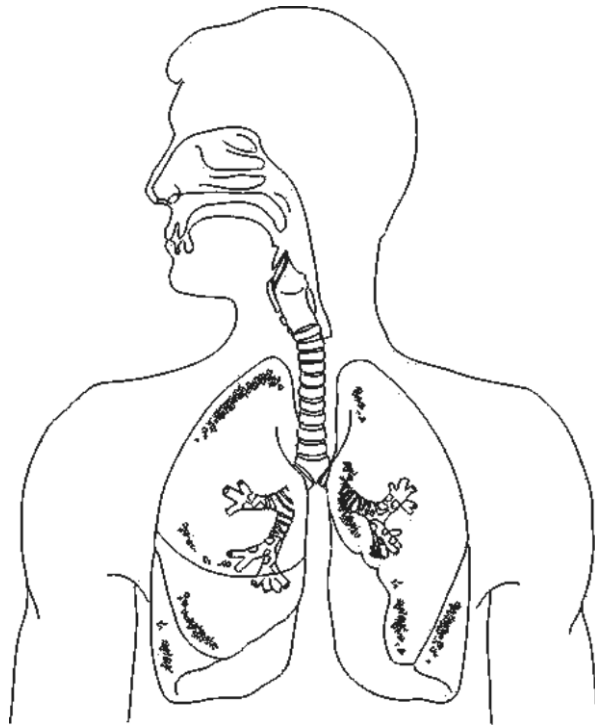


MICHIGAN STATE UNIVERSITY  
RESPIRATORY PROTECTION PROGRAM



Environmental Health & Safety

Engineering Research Complex  
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## I. INTRODUCTION

The purpose of this program is to ensure the protection of all employees from respiratory hazards through the proper use of respirators. Respirators are to be used only when engineering controls (e.g. enclosure or confinement of the operation, ventilation or substitution of less toxic materials) are not feasible, while engineering controls are being installed or repaired, or in emergencies. When respirators are to be used, all requirements of this document shall be met.

## II. RESPONSIBILITIES

### A. Michigan State University

Michigan State University shall provide the proper respirators when such equipment is necessary to protect the health and safety of the employee. The University shall be responsible for the establishment of a respirator protection program in accordance with Title 29, Code of Federal Regulations, OSHA 1910.134 and The State of Michigan, Department of Consumer and Industry Services, Occupational Health Standards for General Industry, Rule 3502.

### B. Environmental Health & Safety

Environmental Health & Safety (EHS) is responsible for the development, documentation, and administration of the Michigan State University respirator program. The Occupational Safety Officer shall serve as the Respirator Program Administrator. EHS shall:

1. Develop a written standard operating procedure document.
2. Evaluate respiratory hazards in the work environment.
3. Provide guidance to campus units for the selection and purchase of approved respirators.
4. Provide instruction to campus units on the proper use, maintenance, and storage of respirator equipment.
5. Provide a fit testing program for respirator wearers.
6. Maintain fit testing, initial training and retraining records.
7. Evaluate the overall effectiveness of the respirator program.

### C. Olin Health Center

MSU Occupational Health at Olin Health Center shall be responsible for the development and implementation of the medical surveillance program for personnel identified as respirator users. This program includes medical criteria and a medical questionnaire to identify those individuals who are fit to wear a respirator. The program shall also include a periodic review by MSU Occupational Health to evaluate the overall effectiveness of the respirator program in preventing adverse health effects.



#### **D. Departmental Units/Supervisors**

The supervisor shall:

1. Identify and report job areas that require or may require respiratory protective equipment.
2. Identify and report the personnel under their supervision required to wear respirators.
3. Assure that employees wearing respirators voluntarily do not wear a respirator in a required use situation.
4. Maintain an inventory of spare parts and new respirators if necessary.
5. Conduct work site inspections to review unit compliance with respirator regulations.
6. Assure that employees receive retraining when the following situations occur:
  - a) Previous training is rendered obsolete by changes in the workplace or the type of respirator.
  - b) Inadequacies in the employee's knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill.
  - c) Any other situation arises in which retraining appears necessary to ensure safe respirator use.

#### **E. Respirator Wearers**

The respirator wearer shall:

1. Complete the MSU Occupational Health respirator wearer questionnaires.
2. Use respirators in accordance with instructions and training received from supervisors and EHS.
3. Store, clean, maintain, and guard against damage to respirator equipment.
4. Report any deficiencies or malfunctions of a respirator to a supervisor or EHS.
5. Go immediately to an area having respirable (clean) air if the respirator fails to provide proper protection.
6. Receive a fit test and retraining at least annually.

### **III. RESPIRATORY PROTECTIVE EQUIPMENT**

The basic purpose of any respirator is to protect the respiratory system from inhalation of hazardous atmospheres. Respirators provide protection either by removing contaminants from the air before it is inhaled or by supplying an independent source of respirable air. See Table 1 and Table 2 for more detailed information on respirator capabilities and modes of operation.

#### **A. Air-Purifying Respirators**

Ambient air, prior to being inhaled, is passed through a filter, cartridge, or canister, which removes contaminants. Different filters are required to remove different contaminants.

1. Non-powered Air-Purifying Respirator



The breathing action of the wearer operates the non-powered type of respirator. Equipped with a tight-fitting facepiece and filter(s), the respirator is secured to the face by means of a strap or harness. The wearer pulls air through the filters during inhalation. **Oxygen must be present in sufficient levels (see Table 1) when using an air-purifying respirator.**

a) The Filtering Facepiece

A filtering facepiece is defined as a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

i. N95 respirators (Picture 1)

These respirators are used on campus for protection against biohazardous aerosols. They do not filter any organic vapors and acid gases. N95 respirators have a NIOSH approval number starting with TC-84xxx (xxx will be a specific number for each NIOSH approval), and are available with or without an exhalation valve. N95 respirators must be fit tested in a required use situation, and should be disposed of after each use.

ii. Dust Masks (Picture 2)

Dust masks, which are generally used for nuisance dust such as cement and hay dusts are non-NIOSH approved filtering facepieces. They do not filter any organic vapors, acid gases and do not provide adequate protection against particulates. This type of respirator does not have a NIOSH approval number, and cannot be fit tested. They should not be used as a substitute for an N95, or for any tight fitting half or fullface respirator.

b) Elastomeric Respirators

The half-mask (picture 3) and full facepiece (picture 4) respirators provide greater protection than the dust mask because their construction allows for a better fit. These respirators provide protection against dusts, mists, fumes, vapors, gases, or any combination of these contaminants depending on the type of filter used. The full facepiece provides that greatest degree of protection in the APR class, and protects the eyes as well.

2. Powered Air-Purifying Respirator (PAPR)

The powered type contains a portable blower, which pushes ambient air through a filter and then supplies purified air to the wearer. The powered type is equipped with a tight-fitting facepiece or a loose-fitting helmet, hood, or suit. A loose fitting PAPR does not



require a fit test. However, inspection to insure proper flow rate and operation is required for safe use.

## B. Atmosphere-Supplying Respirators

Atmosphere supplying respirators provide a clean source of air from a tank or compressor to the wearer. Atmosphere-supplying respirators provide a greater level of protection than air-purifying respirators because they don't rely on a filtering mechanism to provide clean air.

### a) Self-Contained Breathing Apparatus (SCBA)

The wearer carries a supply of air, oxygen, or oxygen-generating material. Normally equipped with full facepiece, but may be equipped with a half-mask facepiece, helmet, or hood. See picture 5.

### b) Air-Line Respirator

Respirable air is supplied through a small-diameter hose from a compressor or compressed air cylinder. The hose is attached to the wearer by a belt and can be detached rapidly in an emergency. A flow-control valve or orifice is provided to govern the rate of airflow to the wearer. Exhaled air passes to the ambient atmosphere through a valve or opening in the enclosure (facepiece, helmet, hood, or suit).

### c) Breathing Air Quality

Compressed air and liquid air shall be of high purity. Breathing air shall meet at least the requirements of the specification for grade D breathing air described in Compressed Gas Association Commodity Specification G-7.1-1966. A compressor used to supply breathing air shall be a breathing air-type compressor. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line purifying sorbent beds and filters installed to further assure breathing air quality. Never hook an air-line respirator up to an oxygen tank.



