Turbo Liner Products

Health & Saftey Data and Testing

Helping make the coatings industry
A better and safer place to work.

Section 1
Safety and Health Guidelines

Polyurea raw materials contain isocyanates and are corrosive.

The hazards associated with processing polyurea spray elastomers:

- Inhalation route of isocyanate exposure
- Trans-dermal or through skin
- Corrosive and can cause skin irritation and chemical burns

Minimum personal protection gear:

- Respirators and instruction in proper use and maintenance
- Tyvek type protective clothing and chemical resistance gloves
- Head and foot protection. Hardhats and steel-toed boots
- Eye protection
- Hearing protection
- Fall protection, where required
- Confined space program, where required
- READ the MSDS and Product Data sheets
- Spill response kit

What are Isocyanates?

- Vary reactive family of chemicals, some with high vapor pressures. Characterized by having at least one (-N=C=O) isocyanate group.
- EXPOSURE LIMITS:
    1. OSHA Permissive Exposure Limit (PEL) 0.02 ppm ceiling
    2. 8-hour Time Weighted Average (TWA) 5.0 ppb (parts per billion)

Effects of isocyanate exposure:

- Asthma-like symptoms
- Chest tightness upon respiration
- Shortness of breath
- Wheezing and coughing

Effects of exposure to corrosive chemicals. Both "A-side" and "B-side" are corrosive chemicals.

- Redness and rashes in area of exposure
- Burning, itching, localized dermatitis
- If untreated, can develop into blisters and open sores

Respirators

Two types of respirators are approved for use when working with isocyanate; full-face supplied air respirators and cartridge respirators with appropriate filters. **All respirators are to be supplied by the employer to each individual who may be exposed. The employer shall be responsible for the establishment and maintenance of the respiratory protection program as outlined in the OSHA CFR 29, Part 1910.14 section b.**

Full-Face, supplied-air respirators:

- Provides best protection for applicators
- Protects face, eyes and respiratory system
- Positive air pressure provides extra protection from isocyanate vapors

- Mandatory for use in confined space applications. Refer to OSHA 20 CFR, Part 1910.134: Confined Space Regulations. See Section 6.
- Respirator users must be properly fit-tested and trained in the use and maintenance of their individual respirators

Organic-vapor cartridge filters:

- Organic-vapor cartridge filters are **NOT** approved by themselves. Must be used with a Dust/Mist (DM) or High Efficiency (HEPA) filter
- Must have a written and strictly adhered to filter "change-out" program
- Cartridge respirators do not provide eye and face protection
- Cartridge respirators do not have positive air pressure, and therefore rely totally on proper fit for isocyanate vapor protection
- Cartridge filter studies that purport the use of organic vapor cartridges with HEPA filters can be used for 40 hours were done with HDI isocyanate, not with MDI isocyanate. MDI is mainly used in polyurea spray applications, and has a lower vapor pressure

Additional personal protection:

- Eye protection. Glasses with side guards
- Chemical resistant gloves, especially when changing drums
- Tyvek type overalls will protect from over-spray during application. Isocyanate and amine aerosols are corrosive and can irritate exposed skin

Hearing protection: OSHA 29 CFR Section 1910.05. See Section 7

- Spray application vehicles should isolate noisy components such as generators and air compressors in a separate area of the application vehicle. Isolate with a noise-insulating bulkhead, if possible
- Excessive noise is one of the most pervasive health hazards in the construction industry
- OSHA limit is 85 decibels averaged over an 8-hour period (TWA)

Medical testing:

- Due to the hazards of isocyanate exposure and potential sensitivity to them, applicators should have a pre-placement physical exam and annual exams that include a pulmonary function test
- Applicators with a history of asthma, chronic respiratory problems, isocyanate sensitivity should consult a physician before working in polyurea applications
- During an application, if anyone exhibits breathing distress or other symptoms of exposure, they must be removed from the site and should be seen by a physician

MDI Isocyanate Exposure Limits

Monitoring Body	TLV/TWA[2]	PEL[3]	LIMIT	COMMENTS
ACGIH	0.051 mg/m3		8-hour day	
OSHA		0.2 mg/m3	Never exceed	At any time

ACGIH TLC's are recommended guidelines by the council of industrial hygienists. The values are not legally binding. Federal and State OSHA PEL's are legally binding exposure limits.

2 = TLV/TWA: Threshold Limit Values/Time Weighted Average
3 = PEL: Permissible Exposure Limit

Other Safety and Health Considerations

- **Scaffolding** – many states have laws governing the use and erection, maintenance and dismantling of scaffolding. Check with the local and state laws where your project is located
- **Hard Hats** – always a good idea
- **Boots** – preferably with steel toes. Many sites mandate steel-toed boots

What is occupational asthma?

Asthma is a respiratory disease. It creates narrowing of the air passages that results in difficult breathing, tightness of the chest, coughing, and breath-sounds such as wheezing.

Occupational asthma refers to asthma that is caused by breathing in specific agents in the workplace. An abnormal response of the body to the presence of an agent in the workplace causes occupational asthma.

The abnormal response, called "sensitization," develops after variable periods of workplace exposure to certain dusts, fumes or vapours.

This sensitization may not show any symptoms of disease or it may be associated with skin rashes (urticaria), hay fever-like symptoms, or a combination of these symptoms.

Not all workers react with an asthmatic response when exposed to industrial agents. Asthma strikes only a fraction of workers. Asthmatic attacks can be controlled either by ending exposure to the agent responsible or by medical treatment.

How does asthma develop?

Asthma is triggered in several ways and most of them are not completely understood. For simplicity, we categorize them into two groups: allergic and non-allergic.

Allergic Asthma

Allergic asthma involves the body's immune system. This is a complex defense system that protects the body from harm caused by foreign substances or microbes. Among the most important elements of the defense mechanism are special proteins called "antibodies." These are produced when the human body contacts an alien substance or microbe. Antibodies react with substances or microbes to destroy them. Antibodies are often very selective, acting only on one particular substance or type of microbe.

But antibodies can also respond in a wrong way and cause allergic disorders such as asthma. After a period of exposure to an industrial substance, either natural or synthetic, a worker may start producing too many of the antibodies called "immunoglobulin E" (IgE). These antibodies attach to specific cells in the lung in a process known as "sensitization."

When re-exposure occurs, the lung cells with attached IgE antibodies react with the substance. This reaction results in the release of chemicals such as "leukotrienes" that are made in the body. Leukotrienes provoke the contraction of some muscles in the airways. This causes the narrowing of air passages which is characteristic of asthma.

Non-Allergic Asthma

Following repeated exposure to an industrial chemical, substances such as leukotrienes are released in the lungs. Again, the leukotriene causes narrowing of air passages typical of asthma. The reasons for such release are still not clear because no antibody reaction seems to be involved.

How long does asthma take to develop?

There is no fixed period of time in which asthma can develop. Asthma as a disease may develop from a few weeks to many years after the initial exposure. Studies carried out on some platinum refinery workers show that in most cases asthma develops in 6 to 12 months. But it may occur within 10 days or be delayed for as long as 25 years.

Analysis of the respiratory responses of sensitized workers has established three basic patterns of asthmatic attacks, as follows:

Immediate - typically develops within minutes of exposure and is at its worst after approximately 20 minutes; recovery takes about 2 hours.

Late - can occur in different forms. It usually starts several hours after exposure and is at its worst after about 4 to 8 hours with recovery within 24 hours. However, it can start 1 hour after exposure with recovery in 3 to 4 hours. In some cases, it may start at night, with a tendency to recur at the same time for a few nights following a single exposure.

Dual or Combined - is the occurrence of both immediate and late types of asthma.

How common is asthma?

The frequency of occupational asthma is unknown, although various estimates are available. In Japan, 15 percent of asthma in males is believed to be occupational. In the United States, two percent of all cases of asthma are thought to be of occupational origin. The number of cases of occupational asthma varies from country to country and from industry to industry. About six percent of animal handlers develop asthma due to animal hair or dust. Between 10 and 45 percent of workers who process subtilisins, the "proteolytic enzymes" like "Bacillus subtilis" in the detergent industry develop asthma. However, preparations of the enzymes in granulated form, which is less readily inhaled, have reduced the likelihood of asthma. Approximately five percent of workers exposed to such chemicals as isocyanates and certain wood dusts develop asthma.

What factors increase the chances of developing asthma?

Some workplace conditions seem to increase the likelihood that workers will develop asthma, but their importance is not fully known. Factors such as the properties of the chemicals, and the amount and duration of exposure are obviously important. However, because only a fraction of exposed workers are affected, factors unique to individual workers can also be important. Such factors include the ability of some

people to produce abnormal amounts of IgE antibodies. The contribution of cigarette smoking to asthma is not known. But smokers are more likely than nonsmokers to develop respiratory problems in general.

How does the doctor know if a worker has asthma?

Sufferers from occupational asthma experience attacks of difficult breathing, tightness of the chest, coughing, and breath sounds such as wheezing, which is associated with air-flow obstruction. Such symptoms should raise the suspicion of asthma. Typically these symptoms are worse on working days, often awakening the patient at night, and improving when the person is away from work. While off work, sufferers from occupational asthma may still have chest symptoms when exposed to airway irritants such as dusts, or fumes, or upon exercise. Itchy and watery eyes, sneezing, stuffy and runny nose, and skin rashes are other symptoms often associated with asthma.

Lung function tests and skin tests can help to confirm the disease. But some patients with occupational asthma may have normal lung function as well as negative skin tests.

The diagnosis of work-related asthma needs to be confirmed objectively. This can be done by carrying out pulmonary function tests at work and off work. Specific inhalation challenges can demonstrate the occupational origin of asthma and may identify the agents responsible when the cause is uncertain. Specific inhalation challenge tests require breathing in small quantities of industrial agents that may induce an attack of asthma. But they are safe when performed by experienced physicians in specialized centres.

How can we control occupational asthma?

Although there are drugs that may control the symptoms of asthma, it is important to stop exposure. If the exposure to the causal agent is not stopped, treatment will be needed continuously and the breathing problems may become permanent. People may continue to suffer from occupational asthma even after removal from exposure. For example, a follow-up study of 75 patients with asthma caused by red cedar dust showed that only half the patients recovered. The remaining half continued to have asthmatic attacks for a period of 1 to 9 years after the termination of exposure.

Dust masks and respirators can help to control workplace exposure. However, these protective devices, in order to be effective, must be carefully selected, properly fitted and well maintained. Preventing further exposure might involve a change of job. If a job change is not feasible, relocation to another area of the plant with no exposure may be essential.

How can we prevent occupational asthma?

The best way to prevent occupational asthma is to replace dangerous substances with less harmful ones. Where this is not possible, exposure should be minimized through engineering controls such as ventilation and enclosures of processes.

Education of workers is also very important. Proper handling procedures, avoidance of spills and good housekeeping reduce the occurrence of occupational asthma.

What occupations are at risk for asthma?

Some of the occupations where asthma has been seen are listed in the following tables. It should be noted that the lists of occupational substances and microbes which can cause asthma are not complete. New causes continue to be added. New materials and new processes introduce new exposures and create new risks.

Table 1
Causes of Occupational Asthma
- Grains, flours, plants and gums

Occupation	Agent
Bakers, millers	Wheat
Chemists, coffee bean baggers and handlers, gardeners, millers, oil industry workers, farmers	Castor beans
Cigarette factory workers	Tobacco dust
Drug manufacturers, mold makers in sweet factories, printers	gum acacia
Farmers, grain handlers	Grain dust
Gum manufacturers, sweet makers	Gum tragacanth
Strawberry growers	Strawberry pollen
Tea sifters and packers	Tea dust
Tobacco farmers	Tobacco leaf
Woollen industry workers	Wool

Table 2
Causes of Occupational Asthma - Animals, insects and fungi

Occupation	Agent
Bird fanciers	Avian proteins
Cosmetic manufacturers	Carmine
Entomologists	Moths, butterflies
Feather pluckers	Feathers
Field contact workers	Crickets

Fish bait breeders	Bee moths
Flour mill workers, bakers, farm workers, grain handlers	Grain storage mites, alternaria, aspergillus
Laboratory workers	Locusts, cockroaches, grain weevils, rats, mice, guinea pigs, rabbits
Mushroom cultivators	Mushroom spores
Oyster farmers	Hoya
Pea sorters	Mexican bean weevils
Pigeon breeders	Pigeons
Poultry workers	Chickens
Prawn processors	Prawns
Silkworm sericulturers	Silkworms
Zoological museum curators	Beetles

Table 3
Causes of Occupational Asthma - Chemicals/Materials

Occupation	Agent
Aircraft fitters	Triethyltetramine
Aluminum cable solderers	Aminoethylethanolamine
Aluminum pot room workers	Fluorine
Autobody workers	Acrylates (resins, glues, sealants, adhesives)
Brewery workers	Chloramine-T
Chemical plant workers, pulp mill workers	Chlorine
Dye weighers	Levafix brilliant yellow, drimarene brilliant yellow and blue, cibachrome brilliant scarlet
Electronics workers	Colophony
Epoxy resin manufacturers	Tetrachlorophthalic anhydride
Foundry mold makers	Furan-based resin binder systems
Fur dyers	Para-phenylenediamine
Hairdressers	Persulphate salts
Health care workers	Glutaraldehyde, latex

Laboratory workers, nurses, phenolic resin molders	Formalin/formaldehyde
Meat wrappers	Polyvinyl chloride vapour
Paint manufacturers, plastic molders, tool setters	Phthalic anhydride
Paint sprayers	Dimethylethanolamine
Photographic workers, shellac manufacturers	Ethylenediamine
Refrigeration industry workers	CFCs
Solderers	Polyether alcohol, polypropylene glycol

Table 4
Causes of Occupational Asthma - Isocyanates and metals

Occupation	Agent
Boat builders, foam manufacturers, office workers, plastics factory workers, refrigerator manufacturers, TDI manufacturers/users, printers, laminators, tinners, toy makers	Toluene diisocyanate
Boiler cleaners, gas turbine cleaners	Vanadium
Car sprayers	Hexamethylene diisocyanate
Cement workers	Potassium dichromate
Chrome platers, chrome polishers	Sodium bichromate, chromic acid, potassium chromate
Nickel platers	Nickel sulphate
Platinum chemists	Chloroplatinic acid
Platinum refiners	Platinum salts
Polyurethane foam manufacturers, printers, laminators	Diphenylmethane diisocyanate
Rubber workers	Naphthalene diisocyanate
Tungsten carbide grinders	Cobalt
Welders	Stainless steel fumes

Table 5
Causes of Occupational Asthma - Drugs and enzymes

Occupation	Agent
Ampicillin manufacturers	Phenylglycine acid chloride
Detergent manufacturers	Bacillus subtilis

Enzyme manufacturers	Fungal alpha-amylase
Food technologists, laboratory workers	Papain
Pharmacists	Gentian powder, flaviastase
Pharmaceutical workers	Methyldopa, salbutamol, dichloramine, piperazine dihydrochloride, spiramycin, penicillins, sulphathiazole, sulphonechloramides, chloramine-T, phosdrin, pancreatic extracts
Poultry workers	Amprolium hydrochloride
Process workers, plastic polymer production workers	Trypsin, bromelin

Table 6
Causes of Occupational Asthma - Woods

Occupation	Agent
Carpenters, timber millers, woodworkers	Western red cedar, cedar of Lebanon, iroko, California redwood, ramin, African zebrawood
Sawmill workers, pattern makers	Mansonia, oak, mahogany, abiruana
Wood finishers	Cocabolla
Wood machinists	Kejaat

Section 2
OSHA Respirator Information

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** I
- **Subpart Title:** Personal Protective Equipment
- **Standard Number:** 1910.134
- **Title:** Respiratory Protection.

- **Appendix:** A , B-1 , B-2 , C , D

This section applies to General Industry (part 1910), Shipyards (part 1915), Marine Terminals (part 1917), Long shoring (part 1918), and Construction (part 1926).

1910.134(a)

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Permissible practice.

1910.134(a)(1)

In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section.

1910.134(a)(2)

The employer shall provide respirators when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators that are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program which shall include the requirements outlined in paragraph (c) of this section.

1910.134(b)

Definitions. The following definitions are important terms used in the respiratory protection standard in this section.

Air-purifying respirator means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Assigned protection factor (APF) [Reserved]

Atmosphere-supplying respirator means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Canister or cartridge means a container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.

Demand respirator means an atmosphere-supplying respirator that admits breathing air to the face piece only when a negative pressure is created inside the face piece by inhalation.

Emergency situation means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant.

Employee exposure means exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

End-of-service-life indicator (ESLI) means a system that warns the respirator user of the approach of the end of adequate respiratory protection, for example, that the sorbent is approaching saturation or is no longer effective.

Escape-only respirator means a respirator intended to be used only for emergency exit.

Filter or air purifying element means a component used in respirators to remove solid or liquid aerosols from the inspired air.

Filtering face piece (dust mask) means a negative pressure particulate respirator with a filter as an integral part of the face piece or with the entire face piece composed of the filtering medium.

Fit factor means a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit test means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. (See also Qualitative fit test QLFT and Quantitative fit test QNFT.)

Helmet means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

High efficiency particulate air (HEPA) filter means a filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Hood means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

Immediately dangerous to life or health (IDLH) means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

Interior structural firefighting means the physical activity of fire suppression, rescue or

both, inside of buildings or enclosed structures that are involved in a fire situation beyond the incipient stage. (See 29 CFR 1910.155)

Loose-fitting face piece means a respiratory inlet covering that is designed to form a partial seal with the face.

Maximum use concentration (MUC) [Reserved].

Negative pressure respirator (tight fitting) means a respirator in which the air pressure inside the face piece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Oxygen deficient atmosphere means an atmosphere with an oxygen content below 19.5% by volume.

Physician or other licensed health care professional (PLHCP) means an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by paragraph (e) of this section.

Positive pressure respirator means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Powered air-purifying respirator (PAPR) means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Pressure demand respirator means a positive pressure atmosphere-supplying respirator that admits breathing air to the face piece when the positive pressure is reduced inside the face piece by inhalation.

Qualitative fit test (QLFT) means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

Quantitative fit test (QNFT) means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Respiratory inlet covering means that portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source, or both. It may be a face piece, helmet, hood, suit, or a mouthpiece respirator with nose clamp.

Self-contained breathing apparatus (SCBA) means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Service life means the period of time that a respirator, filter or sorbent, or other respiratory equipment provides adequate protection to the wearer.

Supplied-air respirator (SAR) or airline respirator means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

This section means this respiratory protection standard.

Tight-fitting face piece means a respiratory inlet covering that forms a complete seal with the face.

User seal check means an action conducted by the respirator user to determine if the respirator is properly seated to the face.

1910.134(c)

Respiratory protection program. This paragraph requires the employer to develop and implement a written respiratory protection program with required worksite-specific procedures and elements for required respirator use. The program must be administered by a suitably trained program administrator. In addition, certain program elements may be required for voluntary use to prevent potential hazards associated with the use of the respirator. The Small Entity Compliance Guide contains criteria for the selection of a program administrator and a sample program that meets the requirements of this paragraph. Copies of the Small Entity Compliance Guide will be available on or about April 8, 1998 from the Occupational Safety and Health Administration's Office of Publications, Room N 3101, 200 Constitution Avenue, NW, Washington, DC, 20210 (202-219-4667).

1910.134(c)(1)

In any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures. The program shall be updated as necessary to reflect those changes in workplace conditions that affect respirator use. The employer shall include in the program the following provisions of this section, as applicable:

1910.134(c)(1)(i)

Procedures for selecting respirators for use in the workplace;

1910.134(c)(1)(ii)

Medical evaluations of employees required to use respirators;

1910.134(c)(1)(iii)

Fit testing procedures for tight-fitting respirators;

1910.134(c)(1)(iv)

Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;

1910.134(c)(1)(v)

Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;

1910.134(c)(1)(vi)

Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;

1910.134(c)(1)(vii)

Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;

..1910.134(c)(1)(viii)

1910.134(c)(1)(viii)

Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and

1910.134(c)(1)(ix)

Procedures for regularly evaluating the effectiveness of the program.

1910.134(c)(2)

Where respirator use is not required:

1910.134(c)(2)(i)

An employer may provide respirators at the request of employees or permit employees to use their own respirators, if the employer determines that such respirator use will not in itself create a hazard. If the employer determines that any voluntary respirator use is permissible, the employer shall provide the respirator users with the information contained in Appendix D to this section ("Information for Employees Using Respirators When Not Required Under the Standard"); and

1910.134(c)(2)(ii)

In addition, the employer must establish and implement those elements of a written respiratory protection program necessary to ensure that any employee using a respirator voluntarily is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user. Exception: Employers are not required to include in a written respiratory protection program those employees whose only use of respirators involves the voluntary use of filtering facepieces (dust masks).

