UNIVERSITY OF NORTH FLORIDA

RESPIRATORY PROTECTION PROGRAM

DEPARTMENT OF
ENVIRONMENTAL HEALTH, SAFETY, INSURANCE & RISK MANAGEMENT

UNIVERSITY OF NORTH FLORIDA RESPIRATORY PROTECTION PROGRAM

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I. INTRODUCTION

In maintaining employee health and safety at the University of North Florida, Environmental Health and Safety (EH&S) has developed and implemented this Respiratory Protection Program.

The contents of this program are to be strictly adhered to when respiratory protection is required. This includes operations where engineering or administrative controls are being implemented or where these controls cannot feasibly maintain airborne emissions below applicable exposure limits. Such equipment shall be provided at no cost to the employee.

This program is designed to satisfy requirements under the Occupational Safety and Health Act (OSHA) chapter 1910 section 134 (29 CFR 1910.134) Respiratory Protection Standard. It includes additional information from the American National Standards Institute (ANSI Z88.2-1992), the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH).

Although developed by EH&S, this program is distributed to and directly enforced by departmental supervisors throughout UNF where respiratory protection is utilized.

The provisions of this program are mandatory in nature where the word **shall** is used and advisory where the word **should** is used.

Exceptions to this program may be granted by EH&S, provided that equally acceptable protective requirements are established and provided to this office in writing.

Definitions

Abrasive-Blasting Respirator: See respirator. A respirator designed to protect the wearer against inhalation of abrasive material and against impact from rebounding abrasive material.

Aerosol: A system of particles, solid or liquids suspended in air.

Airline Respirator: See respirator.

Air-purifying Respirator: See respirator.

Air-Regulating Valve: An adjustable valve used to regulate, but which cannot completely shut off, the airflow to the face piece, helmet, hood or suite of an air-line respirator.

Air-Supply Device: A hand- or motor-operated blower for the hose mask, or a compressor or other source of respirable air for an air-line respirator.

Approved: A device tested and listed satisfactory by the Bureau of Mines (BM) of the U.S. Department of the Interior, or jointly by the Mining Enforcement and Safety Administration

(MESA) of the same and the National Institute of Occupational Safety and Health (NIOSH) of the U.S. Department of Health, Education and Welfare or jointly by the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor and NIOSH of the same.

Breathing Tube: A tube through which respirable air flows to the face piece, mouthpiece, helmet, hood or suit.

Canister (air-purifying): A container with a filter, sorbent, catalyst or any combination thereof, which removes specific contaminants from the air drawn through it.

Canister (oxygen generating): A container filled with a chemical which generates oxygen by chemical reaction.

Carcinogen: A substance known to cause cancer.

Cartridge (air-purifying): A small canister.

Catalyst: In respirator use, a substance which converts a toxic gas (or vapor) into a less toxic one.

Ceiling Concentration: The concentration of an airborne substance that shall not be exceeded at anytime.

Chemical-Cartridge Respirator: See respirator.

Confined Space: An enclosure such as a storage tank, process vessel, boiler, manhole, silo, tank car, sewer tunnel or pit that has limited access, poor ventilation, and which may contain hazardous atmospheres or insufficient oxygen.

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

Corrective Lens: A lens ground to the wearer's individual prescription to permit normal vision.

Demand: In respiratory protection, a mode of operation for air-line or self-contained breathing apparatus where breathing air is supplied to the face piece only during inhalation.

Detachable Coupling: A device which permits the respirator wearer, without using tools, to detach the air-supply line from that part of the respirator worn on the person.

Dust: An airborne particulate generated by mechanical action, usually reduction.

Emergency Respirator Use: Wearing a respirator when a hazardous atmosphere suddenly occurs that requires immediate use of a respirator either for escape, rescue or maintenance.

Exhalation Valve: A device that allows exhaled air to leave a respirator and prevents outside air

from entering through the valve.

Eyepiece: A gas-tight, transparent window in a full-face piece, helmet, hood or suit through which the wearer can see.