Picture 1: N95 Respirator



Picture 2: Dust Mask



Picture 3: Half face



Picture 4: Full Face



Picture 5: SCBA

## IV. RESPIRATOR PROGRAM REQUIREMENTS

### A. MEDICAL CERTIFICATION

When using an air-purifying respirator, breathing can become more difficult because the flow of air is reduced by a filter or cartridge. A determination will be made by MSU Occupational



Health personnel at Olin if the employee is medically able to use respiratory protective equipment. Certification of fitness is required for all wearers of air-purifying respirators. MSU Occupational Health medical staff will administer a medical evaluation program to certify personnel fit to wear a respirator. The components of this program will vary by the type of respirator, length of time per day the respirator will be used, the type of work being done while the respirator is being worn and the age of the worker.

Employees shall receive additional medical evaluation when the employee reports symptoms related to the ability to use/wear a respirator and when workplace conditions change so as to place an increased burden on the employee.

Employees working off campus should complete the appropriate respirator user evaluation forms and send them to MSU Occupational Health for review. MSU Occupational Health will either certify the employee based on the evaluation or request a visit with a designated local health care provider.

Every respirator wearer must be certified/approved by the MSU Occupational Health section at Olin.

## **B. RESPIRATOR SELECTION**

Respirators are selected by a qualified safety and health professional. Many factors are considered in order to select the proper respirator. Respirator selection is based on:

1. Characteristics of Hazardous Operation or Process
  - a) Hot operations: welding, chemical reactions, soldering, melting, molding and burning
  - b) Liquid operations: painting, degreasing, dipping, spraying, brushing, coating, etching, cleaning, pickling, plating, mixing, galvanizing and chemical reactions
  - c) Solid operations: pouring, mixing, separations, extraction, crushing, conveying, loading, bagging and demolition
  - d) Pressurized spraying: cleaning parts, applying pesticides, degreasing, sand blasting and painting
  - e) Shaping operations: cutting, grinding, filing, milling, molding, sawing and drilling
2. Nature of hazard (See tables 3 and 4 for more information).

Air contaminants include particulate solids or liquids, gaseous material in the form of a true gas or vapor, or a combination of gas and particulate matter.

  - a) Gaseous contaminants
    - i. Inert gases (helium, argon, etc.), which do not metabolize in the body but displace air to produce an oxygen deficiency.
    - ii. Acid gases (sulfur dioxide, hydrogen sulfide, hydrogen chloride, etc.) which are acids or produce acids by reaction with water.



- iii. Alkaline gases (ammonia, etc.), which are alkalies or produce alkalies by reaction with water.
  - iv. Organic gases (butane), which exist as true gases or
    - v. Vapors from organic liquids (acetone).
  - vi. Organometallic gases (tetraethyl lead, organo-phosphates, etc.), which have metals attached to organic groups.
- b) Particulate contaminants
- i. Dusts. Mechanically generated solid particulates (0.5 to 10  $\mu\text{m}$ )
  - ii. Fumes. Solid condensation particles of small diameter (0.1 to 1.0  $\mu\text{m}$ )
  - iii. Mists. Liquid particulate matter (5 to 100  $\mu\text{m}$ )
  - iv. Smoke. Chemically generated particulates (solid and liquid) of organic origins (0.01 to 0.3  $\mu\text{m}$ )
3. Concentration of contaminant
- a) Permissible Exposure Limit (PEL): These are the upper exposure limits of airborne concentrations that are accepted as safe, as established by OSHA. The Time Weighted Average (TWA) is the maximum concentration that employees working eight hours per day, forty hours per week can be exposed to with no adverse health effects.
  - b) Threshold Limit Value (TLV): These are the upper exposure limits of airborne concentrations that are accepted as safe for employees to be exposed to on a day-in, day-out basis, as established by the American Council of Governmental Industrial Hygienists.
  - c) Short Term Exposure Limit (STEL): An exposure limit that is the maximum concentration to which workers can be exposed for a period of up to 15 minutes with no detrimental effects.
  - d) Ceilings are concentrations that should not be exceeded for any part of the workday.
  - e) Immediately Dangerous to Life and Health (IDLH): Conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials.
4. Respirator design
- a) NIOSH Approved: All respirators used on campus must be approved by the National Institute of Occupational Safety and Health (NIOSH). NIOSH approved respirators are labeled with a NIOSH ID number. Filters are labeled with the type of hazard the respirator is approved to protect against. Respirator replacement parts are labeled with part numbers and only approved replacement parts should be used. Any modifications that do not use approved replacement parts void the approval of the respirator.
  - b) Enclosure Design





- i. Tight-fitting units: full facepiece and half-mask
- ii. Loose-fitting units: hood, helmet, and enclosed suit

5. Location of Hazardous Area

- a) Confined Space: See special problems.
- b) Proximity to non-contaminated “clean” environment

6. Worker Activity

- a) Duration of job
- b) Physical exertion: light, medium, heavy
- c) Temperature of job area

**C. CARTRIDGE AND FILTER SELECTION AND USAGE**

Cartridges and filters are currently named under 42 CFR 84. This standard creates nine new classes of filters. The series are referred to as N, R and P.

Filter Series	Use in Oil Atmospheres	% Efficiency
N	No	95, 99 or 100
R	Yes, Maximum 8 hours	95, 99 or 100
P	Yes, Possible for longer than 8 hours	95, 99 or 100

The 100 series were formally called HEPA under 30 CFR 11.

The length of time a cartridge will protect against contaminants is dependent on various factors which include:

- a) Hazards present
- b) Contaminant concentration
- c) Breathing rate
- d) Humidity
- e) Temperature

If a cartridge does not have an end of service life indicator, EHS will develop a cartridge change-out schedule based on the above considerations and data that will insure that canisters and cartridges are changed before the end of their service life. This information will be obtained from the manufacturers test data and distributed to wearers at the time of fit testing or refit testing, and as needed. Particulate cartridge change-out schedule will be based on increased breathing resistance.

**D. TRAINING**

- 1. Each wearer shall be given initial training by EHS covering the following topics.



- a) Respiratory Hazards and Health Effects
  - b) How Respirators Work
  - c) Engineering Controls VS Respirator Use
  - d) Medical Evaluation
  - e) Respirator Selection Rationale
  - f) Fit Testing
  - g) Respirator Donning & Fit Testing in the Field
  - h) Maintenance, Cleaning and Storage
  - i) The General Requirements of 29 CFR 1910.134 (written plan, annual refitting, retraining, record keeping)
  - j) How to use the Respirator in an Emergency Situation, Including Situations in Which the Respirator Malfunctions.
  - k) Medical signs and symptoms that may limit the effective use of a respirator
  - l) Why the respirator is necessary
  - m) How improper fit, usage or maintenance can compromise the protection of a respirator.
2. Each wearer shall be given annual retraining covering the following topics:
- a) Why the respirator is necessary
  - b) How improper fit, usage or maintenance can compromise the protection provided by a respirator.
  - c) What the limitations and capabilities of the respirator are.
  - d) How to use the respirator in an emergency situation, including situations in which the respirator malfunctions.
  - e) How to inspect, put on and remove and check the seals of the respirator.
  - f) Proper maintenance and storage of the respirator
  - g) Medical signs and symptoms that may limit the effective use of a respirator
  - h) The general requirements of 29 CFR 1910.134 (written plan, annual refitting, retraining, record keeping)

## **E. RESPIRATOR FIT TESTING**

Respiratory protective equipment will not be ordered, purchased or issued to personnel unless the respirator wearer has received respirator training and passed a fit test. Quantitative or qualitative fit tests will be performed.

A fit test report, when complete and signed by an EHS representative, indicates that the wearer has successfully completed the Occupational Health respirator certification program and EHS quantitative or qualitative fit testing and training requirements. The fit test report is valid for 1 year. Refitting is required when job duties necessitate a change in respirator equipment, when body-weight changes (+/- 20 lbs.) or if a facial structure changes, and at least annually from the initial fit test. The user can only obtain and wear the respirator specified on the fit test report.



## 1. Qualitative Fit Tests

The worker is exposed to an atmosphere containing an odorant, irritant or taste agent and then asked to breathe normally, breathe deeply, move head side to side, move head up and down, grimace, bend at the waist, and talk. The wearer reports any noticeable odor or taste agent that is leaking into the mask.