1910.134(c)(3)

The employer shall designate a program administrator who is qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness.

1910.134(c)(4)

The employer shall provide respirators, training, and medical evaluations at no cost to the employee.

1910.134(d)

Selection of respirators. This paragraph requires the employer to evaluate respiratory hazard(s) in the workplace, identify relevant workplace and user factors, and base respirator selection on these factors. The paragraph also specifies appropriately protective respirators for use in IDLH atmospheres, and limits the selection and use of air-purifying respirators.

1910.134(d)(1)

General requirements.

1910.134(d)(1)(i)

The employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed and workplace and user factors that affect respirator performance and reliability.

1910.134(d)(1)(ii)

The employer shall select a NIOSH-certified respirator. The respirator shall be used in compliance with the conditions of its certification.

1910.134(d)(1)(iii)

The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form. Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be IDLH.

..1910.134(d)(1)(iv)

1910.134(d)(1)(iv)

The employer shall select respirators from a sufficient number of respirator models and sizes so that the respirator is acceptable to, and correctly fits, the user.

1910.134(d)(2)

Respirators for IDLH atmospheres.

1910.134(d)(2)(i)

The employer shall provide the following respirators for employee use in IDLH atmospheres:

1910.134(d)(2)(i)(A)

A full face piece pressure demand SCBA certified by NIOSH for a minimum service life of thirty minutes, or

1910.134(d)(2)(i)(B)

A combination full face piece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply.

1910.134(d)(2)(ii)

Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

1910.134(d)(2)(iii)

All oxygen-deficient atmospheres shall be considered IDLH. Exception: If the employer demonstrates that, under all foreseeable conditions, the oxygen concentration can be maintained within the ranges specified in Table II of this section (i.e., for the altitudes set out in the table), then any atmosphere-supplying respirator may be used.

1910.134(d)(3)

Respirators for atmospheres that are not IDLH.

1910.134(d)(3)(i)

The employer shall provide a respirator that is adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements, under routine and reasonably foreseeable emergency situations.

1910.134(d)(3)(i)(A)

Assigned Protection Factors (APFs) [Reserved]

1910.134(d)(3)(i)(B)

Maximum Use Concentration (MUC) [Reserved]

1910.134(d)(3)(ii)

The respirator selected shall be appropriate for the chemical state and physical form of the contaminant.

1910.134(d)(3)(iii)

For protection against gases and vapors, the employer shall provide:

1910.134(d)(3)(iii)(A)

An atmosphere-supplying respirator, or

1910.134(d)(3)(iii)(B)

An air-purifying respirator, provided that:

1910.134(d)(3)(iii)(B)(1)

The respirator is equipped with an end-of-service-life indicator (ESLI) certified by NIOSH for the contaminant; or

1910.134(d)(3)(iii)(B)(2)

If there is no ESLI appropriate for conditions in the employer's workplace, the employer implements a change schedule for canisters and cartridges that is based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life. The employer shall describe in the respirator program the information and data relied upon and the basis for the canister and cartridge change schedule and the basis for reliance on the data.

1910.134(d)(3)(iv)

For protection against particulates, the employer shall provide:

1910.134(d)(3)(iv)(A)

An atmosphere-supplying respirator; or

1910.134(d)(3)(iv)(B)

An air-purifying respirator equipped with a filter certified by NIOSH under 30 CFR part 11 as a high efficiency particulate air (HEPA) filter, or an air-purifying respirator equipped with a filter certified for particulates by NIOSH under 42 CFR part 84; or

1910.134(d)(3)(iv)(C)

For contaminants consisting primarily of particles with mass median aerodynamic diameters (MMAD) of at least 2 micrometers, an air-purifying respirator equipped with any filter certified for particulates by NIOSH.

TABLE I. -- ASSIGNED PROTECTION FACTORS
[RESERVED]

TABLE II

Altitude (ft.)	Oxygen deficient Atmospheres (% 0_2) for which the employer atmosphere-may rely on supplying respirators
Less than 3,001	16.0-19.5
3,001-4,000	16.4-19.5
4,001-5,000	17.1-19.5

5,001-6,000	17.8-19.5
6,001-7,000	18.5-19.5
7,001-8,000[1]	19.3-19.5.

[1]Above 8,000 feet the exception does not apply. Oxygen-enriched breathing air must be supplied above 14,000 feet.

1910.134(e)

Medical evaluation. Using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee. Accordingly, this paragraph specifies the minimum requirements for medical evaluation that employers must implement to determine the employee's ability to use a respirator.

1910.134(e)(1)

General. The employer shall provide a medical evaluation to determine the employee's ability to use a respirator, before the employee is fit tested or required to use the respirator in the workplace. The employer may discontinue an employee's medical evaluations when the employee is no longer required to use a respirator.

1910.134(e)(2)

Medical evaluation procedures.

1910.134(e)(2)(i)

The employer shall identify a physician or other licensed health care professional (PLHCP) to perform medical evaluations using a medical questionnaire or an initial medical examination that obtains the same information as the medical questionnaire.

1910.134(e)(2)(ii)

The medical evaluation shall obtain the information requested by the questionnaire in Sections 1 and 2, Part A of Appendix C of this section.

1910.134(e)(3)

Follow-up medical examination.

1910.134(e)(3)(i)

The employer shall ensure that a follow-up medical examination is provided for an employee who gives a positive response to any question among questions 1 through 8 in Section 2, Part A of Appendix C or whose initial medical examination demonstrates the need for a follow-up medical examination.

1910.134(e)(3)(ii)

The follow-up medical examination shall include any medical tests, consultations, or diagnostic procedures that the PLHCP deems necessary to make a final determination.

1910.134(e)(4)

Administration of the medical questionnaire and examinations.

1910.134(e)(4)(i)

The medical questionnaire and examinations shall be administered confidentially during the employee's normal working hours or at a time and place convenient to the employee. The medical questionnaire shall be administered in a manner that ensures that the employee understands its content.

1910.134(e)(4)(ii)

The employer shall provide the employee with an opportunity to discuss the questionnaire and examination results with the PLHCP.

1910.134(e)(5)

Supplemental information for the PLHCP.

1910.134(e)(5)(i)

The following information must be provided to the PLHCP before the PLHCP makes a recommendation concerning an employee's ability to use a respirator:

1910.134(e)(5)(i)(A)

(A) The type and weight of the respirator to be used by the employee;

1910.134(e)(5)(i)(B)

The duration and frequency of respirator use (including use for rescue and escape);

1910.134(e)(5)(i)(C)

The expected physical work effort;

1910.134(e)(5)(i)(D)

Additional protective clothing and equipment to be worn; and

1910.134(e)(5)(i)(E)

Temperature and humidity extremes that may be encountered.

1910.134(e)(5)(ii)

Any supplemental information provided previously to the PLHCP regarding an employee need not be provided for a subsequent medical evaluation if the information and the PLHCP remain the same.

1910.134(e)(5)(iii)

The employer shall provide the PLHCP with a copy of the written respiratory protection program and a copy of this section.

Note to Paragraph (e)(5)(iii): When the employer replaces a PLHCP, the employer must ensure that the new PLHCP obtains this information, either by providing the documents directly to the PLHCP or having the documents transferred from the former PLHCP to the new PLHCP. However, OSHA does not expect employers to have employees medically reevaluated solely because a new PLHCP has been selected.

1910.134(e)(6)

Medical determination. In determining the employee's ability to use a respirator, the employer shall:

1910.134(e)(6)(i)

Obtain a written recommendation regarding the employee's ability to use the respirator from the PLHCP. The recommendation shall provide only the following information:

1910.134(e)(6)(i)(A)

Any limitations on respirator use related to the medical condition of the employee, or relating to the workplace conditions in which the respirator will be used, including whether or not the employee is medically able to use the respirator;

1910.134(e)(6)(i)(B)

The need, if any, for follow-up medical evaluations; and

1910.134(e)(6)(i)(C)

A statement that the PLHCP has provided the employee with a copy of the PLHCP's written recommendation.

1910.134(e)(6)(ii)

If the respirator is a negative pressure respirator and the PLHCP finds a medical condition that may place the employee's health at increased risk if the respirator is used, the employer shall provide a PAPR if the PLHCP's medical evaluation finds that the employee can use such a respirator; if a subsequent medical evaluation finds that the employee is medically able to use a negative pressure respirator, then the employer is no longer required to provide a PAPR.

1910.134(e)(7)

Additional medical evaluations. At a minimum, the employer shall provide additional medical evaluations that comply with the requirements of this section if:

1910.134(e)(7)(i)

An employee reports medical signs or symptoms that are related to ability to use a respirator;

1910.134(e)(7)(ii)

A PLHCP, supervisor, or the respirator program administrator informs the employer that an employee needs to be reevaluated;

1910.134(e)(7)(iii)

Information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee reevaluation; or

1910.134(e)(7)(iv)

A change occurs in workplace conditions (e.g., physical work effort, protective clothing, temperature) that may result in a substantial increase in the physiological burden placed on an employee.

1910.134(f)

Fit testing. This paragraph requires that, before an employee may be required to use any respirator with a negative or positive pressure tight-fitting face piece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used. This paragraph specifies the kinds of fit tests allowed, the procedures for conducting them, and how the results of the fit tests must be used.

1910.134(f)(1)

The employer shall ensure that employees using a tight-fitting face piece respirator pass an appropriate qualitative fit test (QLFT) or quantitative fit test (QNFT) as stated in this paragraph.

1910.134(f)(2)

The employer shall ensure that an employee using a tight-fitting face piece respirator is fit tested prior to initial use of the respirator, whenever a different respirator face piece (size, style, model or make) is used, and at least annually thereafter.

1910.134(f)(3)

The employer shall conduct an additional fit test whenever the employee reports, or the employer, PLHCP, supervisor, or program administrator makes visual observations of, changes in the employee's physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

1910.134(f)(4)

If after passing a QLFT or QNFT, the employee subsequently notifies the employer, program administrator, supervisor, or PLHCP that the fit of the respirator is unacceptable,

the employee shall be given a reasonable opportunity to select a different respirator face piece and to be retested.

..1910.134(f)(5)

1910.134(f)(5)

The fit test shall be administered using an OSHA-accepted QLFT or QNFT protocol. The OSHA-accepted QLFT and QNFT protocols and procedures are contained in Appendix A of this section.

1910.134(f)(6)

QLFT may only be used to fit test negative pressure air-purifying respirators that must achieve a fit factor of 100 or less.

1910.134(f)(7)

If the fit factor, as determined through an OSHA-accepted QNFT protocol, is equal to or greater than 100 for tight-fitting half face pieces, or equal to or greater than 500 for tight fitting full face pieces, the QNFT has been passed with that respirator.

1910.134(f)(8)

Fit testing of tight-fitting atmosphere-supplying respirators and tight-fitting powered air-purifying respirators shall be accomplished by performing quantitative or qualitative fit testing in the negative pressure mode, regardless of the mode of operation (negative or positive pressure) that is used for respiratory protection.

1910.134(f)(8)(i)

Qualitative fit testing of these respirators shall be accomplished by temporarily converting the respirator user's actual face piece into a negative pressure respirator with appropriate filters, or by using an identical negative pressure air-purifying respirator face piece with the same sealing surfaces as a surrogate for the atmosphere-supplying or powered air-purifying respirator face piece.

1910.134(f)(8)(ii)

Quantitative fit testing of these respirators shall be accomplished by modifying the face piece to allow sampling inside the face piece in the breathing zone of the user, midway between the nose and mouth. This requirement shall be accomplished by installing a permanent sampling probe onto a surrogate face piece, or by using a sampling adapter designed to temporarily provide a means of sampling air from inside the face piece.

1910.134(f)(8)(iii)

Any modifications to the respirator face piece for fit testing shall be completely removed, and the face piece restored to NIOSH-approved configuration, before that face piece can be used in the workplace.

1910.134(g)

Use of respirators. This paragraph requires employers to establish and implement procedures for the proper use of respirators. These requirements include prohibiting conditions that may result in face piece seal leakage, preventing employees from removing respirators in hazardous environments, taking actions to ensure continued effective respirator operation throughout the work shift, and establishing procedures for the use of respirators in IDLH atmospheres or in interior structural firefighting situations.

1910.134(g)(1)

Face piece seal protection.

1910.134(g)(1)(i)

The employer shall not permit respirators with tight-fitting face pieces to be worn by employees who have:

1910.134(g)(1)(i)(A)

Facial hair that comes between the sealing surface of the face piece and the face or that interferes with valve function; or

1910.134(g)(1)(i)(B)

Any condition that interferes with the face-to-face piece seal or valve function.

1910.134(g)(1)(ii)

If an employee wears corrective glasses or goggles or other personal protective equipment, the employer shall ensure that such equipment is worn in a manner that does not interfere with the seal of the face piece to the face of the user.

1910.134(g)(1)(iii)

For all tight-fitting respirators, the employer shall ensure that employees perform a user seal check each time they put on the respirator using the procedures in Appendix B-1 or procedures recommended by the respirator manufacturer that the employer demonstrates are as effective as those in Appendix B-1 of this section.

1910.134(g)(2)

Continuing respirator effectiveness.

1910.134(g)(2)(i)

Appropriate surveillance shall be maintained of work area conditions and degree of employee exposure or stress. When there is a change in work area conditions or degree of employee exposure or stress that may affect respirator effectiveness, the employer shall reevaluate the continued effectiveness of the respirator.

1910.134(g)(2)(ii)

The employer shall ensure that employees leave the respirator use area:

..1910.134(g)(2)(ii)(A)

1910.134(g)(2)(ii)(A)

To wash their faces and respirator face pieces as necessary to prevent eye or skin irritation associated with respirator use; or

1910.134(g)(2)(ii)(B)

If they detect vapor or gas breakthrough, changes in breathing resistance, or leakage of the face piece; or

1910.134(g)(2)(ii)(C)

To replace the respirator or the filter, cartridge, or canister elements.

1910.134(g)(2)(iii)

If the employee detects vapor or gas breakthrough, changes in breathing resistance, or leakage of the face piece, the employer must replace or repair the respirator before allowing the employee to return to the work area.

1910.134(g)(3)

Procedures for IDLH atmospheres. For all IDLH atmospheres, the employer shall ensure that:

1910.134(g)(3)(i)

One employee or, when needed, more than one employee is located outside the IDLH atmosphere;

1910.134(g)(3)(ii)

Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere;

1910.134(g)(3)(iii)

The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue;

1910.134(g)(3)(iv)

The employer or designee is notified before the employee(s) located outside the IDLH atmosphere enter the IDLH atmosphere to provide emergency rescue;

1910.134(g)(3)(v)

The employer or designee authorized to do so by the employer, once notified, provides necessary assistance appropriate to the situation;

1910.134(g)(3)(vi)

Employee(s) located outside the IDLH atmospheres are equipped with:

1910.134(g)(3)(vi)(A)

Pressure demand or other positive pressure SCBAs, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA; and either

1910.134(g)(3)(vi)(B)

Appropriate retrieval equipment for removing the employee(s) who enter(s) these hazardous atmospheres where retrieval equipment would contribute to the rescue of the employee(s) and would not increase the overall risk resulting from entry; or

1910.134(g)(3)(vi)(C)

Equivalent means for rescue where retrieval equipment is not required under paragraph (g)(3)(vi)(B).

1910.134(g)(4)

Procedures for interior structural firefighting. In addition to the requirements set forth under paragraph (g)(3), in interior structural fires, the employer shall ensure that:

1910.134(g)(4)(i)

At least two employees enter the IDLH atmosphere and remain in visual or voice contact with one another at all times;

1910.134(g)(4)(ii)

At least two employees are located outside the IDLH atmosphere; and

1910.134(g)(4)(iii)

All employees engaged in interior structural firefighting use SCBAs.

Note 1 to paragraph (g): One of the two individuals located outside the IDLH atmosphere may be assigned to an additional role, such as incident commander in charge of the emergency or safety officer, so long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any firefighter working at the incident.

Note 2 to paragraph (g): Nothing in this section is meant to preclude firefighters from performing emergency rescue activities before an entire team has assembled.

1910.134(h)

Maintenance and care of respirators. This paragraph requires the employer to provide for the cleaning and disinfecting, storage, inspection, and repair of respirators used by employees.

1910.134(h)(1)

Cleaning and disinfecting. The employer shall provide each respirator user with a respirator that is clean, sanitary, and in good working order. The employer shall ensure that respirators are cleaned and disinfected using the procedures in Appendix B-2 of this section, or procedures recommended by the respirator manufacturer, provided that such procedures are of equivalent effectiveness. The respirators shall be cleaned and disinfected at the following intervals:

1910.134(h)(1)(i)

Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition;

1910.134(h)(1)(ii)

Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals;

1910.134(h)(1)(iii)

Respirators maintained for emergency use shall be cleaned and disinfected after each use; and

1910.134(h)(1)(iv)

Respirators used in fit testing and training shall be cleaned and disinfected after each use.

1910.134(h)(2)

Storage. The employer shall ensure that respirators are stored as follows:

1910.134(h)(2)(i)

All respirators shall be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the face piece and exhalation valve.

1910.134(h)(2)(ii)

In addition to the requirements of paragraph (h)(2)(i) of this section, emergency respirators shall be:

1910.134(h)(2)(ii)(A)

Kept accessible to the work area;

1910.134(h)(2)(ii)(B)

Stored in compartments or in covers that are clearly marked as containing emergency respirators; and

1910.134(h)(2)(ii)(C)

Stored in accordance with any applicable manufacturer instructions.

..1910.134(h)(3)

1910.134(h)(3)

Inspection.

1910.134(h)(3)(i)

The employer shall ensure that respirators are inspected as follows:

1910.134(h)(3)(i)(A)

All respirators used in routine situations shall be inspected before each use and during cleaning;

1910.134(h)(3)(i)(B)

All respirators maintained for use in emergency situations shall be inspected at least monthly and in accordance with the manufacturer's recommendations, and shall be checked for proper function before and after each use; and

1910.134(h)(3)(i)(C)

Emergency escape-only respirators shall be inspected before being carried into the workplace for use.

1910.134(h)(3)(ii)

The employer shall ensure that respirator inspections include the following:

1910.134(h)(3)(ii)(A)

A check of respirator function, tightness of connections, and the condition of the various parts including, but not limited to, the face piece, head straps, valves, connecting tube, and cartridges, canisters or filters; and

1910.134(h)(3)(ii)(B)

A check of elastomeric parts for pliability and signs of deterioration.

1910.134(h)(3)(iii)

In addition to the requirements of paragraphs (h)(3)(i) and (ii) of this section, self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be maintained in a fully charged state and shall be recharged when the pressure falls to 90% of the manufacturer's recommended pressure level. The employer shall determine that the regulator and warning devices function properly.

1910.134(h)(3)(iv)

For respirators maintained for emergency use, the employer shall:

1910.134(h)(3)(iv)(A)

Certify the respirator by documenting the date the inspection was performed, the name (or signature) of the person who made the inspection, the findings, required remedial action, and a serial number or other means of identifying the inspected respirator; and

1910.134(h)(3)(iv)(B)

Provide this information on a tag or label that is attached to the storage compartment for the respirator, is kept with the respirator, or is included in inspection reports stored as paper or electronic files. This information shall be maintained until replaced following a subsequent certification.

1910.134(h)(4)

Repairs. The employer shall ensure that respirators that fail an inspection or are otherwise found to be defective are removed from service, and are discarded or repaired or adjusted in accordance with the following procedures:

1910.134(h)(4)(i)

Repairs or adjustments to respirators are to be made only by persons appropriately trained to perform such operations and shall use only the respirator manufacturer's NIOSH-approved parts designed for the respirator;

1910.134(h)(4)(ii)

Repairs shall be made according to the manufacturer's recommendations and specifications for the type and extent of repairs to be performed; and

1910.134(h)(4)(iii)

Reducing and admission valves, regulators, and alarms shall be adjusted or repaired only by the manufacturer or a technician trained by the manufacturer.

1910.134(i)

Breathing air quality and use. This paragraph requires the employer to provide employees using atmosphere-supplying respirators (supplied-air and SCBA) with breathing gases of high purity.

