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## **1.0 PURPOSE**

The California State University Sacramento (CSUS) Respiratory Protection Program has been established to maintain, insofar as it is reasonable within the control of the University, an environment that will not adversely affect the health, safety, and well-being of employees. The safety of employees is the major concern. Because of the potential hazards involved from exposure to hazardous substances and atmospheres, the CSUS Office of Environmental Health & Safety (EH&S) will provide guidance on the selection, use, care, and maintenance of respiratory protective equipment and develop safe procedures for their use. All activities involving the use of respiratory protective equipment, including operations, maintenance and research activities in all facilities controlled by CSUS shall be conducted in compliance with California Code of Regulations, Title 8, Section 5144 (Respiratory Protective Equipment) and Code of Federal Regulations, Title 29, Section 1910.134 and the provisions of this program.

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## **2.0 SCOPE**

This program applies, (but is not limited to), any CSUS employees required to wear respiratory protective equipment because their work activities provide for potential exposure to toxic air contaminants that cannot be safely controlled by engineering methods, or by substitution of a less toxic or hazardous material. Additionally, for employees who voluntarily request the use of a respirator, this program shall also apply (exception – the written respiratory protection program does not apply to those employees whose only use of respirators involves the voluntary use of filtering facepieces (dust masks)).

Respiratory protective equipment may be required for work during extended periods or for short-term projects where engineering controls are not practical. Respiratory protective equipment is required for work in:

- a. Environments with toxic contaminant and radioactive levels exceeding acceptable limits.
- b. For emergency use situations.

The workers at CSUS are not trained in using or provided supplied air respiratory protective equipment; therefore, work in oxygen deficient atmospheres is not permitted unless proper ventilation controls are implemented. For work in a confined space, the operations and procedures presented in the CSUS Confined Space Program should be used.

This program will be reviewed annually for any potential updates to regulatory requirements, and also reviewed in when an event led to the mis-use of respiratory protection.

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## **3.0 RESPONSIBILITIES**

It is CSUS policy to provide a safe workplace and to communicate effective information and training necessary to minimize potential hazards to employees and students. Due to the potential risks from

exposure to hazardous substance in the work place, CSUS establishes a Respiratory Protection Program. The program responsibilities are shared by EH&S, Supervisors and the employee.

### **3.1 Office of Environmental, Health and Safety**

The CSUS Office of Environmental Health and Safety is responsible for:

- a. Maintaining the Respiratory Protection Program, including records pertaining to medical evaluation, training and fit testing.
- b. Providing assistance in reviewing purchases of respiratory protective equipment when requested.
- c. Providing instruction and training on the need for respiratory protective equipment; the selection criteria; and respirator fit testing, use and maintenance.
- d. Conducting initial, annual, and other required fit tests for employees who utilize respiratory protective equipment.
- e. Referring employees for medical evaluation prior to wearing a respirator.
- f. Conducting inspections, upon request, for respiratory equipment usage, maintenance, and storage.

### **3.2 Supervisor:**

Each person in charge of any employee, e.g. building trades and building service engineering workers, engaged in work activities is responsible for:

- a. Notifying and arranging with EH&S of the need for respiratory protective equipment.
- b. Identifying, with assistance from EH&S, those employees who may need respiratory protective equipment, and scheduling them for fit testing and training in the proper use of such equipment.
- c. Arranging through EH&S, initial, annual and exit physical examinations for all employees required to wear respirators while performing assigned duties.
- d. Requesting assistance from EH&S in evaluating new and non-routine operations that may present health and safety hazards.
- e. Adhering to guidelines for work with any hazardous materials.
- f. Purchasing respirators and cartridges.
- g. Evaluating, approving (with assistance from EH&S) and selecting all respiratory protection devices before they are purchased.

### **3.3 Employee:**

Any CSUS employee or person who is required to wear respiratory protective equipment is responsible for:

- a. Utilizing the issued respiratory protective device in accordance with instructions and training provided by EH&S and in accordance with the standard operating procedures of this program.
  - b. Successfully completing respiratory protection training.
  - c. Successfully completing the prescribed medical evaluation prior to wearing a respirator.
  - d. Successfully completing a respirator fit test.
  - e. Promptly informing his/her supervisor of any personal health problems that may arise which could be aggravated by the use of respiratory protective equipment.
- Guarding against damage and insuring that the respirators are not disassembled,

modified, or otherwise altered in any way other than by changing the respiratory cartridges/filters.

- Reporting any observed or suspected malfunctioning respirator to the supervisor.
- Using only the specific respiratory protective units for which they have been trained and fit tested.

### **3.4 Authorization of Use of Respiratory Protective Devices**

Only those persons designated by the supervisor and who are engaged in work requiring the use of respiratory protective equipment, and who have been properly fitted and trained shall use such equipment. Voluntary use of a respirator must be approved by the supervisor and the Office of Environmental Health & Safety.

## **4.0 MEDICAL EVALUATION**

Each employee, whose duties require the use of a respirator, will be required to complete a medical examination prior to use of a respirator. The medical examination will be completed by the CSUS medical provider and at no cost to the employee. The medical examination will be completed annually or more frequently if the employee is accidentally exposed to asbestos, hazardous materials or hazardous wastes during the course of work. In addition, an occupational medical examination will be conducted on an employee:

- a. Who works or may potentially work with asbestos containing materials, and hazardous materials and wastes.
- b. Who reports to a supervisor the presence of a health problem that could be aggravated by the use of respiratory protective equipment.
- c. Who has previously used respiratory protective equipment but has experienced respiratory, cardiovascular, or gastrointestinal problems that might prove hazardous to their health and safety.

## **5.0 EDUCATION & TRAINING**

Training of employees in the use of respirators shall include a complete description of equipment used including its purpose and function. Training shall also include the care, inspection, maintenance, cleaning, and storage of the respiratory protective device(s). Instruction shall be provided in the proper donning of a respirator and the negative and positive pressure fit check procedure. Training shall be provided before employee uses respiratory protective equipment, and annually thereafter. The CSUS EH&S shall provide instruction on:

- a. Identification and evaluation of hazards.
- b. Oxygen deficient atmospheres.
- c. Assigned protection factors
- d. Selection and Limitation of Respirators.
- e. Qualitative fit Testing procedures.
- f. Limitations and the availability of specific cartridges intended for the particular hazards.

