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Collodion Safety Guideline

2009

Collodion USP

Collodion is considered the best medium for attaching electrodes when performing diagnostic procedures for more that a few hours, especially in conditions where a secure attachment is needed.

The advantages of collodion include: secure water resistant adhesion, non-conductive, and easy to remove. Once the electrode is attached correctly monitoring can be performed continuously for days even if the patient is active and perspires.

Collodion works because while it is drying (evaporation of the ethyl ether) the nitrocellulose forms a secure non flexible film bonding the electrode and/or gauze to the skin and hair.

The main side effect of Collodion is the ethyl ether fumes during application. Once the collodion has cured there are no other vapors to contend with.

On pages 3 to 15 we have included a copy of information on Ethyl Ether found on the OSHA website. Collodion is a combination of Nitrocellulose (the resin that forms the film) Ethyl Ether and Ethanol. The fumes you notice are Ethyl Ether. Many facilities are concerned about these fumes and wish to confirm that the levels are in the "safe" area in their facilities.

We recommend that you perform testing of the levels of ethyl ether periodically to confirm this.

On pages 16-17 there is a copy of a study performed by Dr. B. Young at EEG Laboratory, Victoria Hospital in Ontario, Canada. In this study they evaluated the concentration of Ethyl ether before renovations and after installing an exhaust fan. Before renovations the highest level of concentration was 163 ppm well below the permissible exposure limit set by OSHA.

In the article below we have highlighted important information in yellow.

There are many ways to reduce the evaporation of the fumes. Among these are:

- Reducing the amount used: By applying collodion in tubes directly on the electrode sight you will be using only what you need, instead of dipping a gauze in a bowl on the tray/ table.
- Using an exhaust fan if possible.
- Portable Fume extractor system. www.sentryair.com
- Ozone Generator to dissipate the ethyl ether fumes in a room.

Here is a summary of the article from OSHA which is reproduced in full below:

> Ethyl ether is a clear, colorless liquid with a characteristic, sweet ether odor. The air odor threshold concentration for ethyl ether is 8.9 parts per million (ppm) parts of air. Page 4

> The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for ethyl ether is 400 ppm (1200 milligrams per cubic meter (mg/m(3))) as an 8-hour time-weighted average (TWA) concentration [29 CFR 1910.1000, Table Z-1]. Page 5

Collodion Safety

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned ethyl ether a threshold limit value (TLV) of 400 ppm (1210 mg/m(3)) as a TWA for a normal 8-hour workday and a 40-hour workweek and a short-term exposure limit (STEL) of 500 ppm (1520 mg/m(3)) for periods not to exceed 15 minutes. Exposures at the STEL concentration should not be repeated more than four times a day and should be separated by intervals of at least 60 minutes [ACGIH 1994, p. 21]. Page 5

2. Effects on Humans: Ethyl ether has been used to produce surgical anesthesia in humans; the concentration that is needed to induce anesthesia in humans ranges from 100,000 to 150,000 ppm. After anesthesia has been induced, it is maintained at about 50,000 ppm because respiratory arrest may occur at higher concentrations [Hathaway et al. 1991]. At 200 ppm, mild nasal irritation occurs, and at 2,000 ppm, dizziness may be experienced [ACGIH 1991; Hathaway et al. 1991]. Brief exposures of the eyes to the liquid or to high vapor concentrations produced burning but no injury. Prolonged exposure may cause temporary corneal epithelial injury [Grant 1986]. Prolonged skin contact can cause burns. Ethyl ether is also a defatting agent, and repeated exposure may cause skin drying and cracking [Genium 1988 Page 6

Ethyl ether is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) (Title III) in 42 USC 11022. Page 10

Mavidon highly recommends working with your material management department to find the right solution for your facility. Collodion offers the best solution in diagnostic procedures to assure proper diagnosis, however your safety is much more important while working with any flammable liquid.

The information in this article is for information purposes only. Mavidon does not by any means suggest you use this information without your own due diligence. Each facility has different needs, therefore there is no way to predict the best solution for your facility.

Please feel welcome to contact us with any questions, comments or solutions you have found for your facility.

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Collodion Safety

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR ETHYL ETHER

INTRODUCTION

This guideline summarizes pertinent information about ethyl ether for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine whether new information is available.