1910.134(i)(1)

The employer shall ensure that compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration accords with the following specifications:

1910.134(i)(1)(i)

Compressed and liquid oxygen shall meet the United States Pharmacopoeia requirements for medical or breathing oxygen; and

..1910.134(i)(1)(ii)

1910.134(i)(1)(ii)

Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:

1910.134(i)(1)(ii)(A)

Oxygen content (v/v) of 19.5-23.5%;

1910.134(i)(1)(ii)(B)

Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;

1910.134(i)(1)(ii)(C)

Carbon monoxide (CO) content of 10 ppm or less;

1910.134(i)(1)(ii)(D)

Carbon dioxide content of 1,000 ppm or less; and

1910.134(i)(1)(ii)(E)

Lack of noticeable odor.

1910.134(i)(2)

The employer shall ensure that compressed oxygen is not used in atmosphere-supplying respirators that have previously used compressed air.

1910.134(i)(3)

The employer shall ensure that oxygen concentrations greater than 23.5% are used only in equipment designed for oxygen service or distribution.

1910.134(i)(4)

The employer shall ensure that cylinders used to supply breathing air to respirators meet the following requirements:

1910.134(i)(4)(i)

Cylinders are tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR part 173 and part 178);

1910.134(i)(4)(ii)

Cylinders of purchased breathing air have a certificate of analysis from the supplier that the breathing air meets the requirements for Grade D breathing air; and

1910.134(i)(4)(iii)

The moisture content in the cylinder does not exceed a dew point of -50 deg. F (-45.6 deg. C) at 1 atmosphere pressure.

1910.134(i)(5)

The employer shall ensure that compressors used to supply breathing air to respirators are constructed and situated so as to:

1910.134(i)(5)(i)

Prevent entry of contaminated air into the air-supply system;

1910.134(i)(5)(ii)

Minimize moisture content so that the dew point at 1 atmosphere pressure is 10 degrees F (5.56 deg.C) below the ambient temperature;

1910.134(i)(5)(iii)

Have suitable in-line air-purifying sorbent beds and filters to further ensure breathing air quality. Sorbent beds and filters shall be maintained and replaced or refurbished periodically following the manufacturer's instructions.

1910.134(i)(5)(iv)

Have a tag containing the most recent change date and the signature of the person authorized by the employer to perform the change. The tag shall be maintained at the compressor.

1910.134(i)(6)

For compressors that are not oil-lubricated, the employer shall ensure that carbon monoxide levels in the breathing air do not exceed 10 ppm.

1910.134(i)(7)

For oil-lubricated compressors, the employer shall use a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. If only high-temperature alarms are used, the air supply shall be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm.

1910.134(i)(8)

The employer shall ensure that breathing air couplings are incompatible with outlets for nonrespirable worksite air or other gas systems. No asphyxiating substance shall be introduced into breathing air lines.

1910.134(i)(9)

The employer shall use breathing gas containers marked in accordance with the NIOSH respirator certification standard, 42 CFR part 84.

1910.134(j)

Identification of filters, cartridges, and canisters. The employer shall ensure that all filters, cartridges and canisters used in the workplace are labeled and color-coded with the NIOSH approval label and that the label is not removed and remains legible.

1910.134(k)

Training and information. This paragraph requires the employer to provide effective training to employees who are required to use respirators. The training must be comprehensive, understandable, and recur annually, and more often if necessary. This paragraph also requires the employer to provide the basic information on respirators in Appendix D of this section to employees who wear respirators when not required by this section or by the employer to do so.

1910.134(k)(1)

The employer shall ensure that each employee can demonstrate knowledge of at least the following:

..1910.134(k)(1)(i)

1910.134(k)(1)(i)

Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator;

1910.134(k)(1)(ii)

What the limitations and capabilities of the respirator are;

1910.134(k)(1)(iii)

How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions;

1910.134(k)(1)(iv)

How to inspect, put on and remove, use, and check the seals of the respirator;

1910.134(k)(1)(v)

What the procedures are for maintenance and storage of the respirator;

1910.134(k)(1)(vi)

How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators; and

1910.134(k)(1)(vii)

The general requirements of this section.

1910.134(k)(2)

The training shall be conducted in a manner that is understandable to the employee.

1910.134(k)(3)

The employer shall provide the training prior to requiring the employee to use a respirator in the workplace.

1910.134(k)(4)

An employer who is able to demonstrate that a new employee has received training within the last 12 months that addresses the elements specified in paragraph (k)(1)(i) through (vii) is not required to repeat such training provided that, as required by paragraph (k)(1), the employee can demonstrate knowledge of those element(s). Previous training not repeated initially by the employer must be provided no later than 12 months from the date of the previous training.

1910.134(k)(5)

Retraining shall be administered annually, and when the following situations occur:

1910.134(k)(5)(i)

Changes in the workplace or the type of respirator render previous training obsolete;

1910.134(k)(5)(ii)

Inadequacies in the employee's knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill; or

1910.134(k)(5)(iii)

Any other situation arises in which retraining appears necessary to ensure safe respirator use.

1910.134(k)(6)

The basic advisory information on respirators, as presented in Appendix D of this section, shall be provided by the employer in any written or oral format, to employees who wear respirators when such use is not required by this section or by the employer.

1910.134(l)

Program evaluation. This section requires the employer to conduct evaluations of the workplace to ensure that the written respiratory protection program is being properly implemented, and to consult employees to ensure that they are using the respirators properly.

1910.134(l)(1)

The employer shall conduct evaluations of the workplace as necessary to ensure that the provisions of the current written program are being effectively implemented and that it continues to be effective.

1910.134(l)(2)

The employer shall regularly consult employees required to use respirators to assess the employees' views on program effectiveness and to identify any problems. Any problems that are identified during this assessment shall be corrected. Factors to be assessed include, but are not limited to:

..1910.134((l)(2)(i)

1910.134(l)(2)(i)

Respirator fit (including the ability to use the respirator without interfering with effective workplace performance);

1910.134(l)(2)(ii)

Appropriate respirator selection for the hazards to which the employee is exposed;

1910.134(l)(2)(iii)

Proper respirator use under the workplace conditions the employee encounters; and

1910.134(l)(2)(iv)

Proper respirator maintenance.

1910.134(m)

Record keeping. This section requires the employer to establish and retain written information regarding medical evaluations, fit testing, and the respirator program. This information will facilitate employee involvement in the respirator program, assist the employer in auditing the adequacy of the program, and provide a record for compliance determinations by OSHA.

..1910.134(m)(1)

1910.134(m)(1)

Medical evaluation. Records of medical evaluations required by this section must be retained and made available in accordance with 29 CFR 1910.1020.

1910.134(m)(2)

Fit testing.

1910.134(m)(2)(i)

The employer shall establish a record of the qualitative and quantitative fit tests administered to an employee including:

1910.134(m)(2)(i)(A)

The name or identification of the employee tested;

1910.134(m)(2)(i)(B)

Type of fit test performed;

1910.134(m)(2)(i)(C)

Specific make, model, style, and size of respirator tested;

1910.134(m)(2)(i)(D)

Date of test; and

1910.134(m)(2)(i)(E)

The pass/fail results for QLFTs or the fit factor and strip chart recording or other recording of the test results for QNFTs.

1910.134(m)(2)(ii)

Fit test records shall be retained for respirator users until the next fit test is administered.

1910.134(m)(3)

A written copy of the current respirator program shall be retained by the employer.

1910.134(m)(4)

Written materials required to be retained under this paragraph shall be made available upon request to affected employees and to the Assistant Secretary or designee for examination and copying.

1910.134(n)

Dates.

1910.134(n)(1)

Effective date. This section is effective April 8, 1998. The obligations imposed by this section commence on the effective date unless otherwise noted in this paragraph. Compliance with obligations that do not commence on the effective date shall occur no later than the applicable start-up date.

1910.134(n)(2)

Compliance dates. All obligations of this section commence on the effective date except as follows:

..1910.134(n)(2)(i)

1910.134(n)(2)(i)

The determination that respirator use is required (paragraph (a)) shall be completed no later than September 8, 1998.

1910.134(n)(2)(ii)

Compliance with provisions of this section for all other provisions shall be completed no later than October 5, 1998.

1910.134(n)(3)

The provisions of 29 CFR 1910.134 and 29 CFR 1926.103, contained in the 29 CFR parts 1900 to 1910.99 and the 29 CFR part 1926 editions, revised as of July 1, 1997, are in effect and enforceable until October 5, 1998, or during any administrative or judicial stay of the provisions of this section.

1910.134(n)(4)

Existing Respiratory Protection Programs. If, in the 12 month period preceding April 8, 1998, the employer has conducted annual respirator training, fit testing, respirator program evaluation, or medical evaluations, the employer may use the results of those activities to comply with the corresponding provisions of this section, providing that these activities were conducted in a manner that meets the requirements of this section.

..1910.134(o)

1910.134(o)

Appendices.

1910.134(o)(1)

Compliance with Appendix A, Appendix B-1, Appendix B-2, and Appendix C of this section is mandatory.

1910.134(o)(2)

Appendix D of this section is non-mandatory and is not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

General requirements. - 1910.132

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- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** I
- **Subpart Title:** Personal Protective Equipment
- **Standard Number:** 1910.132
- **Title:** General requirements.

1910.132(a)

Application. Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

1910.132(b)

Employee-owned equipment. Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

1910.132(c)

Design. All personal protective equipment shall be of safe design and construction for the work to be performed.

..1910.132(d)

1910.132(d)

Hazard assessment and equipment selection.

1910.132(d)(1)

The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall:

1910.132(d)(1)(i)

Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment;

1910.132(d)(1)(ii)

Communicate selection decisions to each affected employee; and,

1910.132(d)(1)(iii)

Select PPE that properly fits each affected employee. Note: Non-mandatory Appendix B contains an example of procedures that would comply with the requirement for a hazard assessment.

1910.132(d)(2)

The employer shall verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment.

1910.132(e)

Defective and damaged equipment. Defective or damaged personal protective equipment shall not be used.

..1910.132(f)

1910.132(f)

Training.

1910.132(f)(1)

The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following:

1910.132(f)(1)(i)

When PPE is necessary;

1910.132(f)(1)(ii)

What PPE is necessary;

1910.132(f)(1)(iii)

How to properly don, doff, adjust, and wear PPE;

1910.132(f)(1)(iv)

The limitations of the PPE; and,

1910.132(f)(1)(v)

The proper care, maintenance, useful life and disposal of the PPE.

1910.132(f)(2)

Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

1910.132(f)(3)

When the employer has reason to believe that any affected employee who has already been trained does not have the understanding and skill required by paragraph (f)(2) of this section, the employer shall retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where:

1910.132(f)(3)(i)

Changes in the workplace render previous training obsolete; or

..1910.132(f)(3)(ii)

1910.132(f)(3)(ii)

Changes in the types of PPE to be used render previous training obsolete; or

1910.132(f)(3)(iii)

Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

1910.132(f)(4)

The employer shall verify that each affected employee has received and understood the required training through a written certification that contains the name of each employee trained, the date(s) of training, and that identifies the subject of the certification.

1910.132(g)

Paragraphs (d) and (f) of this section apply only to 1910.133, 1910.135, 1910.136, and 1910.138. Paragraphs (d) and (f) of this section do not apply to 1910.134 and 1910.137.

[39 FR 23502, June 27, 1974, as amended at 59 FR 16334, April 6, 1994; 59 FR 33910, July 1, 1994; 59 FR 34580, July 6, 1994]

Section 3

Evaluation of the Effectiveness of Air-Purifying Respirator Cartridges in Removing MDI Aerosols from Air

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SUMMARY

Respirator cartridge efficiency tests were conducted with four models of respirator cartridge using laboratory-generated test atmospheres containing diphenyl methane-4,4'-diisocyanate (MDI). The respirator cartridge models were the Cabot/AO R51A (organic vapor), Cabot/AO R91A (organic vapor/ dust, mist filter), Cabot/AO R51HE (organic vapor/ high efficiency filter), and 3M 6001/5010 (organic vapor/ dust, mist filter). The MDI test atmospheres were generated using both spray- and condensation-aerosol formation techniques. MDI concentrations covered the range of 48-9000 μg/m^3 and aerosol particle size (MMAD) was within the range of 0.9-2.5 μm. The test results led to the following conclusions:

- Organic vapor cartridges without a particulate filter were not effective at removing MDI aerosols from air (34% mean removal efficiency for predominantly aerosol atmospheres, 330-9000 μg/m^3; 81% mean removal efficiency for predominantly vapor atmospheres, 48-63 μg/m^3).
- Organic vapor cartridges with dust/mist (DM) or high efficiency (HEPA) filters effectively removed greater than 99% of MDI aerosol and vapor in all test atmospheres.
- Formation of MDI aerosols was evident even at very low (<100 μg/m^3) total MDI concentrations.

INTRODUCTION

Respiratory protection is often used to control inhalation exposures to diisocyanates. Appropriate respiratory protection may consist of an air-supplying respirator or, in certain situations, an air purifying respirator. Ideally, an air-purifying respirator with an end-of-service-life indicator (ESLI) should be used, but none currently exist. One of the pieces of information necessary in supporting both the use of air-purifying respirators in appropriate situations and the development of an appropriate ESLI is data demonstrating the ability of the air-purifying element (cartridge, canister, or filter) to remove the diisocyanate from air. For 2,4-toluenediisocyanate (TDI), such data has been published[1], but for diphenyl methane-4,4'-diisocyanate (MDI) the data do not exist. Further, the MDI case is complicated by the fact that MDI is likely to be present in both aerosol and vapor form in the air. Because of this, an organic vapor cartridge in combination with a particulate filter would be the best candidate air purifying element; data is needed to verify that this combination does effectively trap MDI in both vapor and aerosol forms

and to establish the level of effectiveness of an organic vapor cartridge without a filter in trapping MDI aerosol.

EXPERIMENTAL

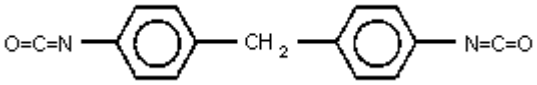
TEST SUBSTANCES

The test substances for this study were polymeric MDI (CAS Registry Number 9016-87-9) and 4,4'-MDI (CAS Registry Number 101-68-8). The analyte of interest for both test substances was 4,4'-MDI.

The polymeric MDI (PAPI* 27) was obtained from The Dow Chemical Company, Freeport, TX (lot 95923). The polymeric MDI test substance was determined[2] to be within product specifications of 40-50% 4,4'-MDI.

The 4,4'-MDI test substance was obtained from Eastman Kodak Company, Rochester, NY. (lot 32377340). The purity was determined[3] to be 98.2%.

The structure of 4,4'-MDI is given below:



Molecular Weight: 250.26

* Trademark of The Dow Chemical Company

TEST CARTRIDGES

The respirator cartridges tested are described in Table 1. All of the cartridges are for twin-cartridge, full- or half-face air-purifying respirators that are NIOSH-certified and commercially available in the United States. The cartridge models were chosen to provide both commonly used examples from a variety of manufacturers and a series of types from one product line to evaluate any differences in effectiveness between dust/mist filters, high-efficiency (HEPA) filters, and organic vapor cartridges without filters. The cartridges were obtained from S&E Industrial Supply Company, Inc., Midland MI and were tested as received from the vendor.

TEST APPARATUS AND METHODS

Cartridge Exposure Chamber

Respirator cartridges were exposed to test atmospheres of MDI in air using a 1-m^3 inhalation toxicology exposure chamber constructed of stainless steel and Teflon-lined glass (Figure 1). The test atmosphere from the aerosol generator (described below) was drawn through the chamber using an exhaust blower. The total flow through the chamber was adjusted to approximately 200 L/min using a balancing valve on the exhaust. Stainless steel access tubes (1" diameter) built into the bottom and sidewalls of the chamber were used as sampling ports for the test atmosphere. HEPA-filtered laboratory air was used as the makeup feed to the entrance of the chamber; the temperature and relative humidity (RH) ranged from 20-23°C and 40-60 %RH, respectively.

Test Atmosphere Generation - Spray Aerosol Technique

High concentration test atmospheres containing MDI aerosol were generated from polymeric MDI (liquid) and dry, compressed air using a Schlick model 970 two-component spray nozzle (Orthos, Inc., Schaumburg, IL). The resultant aerosol was passed through a cyclone to reduce the

quantity of particles greater than 10 µm and was then diluted with make-up air to the concentration of 5,000-9,000 µg/m^3 (equivalent to 490-880 ppb) 4,4'-MDI as it entered the chamber.

Test Atmosphere Generation - Condensation Aerosol Technique

Lower concentration test atmospheres containing MDI aerosol were generated from 4,4'-MDI (solid) using a High Capacity Condensation Aerosol Generator (In-Tox Products, Inc., Albuquerque, NM). The condensation aerosol generator (Figure 2) operates by heating a sample of the solid MDI in a glass boat to produce a vapor atmosphere at elevated temperature (75-130°C), then cooling the atmosphere with dilution streams to initiate condensation. The resultant aerosol was then diluted to the chamber concentration of 40-1200 µg/m^3 (equivalent to 39-120 ppb) 4,4'-MDI with make-up air as it entered the chamber.

Test Atmosphere Characterization - MDI Concentration

The concentration of MDI in the chamber test atmosphere was evaluated using several techniques. For the high concentration (spray generation) studies, gravimetric measurements of total aerosol concentration as well as chemical (derivatization) analyses of 4,4'-MDI concentration were made. For the lower concentration (condensation aerosol generation) studies, only chemical analyses were conducted and a direct-reading isocyanate monitor was used for real-time observations of concentration changes.

Chemical Analysis Method

The atmosphere was monitored for 4,4'-MDI using an adaptation of OSHA Method 47[4, 5]. The method involved drawing air through a glass fiber filter which had been coated with an amine to derivatize the MDI to a stable urea. The urea was subsequently desorbed from the filter and analyzed by high performance liquid chromatography with ultra violet detection (HPLC/UV). The amine used was 1,2-pyridyl piperazine (1,2-PP; CAS [34803-66-2], obtained from Aldrich Chemical Co., Milwaukee, WI). Diethyl phthalate (DEP; CAS [84-66-2], obtained from Aldrich Chemical Co., Milwaukee, WI) was also included in the filter coating to enhance the derivatization of MDI aerosols. Glass fiber filters (Type AE, Gelman, Inc., Ann Arbor, MI) in 13-mm, 37-mm and 47-mm sizes were used for various types of sampling. The filters were coated by adding aliquots of a stock solution of 1,2-PP and DEP in acetonitrile to the filter and letting it air-dry. The 13-mm filters (P/N 66073, Gelman, Inc., Ann Arbor, MI) were coated with $\approx$2 mg of 1,2-PP and $\approx$5 mg of DEP; the other filter sizes were loaded similarly in proportion to their respective surface areas.

Following sampling, the filters were desorbed in 5-10 mL (depending on filter size) of a solution of $\approx 2 \times 10^{-5}$ M 1,2-PP in acetonitrile. Aliquots of the desorbed sample solution were analyzed by HPLC/UV. Details of the analytical conditions are given below:

Column:	YMC Basic; 250 mm × 4.6 mm i.d. stainless steel, 5 µm particle size (YMC Inc., Wilmington NC)
Eluent:	Acetonitrile: 0.1N ammonium acetate (pH adjusted to 6.0), 1:1 v/v; 2 mL/min
Injection Size:	20-25 µL
Detection:	UV, 254 nm, range = 0.0001
Quantitation Limit:	0.1 µg 4,4'-MDI per mL of desorbed sample solution

High Concentration (Spray Generation) Studies

Gravimetric measurements of total aerosol concentration were made using 47-mm diameter, 0.45-µm pore size, Teflon filters (Gelman, Inc., Ann Arbor, MI). The filters were preweighed, placed in a stainless-steel housing which had a 1/4"o.d. × 30" copper probe attached to the inlet of the housing. The probe was placed through the sampling port in the bottom of the chamber and chamber air was drawn through at a rate of approximately 30 mL/min for periods of 100-400 minutes using a battery-operated personal sampling pump (Model 224, SKC Inc., Pittsburgh, PA). Following sampling, the filters were re-weighed using a microbalance (Mettler, Inc.).

Using a similar housing and probe, total 4,4'-MDI concentration (vapor + aerosol) measurements were made with the chemical derivatization analysis method during the high concentration runs. A 37-mm glass fiber filter coated with 1,2-PP (≈16 mg) and DEP (≈44 mg) was used to sample the atmosphere at 30 mL/min for periods of 100-400 minutes. The filters were desorbed and analyzed as described earlier.

