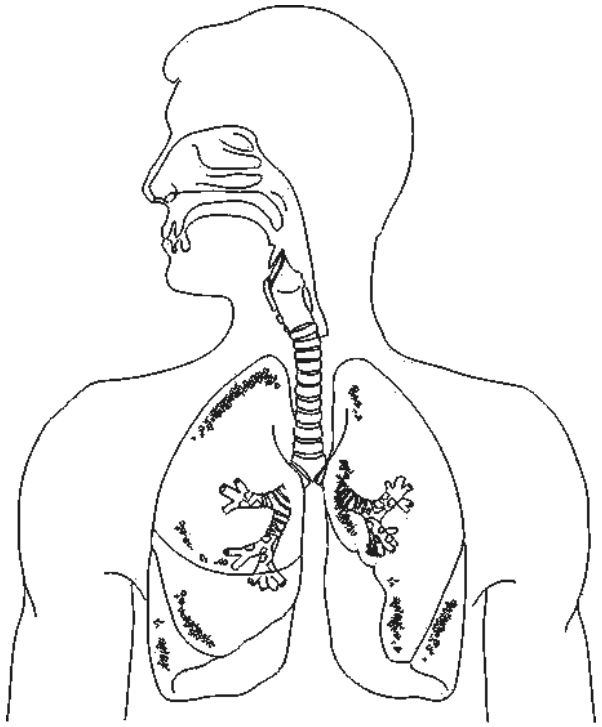
MICHIGAN STATE UNIVERSITY

RESPIRATORY PROTECTION PROGRAM



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Office of Radiation, Chemical and Biological Safety

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Table Of Contents

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. The Office of Radiation, Chemical and Biological Safety

The Office of Radiation, Chemical & Biological Safety (ORCBS) is responsible for the development, documentation, and administration of the Michigan State University respirator program. The Chemical Safety Officer shall serve as the Respirator Program Administrator. The ORCBS 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. University Physician's Office

The University Occupational Health Services at Olin 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 University Occupational Health Services 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. Provide detailed instructions to employees on cleaning, inspecting, repairing, and storing respirators.
5. Maintain an inventory of spare parts and new respirators if necessary.
6. Conduct work site inspections to review unit compliance with respirator regulations.
7. Maintain records of respirator equipment inspections, training, and fit testing at the unit level.
8. 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 Olin and the ORCBS respirator wearer questionnaires.
2. Use respirators in accordance with instructions and training received from supervisors and the ORCBS.
3. Store, clean, maintain, and guard against damage to respirator equipment.
4. Report any deficiencies or malfunctions of a respirator to a supervisor or the ORCBS.
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

      These types of respirators have a facepiece that is composed mostly of the filter. They do not provide as high of a level of protection as a half-mask respirator.

      i. N95 respirators
         These respirators are used on campus for protection against biohazardous aerosols. They do not filter any organic vapors, acid gases or provide adequate protection against particulates. 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 1),
         Dust masks, which are generally used for nuisance dust such as cement and hay dusts are also filtering facepieces. They do not filter any organic vapors, acid gases or provide adequate protection against particulates. This type of respirator does not have a NIOSH approval number, and can not be fit tested. They should not be used as a substitute for an N95, or for any tight fitting half or fullface respirator. These respirators should be discarded when resistance to breathing becomes excessive, or after each use.

   b) The half-mask (picture 2) and full facepiece (picture 3) 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)

   c) 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.

Picture 1: Dust Mask

Picture 2: Half face

Picture 3: Full Face

Picture 4:SCBA

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, hood. See picture 4.

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.

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 University 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. The University 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 Olin for review. Olin 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 University 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 μm)
   ii. Fumes. Solid condensation particles of small diameter (0.1 to 1.0 μm)
   iii. Mists. Liquid particulate matter (5 to 100 μm)
   iv. Smoke. Chemically generated particulates (solid and liquid) of organic origins (0.01 to 0.3 μm)

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 voids 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, the ORCBS 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 the ORCBS 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 ORCBS representative, indicates that the wearer has successfully completed the Olin respirator certification program and the ORCBS quantitative 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, breath 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 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, breath 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.