SUBSTANCE IDENTIFICATION

* Formula

C(4)H(10)O
* Structure

(For Structure, see paper copy)
* Synonyms

Diethyl ether; 1,1'-oxybisethane; ethyl oxide; anesthetic ether;
diethyl oxide; sulfuric ether; ethoxyethane
* Identifiers

1. CAS No.: 60-29-7

2. RTECS No.: KI5775000

3. DOT UN: 1155 26

4. DOT label: Flammable Liquid

* Appearance and odor

Ethyl ether is a clear, colorless liquid with a characteristic, sweet ether odor. The air odor threshold concentration for ethyl ether is 8.9 parts per million (ppm) parts of air.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 74.1

2. Boiling point (at 760 mm Hg): 34.5 degrees C (94.1 degrees F)

3. Specific gravity (water = 1): 0.71 at 20 degrees C (68 degrees F)

4. Vapor density: 2.55

5. Freezing point: -116.3 degrees C (-177.3 degrees F)

6. Vapor pressure at 20 degrees C (68 degrees F): 442 mm Hg

7. Solubility: Slightly soluble in water; soluble in alcohol, acetone, benzene, and chloroform.

8. Evaporation rate: Data not available.

* Reactivity

1. Conditions contributing to instability: Heat, sparks, flame light, shock. Ethers that have been in contact with air or exposed to light for a long time may contain peroxides; ethers that contain peroxides may explode when the caps or stoppers of their containers are removed. Because ethyl ether is a nonconductor, static electric charges may accumulate and cause ignition of its vapors.

2. Incompatibilities: Contact between ethyl ether and strong oxidizing agents, halogens, interhalogens, sulfur and sulfur compounds should be avoided.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving ethyl ether.

4. Special precautions: None reported.

* Flammability

The National Fire Protection Association has assigned a flammability rating of 4 (extreme fire hazard) to ethyl ether.
1. Flash point: -45 degrees C (-49 degrees F) (closed cup)

2. Autoignition temperature: 180 degrees C (356 degrees F)

3. Flammable limits in air (percent by volume): Lower, 1.9; upper, 36.0

4. Extinguishant: For small fires use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam. Use water spray, fog, or alcohol-resistant foam to fight large fires involving ethyl ether DOT 1993, Guide 26].

Fires involving ethyl ether should be fought upwind from the maximum distance possible. Keep unnecessary people away; isolate the hazard area and deny entry. Isolate the area for 1/2 mile in all directions if a tank, rail car, or tank truck is involved in the fire. For a massive fire in a cargo area, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from the area and let the fire burn. Emergency personnel should stay out of low areas. Vapors may travel to a source of ignition and flash back. Vapors are an explosion and poison hazard indoors, outdoors, or in sewers. Containers of ethyl ether may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool fire exposed containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if a rising sound from a venting safety device is heard or if there is discoloration of a container due to fire. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving ethyl ether.

EXPOSURE LIMITS

* OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for ethyl ether is 400 ppm (1200 milligrams per cubic meter (mg/m(3))) as an 8-hour time-weighted average (TWA) concentration [29 CFR 1910.1000, Table Z-1].

* NIOSH REL

* The National Institute for Occupational Safety and Health has not established a recommended exposure limit for ethyl ether.

* ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned ethyl ether a threshold limit value (TLV) of 400 ppm (1210 mg/m(3)) as a TWA for a normal 8-hour workday and a 40-hour workweek and a short-term exposure limit (STEL) of 500 ppm (1520 mg/m(3)) for periods not to exceed 15 minutes. Exposures at the STEL concentration should not be repeated more than four times a day and should be separated by intervals of at least 60 minutes [ACGIH 1994, p. 21].

* Rationale for Limits

The ACGIH limits are based on the risk of narcosis and irritation [ACGIH 1991, p. 631].

HEALTH HAZARD INFORMATION

* Routes of Exposure

Exposure to ethyl ether can occur through inhalation, ingestion, and eye or skin contact [Sittig 1991].
* Summary of toxicology

1. Effects on Animals: Ethyl ether is a severe irritant of the eyes and mucous membrane; at high concentrations, ethyl ether causes central nervous system depression. The oral LD(50) in rats is 1,215 mg/kg, and the LC(50) in rats is 73,000 ppm for 2 hours [NIOSH 1991]. The lethal concentration for a single exposure in monkeys is reportedly between 71,600 ppm and 192,500 ppm ethyl ether by volume. Exposure to a 6.4 percent concentration caused deep anesthesia in mice, and respiratory arrest occurred at 128,000 ppm ethyl ether. Rats exposed chronically over 30 weeks to 2,000 ppm ethyl ether did not experience adverse effects in the blood or kidneys and body weight changes. However, the blood levels of liver enzymes were elevated, although microscopic examination failed to identify any liver damage. A decrease in the weight of the liver relative to body weight was noted [Clayton and Clayton 1982]. Contact of the eyes of rabbits with the liquid or the vapor may produce slight, reversible corneal injury [Grant 1986]. Ethyl ether is mutagenic in bacterial and mammalian test systems [NIOSH 1991].