Low Concentration (Condensation Aerosol Generation) Studies

Total 4,4'-MDI concentration in the test chamber atmosphere was determined using the chemical derivatization analysis method described earlier with 13-mm filters held in a polypropylene syringe filter housing (P/N SX00-013-00, Millipore Corp., Bedford, MA). Air was sampled at a flow rate of 1 L/min using a battery-operated personal sampling pump (Model 224, SKC Inc., Pittsburgh, PA). This technique was preferable for the low concentration studies because the extra capacity of the 37-mm filters was not needed and the small size of the 13-mm filter housing allowed its introduction directly to the chamber through the sample ports, eliminating the need for a sampling probe.

Real-time monitoring of the chamber MDI concentration was also conducted for the lower concentration studies using a paper-tape direct reading instrument (MDI AutoStep, GMD Systems, Inc., Hendersonville, PA). The instrument was used with a Teflon sample probe (1/4" o.d. × 30") attached which was inserted through the chamber sample port. The instrument readings were not used as definitive, but only to monitor changes in the chamber atmosphere and to make adjustments in the condensation aerosol generator.

Test Atmosphere Characterization - Particle Size Distribution

High Concentration (Spray Generation) Studies

Particle size distribution was characterized in the high concentration studies using a seven-stage Marple cascade impactor (Model 266, Anderson, Inc). The first six stages consisted of uncoated 1" glass plates while the last stage was a 47-mm glass fiber filter which had been coated with 1,2-PP (≈26 mg) and DEP (≈72 mg). The impactor was connected to the chamber for sampling through a port on the bottom of the chamber (Figure 1). Following sampling, the seven stages were desorbed and analyzed for 4,4'-MDI as described earlier. The MDI analysis data for each stage was then treated with a probit analysis technique to yield the mass median aerodynamic diameter (MMAD) for the test atmosphere.

Low Concentration (Condensation Aerosol Generation) Studies

Since the particle size for the condensation aerosol atmosphere used in the low concentration experiments was anticipated to be smaller, an annular diffusional denuder (ADD; Model URG-2000, URG Corp., Carrboro, NC) was employed for characterizing the MDI particle size distribution. The ADD and its use in characterizing particulate atmospheres has been described in detail elsewhere[6]. Basically, the ADD consists of a cyclone with a 2.5 µm cut-point, followed by a 2-section frosted glass tubular annulus which was coated with 1,2-PP, followed in turn by two 37-mm 1,2-PP-/DEP-coated filters in series contained in a filter housing (Figure 3). The ADD was connected to the bottom port of the chamber for sampling; air was sampled at a flow rate of 3

L/min using a battery-operated personal sampling pump (Model 224, SKC Inc., Pittsburgh, PA). Following sampling, the filters were desorbed as described earlier. The cyclone was rinsed with a 2-mL aliquot of the 1,2-PP desorbing solution, followed by duplicate 2-mL acetonitrile rinses and a single 1-mL acetonitrile rinse. All of the rinses were combined for analysis. The glass annulus was rinsed with a 2-mL aliquot of acetonitrile followed by a 3-mL aliquot; the aliquots were combined for analysis. The desorption solutions from the various sampler sections were all analyzed by HPLC/UV as described earlier. The results obtained from the ADD describe the MDI mass distribution in three categories: particles > 2.5 µm (cyclone), particles <2.5 µm (filter) and vapor (glass annulus). An example of ADD sampling results for a low-concentration test atmosphere is shown in Table 2.

Test Cartridge Holder

The test cartridges were mounted on a holder that consisted of three AO/Cabot respirator face piece mounts and one 3M 6000 series bayonet mount attached to a 1' × 1' × 1/2" polyethylene plate. This configuration allowed one replicate of each type of respirator cartridge to be tested simultaneously. The holder was situated inside the chamber and the outlet of each respirator mount was connected by a 3/8" o.d. Teflon tubing to a vacuum manifold outside the chamber which drew the test atmosphere through the cartridge (Figure 1). Each line had a rotameter with a needle valve so that the flow through each cartridge could be controlled at 32 L/min. Each cartridge outlet line had a tee in it outside the chamber through which the breakthrough monitoring samples were taken.

Cartridge Breakthrough Monitoring

The cartridge exit air was monitored for 4,4'-MDI using the chemical derivatization analysis method described earlier with 13-mm filters held in a polypropylene syringe filter housing (P/N SX00-013-00, Millipore Corp., Bedford, MA). Air was sampled at a flow rate of 1 L/min using a battery-operated personal sampling pump (Model 224, SKC Inc., Pittsburgh, PA). The 13-mm filter housing was connected directly to the cartridge line sampling tee in the high concentration experiments.

For the low concentration experiments, a 1/8" o.d. Teflon tube of sufficient length to reach the cartridge outlet ($\approx$2 m) was added to the front of each filter housing. During sampling, this tube was threaded through the sample tee and up the cartridge exit line to the exit port of the respirator. When the samples were desorbed, the front cowling of the filter housing with the attached tube was rinsed with desorbing solution and the rinse was added to the rest of the sample solution.

For the high concentration test runs, cartridge breakthrough sampling was continued for 24h or until 10 µg/m^3 4,4'-MDI was reached in the cartridge exit stream, whichever occurred first. Individual breakthrough samples were taken in consecutive 10-60 minute time periods during the test run. For the low concentration test runs, cartridge exposure was continued for 24h; individual breakthrough samples were taken for several 16-240 minute time periods during the test run.

RESULTS AND DISCUSSION

The summary results are presented and discussed below for the two sets of experiments conducted; high concentration (spray generation) studies and low concentration (condensation aerosol generation) studies. The complete data for all runs is included as Appendix A.

HIGH CONCENTRATION (SPRAY GENERATION) STUDIES

Strategy

Initially, tests were carried out using high concentration test atmospheres generated from sprayed polymeric MDI (as described earlier). Mean 4,4'-MDI concentration in the test atmosphere for the high concentration runs was 7300 µg/m^3 (range: 5300-9000 µg/m^3) while the MMAD was 2.13 µm (range: 1.6-2.4 µm). At this concentration, a very high proportion of MDI aerosol would be expected since the maximum vapor concentration of MDI obtained in laboratory atmosphere generation experiments at 25°C has been reported as about 100 µg/m^3[36].

Cartridge Breakthrough Test Results

The 10 µg/m^3 breakthrough time results for each cartridge are shown in Table 3. The individual cartridge breakthrough sample results, expressed as percent of test atmosphere breaking through the cartridge as a function of elapsed exposure time, are shown in Figures 4 and 5 for the two cartridge types where breakthrough was observed. The organic vapor cartridge (Cabot/AO R51A) showed breakthrough to a level of about 100 µg/m^3 in the first 10-minute cartridge exit stream sample. After 100 minutes of exposure to the test atmosphere, the cartridge exit stream of Cabot/AO R51A had reached a concentration representing 50-80% breakthrough of the test atmosphere. Results for the Cabot/AO R91A organic vapor/dust/mist cartridge showed that 10 µg/m^3 breakthrough was reached after a mean time of 200 min; the maximum breakthrough observed in the 400-min test runs was 3-3.5% of the test atmosphere level. The cartridge with the highest filter efficiency class (HEPA), the Cabot/AO R51HE, as well as the 3M 6001A/5010 showed very low MDI concentrations in the cartridge exit samples; all samples represented MDI breakthrough of <0.08% of the test atmosphere.

Discussion

This initial high concentration testing clearly showed that organic vapor cartridges without a particulate filter were ineffective at removing MDI aerosols. The addition of a dust/mist prefilter improved the cartridge's aerosol removal efficiency considerably, although it appears from the Cabot/AO R91A and 3M 6001A/5010 results that dust/mist filters from different manufacturers may differ in their efficiency with small particles. The HEPA filter/organic vapor combination gave the best MDI aerosol removal performance. These findings are consistent with the particulate test requirements used in the U.S. by the National Institute for Occupational Safety and Health (NIOSH) for approval of respirator cartridges[7]. These requirements ensure a 99% minimum efficiency for dust, mist filters and a 99.97% minimum efficiency for HEPA filters. The presence of aerosols of even smaller particle size than in the present study could further accentuate the efficiency differences between dust, mist and HEPA filters noted here.

LOW CONCENTRATION (CONDENSATION AEROSOL GENERATION) STUDIES

Strategy

After reviewing the results from the initial high-concentration test runs, a new set of experiments was designed to evaluate the performance of the cartridges at the lower MDI concentrations more likely to be encountered in actual workplace situations (approximately 1-10 times the 51 µg/m^3 TLV® for MDI). At these concentrations MDI vapor would form a much larger proportion of the total MDI concentration. As described earlier, a condensation aerosol generator was used with undiluted 4,4'-MDI to produce the test atmosphere; an annular diffusional denuder (ADD) was used to characterize the distribution of particles and vapor. The cascade impactor was also used to characterize particle size in two of the higher-concentration condensation aerosol test runs. The characterization results for the condensation aerosol test runs are summarized in Table 4.

A consideration of the spray-generated test results led to the conclusion that the major mechanism of MDI removal by the cartridge from the test atmosphere was mechanical filtration of the aerosol particles. Unlike vapor diffusion, diffusion of aerosol particles in the short residence time in the cartridge sorbent bed will not lead to the numerous surface interactions necessary for efficient adsorption. Because of this, the time-course of breakthrough (which is important in organic vapor sorption mechanisms of respirator cartridge operation) was considered to be of less importance than determining a 'filtration efficiency' for each cartridge. Therefore, cartridge exit samples were not taken consecutively throughout the test run, as in the earlier spray-generated work, but rather at intervals throughout the test run. The apparent 'breakthrough curve' behavior seen for the Cabot/AO R51A and R91A in the spray runs (see Figures 4 and 5) was suspected to be a result of loss of MDI in the cartridge exit stream to the walls of the lines leading to the sampling filter. This possible source of loss was eliminated in the condensation aerosol runs by the addition of a 1/8" Teflon lead-in tube which was analyzed with the sample (see the Experimental section). The validity of this approach of using a filtration efficiency model rather than a vapor adsorption model for the removal of MDI from air by respirator cartridges is demonstrated by the results for the Cabot/AO R51A shown in Table 5. These results show that the cartridge efficiency (defined as the percent of the test atmosphere concentration removed by the cartridge) was the same in the first exit stream sample (0-15 min exposure time) as in the last sample of the run (1415-1434 min exposure time).

Cartridge Breakthrough Test Results

The results of the test runs (expressed as cartridge efficiency) for the MDI condensation aerosol tests are summarized in Table 6. The results are listed in order of increasing test atmosphere concentration, and can be grouped into two concentration ranges: a range where a significant portion of the MDI concentration would be expected to be vapor and a range where the predominant form of MDI concentration would be expected to be aerosol.

Discussion

The results for the Cabot/AO R51A organic vapor cartridge show much better efficiency in the predominantly vapor test runs (mean efficiency = 81%) when compared to that for the predominantly aerosol runs (mean efficiency = 34%). The fact that approximately 20% of the test atmosphere passes the R51A cartridge even at the low concentrations confirms the ADD data indicating that a sizable portion of the MDI in the test atmosphere was in the aerosol form (see Table 4). The MDI vapor present appears to be adsorbed effectively on the charcoal bed of the respirators since all of the other OV respirators with particulate filters showed efficiencies of 99% or greater. The results also demonstrate the difference in efficiency between the two OV/DM respirators noted in the spray-generated tests; the Cabot/AO R91A showed detectable amounts of MDI in the exit stream in all but the lowest concentration while the 3M 6001/5010 (like the Cabot/AO R51HE OV/HEPA) showed no detectable breakthrough in any of the exit stream samples.

CONCLUSIONS

- Organic vapor cartridges without a particulate filter were not effective at removing MDI aerosols from air (34% mean removal efficiency for predominantly aerosol atmospheres, 330-9000 $\mu g/m^3$; 81% mean removal efficiency for predominantly vapor atmospheres, 48-63 $\mu g/m^3$).
- Organic vapor cartridges with dust/mist (DM) or high efficiency (HEPA) filters effectively removed greater than 99% of MDI aerosol and vapor in all test atmospheres.
- Formation of MDI aerosols was evident even at very low (<100 $\mu g/m^3$) total MDI concentrations.

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Table 1.
Respirator Cartridges Tested Against MDI

Respirator Manufacturer[1]	Cartridge/Filter Model Number(s)	NIOSH/MSHA Approval Type(s)[2]	Lot Number Used
AO/Cabot	R51A cartridge	OV	102791
AO/Cabot	R91A cartridge	OV, DM, Paint	081291
AO/Cabot	R51HE cartridge	OV, HEPA, Paint	93250

Table 2.
Example Annular Diffusional Denuder Results from MDI Condensation Aerosol Test Atmosphere Characterization: Chamber Run 95-5.

ADD Section	Particle Size Interval	µg/m^3 MDI	% in Interval
Cyclone	> 2.5µm	12	2.9
First AD	Vapor	42	10.1
Second AD	Vapor	<0.04	<0.01
First Filter	<2.5µm	360	87.0
Second Filter	<2.5µm	<0.04	<0.01
	Total:	414	100
	Results from 13mm filter sample taken at the same time:	410	

Table 3.
Results of Respirator Cartridge Breakthrough Testing with Spray-Generated MDI Aerosol Test Atmospheres (5300-9000 µg/m^3 (Mean=7300), MMAD = 2.13 µm)

Cartridge	Type[1]	10 µg/m^3 (0.977 ppb) Breakthrough Time (min)
Cabot/AO R51 HE	OV/HEPA	>1440
3M 6001/5010	OV/DM	>1440
Cabot/AO R91A	OV/DM	200
Cabot/AO R51A	OV	<10

[1]
OV = organic vapor
DM = dust, mist
HEPA = high efficiency particulate

Table 4.
Test Atmosphere Characterization Results from MDI Condensation Aerosol Test Runs

		Annular Diffusional Denuder Results (% of mass in interval)			Cascade Impactor Results	
Test Run	µg/m^3 MDI (TWA)	Particle, >2.5µm	Particle, <2.5µm	Vapor	MMAD (µm)	84% of mass less than (µm):
1	63	<0.3	15.4	84.6	-	-
2	48	2.1	17.0	80.9	-	-
3	1200	-	-	-	-	-
4	330	1.4	84.0	14.6	0.89	1.25
5	650	2.9	87.0	10.1	0.92	1.34

Table 5.
Example Cartridge Efficiency Results from an MDI Condensation Aerosol Test Run.

Test Cartridge: Cabot/AO R51A
Mean MDI Concentration: 650 µg/m^3

Elapsed Time Interval(min)	Test Atmosphere MDI Conc. (µg/m^3)	Exit Stream MDI Conc. (µg/m^3)	Cartridge Efficiency
1 to 15	622	367	41%
1005 to 1020	408	275	33%
1415 to 1434	357	235	34%
		Mean:	36%
		RSD:	12%

Table 6.
Summary of Cartridge Efficiency Results from MDI Condensation Aerosol Test Runs

		Cartridge Efficiency			
MDI Conc. ($\mu g/m^3$)	Predominant MDI Form	AO R51A (OV)[1]	AO R91A (OV/DM)	3M 6001/5010 (OV/DM)	AO R51HE (OV/HEPA)
48	Vapor	75%	>99.9%	>99.9%	>99.9%
62	Vapor	86%	99.2%	>99.8%	>99.8%
330	Aerosol	30%	99.3%	>99.98%	>99.98%
650	Aerosol	36%	99.1%	>99.98%	N/A
650	Aerosol	36%	N/A	N/A	N/A
1200	Aerosol	35%	99.6%	>99.96%	>99.96%

N/A = not applicable (cartridge not run under this condition)

