homes, office, laboratories, and schools). However, in comparison to other commonly-detected analytes in the other studies, the two studies by Tran and Kannan had much greater analytical sensitivity, reporting phthalate and siloxane concentrations approximately 1000-fold, or more, lower than levels for analytes reported in other studies. Of particular note, dibutyl phthalate was detected in nail salon samples at less than 1 ug/m^3 (Tran and Kannan, 2015a).[42]

Two studies reported measurements of total volatile organic compound (TVOC) concentration, standardized as isobutylene equivalents.[43] Mean or median concentrations of 1.1 and 4.8 ppm isobutylene equivalents were reported, with a maximum of 38 ppm isobutylene equivalents in one study. Other studies suggest TVOC concentrations in non-industrial indoor environments are generally expected to be below about 2.5 ppm.[44]

Some formaldehyde concentrations reported for nail salon air appear elevated compared with the highest mean formaldehyde concentration of 0.01 ppm reported for six large office buildings in metropolitan areas within the states of Iowa, Minnesota, and Nebraska.[45] However, in their review of the scientific literature, Wolkoff and Nielsen noted[46] that formaldehyde concentrations in both personal and stationary air samples tend to be 0.04 ppm or less in Europe and North America, with the exception of new housing or buildings with extensive wooden surfaces, where the concentration may exceed 0.08 ppm. This suggests that even the maximum formaldehyde concentration reported for a California nail-specialist personal air sample (0.065 ppm) did not exceed formaldehyde air concentrations reported for air in new housing or buildings with extensive wooden surfaces (0.08 ppm or more). In a subset of 12 personal and 6 area samples from three salons in California,[47] found that median formaldehyde levels ranged from 0.0023 – 0.0025 ppm when "correcting" indoor results by subtracting corresponding outdoor levels. The maximum "corrected" formaldehyde result reported in this study was 0.029 ppm, within the background range reported by Wolkoff and Nielson.

Methyl methacrylate was reported at concentrations of up to 6.8 ppm in personal air, and up to 4.1 ppm in area air in three studies that analyzed for it (two in California, one in Utah). Background levels of methyl methacrylate are generally very low. For example, a NYS DOH study that collected and analyzed 227 samples from oil-heated New York homes calculated an

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[42] Tran TM, Kannan K. 2015a. Occurrence of phthalate diesters in particulate and vapor phases in indoor air and implications for human exposure in Albany, New York, USA. Arch Environ Contam Toxicol. Apr;68(3):489-99.

[43] TVOC measurements represent airborne mixtures of many chemicals and are commonly standardized to an equivalent concentration of isobutylene.

[44] EC JRC. 1997. European Commission Joint Research Centre - Environment. Total volatile organic compounds (TVOC) in indoor air quality investigations, report 19. Brussels. Contract No.: EUR 17675 EN.

Molhave L, Clausen G, Bergund B, et al. 1997. Total volatile organic compounds (TVOC) in indoor air quality investigations. Indoor Air. Dec; 7(4):225-240.

Reynolds SJ, Black DW, Borin SS, et al. 2001. Indoor environmental quality in six commercial office buildings in the midwest United States. Appl Occup Environ Hyg. Nov;16(11):1065-77.

[45] Reynolds SJ, Black DW, Borin SS, et al. 2001. Indoor environmental quality in six commercial office buildings in the midwest United States. Appl Occup Environ Hyg. Nov;16(11):1065-77.

[46] Wolkoff, P, Nielsen GD. Nielsen. 2010. Non-cancer effects of formaldehyde and relevance for setting an indoor air guideline. Environment international 36.7 (2010): 788-799.

[47] McNary JE, Jackson EM. 2007. "Inhalation exposure to formaldehyde and toluene in the same occupational and consumer setting." Inhalation toxicology 19.6-7: 573-576.

upper bound methyl methacrylate concentration (excluding outliers) of 0.0001 ppm.[48] The sale, use, or application of monomeric methyl methacrylate to any person by appearance enhancement businesses was prohibited in New York State in 2001 (Article 27, Section 404-a of the General Business Law).

[48] NYS DOH. 2005. New York State Department of Health. Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes. Available at: https://www.health.ny.gov/environmental/indoors/air/fuel_oil.htm.

Table A3. Analytes quantified in domestic nail salon air [all concentrations are in parts-per-million (ppm) unless otherwise indicated].

	Quach *et al*. (2011)		Goldin *et al*. (2014)	Alaves *et a*l. (2013)	Garcia et al. (2015)	McNary & Jackson (2007)		
	Alameda County, CA		Boston, MA	Salt Lake City, UT	San Francisco, CA	Throughout California		
	n = 3 salons (Area Air)	*n* = 20 salons (Personal Air)	*n* = 21 salons (Indoor Air)	*n* = 12 salons (Area Air)	n = 11 salons (Personal Air)	n = 30 salons[a]		
						Nail tech (Personal Air)	Client (Personal Air)	Area Air
	Mean[b] (Range)	Mean (Range)	Median (Range)	Mean (Range)	Mean (Range)	Median	Median	Median
Acetone	3.10 (0.31 – 6.60)	[c]		6.1 (1.6 - 13)				
Benzene				0.00044 (ND – 0.0015)				
Butyl acetate	0.03 (0.01 – 0.06)							
Ethyl acetate	0.09 (0.02 – 0.15)	0.53 (0.02 – 5.50)		0.37 (0.05 - 2)				
Formaldehyde				0.017 (0.0087 – 0.032)		0.02	0.021	0.02
Isopropyl alcohol	0.82 (0.06 – 2.0)			0.77 (0.26 – 1.3)				
Methyl methacrylate	0.04 (0.01 – 0.06)			0.87 (ND – 4.1)	1.1 (0.02 – 6.8)			
Isopropyl acetate		0.04 (0.02 – 0.15)						
Toluene		0.15 (0.02 – 1.0)		0.098 (0.014 – 0.31)	0.10 (0.04 – 0.16)	0.17	0.116	0.106