### (a) Banana Oil Test

This chemical has a pleasant, easily detectable odor, which is used to check the facepiece seal when organic vapor cartridges are used. If the user detects any odor, it is an indication that the fit is faulty, and that adjustment to the respirator seal is required. This test has two limitations; the odor threshold varies widely among individuals and odor fatigue can occur.

### (b) Irritant Smoke Test

This qualitative test involves exposing the wearer to an irritating aerosol produced by a smoke tube. If the user detects any irritant smoke, it is an indication that the fit is faulty, and adjustment to the respirator seal is required. This test has an advantage in that the wearer usually reacts involuntarily to any leakage seal by coughing or sneezing. Only properly trained personnel should conduct the irritant smoke fit test.

### (c) Bitrex

This compound has a bitter taste, and is used to detect leaks in respirators. This is a common fit testing method for the N95 respirators. Respirator users must be subjected to a taste threshold test to assure the Bitrex can be tasted. Taste fatigue may also occur with this fit testing method.

## 2. Quantitative Fit Test:

### a) TSI Portacount

A particle counting instrument is used to accurately measure respirator fit by comparing the dust concentration in the surrounding air with the dust concentration inside the respirator. The ratio of these concentrations is called the fit factor. A modified filter cartridge (or a modified respirator facepiece) equipped with a sampling port is used to collect air from inside the respirator. With the sampler attached, the wearer is asked to: breathe normally, breathe deeply, move head side to side, move head up and down, grimace, bend at the waist, and talk. During these movements, any leakage is measured by the particle counting device. After the fit test, a final fit test report is generated (Appendix A).



An acceptable fit test is a measured fit factor at least 10 times greater than the assigned protection factor (APF) listed in tables 5, 6 and 7. APF's are a characteristic of respirator design. A fit factor of at least 10 times the APF is used as acceptance criteria because APF's are not considered reliable predictors of performance levels that will be achieved during actual use.

b) OHD Quantifit

The Quantifit works by creating and maintaining a negative pressure within the respirator mask. Air is removed from the respirator mask until the challenge pressure is reached. If there isn't a leak, the Quantifit doesn't remove any more air from the respirator mask. If there is a leak, air will enter the respirator, and the pressure will rise. Air will be removed from the respirator until the challenge pressure returns. The process lasts 8 seconds, and the test ends. During the fit test, the Quantifit measures exactly how much air it removed from the respirator after reaching the challenge pressure. This measurement is used to calculate the leak rate.

Redon protocol: Five-step protocol performs tests with three different donnings to assure that the test subject is proficient at donning a respirator to achieve adequate fit.

1. Face Forward
2. Bend Over
3. Shake Head
4. Redon Respirator (1)
5. Redon Respirator (2)

When Self-Contained Breathing Apparatus (SCBA) Respirators are used, the SCBA protocol will be used. It is identical to the Redon protocol with the one exception that the challenge pressure is increased. The Redon uses a breathing rate of 0.58 H<sub>2</sub>O, while the SCBA uses a breathing rate of 1.50 H<sub>2</sub>O. The assumption is that the user will be under more stress and therefore will create a higher breathing rate.

The leak rate determined from the protocol described above is used to calculate the fit factor of the respirator expressed by the following equation.

$$Fit\ Factor = \frac{Modeled\ Breathing\ Rate\ (cc/min)}{Measured\ Leak\ Rate\ (cc/min)}$$

The modeled breathing rate is the rate at which an individual breathes, predetermined for the standard protocols.



An acceptable fit test is a measured fit factor at least 10 times greater than the assigned protection factor (APF). APF's are a characteristic of respirator design. A fit factor of at least 10 times the APF is used as acceptance criteria because APF's are not considered reliable predictors of performance levels that will be achieved during actual use.

**The following table will be used to determine what type of fit test shall be performed:  
Acceptable Fit-Testing Methods**

Acceptable Fit-Testing Methods		
	QLFT	QNFT
Half-Face, Negative Pressure, APR (<100 fit factor)	Yes	Yes
Full-Face, Negative Pressure, APR (<100 fit factor) used in atmospheres up to 10 times the PEL	Yes	Yes
Full-Face, Negative Pressure, APR (>100 fit factor)	No	No
Powered Air-Purifying Respirator (PAPR)	Yes	Yes
Supplied-Air Respirators (SAR), or SCBA used in Negative Pressure (Demand Mode) (>100 fit factor)	No	Yes
Supplied-Air Respirators (SAR), or SCBA used in Positive Pressure (Pressure Demand Mode)	Yes	Yes
SCBA/SAR – IDLH, Positive Pressure	Yes	Yes
Loose-fitting Respirators (e.g., hoods, helmets)	Fit-testing Not Required	

3. Field Fit Checks

After successfully completing an initial EHS fit test, employees must check the fit of their respirator immediately before and periodically during respirator use in the field.

(a) Positive Pressure Check

Cover the exhalation valve with your hand and exhale gently into the facepiece. If a slight positive pressure is built up inside the facepiece without any evidence of leakage, the fit is satisfactory. This test method is the most widely used to check proper fit in the field.

(b) Negative Pressure Check

Close off the air inlet valves (i.e., cover the cartridges with your hands), inhale gently to collapse the facepiece slightly, and hold your breath for 10 seconds. If the facepiece remains slightly collapsed and no leakage is detected, the respirator fits



properly. It may be difficult to get a good seal when trying to cover the inlet valves (cartridges).

#### 4. Considerations For Proper Fit

##### (a) Facial Hair

A person who has hair (stubble, mustache, sideburns, beard, low hairline or bangs) which passes between the face and the sealing surface of a tight-fitting facepiece shall not be permitted to wear a respirator with a tight fitting facepiece. A person who has hair (mustache, beard) which interferes with the functions of the respirator valve(s) shall not be permitted to wear a respirator.

##### (b) Glasses and Eye/Face Protective Devices

If a spectacle, goggle, face shield or welding helmet must be worn with a respirator, it shall be worn so as not to adversely affect the respirator seal. Spectacles that have temple bars or straps which pass between the sealing surface of a respirator facepiece and the wearers face shall not be used. If a full facepiece respirator is used, special frames for mounting prescription glasses are available if needed.

## F. ISSUANCE AND ASSIGNMENT OF RESPIRATORS

### A. Required Use of Respirators

If an employee is required to wear **any** respirator by the employer (including filtering facepieces, half face or full face), then the employee is to be placed in the MSU Respiratory Protection Program.

The following are examples of required use situations:

- Where a respirator is not required by law, but is still required by the employer.
- When a hazard assessment determines that airborne contaminant concentrations of contaminants require a respirator to protect employee health.
- When the standard Personal Protective Equipment for a task includes a respirator (i.e. cleaning a boiler, painting).

Inclusion in the program requires a medical exam from Occupational Health, fit testing, training and provisions of a cartridge change out program from EHS.

### B. Voluntary Use of Respirators

EHS will conduct a respiratory assessment to determine if a respirator is voluntary use. In a situation where air monitoring has been conducted and no respiratory hazard exists, an employee may voluntarily wear a NIOSH approved filtering facepiece (i.e. N-95



respirator) or dust mask. These employees will not be included in the respiratory protection program. If an employee chooses to wear an elastomeric respirator, then the employee must be placed in the MSU respiratory protection program. Voluntary users will be provided with the information in CFR 1910.134 Appendix D.

It is the responsibility of the supervisor to assure employees wearing dust masks or filtering facepieces do not wear these respirators for operations that have not been evaluated by EHS.

The following are examples of voluntary use situations that do not require employees to be in the respiratory protection program:

- Wearing a dust mask for comfort while sweeping a floor after a respiratory assessment has been conducted by EHS and no respiratory hazard exists.
- Wearing an N-95 respirator for wood grinding after a respiratory assessment has been conducted by EHS and no respiratory hazard exists.
- Wearing an N-99 respirator for sifting soil samples after a respiratory assessment has been conducted by EHS and no respiratory hazard exists.

The following are examples of voluntary use situations that require employees to be in the respiratory protection program:

- Wearing an elastomeric half face respirator for comfort while sweeping a floor.
- Wearing a full face respirator for comfort while working with a chemical that smells bad.
- A pregnant woman wearing an elastomeric half face respirator to keep exposure to a chemical as low as possible.

#### **G. RESPIRATORY PROTECTION FOR POTENTIALLY INFECTIOUS AGENTS (i.e. TB, Hantavirus, others)**

If an employee is required to wear an air-purifying respirator (including N95's) for protection against potentially infectious aerosols in their work environment, they must be placed in the respiratory protection program and comply with all applicable provisions of the program. For further information, refer to the MSU Biosafety Manual or any other applicable exposure control plan and contact EHS Biosafety Staff at 355-0153.

