U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION REPORT 75-128-262
RADIANT LADY BEAUTY SALON, INC.
DENVER, COLORADO

FEBRUARY 1976

I. TOXICITY DETERMINATION

It has been determined that a toxic situation does not exist at the Radiant Lady Beauty Salon, Inc. This conclusion is based on the results of the environmental and the medical investigations conducted on August 21, 1975, and September 18-20, 1975.

The medical investigation, which consisted of questionnaires, physical examinations, pre- and post-shift pulmonary function tests, and chest radiographs, did not reveal any cases suggestive of thesaurosis.

The environmental investigation which consisted of environmental sampling for polyvinylpyrrolidone, ethanol, isobutane, and Freon 11, revealed trace amounts of ethanol, Freon 11, and polyvinylpyrrolidone Isobutane concentrations ranged from 373 mg/M^3 to 1935 mg/M^3 . Isobutane is found in one hair spray preparation that is no longer used at this beauty salon.

II. DISTRIBUTION AND AVAILABILITY

Copies of this hazard evaluation determination are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, Fifth and Walnut Streets, Cincinnati, Ohio 45202.

Copies have been sent to:

a) Radiant Lady Beauty Salon, Inc.
b) U.S. Department of Labor - Region VIII
c) NIOSH - Region VIII

For the purpose of informing the approximately eight "affected employees," this report shall be posted in a prominent place accessible to the workers for a period of 30 days.

INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from the President of Radiant Lady Beauty Salon, Inc., Denver, Colorado, to evaluate the hazards associated with air contaminants present in hair sprays and their effect on the cosmetologists.

IV. HEALTH HAZARD EVALUATION

A. Description of the beauty salon

The Radiant Lady Beauty Salon, Inc., is typical of many beauty salons in size and types of services rendered. The salon is open six days per week from 7:30 a.m. to 6:00 p.m. The busiest days are Friday and Saturday. Services rendered include permanents, wash, cut, blow dry, tinting, frosting, manicuring, and wig wash and style. This salon is capable of accommodating up to 15 customers. Seven full-time cosmetologists and a part-time manicurist, all white females, are currently employed.

B. Evaluation Methods

1. Environmental Evaluation Methods

Personal breathing zone and general room samples for polyvinylpyrrolidone (PVP), Freon 11, isobutane, and ethanol were taken. Samples for PVP were collected and analyzed using the method of Larkin and Kupel.[12] Freon 11, isobutane, and ethanol were collected on organic charcoal sampling tubes and analyzed by gas chromatography.

2. Medical Evaluation Methods

The medical investigation consisted of a non-directed questionnaire, pre- and post-shift pulmonary function tests (PFT), and a physical examination limited to a cutaneous examination, examination of the eyes, nose, and throat, and chest auscultation. All subjects had a chest X-ray examination carried out either prior to or just after the NIOSH field visit. Informed consent was obtained from all participants.

A questionnaire was administered and focused on: possible work related illness, acute and chronic symptoms that might be related to the use of various aerosols and reagents, an extensive allergic history, a smoking history, an occupational history, a past cardio-pulmonary history, and the history of miscarriage, stillbirths or children with congenital defects of any kind. Eight (8) persons were evaluated.

C. Evaluation Criteria

1. Environmental Criteria

Two sources of criteria were used to assess workroom concentrations of air contaminants in this evaluation: (1) Recommended and proposed threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) (1975); and (2) Occupational health standards as promulgated by the U.S. Department of Labor (Federal Register, June 27, 1974, Title 29, Chapter XVII, Subpart G).