TVOC[d]			4.8 (0.061 – 38)		1.1 (0.33 – 4.00)			
PM2.5[e] (mcg/m^3)			18 (6.1 – 56)					
Carbon dioxide			1,100 (660 – 1,600)					

[a] The study reported that “at least half” were nail salons without other services provided
[b] Arithmetic mean (= average)
[c] Blank entries indicate chemical was not reported as a target analyte
[d] Total volatile organic compounds reported as isobutylene equivalents
[e] Particulate matter less than 2.5 micrometers in aerodynamic diameter (= fine particulate matter)

Table A4. Total (combined vapor- and particulate-phase) concentrations of phthalate diesters in nail salon (*n*=2) and hair salon (*n*=4) indoor air samples (Tran and Kannan, 2015a).

Analyte	Nail Salon Mean (ng/m^3)	Nail Salon Range (ng/m^3)	Hair Salon Mean (ng/m^3)
Dimethyl phthalate (DMP)	114	109 to 120	44
Diethyl phthalate (DEP)	1759	1266 to 2251	1627
Diisobutyl phthalate (DIBP)	304	225 to 384	653
Dibutyl phthalate (DBP)	335	213 to 458	641
Di-*n*-hexyl phthalate (DNHP)	<LOQ	<LOQ	<LOQ
Benzylbutyl phthalate (BzBP)	8	3.78 to 13.17	13.5
Diethylhexyl phthalate (DEHP)	76	37.1 to 114.5	295
Dioctyl phthalate (DOP)	<LOQ	<LOQ	<LOQ
Total		*2100 to 3095*	

ng = nanogram
LOQ = Limit of Quantification
Analyte concentration ranges for hair salon samples are not available.

Table A5. Total (combined vapor- and particulate-phase) concentrations of siloxanes in nail salon and hair salon indoor air samples (*n*=6) (Tran and Kannan, 2015b).

Analyte	Frequency Detected (%)	Salon Mean (ng/m^3)	Salon Range (ng/m^3)
Hexamethylcyclotrisiloxane (D3)	100	13	8.44 – 19.2
Octamethylcyclotetrasiloxane (D4)	100	495	206 - 752
Decamethylcyclopentasiloxane (D5)	100	3200	530 - 5130
Dodecamethylcyclohexasiloxane (D6)	100	444	160 - 1040
Octadecamethylcycloheptasiloxane (D7)	100	48.4	20.7 - 92.2
Octamethyltrisiloxane (L3)	83.3	1.0	nd - 2.75
Decamethyltetrasiloxane (L4)	83.3	4.96	nd – 11.1
Dodecamethylpentasiloxane (L5)	100	22.7	5.1 - 41.3
Tetradecamethylhexasiloxane (L6)	100	147	41 - 235
L7	100	520	194 - 792
L8	100	709	282 - 1090
L9	100	420	50.2 - 869
L10	100	167	19.2 - 576
L11	83.3	83.3	nd - 38.1
Total		*6210*	

ng = nanogram
LOQ = Limit of Quantification

Note: Analytes L7 through L11 were linear polydimethylsiloxanes purchased from Sigma-Aldrich (St. Louis, MO, USA).

Appendix 4

Existing laws, regulations and guidance

As a component of this review, DOH researched existing regulatory approaches in other jurisdictions that apply to chemical prohibitions or avoidance guidance in nail salon products. This is not an exhaustive legal analysis. We researched existing regulatory documentation from a selection of local, state, and federal agencies (in the U.S. and internationally), and independent third-party standards-setting organizations. We also consulted with technical expert counterparts in some agencies regarding existing programs. The main purpose of the summary presented here is to provide examples of existing approaches to chemical regulatory policy as applied in other jurisdictions to nail salon products (or to broader categories of cosmetics and personal-care products). Regulatory approaches to chemical elimination or avoidance in nail products and other cosmetic or personal-care products can involve statutes, executive orders, regulations, or guidance, and can be implemented at the local, state, or federal level.

The following section briefly summarizes the findings of this review for current laws, regulations, and guidance that apply to chemicals used in nail salon products.

U.S. Food and Drug Administration (FDA)

Nail products are regulated by the FDA as cosmetics. Like all cosmetics, nail products are not subject to FDA review and approval of safety or efficacy prior to being placed into commerce (referred to as “premarket approval”). However, federal law requires that cosmetics (including nail products) sold in the U.S. must be free of poisonous or harmful substances that might injure users when the products are used as directed, and FDA may pursue enforcement action (e.g., product recalls) against products if they injure users when used as directed. The FDA has prohibited or restricted the use of several chemicals in cosmetics. This list includes bithionol, chlorofluorocarbon propellants, chloroform, halogenated salicylanilides, hexachlorophene, mercury compounds, methylene chloride, prohibited cattle materials, vinyl chloride, and zirconium-containing complexes. A search of the FDA weekly enforcement reports (January 2004 - July 2015) revealed one recall on a nail polish remover due to low pH and undeclared ingredients. FDA guidance instructs consumers to read product labels, heed any warnings, and discontinue use if an allergic reaction occurs. Consumers are also encouraged to contact FDA if they have a bad reaction to any cosmetics.