[1]
OV = organic vapor
DM = dust, mist
HEPA = high efficiency particulate

Figure 1. Respirator Test Chamber

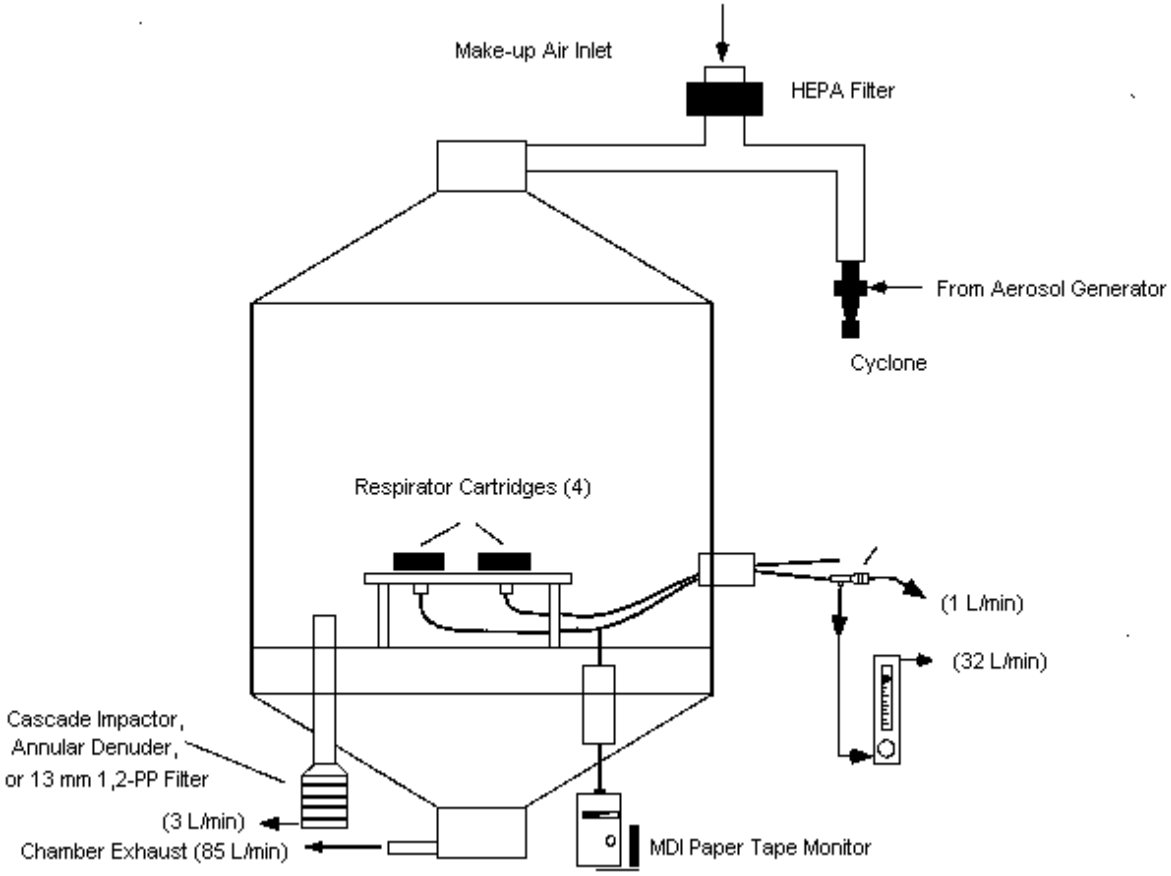


Figure 2. Condensation Aerosol Generator

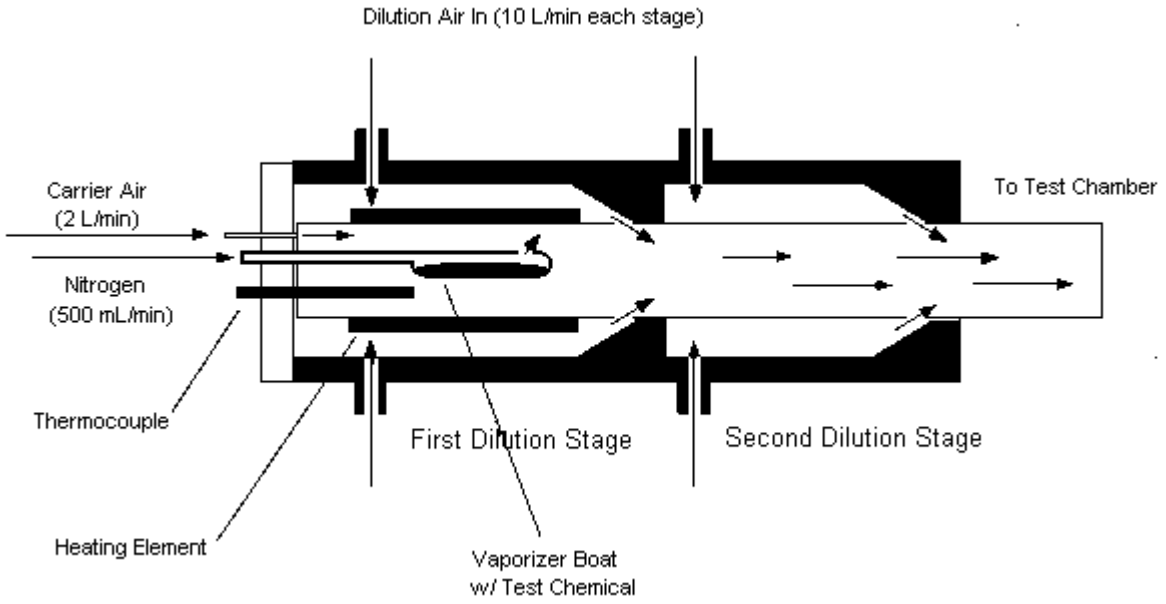


Figure 3. Diagram of the Annular Diffusional Denuder (ADD) Sampler

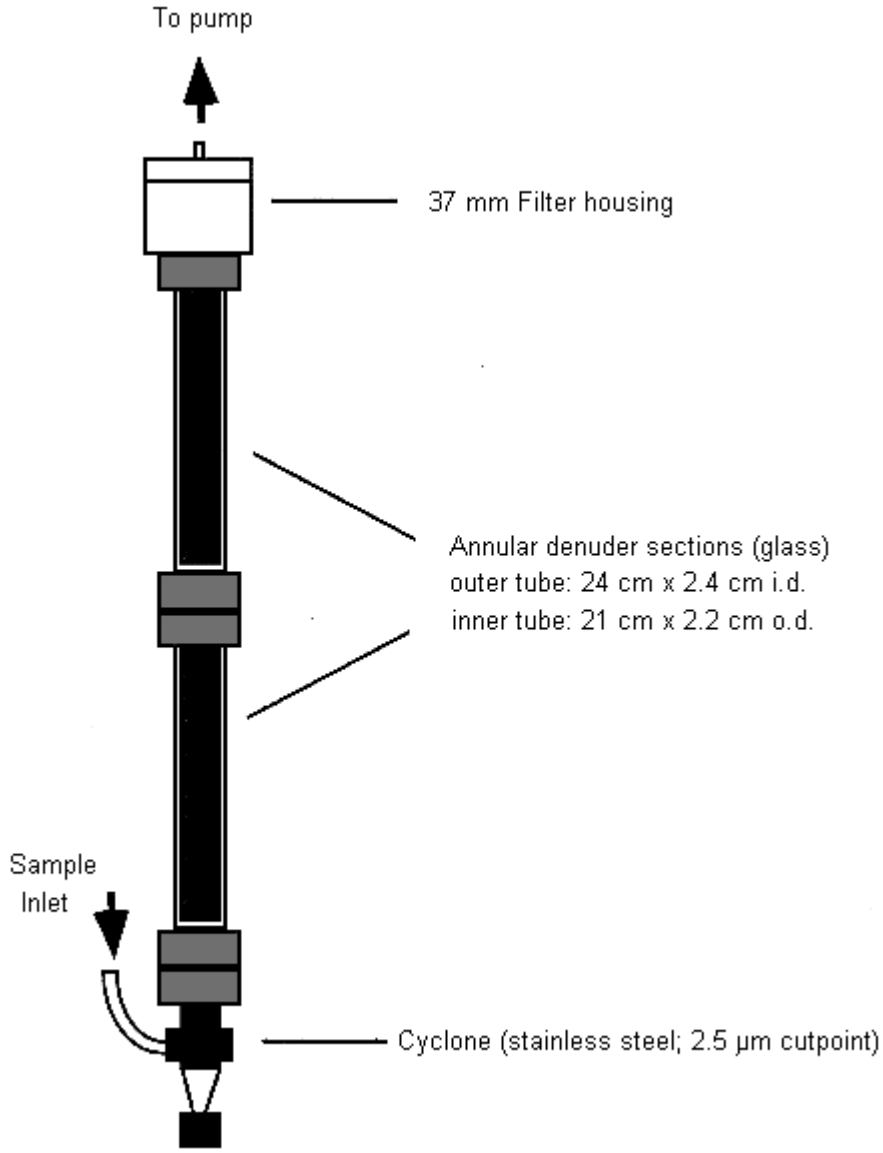


Figure 4. Breakthrough Results for AO/Cabot R51A OV Cartridge with High Concentration MDI Aerosol Atmosphere (7050 µg/m^3, MMAD = 2.13 µm)

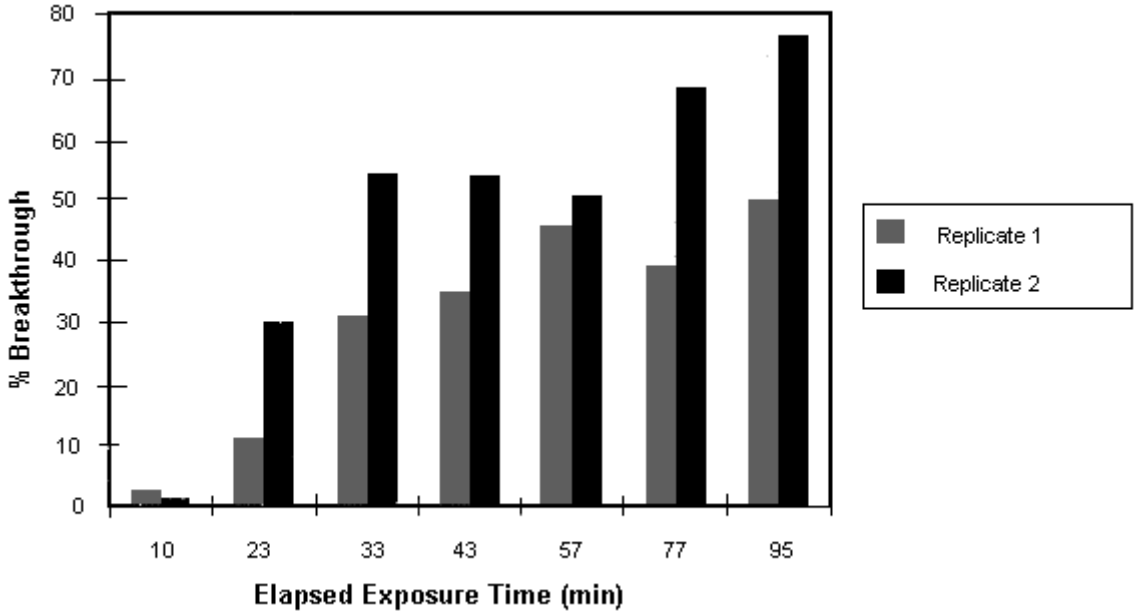
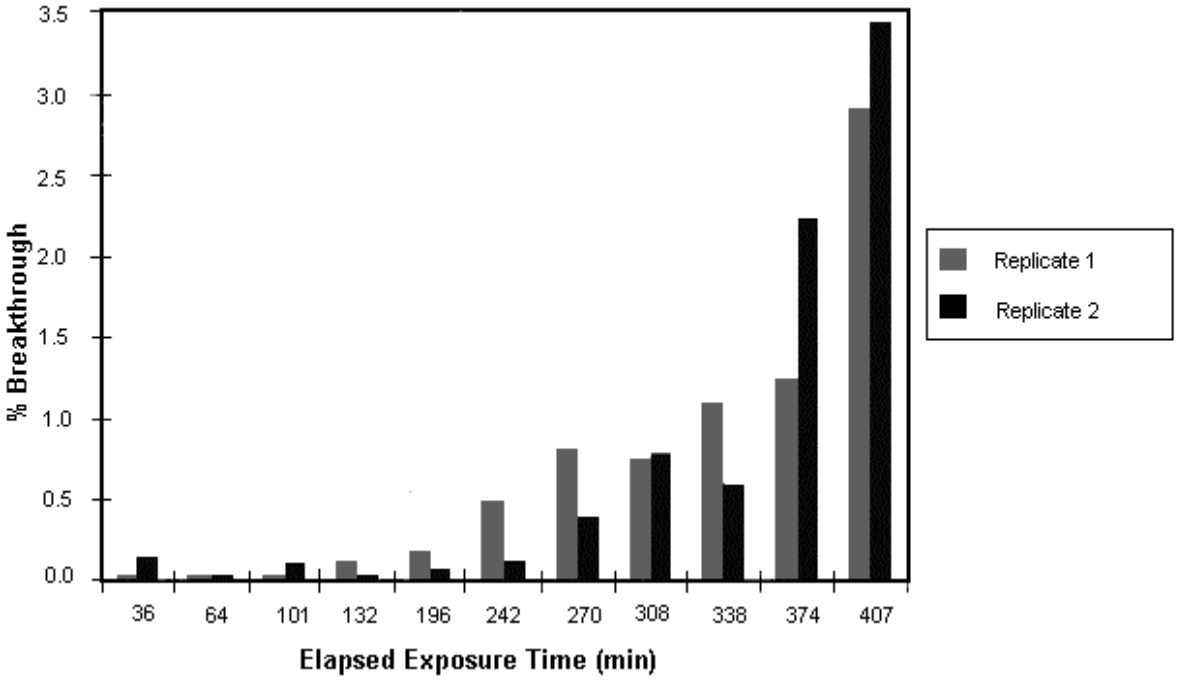


Figure 5. Breakthrough Results for AO/Cabot R91A OV/DM Cartridge with High Concentration MDI Aerosol Test Atmosphere (8500 µg/m^3, MMAD = 2.13 µm)



Section 4
OSHA Eye and Face Protection – section 1910.133

Eye and face protection. - 1910.133

Regulations (Standards - 29 CFR) - Table of Contents

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** I
- **Subpart Title:** Personal Protective Equipment
- **Standard Number:** 1910.133
- **Title:** Eye and face protection.

1910.133(a)

General requirements.

1910.133(a)(1)

The employer shall ensure that each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.

1910.133(a)(2)

The employer shall ensure that each affected employee uses eye protection that provides side protection when there is a hazard from flying objects. Detachable side protectors (e.g. clip-on or slide-on side shields) meeting the pertinent requirements of this section are acceptable.

1910.133(a)(3)

The employer shall ensure that each affected employee who wears prescription lenses while engaged in operations that involve eye hazards wears eye protection that incorporates the prescription in its design, or wears eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.

1910.133(a)(4)

Eye and face PPE shall be distinctly marked to facilitate identification of the manufacturer.

..1910.133(a)(5)

1910.133(a)(5)

The employer shall ensure that each affected employee uses equipment with filter lenses that have a shade number appropriate for the work being performed for protection from injurious light radiation. The following is a listing of appropriate shade numbers for various operations.

Filter Lenses for Protection Against Radiant Energy

Operations	Electrode Size 1/32 in.	Arc Current	Minimum(*) Protective Shade
Shielded metal arc welding	Less than 3	Less than 60 ...	7
	3-5	60-160	8
	5-8	160-250	10
	More than 8	250-550	11
Gas metal arc welding and flux cored arc welding		less than 60 ...	7
		60-160	10
		160-250	10
		250-500	10
Gas Tungsten arc welding		less than 50 ...	8
		50-150	8
		150-500	10
Air carbon Arc cutting	(Light)	less than 500 ..	10
	(Heavy)	500-1000	11
Plasma arc welding		less than 20 ...	6
		20-100	8
		100-400	10
		400-800	11
Plasma arc cutting	(light)(**)	less than 300 ..	8
	(medium)(**)	300-400	9
	(heavy)(**)	400-800	10
Torch brazing	.....		3
Torch soldering	.....		2

Carbon arc welding	.....		14

Filter Lenses for Protection Against Radiant Energy

Operations	Plate thickness-inches	Plate thickness-mm	Minimum (*) Protective Shade
Gas Welding:			
Light	Under 1/8	Under 3.2	4
Medium	1/8 to 1/2	3.2 to 12.7	5
Heavy	Over 1/2	Over 12.7	6
Oxygen cutting:			
Light	Under 1	Under 25	3
Medium	1 to 6	25 to 150	4
Heavy	Over 6	Over 150	5

Footnote (*) As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade that gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.

Footnote (**) These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the work piece.

1910.133(b)

Criteria for protective eye and face devices.

1910.133(b)(1)

Protective eye and face devices purchased after July 5, 1994 shall comply with ANSI Z87.1-1989, "American National Standard Practice for Occupational and Educational Eye and Face Protection," which is incorporated by reference as specified in Sec. 1910.6.

1910.133(b)(2)

Eye and face protective devices purchased before July 5, 1994 shall comply with the ANSI "USA standard for Occupational and Educational Eye and Face Protection," Z87.1-1968, which is incorporated by reference as specified in Sec. 1910.6, or shall be demonstrated by the employer to be equally effective.

[59 FR 16360, April 6, 1994; 59 FR 33910, July 1, 1994; 61 FR 9227, March 7, 1996; 61 FR 19547, May 2, 1996]

Section 5
OSHA Confined Space Information
Confined Space Checklist

Safety and Health Topics:

Confined Spaces

Many workplaces contain spaces that are considered "confined" because their configurations hinder the activities of any employees who must enter, work in, and exit them. For example, employees who work in process vessels generally must squeeze in and out through narrow openings and perform their tasks while cramped or contorted. OSHA uses the term "confined space" to describe such spaces. In addition, there are many instances where employees who work in confined spaces face increased risk of exposure to serious hazards. In some cases, confinement itself poses entrapment hazards. In other cases, confined space work keeps employees closer to hazards, such as asphyxiating atmospheres or the moving parts of machinery. OSHA uses the term "permit-required confined space" (permit space) to describe those spaces that both meet the definition of "confined space" and pose health or safety hazards.

Related Safety and Health Topics

- Construction: Confined Spaces

Recognition

- Small Business Outreach Training Program Instructional Guide. OSHA Training Institute (1997). This document contains basic information about occupational safety and health, with specific focus on the needs of small business. It contains the following sections regarding Confined Spaces, and also provides discussion/overheads and student handouts:
  - Confined space hazards, overheads (1.91 MB PDF file), handouts (253 KB PDF file).
  - Permit-required confined space standard, overheads (1.59 MB PDF file), handouts (260 KB PDF file).
- Criteria for a Recommended Standard: Working in Confined Spaces. NIOSH (1979, December), 1 page. Table of contents to this document. The document is available as PDF files.
- Preventing Occupational Fatalities in Confined Spaces. NIOSH Alert (1986, January), 4 pages.
- Confined Space Entry Policy and Procedures Manual. St. Olaf College, 18 pages.
- Entering and Working in Confined Spaces. Oklahoma State University (1995, July 31), 1 page. Table of Contents to this Confined Spaces Manual.
- Confined Space Entry. Oregon State University's Safety Handbook, 91 KB PDF, 3 pages.
- Asphyxiation Hazard in Pits: Potential Confined Space Problem. OSHA Hazard Information Bulletin (1993, June 13), 1 page.
- Suffocation Hazards in Flat Storage Buildings and Tanks. OSHA Hazard Information Bulletin (1994, December 15), 1 page.
- Confined Space Hazards a Threat to Farmers. National Ag Safety Database (1992, May), 4 pages.
- Beware of Manure Pit Hazards. National Ag Safety Database (1993, May), 4 pages.
- Preventing Deaths of Farm Workers in Manure Pits. NIOSH Alert (1990, May), 4 pages.
- NIOSH Warns Farmers of Deadly Risk of Grain Suffocation. NIOSH Update (1993, April 28), 2 pages.
- Occupational Confined Space-Related Fatalities: Surveillance and Prevention. NIOSH Fatality Assessment and Control Evaluation (FACE) Project. The National Ag Safety Database provides a short (1 page) description of this project.
  - Two Men Die in Well Cleaning Operation–Maryland (1993), 4 pages.

    - Carbon Monoxide Kills Three Volunteer Firefighters Inside Well in Pennsylvania (1990), 4 pages.
    - Three Sanitation Workers and One Policeman Die in an Underground Pumping Station in Kentucky (1985), 1 page.

Evaluation

- Confined Spaces Advisor 1.1. OSHA (1997, December). This is interactive expert help for the Permit-Required Confined Spaces Standard (29 CFR 1910.146). It will assist users to identify confined spaces and deal with permit-required confined spaces. The program is available in both online and downloadable versions.
    - Online: Confined Spaces Advisor 1.1
    - Downloadable: Confined Spaces Advisor 1.1
- Permit-required Confined Space Decision Flow Chart. OSHA Regulation 1910.146 App A (1993, June), 2 pages.
- Procedures for Atmospheric Testing. OSHA Regulation 1910.146 App B.
- Air Testing Equipment. Department of Energy, Occupational Safety and Health Technical Reference (OTR), (1996, April), 2 pages.
- Confined-Space Reentry Checklist. Department of Energy, Occupational Safety and Health Technical Reference (OTR), (1996, April), 1 page.

Control

- OSHA Standards
    - 1910.146 App C, Examples of Permit-required Confined Space Programs
    - 1910.146 App D, Confined Space Pre-Entry Check List
    - 1910.146 App E, Sewer System Entry
    - Part 1915, Subpart B, App A, Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment.
- Confined-Space Entry. Department of Energy, Occupational Safety and Health Technical Reference (OTR), (1996, April). Table of Contents to this chapter. Contains elements of the DOE confined spaces program.
- Confined Space Entry. Department of Energy, Health and Safety Plan Guidelines. Contains guidelines on establishing a site-specific confined spaces program.
- Confined Space Entry Policy and Procedure. Sonoma State University, 6 pages. Example of a confined space entry program.
- Confined Space. National Institute for Environmental Health and Safety (1998, January 6), 9 pages. Example of a confined space entry program. Includes duties of individual jobs.
- Confined Space Management, Confined Space Rescue, Mark A. Brown, Rescue Net (1998), 3 pages. Provides an introduction to the topic of confined space rescues.
- OSHA Confined Space Entry Poster. National Ag Safety Database, 1 page. The poster is available as PDF files in 3 sizes.

Compliance

- Hugo Employers Fined for "Confined Space" Violations; Several Workers Injured. OSHA Regional News Release (2003, June). The alleged failure of three Hugo, Oklahoma, companies to train employees and give them adequate gear for working inside confined spaces with unsafe air has resulted in proposed penalties totaling $427,500 from the U.S. Department of Labor's Occupational Safety and Health Administration
- Compliance information, including Standards, Directives and Interpretations, is provided on a separate page.

Training

- Small Business Outreach Training Program Instructional Guide. OSHA Training Institute (1997). This guide contains basic information about selected topics in occupational safety and health. It is designed to provide ideas and organizational assistance to instructors who wish to present these topics, which specifically focus on the needs of small business. One section discusses confined space hazards, and another section discusses OSHA's permit-required confined space standard.
- Video Abstracts: Confined Space Entry. National Ag Safety Database provides references to several videos relating to confined space entry. These are available at minimal cost.

Other

- Construction: Confined Space Safety and Health Topics Page.
- Confined Space Entry. Oklahoma State University, 1 page. Links to a number of articles and information sheets relating to confined spaces.
- AIHA Confined Spaces Committee. The American Industrial Hygiene Association Confined Spaces Committee is a group of professionals from academia, general industry, consulting, enforcement, and maritime operations. All of the committee's collective knowledge and experience is available to any interested party through this page.

Revised: 24 June 2003

PERMIT-REQUIRED CONFINED SPACES - 1910.146

Introduction

Requirements of the Standard

- General Requirements
- Written Program
- Permit System
- Entry Permits
- Training and Education
- Authorized Entrant's Duties
- Attendant's Duties
- Entry Supervisor's Duties
- Emergencies

References:

29 CFR 1910.0146: ***Permit-Required Confined Space***

Appendix A: ***Permit-Required Confined Space Decision Flow Chart***
Appendix B: ***Procedures for Atmospheric Testing***
Appendix C: ***Examples of Permit-Required Confined Space Program***
Appendix D: ***Confined Space Pre-Entry Check List***
Appendix E: ***Sewer System Entry***

Additional Sources of Information

Confined Spaces (OSHA Web Page)

Discussion/Overheads - 1.59 M

Student Handouts - 260 K

Self-Inspection Checklist

PERMIT-REQUIRED CONFINED SPACES - 1910.146

INTRODUCTION

Many workplaces contain spaces that are considered to be "confined" because their configurations hinder the activities of any employees who must enter into, work in, and exit from them. In many instances, employees who work in confined spaces also face increased risk of exposure to serious physical injury from hazards such as entrapment, engulfment, and hazardous atmospheric conditions. Confinement itself may pose entrapment hazards, and work in confined spaces may keep employees closer to hazards, such as an asphyxiating atmosphere, than they would be otherwise. For example, confinement, limited access, and restricted airflow can result in hazardous conditions that would not arise in an open workplace. The term "permit-required confined space" (i.e., permit space) refers to those spaces that meet the definition of a "confined space" and pose health or safety hazards, thereby requiring a permit for entry.