- g. Proper donning
- h. Negative and positive pressure checks
- i. Maintenance, cleaning, and storage

### **6.0 RESPIRATOR SELECTION**

Air purifying respirators will be selected by a qualified health and safety professional of the CSUS EH&S. The following factors should be considered when selecting and wearing an air purifying respirator:

- a. Improper use of a respirator may result in damage to an individual's health, including certain delayed lung diseases such as silicosis, pneumoconiosis, or asbestosis. These diseases may cause death.
- b. Air purifying respirators are **not** designed to be used in any atmosphere:
  - That is immediately dangerous to your life or health (IDLH).
  - From which you **CANNOT** escape without the aid of the respiratory protective equipment.
  - Containing less than 19.5 percent oxygen.
  - With unknown contaminants. Under the aforementioned conditions, air supplied respiratory protective equipment or self-contained breathing apparatus are needed.
  - Where the chemical has poor warning properties
- c. **DO NOT** wear an air purifying respirator until you have:
  - Completed the medical examination and been approved by the CSUS medical provider.
  - Been trained by the CSUS EH&S in the use of the respirator.
  - Completed a respirator fit test.
- d. **DO NOT** modify or alter your respirator in any manner, unless specified in the respirator's instruction manual. Use only NIOSH approved components and replacement parts for your specific respirator. Failure to use NIOSH approved components and a replacement part **VOIDS** the NIOSH approval of the entire respirator, invalidates all manufacturers' warranties, and may result in lung disease or exposure to other hazardous or life threatening conditions.
- e. Inspect all components of your respirator daily for signs of tear, damage, or wear that may reduce the degree of protection provided. Immediately replace any worn or damaged components with NIOSH approved components or remove the respirator from service. See the **MAINTENANCE** section of this manual (Section 9.0) for proper inspection, cleaning, and storage of your respirator.
- f. If you have any questions concerning the use and care of your respirator, ask your supervisor. For technical assistance or additional information about your respirator or conditions of use, contact CSUS Office Of Environmental Health & Safety (916) 278-6119

The proper type of respirator must be selected using the Respirator Decision Logic Sequence in the National Institute type of Occupational Safety and Health (NIOSH) document, *NIOSH Respiratory Decision Logic*, USDHHS, 2004 or as prescribed by the respirator manufacturer. The Respirator Selection Logic Sequence can be found in Appendix A and also in Appendix B. The text should be reviewed as part of the respirator selection process and a copy of the text can be obtained from EH&S.

In addition, the following questions should be answered to assist in selecting the proper respirator.

- a. Is the contaminant a gas, vapor, mist, dust, or fume (or a combination of these)?
- b. What is the estimated contaminant concentration? Will that concentration vary?
- c. What is the Permissible Exposure Limit (PEL) or the Threshold Limit Value for the contaminant?
- d. Could the contaminant concentration be Immediately Dangerous to Life and Health (IDLH)?
- e. If the contaminant is flammable does the estimated concentration approach the Lower Explosive Limit (LEL)?
- f. Does the contaminant have adequate warning properties?
- g. Will the contaminant irritate the eyes at the estimated concentration?
- h. If the contaminant is a gas or vapor is there any available absorbent that traps it efficiently?
- i. Can the contaminant be absorbed through the skin as a vapor or a liquid?
- j. What respirator will provide the required protection factor?
- k. Will the respirator be used for routine (daily or frequent) use or non-routine or emergency use?

### **7.0 OPERATING PROCEDURES FOR CERTAIN TYPES OF RESPIRATORY EQUIPMENT**

This section contains operating instructions and limitations for each type of respiratory equipment that may be routinely used at CSUS.

#### **7.1 General Use Limitations**

- a. Facial hair that interferes with face to mask fit is not permitted.
- b. Successful completion of a medical exam
- c. Successful completion of training and fit testing is required.
- d. If an employee exhibits/experiences difficulty in breathing (that is unrelated to respirator functions), during testing or use, the employee shall be referred to a physician to determine fitness to see such equipment while performing assigned duties.

#### **7.2 Dust Masks**

Availability and types for use:

- a. Dust masks of various kinds, including disposable types, may be used for protection against low concentrations of certain nuisance dusts. They must have NIOSH approval.
- a. Limitations. Dust masks provide no protection against gases, vapors, or toxic contaminants. Also they supply no oxygen and therefore they cannot be used in oxygen deficient atmospheres. **These must not be used for asbestos work.**

Procedure: When a dust mask is required for a job situation, the user should:

- a. Put on the mask and adjust it for proper fit. Some masks have adjustable face sealing areas.
- b. Discard a disposable dust mask after use. If the dust mask has a replaceable dust filter, replace the dust filter with a new one when normal breathing becomes difficult or odor breakthrough occurs.

### 7.3 Air Purifying Half Mask Respirators

- a) **Availability and types for use:**  
Half mask respirators are the most widely used types of respirators. Several brands and sizes of these types are available on the market to assure employee comfort and a satisfactory fit. Various types of filters, chemical cartridges, and combination filter cartridges are available for employee protection.
- b) **Limitations:**  
Since this type of respirator does not supply air, it cannot be used in oxygen deficient atmospheres, in IDLH atmospheres, or in confined spaces. It can only be used for protection against the contaminants and the concentration limits specified by the manufacturer. The wearer should leave an area immediately if the employee smells gas or vapor inside the mask or if the breathing resistance increases. No air purifying respirator shall be used against a contaminant which does not display adequate odor or other warning properties. The half mask respirator shall not be worn when facial hair extends under the face mask sealing area.
- c) **Procedure. To put on and adjust the half mask respirator:**
- Use the mask approved for use, as indicated on the Respirator Training/Fit Test Record.
  - Hold the mask so the narrow nose cup points upward.
  - Grasp both lower mask straps and hook them behind the neck allowing the chin to fit in first.
  - Grasp both top straps and hook them behind the head and above the ears making sure of a proper fit on the nose.
  - Adjust the straps so the fit is snug but comfortable by pulling both straps simultaneously to the rear and not outward.
  - Check for leaks by using the qualitative negative/ positive pressure fit check. (See the section on qualitative fit testing.)
  - Each user of respiratory protective equipment must inspect, clean, and maintain the respirator after each use. Any parts showing wear must be replaced at this time with parts approved for specific respirator.