#### **H. CONTINUING RESPIRATOR EFFECTIVENESS**

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.



The respirator wearer shall leave the respirator use area when the following conditions are met or needed:

1. To wash their faces and respirator facepieces as necessary to prevent eye or skin irritation associated with respirator use.
2. If vapor or gas breakthrough is detected, if there is a change in breathing resistance, or leakage of the facepiece
3. To replace the respirator of the filter, cartridge or canister elements

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

## I. RESPIRATOR CLEANING AND MAINTENANCE

Respirators should be regularly cleaned and disinfected. Respirators issued for the exclusive use of one worker may be cleaned as often as necessary. Weekly or monthly cleaning is usually adequate but more frequent cleaning may be necessary. Shared respirators or emergency use respirators must be cleaned and disinfected after each use. The need for respirator decontamination should also be considered when determining the frequency of cleaning.

### 1. Cleaning and Disinfecting

These procedures are provided for supervisors to arrange for proper cleaning of respirators. They are general in nature, and the supervisor as an alternative may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees.

Procedures for Cleaning Respirators:

- a) Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure- demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or replace any defective parts.
- b) Wash components in warm (43°C [110°F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.
- c) When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:
  - i. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43°C (110°F); or,
  - ii. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45% alcohol) to one liter of water at 43°C (110°F); or,





- iii. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.
- d) Rinse components thoroughly in clean, warm (43°C [110°F] maximum), preferably running water. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.
- e) Components should be hand-dried with a clean lint-free cloth or air-dried.
- f) Reassemble facepiece.
- g) Test the respirator to ensure that all components work properly.

## 2. Storage

When not in use, the respirator and cartridges should be kept in a sealed container and stored in a clean, dry, moderate temperature, non-contaminated environment. It is especially important to keep gas and vapor cartridges in a sealed container so they do not passively adsorb gases and vapors from the storage area, thereby reducing the filter service life. Particulate filters should also be protected from dusts and dirt. Emergency use respirators should be stored in a sturdy compartment that is quickly accessible and clearly marked. If a respirator has become contaminated, cleaning it prior to storage is crucial.

## 3. Replacement Parts

Consult the manufacture or distributor for replacement parts and filters. EHS has a list of replacement parts and filters for each respirator model.

## 4. Inspection Procedures and Schedules

Each respirator shall be inspected routinely before and after use. Respirators shall be inspected by the user immediately prior to each use to ensure that it is in proper working condition. After cleaning, each respirator shall be inspected to determine if it is in proper working condition and if it needs replacement of parts or repairs. Each respirator stored for emergency or rescue use shall be inspected at least monthly, and shall be checked for proper function before and after each use.

### a) Inspection Checklist for Disposable Respirators

- i. Holes in filter
- ii. Elasticity of straps
- iii. Deterioration of straps and metal nose clip

### b) Inspection Checklist for Air-purifying respirators



- i. Facepiece
  - ✓ Dirt
  - ✓ Cracks, tears, or holes
  - ✓ Distortion of facepiece
  - ✓ Cracked, scratched, or loose fitting lenses
  
- ii. Headstraps
  - ✓ Breaks or tears
  - ✓ Loss of elasticity
  - ✓ Broken buckles or attachments
  - ✓ Worn serration on head harness which might allow facepiece to slip
  
- iii. Inhalation and Exhalation Valves
  - ✓ Dust particles, dirt, or detergent residue on valve and valve seat
  - ✓ Cracks, tears, or distortion in valve material
  - ✓ Missing or defective valve covers
  
- iv. Filter Elements
  - ✓ Proper filter for the hazard
  - ✓ Approval designation
  - ✓ Missing or worn gaskets
  - ✓ Worn threads on filter and facepiece
  - ✓ Cracks or dents in filter housing
  - ✓ Deterioration of gas mask canister harness
  - ✓ Service life indicator, or end of service date
  
- v. Breathing tube
  - ✓ Cracks or holes
  - ✓ Missing or loose hose clamps
  - ✓ Broken or missing end connectors
  - ✓ Flow rate on PAPR
  
- c) Inspection Checklist For Atmosphere-supplying Respirators
  - i. Hood, Helmet, Blouse, or Full Suit
    - ✓ Rips or torn seams
    - ✓ Headgear suspension
    - ✓ Cracks or breaks in face shield
    - ✓ Protective screens that are intact and fit correctly over face shields, hoods, or blouses
  
  - ii. Air supply systems
    - ✓ Breathing air quality
    - ✓ Breaks or kinks in air supply hoses and fittings
    - ✓ Tightness of connections



- ✓ Settings of regulators and valves
- ✓ Correct operations of air-purifying elements and alarm for carbon monoxide or high temperatures

## J. DOCUMENTATION AND RECORD KEEPING

Records of respirator fit tests must be kept for the duration of employment. Units are responsible for maintaining their own record keeping system. See example of quantitative fit test report (Appendix A).

## K. SPECIAL PROBLEMS

### 1. Vision

When a respirator user must wear corrective lenses, a protective spectacle or goggle, a face shield, a welding helmet, or other eye and face protective device, the item shall be fitted to provide good vision and shall be worn in such a manner as to not interfere with the seal between the respirator and the wearer.

Temple bars or straps of a corrective spectacle which pass between the sealing surface of a full facepiece respirator and the face may prevent a good seal and therefore such a spectacle shall not be worn with a full facepiece respirator. Special corrective lenses, which are made to be mounted inside a full facepiece, are available and should be used by a person who needs corrective lenses.

### 2. Communications

Speech transmission while wearing a respirator is often necessary to perform specific tasks. Although a respirator facepiece distorts the human voice to some extent, the respirator's exhalation valve usually provides a pathway for some speech transmission over short distances in relatively quiet areas. However, talking while wearing a respirator equipped with a facepiece may adversely affect the seal of the facepiece, especially a quarter-mask or half-mask facepiece.

### 3. Immediately Dangerous to Life or Health (IDLH) Atmospheres

An IDLH atmosphere is one that is oxygen deficient or contains excessive concentrations of a contaminant, including concentrations of a substance above the lower flammable limits. IDLH atmospheres will not be entered without prior EHS approval. IDLH situations containing flammable atmospheres will only be entered by the East Lansing Fire Department. Entrants will be highly trained by EHS in anticipated hazards, use the buddy system for entry, and notify the East Lansing Fire Department prior to entry. Under no circumstances should air purifying respirators be used in an IDLH atmosphere. When respirators are required for entry into IDLH atmospheres, a supplied air respirator



shall be used with escape bottles, and at least one standby person shall be present in a safe area. Communications (visual, voice, signal-line, telephone, radio, or other suitable means) shall be maintained between the standby person and the respirator wearers. In addition, the standby person will call East Lansing Fire Department for emergency assistance and will be trained in the specific worksite procedures developed and appropriated rescue devices by EHS. This does not apply to HAZMAT situations.

#### 4. Confined Spaces

All confined spaces shall be entered in accordance with the MSU Confined Space Program.

#### 5. Low-Temperature Environments

A low-temperature environment may cause fogging of the lens in a respiratory-inlet covering and freezing or improper sealing of the exhalation valve. Coating the inside surface of the lens may prevent fogging at low atmospheric temperatures approaching 32 °F, but severe fogging of the lens may occur at temperatures below 0 °F. Full facepieces are available with nose cups that direct the warm and moist air through the exhalation valve without contacting the lens, and these facepieces should provide satisfactory vision at temperatures as low as -25 °F. At very low atmospheric temperatures, the exhalation valve of a respirator may freeze open or closed due to the presence of moisture. Dry respirable air should be used with an airline respirator and with the type of self-contained breathing apparatus that employs a cylinder of air when these devices are used in low-temperature atmospheres.

#### 6. High-Temperature Environments

A person working in a high temperature environment is under stress due to the heat. Wearing a respirator in such an environment applies additional stress, which can be minimized by using a respirator having a low weight and a low resistance to breathing. The air-line-type supply-air respirator is recommended for use in a high-temperature environment.