2. Effects on Humans: Ethyl ether has been used to produce surgical anesthesia in humans; the concentration that is needed to induce anesthesia in humans ranges from 100,000 to 150,000 ppm. After anesthesia has been induced, it is maintained at about 50,000 ppm because respiratory arrest may occur at higher concentrations [Hathaway et al. 1991]. At 200 ppm, mild nasal irritation occurs, and at 2,000 ppm, dizziness may be experienced [ACGIH 1991; Hathaway et al. 1991]. Brief exposures of the eyes to the liquid or to high vapor concentrations produced burning but no injury. Prolonged exposure may cause temporary corneal epithelial injury [Grant 1986]. Prolonged skin contact can cause burns. Ethyl ether is also a defatting agent, and repeated exposure may cause skin drying and cracking [Genium 1988].

* Signs and symptoms of exposure

1. Acute exposure: Ethyl ether causes a wide range of effects depending on the concentration and length of exposure. Symptoms include irritation of the nose and eyes, dizziness, acute excitement, drowsiness, vomiting, paleness, decreased pulse rate, decreased body temperature, irregular respiration, muscle relaxation, lung irritation with increased bronchial secretions, laryngospasm, loss of consciousness, and death [Clayton and Clayton 1982]. Post-narcosis effects include excessive salivation, vomiting, headaches, and irritation of the respiratory tract [Clayton and Clayton 1982].

2. Chronic exposure: Long-term exposure of the skin to ethyl ether may cause dermatitis.

EMERGENCY MEDICAL PROCEDURES

* Emergency medical procedures: [NIOSH to supply]

5. Rescue: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the Material Safety Data Sheet required by OSHA's Hazard Communication Standard [29 CFR 1910.1200]). All workers should be familiar with

emergency procedures, the location and proper use of emergency equipment, and methods of protecting themselves during rescue operations.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve ethyl ether and lead to worker exposures to this substance:

* The manufacture and transportation of ethyl ether
* Used as a solvent for waxes, fats, oils, alkaloids, gums, resins, nitrocellulose, hydrocarbons, raw rubber, smokeless powder, textiles, rayon, plastic, and dyes

* Used as an anesthetic in human and animal medicine

* Liberated from manufacture of alkali or sodium ethylxanthotes by heated processes; from manufacture of warm- and cold-process pharmaceuticals; from manufacture of chemicals from cold processesþ Grignard reactions and acetic acid recovery

* Used as a refrigerant; as an extractant in diesel fuels and dry cleaning; as a chemical reagent for organic reactions

* Used as an additive in motor fuels, perfumes, and denatured alcohol

* Used as an intermediate for monoethanolamine and ethylene

* Used as an anesthetic, antispasmodic, and rubefacient in animal medicine

Methods that are effective in controlling worker exposures to ethyl ether, depending on the feasibility of implementation, are as follows:

* Process enclosure
* Local exhaust ventilation
* General dilution ventilation
* Personal protective equipment

Workers responding to a release or potential release of a hazardous substance must be protected as required by paragraph (q) of OSHA's Hazardous Waste Operations and Emergency Response Standard [29 CFR 1910.120].

Good sources of information about control methods are as follows:

1. ACGIH [1992]. Industrial ventilation--a manual of recommended practice. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation--a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL SURVEILLANCE

OSHA is currently developing requirements for medical surveillance. When these requirements are promulgated, readers should refer to them for additional information and to determine whether employers whose employees are exposed to ethyl ether are required to implement medical surveillance procedures.