In the following tabulation of criteria, the 1975 ACGIH TLV and the current OSHA standards which are identical for ethanol and Freon 11, are presented below:

Substance	Permissible Exposures 8-Hour Time-Weighted Exposure Basis
Ethanol	1,900 mg/M^3 [a]
Freon 11[c]	7,600 mg/M^3
Isobutane	[b]
PVP	[b]

[a] mg/M^3 = Milligrams of substance per cubic meter of air

[b] No occupational health standards exist for these chemicals

[c] Trade name; generic name is 1, 1, 2-Trichloro 1, 2, 2-trifluoroethane

Occupational health standards are established at levels designed to protect individuals occupationally exposed to individual toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

2. Medical Criteria

Medical data on the individual components of the several aerosols employed at the Radiant Lady Beauty Salon are scanty; however, aerosol sprays may cause mucous membrane irritation. Moreover, it is well documented that persons with chronic bronchitis, emphysema and asthma may be made symptomatically worse by the use of chemical aerosols.

The three essential components of an aerosol spray are the propellant, the solvent, and the active ingredient. The most common propellants are fluorohydrocarbons bearing the trade name, Freon (trademark, E.I. DuPont de Nemours & Co.). A common solvent in hair sprays is denatured alcohol (ethanol). As an estimate of the indoor concentration of respirable aerosol generated from a spray can, during use an aerosol spray can may lose approximately one gram of weight per second. Ten percent of this weight is non-volatile aerosol (solvent plus active ingredients) and one-half of this fraction remained airborne (respirable). The amount added to the ambient air would be 50 mg per second. Assuming that the volume of the room is 10 M^3 and mixing is complete, then the concentration emitted would be 5 mg per M^3 per second. If 90 percent by weight of the aerosol was in the large mode (particle size greater than several microns in diameter), the distribution of particles according to size would be: large mode - 4.5 mg/M^3/sec; submicronic mode - 0.5 mg/M^3/sec. The decay of aerosol concentration with time is a function of room ventilation and aerodynamic size of the particles.[1]

Two of the components of aerosol sprays, solvents and active ingredients are contained in the non-volatile aerosol. Approximately 90 percent or more of the aerosol weight is likely to be in particles greater than several microns in diameter. These particles once inhaled deposit principally in the nose and throat and the larger central airways. The submicronic particles, representing 10 percent or less of the total mass, deposit in the small airways and alveolar regions. It is presumably these submicronic particles that are responsible for any granulomatous lesions of the lungs and for any reversible small airways obstruction immediately after exposure. Zuskin and Bouhuys[2] investigated whether hair spray aerosols could alter respiratory function in healthy persons. They found that these exposures caused acute, short-lasting effects on ventilatory function. The reductions of flow rates immediately after exposure were large and consistent. All subjects reacted to a preparation containing polyvinylpyrrolidone (PVP); however, the other aerosols that did not contain PVP also exerted similar effects. These changes in ventilatory function were postulated to reflect constriction of small airways rather than large airway constriction. Although these effects were statistically significant, their practical importance is questionable and perplexing in view of the conflicting epidemiologic data (to be discussed below). These workers conclude that individual sensitivity to the airway constriction action of hair

spray aerosols varies considerably and that sensitive persons may leave their jobs. Such self-selection factors may account for the absence of an obvious excess of airway disease among beauticians.

Whether or not the repeated use of hair sprays can cause chronic respiratory disease remains at the present time controversial. The following is a partial summary of the literature dealing with this controversy:

In 1958, Bergmann et al.[3] described several subjects with a chronic pulmonary disease they called "Thesaurosis" or storage disease. This clinical entity occurred in two young women exposed to hair sprays and was attributed by these investigators to the inhalation of polyvinylpyrrolidone (PVP), the major resin constituent of hair spray. These first two patients were asymptomatic with a history of heavy exposure to hair spray. Both had pulmonary infiltrates and hilar lymphadenopathy on chest X-ray. A scalene lymph node biopsy in one patient revealed granulomatous reaction. In an attempt to develop an animal model, Bergmann injected hair spray residues into the groin area of guinea pigs and produced a granulomatous reaction.
In 1962, Bergmann et al.[4] reported 12 new cases, including three autopsies. They claimed this entity is characterized radiographically by fluffy, hazy infiltrates and hilar adenopathy. Lymph node biopsy revealed findings which varied from reticuloendothelial hyperplasia to frank sarcoid granulomata. Microscopic lesions in the lungs resembled idiopathic pulmonary fibrosis and in the more chronic cases more closely resembled fibrosing alveolitis. Granulomata were occasionally observed in the lung and these workers also noted the presence of PAS-positive granules in the lung parenchyme. However, these PAS-positive granules are not specific for thesaurosis. Bergmann and colleagues further noted that when the use of hair spray was stopped, the disease resolved.