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

Respirator Type	Qualitative	Quantitative
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	Yes
PAPR	Yes	Yes
Supplied-Air Respirators (SAR) used in Negative Pressure (Demand Mode)(>100 fit factor), or SCBA	No	Yes
Supplied-Air Respirators (SAR), used in Positive Pressure (Pressure Demand Mode) or SCBA	Yes	Yes
SCBA - Structural Fire Fighting, Positive Pressure	Yes	Yes
SCBA/SAR - IDLH, Positive Pressure	Yes	Yes
Mouthbit Respirators	Fit- testing Not Required	
Loose-fitting Respirators (e.g., hoods, helmets)	Fit- testing Not Required	

3. Field Fit Checks
   After successfully completing an initial ORCBS 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, faceshield 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 Olin, fit testing, training and provisions of a cartridge change out program from the ORCBS.

B. Voluntary Use of Respirators

When an employee chooses to use a dust mask for comfort, and not for protection against levels of contaminants that would require respiratory protection, the employee does not

need training or fit testing. If an employee chooses to use a respirator with a tight fitting facepiece (i.e. a rubber half face) for comfort, then employee must be placed in the MSU respiratory protection program.

It is largely the responsibility of the supervisor to assure that employees wearing dust masks on a voluntary basis do not wear these respirators in a situation that would require a respirator, such as above the exposure limit or action level. Call the ORCBS to evaluate respiratory hazards.

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.
- Wearing a dust mask while weighing a non-toxic powdered chemical in a lab.
- Wearing a dust mask for comfort while sifting soil samples.

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

- Wearing a rubber 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 a 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 the ORCBS 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. The ORCBS 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 to ensure that it is in proper working condition use. 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 faceshield
- ✓ Protective screens that are intact and fit correctly over faceshields, 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. Under no circumstances should air purifying respirators be used in an IDLH atmosphere. When respirators are required for entry into IDLH atmospheres, an supplied air respirator shall be used, and at least one standby person shall be present in a safe area. The standby person shall have the proper equipment available to assist the respirator wearers in case of emergency. Communications (visual, voice, signal-line, telephone, radio, or other suitable means) shall be maintained between the standby person and the respirator wearers. Respirator wearers in IDLH atmospheres shall be equipped with a safety harness and a safety line to permit them to be removed to a safe area in case of an emergency.

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. The ORCBS 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[a] or positive pressure[b]).
   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[c]
   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[d]
   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.

[a] Device produces negative pressure in respiratory-inlet covering during inhalation

[b] Device produces positive pressure in respiratory-inlet covering during both inhalation and exhalation

[c] 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

[d] 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

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 the ORCBS/Olin respirator wearer questionnaire. This questionnaire will be used for respirator selection purposes/and medical screening information.

TABLE 3.

Classification of Respiratory Hazards According to Their Biological Effect

Oxygen Deficiency

Minimum legal requirements: 19.5% oxygen by volume for respirable air at sea-level conditions

Occurrence: Confined or unventilated cellars, wells, mines, ship holds, tanks, burning buildings, and enclosures containing inert atmospheres:

Atmospheric oxygen content (percent by volume) versus expected physical conditions:
20.9%: Oxygen content of normal air at sea-level conditions.

Oxygen Percent Volume	Physiological Effects
16%-12%	Loss of peripheral vision, increased breathing volume, accelerated heartbeat, impaired attention and thinking, impaired coordination
12%-10%	Very faulty judgment, very poor muscular coordination, muscular exertion causes fatigue that may cause permanent heart damage, intermittent respiration.
10%-6%	Nausea, vomiting, inability to perform vigorous movement, unconsciousness followed by death
Less than 6%	Spasmatic breathing, convulsive movements, death in minutes

Gas and Vapor Contaminants

Asphyxiants: 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).

Irritants: 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)

Anesthetics: 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]).

Sensitizers: Cause increased probability of physiological reactions (for example: isocyanates, epoxy resin systems).

Systemic poisons: 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]).

Carcinogens: Produce cancer in some individuals after a latent period (for example: vinyl chloride, benzene).

Particulate Contaminants
(dust, fog, fume, mist, smoke, and spray)

Relatively inert: May cause discomfort and minor irritation, but generally without injury at reasonable concentrations (for example: marble, gypsum).