Face piece: That portion of a respirator that covers the wearer's nose and mouth in a quarter-mask (above the chin), or under the chin in a half-face unit, or that covers the nose, mouth and eyes in a full face piece unit. It is designed to make a gas-tight seal with the face and includes headbands, exhalation valve, and connections for an air-purifying device or respirable air source or both.

Face Shield: A device worn in front of the eyes and a portion of, or all of, the face, whose predominant function is to protect the eyes and face.

Filter: A media component used in respirators to remove solid or liquid particules form inspired air.

Filter Respirator: See respirator.

Full Face piece: See face piece.

Fume: an airborne particulate generated when a solid is heated until it vaporizes and then condenses.

Gas Mask: See respirator.

Goggle: A device with contour-shaped eyecups with glass or plastic lenses, worn over the eyes and held in place by a headband or other suitable means for the protection of the eyes and eye sockets.

Hazardous Atmosphere: Any atmosphere, either immediate or not immediately dangerous to life or health, which is oxygen deficient or which contains a toxic or disease-producing contaminant exceeding the legally established Permissible Exposure Limit (PEL) or where applicable, the Threshold Limit Value (TLV).

Head Harness: That part of the face piece assembly which secures the face piece to the wearer.

Helmet: That portion of the respirator which shields the eyes, face, neck and other parts of the head.

High-Efficiency Filter: A filter which removes from the air 99.97% or more of monodispersed dioctyle phthalate (DOP, a test agent) having a mean particle diameter of 0.3 micrometers.

Hood: That portion of a respirator which covers the head, neck and portions of the shoulders.

Hose Mask: See respirator.

Immediately Dangerous to Life or Health (IDLH): An atmosphere that poses an immediate hazard

to life or produces immediate irreversible health effects upon exposure without protection. NOTE: NIOSH maintains a thirty-minute time limit in place of immediate for their definition.

Inhalation Valve: A device that allows respirable air to enter a respirator and prevents exhaled air from leaving the respirator through the valve.

Maximum Use Concentration (MUC) of filter, cartridge, or canister: The maximum concentration of a contaminant for which an air-purifying filter, cartridge or canister is approved for use. The MUC is a product of the contaminant's exposure limit and the respirator's protection factor.

Mist: A dispersion of liquid particles or droplets usually created by spraying.

Mouthpiece: That portion of a respirator which is held in the wearer's mouth and is connected to an air-purifying device or respirable air source, or both. It is designed to make a gas-tight seal with the mouth.

Negative Pressure Respirator: A respirator in which the air pressure inside the device is positive during exhalation and negative during inhalation relative to outside the device.

Nonroutine Respirator: Wearing a respirator when carrying out a special task that occurs infrequently.

Nose Clamp: A device used with a respirator equipped with a mouthpiece that closes the nostrils of the wearer.

Odor Threshold Limit: The lowest concentration of a contaminant in air that can be detected by the olfactory sense (smell).

Oxygen Deficiency: An atmosphere which contains less than 19.5% oxygen by volume requiring air-supplied respirators.

Particulate Matter: A suspension of fine solid or liquid particules in air such as: dust, fog, fume, mist, smoke, or spray.

Permissible Exposure Limit (PEL): The legally established time-weighted average (TWA) concentration or ceiling concentration of a contaminant that shall not be exceeded as promulgated by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor.

Personal Protective Equipment (PPE): Devices worn to protect personnel from exposure to hazardous materials/environments.

Positive-Pressure Respirator: A respirator in which the air pressure inside the respirator is positive during inhalation and exhalation in relation to the outside atmosphere.

Powered Air-Purifying Respirator: See respirator (PAPR).

Pressure-Demand: In respiratory protection, a mode of operation for self-contained breathing apparatus or air-line respirators where positive pressure is maintained in the face piece at all times. If a leak occurs in the face piece air would flow out of the mask.

Protection Factor (PF): The ratio of the ambient concentration of an airborne substance to the concentration of the substance inside the respirator at the breathing zone of the wearer. The protection factor is a measure of the degree of protection provided by a respirator to the wearer.