Unfortunately, there is much data to suggest that thesaurosis is not a definite clinico-pathological entity. Its relative infrequency in persons exposed to hair sprays suggests that it may be a manifestation of hypersensitivity (allergy). In many of the reports of so-called thesaurosis, the clinical picture, radiographic findings, and the pathology are pathognomonic of Boeck's sarcoid. Moreover, most of the patients with sarcoidosis, especially those with hilar adenopathy alone, improve spontaneously. This syndrome, as described by Bergmann, could well be sarcoidosis. Further circumstantial evidence against the concept of thesaurosis is the failure to demonstrate PVP in the lungs of several subjects with so-called thesaurosis--a supposed <u>storage</u> disease. The fact that PVP has been shown to be retained in lymph nodes is not surprising since being inert, once it is deposit in the lungs, it is taken up by the pulmonary macrophages and deposited in the regional lymph nodes.

The results of several well-controlled epidemiologic studies are conflicting. In one study, McLaughlin and Bidstrup[5] were unable to find a single subject with thesaurosis in a survey of 505 hair dressers. A similar study carried out by Sharma and Williams[6] in which lung volumes and diffusing capacities of 62 exposed cosmetologists were compared to 33 controls provided no evidence that thesaurosis exists. Palmer[7] compared 262 student cosmetologists and 213 graduate cosmetologists from Utah with 569 matched controls. Four findings were more frequent in the beauticians than in their matched controls: abnormal chest X-rays, reduced vital capacity, reduced single breath diffusing capacity for carbon monoxide (CO) and atypical sputum cytology. This study reported the prevalence of the "thesaurosis sarcoid" syndrome was 22.5% in graduate cosmetologists, which was a significant increase over that prevalence seen in the student cosmetologists or control group. No definitive correlations were found between the area sample concentration of aerosol particulates and sputum cytology or chronic respiratory disease findings. However, a significant relationship was found between the prevalence of the "thesaurosis-sarcoidosis" symptoms and environmental concentration of aerosol particulates. Analysis of these examinees with a history of allergies showed a non-significant increase in prevalence of sarcoid symptoms, atypical sputum cytology, and a significant increase of chronic respiratory disease. Allergic cosmetologists and controls showed 1.4 times more borderline chronic respiratory disease than non-allergies.

In view of the conflicting epidemiologic evidence and the fact that aerosols have an acute effect on respiratory function, the question of whether aerosols are harmful cannot be answered at the present time. Additional prospective epidemiologic studies and basic research are needed.[8]

Based on the foregoing information, the acute signs and/or symptoms of exposure to the various aerosols and reagents that were sought included: irritation of the mucous membranes of the eyes, nose, and throat, headache, nausea and/or vomiting, shortness of breath, cough, wheezing and chest discomfort. The chronic symptoms and/or signs or exposure to aerosols and reagents (compatible with the signs and or symptoms of so-called thesaurosis) that were sought included the development of a new allergy related to these aerosols and reagents, weakness, fatigue, weight loss, chronic cough, chronic sputum production, chest discomfort, and shortness of breath over a period of time.

The pulmonary function tests were evaluated in accordance with the following criteria. A medically significant acute change was said to have occurred over the course of the work shift if an acute decrease in $MMEF_{25-75\%}$ and/or $FEV_{1.0}$ greater than 10% of the pre-shift value was noted. The following criteria were used to diagnose obstructive

lung disease: an $FEV_{1.0}$ less than 70% of the predicted value with a normal FVC; and/or an $MMEF_{25-75\%}$ less than 75% of the predicted value.