A **confined space** has limited or restricted means of entry or exit, is large enough for an employee to enter and perform assigned work, and is not designed for continuous occupancy by the employee. These

spaces may include, but are not limited to, underground vaults, tanks, storage bins, pits and diked areas, vessels, and silos.

A **permit-required confined space** is one that meets the definition of a confined space and has one or more of these characteristics: (1) contains or has the potential to contain a hazardous atmosphere, (2) contains a material that has the potential for engulfing an entrant, (3) has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section, and/or (4) contains any other recognized serious safety or health hazards.

REQUIREMENTS OF THE STANDARD General

In general, employers must evaluate the workplace to determine if spaces are permit-required confined spaces. (See flow chart). If there are permit spaces in the workplace, the employer must inform exposed employees of the existence, location, and danger posed by the spaces. This can be accomplished by posting danger signs or by another equally effective means. The following language would satisfy the requirements for such a sign:

DANGER--PERMIT REQUIRED-CONFINED SPACE--
AUTHORIZED ENTRANTS ONLY

If employees are not to enter and work in permit spaces, employers must take effective measures to prevent their employees from entering the permit spaces.

If employees are to enter permit spaces, the employer must develop a written permit space program, which shall be made available to employees or their representatives. Under certain conditions, the employer may use alternate procedures for worker entry into a permit space. For example, if employers can demonstrate with monitoring and inspection data that the only hazard is an actual or potential hazardous atmosphere, which can be made safe for entry by the use of continuous forced air ventilation alone, they may be exempted from some requirements, such as permits and attendants. Even in such circumstances, however, the internal atmosphere of the space must be tested first for oxygen content, second for flammable gases and vapors, and third for potential toxic air contaminants before any employee enters.

Written Program

The employer who allows employee entry must develop and implement a written program for permit-required confined spaces.

Among other things, the OSHA standard requires the employer's program to:

- Identify and evaluate permit space hazards before allowing employee entry;
- Test conditions in the permit space before entry operations and monitor the space during entry;
- Perform in the following sequence, appropriate testing for atmospheric hazards: oxygen, combustible gases or vapors, and toxic gases or vapors;
- Implement necessary measures to prevent unauthorized entry;
- Establish and implement the means, procedures and practices --such as specifying acceptable entry conditions, isolating the permit space, providing barriers, verifying acceptable entry conditions, purging, making inert, flushing, or ventilation of the permit space--to eliminate or control hazards necessary for safe permit-space entry operations;
- Identify employee job duties;
- Provide, maintain, and require, at no cost to the employee, the use of personal protective equipment and any other equipment necessary for safe entry (e.g., testing, monitoring, ventilating, communications, and lighting equipment; barriers, shields, and ladders);

- Ensure that at least one attendant is stationed outside the permit space for the duration of entry operations;
- Coordinate entry operations when employees of more than one employer are to be working in the permit space;
- Implement appropriate procedures for summoning rescue and emergency services;
- Establish, in writing, and implement a system for the preparation, issuance, use, and cancellation of entry permits;
- Review established entry operations and annually revise the permit-space entry program; and
- When an attendant is required to monitor multiple spaces, implement the procedures to be followed during an emergency in one or more of the permit spaces being monitored.

If hazardous conditions are detected during entry, employees must immediately leave the space, and the employer must evaluate the space to determine the cause of the hazardous atmospheres.

When entry to permit spaces is prohibited, the employer must take effective measures to prevent unauthorized entry. Non-permit confined spaces must be reevaluated when there are changes in their use or configuration and, where appropriate, must be reclassified.

If testing and inspection data prove that a permit-required confined space no longer poses hazards, that space may be reclassified as a non-permit confined space. If entry is required to eliminate hazards and to obtain the data, the employer must follow procedures as set forth under sections (d) through (k) of the standard. A certificate documenting the data must be made available to employees entering the space. The certificate must include the date, location of the space, and the signature of the person making the certification.

Contractors also must be informed of permit spaces and permit space entry requirements, any identified hazards, the employer's experience with the space (i.e., the knowledge of hazardous conditions), and precautions or procedures to be followed when in or near permit spaces.

When employees of more than one employer are conducting entry operations, the affected employers must coordinate entry operations to ensure that affected employees are appropriately protected from permit space hazards. Contractors also must be given and other pertinent information regarding hazards and operations in permit spaces and be debriefed at the conclusion of entry operations.

Permit System

A permit, signed by the entry supervisor and verifying that pre-entry preparations have been completed and that the space is safe to enter, must be posted at entrances or otherwise made available to entrants before they enter a permit space.

The duration of entry permits must not exceed the time required to complete an assignment. Also, the entry supervisor must terminate entry and cancel permits when an assignment has been completed or when new conditions exist. New conditions must be noted on the canceled permit and used in revising the permit space program. The standard also requires the employer to keep all canceled entry permits for at least 1 year.

Entry Permits

Entry permits must include the following information:

- Test results;
- Tester's initials or signature;
- Name and signature of supervisor who authorizes entry;
- Name of permit space to be entered, authorized entrant(s), eligible attendants, and individual(s) authorized to be entry supervisor(s);

- Purpose of entry and known space hazards;
- Measures to be taken to isolate permit spaces and to eliminate or control space hazards, i.e., locking out or tagging of equipment and procedures for purging, making inert, ventilating and flushing permit spaces;
- Name and telephone numbers of rescue and emergency services;
- Date and authorized duration of entry;
- Acceptable entry conditions;
- Communication procedures and equipment to maintain contact during entry;
- Additional permits(s), such as for hot work, that have been issued to authorize work in the permit space;
- Special equipment and procedures, including personal protective equipment and alarm systems; and
- Any other information needed to ensure employee safety.

Training and Education

Before initial work assignment begins, the employer must provide proper training for all workers who are required to work in permit spaces. Upon completing this training, employers must ensure that employees have acquired the understanding, knowledge, and skills necessary for the safe performance of their duties. Additional training is required when (1) the job duties change, (2) there is a change in the permit-space program or the permit space operation presents a new hazard, and (3) when an employee's job performance shows deficiencies. Training also is required for rescue team members, including cardiopulmonary resuscitation (CPR) and first-aid training (see Emergencies). Employers must certify that training has been accomplished.

Upon completion of training, employees must receive a certificate of training that includes the employee's name, signature or initials of trainer(s), and dates of training. The certification must be made available for inspection by employees and their authorized representatives.

In addition, the employer also must ensure that employees are trained in their assigned duties.

Authorized Entrant's Duties

- Know space hazards, including information on the mode of exposure (e.g., inhalation or dermal absorption), signs or symptoms, and consequences of the exposure;
- Use appropriate personal protective equipment properly (e.g., face and eye protection, and other forms of barrier protection such as gloves, aprons, and coveralls);
- As necessary, maintain communication (i.e., telephone, radio, visual observation) with attendants to enable the attendant to monitor the entrant's status as well as to alert the entrant to evacuate;
- Exit from permit space as soon as possible when ordered by an authorized person, when the entrant recognizes the warning signs or symptoms of exposure exist, when a prohibited condition exists, or when an automatic alarm is activated; and
- Alert the attendant when a prohibited condition exists or when warning signs or symptoms of exposure exist.

Attendant's Duties

- Remain outside permit space during entry operations unless relieved by another authorized attendant;
- Perform no-entry rescues when specified by employer's rescue procedure;
- Know existing and potential hazards, including information on the mode of exposure, signs or symptoms, consequences of the exposure, and their physiological effects;
- Maintain communication with and keep an accurate account of those workers entering the permit-required space;

- Order evacuation of the permit space when a prohibited condition exists, when a worker shows signs of physiological effects of hazardous exposure, when an emergency outside the confined space exists, and when the attendant cannot effectively and safely perform required duties;
- Summon rescue and other services during an emergency;
- Ensure that unauthorized persons stay away from permit spaces or exit immediately if they have entered the permit space;
- Inform authorized entrant's and entry supervisor of entry by unauthorized persons; and;
- Perform no other duties that interfere with the attendant's primary duties.

Entry Supervisor's Duties

- Know space hazards including information on the mode of exposure, signs, or symptoms and consequences of exposure;
- Verify emergency plans and specified entry conditions such as permits, tests, procedures, and equipment before allowing entry;
- Terminate entry and cancel permits when entry operations are completed or if a new condition exists;
- Take appropriate measures to remove unauthorized entrants; and
- Ensure that entry operations remain consistent with the entry permit and that acceptable entry conditions are maintained.

Emergencies

The standard requires the employer to ensure that rescue service personnel are provided with and trained in the proper use of personal protective and rescue equipment, including respirators; trained to perform assigned rescue duties; and have had authorized entrant's training. The standard also requires that all rescuers be trained in first aid and CPR and, at a minimum, one rescue team member be currently certified in first aid and in CPR. The employer also must ensure that practice rescue exercises are performed yearly, and that rescue services are provided access to permit spaces so that they can practice rescue operations. Rescuers also must be informed of the hazards of the permit space.

Also, when appropriate, authorized entrants who enter a permit space must wear a chest or full body harness with a retrieval line attached to the center of their backs near shoulder level, or above their heads. Wristlets may be used if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard. Also, the employer must ensure that the other end of the retrieval line is attached to a mechanical device or to a fixed point outside the permit space. A mechanical device must be available to retrieve personnel from vertical type permit spaces more than 5 feet deep.

In addition, if an injured entrant is exposed to a substance for which a Material Safety Data Sheet (MSDS) or other similar written information is required to be kept at the worksite, that MSDS or other written information must be made available to the medical facility treating the exposed entrant.

Checklist of Considerations for Entry Working in and Exiting Confined Spaces

ITEM	CLASS A	CLASS B	CLASS C
1. Permit	x	x	x
2. Atmospheric Testing	x	x	x
3. Monitoring	x	o	o
4. Medical Surveillance	x	x	o
5. Training of Personnel	x	x	x
6. Labeling and Posting	x	x	x
7. Preparation			
Isolate/lockout/tag	x	x	o
Purge and ventilate	x	x	o
Cleaning processes	o	o	o
Requirements for special equipment/tools	x	x	o
8. Procedures			
Initial plan	x	x	x
Standby	x	x	o
Communications/observation	x	x	x
Rescue	x	x	x
Work	x	x	x
9. Safety Equipment and Clothing			
Head protection	o	o	o
Hearing protection	o	o	o
Hand protection	o	o	o
Foot protection	o	o	o
Body protection	o	o	o
Respiratory protection	o	o	o
Safety belts	x	x	x
Life lines/harness	x	o	o
10. Rescue Equipment	x	x	x
11. Record Keeping/Exposure	x	x	x

X = requirement
O = determination by the qualified person

How to Test

In order to have a safe work environment, the oxygen levels must be between 19.5 – 25%. It is necessary to test for toxic vapors BEFORE anyone goes into the confined space and before blowers are put into the area. Atmosphere testing in your confined space must be for:

1. Proper oxygen content
2. Presence of flammable or explosive substances
3. Presence of toxic gasses and/or vapors

The equipment should be checked out and tested prior to coming to the site.

Equipment needed:

- Warning sign
- Barricade or pylons
- Ventilating equipment
- Portable lighting
- Full face air-supplied respirator

- Life line and harness
- Mechanical lift devices
- Fire extinguisher
- Distress monitor
- Tyvek suits
- Gloves
- Boots

SOME of the common warning signals of an unsafe environment are:

- Shallow, rapid breathing
- Blurred vision
- Exaggerated sense of feeling good
- Disorientation
- Profuse sweating
- Ringing in ears
- Smell of solvent
- Slippery, sweet taste on the lips
- Dryness of throat
- Chest pains
- Change of heart rate
- Sudden skin irritation
- Loss of manual dexterity
- Loss of coordination
- Weakness in the knees

It should be stated that there must be a Confined Space Entry Team. There are duties and responsibilities of each member in the Confined Space Entry Team.

1. Pit Man: enters the confined space while attached to a rescue line.
2. Observer: responsible for pit man's safety and has a respirator nearby at all times.
3. 2nd Observer: summons help

OSHA requires a written rescue plan including:

- a list of all people at job site
- task each person is doing for the confined space entry
- each participant's duty in the event of rescue
- name and phone numbers for additional help
- maintained by 2nd Observer

Appendix C presents information that will help an employer conduct a training program on confined spaces.

Appendices

1. Appendix A: OSHA 29 CFR Part 1910, Permit Required Confined Spaces
2. Appendix B: State of Michigan Department of Labor Construction Safety Standards Commission, Safety Standards Part 90 Confined Space Entry
3. Appendix C: NIOSH Publication #80-106 (1979), Confined Space Personnel Training Considerations
4. Appendix D: Confined Space Entry Equipment Information
5. All appendices are for informational purposes only
6. Appendix D presents examples of personal protective equipment.

Confined Space Classification Table

Parameters	Class A	Class B	Class C
Characteristics	Immediately dangerous to life - rescue procedures require the entry of more than one individual fully equipped with life support equipment – maintenance of communication requires an additional standby person stationed within the confined space.	Dangerous, but not immediately life threatening – rescue procedures require the entry of no more than individual fully equipped with life support equipment – indirect visual or auditory communication with workers.	Potential hazard – requires no modification of work procedures – standard procedures – direct communication with workers, from outside confined space.
Oxygen	16% or less * (122 mm Hg) or greater than 25% * (190 mm Hg)	16.1% to 19.4% * (122 – 147 mm Hg) or 21.5% to 25% (163 – 190 mm Hg)	19.5% - 21.4% * (148 – 163 mm Hg)
Flammability Characteristics	20% or greater LFL	10% - 19% LFL	10% LFL or less
Toxicity	**IDLH	Greater than contamination level referenced in 29 CFR Part 1910 Sub Part Z – less than **IDLH	Less than contamination referenced in 29 CFR Part 1910 Sub Part Z

* = Based upon a total atmospheric pressure of 760 mm Hg (sea level)
** = Immediately dangerous to Life or Health – as referenced in HIOSH Registry of Toxic and Chemical Substance, Manufacturing Chemists data sheets, industrial hygiene guides or other recognized authorities.

Section 6
Lockout/Tagout Policy
Miscellaneous Safety Policies

LOCKOUT/TAGOUT POLICY

1. **Policy**

   All employees will be protected from injuries caused by **unexpected** energizing or start up of machines or equipment, or release of stored energy during service, repair, maintenance, operation, and associated activities. This policy establishes **minimum** performance requirements for the control of such potentially hazardous conditions. This will be accomplished by locking out and tagging out energy isolating devices, and otherwise disabling machines or equipment to prevent unexpected energizing, start-up or release of stored energy.
   Normal production operations are not covered by this policy. Repairing and/or maintaining equipment during normal production operations are covered by this policy only if:

   A. An employee is required to remove or bypass a guard or other safety device; or
   B. An employee is required to place any part of his or her body into an area on a machine or piece of equipment where work is actually performed upon the material being processed (point of operation) or where an associated danger zone exists during a machine operating cycle.

   This policy does not apply to the following:

   C. Work on cord and plug connected electric equipment for which exposure to the hazards of unexpected energizing or start up of the equipment is controlled by the unplugging of the equipment from the energy source and by the plug being under the exclusive control of the employee performing maintenance or repair.
   D. Hot tap operations involving transmission and distribution systems when they are performed on pressurized pipelines, provided that it has been demonstrated to the Health and Safety Branch (HSB) that (1) continuity of service is essential; (2) shutdown of the system is impractical; (3) documented procedures are followed, and (4) special equipment is used which will provide proven effective protection for employees.

2. **References**

   American National Standards Institute (ANSI) "American National Standard for Personnel Protection - Lockout/Tagout of Energy Sources - Minimum Safety Requirements", Z244.1-1982 New York, N.Y.

   Accident Prevention Manual for Industrial Operations, Engineering and Technology 8th. Ed. Chapters 8 and 15.

   U.S. Department of Labor, OSHA regulations, 29 CFR 1910.147, "Control of hazardous energy sources (lockout/tagout)" standard.

3. **Definitions**
   a. **Affected Employee**: An employee whose job requires him/her to operate or use a machine or equipment on which maintenance or repair is being performed under this lockout/tagout policy, or whose job requires him/her to work in an area in which such maintenance or repair is being performed.

b. **Authorized Individual**: A knowledgeable individual to whom the supervisor has given the authority and responsibility to lock or implement a lockout/tagout procedure on machines or equipment to perform maintenance or repair. An authorized individual and an affected employee may be the same person when the affected employee's duties also include performing maintenance or repair of a machine or equipment which must be locked and tagged out.
c. **Knowledgeable Individual**: An individual who is qualified to operate the controls or equipment and is familiar with the effects of operation.
d. **"Capable of being locked out"**. An energy isolating device will be considered to be capable of being locked out if it has any of the following:
    1. it is designed with a hasp or other attachment or integral part to which, or through which, a lock can be affixed,
    2. it has a locking mechanism built into it, or
    3. if a lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.
e. **Energy Isolating Device**: A mechanical device that physically prevents the transmission or release of energy, including, but not limited to, the following: a manually operated electrical circuit breaker, a disconnect switch, a manually operated switch, a slide gate, a slip blind, spectacle flange, a line valve, blocks, and similar devices with a visible indication of the position of the device. (**Push buttons, selector switches, and other control-circuit type devices are not energy isolating devices.**)
f. **Energy Source**: Any electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy source that could cause injury to personnel.
g. **Hot Tap**: A procedure used in repair and maintenance activities which involves welding on a piece of equipment (pipelines, vessels or tanks) under pressure, in order to install connections or appurtenances. It is commonly used to replace or add sections of pipeline without the interruption of service for air, gas, water and steam distribution systems. Other methods of attachment can also be used.
h. **Lockout Device**: A device that utilizes a lock and key to hold an energy isolating device in the safe position and prevents a machine or equipment from being energized.
i. **Lockout/Tagout**: The placement of a lock and tag on the energy isolating device in accordance with an established procedure, indicating that the energy isolating device shall not be operated until removal of the lock/tag in accordance with an established procedure. (The term "lockout/tagout requires the combination of a lockout device and a tagout device).
j. **Maintenance and Repair**: Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining machines or equipment. These activities include but are not limited to lubrication, cleaning or unjamming of machines or equipment and making adjustments or tool changes, where the employee may be exposed to the **unexpected** start-up of the equipment or release of hazardous energy.
k. **Shall**: The word "shall" always implies a mandatory requirement.
l. **Tagout Device**: A prominent warning device, such as a tag, that can be securely attached to equipment or machinery for the purpose of warning personnel not to operate an energy isolating device and identifying the applier or authority who has control of the procedure.

4. Responsibilities

. **Supervisor (or Acting Supervisor)**
    1. Maintains awareness of all aspects of the NIEHS lockout/tagout policy.
    2. Ensures that all employees under their supervision understand the requirements for compliance with this policy and are made aware of the lockout/tagout procedure and are issued appropriate locks/tags.
    3. Conducts a periodic inspection of the energy control procedure at least annually to ensure that the procedure and the requirements of this policy are being followed.
    4. Certifies that the periodic inspections have been performed.

a. **Employee**

1. Maintains awareness of all aspects of the lockout/tagout policy and complies with all procedures.

b. **Health and Safety Branch (HSB)**

1. Provides necessary employee training for lockout/tagout procedures.
2. Conducts periodic inspections of work sites to ensure compliance with lockout/tagout procedures.
3. Provides guidance regarding the applicability of the lockout/tagout policy.
4. Approves/disapproves exceptions of the lockout/tagout policy.

5. General

. **Lockout/Tagout**

1. Implementation of lockout/tagout shall be performed only by authorized employees.
2. Before any employee performs any maintenance or repair of a machine or equipment where unexpected start up or release of stored energy could occur and cause injury, the machine or equipment shall be isolated, and rendered inoperative.
3. If an energy isolating device is capable of being locked out, then this policy requires that a lockout and tagout be utilized. If an energy isolating device is not capable of being locked out, then a tagout shall be utilized.
4. Whenever major replacement, repair, renovation or modification of machines or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machines or equipment shall be designed to accept a lockout device.
5. The following devices contain high voltage power supplies that can be tagged out, but not locked out:
6. Mass Spectrometers up to 60,000 volts, located in Building 6, Mass Spec Lab.
7. VG12-250 Mass Spectrometer
8. ZAB-4F, Mass Spectrometer
9. Kratos Analytical, Mass Spectrometer

Procedures during repairs on above devices shall include at least two persons. One person shall be at the disconnect area, while the other person performs repair and/or testing.

a. **Energy Control Procedure**

The NIEHS Facilities Engineering Branch (FEB) shall develop, document and utilize procedures to control potentially hazardous energy when employees are engaged in the activities covered by this policy. **Exceptions to this requirement are listed in Appendix 1.** It should be noted that most maintenance and repairs at NIEHS will be covered by one or more of these exceptions.