### 7.4 Air Purifying Full Face Mask Respirators

- a. **Availability and types for use:**  
Full face mask respirators provide more protection than half masks because their shape allows a better mask to face seal. They also protect the eyes from irritating chemicals or particulate atmospheres. Full face masks may be equipped with the various types of air purifying filters, chemical cartridges, combination filter cartridges, and gas mask canisters, dependent upon the protection required.
- b. **Limitations:**  
Air purifying full face masks have the same limitations for use as half mask respirators. Additionally, standard eye glasses interfere with the mask to face seal; therefore contact your supervisor and/or EH&S for more information on obtaining a proper pair of eyeglasses which insert into the facemask.
- c. **Procedure: To put on a full mask**

- Loosen all straps, pull the harness over the head, and place the chin in the chin cup.
- Pull the head harness well down on the back of the head.
- Tighten the harness gently, starting with the bottom straps and then the middle and top straps.
- Check the fit by closing off the air hose, or cartridge/canister openings, and using the qualitative negative/positive fit check. See the section on qualitative fit testing.
- Each user of respiratory protective equipment must inspect, clean, and maintain the respirator after each use. Any parts showing wear must be replaced at this time with parts approved for the specific respirator.

### **7.5 Powered Air Purifying Respirators (PAPR)**

- a. Availability and types for use:  
Unlike the previously described half face mask and full face mask air purifying respirators which depend on the wearer's ability to draw air in through the respirator cartridges, define its use limitations. EH&S should be contacted to evaluate individual case circumstances.
- b. PAPRs use a battery powered blower to force air into the face mask under positive pressure. This positive pressure feature provides an extra level of protection. The feature permits the equipment to be used in atmospheres with chemical concentrations exceeding the protection factor limitations of more conventional negative pressure air purifying respiratory equipment. PAPRs will force air to the outside of the mask at any face seal failure point. This feature can permit the equipment to be used by personnel who, due to a disability, are unable to obtain a good fit with negative pressure air purifying respiratory protective equipment.
- c. Limitations:  
Considering that a mechanical device still draws contaminated air through purifying elements and supplies it to the inside of the face mask under positive pressure, these units are subject to similar limitations as negative pressure air purifying respiratory protective equipment; contaminants must possess good warning properties and ambient oxygen concentrations must be adequate to support life. Equipment use requirements will vary depending upon individual case circumstances. Factors requiring the choice of this equipment also

### **7.6 Respirator Cartridges**

Respirator cartridges consist of either a particulate filter, chemical gas and vapor removing, or a combination. The particulate filters are provided in nine classes (three levels of filter efficiency, each with three categories of resistance to filter efficiency degradation). The three levels of filter efficiency are 95%, 99% and 99.97%. The three categories of resistance to filter efficiency degradation are labeled N, R, and P. Based on this information, a particulate filter marked N95 would designate an N-series filter that is at least 95% efficient. The selection of N-, R-, and P series filters depends on the presence or absence of oil particles, as follows:

- a. If no oil particles are present in the work environment, use a filter of any series (i.e., N-, R-or P series).

- b. If oil particles (e.g., lubricants, cutting fluids, glycerine, etc) are present in the work area, use an R- or P-series filter. The R-series filters should be used only for a single shift (or for 8 hours of continuous or intermittent use) when oil is present. Note: N-series filters cannot be used if oil particles are present.
- c. If oil particles are present in the work area and the filter is to be used for more than one work shift, use only a P-series filter.

Therefore, prior to performing work and using particulate filters, the work area should be assessed for the presence of oil particles. Chemical gas and vapor removing cartridges are designed for specific chemical classes (e.g. acid gases, organic vapors, ammonia, etc.). The cartridges and canisters are color coded as specified in the American National Standards Institute (1973) and are as follows: Manufacturers mark combination gas-and vapor-removing and particulate filter cartridges with appropriate colors for each section. For example, a combination organic vapor/high efficiency particulate cartridge is colored black and magenta. Each manufacturer provides information on their cartridges, usually in the form of a colorful wall chart.

Contaminant	Cartridge Color
Acid gas	White
Organic vapor	Black
Ammonia gas	Green
Acid gas and organic vapor	Yellow
Particulate	Gray
High-efficiency particulate air	Purple or Pink
Radioactive material	Magenta

## 8.0 FIT TESTING REQUIREMENTS

Despite respirator design and manufacture to give maximum protection, efficiency can be lost if there is an improper fit. Many manufacturers now produce a given model respirator in two or three sizes permitting proper fit of employees with one brand of respirator. It is imperative that the user know when the respirator fits properly. This can be checked by a number of tests and fitting procedures as outlined below. The negative and positive pressure checks may be conducted with any cartridge of filter. Use of either Smoke Test of the Isoamyl Acetate Vapor Test will depend on the types of cartridge in use of

available.

Qualitative fit testing is limited to protection factors of 10 (ie. ten times the PEL). Although equipment such as full face respirators may be able to provide greater protection, this can only be verified to a maximum of 10 by this method. Quantitative fit testing procedures must be employed for verification of higher protection factors.

### **8.1 Negative Pressure Seal Check**

The wearer can perform this test alone in the field. It consists of merely closing off the inlets of the canister, cartridges or filters by covering with the palms of the hands, or placing seals over the canister or cartridge inlets, or by squeezing breathing tubes so that air cannot pass. Inhale gently so the face piece collapses slightly. Hold the breath for ten seconds. If the face piece remains slightly collapsed and inward leakage is not detected, the respirator is assumed tight and the exhalation valve and face piece is not leaking.

### **8.2 Positive Pressure Seal Check**

This test is much like the negative pressure test. It is conducted by closing off the exhalation valve and exhaling into the face piece. The fit is considered satisfactory if a slight positive pressure can be built up inside the face piece without any evidence of outward leakage. For some respirators the exhalation valve cover must be removed. Carefully replace it after the test.

### **8.3 Fitting Procedures**

- a. An employee shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension, and how to assess a comfortable respirator.
- b. An employee shall conduct the negative and positive pressure fit checks until an acceptable fit is obtained with the selected respirator.
- c. Prior to performing the qualitative fit test, the employee shall be given complete instructions as to their part in the test procedures. The employee shall wear the face piece for at least five minutes before performing the fit check.
- d. Respirator restraining straps should not be over tightened for testing. The straps shall be adjusted by the wearer to give a reasonably comfortable fit typical of normal use.
- e. The employee shall perform the following exercises, in the given order.
  - **Normal breathing.** In the normal standing position, without talking, the employee shall breathe normally for at least one minute.
  - **Deep breathing.** In the normal standing position, the employee shall breathe slowly and deeply for one minute, taking caution so as not to hyperventilate.
  - **Turning head side to side.** Standing in place, the employee shall slowly turn head from side to side between the extreme positions on each side. The head shall be held at each extreme position momentarily so the employee can inhale at each side. Complete this exercise for one minute
  - **Moving head up and down.** Standing in place, the employee shall slowly move head up and down. The employee shall be instructed to inhale in the up position (i.e. when looking toward the ceiling). Complete this exercise for one minute.