D. Evaluation Results

1. Environmental Evaluation Results

The individual sample results for Freon 11, isobutane, ethanol, polyvinylpyrrolidone (PVP) are listed on Tables I and II. It is obvious that all compounds except isobutane were found in trace amounts. Isobutane concentrations ranged from 373 mg/M^3 to 1935 mg/M^3. Trace amounts of PVP were measured in the general area samples but none was measured in the breathing zone samples. The reasons for and the significance of this slight discrepancy are not readily apparent.

2. Medical Evaluation Results

Seven full-time cosmetologists and a part-time manicurist--all white females--are currently employed. The following table summarizes the epidemiologic data of this group:

Subject	Age	Approximate Duration of Employment as a Beautician (Including Cosmetology School)	Occupation
A	27	28 months	Cosmetologist
B	19	27 "	"
C	20	26 "	"
D	32	108 "	"
E	23	72 "	"
F	34	81 "	"
G	27	15 "	"
H	63	175 "	Manicurist

In response to the questionnaires dealing with health complaints or problems in the past or present possibly related to their present employment, two persons reported the following: subject D reported that prior to July, 1975, she used a preparation called "Vita E" which produced irritation of the mucous membranes of the eyes and nose as well as cough and chest soreness. This agent was replaced in July, 1975, by "Tresemme Two" which employs carbon dioxide (CO_2) as a propellant. She is now asymptomatic. These symptoms may represent an irritative process but an allergic phenomenon cannot be ruled out. Subject G reported that her nose was occasionally and transiently irritated by nail polish remover. Subject A reported a history of eczematous hand dermatitis related to the use of shampoos and detergents that antedated her present job. Other than two active cigarette smokers (subjects G and H) who reported chronic cough, sputum production and shortness of breath, which they related to their cigarette smoking, no person reported any signs or symptoms consistent with a diagnosis of chronic respiratory disease such as thesaurosis or sarcoidosis. Subject G reported that her bronchitic symptoms were occasionally aggravated by bathroom cleaners, insect repellants and hair sprays.

A review of allergic histories was essentially unremarkable. One person noted above reported a cutaneous allergy to soaps and detergents. Subject E reported a history of cutaneous allergy to the "Permanent Wave" solutions. She now wears gloves when using these solutions and is under the care of a physician. Subject H reported occasional sneezing when using oven cleaners and frying pan sprays. This may represent an irritative process rather than a truly allergic phenomenon.

On the day of the NIOSH visit which was considered a very busy, typical working day, only one person noted the acute onset of any symptoms. Subject B noted a transient headache that she related to the odor of nail polish being applied by the manicurist. The remaining seven persons were asymptomatic. All physical examinations were unremarkable and revealed no mucous membrane irritation, respiratory distress or wheezing. Small patches of eczematous hand dermatitis were noted in the examination of subject A.

Pre- and post-shift PFT's were carried out employing a Vitalograph Spirometer. Five forced expiratory maneuvers were carried out and the "best" curve was selected and analyzed for vital capacity (VC), forced expiratory volume in one second ($FEV_{1.0}$), and maximal mid-expiratory flow rate ($MMEF_{25-75\%}$). These measurements were corrected to body temperature and standard barometirc pressure of 760 mmHg (BTPS). The predicted values were calculated according to the formulae of Morris, Koski, and Johnson.[9] The results of these tests and the predicted values for each subject are contained in Table III. (Note that only six subjects are listed in this Table since two subject's tracings

were technically poor and cannot be evaluated.) After the post-shift tests, each subject, except subject H, inhaled several breaths of isoproterenol sulfate delivered in an inert propellant via a commercial medi-haler in order to evaluate the presence or absence of chronic underlying bronchospasm. Isoproterenol is a potent bronchodilator commonly used in the treatment of bronchial asthma. Each inhalation delivers a measured dose of 0.075mg to the subject. Each person, therefore, served as her own control in the analysis of these data.