Methyl Methacrylate State Prohibitions

Liquid methyl methacrylate (MMA) was used in artificial nail products for many years. In the early 1970s, the Food and Drug Administration (FDA) determined that liquid MMA should not be used in artificial nail products due to adverse reactions (redness, swelling, and pain in the nail bed) among people who had become allergic from repeated exposures to MMA[49,50]. While there is no federal regulation specifically prohibiting MMA in nail products, the use of MMA has

[49] Food and Drug Administration (FDA). 2014. Nail Care Products. Accessed July 6, 2015 at: http://www.fda.gov/Cosmetics/ProductsIngredients/Products/ucm127068.htm#mono

[50] U.S. Environmental Protection Agency (US EPA). 2007. Protecting the Health of Nail Salon Workers. Accessed July 6, 2015 at: http://www.epa.gov/oppt/salon/nailsalonguide.pdf

been prohibited in nail salons or appearance enhancement businesses in 33 states[51] and the District of Columbia. In New York State, Article 27, section 404-a, of the General Business Law bans appearance enhancement owners or operators from knowingly selling, using or applying monomeric methyl methacrylate to any person[52]. In addition, the city of Boston has banned use of MMA in nail salons[53] while no such ban exists at the state level.

California Proposition 65[54]

Proposition 65 (Prop 65) is intended to inform California citizens about the presence of chemicals known to cause cancer, birth defects or other reproductive harm in consumer products. Prop 65 requires the State of California to publish a list of these chemicals and businesses must provide a warning (in the form of a product label) to consumers if their products contain a listed chemical. The goal of the program is, in part, to allow consumers to make better-informed decisions about product use. However, Prop 65 labeling requirements are based on the presence of chemicals in products above a minimum level, not on the likelihood or degree of exposure from the use of labeled products. It is possible that routine use of products labeled under Prop 65 may not result in any chemical exposure to the user.

California Safe Cosmetics Act[55]

The California Safe Cosmetics Act requires manufacturers, packers, and/or distributors named on the product label to provide a list of all cosmetic products that contain any ingredients known to cause cancer, birth defects, or other reproductive harm. This list must be submitted to the California Safe Cosmetics Program in the California Department of Public Health (CDPH). The CDPH maintains a guidance list of chemical agents known or suspected to cause cancer, birth defects, or other reproductive harm to assist companies with reporting. This list is comprised of chemicals identified as causing cancer, birth defects, or other reproductive harm from the following sources: Prop 65 (see above); U.S. Environmental Protection Agency; National Toxicology Program; and the International Agency for Research on Cancer. In addition, CDPH maintains a publicly-available searchable database of product ingredient information submitted by companies. This database allows users to search for specific products and see the reportable ingredients associated with the product. An individual can then click on the reportable ingredient for more information. As with Prop 65, this information indicates the presence of chemicals in cosmetic products, but does not determine the amount of exposure to reportable chemicals that is expected to occur with use of a product.

California Safer Consumer Products Regulations[56]

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[51] Alabama, Arizona, Arkansas, California, Colorado, Delaware, Florida, Illinois, Iowa, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Rhode Island, South Dakota, Tennessee, Texas, Utah, Washington, West Virginia, Wisconsin

[52] N.Y. GBS. LAW § 404-a: NY Code - Section 404-A: Monomeric methyl

[53] Boston Public Health Commission. 2013. Nail Salon Regulation. Accessed at: http://www.bphc.org/boardofhealth/regulations/Documents/Nail_Salon_Regulation.pdf

[54] Office of Environmental Health Hazard Assessment. Proposition 65. California. Accessed at: http://www.oehha.ca.gov/prop65/law/index.html

[55] California Department of Public Health. California Safe Cosmetics Program. Occupational Health Branch. Accessed at: http://www.cdph.ca.gov/programs/cosmetics/Pages/default.aspx

[56] California Department of Toxic Substances Control. Safer Consumer Products Regulations. Accessed at: https://www.dtsc.ca.gov/SCPRegulations.cfm

The California Safer Consumer Products regulations require manufacturers, or other responsible entities, to seek safer alternatives to harmful chemical ingredients in widely used products. The regulations established an initial list of approximately 1,200 Candidate Chemicals, based on work done by other authoritative organizations[57], and required the California Department of Toxic Substances Control (DTSC) to prioritize product/Candidate Chemical combinations to develop a list of Priority Products. Manufacturers (or other responsible entities) are required to contact DTSC if their product appears on the Priority Products list. Manufacturers are then required to perform an Alternatives Analysis for the product and the Candidate Chemical to determine how to limit exposures to (or the level of adverse public health and environmental impacts posed by) the Candidate Chemical. DTSC is then required to identify and implement regulatory responses to protect public health and/or the environment and maximize the use of acceptable and feasible alternatives of least concern. DTSC has completed a Work Plan to move these requirements forward. In this Work Plan, nail care products fall under one category (beauty, personal care, and hygiene products) of the six product categories from which DTSC may choose priority products for regulation. In March, 2014, DTSC proposed an initial list of three priority products from the building products/household furnishings product category (methylene chloride paint strippers, certain polyurethane spray foams, and children's foam padded sleeping products containing 2 flame retardant chemicals). As of July, 2015, the formal rule-making process to regulate these three priority products has not been initiated. Any regulatory requirements for other priority products (such as nail products) under this program would be proposed in a future rule-making process.