1. The procedures shall clearly and specifically outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance including, but not limited to the following:
    a. A specific statement of the intended use of the procedure;
    b. Specific procedural steps for shutting down, isolating, blocking and securing machines or equipment to control hazardous energy;
    c. Specific procedural steps for the placement, removal and transfer of lockout devices or tagout devices and the responsibility for them; and
    d. Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures.

b. **Protective Materials and Hardware**

Lockout and tagout devices shall be provided by NIEHS and shall be the only authorized device(s) used for lockout/tagout of energy devices and shall not be used for other purposes. Lockout devices are identified by the word "SAFETY" stamped in red on each device. Each lockout device is to be stamped with the employees name and color coded to indicate type of trade or craft. Each employee will be issued two keys and no two key configurations shall be the same. No one else shall have duplicate keys. Proper tags are shown in Appendix 2.

Tagout devices, including their means of attachment, shall be substantial enough to prevent inadvertent or accidental removal. Attachment means shall be a one-piece, nylon cable tie which shall be non-reusable, self- locking and non-releasable with a minimum unlocking strength of no less than 50 pounds.

c. **Periodic Inspections**
    1. The FEB will conduct a periodic inspection of the energy control procedure at least annually to ensure that the procedures and the requirements of this policy are being followed.
    2. The periodic inspections shall be performed by an authorized FEB employee other than the one(s) utilizing the energy control procedure being inspected. The inspections shall be designed to correct any deviations or inadequacies observed.
    3. Where lockout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected.
    4. The inspector shall certify that the periodic inspections have been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, the employees included in the inspection and the person performing the inspection.
    5. Copies of the inspection report shall be sent to the Chiefs of FEB and HSB.
d. **Training and Communication**
    1. The HSB and FEB will provide joint training to ensure that the purpose and function of the energy control program is understood by employees and that the knowledge and skills required for the safe application, usage, and removal of energy controls are required by employees. The training will include the following:
        . FEB will train each authorized employee in the recognition of hazardous energy sources, the type and magnitude of the energy available in the workplace, and methods and means necessary for energy isolation and control.
        a. The HSB and FEB will jointly instruct each affected employee in the purpose and use of the energy control procedure.
        b. The HSB and FEB shall instruct all other employees whose work operations are or may be in an area where energy control procedures may be utilized, about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment which are locked out or tagged out.
    2. The HSB and FEB will train employees in the limitations of tags when tags are used in lieu of lockout devices.
    3. Retraining will be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment or processes that present a new hazard, or when there is a change in the energy control procedures.
        . Additional retraining shall also be conducted whenever a periodic inspection reveals, or whenever there is reason to believe, that there are

deviations from or inadequacies in the employee's knowledge or use of the energy control procedures.

4. The HSB will certify that employee training has been accomplished and is being kept up to date. The certification shall contain each employee's name and dates of training.

6. Procedures (Appendix 3) (Appendix 4 - presents the Lockout/Tagout steps in brief form)

. **Preplanning for Lockout (Preparation for Shutdown)**

1. An initial survey shall be made to determine which switches, valves, or other energy isolating devices apply to the equipment being locked out. More than one energy source (electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or others) may be involved. Any questionable identification of sources shall be cleared by the employees with their supervisors. Before lockout commences, job authorization should be obtained from the supervisor.
2. Only supervisors or authorized individuals shall prescribe the appropriate duties and responsibilities relating to the actual details of affecting the lockout/tagout. Energy isolating devices shall be operated only by authorized individuals or under the direct supervision of authorized individuals. Where high voltages greater than 480V are involved, the supervisor electrician shall be responsible for turning off the main power controls.
3. All energy isolating devices shall be adequately labeled or marked to indicate their function. The identification shall include the following:
    . equipment supplied
    a. energy type and magnitude
4. Where system complexity requires, a written sequence in checklist form should be prepared for equipment access, lockout/tagout, clearance, release, and start-up.

a. **Lockout/Tagout Procedures (Appendix 3)**

1. **Preparation**. Notify all affected employees that a lockout is required and the reason therefore.
2. **Machine or Equipment Shutdown**. If the equipment is operating, shut it down by the normal stopping procedure (depress stop button, open toggle switch, etc.). Disconnect switches should never be pulled while under load, because of the possibility of arcing or even explosion. Personnel knowledgeable of equipment operation should be involved with shut down or re-start procedures.
3. **Machine or Equipment Isolation**. Operate the switch, valve, or other energy isolating device so that the energy source(s) (electrical, mechanical, hydraulic, etc.) is(are) disconnected or isolated from the equipment. Stored energy, such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc., must also be dissipated, disconnected, or restrained by methods such as grounding, repositioning, blocking, bleeding-down, etc. Pulling fuses is not a substitute for locking out. A yanked fuse is no guarantee the circuit is dead, and even if it were dead, there's nothing to stop someone from unthinkingly replacing the fuse.

   CAUTION: Intermittently operating equipment such as pumps, blowers, fans, and compressors may seem harmless when dormant. Don't assume that because equipment isn't functioning, it will stay that way.

4. **Application of Lockout/Tagout**. Lockout and tag the energy isolating device with an assigned individual lock, even though someone may have locked the control before you. You will not be protected unless you put your own padlock on it. For some equipment it may be necessary to construct attachments to which locks can be applied. An example is a common hasp to cover an operating button. Tags shall be attached to the energy isolating device(s) and to the normal

operating control and shall be attached in such a manner as to preclude operation.

5. **Verification of Isolation**. After ensuring that no personnel can be exposed and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate.

   If there is a possibility of reaccumulation of stored energy to a hazardous level, verification of isolation shall be continued until the maintenance or repair is completed, or until the possibility of such accumulation no longer exists.

   CAUTION: Return operating controls to neutral position after the test. A check of system activation (e.g. use of voltmeter for electrical circuits) should be performed to assure isolation.

6. The equipment is now locked out.

b. **Release from Lockout/Tagout**
   1. Before lockout or tagout devices are removed and energy is restored to the machine or equipment, inspect the work area to ensure that nonessential items have been removed and to ensure that machine or equipment components are operationally intact.
   2. Check work area to ensure that all employees are in the clear.
   3. Notify affected employees that lockout/tagout devices have been removed.
   4. Each lockout/tagout device shall be removed from each energy isolating device by the employee who applied the device. The energy isolating devices may be opened or closed, i.e., circuit breakers, to restore energy to equipment.

c. **Lockout/Tagout Interruption (Testing of Energized Equipment)**

   In situations where the energy isolating device(s) is locked/tagged and there is a need for testing or positioning of the equipment/process, the following sequence shall apply:

   1. Clear equipment/process of tools and materials.
   2. Clear personnel.
   3. Clear the control of locks/tags according to established procedure.
   4. Proceed with test, etc.
   5. De-energize all systems and re-lock/re-tag the controls to continue the work.

d. **Outside Personnel (Contractors, etc.)**
   1. Whenever outside service personnel are to be engaged in activities covered by the scope and application of this policy the NIEHS and **all** contractors (including on-site contractors) shall inform each other of their respective lockout or tagout procedures.
   2. The NIEHS shall ensure that NIEHS personnel understand and comply with the restrictions and prohibitions of any contractor's energy control procedures. Contractors shall ensure that their personnel do likewise for NIEHS' policies as well as other contractor's policies.

e. **Procedure Involving More Than One Person**

   In the preceding steps, if more than one individual is required to lock out equipment, each shall place a personal lock and tag on the group lockout device when he/she begins work, and shall remove those devices when he/she stops working on the machine or equipment. The supervisor, with the knowledge of the crew, may lock out equipment for the whole crew. In such cases, it shall be the responsibility of the supervisor to carry out all steps of the lockout procedure and inform the crew when it is safe to work on the equipment. Additionally, the supervisor shall not remove a crew lock until it has been verified that all individuals are clear.

f. **Shift Change Coordination**

Supervisors shall ensure the continuity of lockout/tagout protection during shift or personnel changes. Each worker shall be responsible for removing his own padlock and tag at the completion of his shift. If work is to cease until the following day the supervisor shall place his personal padlock and tag on the equipment and the workers shall remove their padlocks and tags. When work resumes the workers shall affix his personal lock and tag to the equipment and the supervisor shall remove his lock and tag.

g. **Conditions for Padlock Removal by the General Foreman or Chief, FEB**

Lockout/tagout devices shall be removed only by the owner of the device except in the following situations:

1. Owner incapacitated by illness, etc.
2. Owner no longer works for NIEHS
3. Owner is on flex or leave and cannot be reached by telephone. If the owner is reached and the situation warrants then he/she will be required to come to work and remove the padlock.

If the General Foreman or Chief, FEB determines that circumstances warrant the removal of a lockout/tagout device, every effort must be made to contact the owner of the device. After the above conditions have been met the General Foreman or Chief, FEB may remove the device in the presence of a member of the HSB. A padlock shall not be cut but may be removed by changing the core of the lock.

7. APPENDIX 1

8. **EXCEPTION:** It is not necessary to document the required procedure for a particular machine or equipment, when all of the following elements exist:
   . the machine or equipment has no potential for stored or residual energy or reaccumulation of stored energy after shut down which could endanger employees;
   a. the machine or equipment has a single energy source which can be readily identified and isolated;
   b. the isolation and locking out of that energy source will completely de-energize and deactivate the machine or equipment;
   c. the machine or equipment is isolated from that energy source and locked out during servicing or maintenance;
   d. a single lockout device will achieve a locked-out condition;
   e. the lockout device is under the exclusive control of the authorized employee performing the servicing or maintenance;
   f. the servicing or maintenance does not create hazards for other employees; and
   g. the NIEHS, in utilizing this exception, has had no accidents involving the unexpected activation or start-up of the machine or equipment during maintenance or repair activities.

APPENDIX 3

The established procedure for the application of lockout/tagout shall cover the following elements and actions and shall be done in the following sequence.

h. **Preparation for shutdown.** Before an authorized or affected employee turns off a machine or equipment, the authorized employee shall have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

i. **Machine or equipment shutdown.** The machine or equipment shall be turned off or shut down using the procedures required by this standard. An orderly shutdown must be utilized to avoid any additional or increased hazards(s) to employees as a result of equipment de-energization.
j. **Machine or equipment isolation.** All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s).
k. **Lockout or tagout device application.**
l. **Stored energy.** Following the application of lockout or tagout devices to energy isolating devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, and otherwise rendered safe.

   If there is a possibility of reaccumulation of stored energy to a hazardous level, verification of isolation shall be continued until the servicing or maintenance is completed, or until the possibility of such accumulation no longer exists.

m. **Verification of Isolation.** Prior to starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and de-energization of the machine or equipment have been accomplished.
n. **Release from lockout or tagout.**

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Section 7
OSHA Occupational Noise Exposure Rules

Occupational noise exposure. - 1910.95

Regulations (Standards - 29 CFR) - Table of Contents

• Part Number:	1910
• Part Title:	Occupational Safety and Health Standards
• Subpart:	G
• Subpart Title:	Occupational Health and Environment Control
• Standard Number:	1910.95
• Title:	Occupational noise exposure.
• Appendix:	A , B , C , D , E , F , G , H , I

1910.95(a)

Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:

FIGURE G-9 - Equivalent A-Weighted Sound Level
(For Figure G-9, Click Here)

Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table 1.G-16.

1910.95(b)

1910.95(b)(1)

When employees are subjected to sound exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

1910.95(b)(2)

If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

TABLE G-16 - PERMISSIBLE NOISE EXPOSURES (1)

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Footnote (1) When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C (1)/T (1) + C (2)/T (2) C (n)/T (n) exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

.1910.95(c)

1910.95(c)

"Hearing conservation program."

1910.95(c)(1)

The employer shall administer a continuing, effective hearing conservation program, as described in paragraphs (c) through (o) of this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent. For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with appendix A and Table G-16a, and without regard to any attenuation provided by the use of personal protective equipment.

1910.95(c)(2)

For purposes of paragraphs (c) through (n) of this section, an 8-hour time-weighted average of 85 decibels or a dose of fifty percent shall also be referred to as the action level.

1910.95(d)

"Monitoring."

1910.95(d)(1)

When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the employer shall develop and implement a monitoring program.

1910.95(d)(1)(i)

The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protectors.

1910.95(d)(1)(ii)

Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, the employer shall use representative personal sampling to comply with the monitoring requirements of this paragraph unless the employer can show that area sampling produces equivalent results.

..1910.95(d)(2)

1910.95(d)(2)

1910.95(d)(2)(i)

All continuous, intermittent and impulsive sound levels from 80 decibels to 130 decibels shall be integrated into the noise measurements.

1910.95(d)(2)(ii)

Instruments used to measure employee noise exposure shall be calibrated to ensure measurement accuracy.

1910.95(d)(3)

Monitoring shall be repeated whenever a change in production, process, equipment or controls increases noise exposures to the extent that:

1910.95(d)(3)(i)

Additional employees may be exposed at or above the action level; or

1910.95(d)(3)(ii)

The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of paragraph (j) of this section.

1910.95(e)

"Employee notification." The employer shall notify each employee exposed at or above an 8-hour time-weighted average of 85 decibels of the results of the monitoring.

1910.95(f)

"Observation of monitoring." The employer shall provide affected employees or their representatives with an opportunity to observe any noise measurements conducted pursuant to this section.

..1910.95(g)

1910.95(g)

"Audiometric testing program."

1910.95(g)(1)

The employer shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels.

1910.95(g)(2)

The program shall be provided at no cost to employees.

1910.95(g)(3)

Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation, or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and checking calibration and proper functioning of the audiometers being used. A technician who operates microprocessor audiometers does not need to be certified. A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist or physician.

1910.95(g)(4)

All audiograms obtained pursuant to this section shall meet the requirements of Appendix C: "Audiometric Measuring Instruments."

1910.95(g)(5)

"Baseline audiogram."

1910.95(g)(5)(i)

Within 6 months of an employee's first exposure at or above the action level, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared.

..1910.95(g)(5)(ii)

1910.95(g)(5)(ii)

"Mobile test van exception." Where mobile test vans are used to meet the audiometric testing obligation, the employer shall obtain a valid baseline audiogram within 1 year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than 6 months after the employee's first exposure at or above the action level, employees shall wearing hearing protectors for any period exceeding six months after first exposure until the baseline audiogram is obtained.

1910.95(g)(5)(iii)

Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise.

1910.95(g)(5)(iv)

The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

1910.95(g)(6)

"Annual audiogram." At least annually after obtaining the baseline audiogram, the employer shall obtain a new audiogram for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

1910.95(g)(7)

"Evaluation of audiogram."

1910.95(g)(7)(i)

Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift as defined in paragraph (g)(10) of this section has occurred. This comparison may be done by a technician.

..1910.95(g)(7)(ii)

1910.95(g)(7)(ii)

If the annual audiogram shows that an employee has suffered a standard threshold shift, the employer may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

1910.95(g)(7)(iii)

The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:

1910.95(g)(7)(iii)(A)

A copy of the requirements for hearing conservation as set forth in paragraphs (c) through (n) of this section;

1910.95(g)(7)(iii)(B)

The baseline audiogram and most recent audiogram of the employee to be evaluated;

1910.95(g)(7)(iii)(C)

Measurements of background sound pressure levels in the audiometric test room as required in Appendix D: Audiometric Test Rooms.

1910.95(g)(7)(iii)(D)

Records of audiometer calibrations required by paragraph (h)(5) of this section.

..1910.95(g)(8)

1910.95(g)(8)

"Follow-up procedures."

1910.95(g)(8)(i)

If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in paragraph (g)(10) of this section has occurred, the employee shall be informed of this fact in writing, within 21 days of the determination.

1910.95(g)(8)(ii)

Unless a physician determines that the standard threshold shift is not work related or aggravated by occupational noise exposure, the employer shall ensure that the following steps are taken when a standard threshold shift occurs:

1910.95(g)(8)(ii)(A)

Employees not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.

1910.95(g)(8)(ii)(B)

Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

1910.95(g)(8)(ii)(C)

The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

1910.95(g)(8)(ii)(D)

The employee is informed of the need for an otological examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.

..1910.95(g)(8)(iii)

1910.95(g)(8)(iii)

If subsequent audiometric testing of an employee whose exposure to noise is less than an 8-hour TWA of 90 decibels indicates that a standard threshold shift is not persistent, the employer:

1910.95(g)(8)(iii)(A)

Shall inform the employee of the new audiometric interpretation; and

1910.95(g)(8)(iii)(B)

May discontinue the required use of hearing protectors for that employee.

1910.95(g)(9)

"Revised baseline." An annual audiogram may be substituted for the baseline audiogram when, in the judgment of the audiologist, otolaryngologist or physician who is evaluating the audiogram:

1910.95(g)(9)(i)

The standard threshold shift revealed by the audiogram is persistent; or

1910.95(g)(9)(ii)

The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

1910.95(g)(10)

"Standard threshold shift."

1910.95(g)(10)(i)

As used in this section, a standard threshold shift is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

..1910.95(g)(10)(ii)

1910.95(g)(10)(ii)

In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram according to the procedure described in Appendix F: "Calculation and Application of Age Correction to Audiograms."

1910.95(h)

"Audiometric test requirements."

1910.95(h)(1)

Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

1910.95(h)(2)

Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that meet the specifications of, and are maintained and used in accordance with, American National Standard Specification for Audiometers, S3.6-1969, which is incorporated by reference as specified in Sec. 1910.6.

1910.95(h)(3)

Pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Appendix C: "Audiometric Measuring Instruments."

1910.95(h)(4)

Audiometric examinations shall be administered in a room meeting the requirements listed in Appendix D: "Audiometric Test Rooms."

..1910.95(h)(5)

1910.95(h)(5)

"Audiometer calibration."

1910.95(h)(5)(i)

The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 decibels or greater require an acoustic calibration.

1910.95(h)(5)(ii)

Audiometer calibration shall be checked acoustically at least annually in accordance with Appendix E: "Acoustic Calibration of Audiometers." Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviations of 15 decibels or greater require an exhaustive calibration.

1910.95(h)(5)(iii)

An exhaustive calibration shall be performed at least every two years in accordance with sections 4.1.2; 4.1.3.; 4.1.4.3; 4.2; 4.4.1; 4.4.2; 4.4.3; and 4.5 of the American National Standard Specification for Audiometers, S3.6-1969. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

1910.95(i)

"Hearing protectors."

1910.95(i)(1)

Employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees. Hearing protectors shall be replaced as necessary.

1910.95(i)(2)

Employers shall ensure that hearing protectors are worn:

1910.95(i)(2)(i)

By an employee who is required by paragraph (b)(1) of this section to wear personal protective equipment; and

..1910.95(i)(2)(ii)

1910.95(i)(2)(ii)

By any employee who is exposed to an 8-hour time-weighted average of 85 decibels or greater, and who:

1910.95(i)(2)(ii)(A)

Has not yet had a baseline audiogram established pursuant to paragraph (g)(5)(ii); or

1910.95(i)(2)(ii)(B)

Has experienced a standard threshold shift.

1910.95(i)(3)

Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by the employer.

1910.95(i)(4)

The employer shall provide training in the use and care of all hearing protectors provided to employees.

1910.95(i)(5)

The employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

1910.95(j)

"Hearing protector attenuation."

1910.95(j)(1)

The employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The employer shall use one of the evaluation methods described in Appendix B: "Methods for Estimating the Adequacy of Hearing Protection Attenuation."

..1910.95(j)(2)

1910.95(j)(2)

Hearing protectors must attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by paragraph (b) of this section.

1910.95(j)(3)

For employees who have experienced a standard threshold shift, hearing protectors must attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or below.

1910.95(j)(4)

The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided may no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary.

1910.95(k)

"Training program."

1910.95(k)(1)

The employer shall institute a training program for all employees who are exposed to noise at or above an 8-hour time-weighted average of 85 decibels, and shall ensure employee participation in such program.

1910.95(k)(2)

The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated to be consistent with changes in protective equipment and work processes.

1910.95(k)(3)

The employer shall ensure that each employee is informed of the following:

..1910.95(k)(3)(i)

1910.95(k)(3)(i)

The effects of noise on hearing;

1910.95(k)(3)(ii)

The purpose of hearing protectors, the advantages, disadvantages, and attenuation of various types, and instructions on selection, fitting, use, and care; and

1910.95(k)(3)(iii)

The purpose of audiometric testing, and an explanation of the test procedures.