There were no acute changes in MMEF and/or $FEV_{1.0}$ greater than 10% over the course of the work shift. The results of isoproterenol inhalation challenge revealed only two persons with a 9-10% change in MMEF when comparing the post-shift values with the post-isoproterenol values.

One subject (subject F) fulfilled the criteria for early obstructive lung disease. All other baseline pre-shift values were entirely within normal limits.

Analysis of the mean pre- and post-shift FVC, $FEV_{1.0}$ and MMEF--both before and after isoproterenol challenge--revealed only small, inconsistent changes that are probably not medically significant.

The following table summarizes the results of the chest X-ray examinations:

Subject	X-ray Result
A	Several granulomata on the left; otherwise the lungs are clear.
B	Within normal limits
C	Within normal limits
D	Within normal limits
E	A solitary granuloma; otherwise normal
F	Within normal limits
G	Within normal limits
H	Within normal limits

None of the chest X-rays revealed any changes suggestive of infiltrative lung disease, chronic lung disease, thesaurosis, or sarcoidosis.

E. Summary of Investigations and Conclusions

An environmental-medical investigation to evaluate the possible relationship between exposure to hair sprays and cigarette smoke and the development of chronic lung disease was conducted. Analysis of the questionnaires revealed little to suggest that chronic exposure to either hair sprays or cigarette smoke (to be clearly distinguished from smoking) produces chronic respiratory disease. There is no question that hair sprays, strong perfumes, and cigarette smoke may aggravate hay fever symptoms, asthma and chronic bronchitis. However, the data on the chronic health effects of cigarette smoke on non-smokers in public places is not available.[10, 11] However, allergy to these agents has generally not been implicated in the etiology of asthma or hay fever.

Pulmonary function tests revealed no symptomatic acute airway obstruction over the course of the work day. Pre-shift baseline values were entirely within normal limits, with the exception of one person whose test results are indicative of early obstructive lung disease, probably due to cigarette smoking. Chest roentgenograms were essentially negative for interstitial and chronic lung disease.

The results of the environmental sampling indicated that exposures to polyvinylpyrrolidone (PVP) were very low. Of the five samples, two were below the NIOSH detection limits of seven micrograms per sample and the remaining three ranged from 0.02 mg/M^3 to 0.07 mg/M^3. The concentrations of Freon 11 ranged from 3 mg/M^3 to 41 mg/M^3 and the concentrations of ethanol ranged from nondetectable to 3 mg/M^3. These environmental concentrations are very low when compared to the current occupational health standards for ethanol and Freon 11. The concentrations of isobutane ranged from 373 mg/M^3 to 1935 mg/M^3. At the present time there are no occupational health standards for polyvinylpyrrolidone or isobutane; however, isobutane is found in only one hair spray preparation which is no longer used in this beauty salon.

Based on a thorough inspection of the beauty salon, medical questionnaires, pulmonary function tests and environmental measurements, it is concluded that a toxic situation does not exist. Under certain circumstances hair sprays, cigarette smoke and other strong smelling compounds may aggravate hay fever and asthma, and may on occasion produce transient mucous membrane irritation. Several cases of cutaneous allergy to some of the agents in the work place were reported. One subject noted a skin allergy to soaps and detergents and one noted an allergy to "permanent wave" solution. The results of interviews, physical examinations, pulmonary function tests and chest X-rays did not reveal any cases suggestive of thesaurosis.

F. Recommendations

It is recommended that the management of the Radiant Lady Beauty Salon continue its efforts in obtaining hair sprays that contain non-harmful agents such as carbon dioxide as propellants. Further research into the biological effects of polyvinylpyrrolidone and other constituents of aerosol hair sprays are needed. Research into the health effects of cigarette smoke on non-smokers in public places is needed.