* Medical Screening

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures. To detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.
* Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to ethyl ether, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin, liver, kidneys, and respiratory system. Medical surveillance for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society.
A preplacement medical evaluation is recommended to assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to ethyl ether at or below the prescribed exposure limit. The health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the skin, liver, kidneys, or respiratory system.
* Periodic medical evaluations

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local

standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to ethyl ether exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of ethyl ether on the skin, liver, kidneys, or respiratory system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.
* Termination medical evaluations

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.
* Biological monitoring

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. A readily available biological monitoring method for ethyl ether involves the measurement of ether concentrations in the blood by means of gas chromatography. Blood ether concentrations have been found to correlate with both the degree of worker exposure and the extent of intoxication; blood ether concentrations should not exceed a level of about 20 mg/L in asymptomatic workers.

WORKPLACE MONITORING AND MEASUREMENT

Determination of a worker's exposure to airborne ethyl ether is made using a charcoal tube (100/50 mg sections, 20/40 mesh). Samples are collected at a maximum flow rate of 0.2 liter/minute (STEL or TWA) until a maximum collection volume of 3 liters (STEL or TWA) is reached. The sample is then treated with ethyl acetate. Analysis is conducted by gas chromatography using a flame ionization detector (GC/FID). This method is fully validated and is described in the OSHA Computerized Information System [OSHA 1994] and in NIOSH Method No. 1610 [NIOSH 1994b].

PERSONAL HYGIENE PROCEDURES

If ethyl ether contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with ethyl ether should be removed immediately, and provisions should be made for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of ethyl ether, particularly its potential for causing narcosis.

A worker who handles ethyl ether should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, applying cosmetics, or taking medication.

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Workers should not eat, drink, use tobacco products, apply cosmetics, or take medication in areas where ethyl ether or a solution containing ethyl ether is handled, processed, or stored.

STORAGE

Ethyl ether should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's Hazard Communication Standard [29 CFR 1910.1200]. Detached outside storage is preferred; if containers are stored inside, a standard flammable liquids storage room or cabinet should be used. Containers of ethyl ether should be protected from physical damage, direct sunlight, ignition sources, and should be stored separately from strong oxidizing agents, halogens, interhalogens, sulfur and sulfur compounds.

SPILLS AND LEAKS

In the event of a spill or leak involving ethyl ether, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill or leak:

1. Notify safety personnel.

2. Remove all sources of heat and ignition.

3. Ventilate potentially explosive atmospheres.

4. Do not touch the spilled material; stop the leak if it is possible to do so without risk.

5. Use non-sparking tools.

6. Water spray may be used to reduce vapors, but the spray may not prevent ignition in closed spaces.

7. For small liquid spills, take up with sand or other noncombustible absorbent material and place into closed containers for later disposal.

8. For large liquid spills, build dikes far ahead of the spill to contain the ethyl ether for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

* Emergency planning requirements

Ethyl ether is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) (Title III) in 42 USC 11022.

* Reportable quantity requirements for hazardous releases

A hazardous substance release is defined by EPA as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of contaminated containers) of hazardous substances. In the event of a release that is above the reportable quantity for that chemical, employers are required to notify the proper Federal, State, and local authorities [40 CFR 355.40]. The reportable quantity of ethyl ether is 100 pounds. If an amount equal to or greater than this quantity is released within a 24-hour period in a manner that will expose persons outside the facility, employers are required to do the following:
- Notify the National Response Center **immediately** at (800) 424-8802 or at (202) 426-2675 in Washington, D.C. [40 CFR 302.6].
* Community right-to-know requirements

Employers are not required by EPA in 40 CFR Part 372.30 to submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of ethyl ether emitted or released from their facility annually.
* Hazardous waste management requirements

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA has specifically listed many chemical wastes as hazardous. Ethyl ether is listed as a hazardous waste under RCRA and has been assigned EPA Hazardous Waste No. U117. It is approved for land disposal after treatment and only if the concentration of ethyl ether in the waste or treatment residual does not exceed 160 mg/kg.
Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (703) 412-9810 (in the Washington, D.C. area) or toll-free at (800) 424-9346 (outside Washington, D.C.). In addition, relevant State and local authorities should be contacted for information on any requirements they may have for the waste removal and disposal of this substance.