### **L. EVALUATION OF RESPIRATOR PROGRAM EFFECTIVENESS**

Periodic review of the effectiveness of the respirator program is essential. EHS will conduct periodic surveys to determine the effectiveness of the respirator program. This will include work site inspections, interviews with respirator wearers, air monitoring, and review of records. Acceptance of respirators by the user is especially important. Users will be consulted about their acceptance of wearing respirators during the annual refit testing. This includes comfort, resistance to breathing, fatigue, interference with vision, interference with communications, restriction of movement, interference with job performance, and confidence in the effectiveness of the respirator to provide adequate protection. Medical re-certification



of respirator wearers will be as per the requirements of the Occupational Health Division at Olin.

The above information can serve as an indication of the degree of protection provided by respirators and the effectiveness of the respirator program. Action shall be taken to correct any insufficiencies found in the program.



TABLE 1.

*Classification and Description of Respirators by Mode of Operation*

---

**I. Atmosphere-Supplying Respirators**

A respirable atmosphere independent of the ambient air is supplied to the wearer.

**A. Self-Contained Breathing Apparatus (SCBA)**

A supply of air, oxygen, or oxygen-generating material is carried by the wearer. Normally equipped with full facepiece, but may be equipped with a quarter-mask facepiece, half-mask facepiece, helmet, hood, or mouthpiece and nose clamp.

1. **Closed-Circuit SCBA:** (oxygen only, negative pressure<sup>a</sup> or positive pressure<sup>b</sup>).

a) Compressed or liquid oxygen type.

Equipped with a facepiece or mouthpiece and nose clamp. High-pressure oxygen from a gas cylinder passes through a high-pressure reducing valve and, in some designs, through a low-pressure admission valve to a breathing bag or container. Liquid oxygen is converted to low-pressure gaseous oxygen and delivered to the breathing bag. The wearer inhales from the bag, through a corrugated tube connected to a mouthpiece or facepiece and a one-way check valve. Exhaled air passes through another check valve and tube into a container of carbon-dioxide removing chemical and reenters the breathing bag. Make-up oxygen enters the bag continuously or as the bag deflates sufficiently to actuate an admission valve. A pressure-relief system is provided, and a manual by-pass system and saliva trap may be provided depending upon the design.

b) Oxygen-generating type.

Equipped with a facepiece or a mouthpiece and nose clamp. Water vapor in the exhaled breath reacts with chemical in the canister to release oxygen to the breathing bag. The wearer inhales from the bag through a corrugated tube and one-way check valve at the facepiece. Exhaled air passes through a second check valve/breathing tube assembly into the canister. The oxygen-release rate is governed by the volume of exhaled air. Carbon dioxide in the exhaled breath is removed by the canister fill.

2. **Open-Circuit SCBA:** (compressed air, compressed oxygen, liquid air, liquid oxygen). A bypass system is provided in case of regulator failure except on escape-type units.

a) Demand type<sup>c</sup>

Equipped with a facepiece or mouthpiece and nose clamp. The demand valve permits oxygen or air flow only during inhalation. Exhaled breath passes to ambient atmosphere through a valve(s) in the facepiece.

b) Pressure-demand type<sup>d</sup>

Equipped with a facepiece only. Positive pressure is maintained in the facepiece. The apparatus may have provision for the wearer to select the demand or pressure-demand mode of operation, in which case the demand mode should be used only when donning or removing the apparatus.

**B. Supplied-Air Respirators**

1. **Hose Mask:** Equipped with a facepiece, breathing tube, rugged safety harness, and large-diameter heavy-duty non-kinking air-supply hose. The breathing tube and air-supply hose are securely attached to the harness. The facepiece is equipped with an exhalation valve. The harness has provision for attaching a safety line.

a) Hose mask with blower.

Air is supplied by a motor-driven or hand-operated blower. The wearer can continue to inhale through the hose if the blower fails. Up to 300 feet (91 meters) of hose length is permissible.

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<sup>a</sup> Device produces negative pressure in respiratory-inlet covering during inhalation

<sup>b</sup> Device produces positive pressure in respiratory-inlet covering during both inhalation and exhalation

<sup>c</sup> Equipped with a demand valve that is activated on inhalation and permits the flow of breathing atmosphere to the facepiece. On exhalation, pressure in the facepiece becomes positive and the demand valve is deactivated

<sup>d</sup> A positive pressure is maintained in the facepiece by a spring-loaded or balanced regulator and exhalation valve



- b) Hose mask without blower.

The wearer provides motivating force to pull air through the hose. The hose inlet is anchored and fitted with a funnel or like object covered with a fine mesh screen to prevent entrance of coarse particulate matter. Up to 75 feet (23 meters) of hose length is permissible.

- 2. **Air-Line Respirator:** Respirable air is supplied through a small-diameter hose from a compressor or compressed air cylinder(s). The hose is attached to the wearer by a belt or other suitable means and can be detached rapidly in an emergency. A flow-control valve or orifice is provided to govern the rate of airflow to the wearer. Exhaled air passes to the ambient atmosphere through a valve(s) or opening(s) in the enclosure (facepiece, helmet, hood, or suit). Up to 300 feet (91 meters) of hose length is permissible.

- a) Continuous-flow class.

Equipped with a facepiece, hood, helmet, or suit. At least 115 liters (four cubic feet) of air per minute to tight-fitting facepieces and 170 liters (six cubic feet) of air per minute to loose-fitting helmets, hoods, and suits is required. Air is supplied to a suit through a system of internal tubes to the head, trunk, and extremities through valves located in appropriate parts of the suit.

- b) Demand type.

Equipped with a facepiece only. The demand valve permits flow of air only during inhalation.

- c) Pressure-demand type

Equipped with a facepiece only. A positive pressure is maintained in the facepiece.

- 3. **Combination Air-Line Respirators with Auxiliary Self-Contained Air Supply**

Include an air-line respirator with an auxiliary self-contained air-supply. To escape from a hazardous atmosphere in the event the primary supply fails to operate, the wearer switches to the auxiliary self-contained air supply. Devices approved for both entry into and escape from dangerous atmospheres have a low-pressure warning alarm and contain at least 15-minute self-contained air supply.

## II. Air-Purifying Respirators

Ambient air, prior to being inhaled, is passed through a filter, cartridge, or canister, which removes particles, vapors, gases, or a combination of these contaminants. The breathing action of the wearer operates the nonpowered type of respirator. The powered type contains a blower - stationary or carried by the wearer - which passes ambient air through an air-purifying component and then supplies purified air to the respirator-inlet covering. The nonpowered type is equipped with a facepiece or mouthpiece and nose clamp. The powered type is equipped with a facepiece, helmet, hood, or suit.

### A. Vapor- and Gas-Removing Respirators

Equipped with cartridge(s) or canister(s) to remove a single vapor or gas (for example: chlorine gas), a single class of vapors or gases (for example: organic vapors), or a combination of two or more classes of vapors or gases (for example: organic vapors and acidic gases) from air.

### B. Particulate-Removing Respirators

Equipped with filter(s) to remove a single type of particulate matter (for example: dust) or a combination of two or more types of particulate matter (for example: dust and fume) from air. Filter may be a replaceable part or a permanent part of the respirator. Filter may be of the single-use or the reusable type.

### C. Combination Particulate- and Vapor- and Gas-Removing Respirators

Equipped with cartridge(s) or canister(s) to remove particulate matter, vapors, and gases from air. The filter may be a permanent part or a replaceable part of a cartridge or canister.

### D. Combination Atmosphere-Supplying and Air-Purifying Respirators

Provide the wearer with the option of using either of two different modes of operation: (1) an atmosphere-supplying respirator with an auxiliary air-purifying attachment which provides protection in the event the air supply fails or (2) an air-purifying respirator with an auxiliary self-contained air supply which is used when the atmosphere may exceed safe conditions for use of an air-purifying respirator.



TABLE 2.

Capabilities and Limitations of Respirators

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**I. Atmosphere-Supplying Respirators**

Atmosphere-supplying respirators provide protection against oxygen deficiency and toxic atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions.

*General limitations:* Except for some air-line suits, no protection is provided against skin irritation by materials such as ammonia and hydrogen chloride, or against sorption of materials such as hydrogen cyanide, tritium, or organic phosphate pesticides through the skin. Facepieces present special problems to individuals required to wear prescription lenses. Use of atmosphere-supplying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions.