- **Reading or Talking.** The employee shall read or talk out loud so as to be heard clearly by the test monitor. The employee can count backward from 100 or read the Rainbow Passage.
- **Bending over.** The employee shall bend at the waist as if the employee were to touch their toes. Complete this exercise for one minute.
- **Normal breathing.** Same as exercise 5a.
  - a. The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of respirator shall be tried. The respirator shall not be adjusted once the fit test exercises begin. Any adjustment voids the test, and the fit test must be repeated.
  - b. Upon successful completion of the qualitative fit test, an individually assigned respirator will be issued to the employee. Confirmation of successful completion of the fit test will be supported by a completed Respirator Training/Fit Test Record form. A copy of this form will be distributed to the employee, employee's supervisor and EH&S as part of the recordkeeping process.

### **8.3.1 Quantitative Fit Testing Procedures**

For quantitative fit testing, a TSI PortaCount will be used to complete the seal testing. Procedures for completing the fit testing will follow the instruction manual for using the PortaCount instrument.

### **8.3.2 Qualitative Fit Testing: Irritant Smoke Test**

This qualitative fit test will be performed in the following manner:

- a. Air purifying respirators should be equipped with a High Efficiency Particulate Air (HEPA) cartridge or a P100 series filter.
  - b. Only stannic chloride smoke tubes shall be used for this protocol.
  - c. No form of test enclosure or hood for the employee shall be used.
  - d. The employee shall conduct a visual inspection and properly don the respirator and wear it for a few minutes prior to fit testing.
  - e. The employee shall perform the negative and positive pressure check prior to the fit test.
  - f. Advise employee that the smoke can be irritating to the eyes and instruct them to keep their eyes closed while the test is performed.
  - g. If the respirator wearer detects the penetration of smoke into the respirator during the test, the wearer should be permitted to re-adjust the seal of the respirator.
  - h. The test operator shall direct the stream of irritant smoke from the smoke tube toward the face seal area of the test subject, using the aspirator squeeze bulb. The test operator shall begin at least 12 inches from the face piece and move the smoke stream around the whole perimeter of the mask. The operator shall gradually make two more passes around the perimeter of the mask, moving to within six inches of the respirator.
- If the respirator wearer still does not detect penetration of the smoke into the respirator, the test monitor should direct the wearer in the series of exercises described above in Section 7.3, item 5.
  - The exercises in Section 7.3, item 5 shall be performed by the test subject while the

respirator seal is being continually challenged by the smoke, directed around the perimeter of the respirator at a distance of six inches.

- If the person being fit tested reports detecting the irritant smoke at any time, the test is failed. The person being retested must repeat the entire sensitivity check and fit test procedure.
- If the respirator wearer is unable to detect penetration of smoke in the respirator, the wearer has achieved satisfactory fit with the respirator.

### **8.3.3 Qualitative Fit Testing: Isoamyl Acetate Vapor (Banana Oil) Test**

The use of the Isoamyl Acetate Vapor & Saccharine Tests for respiratory fit testing will be limited to support Aerosol Transmissible Disease respiratory protection of the N-95 or N-100 masks. If the Isoamyl Acetate Vapor or Saccharine Tests is to be performed, the instructions provided in 29CFR, 1910.134, Appendix A, shall be used.

### **8.4 Fit Testing Requirements**

Qualitative fit testing will be repeated at least annually. Asbestos abatement workers will be tested every six months. In addition, because the seal of the respirator may be affected, qualitative fit testing shall be repeated immediately if the employee has:

- a. A weight change of 20 lbs. or more.
- b. Significant facial scarring in the area of the face piece seal.
- c. Significant dental changes, i.e., multiple extractions without prosthesis, or dentures.
- d. Reconstructive or cosmetic surgery.
- e. Or any other condition that may interfere with face piece sealing.
- f.

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## **9.0 RECORD KEEPING**

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Upon successful completion of the qualitative fit test, EH&S will maintain the following records:

- a. Medical Evaluation Report.
- b. Respiratory Training/Fit Test Record
- c. Respiratory Protection Training Record

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## **10.0 MAINTENANCE & CARE OF RESPIRATORS**

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The maintenance and care of respirators shall include:

- a. Inspection for defects.
- b. Cleaning and disinfecting.
- c. Repair.
- d. Storage

The primary responsibility for maintaining the respirators in proper and clean condition rests with the employee.

### 10.1 Inspection for Defects

Inspections identify damaged or malfunctioning respirators before they can be used. All respirators are to be inspected before and after each use and those not used routinely (i.e., emergency respirators) shall be inspected after each use and at least monthly. Respirator inspections shall include the checking of:

- a. Tightness of the connections.
- b. Face piece.
- c. Valves.
- d. Connecting tubes.
- e. Canisters, filters, or cartridges.

### 10.2 Field Inspection of Air Purifying Respirators

Examine the face piece for:

- a. Excessive dirt.
- b. Cracks, tears, holes, or physical distortion of shape.
- c. Inflexibility of rubber face piece.
- d. Cracked or badly scratched lenses in full face pieces.
- e. Missing mounting clips, badly worn threads, or missing gaskets if required.

Examine the head straps or head harness for:

- a. Breaks.
- b. Loss of elasticity.
- c. Broken or malfunctioning buckles in attachments.
- d. Excessive wear on attachments.
- e. Excessive wear on head harness which might permit slippage.

Examine the exhalation valve for the following after removing its cover:

- a. Foreign material such as detergent residue, dust, or human hair.
- b. Cracks, tears, or distortion in the valve material.
- c. Improper insertion of the valve body in the face piece.
- d. Missing or defective valve cover.
- e. Improper installation of the valve in the valve body.
- f. Incorrect cartridge, canister, or filter for the hazard.

Examine the air purifying element for:

- a. Incorrect installation, loose connections, missing or worn gasket or cross threading in the holder.
- b. Expired shelf life date on the cartridge or canister.
- c. Cracks or dents in the outside case of the filter, cartridge, or canister.

If the device has a corrugated breathing tube examines it for:

- a. Broken or missing end connectors.
- b. Missing or loose hose clamps.
- c. Deterioration, determined by stressing the tube and looking for cracks.