Regulations in Other Countries

Several examples of regulatory programs in other countries were found that place restrictions or prohibitions on the use of certain chemicals in cosmetics, personal-care products, and/or nail products:

- The European Commission Regulation 1223/2009 requires that cosmetic products undergo a pre-market safety assessment (i.e., premarket approval) that evaluates a product's composition, chemical exposure under normal and reasonably foreseeable use, toxicological properties of product ingredients, and a weight-of-evidence safety assessment conclusion for the product. EC 1223/2009 prohibits the use of chemicals falling under certain regulatory classifications as carcinogenic/mutagenic/reproductive toxicant (CMR) chemicals. It also includes a list (Annex II) of over 1300 individual chemicals and chemical classes that are prohibited in all cosmetics, and separate list of chemicals that cannot be used except subject to specific use restrictions (Annex III). The regulation prohibits the use of colorants, preservatives, and UV filters, other than those specifically allowed in Annex IV (colorants), Annex V (preservatives), and Annex VI (UV filters).
- Cosmetics are regulated in Canada under the Food and Drugs Act (RSC, 1985, c F-27), and the Canadian Cosmetics Regulation (CRC c 869). As in the U.S., manufacturers are required to assure that cosmetic products comply with Canadian law prior to being placed into commerce, but there is no premarket approval process. However, Health

[57] Prop 65; European Commission; US EPA; Health Canada and Environment Canada; IARC; ATSDR; NTP; Washington Departmnet of Ecology; California Department of Public Health; California State Water Resources Control Board; California Air Resources Board; California Office of Environmental Health Hazard Assessment; California Environmental Contaminant Biomonitoring Program; Oslo and Paris Conventions for the Protection of the Marine Environment of the North-East Atlantic; CDC.

Canada does maintain a list of prohibited or restricted chemical ingredients known as the Cosmetic Ingredient Hotlist.[58] The Hotlist is structured similarly to the EC 1223/2009 Annexes II (prohibited chemicals) and III (restricted use chemicals). The Hotlist represents chemicals considered by Health Canada to be inappropriate for cosmetic use, and is reviewed and updated by the agency as new scientific data becomes available.

- In Japan, Ministry of Health and Welfare Notification No. 331 of 2000 establishes prohibitions or restrictions on the use of certain chemicals or chemical classes in cosmetic products.[59] Notification 331 includes a list of 30 chemicals or chemicals classes prohibited from all cosmetic products (Appendix 1). It also contains limitations on the use of other ingredients by setting maximum allowable concentrations either for all cosmetic products or for specific types or intended uses of cosmetic products (Appendices 2 – 4).

Guidance Documents for Nail Salons

The guidance documents in Table A6 provide nail salon owners and employees with best practices to reduce exposures to chemicals and other hazards found in nail salons. These include appropriate general ventilation of the indoor air as well as more focused ventilation in areas where chemicals are used (e.g., chemical dispensing areas, work tables). Personal protective equipment is also discussed and includes protective clothing, dust masks, gloves, and goggles when appropriate. The documents identify commonly used chemicals and emphasize reading product labels and understanding how to use the products properly. Each guidance document also indicates chemicals that the agencies recommend trying to avoid in nail products.

[58] http://www.hc-sc.gc.ca/cps-spc/cosmet-person/hot-list-critique/index-eng.php
[59] http://www.mhlw.go.jp/file/06-Seisakujouhou-11120000-Iyakushokuhinkyoku/0000032704.pdf

Table A6: **Available Guidance Documents and Recommendations for Chemicals to Avoid in Nail Salon Products**

Issuing Agency/Organization	Guidance Document	Chemicals to Avoid
U.S. Environmental Protection Agency[60]	"Protecting the Health of Nail Salon Workers"	Liquid methyl methacrylate
Occupational Safety and Health Administration[61]	"Stay Healthy and Safe While Giving Manicures and Pedicures"	Toluene Formaldehyde Dibutyl phthalate Methacrylic acid
National Institute for Occupational Safety and Health[62]	"Controlling Chemical Hazards during the Application of Artificial Fingernails"	NA
California Healthy Nail Salon Collaborative[63,64]	"Stay Healthy and Safe While Giving Manicures and Pedicures"	Toluene Formaldehyde Dibutyl phthalate Butyl acetate Methyl acetate Ethyl acetate Methyl ethyl ketone Methyl methacrylate
	"Understanding the Toxic Trio: Protecting yourself at work"	
Massachusetts Office of Labor and Workforce Development[65]	Artificial Fingernails and Indoor Air Quality – A Guide to Controlling Chemical Exposures	Methacrylates Formaldehyde Benzoyl peroxide Methyl ethyl ketone Acetone Xylene Ethyl ether Methylene chloride Acetonitrile Glycol ethers

[60] U.S. Environmental Protection Agency. Protecting the Health of Nail Salon Workers. Accessed at: http://www.epa.gov/oppt/salon/nailsalonguide.pdf
[61] Occupational Safety and Health Administration. Stay Healthy and Safe While Giving Manicures and Pedicures. Accessed at: https://www.osha.gov/Publications/3542nail-salon-workers-guide.pdf
[62] National Institute for Occupational Safety and Health. Controlling Chemical Hazards during the Application of Artificial Fingernails. Accessed at: http://www.cdc.gov/niosh/docs/99-112/pdfs/99-112.pdf
[63] California Healthy Nail Salon Collaborative. Stay Healthy and Safe While Giving Manicures and Pedicures. Accessed at: http://www.cahealthynailsalons.org/wp-content/uploads/2014/04/Nail-Salon-Booklet-FINAL-English-March-26-2014-adjusted-for-color-copier-and-single-pages.pdf
[64] California Healthy Nail Salon Collaborative. Understanding the Toxic Trio: Protecting yourself at work. Accessed at: http://www.cahealthynailsalons.org/wp-content/uploads/2010/07/Toxic_Trio_EN_March2012.pdf
[65] Massachusetts Office of Labor and Workforce development. Artificial Fingernails and Indoor Air Quality – A guide to Controlling Chemical Exposures. Accessed at: http://www.mass.gov/lwd/docs/dos/mwshp/hib400.pdf