Pulmonary-fibrosis-producing: Produce nodulation and fibrosis in the lung, possibly leading to complications (for example: quartz, asbestos). Chemical irritants: Produce irritation, inflammation, and ulceration in upper respiratory tract (for example: acidic mists, alkalies).

Carcinogens: Produce cancer in some individuals after a latent period (for example: vinyl chloride, benzene).

Combinations of Gas, Vapor, and Particulate Contaminants

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.

From ANSI Standard Z88.2-1980

TABLE 4.

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

Gas and Vapor Contaminants	Particulate Contaminants
Inert: 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). **Acidic**: 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). **Alkaline**: 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). **Organic**: 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). **Organometallic**: Compounds in which metals are chemically bonded to organic groups (for example: ethyl silicate, tetraethyl lead, and organic phosphate). **Hydrides**: Compounds in which hydrogen is chemically bonded to metals and certain other elements (for example: diborane and tetraborane).	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: **Dust**: A solid, mechanically produced particle with sizes varying from submicroscopic to visible or macroscopic. Spray: A liquid, mechanically produced particle with sizes generally in the visible or macroscopic range **Fume**: A solid condensation particle of extremely small particle size, generally less than one micrometer in diameter **Smoke**: 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.

From ANSI Standard Z88.2-1980TABLE 5.

TABLE 5.

Assigned Protection Factor Classifications of Respirators for Protection Against Particulate Exposures

Assigned Protection Factor	Type of Respirator
5	Single-use or quarter mask respirator
10	Any air-purifying half-mask respirator including disposable (see definition in Glossary) equipped with any type of particulate filter except single use.
	Any air-purifying full facepiece respirator equipped with any type of particulate filter.
	Any supplied-air respirator equipped with a half-mask and operated in a demand (negative pressure) mode.
25	Any powered air-purifying respirator equipped with a hood or helmet and any type of particulate filter.
	Any supplied-air respirator equipped with a hood or helmet and operated in a continuous flow mode.
50	Any air-purifying full facepiece respirator equipped with a high efficiency filter.
	Any powered air-purifying respirator equipped with a tight-fitting facepiece and a high efficiency filter.
	Any supplied-air respirator equipped with a full facepiece and operated in a demand (negative pressure) mode.
	Any supplied-air respirator equipped with a tight-fitting facepiece and operated in a continuous flow mode.
	Any self-contained respirator equipped with a full facepiece and operated in a demand (negative pressure) mode
1000	Any supplied-air respirator equipped with a half-mask and operated in a pressure demand or other positive pressure mode.
2000	Any supplied-air respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
10000	Any self-contained respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
	Any supplied-air respirator equipped with a full facepiece operated in a pressure demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure demand or other positive pressure mode.

From NIOSH Guide to Industrial Respiratory Protection DHHS Publication No. 87-116, 1987

TABLE 6.

Assigned Protection Factor Classifications of Respirators for Protection Against Gas/Vapor Exposures

Assigned Protection Factor	Type of Respirator
10	Any air-purifying half face respirator (including disposable) equipped with appropriate gas/vapor cartridges.
	Any supplied-air respirator equipped with a half face and operated in a demand (negative pressure) mode.
25	Any powered air-purifying respirator with a loose-fitting hood or helmet.
	Any supplied-air respirator equipped with a hood or helmet and operated in a continuous flow mode.
50	Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges or gas mask (canister respirator).
	Any powered air-purifying respirator equipped with a tight-fitting facepiece and appropriate gas/vapor cartridges or canisters.
	Any supplied-air respirator equipped with a full facepiece and operated in a demand (negative pressure) mode.
	Any supplied-air respirator equipped with a tight-fitting facepiece operated in a continuous flow mode.
	Any self-contained respirator equipped with a full facepiece and operated in a demand (negative pressure) mode.
1000	Any supplied-air respirator equipped with a half-mask and operated in a pressure demand or other positive pressure mode.
2000	Any supplied-air respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
10000	Any self-contained respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
	Any supplied-air respirator equipped with a full facepiece operated in a pressure demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure demand or other positive pressure mode.

From NIOSH Guide to Industrial Respiratory Protection
DHHS Publication No. 87-116, 1987

TABLE 7.