1910.95(l)

"Access to information and training materials."

1910.95(l)(1)

The employer shall make available to affected employees or their representatives copies of this standard and shall also post a copy in the workplace.

1910.95(l)(2)

The employer shall provide to affected employees any informational materials pertaining to the standard that are supplied to the employer by the Assistant Secretary.

1910.95(l)(3)

The employer shall provide, upon request, all materials related to the employer's training and education program pertaining to this standard to the Assistant Secretary and the Director.

..1910.95(m)

1910.95(m)

"Record keeping" –

1910.95(m)(1)

"Exposure measurements." The employer shall maintain an accurate record of all employee exposure measurements required by paragraph (d) of this section.

1910.95(m)(2)

"Audiometric tests."

1910.95(m)(2)(i)

The employer shall retain all employee audiometric test records obtained pursuant to paragraph (g) of this section:

1910.95(m)(2)(ii)

This record shall include:

1910.95(m)(2)(ii)(A)

Name and job classification of the employee;

1910.95(m)(2)(ii)(B)

Date of the audiogram;

1910.95(m)(2)(ii)(C)

The examiner's name;

1910.95(m)(2)(ii)(D)

Date of the last acoustic or exhaustive calibration of the audiometer; and

1910.95(m)(2)(ii)(E)

Employee's most recent noise exposure assessment.

1910.95(m)(2)(ii)(F)

The employer shall maintain accurate records of the measurements of the background sound pressure levels in audiometric test rooms.

1910.95(m)(3)

"Record retention." The employer shall retain records required in this paragraph (m) for at least the following periods.

..1910.95(m)(3)(i)

1910.95(m)(3)(i)

Noise exposure measurement records shall be retained for two years.

1910.95(m)(3)(ii)

Audiometric test records shall be retained for the duration of the affected employee's employment.

1910.95(m)(4)

"Access to records." All records required by this section shall be provided upon request to employees, former employees, representatives designated by the individual employee, and the Assistant Secretary. The provisions of 29 CFR 1910.20 (a)-(e) and (g)-

1910.95(m)(4)(i)

apply to access to records under this section.

1910.95(m)(5)

"Transfer of records." If the employer ceases to do business, the employer shall transfer to the successor employer all records required to be maintained by this section, and the successor employer shall retain them for the remainder of the period prescribed in paragraph (m)(3) of this section.

1910.95(n)

"Appendices."

1910.95(n)(1)

Appendices A, B, C, D, and E to this section are incorporated as part of this section and the contents of these appendices are mandatory.

..1910.95(n)(2)

1910.95(n)(2)

Appendices F and G to this section are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

1910.95(o)

"Exemptions." Paragraphs (c) through (n) of this section shall not apply to employers engaged in oil and gas well drilling and servicing operations.

1910.95(p)

"Startup date." Baseline audiograms required by paragraph (g) of this section shall be completed by March 1, 1984.
[39 FR 23502, June 27, 1974, as amended at 46 FR 4161, Jan. 16, 1981; 46 FR 62845, Dec. 29, 1981; 48 FR 9776, Mar. 8, 1983; 48 FR 29687, June 28, 1983; 54 FR 24333, June 7, 1989; 61 FR 5507, Feb. 13, 1996; 61 FR 9227, March 7, 1996]

Section 8
OSHA Hearing Conservation Information

Below is a link to the revised OSHA publication address hearing conservation

http://www.osha.gov/Publications/osha3074.pdf

Section 9
OSHA Fall Prevention Guidelines

Fall Prevention Guidelines

1. All fall protection equipment shall meet or exceed the appropriate **American National Standards Institute (ANSI)** standard.

2. Ladders, walkways, work platforms, and open-sided floors shall comply with Occupational Safety and Health Administration (OSHA) regulations or fall protection must be used.

3. All personnel exposed to a potential free fall > six feet must receive fall protection training.

4. Safety approved aerial lifts may be used for working at heights, however, all operators must wear approved fall protection and be secured by a lanyard when the working height is six feet or higher.

5. Lanyards must be attached to prevent a free fall of six feet.

6. Approved attached points shall be established and marked in areas where lifelines and lanyards are used regularly. Lifeline attach points shall be capable of supporting a load of 5,400 pounds.

7. All fall protection equipment shall be visually inspected for defects prior to each use. If there is evidence of excessive equipment wear or deterioration or if mechanical malfunction is detected, the item shall be removed from service.

8. Fall protection equipment and assemblies shall be inspected according to the manufacturer's recommendations. Each belt and lanyard shall bear manufacturer identification marks.

9. Safety belts or lanyards that have been subjected to an impact load shall be destroyed. Load testing shall not be performed on fall protection equipment.

10. Personnel requiring the use of fall protection equipment shall employ the "Buddy System" or have an observer to render assistance when and if required. A trained observer must be present when personnel are performing work involving confined space entry.

Fall Protection Equipment

Introduction

Before you can begin a fall protection program, you must identify the potential fall hazards in your workplace. Any time a worker is at a height of six feet or more, the worker is at risk and needs to be protected. The two ways of accomplishing this are: **engineering controls** and fall protection equipment. Engineering controls can be as simple as moving the work to ground level and eliminating the work height. Or they can mean the addition of platforms, railings and toe boards to provide permanent, secure access to high maintenance areas and devices. The number of engineering controls is extensive, so contact your plant engineering or maintenance department for further assistance. When engineering controls are not feasible or practical, such as construction or maintenance projects, a personal fall protection system is employed to prevent injuries from falls.

Fall Protection Systems

Fall protection systems can consist of devices that arrest a free fall or devices that restrain a worker in position to prevent a fall from occurring. A **fall arrest system** (**see Figures A, B and C**) is employed when a worker is at risk of falling from an elevated position. A **positioning system** (**see Figure D**) restrains the elevated worker, preventing him from getting into a hazardous position where a fall could occur, and also allows hands-free work. Both systems have three components: harnesses or belts, connection devices and tie-off points.

Harnesses and Belts

Full-body harnesses wrap around the waist, shoulders and legs (**see Figures A, B and C**). A D-ring located in the center of the back provides a connecting point for lanyards or other fall arrest connection devices. In the event of a fall, a full-body harness distributes the force of the impact throughout the trunk of the body—not just in the abdominal area. This allows the pelvis and shoulders to help absorb the shock, reducing the impact to the abdominal area.

Maximum force arrest on a full-body harness, which is used for the most severe free fall hazards, is 1800 pounds. Full-body harnesses come with optional side, front and shoulder D-rings. The side and front D-rings are connection points used for work positioning, and the shoulder D-rings are for retrieval from confined spaces.

Three factors determine the arresting force from a fall: lanyard material type, free fall distance and the weight of the worker. The use of a shock-absorbing lanyard or a higher tie-off point will reduce the impact force.

Belts are used in positioning system applications. These belts have two side D-rings, and are used only for restraining a worker in position. This type of belt is not used for any vertical free fall protection *(see Figure D)*.

IMPORTANT NOTE: ANY EQUIPMENT EXPOSED TO A FALL MUST BE TAKEN OUT OF SERVICE AND NOT USED AGAIN FOR FALL PROTECTION.

Connection Devices

Connection devices attach the belt or harness to the final tie-off point. This can be one device, such as a lanyard, or a combination of devices, such as lanyards, lifelines, work lines, rope grabs, tie-off straps and carabineers.

Lanyards are used both to restrain workers in position, and to arrest falls. When using a lanyard as a restraining device, the length is kept as short as possible (**see Figure D**), as a restraining lanyard should not allow a worker to fall more than two feet. Restraining lanyards are available in a variety of materials, including steel cables, rebar chain assemblies and nylon rope. Fall protection lanyards (**see Figures A and C**) can be made of steel, nylon rope, or nylon or Dacron webbing.

Fall protection lanyards may also have a shock-absorbing feature built in, thus reducing the potential fall arrest force. Remember that maximum arrest force is 900 pounds for belts, or 1800 pounds for full-body harnesses. With a belt, the use of a shock-absorbing lanyard is recommended because it limits the arresting force from a six-foot drop to 830 pounds. If a shock-absorbing lanyard is not used, the tie-off point must be high enough to limit the arrest force to less than the 900-pound limit. The height of this tie-off point will vary, depending on the lanyard material and the weight of the person involved. A lanyard used for a fall is limited to allow a maximum six-foot free fall. For this reason, most lanyards are a maximum of six feet long. However, if a higher tie-off point is used, the lanyard can be longer if the free fall distance does not exceed 6 feet.

Lifelines add versatility to the fall arrest system. When used in conjunction with **rope grabs** (**see Figure C**), a lifeline allows the worker to move along the length of the line rather than having to disconnect and find a new tie-off point. The rope grab is engineered to arrest a fall instantly. A rope grab and lifeline system is a passive form of protection, allowing the user to move as long as tension is slack on the lifeline. If a fall occurs, the tension on the rope grab triggers the internal mechanism to arrest the fall. **Retractable lifelines** (**see Figure B**) automatically retract any slack line between the worker and the tie-off point. While this type of line doesn't require a rope grab, it must be kept directly above the worker to eliminate any potential swing hazard if the worker falls.

A **cross-arm strap** (**see Figure A**) is used at a tie-off point with a large diameter, such as an I-beam, to which a lanyard or lifeline cannot directly attach. Using a cross-arm strap ensures the lanyard or lifeline doesn't become abraded from wrapping around the I-beam. A carabineer (**see Figure D**) works in the same situations. It is used for tie-off points with a diameter of one to five inches, and then the lanyard is attached to the carabineer.

Tie-Off Points

A **tie-off point** (**see Figures A, B, C and D**) is where the lanyard or lifeline is attached to a structural support. This support must have a 5000-pound capacity for each worker tying off. Workers must always tie off at or above the D-ring point of the belt or harness. This ensures that the free fall is minimized, and that the lanyard doesn't interfere with personal movement. Workers must also tie off in a manner that ensures no lower level will be struck during a fall. To do this, add the height of the worker, the lanyard length, and an elongation factor of 3.5 feet. Using this formula, a six-foot tall worker requires a tie-off point at least 15.5 feet above the next lower level.

Other Devices

For confined space applications, a **tripod and winch system** is used as both the tie-off point and connection device. It is used in conjunction with a full-body harness to lower and raise workers into tanks or manholes. Make sure that the tripod system you choose is designed for your application. Never **use a material-handling device for personnel** unless it is specifically designed to do so.

Ladder systems are lifelines attached directly to a ladder. The systems consist of a cable or channel, with a grabbing device attached for a connection point.

Inspection and Maintenance

New OSHA regulations require that all fall arrest equipment be inspected prior to its use. This includes looking for frays or broken strands in lanyards, belts and lifelines, and oxidation or distortion of any metal connection devices. To properly maintain the devices, periodic cleaning is necessary. Clean all surfaces with a mild detergent soap, and always let the equipment air dry away from excess heat. Follow the manufacturer's instructions for cleaning and maintenance.

IMPORTANT NOTE: ANY EQUIPMENT EXPOSED TO A FALL MUST BE TAKEN OUT OF SERVICE AND NOT USED AGAIN FOR FALL PROTECTION.

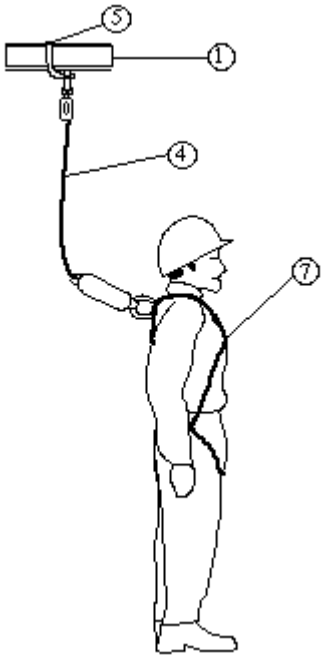
Product Reference

Lab Safety Supply has the products you need to keep your workers safe and comply with current regulations. Please refer to the Confined Space, Fall Protection and Ladders sections of your **Lab Safety Supply** General Safety Catalog for details.

Sources for More Information

Federal Register, Vol. 59, No. 152, August 9, 1994, pp. 40672–40753.
29 CFR 1910 Subpart F, Powered Platforms, Man lifts, and Vehicle-Mounted Platforms
29 CFR 1910 Subpart D, Walking-Working Surfaces
29 CFR 1926 Subpart M, Floor and Wall Openings
29 CFR 1926 Subpart X, Stairways and Ladders
29 CFR 1926.104, Safety Belts, Lifelines and Lanyards
29 CFR 1926.105, Safety Nets
29 CFR 1926.451, Scaffolding
ANSI A10.14-1991, Standard for Construction and Demolition Operations—Requirements for Safety Belts, Harnesses, Lanyards and Lifelines for Construction and Demolition Use.
ANSI Z359.1-1992, Standard for Personal Arrest Systems, Subsystems and Components.

Figure A



1. Tie-off Point
2. Lifeline
3. Rope Grab
4. Shock-Absorbing Lanyard
5. Cross-Arm Strap
6. Retractable Lifeline
7. Full-Body Harness
8. Restraining Belt
9. Restraining Lanyard
10. Carabineer

Figure B

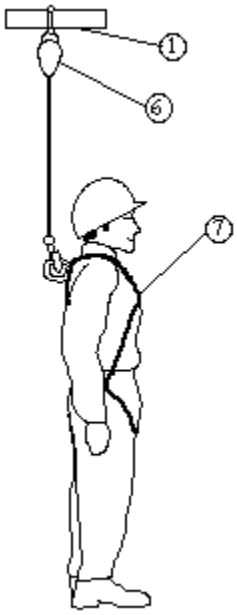


Figure C

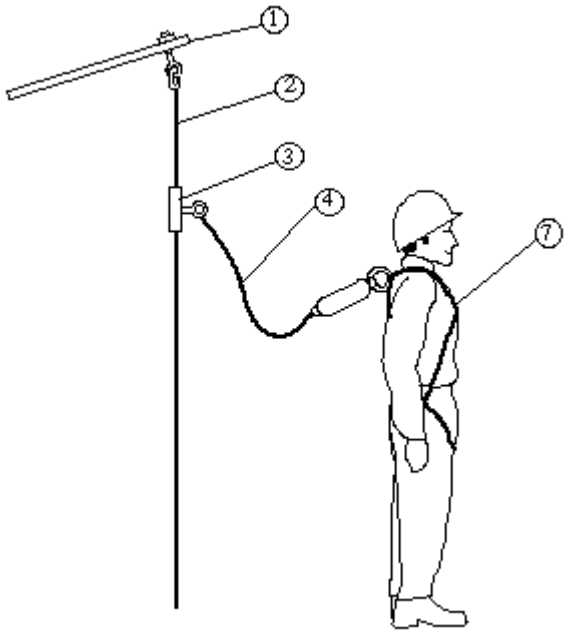
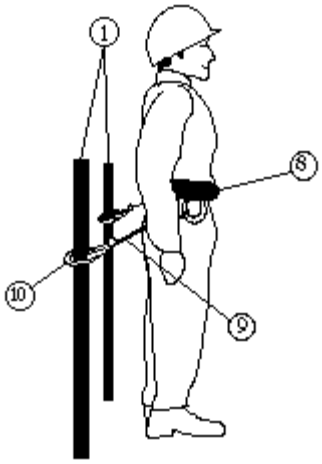


Figure D



Section 10
Links to Health and Safety Sites

Polyurea Chemicals:

- www.osha.gov/comp-links.html
- www.mmm.com/occsafety/
- www.huntsman.com/index.cfm?PageID=824
- www.polyurethane.org/safe_handling/index.html
- www.sprayfoam.org
- www.baycareonline.com/index2.html

Personal Protective Gear:

- www.3m.com/market/safety/ohes2/index.html
- www.allegrosafety.com/catagories
- www.safecoinc.com/framecontent.asp
- www.spill911.com

Coatings Testing Instruments:

- www.elcometer.com
- www.bykgardner.com

Safety and Health Guidelines Test

Section 1:

What are the hazards associated with processing Isocyanate reactive spray elastomers:
A - Inhalation route of isocyanate exposure
B - Trans-dermal or through skin
C - Corrosive and can cause skin irritation and chemical burns
D - All of the above

What are Isocyanates?
A - Vary reactive family of chemicals, some with high vapor pressures. Characterized by having at least one (-N=C=O) isocyanate group.
B - The ice that grows in your freezer.
C - A Chemical used to kill nats.
D - All of the above.

What are the OSHA exposure limits of Isocyanates?
A - 2.02 ppm ceiling
B - 0.02 ppm ceiling
C - 10.02 ppm ceiling
D - 1.50 ppm ceiling

Effects of isocyanate exposure:
A - Asthma-like symptoms
B - Chest tightness upon respiration
C - Shortness of breath, Wheezing and coughing
D - All of the above.

What are the two types of respirators that are approved for use when working with isocyanates?

_____
_____

What is occupational asthma?
A - Asthma that is caused by breathing in specific agents
in the workplace.
B - Something you get when looking for a job.
C - A disease you can catch from a co-worker that has asthma.

What is the abnormal response, called that develops after variable periods of Workplace exposure to certain dusts, fumes or vapours.
A - Insanity
B - Responsibility
C - Stupidity
D - Sensitization

Safety and Health Guidelines Test

Section 2:

Asthma is triggered in several ways and most of them are not completely understood. For simplicity, we categorize them into two groups. They are?
1 - _____
2 - _____

How long does asthma take to develop?
A - **Immediate** - typically develops within minutes of exposure and is at its worst after approximately 20 minutes; recovery takes about 2 hours.
B - **Late** - can occur in different forms. It usually starts several hours after exposure and is at its worst after about 4 to 8 hours with recovery within 24 hours. However, it can start 1 hour after exposure with recovery in 3 to 4 hours. In some cases, it may start at night, with a tendency to recur at the same time for a few nights following a single exposure.
C - **Dual or Combined** - is the occurrence of both immediate and late types of asthma.
D - All of the above.

How can we control occupational asthma?
A - Wear dust masks and respirators.
B - Wear protective eyewear & clothing.
C - A controlled workplace.
D - All of the above.

Choose the 3 most important things you need when in a spray area:
A - Full faced supplied air respirator for spraying and half mask respirator when using support chemicals (acrtone, NMP, DMP, DOP).
B - Bubble gum.
C - Protective spray suit.
D - Protective gloves.

List 5 occupations you can get occupational asthma from:
1 - _____
2 - _____
3 - _____
4 - _____
5 - _____

Student's Signature: _____ Initial _____

Testing Date: _____

Testing Supervisor's Signature: _____ Initial _____

Shop Equipment Guidelines

DUST MASKS MUST BE WORN:
When you are sanding or in the area where someone is sanding a vehicle.
(Example if someone is inside a truck be sanding and you are standing by the truck bed leaning on the bed rail you MUST wear a dust mask.

CHARCOAL RESPIRATORS (HALF OR FULLFACED) MUST BE WORN:
When working with any support chemicals (DOP,NMP,DPM,CU-6,ACETONE Ect.)
Under no circumstances should a charcoal (PAPR's are ok because you can test them and know that they are flowing air properly) respirator be worn inside the spray area unless the equipment is not in operation. You must always where these when pouring these chemicals. NO EXCEPTIONS!

FRESH AIR SYSTEMS W/ FULLFACED MASK MUST BE WORN:
When equipment is in operation spraying or when you are in the spray area observing.
NO EXCEPTIONS!

PAPR (PERSONEL AIR POWERED RESPIRATOR) MUST BE USED WHEN:
When equipment is in operation spraying or when you are in the spray area observing.

RUBBER GLOVES MUST BE WORN:
When you are handling all chemicals, cleaning equipment or when spraying.
NO EXCEPTIONS!

SPRAY SUITS MUST BE WORN:
When you are spraying or in the spray area, the spray hood is also required.
NO EXCEPTIONS!

Remember all chemicals can and will penetrate you skin through contact. It is necessary that you protect yourself at all times when using any isocyanates or chemicals.
These guidelines MUST be followed NO EXCEPTIONS!!!

If you choose not to follow these guidelines you will be terminated on the spot.
These guidelines are for your safety. Respiratory and personal safety is no laughing matter. You must take care of yourself at all times.

Student's Signature: _____ Initial _____

Testing Date: _____

Testing Supervisor's Signature: _____ Initial _____

Helping make the coatings industry A better and safer place to work.

Prepared by: Mark Pfaff
Turbo Liner Inc.