Voluntary Certification Programs for Nail Salons and Nail Products

Voluntary certification programs exist that are intended to recognize nail salons or certain types of products that have fulfilled a set of criteria for being "green" or "environmentally preferable" as prescribed by the entity issuing the recognition. These programs have been set up by federal, state, and local agencies as well as private organizations. There is no overarching regulatory oversight or standardization of these voluntary programs regarding the nature or stringency of the criteria required to obtain certification, or the review process involved in assessing and validating applications for certification. As a result, the scope and depth of the criteria used to evaluate applications in different programs can vary a great deal. In other words, salons or products certified under different voluntary programs could possess very different attributes regarding environmental or public health criteria.

Typically, nail salons seeking certification are required to use "safer" or "greener" products, improve indoor air quality within the salon, address waste generated by the salon, and train staff in safer practices. Once certified, salons can use the recognition in marketing their business.

Certification programs for "green" or "environmentally preferable" products focus on criteria related to ingredient toxicity, user exposure, and potentially other factors such as energy use and waste production. Two well-established product certification programs in North America have certification criteria that address the category of cosmetic and personal-care products as a whole, rather than nail salon products specifically. One product (described as a "versatile caring elixir") is currently listed as certified under the Green Seal GS-50 standard for personal care and cosmetic products. Thirty-two products produced by two manufacturers are currently listed as certified under the EcoLogo/UL Standard 2845 for personal care products. They are hair-care products, skin lotions, or skin moisturizers. No nail products are listed as certified under either voluntary standard.

Table A7 identifies a few of the certification programs available for nail salons and nail care products (as a subset of cosmetic products), as well as any specific chemicals that are restricted through the programs. This information is presented primarily to provide examples of chemical prohibitions considered as part of both salon and product certification criteria. We have not attempted to formally evaluate the strengths and weaknesses of these programs with respect to potential health or environmental impacts. Although these programs all rely, at least in part, on prohibiting certain chemicals in cosmetics or nail salon products, it is notable that at least one published account exists of research that found label claims intended to satisfy such criteria (in this case, claims regarding the so-called "toxic trio" of toluene, dibutyl phthalate, and formaldehyde) were frequently not substantiated.[66]

[66] Guo et al., 2012. Summary of data and findings from testing of a limited number of nail products. CA EPA, Department of Toxic Substance Control. Available at: http://www.dtsc.ca.gov/PollutionPrevention/upload/NailSalon_Final.pdf

Table A7: Chemical restrictions components of Voluntary Certification Programs for Nail Salons & Cosmetic Products

Issuing Agency/Organization	Certification Program	Prohibited Chemicals[a]
Counties and Cities in California • Alameda County Environmental Health • San Francisco Department of the Environment • San Mateo County Health System • Santa Monica Office of Sustainability and the Environment	Healthy Nail Salon Recognition Program[67]	Dibutyl phthalate Toluene Formaldehyde Methyl ethyl ketone
California Department of Toxic Substances Control and Local Governments	Green Business Program – Green Nail Salons[68]	Ethyl acetate Toluene Ethyl cyanoacrylate Butyl acetate Dibutyl phthalate Methyl ethyl ketone Tosylamide formaldehyde resin Acetone

[67] San Francisco Department of the Environment. Regulation to adopt standards and process for nail salons to qualify for San Francisco's Healthy Nail Salon Recognition Program. Accessed at: http://www.sfenvironment.org/sites/default/files/fliers/files/sfe_th_hnsrp_reg_12-01.pdf

[68] California Department of Toxic Substances Control. Guidance on Becoming a "Greener' Nail Salon. Accessed at: https://www.dtsc.ca.gov/PollutionPrevention/upload/Guidance_GreenNailSalon.pdf

Issuing Agency/Organization	Certification Program	Prohibited Chemicals[a]
Green Seal, Inc.	GS-50 - Standard For Personal Care and Cosmetic Products[69]	2-Butoxyethanol Alkylphenol ethoxylates Benzophenone Bisphenol A Butylated hydroxytoluene Ethoxylated chemicals Ethylene-diamine-tetra-acetic acid Formaldehyde Halogenated organic solvents Heavy metals Methyldibromo glutaronitrile Mercury-containing compounds Mineral oils Mono-, di-, or Triethanolamines Nitrilotriacetic acid Nitro-musks Optical brighteners Parabens Paraffin wax Petrolatum Phthalates Polycyclic musks Triclosan
Underwriters Laboratories	EcoLogo/UL Standard 2845 - Standards for Sustainability for Personal Care Products[70]	Halogenated organic solvents Butoxy-ethanol Phosphates Nitrilotriacetic acid Ethylene-diamine-tetra-acetic acid Alkylphenol ethoxylates

[a] Products endorsed under the respective voluntary program shall not contain chemicals listed as prohibited.