Assigned Protection Factor Classifications of Respirators for Protection Against Combination Gas/Vapor and Particulate Exposures

Assigned Protection Factor	Type of Respirator
10	Any air-purifying half-mask respirator equipped with appropriate gas/vapor cartridges in combination with any type of particulate filter.
	Any full facepiece respirator with appropriate gas/vapor cartridges in combination with a dust or mist or fume; dust and mist; or dust, mist, and fume filter.
	Any supplied-air respirator equipped with a half-mask and operated in a demand (neg. pressure) mode.
25	Any powered air-purifying respirator equipped with a loose-fitting hood or helmet
	Any supplied-air respirator equipped with a hood or helmet and operated in a continuous flow mode.
50	Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridge in combination with a high efficiency filter or an appropriate canister incorporating a high efficiency filter.
	Any powered air-purifying respirator with a tight-fitting facepiece equipped with appropriate gas/vapor cartridges in combination with a high efficiency filter or an appropriate canister incorporating a high efficiency filter.
	Any supplied-air respirator equipped with a full facepiece and operated in demand (neg. pressure) mode.
	Any supplied-air respirator equipped with a tight-fitting facepiece and operated in a continuous flow mode.
	Any self-contained respirator equipped with a full facepiece and operated in a demand (neg. pressure) mode.
1000	Any supplied-air respirator equipped with a half-mask and operated in a pressure demand or other positive pressure mode.
2000	Any supplied-air respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
10000	Any self-contained respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
	Any supplied-air respirator equipped with a full facepiece operated in a pressure demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure demand or other positive pressure mode.

From NIOSH Guide to Industrial Respiratory Protection DHHS Publication No. 87-116, 1987

Appendix A

LAST NAME ZERO
FIRST NAME TEST

FIT TEST REPORT

Fit Test Information

ID NUMBER	1234		
LAST NAME	ZERO	**CUSTOM1**	
FIRST NAME	TEST	**CUSTOM2**	
COMPANY		**CUSTOM3**	
LOCATION		**CUSTOM4**	
NOTE	CONFIRMS MAX FIT FACTOR		
TEST DATE	02/15/2000	**PORTACOUNT S/N**	41834
TEST TIME	09:24	**N95 COMPANION**	N
DUE DATE	02/15/2001		
RESPIRATOR		**PROTOCOL**	DEFAULT 29CFR1910.134
MANUFACTURER	TSI	**PASS LEVEL**	500
MODEL	ZERO FILTER		
MASK STYLE	1602066		
MASK SIZE	FILTER		
APPROVAL			
EFF. <99%	N		

EXERCISE	DURATION (SEC)	FIT FACTOR	PASS
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 _____ DATE _____
WEINSTEIN

NAME _____ DATE _____
TEST ZERO

Appendix B

Survivair Respirator Cartridge Service Life Estimate

Employee Information

Date:	Joe Respirator
Employee Number:	000-00-0000
Job Title/Job Description:	Respirator Wearer
Employer:	University
Employer Location/Address:	Campus
Comments:	Survivair Blue 1 Half Mask

Estimated Cartridge Service Life

Survivair Cartridge Model:	7853
Estimated Service Life:	8.51 Hours
	510.67 Minutes

Contaminant Information

Contaminant Name:	Acetic acid	
Contaminant CAS Number:	64-19-7	
Permissible Exposure Limits:	Exposure Limit (PEL, TLV, WEEL):	10.0000 ppm
	STEL (OSHA, TLV):	15.0000 ppm
	Ceiling (OSHA, TLV):	0.0000 ppm
	IDLH:	50.0000 ppm

Work Site Parameters

Contaminant Concentration:	5.0000 ppm
Temperature:	23.9 C
Relative Humidity:	66% to 80%
Work Rate:	Moderate - continuous movement (50 lpm)
Safety Factor:	%

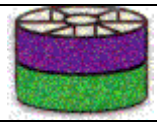
Warnings and Limitations of Liability

This program was prepared using the most recent data available. This information was taken from the results of testing and from published sources believed to be accurate. SURVIVAIR makes no warranty that the information used to prepare this program or the results obtained by its use, is truly accurate and does not imply warranty of merchantability, or fitness for a particular purpose.