Examine the harness of the front or back mounted gas mask for:

- a. Damage or wear to the canister holder.

- b. Broken harness straps for fastening.

### **10.3 Defects Found In Field Inspection**

If defects are found during any field inspection, two remedies are possible. If the defect is minor, repair and/or adjustment may be made on the spot. If it is major, the device should be removed from service until it can be repaired. A spare unit should replace the unit removed from service. Under no circumstances should a defective device remain in the field. In addition,

- a. All respirators maintained for use in emergency situations shall be inspected at least monthly and in accordance with the manufacturer's recommendations, and shall be checked for proper function before and after each use; and
- b. Emergency escape-only respirators shall be inspected before being carried into the workplace for use.
- c. A check of respirator function, tightness of connections, and the condition of the various parts including, but not limited to, the facepiece, head straps, valves, connecting tube, and cartridges, canister or filters; and
- d. All respirators used in routine situations shall be inspected before each use and during cleaning;

### **10.4 Inspection during Cleaning**

Because respirator cleaning usually involves some disassembly, it presents a good opportunity to examine each respirator thoroughly. Respirators should be inspected after cleaning operations and before reassembly have been accomplished. Respirators whether used routinely or for emergencies, shall be cleaned and disinfected after each use. Respirators should be washed with detergent and warm water using a brush, thoroughly rinsed in clean water, and dried in a clean place. To avoid damaging the rubber and plastic in the respirator face pieces, the cleaning water should not exceed 140 degrees F, not less than 120 degrees F to insure adequate cleaning. The respirators may be allowed to dry in room air on a clean surface.

### **10.5 Storage**

After inspection, cleaning and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture or damaging chemicals.

- a. Respirators, such as dust respirators, will be placed in plastic bags or other suitable containers in designated areas. Respirators should not be stored in such places as vehicles (trunk) or tool boxes unless they are in carrying cases or cartons.
- b. Respirators should be packed or stored so that the face piece and exhalation valve will rest in a normal position and function will not be impaired by the elastomer setting in an abnormal position.
- c. Must be kept accessible to the work area; and

## 11.0 DEFINITIONS

**Aerosol:** Particles, solid, or liquid suspended in air.

**Approved:** Tested and listed as satisfactory by the National Institute for Occupational Safety and Health (NIOSH).

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

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

**Ceiling Limit:** The maximum concentration of an airborne contaminant to which an employee may be exposed at any time.

**Confined Space:** An enclosure such as a storage tank, process vessel, boiler, silo, tank car, pipeline, tube, duct, sewer, underground utility vault, tunnel, or pit that has limited means of egress and poor natural ventilation and that may contain hazardous contaminants or be oxygen deficient.

**Contaminant:** A harmful, irritating, or nuisance material that is foreign to the normal atmosphere.

**Exhalation Valve:** A device that allows exhaled air to leave a respiratory device and prevent outside air from entering through the valve.

**Facepiece:** That portion of a respirator that covers the wearer's nose, mouth, and eyes in a full facepiece. It is designed to make a gas-tight or dust-tight fit with the face and includes the headbands, exhalation valve(s), and connections for an air-purifying device.

**Filter:** A fibrous medium used in respirators to remove solid or liquid particles from the airstream entering the respiratory enclosure.

**Fit Check:** A procedure used to check suitable respirator design and size by blocking the intake port(s), then exhaust port(s), and inhaling and exhaling, respectively.

**High-Efficiency Particulate Aerosol (HEPA) Filter:** A filter designed to remove 99.97 percent of a specific type of particle material from air.

**IDLH Atmosphere:** An atmosphere immediately dangerous to life or health (IDLH). An IDLH atmosphere poses an immediate hazard to life, such as being oxygen deficient (containing less than 19.5 oxygen), contains explosive or flammable atmospheres, and or/concentrations of toxic substances, or procedures an irreversible debilitating effect on health

**Inhalation Valve:** A device that allows respirable air to enter and prevents exhaled air from leaving

the face piece.

**National Institute for Occupational Safety and Health (NIOSH):** A federal agency that tests, approves, and certifies respiratory protection equipment.

**Particulate Matter:** A suspension of fine solid or liquid particles in air, such as asbestos, dust, fog, fume, mist, smoke, or spray. Particulate matter suspended in air is commonly known as an aerosol.

**Permissible Exposure Limit (PEL):** time-weighted average concentration that must not be exceeded during any 8-hour workshift of a 40-hour workweek. Established and enforced by the Occupational Safety and Health Administration.

**Pesticide:** For the purpose of this manual, the terms pesticide and pesticide chemical are synonymous with economic poison, as defined under the United States Department of Agriculture's Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

**Pneumoconiosis-Producing Dust:** Dust that may produce (when inhaled, deposited, and retained in the lungs) signs, symptoms, and findings of pulmonary disease.

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

**Protection Factor (PF):** With respiratory protective equipment - the ratio of the airborne concentration of the contaminant outside the facepiece to the concentration inside the facepiece. For example: if a half-face respirator has a protection factor of 10, it may be used for protection in atmospheres with a contaminant concentration up to 10 times the permissible exposure limit (PEL).

(a) **Assigned Protection Factor (APF)** - The minimum anticipated protection provided by a properly functioning respirator or class of respirators to a given percentage of properly fitted and trained users.

(b) **Workplace Protection Factor (WPF)** - A measure of the protection provided in the workplace by a properly functioning respirator when correctly worn and used.

**Pulmonary Function Test:** Tests requiring use of an approved spirometer including forced vital capacity (FVC) (the maximum amount of air that can be expired from the lung after full inhalation) and forced expiratory volume after one second (FEV1) (the amount of air forcibly expired in one second after full inhalation).

**Qualitative Fit Test:** A test procedure to determine the effectiveness of the seal between the face mask and the wearer's face usually performed during the fitting process. This means of testing relies on the subject's sensory response to detect the challenge agent and could allow the users to wear a respirator without truly knowing if there is an adequate fit.

**Respirator:** A device to protect the wearer from inhalation of harmful airborne contaminants.

**Short Term Exposure Limit (STEL):** A 15-minute time-weighted average exposure which is not to be exceeded at any time during a workday even if the 8-hour time-weighted average is below the PEL.