**A. Self-Contained Breathing Apparatus (SCBA) The wearer carries his own breathing atmosphere.**

*Limitations:* The period over which the device will provide protection is limited by the amount of air or oxygen in the apparatus, the ambient atmospheric pressure (service life of open-circuit devices is cut in half by a doubling of the atmospheric pressure), and the type of work being performed. Some SCBA devices have a short service life (less than 15 minutes) and are suitable only for escape (self-rescue) from an irrespirable atmosphere. Chief limitations of SCBA devices are their weight or bulk, or both, limited service life, and the training required for their maintenance and safe use.

1. **Closed-Circuit SCBA:** The closed-circuit operation conserves oxygen and permits longer service life at reduced weight. The negative-pressure type produces a negative pressure in the respiratory-inlet covering during inhalation, and this may permit inward leakage of contaminants; whereas the positive-pressure type always maintains a positive pressure in the respiratory-inlet covering and is less apt to permit inward leakage of contaminants.
2. **Open-Circuit SCBA:** The demand type produces a negative pressure in the respiratory-inlet covering during inhalation, whereas the pressure-demand type maintains a positive pressure in the respiratory-inlet covering during inhalation and is less apt to permit inward leakage of contaminants.

**B. Supplied-Air Respirators.** The respirable air supply is not limited to the quantity the individual can carry, and the devices are lightweight and simple.

*Limitations:* Limited to use in atmospheres from which the wearer can escape unharmed without the aid of the respirator. The wearer is restricted in movement by the hose and must return to a respirable atmosphere by retracing his route of entry. The hose is subject to being severed or pinched off.

1. **Hose mask:** The hose inlet or blower must be located and secured in a respirable atmosphere.
  - a) **Hose mask with blower.**  
If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation.
  - b) **Hose mask without blower.**  
Maximum hose length may restrict application of device.
2. **Air-Line Respirator (Continuous Flow, Demand, and Pressure-Demand Types):** The demand type produces a negative pressure in the facepiece on inhalation, whereas continuous-flow and pressure-demand types maintain a positive pressure in the respiratory-inlet covering and are less apt to permit inward leakage of contaminants. Air-line suits may protect against atmospheres that irritate the skin or that may be absorbed through the unbroken skin.

*Limitations:* Air-line respirators provide no protection if the air supply fails. Some contaminants, such as tritium, may penetrate the material of an air-line suit and limit its effectiveness. Other





contaminants, such as fluorine, may react chemically with the material of an air-line suit and damage it.

**C. Combination Airline Respirators with Auxiliary Self Contained Air Supply**

The auxiliary self-contained air supply on this type of device allows the wearer to escape from a dangerous atmosphere. This device with auxiliary self-contained air supply is approved for escape and may be used for entry when it contains at least a 15-minute auxiliary self-contained air supply.

**II. Air-Purifying Respirators**

*General limitations:* Air-purifying respirators do not protect against oxygen-deficient atmospheres nor against skin irritations, or sorption through the skin of airborne contaminants

The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the design efficiency and capability of the cartridge, canister, or filter and the facepiece-to-face seal on the user. For gases and vapors, the maximum concentration for which the air-purifying element is designed is specified by the manufacturer or is listed on labels of cartridges and canisters.

Nonpowered air-purifying respirators will not provide the maximum design protection specified unless the facepiece or mouthpiece/nose clamp is carefully fitted to the wearer's face to prevent inward leakage. The time period over which protection is provided is dependent on canister, cartridge, or filter type; concentration of contaminant; humidity levels in the ambient atmosphere; and the wearer's respiratory rate.

The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. Nonpowered air-purifying respirators may cause discomfort due to a noticeable resistance to inhalation. This problem is minimized in powered respirators. Respirator facepieces present special problems to individuals required to wear prescription lenses. These devices do have the advantage of being small, light, and simple in operation.

Use of air-purifying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specific conditions.

**A. Vapor- and Gas-Removing Respirators**

*Limitations:* No protection is provided against particulate contaminants. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air. An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

Use should be avoided in atmospheres where the contaminant(s) lack sufficient warning properties (that is: odor, taste, or irritation at a concentration in air at or above the permissible exposure limit). (Vapor- and gas-removing respirators are not approved for contaminants that lack adequate warning properties). Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions.

1. Full Facepiece Respirator: Provides protection against eye irritation in addition to respiratory protection.
2. Quarter-Mask and Half-Mask Facepiece Respirator: A fabric covering (facelet) available from some manufacturers shall not be used.
3. Mouthpiece Respirator: Shall be used only for escape applications. Mouth breathing prevents detection of contaminant by odor. Nose clamp must be securely in place to prevent nasal breathing. A small lightweight device that can be donned quickly.



**B. Particulate-Removing Respirators**

*Limitations:* Protection against nonvolatile particles only. No protection against gases and vapors. Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions.

1. Full Facepiece Respirator: Provides protection against eye irritation in addition to respiratory protection.
2. Quarter-Mask and Half-Mask Facepiece Respirator: A fabric covering (facelet) available from some manufacturers shall not be used unless provided for use with respirator.
3. Mouthpiece Respirator: Shall be used only for escape applications. Mouth breathing prevents detection of contaminant by odor. Nose clamp must be securely in place to prevent nasal breathing. A small, lightweight device that can be donned quickly.

**C. Combination Particulate- and Vapor- and Gas-Removing Respirators**

The advantages and disadvantages of the component sections of the combination respirators as described above apply.

**D. Combination Atmosphere-Supplying and Air-Purifying Respirators**

The advantages and disadvantages, expressed above, of the mode of operation being used will govern. The mode with the greater limitations (air-purifying mode) will mainly determine the overall capabilities and limitations of the respirator, since the wearer may for some reason fail to change the mode of operation even though conditions would require such a change.

Each respirator wearer must complete and submit EHS/Olin respirator wearer questionnaire. This questionnaire will be used for respirator selection purposes/and medical screening information.

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TABLE 3.

**Classification of Respiratory Hazards According to Their Biological Effect**

Oxygen Deficiency	Gas and Vapor Contaminants	Particulate Contaminants (dust, fog, fume, mist, smoke, and spray)
<p><b>Minimum legal requirements:</b> 19.5% oxygen by volume for respirable air at sea-level conditions</p> <p><b>Occurrence:</b> Confined or unventilated cellars, wells, mines, ship holds, tanks, burning buildings, and enclosures containing inert atmospheres:</p> <p><b>Atmospheric oxygen content (percent by volume) versus expected physical conditions:</b> 20.9%: Oxygen content of normal air at sea-level conditions.</p> <p><b>Oxygen Percent Volume</b></p> <p><b>Physiological Effects</b></p> <p><b>16%-12%</b> Loss of peripheral vision, increased breathing volume, accelerated heartbeat, impaired attention and thinking, impaired coordination</p> <p><b>12%-10%</b> Very faulty judgment, very poor muscular coordination, muscular exertion causes fatigue that may cause permanent heart damage, intermittent respiration.</p> <p><b>10%-6%</b> Nausea, vomiting, inability to perform vigorous movement, unconsciousness followed by death</p> <p><b>Less than 6%</b> Spasmodic breathing, convulsive movements, death in minutes</p>	<p><b>Asphyxiants:</b> Interfere with utilization of oxygen in the body Chemical asphyxiants: Low concentrations interfere with supply or utilization of oxygen in the body (for example: carbon monoxide, hydrogen cyanide, cyanogen, and nitriles).</p> <p><b>Irritants:</b> May be corrosive. May cause irritation and inflammation of parts of the respiratory system (also skin and eyes) and pulmonary edema (for example: ammonia hydrogen chloride, formaldehyde, sulfur dioxide, chlorine, ozone, nitrogen dioxide, phosgene, and arsenic trichloride)</p> <p><b>Anesthetics:</b> Cause loss of feeling and sensation with unconsciousness and death possible (for example: nitrous oxide, hydrocarbons, and ethers). Some anesthetics injure body organs (for example: carbon tetrachloride [liver and kidneys], chloroform [liver and heart], benzene [bone marrow], and carbon disulfide [nervous system]).</p> <p><b>Sensitizers:</b> Cause increased probability of physiological reactions (for example: isocyanates, epoxy resin systems).</p> <p><b>Systemic poisons:</b> Damage organs and systems in the body (for example: mercury [nervous system and various organs], phosphorus [bone], hydrogen sulfide [respiratory paralysis], and arsine [red blood cells and liver]).</p> <p><b>Carcinogens:</b> Produce cancer in some individuals after a latent period (for example: vinyl chloride, benzene).</p>	<p><b>Relatively inert:</b> May cause discomfort and minor irritation, but generally without injury at reasonable concentrations (for example: marble, gypsum).</p> <p><b>Pulmonary-fibrosis-producing:</b> Produce nodulation and fibrosis in the lung, possibly leading to complications (for example: quartz, asbestos). <b>Chemical irritants:</b> Produce irritation, inflammation, and ulceration in upper respiratory tract (for example: acidic mists, alkalis).</p> <p><b>Carcinogens:</b> Produce cancer in some individuals after a latent period (for example: vinyl chloride, benzene).</p>
<p><b>Combinations of Gas, Vapor, and Particulate Contaminants</b> Combinations of contaminants may occur simultaneously in the atmosphere. Contaminants may be entirely different substances (dusts and gases from blasting) or the particulate and vapor forms of the same substance. Synergistic effects (joint action of two or more agents that result in an effect which is greater than the sum of their individual effects) may occur. Such effects may require extraordinary protective measures.</p>		

From ANSI Standard Z88.2-1980



TABLE 4.