RESPIRATORY PROTECTION

* Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of ethyl ether exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers

should only use respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).
* Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's Respiratory Protection Standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the latest edition of the NIOSH Respirator Decision Logic [NIOSH 1987b] and the NIOSH Guide to Industrial Respiratory Protection [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Workers should use appropriate personal protective clothing and equipment that must be carefully selected, used, and maintained to be effective in preventing skin contact with ethyl ether. The selection of the appropriate personal protective equipment (PPE) (e.g., gloves, sleeves, encapsulating suits) should be based on the extent of the worker's potential exposure to ethyl ether. The resistance of various materials to permeation by ethyl ether is shown below:

Material	**Breakthrough time (hr)**
polyvinyl alcohol	>8
teflon	>8
4H (PE/EVAL)	>8
barricade	>8
responder	>4
butyl rubber	<1(*)
natural rubber	<1(*)
neoprene	<1(*)
nitrile rubber	<1(*)
polyethylene	<1(*)
polyvinyl chloride	<1(*)
viton	<1(*)
saranex	<1(*)
chemrel	<1(*)

(*) Not recommended, degradation may occur

To evaluate the use of these PPE materials with ethyl ether, users should consult the best available performance data and manufacturers' recommendations. Significant differences have been demonstrated in the chemical resistance of generically similar PPE materials (e.g., butyl) produced by different manufacturers. In addition, the chemical resistance of a mixture may be significantly different from that of any of its neat components.

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Any chemical-resistant clothing that is used should be periodically evaluated to determine its effectiveness in preventing dermal contact. Safety showers and eye wash stations should be located close to operations that involve ethyl ether.

Splash-proof chemical safety goggles or face shields (20 to 30 cm long, minimum) should be worn during any operation in which a solvent, caustic, or other toxic substance may be splashed into the eyes.

In addition to the possible need for wearing protective outer apparel (e.g., aprons, encapsulating suits), workers should wear work uniforms, coveralls, or similar full-body coverings that are laundered each day. Employers should provide lockers or other closed areas to store work and street clothing separately. Employers should collect work clothing at the end of each work shift and provide for its laundering. Laundry personnel should be informed about the potential hazards of handling contaminated clothing and instructed about measures to minimize their health risk.

Protective clothing should be kept free of oil and grease and should be inspected and maintained regularly to preserve its effectiveness.

Protective clothing may interfere with the body's heat dissipation, especially during hot weather or during work in hot or poorly ventilated work environments.

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Collodion Safety

Best regards,
Bryan Young

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Vapors from Collodion and Acetone in an EEG Laboratory

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Summary: In the many EEG laboratories, the collodion-acetone technique has lost favor because of offensive vapors. We measured vapor concentrations of diethyl ether and acetone, the two principal vapors from this technique, to determine whether they reached toxic levels. We found that diethyl ether vapors usually reached the olfactory threshold, but acetone concentration did not. Neither reached concentrations that were systemically toxic. We then developed an inexpensive, effective method of reducing concentrated vapors during electrode application and removal and documented a significant reduction in vapor concentrations. With this information and with an inexpensive, "in house" vapor extraction system, technologist and patient satisfaction with the collodion method should greatly improve. **Key Words:** Collodion—Diethyl ether—Acetone—Vapors—Electrode application.

The best technique for securing EEG disk electrodes to the scalp involves the use of collodion dried with a jet of air (Henry, 1979; Chiappa, 1983; Epstein, 1985; Reilly, 1987). An organic solvent, usually acetone, is the most effective agent to remove collodion-applied electrodes (Cooper et al., 1980). Even in laboratories with central ventilation systems, both the technologist and the patient are subjected to concentrated vapors from these substances at the time of electrode application and removal. Such exposure is unpleasant and not uncommonly produces nausea, vomiting, and, occasionally, secondary fainting in patients. Because of these problems, many EEG laboratories are abandoning this "gold standard" method of electrode application and removal.

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The principal ingredient of collodion is pyroxylin, a nitrated cellulose that is soluble in organic solvents (Reynolds, 1982). Most EEG laboratories use a preparation of pyroxylin with diethyl ether and ethyl alcohol (Reynolds, 1982). Diethyl ether is volatile, has a characteristic pungent odor (Verschueren, 1983), and is toxic for short-term exposure in concentrations over 1,500 mg/m^3 (American Conference of Governmental Industrial Hygienists, 1988–1989).

Acetone liquid is irritating to the eyes. As a vapor, it is a respiratory irritant and may be systemically and neurologically toxic at high (>2,375 mg/m^3) concentrations (Krasavage et al., 1982).

We measured the vapor concentrations of diethyl ether and acetone at the time of electrode application and removal, respectively. Further, with a simple and inexpensive extraction system, we successfully reduced solvent vapor concentrations to below olfactory detection.