Rescue Respirator Use: Wearing a respirator for entry into a hazardous atmosphere to rescue personnel in a hazardous atmosphere.

Resistance: Opposition to the flow of air, as through a canister/cartridge/filter, orifice, valve or hose.

Respirable: Suitable for breathing.

Respirator: A device designed to protect the wearer from the inhalation of harmful atmospheres.

Respiratory-Inlet Covering: That portion of a respirator which connects the wearer's respiratory tract to an air purifying device or respirable air source or both. It may be a face piece, helmet, hood, suit or mouthpiece.

Routine Respirator Use: Wearing a respirator as a normal procedure when carrying out a regular and frequently repeated task.

Sanitization: The removal of dirt and the inhibiting of the agents that cause infection and disease.

Self-Contained Breathing Apparatus (SCBA): A device that is worn on the back of personnel requiring air-supplied respiratory protection. See respirator.

Service Life: The period of time that a respirator provides adequate protection to the wearer. Such as the period of time that an air-purifying device is effective for removing a harmful substance from inspired air.

Short Term Exposure Limit (STEL): A 14-minute TWA designed for short duration exposure limits during escape or periodic duties.

Sorbent: A material which is contained in a cartridge/canister which removes toxic gases/vapors from inhaled air.

Supplied-Air Respirator (ASR): A device that provides an independent source of clean, respirable air to personnel in oxygen deficient or highly contaminated atmospheres. See respirator.

Supplied-Air Suit: A suit that is impermeable to most particulate and gaseous contaminants and that is provided with an adequate supply of respirable air.

Time-Weighted Average (TWA): The average concentration of a contaminant in air during a specific time period.

Valve: A device which controls the pressure, direction or rate of respirable air flow.

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

Welding Helmet: A device designed to provide protection for the eyes and face against radiant energy and molten metal splatter encountered in the welding and cutting of metals.

Window Indicator: A device on a cartridge or canister that visually denotes the service of the cartridge/canister.

II. RESPONSIBILITY

It shall be the responsibility of EH&S to oversee the implementation of this Respiratory Protection Program and remain available for assistance as needed by departmental supervisors.

This includes:

a. Hazard Assessment; determining the type(s) and concentration (s) of air contamination associated with teaching, research, maintenance and emergency operations

b. Assisting with respirator selection

c. Providing instructional materials and guidance for employee training in the proper use, care and operation of respirators

d. Providing technical assistance during fit testing

e. Providing guidance during maintenance and cleaning procedures

f. Providing guidance for emergency uses

g. Providing oversight of medical surveillance

h. Ensuring record collection

i. Implementing program evaluation

EH&S shall ensure state-of-the-art techniques and information remains available. Finally, EH&S will periodically evaluate and revise the program as new information arises.

The direct implementation of this program shall lie with impacted departmental supervisors. This includes departments/areas where respiratory protection is worn for routine, non-routine, or emergency use.

The supervisor shall ensure that all forms as indicated in the accompanying sections are completed and maintained on file in the department office. Form I, Respirator Use, shall be completed and a copy sent to EH&S for each person required to wear respiratory protection. The supervisor shall ensure that all employees are thoroughly familiar with the provisions of the Respiratory Protection Program and that they are fitted and properly trained in the use and care of the protective equipment assigned. The supervisor shall also ensure that respiratory protection utilized carries the approval of the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

Each employee shall ensure that respiratory protection is cleaned, worn, stored and maintained according to the provisions of this Program and that damage, defects or problems are reported to supervisors immediately.

Specific limitations apply to respiratory protective devices including:

a. Contact lenses shall not be worn in conditions requiring respiratory protection where contaminants can be trapped under or react with the lens causing severe irritation/damage,

b. If corrective lenses are required, goggles shall be worn over glasses on half-face units, and specialized frames can be ordered for use in full-face units as the temple bars of standard eyeglasses will prevent an adequate face-to-face piece seal and deny respiratory protection,

c. No facial hair that may interfere with the face-to-face piece seal of a respirator is allowed (this includes long-handled mustaches, sideburns and full beards),

d. Personnel with dentures or partial plates shall keep these in place during respirator use as removal can change the shape of the face and prevent an effective seal.