[69] Green Seal. Standard for Personal Care and Cosmetic Products. Accessed at: http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=37

[70] EcoLogo. 2013. Standard for Sustainability for Personal Care Products. Underwriters Laboratories. Accessed at: http://industries.ul.com/environment/certificationvalidation-marks/ecologo-product-certification#cleaning

Table A8*: Chemical prohibitions or avoidance recommendations related to chemicals of interest listed in Table A1

The following table identifies chemicals found in nail products and associated requirements to eliminate the chemical from certain cosmetic products or recommendations to avoid the use of the chemical. Chemicals found in the Table A1 were cross-referenced with lists of restricted or prohibited chemicals in cosmetic products and/or guidance documents from other authoritative bodies.[71]

Chemical	Regulations[a]	Guidance
Acetone	NA[b]	NA
Acetonitrile	Health Canada: prohibited in cosmetics European Commission: prohibited in cosmetics	Massachusetts: avoid use "if at all possible"
Benzene	Health Canada: prohibited in cosmetics European Commission: prohibited in cosmetics	California: Prop 65 California Safe Cosmetics Program: cancer
Benzoyl peroxide	Health Canada**:** restricted in cosmetics European Commission: restricted in cosmetics	Massachusetts**:** keep exposures as low as possible
Dibutyl phthalate	European Commission: prohibited in cosmetics	California: Prop 65 California Healthy Nail Salon Collaborative: choose nail polishes without dibutyl phthalate San Francisco: choose products without dibutyl phthalate OSHA: choose products without dibutyl phthalate
Di(2-ethylhexyl) phthalate	Health Canada: prohibited in cosmetics European Commission: prohibited in cosmetics	California: Prop 65 California Safe Cosmetics Program: cancer
Dimethyl p-toluidine	Health Canada: prohibited in cosmetics European Commission: prohibited in cosmetics	California: Prop 65
Ethyl cyanoacrylate	Health Canada**:** restricted in cosmetics	NA

[71] Reference sources for the underscored jurisdictions named in the table are cited within the body of the appendix narrative.

Chemical	Regulations[a]	Guidance
Formaldehyde (includes Formalin disinfectants)	Health Canada: restricted in cosmetics European Commission**:** restricted in cosmetics Japan Ministry of Health and Welfare: prohibited in cosmetics (formalin)	California: Prop 65 California Healthy Nail Salon Collaborative: choose nail polishes without formaldehyde San Francisco: choose products without formaldehyde OSHA: choose products without formaldehyde California Safe Cosmetics Program: cancer Massachusetts**:** avoid use
Hydroquinone	Health Canada: restricted in cosmetics European Commission**:** restricted in cosmetics (hair dyes only)	NA
Methyl methacrylate (monomer)	33 States have implemented prohibitions on methyl methacrylate Health Canada: prohibited in cosmetics Boston, MA: prohibited in nail products	Massachusetts**:** keep exposures as low as possible.

Chemical	Regulations[a]	Guidance
Other acrylates & methacrylates: butyl methacrylate ethylene dimethacrylate Ethyl methacrylate 2-hydroxyethyl acrylate 2-hydroxyethyl methacrylate 2-hydroxypropyl acrylate Isobutyl methacrylate	NA	Health Canada: ethyl methacrylate products required to carry a cautionary label to "avoid skin contact" Massachusetts: ethyl methacrylate -- keep exposures as low as possible.
Methacrylic acid	Health Canada: restricted in cosmetics	NA
Methanol	Health Canada: child-resistant packaging European Commission: restricted in cosmetics Japan Ministry of Health and Welfare: prohibited in cosmetics	California: Prop 65 California Safe Cosmetics Program: developmental toxicity
Methyl Ethyl Ketone (MEK)	NA	California Healthy Nail Salon Collaborative: choose thinners without methyl ethyl ketone San Francisco: choose products without methyl ethyl ketone
Methylene chloride	FDA: prohibited in cosmetics Japan Ministry of Health and Welfare: prohibited in cosmetics European Commission**:** restricted in cosmetics	Massachusetts**:** avoid use California: Prop 65 California Safe Cosmetics Program: cancer

Chemical	Regulations[a]	Guidance
t-Butyl acetate n-Butyl acetate Ethyl acetate Isopropyl acetate Methyl acetate	NA	California Healthy Nail Salon Collaborative: chose removers that do not contain butyl acetate, methyl acetate or ethyl acetate San Francisco: choose products without acetates
Ortho-phenyl phenol	Japan Ministry of Health and Welfare: restricted in cosmetics	California: Prop 65
phthalic anhydride	NA	NA
quaternary ammonium compounds	NA	NA
Toluene	FDA: restricted to concentrations no greater than 50%	California: Prop 65 California Safe Cosmetics Program: developmental, female reproductive toxicity California Healthy Nail Salon Collaborative: choose products that do not contain toluene San Francisco: choose products without toluene OSHA: choose products that do not contain toluene
tosylamide formaldehyde resin	NA	NA

[a] Regulations are enforceable legal requirements; guidance is not legally enforceable.

[b] Not available

Voluntary Certification and Recognition Programs

The following excerpts from voluntary certification and recognition programs are provided as examples of what model certification programs can entail. These excerpts focus on areas in the requirements that restrict certain chemicals.

Healthy Nail Salon Recognition Program (California)[72]

D. Recognition Criteria

In order to qualify for the Healthy Nail Salon Recognition Program, salons must be in compliance with the Board of Barbering and Cosmetology's professional code, must choose safer nail products and implement safer practices as established by San Francisco Department of Environment's (SFE) program staff.

1. *Choose nail polishes that do not contain the toxic trio (dibutyl phthalate (DBP), toluene, and formaldehyde).*
2. *Use safer nail polish removers, including but not limited to acetone.*
3. *Avoid using nail polish thinners unless absolutely necessary. When using thinners do not use those containing toluene and methyl ethyl ketone (MEK).*
4. *Ensure that all nail salon staff wear nitrile gloves when using nail products.*
5. *Ventilate the salon to improve air quality in the salon. Designate a specific area for artificial nail services and properly ventilate the area.*
6. *Install mechanical ventilation unit(s) within one year of entering recognition program, if one does not already exist.*
7. *Train all nail salon staff onsite (on payroll and on contract) and owners on safer practices using SFE's guide if one does not already exist.*
8. *Allow SFE program staff to monitor air quality within the salon.*
9. *Be committed to trying and adopting safer artificial nail products.*
10. *Do not allow customers to bring in products unless they meet program criteria.*

Safer products and practices will be determined by SFE program staff on a case by case basis in consultation with nail salons.