*Classification of Respiratory Hazards According to Their Properties  
Which Influence Respirator Selection*

<b>Gas and Vapor Contaminants</b>	<b>Particulate Contaminants</b>
<p><b>Inert:</b> Substances that do not react with other substances under most conditions, but create a respiratory hazard by displacing air and producing oxygen deficiency (for example: helium, neon, argon).</p> <p><b>Acidic:</b> Substances that are acids or that react with water to produce an alkali. In water, they produce positively charged hydrogen ions (H+1) and a pH of less than 7. They taste sour, and many are corrosive to tissues (for example: hydrogen chloride, sulfur dioxide, fluorine, nitrogen dioxide, acetic acid, carbon dioxide, hydrogen sulfide, and hydrogen cyanide).</p> <p><b>Alkaline:</b> Substances that are alkalies or that react with water to produce an alkali. In water, they result in the production of negatively charged ions (OH-1) and a pH greater than 7. They taste bitter, and many are corrosive to tissues (for example: ammonia, amines, phosphine, arsine, and stibine).</p> <p><b>Organic:</b> The compounds of carbon. Examples are saturated hydrocarbons (methane, ethane, butane), unsaturated hydrocarbons (ethylene, acetylene), alcohols (methyl ether, ethyl ether), aldehydes (formaldehyde), ketones (methyl ketone), organic acids (formic acid, acetic acid), halides (chloroform, carbon tetrachloride), amides (formamide, acetamide), nitriles (acetonitrile), isocyanates (toluene diisocyanate), amines (methylamine), epoxies (epoxyethane, propylene oxide), and aromatics (benzene, toluene, xylene).</p> <p><b>Organometallic:</b> Compounds in which metals are chemically bonded to organic groups (for example: ethyl silicate, tetraethyl lead, and organic phosphate).</p> <p><b>Hydrides:</b> Compounds in which hydrogen is chemically bonded to metals and certain other elements (for example: diborane and tetraborane).</p>	<p>Particles are produced by mechanical means disintegration processes such as grinding, crushing, drilling, blasting, and spraying; or by physiochemical reactions such as combustion, vaporization, distillation, sublimation, calcination, and condensation. Particles are classified as follows:</p> <p><b>Dust:</b> A solid, mechanically produced particle with sizes varying from submicroscopic to visible or macroscopic. <b>Spray:</b> A liquid, mechanically produced particle with sizes generally in the visible or macroscopic range</p> <p><b>Fume:</b> A solid condensation particle of extremely small particle size, generally less than one micrometer in diameter</p> <p><b>Smoke:</b> A system which includes the products of combustion, pyrolysis, or chemical reaction of substances in the form of visible and invisible solid and liquid particles and gaseous products in air. Smoke is usually of sufficient concentration to perceptibly obscure vision.</p>

From ANSI Standard Z88.2-1980TABLE 5.



**TABLE 5. Assigned Protection Factors.**

Table 5 : Assigned Protection Factors					
Type of Respirator <sup>1,2</sup>	Quarter mask	Half mask	Full facepiece	Helmet/Hood	Loose-fitting facepiece
1. Air-Purifying Respirator	5	10 <sup>3</sup>	50	—	—
2. Powered Air-Purifying Respirator (PAPR)	—	50	1,000	25/1,000 <sup>4</sup>	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand Mode	—	10	50	—	—
• Continuous Flow Mode	—	50	1,000	25/1,000 <sup>4</sup>	25
• Pressure-demand or other positive-pressure mode	—	50	1,000	—	—
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand Mode	—	10	50	50	—
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)	—	—	10,000	10,000	—

Notes:

<sup>1</sup>Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

<sup>2</sup>The assigned protection factors in Table are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements

<sup>3</sup>This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

<sup>4</sup>The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

<sup>5</sup>These APFs do not apply to respirators used solely for escape. For escape respirators used in association with specific substances covered by 29 CFR 1910 subpart Z, employers must refer to the appropriate substance-specific standards in that subpart. Escape respirators for other IDLH atmospheres are specified by 29 CFR 1910.134(d)(2)(ii).

From OSHA Assigned Protection Factors for the Revised Respiratory Protection Standard (2009)



Appendix A. Sample Fit Test Form

EHS	Fit Test Result Report	Test Date:- 08-07-2015 9:02:29 am
<b>Joe Respirator</b>		
Department Name:		
Medical Evaluation Date:		
Job Code:		
Mask: <b>3M 6000 Series Small Half Mask</b>		
Challenge: Pressure:	<b>0.58</b>	Protocol: <b>REDON (APR)</b>
Last NIST Calibration:	<b>08-26-14</b>	Respiratory Rate: <b>53.80</b>
Minimum Passing Fit Factor:	<b>100</b>	Last Daily Calibration: <b>07-22-15</b>
Other :		Serial No: <b>3042</b>
Notes:		
Step Number	Fit Factor	Leak Rate
1 Don & Face Forward	271	198
2 Bend at Waist & Face Floor	271	198
3 Shake Head, Stop & Face Forward	968	55
4 Redon & Face Forward	968	55
5 Redon & Face Forward	596	90
<b>Test Result</b>	<b>449</b>	<b>119</b>
<div style="border: 1px solid black; padding: 5px; display: inline-block;"><b>PASS</b></div>		
_____ <i>Adam Calisti</i>		
_____ <i>Joe Respirator</i>		
Search Criteria:-		Page 1 of 1



Appendix A

LAST NAME      ZERO  
FIRST NAME     TEST

**FIT TEST REPORT**

Fit Test Information

ID NUMBER	1234	CUSTOM1	
LAST NAME	ZERO	CUSTOM2	
FIRST NAME	TEST	CUSTOM3	
COMPANY		CUSTOM4	
LOCATION			
NOTE	CONFIRMS MAX FIT FACTOR		
TEST DATE	02/15/2000	PORTACOUNT S/N	41834
TEST TIME	09:24	NS5 COMPANION	N
DUE DATE	02/15/2001		
RESPIRATOR		PROTOCOL	DEFAULT
MANUFACTURER	TSI	PASS LEVEL	29CFR1910.134
MODEL	ZERO FILTER		500
MASK STYLE	1602066		
MASK SIZE	FILTER		
APPROVAL			
EFF. <99%	N		

<u>EXERCISE</u>	<u>DURATION (SEC)</u>	<u>FIT FACTOR</u>	<u>PASS</u>
NORMAL BREATHING	60	557000	Y
DEEP BREATHING	60	557000	Y
READING OR TALKING	60	564000	Y
HEAD UP AND DOWN	60	565000	Y
HEAD SIDE TO SIDE	60	560000	Y
GIMMACE	30	141000	
BEND	60	563000	Y
NORMAL BREATHING	60	561000	Y
OVERALL FF		409000	Y

FIT TEST OPERATOR      WEINSTEIN      DATE \_\_\_\_\_

NAME      TEST ZERO      DATE \_\_\_\_\_



## Appendix B. Sample Change Out Calculation

### Report Details

**Country:** United States - English  
**Date:** 08/04/2015  
**3M Contact Information:** PSD Technical Service 1-800-243-4630  
**Comments:**

### Cartridge

**Product Name** 6001  
**Description** NIOSH approved against certain organic vapors. Use with 3M(TM) Half and Full Facepieces 6000, 7000 and FF-400 Series with bayonet filter holders.