FORM I

RESPIRATOR USE RECORD

Employee:_____

Social Security No.:_____

Building Name/No.:_____Room No.:_____

Supervisor Name:_____

Supervisor Title:_____

Date:_____Phone No.:_____

Operation requiring respirator:_____

_____

Type of respirator(s) used (circle):

Positive Pressure Device	Negative Pressure Device
SCBA	Half Face Air Purifying
Supplied Air Line	Full Face Air Purifying
Combination Ai r Line/SCBA	Powered Air Purifying Respirator

Level of Work Effort (circle):

Light Moderate Strenuous Heavy

Length of work effort (estimated in hours):_____

Extent of Usage (circle):

Daily Weekly Monthly Emergency Use Only

Form completed by:_____

Employee Signature:_____

cc: Dept. File
Environmental Health and Safety

III. EXPOSURE MONITORING

All areas where respiratory protection is required shall be evaluated for exposure potential. Information utilized in determining the need for air monitoring include length of time spent in the environment in question, recommendations from Material Safety Data Sheets (MSDS) and an evaluation by EH&S. If air monitoring is justified, parameters and pertinent data shall be recorded on Form II, Exposure Monitoring Record. Copies of this form shall be maintained at impacted departmental offices and EH&S. This evaluation shall also be conducted when process changes are made and include:

a. The identity of the substance suspected of causing employee overexposure.

b. The potential for engineering or administrative controls to maintain exposures below acceptable limits.

c. The estimated average and maximum potential exposure expected during normal operations. This estimate must be made for each job classification and include 8 hour time-weighted average (TWA) monitoring where justified.

d. The estimated peck exposure that can be expected from short-term activities such as clean up or maintenance operations for comparison with short-term exposure limits (STEL).

e. The type of respiratory protection required for the specific operation and other applicable personal protective equipment (PPE) based on the air monitoring results.

f. The monitoring frequency of impact substances shall be based on changes in process or substances involved and include specified monitoring schedules as required in OSHA standards.

FORM II

EXPOSURE MONITORING RECORD

Employee:_____

Date:_____Social Security No.:_____

Department:_____Building :_____

Supervisor:_____

Phone:_____Room No.:_____

Operation /Location:_____

_____

_____

Target Compound:_____

Type of sample (circle):

Personal/TWA Personal/STEL Personal/Ceiling

Area/TWA Area/STEL Area/Ceiling

Grab Sample Dosimeter

Calibration Date/Time:_____

Flowrate:_____Lpm Duration:_____min

Volume:_____Liters

Results/Comments:_____

Respiratory Protection Required: Y or N

Type:_____

cc: Dept. File
Environmental Health and Safety

IV. RESPIRATOR TYPES, SELECTION AND USE

The basic purpose of any respirator is to protect the wearer from inhalation of hazardous materials/atmosphere. Respirators provide protection either by removing contaminants from the air before inhalation or by supplying an independent source of clean air. These principles delineate the two basic respirator types.

A device that removes contaminants from the ambient air is called an air-purifying respirator (APR). These devices operate under negative pressure created through inhalation. This negative pressure allows contaminated air through purifying elements and into the face piece. A device that provides a clean source of breathable air independent of ambient air is called an air-supplying respirator (ASR). These devices operate under positive pressure created by the external air source. Both can be sub classified by the type of inlet covering and the mode of operation.

The inlet covering serve as a barrier against contaminated atmospheres and as a framework to which air-purifying or air-supplying elements are attached.

Tight-Fitting Respirators

Tight-fitting coverings or face pieces are made of flexible materials such as butyl rubber, silicone, or neoprene. The face pieces are held on by the use of rubber or elastic straps which buckle at the back of the head.

These face pieces are of three basic configurations. A quarter-face covers just the mouth and nose and the lower sealing surface rests above the chin. These are typically used for protection against nuisance particulates or very low concentrations of known contaminants.

A half-face mask covers the nose, mouth and chin. These provide a larger sealing surface than the quarter-mask and are preferred for use against more toxic materials. Both of the above devices provide no eye protection.