METHODS

Multiple air samples were collected using the Dupont Genesis Air Sampling Pump during application (for diethyl ether) and removal (for acetone) of electrodes before and after the installation of the vapor extraction system (see Fig. 1 and Table 1). Collection of diethyl ether and acetone vapors was accomplished by using small glass tubes filled with activated charcoal (20/40 mesh, NIOSH approved), through which the air was drawn at a low flow rate (100–200 ml/min) over 15 min per sample. After the charcoal was desorbed with carbon disulfide, gas chromatography was used to determine the quantity of the solvent vapors present (National Institute for Occupational Safety and Health, 1977). The vapor concentration was then calculated based on the volume of air sampled.

Results for differences in vapor concentrations before and after the vapor extraction system was implemented were subjected to the *t* test for independent samples.

The vapor extraction system consisted of a three-speed Delhi fan model D507 with a 20-cm intake and 15.25 cm × 21 cm exhaust designed to yield a flow rate of 17 m^3/s. This system was connected via collapsable dryer hose (7.6 cm in diameter) to a hood constructed from a discarded conical metal lampshade (23 cm at maximal diameter). The hood was 15–20 cm above the patient's head; the vapors were extracted to a vent outside the hospital (see Fig. 1). Total cost for fitting the three recording rooms was $848 for equipment and $641 for labor for a total of $1,489 (U.S. dollars).

Capture and face velocities for the vapor extraction system were measured using a Mini Anemometer Series 490 by Kurz Instruments, Inc.

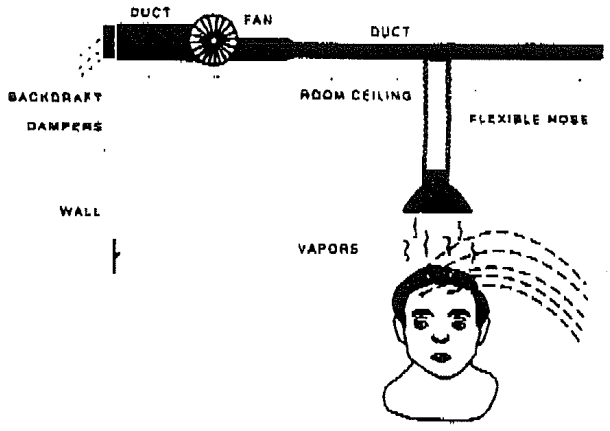

FIG. 1. The fume extraction apparatus is shown. The wall shown is the outside wall of the building. Further details are given in text.

TABLE 1. *Concentrations of solvents*

Solvent	Before renovations (concentration mg/m^3)	After renovations (concentration mg/m^3)
Diethyl ether		
Individual values	140, 163, 100, 77.4, 124	16.8, 17.1, 15.4, 11.8, 8.4, 8.1, 25, 14.9
Mean	121	14.7
Acetone		
Individual values	160, 80, 133, 149, 112	4.2, 3.7, 1.6, 1.4, 1.6, 2.8, 2.8
Mean	127	2.6

RESULTS

Capture velocity for the vapor extraction system was 0.3 m/s; face velocity at the hood was approximately 1.1 m/s.

Table 1 shows the reductions in vapor concentrations for diethyl ether and acetone following the renovations ($p < 0.0005$ for each).

After these renovations, odors from these vapors were no longer obvious to the technologists and related spontaneous patient complaints were rare.

DISCUSSION

Diethyl ether is mildly toxic by inhalation. Its odor threshold is 0.3–20 mg/m^3, and it can be readily detected at 20–125 mg/m^3 (Verschueren, 1983). However, acute toxic effects beginning with severe nasal irritation occur at 600 mg/m^3. If inhaled in sufficient quantity, it may produce toxic central nervous system effects such as EEG changes and drowsiness (Sax and Lewis, 1987, 1989). We were successful in reducing vapor levels, which were above the odor threshold and frankly offensive, to levels that were detectable to most individuals. Concentrations did not exceed recommended exposure limits.

The quoted odor threshold for acetone is 460 mg/m^3 (ACGIH, 1988–1989). Inhalation can produce EEG changes, nasal and conjunctival irritation, respiratory effects, nausea and vomiting, and a sensation of muscle weakness. Although our initial values were below the quoted odor thresholds, some patients perceived the odor during electrode removal before but not after renovations. We have, therefore, continued to use the vapor extraction system during electrode removal.