**Test Subject:** A person wearing a respirator for fit-testing.

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

**Threshold Limit Value (TLV):** A list published yearly by the American Conference of Governmental Industrial Hygienists that refers to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. Airborne particulate concentrations are generally listed as milligrams per cubic meter of air (mg/m<sup>3</sup>), and gaseous concentrations are listed as parts per million (ppm) by volume. TLVs can be provided in the following categories: TLV-Time Weighted Average (TLV-TWA), TLV-Short Term Exposure Limit (TLV-STEL), and the TLV-Ceiling (TLV-C).

**Vapor:** The gaseous state of a substance that is solid or liquid at ordinary temperatures and pressure.

## Appendix A: Respirator Decision Logic Sequence and Filter Change-out Schedule

### Respirator Decision Logic Sequence

After all criteria have been identified and evaluated and after the requirements and restrictions of the respiratory protection program have been met, the following sequence of questions can be used to identify the class of respirators that should provide adequate respiratory protection:

1. Is the respirator intended for use in an oxygen-deficient atmosphere, i.e., less than 19.5% oxygen at sea level?
  - a. If yes, stop. This is an IDLH (immediately dangerous to life and health) environment. Employees are not authorized to enter.
  - b. If no, proceed to Step 2.
2. Is the respirator intended for use during emergency situations?
  - a. If yes, an atmosphere-supplying respirator is recommended.
  - b. If no, proceed to Step 3.
3. Is the exposure concentration of the contaminant, as determined by acceptable industrial hygiene methods, less than the applicable exposure limit? (Whenever a worker is given a respirator to use on a voluntary basis when ambient levels are below applicable limits, OSHA requires the implementation of a complete respiratory protection program, which includes medical evaluation, training, fit testing, periodic environmental monitoring.
  - a. If yes, a respirator would not be required except for an escape situation. Proceed to Step 4.
  - b. If no, proceed to Step 5.
4. Are conditions such that a worker who is required to wear a respirator can escape from the work area and not suffer loss of life or immediate or delayed irreversible health effects if the respirator fails, i.e., are the conditions not immediately dangerous to life or health (IDLH)?
  - a. If yes, conditions are not considered to be IDLH. Proceed to Step 5.
  - b. If no, conditions are considered to be IDLH. Stop. Employees are not authorized to enter or work in that environment.
5. Is the contaminant an eye irritant, or can the contaminant cause eye damage at the exposure concentration?
  - a. If yes, a respirator equipped with a full facepiece, helmet, or hood is recommended. Proceed to Step 6.
  - b. If no, a half-face respirator may still be an option, depending on the exposure concentration. Proceed to Step 6.

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6. Divide the 8-hour time-weighted average (TWA) exposure concentration for the contaminant (or maximum exposure concentration for a contaminant with a ceiling limit) determined in Step 4 by the applicable exposure limit to determine the minimum protection factor has been calculated, proceed to Step 7.
7. If the physical state of the contaminant is a particulate (solid or liquid) during periods of respirator use, proceed to Step 8; if it is a gas or vapor, proceed to Step 9; if it is combination of gas or vapor and particulate, proceed to Step 10.

## 8. Particulate Respirators

- 8.1. Is the particulate respirator intended only for escape purposes?
  - a. If yes, use pre-determined “escape only” respirators.
  - b. If no, the particulate respirator is intended for use during normal work activities. Proceed to Step 8.2.
- 8.2. An atmosphere-supplying respirator, OR a NIOSH-certified filter medium that will provide protection against exposure to the particulate in question is recommended. Refer to the respiratory protection equipment inventory list when choosing the filter (**attach list to this document**). Proceed to Step 8.3.
- 8.3 Respirators that have assigned protection factors (APFs) equal to or greater than the minimum protection factor determined in Step 6 are recommended. Maximum airborne concentrations for each level of respiratory protection can be calculated by multiplying the applicable exposure limit by the APF for that class of respirators. Refer to the respiratory protection equipment inventory list when choosing the filter.

## 9. Gas/Vapor Respirators

- 9.1 Is the gas/vapor respirator intended for “escape only” purposes?
  - a. If yes, use pre-determined “escape only” respirators.
  - b. If no, the gas/vapor is intended for use during normal work activities. Proceed to Step 9.2
- 9.2 Are the warning properties for the gas/vapor contaminant adequate at or below the applicable exposure limit?
  - a. If yes, proceed to Step 9.3
  - b. If no, an atmosphere-supplying respirator, OR an air-purifying respirator equipped with a NIOSH-certified end-of-service-life indicator (ESLI) for the contaminant is recommended. (Note: In the absence of ESLI, a cartridge/canister change schedule based on objective information or data shall be implemented). Refer to the respiratory

protection equipment inventory list when choosing the respirator.  
Proceed to Step 9.4

9.3 An air-purifying chemical cartridge/canister respirator, is recommended that has a sorbent suitable for the chemical properties of the anticipated gas/vapor contaminants and for the anticipated exposure levels. The air-purifying chemical cartridge/canister respirator shall be equipped with a NIOSH-certified end-of-service-life indicator (ESLI) for the contaminant. (Note: In the absence of ESLI, a cartridge/canister change schedule based on objective information or data shall be implemented). Refer to the respiratory protection equipment inventory list when choosing the respirator. Proceed to Step 9.4.

9.4 Respirators that have APFs equal to or greater than the minimum protection factor determined in Step 6 are recommended. Maximum airborne concentrations for each class of respiratory protection can be calculated by multiplying the applicable exposure limit by the APF for that class of respirators. The calculated maximum use concentration limits should not be exceeded. Refer to the respiratory protection equipment inventory list when choosing the respirator.

## 10. Combination Particulate and Gas/Vapor Respirators

10.1. Is the combination respirator intended for “escape only” purposes?

- a. if yes, use pre-determined “escape only” respirators.
- b. If no, the combination respirator is intended for use during normal activities. Proceed to Step 10.2.

10.2. Does the gas/vapor contaminant have adequate warning properties at or below the applicable exposure limit?

- a. If yes, proceed to Step 10.3.
- b. If no, an atmosphere-supplying respirator, or an air-purifying respirator equipped with a NIOSH-certified end-of-service-life indicator (ESLI) for the contaminant is recommended. (Note: In the absence of ESLI, a cartridge/canister change schedule based on objective information or data shall be implemented). Refer to the respiratory protection equipment inventory list when choosing the respirator. Proceed to Step 10.4

10.3 An air-purifying chemical cartridge/canister is recommended that has a particulate prefilter suitable for the specific type(s) of gas/vapor and particulate contaminant(s) and for the exposure concentrations. The air-purifying chemical cartridge/canister respirator shall be equipped with a NIOSH-certified end-of-service-life indicator (ESLI) for the contaminant. (Note: In the absence of ESLI, a cartridge/canister change schedule based on objective information or data shall be implemented). Refer to

the respiratory protection equipment inventory list when choosing the respirator. Proceed to Step 10.4.