The third type of tight-fitting device is the full-face respirator. This mask covers the area from the hairline to below the chin.

Because of this large sealing surface they provide the greatest degree of respiratory protection, provide some degree of eye protection and are the most commonly used of the three types.

Mouthpiece respirators are the most basic types of device and consist of a nose clamp and mouthpiece that is held in the teeth. These devices prevent verbal communication, may cause fatigue of the jaw and provide no eye protection. Therefore they are restricted for use as escape devices.

Loose-fitting Respirators

These devices include hoods, helmets, suits and blouses. At a minimum, they must enclose the head and when the neck and shoulders are included consist of a hood. A helmet incorporates a rigid headgear into the design and a blouse extends down to the waist and may include wrist-length sleeves. These are typically used for abrasive blasting and hood/helmet materials are designed to withstand rebounding particules. Compressed air breathing sources are normally used and headgear include an impact resistant eye-shield for protection against abrasive particles.

A. Air-purifying Respirators

1. Particulate Filtering APR's

These are used for protection against dusts, mists, and fumes. A dust is a mechanically generated solid particulate, a mist is a liquid condensation particulate and a fume is a solid condensation particulate usually produced from vaporized solids.

Most particulate filtering devices use fibrous materials to remove the contaminant. As a particule is drawn into the filter through inhalation, the filter media traps it. The efficiency of the filter depends on the size, velocity and composition of the particle. As particles are captured in the media it becomes clogged. This loading process can potentially increase the collection efficiency of the filter, but also increases the breathing resistance eventually requiring replacement of the filter cartridge.

Current filter manufacturers utilize five mechanisms in particle capture. These include interception, sedimentation, impaction, diffusion and electrostatic capture.

During interception, the filter media captures particulates as they are carried in the inhaled air stream. Sedimentation occurs in large particles (>2 u) where the effects of gravity pull particles from the air stream.

Inertial impaction occurs as particles are drawn into the filter media and are too large or heavy to change directions and avoid capture.

Diffusion occurs in very small particles subject to collision with air molecules.

These collisions cause random motion among the particulates increasing the chances of capture by the media.

In electrostatic capture, the filter media is charged which attracts particulates and aids in capture through interception and diffusion.

All of these mechanisms are affected by particulate size and weight, velocity, composition and environmental conditions. In general large, heavy particles are usually removed by inertial impact

and interception. Large, light particles are removed by diffusion and interception. Diffusion can also remove very small particulates.

The filter media for particulate capture includes three basic types. The most common is the flat disk of random laid, non-woven fiber material which is designed to provide maximum natural collection with minimum resistance. Other types include natural wool or synthetic blend felt to which an electrostatic charge is applied. A disadvantage to this type is the loss of the charge due to oily atmospheres, high humidity and age. A sticky resin can also be applied to the fiber material causing particules to adhere to the filter pad. Finally a high efficiency particulate air (HEPA) filter has been developed for protection against radioactive particles, asbestos fibers and other carcinogenic particulates considered respirable (<10 u).

The following types of particulates respirators are certified for use by NIOSH/MSHA and UNF.

a. Replaceable or reusable dust and mist respirators designed for protection against (1) dusts and mists with a permissible exposure limit (PEL) <0.05 milligrams per cubic meter (mg/m3) of air, (2) dust and mists having a PEL <2 million particles per cubic foot (mppcf) of air.

b. Replaceable fume filters designed as respiratory protection against fumes of various metals having a PEL <0.05 mg/m3.

c. Respirators with replaceable filters for protection against dusts, fumes and mists of materials with a PEL <0.05 mg/m3 or 2 mppcf (for combination cartridges).

d. Single use respirators designed for nuisance dusts and mists can be used if either the filter or the entire face piece is disposable. These respirators are not to be used for protection against asbestos, highly toxic or radioactive particulates.

2. Gas and Vapor Removing APR's

These devices are used for protection against the other major class of airborne contaminants; gases and vapors. APR's are commercially available for specific gases/vapors (i.e. ammonia gas and mercury vapor) and classes of gases/vapors (i.e. acid gases and organic vapors).