V. AUTHORSHIP AND ACKNOWLEDGEMENT

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TABLE I

ATMOSPHERIC CONCENTRATIONS OF
FREON 11, ISOBUTANE, AND ETHANOL

September 19, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations Freon 11 mg/M^3	Isobutane mg/M^3	Ethanol mg/M^3	Type Sample
1	Cosmetologist Station 1	205	35	1626	3	OBZ
2	Cosmetologist Station 2	206	41	1935	3	OBZ
3	Cosmetologist Station 3	207	33	1570	3	OBZ
4	Cosmetologist Station 4	209	27	1291	3	OBZ
5	Cosmetologist Station 5	210	9	373	0	OBZ
6	Cosmetologist Station 6	210	12	574	1	OBZ
	HYGIENIC STANDARDS		7,600	*	1,900	

OBZ = Operator's Breathing Zone

* no occupational health standard exists for this chemical

TABLE II

ATMOSPHERIC CONCENTRATIONS OF
POLYVINYLPYRROLIDONE (PVP)

September 19, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concen. Polyvinylpyrrolidone mg/M^3	Type Sample
1	Cosmetologist Station 1	450	0	OBZ
2	Cosmetologist Station 2	158	0	OBZ
3	Between Stations 3 & 4	175	0.07	General Room
4	Between Stations 5 & 6	430	0.02	General Room
8	Near Station 1	210	0.04	General Room
	HYGIENIC STANDARD		*	

OBZ = Operator's Breathing Zone

* no occupational health standard exists for this chemical

TABLE III

PULMONARY FUNCTION TEST RESULTS

Radiant Lady Beauty Salon

	PRE-SHIFT			POST-SHIFT			POST-ISOPROTERENOL			PREDICTED		
	FVC L/sec. (% Pred.)	$FEV_{1.0}$ Liters	MMEF L/sec.	FVC	$FEV_{1.0}$	MMEF	FVC	$FEV_{1.0}$	MMEF	FVC	FEV 1.0	MMEF
NON-SMOKERS												
A.	4.15(101)	4.04(124)	5.78(156)	4.15(101)	3.98(122)	5.78(156)	4.09(100)	3.98(122)	6.16(166)	4.09	3.27	3.70
B.	3.80(96)	3.44(108)	4.00(106)	3.71(94)	3.38(106)	3.96(105)	3.80(96)	3.53(110)	3.98(106)	3.94	3.20	3.76
C.	4.60(100)	4.23(114)	5.46(133)	4.53(98)	4.34(117)	6.00(147)	4.63(101)	4.47(120)	6.36(156)	4.60	3.71	4.09
D.	4.92(117)	4.34(131)	4.15(113)	4.86(116)	4.15(125)	3.91(101)	4.91(117)	4.26(128)	3.91(107)	4.20	3.32	3.67
Mean (N=4)	4.37	4.01	4.41	4.31	3.96	4.91	4.35	4.06	5.10	-	-	-
% Change Between Pre-Post Shift	-	-	-	-1.37%	-1.25%	+11.34%	-	-	-			
% Change Between Post-Shift and Post- Isoproterenol Means	-	-	-	-	-	-	+1.03%	+2.53%	+3.87%			
SMOKERS												
E.	4.47(121)	3.42(118)	2.68(80)	4.34(118)	3.38(116)	2.78(82)	4.34(118)	3.44(118)	2.96(88)	3.69	2.91	3.3
F.	2.78(89)	2.13(93)	1.54(59)	2.88(92)	2.07(90)	1.53(59)	-	-	-	3.14	2.30	2.5
Mean - All Subjects (N=5)*	4.39	3.89	3.62	4.31	3.84	4.48	4.35	3.93	4.67	-	-	-
Pre vs. Post Means	-	-	-	-1.82%	-1.29%	-1.23%	-	-	-			
Post-Shift vs. Isoproterenol	-	-	-	-	-	-	+0.93%	+2.34%	+4.24%			

* One or more observation not used because its pair missing.