California Green Business Program – Green Nail Salons[73]

All cosmetic products used must come from manufacturer or distributor that registers with the CA Department of Public Health – Occupational Health Branch Safe Cosmetics program: http://www.cdph.ca.gov/programs/cosmetics/Pages/default.aspx. If registration is not showing at Department web site request a letter from the manufacturer or distributor that the company's products are in compliance with the CA Safe Cosmetics Acts reporting requirements.

[72] http://www.sfenvironment.org/sites/default/files/fliers/files/sfe_th_hnsrp_reg_12-01.pdf
[73] https://www.dtsc.ca.gov/PollutionPrevention/upload/Guidance_GreenNailSalon.pdf

A. Cosmetic Safety and Chemical Use

Required: Please ensure all cosmetics and nail care products have met the following five (5) criteria:

11. *Products used in shop currently meet or exceed the formulation standards of the EU Cosmetics Directive 76/768/EEC. Obtain safety ratings for products used/sold from the Skin Deep Database found here: http://www.cosmeticsdatabase.com or require products used only come from Manufacturer(s) that are certified to the Compact for Safe Cosmetics.*

12. *Avoid chemicals on County of San Francisco, Department of the Environment list of nail polish chemicals of high concern.*

13. *Prohibit the use and sale of traditional acrylic nails and gel products, unless they meet condition above (A. 1), **or** if adequate personal protective equipment is used by the technician and client, e.g. Particulate facemasks, gloves and ventilated table (or dust removal system) to remove and capture sanding dust.*

14. *Nail Care Products- Ask for the chemical safety data sheets (MSDS) from suppliers for all products used-employee should understand how to read the MSDS (retain on-site).*

15. *Promote natural nail care by replacing toxic chemicals with less toxic products for the following products if alternatives exist that are economically and functionally equivalent:*

    - ***Nail Glues**: Products usually contain: ethyl acetate, toluene, ethyl cyanoacrylate.*
    - ***Nail Polish**: Polishes can contain: butyl acetate, dibutyl phthalate, methyl ethyl ketone, toluene, tosylamide formaldehyde resin.*
    - ***Nail Polish Removers**: Refrain from using removers containing acetone.*

Green Seal – Personal Care and Cosmetic Products[74]

Prohibited Compounds

There are several hazardous compounds that may not be prohibited as a result of the other criteria in the Proposed Standard but may warrant exclusion in a more sustainable product. Further, there may not be a means to prohibit the compounds based on their end point. For example, there are several known endocrine disruptors used in these products. However, until recently there has not been an accepted testing procedure for such activity. In 2010, the EPA published the final guidelines for endocrine disruptor screening testing[27].

[74] http://www.greenseal.org/Portals/0/Documents/Standards/GS-50%20Std%20Dev/GS-50_Background_Proposed_Standard_Personal_Care_and_Cosmetic_Products_6-25-10.pdf

The final guidelines are part of a series of test guidelines that have been developed by the Office of Chemical Safety and Pollution Prevention (OCSPP) for use in the testing of pesticides and toxic substances. However, there is limited data available for all of the chemicals used in personal care products using these tests. As a result, the Proposed Standard will propose the use of the test guidelines for chemicals that have been identified as priority chemicals by the EPA[28] and EU[29]. In addition, known endocrine disruptors will be specifically prohibited. By far the largest group of chemicals with endocrine disruptor effects are phthalates including, but not limited to dibutylphthalate, dietylhexylphthalate, butyl benzyl phthalate, and bis-(2-etoxymethyl) phthalate. The Netherlands Organization (TNO) conducted a market survey in the Netherlands and found that phthalates were in 49 out of 55 cosmetic products, with diethyl phthalate the most common[30]. A similar study in the Untied States had the same results (72% of all products tested had phthalates), with dibutyl phthalate found in 7% of deodorant, fragrance, and hair spray products tested[31]. As a result, the group of phthalate materials will be prohibited.

Another group of compounds used in these products with endocrine disruptor activity are parabens, such as methylparaben, ethylparaben, propylparaben, butylparaben, isobutylparaben, isopropylparaben, and benzylparaben. These compounds are commonly used as preservatives in personal care products. According to the National Institutes of Health[32], parabens bind with to estrogen receptors and regulate estrogen-responsive reporter gene expression in experimental cell systems. The estrogenic activities of the parabens increase as the length and branching of the alkyl ester increase. The ER relative binding activity of parabens is in the following approximate order: 2-ethylhexyl > heptyl > benzyl > butyl > propyl = ethyl > methyl. Parabens also can cause skin irritation and contact dermatitis in individuals with paraben allergies, a small percentage of the population[33]. As a result, the class of parbens will be prohibited.

There are several materials that are prohibited due to their carcinogenicity or developmental toxicity. However, given their widespread use in personal care products they will be explicitly listed as prohibited materials. These include 2-butoxyethanol (EPA IRIS classification C), mercury-containing preservatives (Prop 65 developmental toxin), and formaldehyde donors. For example, formaldehyde is carcinogenic to humans (IARC classification 1) and would be a prohibited ingredient according to the carcinogen criterion proposed. However, there are commonly used preservative ingredients that are known to release formaldehyde over time (Bronopol; DMDM-hydantoin; Tris Nitro, 2-bromo-2-nitropropane-1,3-diol; 5-bromo-5-nitro-1,3-dioxane; diazolidinyl urea; imidazolidinyl urea; sodium hydroxy methyl glycinate). To further limit the content of known carcinogens, these formaldehyde-donor compounds were added to the list of other prohibited materials.