Unlike particulates filtering devices which are effective against particulates as a whole, the cartridges used in gas/vapor removal are designed to be specific for known contaminants.

These respirators are fitted with cartridges or canisters containing a granular material commonly referred to as sorbent. The general method by which removal occurs is called sorption. Three specific mechanisms are used in the sorption of gases/vapors.

a. Absorption retains the contaminant on the surface of the sorbent granules by physical attraction. Activated charcoal is the most common absorbent used in this

mechanism. If chemical attraction is necessary (chemisorption), the charcoal can be impregnated with other substances to make it more selective against specific gases/vapors. For example activated charcoal impregnated with iodine removes mercury vapors, with metallic oxides removes acid gases, and with salts or metals removes ammonia gas. Other sorbents include molecular sieves, activated alumina, and silica gel.

b. Absorption may also be used to remove gases/vapors. Absorbents collect contaminants by allowing penetration deep into the pores of the sorbent where chemical bonding holds them. Most absorbents are used for protection against acid gases. These include mixtures of sodium or potassium hydroxide with lime and/or caustic silicates.

c. Catalysis is the third method of gas/vapors removal. A catalyst is a substance that influences the rate of chemical reactions and can cause them to occur more readily. An example of a catalyst used in respirator cartridges is Hopcalite, a mixture of manganese and copper oxides, which speeds the reaction between carbon monoxide and oxygen to form water vapor and carbon dioxide. These cartridges have a relatively short lifespan and are subject to damage from moisture buildup.

In contrast to mechanical filters which become more efficient with use, sorbent cartridges reach a saturation point where breakthrough occurs allowing contaminants into the face piece. Therefore it is recommended that they be protected from the environment while not in use as interaction with the air will speed saturation.

Some respirators utilize canisters instead of cartridges. In general, canisters are larger than cartridges, contain more sorbent and can be used against higher contaminant concentrations. Cartridges are chin mounted usually in pairs while canisters can be chin, front or back mounted and connected to a flexible breathing hose. The canisters are typically certified for single or specific classes of gases/vapors and respirators utilizing them are commonly called gas masks.

Since the majority of workplaces involve more than one type of respiratory hazard, respirators are usually equipped with combination cartridges.

These cartridges are capable of removing both particulate and gas/vapor air contaminants and are available from most manufacturers.

A specialized type of combination cartridge is the Type N or Universal canister. It is similar to the larger front or back-mounted canister but contains several layers of sorbent materials. These include media for ammonia, acid gas, organic vapors, a catalyst for carbon monoxide and a HEPA filter for asbestos and radioactive particles. Because the Type N canister is the same size as normal canisters and therefore offers limited space for each sorbent layer, it has a shorter lifespan than conventional canisters.

All canisters approved for use against carbon monoxide must have an indicator that shows when the canister is spent. The indicator actually shows the condition of the drying agent upstream of the catalyst. The catalyst is rendered useless by moisture which stops the chemical reaction and clogs the cartridge.

3. Powered Air-Purifying Respirators (PAPR)

These devices remove airborne contaminants through the same mechanisms as non-powered APR's but utilize a small blower to provide a degree of positive pressure in the face piece. The purifying element may be filter to remove particulates, a cartridge to remove gases/vapors or a combination cartridge to remove both.

PAPR's come is several configurations including those with belt-mounted cartridges and blower on chin mounted cartridges and blower. A third type of PAPR consists of a loose fitting helmet or hood and face piece. Purified air is circulated over the face and out under the face piece. These devices utilize a small, rechargeable battery pack usually worn at the belt to power the blower.

The tight fitting half and full-face PAPR's must deliver at least four cubic feet of air per minute or ll5 liters per minute (Lpm). The hood or helmet PAPR's must deliver more air, at least six (170 Lpm), because they are loose fitting and the potential for leakage is greater.