10.4. Respirators that have APF's equal to or greater than the minimum protection factor determined in Step 7 are recommended. Maximum airborne concentrations for each level of respiratory protection can be calculated by multiplying the applicable exposure limit by the APF for that class of respirators. The calculated maximum use concentration limits should not be exceeded. Refer to the respiratory protection equipment inventory list when choosing the respirator.

### Filter and Cartridge Change-Out Schedule

#### A. FILTER CHANGE OUT SCHEDULES

The service life of all filters is limited by considerations of hygiene, damage, and breathing resistance. All filters should be replaced whenever they are damaged, soiled, or causing noticeably increased breathing resistance.

Filter Series	Recommended Change Schedule
N	When breathing becomes difficult, or when breakthrough odor or taste is detected
R	After each 8-hour shift or 8 hours of use
P	Follow manufacturer's time-use recommendation

#### B. CARTRIDGE CHANGE SCHEDULES

OSHA has substance-specific standards that provide mandatory change out schedules. Employees exposed to any of the following contaminants at or above the OSHA Permissible Exposure Limit (PEL) shall change cartridges/canisters according to their requirements:

Contaminant	OSHA Mandatory Cartridge Change Rules
Acrylonitrile	End of service life or end of shift
Benzene	End of service life or beginning of shift
Butadiene	Every 1, 2 or 4 hours based on concentration and at the beginning of each shift
Formaldehyde	Cartridges every 3 hours or end of shift; canisters every 2 or 4 hours, according to (g)(2)(ii) of Formaldehyde Standard 1910.1048
Vinyl Chloride	End of service life or end of shift in which they are first used
Methylene Chloride	Canisters for emergency escape only, replace after use

Employees NOT included under OSHA's substance specific requirements shall change their cartridges/canisters according to the Program Administrator's recommendations for their department/area. **For conservative purposes, employees should change their cartridges every 8 hours of work or at the end of the shift.**

Since hazards and their concentrations continuously vary at University of California, Irvine, EH&S as with other facilities, the development of change schedules will rely on good judgment and available data. There is no OSHA-accepted method for determining a cartridge's service life when exposed to mixtures; therefore, OSHA's recognized rules of thumb and factors affecting cartridge service life are taken into consideration:

#### OSHA's Rules of Thumb

- If the chemical's boiling point is  $>70^{\circ}\text{C}$  ( $158^{\circ}\text{F}$ ) and the concentration is less than 200 ppm, you can expect a service life of 8 hours at a normal work rate
- Service life is inversely proportional to work rate
- Reducing concentration by a factor of 10 will increase the service life by a factor of 5
- Humidity above 85% will reduce service life by 50%

#### Factors that Reduce Cartridge Service Life

- Exertion level (work rate)
- Cartridge variability (charcoal content, characteristics)
- Temperature
- Humidity
- Multiple Contaminants

### III. Respirator Selection Logic Sequence

After all criteria have been identified and evaluated and after the requirements and restrictions of the respiratory protection program have been met, the following sequence of questions can be used to identify the class of respirators that should provide adequate respiratory protection. Note that if OSHA has promulgated a substance – specific standard for a contaminant found in your workplace, respirator selection must meet or exceed the respirators required in that standard. (OSHA General Industry Air Contaminants Standard, 29 CFR 1910.1000).

Step 1. Is the respirator intended for use during fire fighting?

- a. If yes, only a full-facepiece, pressure-demand, self-contained breathing apparatus (SCBA) meeting the requirement of the NFPA 1981, Standard on Open-circuit Self-contained Breathing Apparatus for Fire and Emergency Services (2002 edition) is required. Information on NFPA 1981 can be found at <http://www.nfpa.org>.
- b. If no, proceed to Step 2.

Step 2. Is the respirator intended for use in an oxygen-deficient atmosphere, i.e., less than 19.5% oxygen?

- a. If yes, any type of SCBA other than escape only, or supplied-air respirator (SAR) with an auxiliary SCBA is required. Auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted.

**If yes, and contaminants are also present, proceed to Step 3 to determine if the hazard requires the SCBA or SAR/SCBA to meet a specific APF level.**

- b. If no, proceed to Step 3.

Step 3. Is the respirator intended for entry into unknown or IDLH atmospheres (e.g., an emergency situation)?

- a. If yes, one of two types of respirators are required: a pressuredemand SCBA with a full facepiece or a pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA. Auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted.
- b. If no, proceed to Step 4.

Step 4. Is the exposure concentration of the contaminants, as determined by acceptable industrial hygiene methods, less than the NIOSH REL or other applicable exposure limit?

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- a. If yes, a respirator is not required for routine work. For escape respirators, determine the potential for generation of a hazardous condition caused by an accident, spill or equipment failure. See Section IV. Page 17, for a discussion and selection of escape respirators. Proceed to Step 6.\*
- b. If no, proceed to Step 5.

\* If respirators are required by the employer to be worn (even if below the occupational exposure limit), OSHA requires that the employer establish

and implement a written respiratory protection program with worksite specific procedures. If an employer provides respirators at the request of employees or permits employees to use their own respirators when exposure levels are below the applicable limits, this is considered voluntary respirator use. OSHA requires that employers provide to their employees the information contained in Appendix D of 29 CFR 1910.134, that they establish and implement those elements of a written program necessary to ensure that any employee using a respirator voluntarily is medically able to wear the respirator (except that medical evaluation is not required for voluntary use of filtering facepieces) and that the respirator is cleaned, stored, and maintained so that it does not represent a health hazard to the wearer.

Step 5. Are conditions such that a worker who is required to wear a respirator can escape from the work area and not suffer loss of life or immediate or delayed irreversible health effects if the respirator fails, i.e., are the conditions not immediately dangerous to life or health (IDLH)? IDLH values for certain compounds can be found in the NIOSH Pocket Guide for Chemical Hazards. This document can be accessed at <http://www.cdc.gov/niosh/npg/npg.html>. IDLH values for some substances can also be found on the NIOSH internet at <http://www.cdc.gov/niosh/idlh/idlh-1.html>.

a. If yes, conditions are not considered to be IDLH. Proceed to Step 6.

b. If no, conditions are considered to be IDLH. Two types of respirators are recommended: a pressure-demand, full-facepiece SCBA or a pressuredemand, full-facepiece SAR in combination with an auxiliary pressuredemand, full-facepiece SCBA. The auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted. An auxiliary unit means that the SAR unit includes a separate air bottle to provide a reserve source of air should the airline become damaged. The auxiliary unit shares the same mask and regulator, and enables the SAR to function as an SCBA if needed.