### Image



### WARNING:

These results are estimates only and must be used with caution. Change cartridge earlier if taste, smell or irritation from the contaminant is detected.

Your estimated service life is greater than 8 hours. Please see information on contaminant migration through the cartridge in the Help document. Establish cartridge change schedules that are easy for workers to remember (e.g., 1 day, 1 week, 1 month).

### Solution

**Estimated Service Life is 370 Hours** until breakthrough to 10% of the exposure concentration (0.5 ppm)  
Service life calculation based on Toluene at an Exposure = 5.0 ppm

### Contaminants

Contaminant	CAS Number	Exposure	Exposure Limit	Molecular Weight	Odor Threshold
Toluene	108-88-3	5 ppm	20 ppm TLV	92.14	0.16

### Environment Questions

**Relative Humidity** <65%  
**Atmospheric Pressure** 1.0  
**Temperature** 68 Fahrenheit  
**Work Rate** Medium





## Appendix C. Respirator at MSU Handout

# Respiratory Protection at MSU

## Use of Air Purifying Respirators

Ambient air, prior to being inhaled, is passed through a filter, cartridge, or canister which removes contaminants. Different filters are required to remove different contaminants.

These respirators provide protection against dusts, mists, fumes, vapors, gases, or any combination of these contaminants depending on the type of filter used. An Air Purifying Respirator is not to be used in an oxygen deficient atmosphere because it does not supply oxygen.

## Fit Test and Training

Before an employee can wear a respirator, they must be medically certified by an approved health care provider. A fit test and initial training will be performed by EHS. Personnel must successfully pass the fit test before being issued an air-purifying respirator.

Employees must receive a refit test at least annually from the initial fit testing. During this time, EHS will fit test the wearer in their own respirator, and conduct retraining.

## Fit Checks

After successfully completing an initial EHS fit test, employees should check the fit of their respirator immediately before and periodically during respirator use in the field.

To perform the positive pressure check, cover the exhalation valve with your hand and exhale gently into the facepiece. If a slight positive pressure is built up inside the facepiece without any evidence of leakage, the fit is satisfactory.

To perform the negative pressure check, close off the air inlet valves (i.e., cover the cartridges with your hands), inhale gently to collapse the facepiece slightly, and hold your breath for 10 seconds. If the facepiece remains slightly collapsed and no leakage is detected, the respirator fits properly.

## Cleaning and Storage

Respirators should be regularly cleaned and disinfected. Respirators issued for the exclusive use of one worker may be cleaned as often as necessary. Weekly or monthly cleaning is usually adequate but more frequent cleaning may be necessary. Shared respirators or emergency use respirators must be cleaned and disinfected after each use. To properly clean a respirator, follow these steps

- a. Remove any filters or cartridges. Disassemble valves and other reusable facepiece parts.
- b. Wash the facepiece and associated parts) with a mild detergent and warm water. Liquid dish washing detergent works well. Do not use organic solvents.
- c. Rinse the respirator facepiece and parts in clean, warm water.  
Prepare a disinfectant solution to kill germs Note: Some cleaning solutions will also act as a disinfectant.
- d. Immerse the facepiece and parts in the disinfectant solution for two minutes. Rinse with clean warm water and air dry overnight.
- e. After drying, reassemble the respirator and place the facepiece in a sealable plastic bag other air-tight container. Zip-lock baggies work well as storage containers for smaller respirators

## Cartridge Use

If a cartridge does not have an end of service life indicator, EHS will develop a cartridge change out schedule based on data that will insure that canisters and cartridges are changed before the end of their service life.



**Appendix D. (Mandatory) Information for Employees Using Respirators When not Required Under Standard**

**Appendix D  
Information for Employees Using Respirators When Not Required Under the Standard (Mandatory)**

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

[63 FR 1152, Jan. 8, 1998; 63 FR 20098, April 23, 1998]



**Appendix E. MSU Training on Respiratory Protection Answer Key**

Name \_\_\_\_\_ Date \_\_\_\_\_ Department \_\_\_\_\_

1. **What are the respiratory hazards and health effects of the substances with which you are working?**
2. **It is necessary to wear a respirator because:**
  - a. Wearing a respirator may be required by law
  - b. A respirator protects against harmful or toxic airborne contaminants
  - c. A respirator may protect your eyes
  - d. **All of the above**
3. **Which of the following are considered when selecting a respirator?**
  - a. Protection factor
  - b. Other PPE that may be needed while wearing a respirator
  - c. Comfort for the user
  - d. Contaminant the respirator will be used for
  - e. **All of these are used to when selecting a respirator**
4. **How does a respirator work?**
  - a. It removes the source of contamination
  - b. **It creates a seal on your face forcing inhaled air to be filtered**
  - c. It makes the chemicals non-hazardous
  - d. None of the above
5. **A person must have current medical clearance to use a respirator.**
  - a. **True**
  - b. False
6. **Which is a purpose of a fit test?**
  - a. **To assure that the respirator creates a good seal with your face**
  - b. To assess if a chemical being used is hazardous
  - c. To make sure you are wearing the right chemical gloves
7. **How can you test the fit and function of a respirator before you wear it?**
  - a. It is not possible to check the fit
  - b. Expose yourself to a chemical and see if you smell it
  - c. **Perform a positive and negative pressure check**
  - d. There is no need to check the fit of your respirator
8. **What are some proper ways to store a respirator? Choose two.**
  - a. Throw it in a box when you are done
  - b. Hang it on a hook
  - c. **Put it in a bag, and keep it away from chemicals**
  - d. **Make sure the respirator is not bent out of shape**
9. **What should you do when the respirator malfunctions?**
  - a. Go to an area with clean air immediately
  - b. Fix the respirator before it is used again
  - c. Just keep working
  - d. **Both A and B**



**Occupational Safety**  
Environmental Safety & Health

- 10. Which medical conditions can be aggravated by wearing a respirator?**
- a. Bad knee joint and arthritis
  - b. Hair loss
  - c. **Asthma and high blood pressure**
  - d. Wearing a respirator will not aggravate any medical conditions
- 11. What are general requirements of the “Respirator Law” 29 CFR 1910.134?**
- a. Medical evaluation
  - b. Fit testing
  - c. Written plan
  - d. Annual refit testing
  - e. **All of the above**



Appendix F. MSU Retraining on Respiratory Protection Test Answer Key

## MSU Re-Training on Respiratory Protection Answer Key

Name \_\_\_\_\_ Department \_\_\_\_\_ Date \_\_\_\_\_

1. **What are you exposed to that you use a respirator?**
2. **What type of respirator do you wear (cartridge, PAPR, SCBA)?**
3. **How often do you use it?**
4. **In what ways do improper fit, usage or maintenance affect the protection your respirator gives you?**

These all affect the ability of the respirator to filter or remove contaminants. If the respirator does not fit, there may be a direct route for contaminants to be inhaled. Improper maintenance may cause the respirator to malfunction.

5. **What are the limitation and capabilities of a respirator?**

Air purifying (cartridge, filtering mask, PAPR) cannot supply air, cannot be used in IDLH environment, and are specific to the contaminant.

SCBA has time limit and hinders maneuvering.

Supplied air can hinder maneuvering.

6. **What should be done in an emergency situation, especially if the respirator malfunctions?**

Leave the contaminated area. Do not reenter until the proper functioning equipment is in place.

7. **What should be inspected on a respirator before and after each use?**

Straps, valves, sealing surface, face piece (on full face), cartridges correct for contaminant (if cartridge style).

8. **How can you check the seals of the respirator?**

Negative pressure check (cover filters and breathe in).

Positive pressure check (cover exhalation and breathe out).

9. **List three aspects of proper maintenance and storage of respirators.**

Regular cleaning, storage in a non-contaminated area, regular inspection, storage in a baggie, storage in such a way that it does not affect the shape of the respirator.

10. **What are the medical signs and symptoms that may limit the effective use of a respirator?**

Asthma, heart conditions, COPD, extreme claustrophobia.

11. **Which of the following are general requirements of the law (OSHA 1910.134)?**

A. Written plan

B. Annual re-fit testing

C. This training

D. Record keeping

E. All of the above



**12. Do you have any problems when you wear the respirator?**

***EHS Use Only:***

**13. Condition of respirator**

**14. Is the respirator clean?**

**15. Comments**