No other oral warranties, representations, or guarantees of any kind have been made by SURVIVAIR, its distributors, or the agents of either of them, that in any way alters the terms of this warranty. Except as herein provided, SURVIVAIR shall have no liability for any loss or damage, whether direct, indirect, incidental, or consequential, to any purchaser of this program arising from the sale, use, or operation of this program.

SURVIVAIR reserves the right to incorporate design changes into any of its products, or this program, at any time without prior notification of the users of the products. This includes, but is not limited to, the effect the changes may have on the cartridge service life calculation estimates prepared by this program.

Appendix C

SURVIVAIR CARTRIDGES MSU ORCBS				
CARTRIDGE ORDER #	DESCRIPTION	APPROVED FOR:	PHYSICAL PLANT CODE #	CARTRIDGE TYPE / COLOR
100144	Organic Vapors Cartridge	Organic vapors	OB485	
100344	Organic Vapors/ Acid Gases Cartridge	Organic vapors, chlorine, hydrogen chloride, sulfur dioxide, or chlorine dioxide, hydrogen fluoride or hydrogen sulfide (escape only)	OB550	
105014	P100 Filter	At least 99.97% efficient against all types of particulate aerosols	9A900	
105810	Multi-Contaminant (MC) Cartridge/P100 Filter	Ammonia, chlorine, chlorine dioxide, hydrogen chloride, hydrogen fluoride, hydrogen sulfide (escape only), formaldehyde, methylamine, sulfur dioxide or organic vapors; at least 99.97% efficient against all types of particulate aerosols	OH458	
105314	Organic Vapor/Acid Gases Cartridge/P100 Filter	Organic vapors; chlorine, hydrogen chloride, chlorine dioxide or sulfur dioxide; hydrogen fluoride or hydrogen sulfide (escape only); at least 99.97% efficient against all types of particulate aerosols	3A500	
105410	Ammonia/Methylamine Cartridge/P100 Filter	Ammonia or methylamine; at least 99.97% efficient against all types of particulate aerosols late aerosols.	8F009	
210010	Half Mask Respirator Small	Blue 1 Series Small Half Mask Respirator Small	OB378	
220010	Half Mask Respirator Medium	Blue 1 Series Half Mask Respirator Medium	4C216	
230010	Half Mask Respirator Large	Blue 1 Series Half Mask Respirator Large	6E 243	
420010	Full Face Respirator Standard Size	Full Face Respirator Standard Size		
410010	Full Face Respirator Small Size	Full Face Respirator Small Size		

Employee Name_____Contaminant_____

Cartridge_____Use Recommendation_____

Estimated Service Life_____

Notes:_____

_____

_____

Appendix D

MSU Training on Respiratory Protection

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 cleans all of the air around you
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. 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

6. 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

7. 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

8. 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

9. Which medical conditions can be aggravated by wearing a respirator?
a. Bad knee joint and arthritis
b. Hairloss
c. Asthma and high blood pressure
d. Wearing a respirator will not aggravate any medical conditions

10. What are general requirements of the "Respirator Law" 29 CFR 1910.134?

a. Fit testing
b. Written plan
c. Annual refit testing
d. All of the above

Appendix E

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 the ORCBS. 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 , the ORCBS will fit test the wearer in their own respirator, and conduct retraining.

Fit Checks.

After successfully completing an initial ORCBS 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 an 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, the ORCBS 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.

MSU Re-Training on Respiratory Protection
Answer Key

1. **Why is wearing a respirator necessary? What type of respirator do you wear?**

   To protect against airborne contaminants such as particulates or vapors that may be toxic or harmful. Wearing a respirator may be required by law.

2. **In what ways do improper fit, usage or maintenance compromise the protection of a respirator?**

   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.

3. **What are the limitations and capabilities of a respirator?**

   Air Purifying Respirators do not supply oxygen and can not be used at very high concentrations of contaminants. They do filter or remove airborne contaminants.

4. **What should be done in an emergency situation, including situations in which the respirator malfunctions?**

   Leave the contaminated area and go to an area with non-contaminated air.

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

   Straps, inhalation and exhalation valves, the facepiece, the fit .

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

   Positive and negative pressure fit checks

7. **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 does not effect the shape of the respirator.

8. **What are the medical signs and symptoms that may limit the effective use of a respirator? Do any of these happen to you while wearing a respirator?**

   Hard time breathing, unusually high heart rate, smoking.

9. **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

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