Step 6. Is the contaminant an eye irritant, or can the contaminant cause eye damage at the workplace concentration? Information on eye irritation is included

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in the International Programme on Chemical Safety, International Chemical Safety Cards which can be accessed at

<http://www.cdc.gov/niosh/ipcs/nicstart.html>.

a. If yes, a respirator equipped with a full facepiece, helmet, or hood is recommended. Proceed to Step 7.

b. If no, a half-mask or quarter-mask respirator may still be an option, depending on the exposure concentration. Proceed to Step 7.

Step 7. Determine the maximum hazard ratio (HR) by the following:

- Divide the time-weighted average (TWA) exposure concentration for the contaminant determined in Step 4 by the NIOSH REL or other applicable exposure limit. If the exposure limit is an 8 hour limit the TWA used must be on 8 hour average. If the exposure limit is based on 10 hours, use a 10 hour TWA.
- If the contaminant has a ceiling limit, divide the maximum

exposure concentration for the contaminant determined in Step 4 by the ceiling limit.

- If the contaminant has a short term exposure limit (STEL), divide the maximum 15 min TWA exposure concentration for the contaminant determined in Step 4 by the STEL.
- For escape respirators, determine the potential for generation of a hazardous condition caused by an accident or equipment failure.
- If a potentially hazardous condition could occur or a hazard ratio greater than 1 has been calculated, proceed to Step 8.

Step 8. If the physical state of the contaminant is:

- a particulate (solid or liquid aerosol) during periods of respirator use, proceed to Step 9;
- a gas or vapor, proceed to Step 10;
- a combination of gas or vapor and particulate, proceed to Step 11.

Step 9. Particulate Respirators

9.1. Is the particulate respirator intended only for escape purposes?

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- a. If yes, see Section IV (page 17), for a discussion and selection of escape respirators.
- b. If no, the particulate respirator is intended for use during normal work activities. Proceed to Step 9.2.

9.2. A filter series (N, R or P) that will provide protection against exposure to the particulate in question is recommended.

a. The selection of N-, R-, and P-series filters depends on the presence or absence of oil particles, as follows:

- If no oil particles are present in the work environment, use a filter of any series (i.e., N-, R-, or P-series).
- If oil particles (e.g., lubricants, cutting fluids, glycerine, etc.) are present, use an R- or P-series filter. **Note:** N-series filters cannot be used if oil particles are present.
- If oil particles are present and the filter is to be used for more than one work shift, use only a P-series filter.

b. Selection of filter efficiency (i.e., 95%, 99%, or 99.97%) depends on how much filter leakage can be accepted. Higher filter efficiency means lower filter leakage.

**Note:** To help you remember the filter series, use the following guide:

N for *N*ot resistant to oil,

R for **R**esistant to oil

P for oil **P**roof

Additional information on selecting the appropriate filter certified under 42CFR84 can be found at

<http://www.cdc.gov/NIOSH/userguid.html>. Proceed to Step 9.3.

9.3. Respirators that have not been eliminated from Table 1 by the previous steps and that have APFs equal to, or greater than, the maximum hazard ratio determined in Step 7 are recommended.<sup>1</sup> Note, however, that the maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be

protected by a class of respirator and is determined by the lesser of:

- APF X exposure limit
- The respirator manufacturer's MUC for a hazardous substance (if any)

<sup>1</sup> If the respirator is intended for use in an oxygen-deficient atmosphere, only SCBA or SAR with an auxiliary SCBA, can be selected from the Table.

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- The IDLH, unless the respirator is a pressure-demand, fullfacepiece SCBA or combination pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA.

For multi-component mixtures the MUC can be calculated by:

$$C_1/MUC_1 + C_2/MUC_2 + \dots C_n/MUC_n = 1$$

### Step 10. Gas/Vapor Respirators

10.1. Is the gas/vapor respirator intended only for escape?

- a. If yes, refer to escape respirators Section IV (page 17).
- b. If no, the gas/vapor respirator is intended for use during normal work activities. Proceed to Step 10.2.

10.2. An air-purifying chemical cartridge/canister respirator is recommended that has a sorbent suitable for the chemical properties of the anticipated gas/vapor contaminant(s) and for the anticipated exposure levels.

Information on cartridges or canisters approved for use for classes of chemicals or for specific gases or vapors can be found in the NIOSH Certified Equipment List

<http://www.cdc.gov/NIOSH/npptl/topics/respirators/cel/>. Proceed to Step

10.3.

10.3. Respirators that have not been eliminated from Table 2 by the previous steps and that have APFs equal to, or greater than, the maximum hazard ratio determined in Step 7 are recommended.<sup>1</sup> Note, however, that the maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected by a class of respirator and is determined by the lesser of:

- APF X exposure limit
- The respirator manufacturer's MUC for a hazardous substance (if any)
- The IDLH, unless the respirator is a pressure-demand, fullfacepiece SCBA or combination pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA.

For multi-component mixtures the MUC can be calculated by:

$$C_1/MUC_1 + C_2/MUC_2 + \dots C_n/MUC_n = 1$$

<sup>1</sup> If the respirator is intended for use in an oxygen-deficient atmosphere, only SCBA or SAR with an auxiliary SCBA, can be selected from the Table.

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### Step 11. Combination Particulate and Gas/Vapor Respirators

11.1. Is the combination respirator intended for "escape only" purposes?

- a. If yes, refer to escape respirators on page 17, for a discussion and selection of "escape only" respirators.

b. If no, the combination respirator is intended for use during normal work activities. Proceed to Step 11.2.

11.2 From Table 3, select a respirator type, not eliminated by the previous steps, and have APFs equal to, or greater than, the maximum hazard ratio determined in Step 7. are recommended.<sup>1</sup> Note, however, that the maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected by a class of respirator and is determined by the lesser of:

- APF X exposure limit
- The respirator manufacturer's MUC for a hazardous substance (if any)
- The IDLH, unless the respirator is a pressure-demand, fullfacepiece SCBA or combination pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA.

For multi-component mixtures the MUC can be calculated by:  $C_1/MUC_1 + C_2/MUC_2 + \dots C_n/MUC_n = 1$