PAPR's are sometimes preferred over APR's because they supply a source of positive pressure and allow use in higher contaminant concentrations. They also tend to keep the wearer cooler and less fatigued. This is due to the increased air movement in the mask and the decreased effort required for inhalation. However, one disadvantage of PAPR's is the potential for shorter cartridge life spans also due to the positive pressure aspect.

4. Advantages and Disadvantages of APR's

a. APR's are generally small and easily maintained. They can restrict the wearer's movements but not as much as other protective devices. Communications and visual field are restricted which can result in decreased ability to accomplish job functions and increase the probability for accidents.

Therefore care must be taken during use. The many combinations of mouthpieces, face pieces, filters, cartridges and canisters allow the user to match the respirator to the particular situation and ensure proper fit.

APR's cannot be used in oxygen deficient atmospheres (<19.5%) nor in atmospheres immediately dangerous to life and health (IDLH). Further, the limits of airborne contamination are listed on the cartridge and should not be exceeded as breakthrough can occur. This means that the type and properties of the contaminants must be known and that air monitoring may be required to confirm these conditions before a respirator can be used.

Another important consideration is the negative pressure created in the face piece during inhalation. This would allow contaminants inside the mask should a leak or improper fit occur. Care should be taken to provide a respirator that is fitted to the wearer and training to ensure proper donning and adjustment.

b. Particulate filtering respirators have the advantages of light weight, small size and ease of maintenance. In general they will not affect the mobility of the wearer and present little physiological strain. The resistance to breathing is minimal at first but may increase as the filter becomes loaded. The dirtier the work setting, the quicker the filter becomes loaded and the sooner the filter must be replaced. The filter elements should be replaced as breathing resistance becomes excessive or if the filter suffers physical damage. Filter elements should be cleaned and reused if so designed and stored to prevent exposure to the environment. The wearer must also know the type of particulate to ensure proper filter selection.

c. Gas/Vapor removing respirators have the same advantages as particulate filtering devices in size and weight. However, certain cartridges/canisters have higher breathing resistance than filters and therefore cause an increased burden on the wearer. Like filters, cartridges/canisters are subject to degradation from the environment. Extremes in humidity can cause clogging and interrupt the chemical reactions occurring in the cartridge.

   Unlike filters, cartridges/canisters have a sorbent material which becomes spent or saturated with use. This can occur rapidly in high concentrations and allow contaminants into the face piece. For this reason, it is crucial that the wearer be familiar with the type of contaminant and its warning properties. These properties include odor, taste and eye, throat or facial irritations. If these properties are detected during use, the wearer must exit the area to a clean environment and replace the cartridge. If a wearer detects one of these properties and then the sensations disappear, cartridge replacement should still occur. Many compounds can cause fatigue of nerve endings and dull the senses (olfactory fatigue). This is especially common during continued exposure to low concentrations. It is not an indication that the exposure has ceased.

   In addition to warning properties, users should institute a regular change-out schedule for cartridge replacement. These schedules should be based on the contaminant concentrations and the cartridge service-life data available from the respirator manufacturer. Users should replace cartridges/canisters when warning properties are detected, if damage occurs or when the change-out schedule indicates.

d. PAPR's have the advantage of providing an air stream to the wearer. This tends to provide a cooling effect and decreases breathing resistance thereby making the respirator more comfortable to wear. PAPR's with loose fitting headgear are also

more comfortable and can sometimes be used by those with facial hair or other restrictions applicable to tight fitting PAPR's.

Disadvantages include those common to all APR's such as bulkiness, decreased visibility and communications. PAPR's also have additional considerations of battery replacement and mechanical failure. If the blower should stop, the user should leave the work area and proceed to a clean area for repairs/replacement. Finally, PAPR's are more expensive to purchase and maintain than APR's.

B. Air Supplying Respirators

These devices are designed to provide a clean source of air regardless of the working environment and are specially designed to protect employees from hazardous atmospheres at greater concentrations than APR's. Because of this distinct advantage the use and care of these devices are more restrictive.