Materials that are known to be contaminated with toxic substances will be prohibited. For example, it is known that ethoxylated chemicals can be contaminated with 1,4-dioxane. Testing of personal care and cosmetic products found that about one-third of products were contaminated with 1,4-dioxane[17]. 1,4-dioxane is a possible carcinogen on the IARC list (and would be prohibited if it were directly added to the product under the Proposed Standard). Ethoxylated alcohols include polyethylene glycols, polyethylene, polyoxyethylene, or sodium laureth sulfate, are used in products included in the Proposed Standard. As a result, ethoxylated chemicals will be prohibited. Diethanolamine (DEA) is on the TLV list with a skin notation, a hazardous air pollutant, and an asthmagen. However, it is included in the list of prohibited compounds since it, along with

triethanolamine (TEA) and monoethanolamine (MEA), may cause the formation of cancer-causing nitrosamines in products. It is thought that the specific nitrosamine formed is known as N-nitrosodiethanolamine or NDELA. Most nitrosamines, including those formed from DEA or TEA, are carcinogenic. Further, the National Toxicology Program (NTP) completed a study in 1998 that found an association between the topical application of diethanolamine (DEA) and some DEA-related ingredients and cancer in laboratory animals[34]. For the DEA-related ingredients, the NTP study suggests that the carcinogenic response is linked to possible residual levels of DEA. As a result, these compounds are prohibited. Mineral oil (paraffinic oils, naphthenic oils, aromatic oils) and petrolatum are known to be contaminated with polycyclic aromatic hydrocarbons (probable carcinogens according to NTP). These compounds will be prohibited.

Human toxicological and epidemiologic data on oxybenzone (i.e., Benzophenone-3) suggest it to be the most common source photo allergies[35]. Oxybenzone animal studies have demonstrated a range of effects including hormone disruption[36]. An April 2008 study published in Environmental Health Perspectives revealed that, when exposed to benzophenone, cinnamate, or camphor-based sunscreens, coral developed viral infections that led to bleaching[37]. Given the widespread use of the benzophenone chemical class and that it is significantly absorbed through the skin[38], it will be prohibited. Cinnamate and camphor derivatives, in addition to potentially contributing to coral bleaching, have been shown to have hormone disruption activity[39]. However, these sunscreen ingredients do not appear to be absorbed through the skin in significant concentrations[40]. Thus, they will not be prohibited. However, there will be limits on the form sunscreen products can be in – not allowing for powders or sprays.

SCCS/SCCP evaluated the data on methyldibromo glutaronitrile (1,2-Dibromo-2,4-dicyanobutanone), a preservative commonly used in personal care products, and concluded that its use should be limited due to its demonstrated contact allergy effects[41]. The SCCS/SCCP also stated that triclosan should not be used for leave on products, thus they will be prohibited[42].

The following chemicals are prohibited specifically due to their aquatic hazards. Musks, nitro-musks and polycyclic musks are prohibited because of their bioaccumualtation and aquatic effects. Phosphates are prohibited due to their contribution to eutrophiciation effects. Nitrilotriacetic acid (NTA) and ethylene diaminetetra-acetic acid (EDTA) are poorly degradable and are suspected of remobilizing heavy metals in e.g. riverbeds. NTA is also a suspected carcinogen. There have been issues with the biodegradation, effects on microflora and fish, and skin sensitization or irritation of traditional, fluorescent, optical brighteners. Alkylphenol ethoxylates (APEs) degrade into nonylphenol and other products which are known to persist and bioaccumulate in waterways and aquatic life and act as endocrine disrupters.

Hazardous air pollutants (HAPs) cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. As a result, the EPA regulates these substances[43]. There are some that are included in personal care products such as ethylene glycol, phenol, phthalic anhydride, and hydroquinone (used as a skin lightener). As a result, HAPs will be prohibited.

According to the EPA[44], "Stratospheric ozone is a naturally-occurring gas that filters the sun's ultraviolet (UV) radiation. A diminished ozone layer allows more radiation to reach the Earth's surface. For people, overexposure to UV rays can lead to skin cancer, cataracts, and weakened immune systems." Ozone depleting substances have been identified in the global initiative, the Montreal Protocol. These are regulated by the EPA and classified as Class I and Class II, and also classified by GHS as Category 1. These will be prohibited.

The primary active ingredients for antiperspirant are aluminum-based. There has been question about aluminum's safety, especially related to causing Alzheimer's disease (and to some extent to breast cancer, but aluminum is not listed as a carcinogen by any of the authorities on cancer). A preliminary study showed "a trend toward a higher risk [of Alzheimer's] with increasing frequency of use" of antiperspirant[45]. One of the key questions related to this concern is the extent of dermal (or even nasal-olfactory) absorption of aluminum and subsequent transport and uptake into the brain with antiperspirant use[46]. This seems to be unanswered. Since spray and aerosol products can be inhaled or swallowed, these materials can then be transported throughout the body. As a result, antiperspirant and deodorant will not be allowed to be in spray or aerosol packages. A recent review on the risk factors for Alzheimer's was completed in Canada[47]. They found that there was no statistically significant association with antiperspirant use and Alzheimer's. As a result, at this time there will be not be a prohibition for aluminum-containing antiperspirants.

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