1. Self-Contained Breathing Apparatus (SCBA)

These devices allow the user to be provided with clean breathing air independent of external sources. The wearer does not have to rely on or be limited by stationary air sources such as an air compressor. Enough breathable air is carried by the user to last up to four hours depending on the design of the unit. SCBA's are classified by mode of operation into two types, closed circuit and open circuit.

a. Closed-circuit SCBA's, or rebreathers as they are sometimes called, allow recirculation or breathing air. Exhaled air is scrubbed to remove carbon dioxide and a compressed or liquid source, or an oxygen-generating solid restores the oxygen content.

These devices are designed primarily for 1 - 4 hour use in oxygen deficient or IDLH atmospheres.

Until recently, all closed circuit SCBA's were non-positive devices meaning negative pressure is created during inhalation. Therefore, they should be restricted for use during activities requiring long-term, uninterrupted protection.

The most common type of closed circuit SCBA utilizes a compressed oxygen source supplying an inflatable bag. Exhaled air passes through a sorbent that removes carbon dioxide and the air is returned to the bag. Thus only consumed oxygen is replaced by the compressed source. This rebreathing process requires only oxygen be replaced and allows long-term protection.

Another type of closed circuit SCBA uses an oxygen-generating solid such as potassium super oxide. Oxygen is not released until the exhaled breath reaches the

canister. Water vapor and carbon dioxide in the breath react with the potassium super oxide releasing oxygen. This unit provides a positive pressure in the face piece as oxygen is continually released into reservoir bags once the reaction is initiated. This type of device is lighter and simple than the cylinder type, but typically has a one-hour supply of oxygen that cannot be turned off once initiated.

b. An open-circuit SCBA allows exhaled air to exhaust without recirculation. Another basic difference is that only compressed is used in the cylinder, NOT compressed oxygen. High-pressure cylinders (2000-45000 psi) supply compressed air through a regulator that reduces the pressure to the face piece. Expected service life ranges from 30-60 minutes depending on the size of the cylinder. Two common cylinder types are available and include steel and spun fiberglass around an aluminum core. The steel is more durable, but weighs more and must be hydrostatically tested every five years. The composite is lighter, but must be hydrostatically tested every three years and is more susceptible to physical damage.

   Two modes of open-circuit SCBA operation are currently available, demand and pressure-demand. In the demand mode, air from the regulator is not released until the wearer inhales creating negative pressure in the face piece. Due to this negative pressure and the possibility of leakage into the mask, demand SCBA's should not be used in IDLH atmospheres. However, they are adequate for oxygen-deficient atmospheres.

   In the pressure-demand mode of operation, a positive pressure is maintained in the face piece at all times. Because of this positive pressure, any leakage will be outward. Therefore, a pressure-demand SCBA provides very good protection and can be used in either IDLH or oxygen deficient atmospheres. This mode of operation allows the same service life as that expected from the demand unit unless a poor fit is achieved or leakage occurs.

   Some open-circuit SCBA's can be switched from demand to pressure-demand modes during fit and adjustment. This donning switch allows the face piece to be put on without loss of breathing air in the demand mode. However, once the mask is donned and adjusted properly, the unit should be switched to the pressure-demand mode to insure maximum protection during use.

   Several required safety features are found on SCBA's certified by NIOSH or MSHA. These include:

   - a pressure gauge visible to the wearer during use indicating the remaining air supply

   - a warning device indicating remaining service life at 20-25% capacity of the cylinder

- a bypass valve in case the regulator fails and it is necessary to conserve or continue air flow

- fittings and connections that are not compatible with compressed oxygen or liquid air devices.

Areas using SCBA equipment on a regular basis should set up a charging station. Where units are used for emergency situations, local distributors can arrange for charging. when an area does not have a method for cylinder charging, enough spare cylinders should be available to deal with emergency situations. When charging is feasible, the cascade system of refilling cylinders is the easiest to use. It is based on the equalization between large cylinder supply tanks and the smaller SCBA tank.

Usually, two or more supply tanks of respirable air are connected in series through tee-block fittings and pigtails. A manifold outlet is connected to the last cylinder complete with high pressure gauge. A 5-foot length of high-pressure hose with an air fitting is used to connect the SCBA tank to the manifold.

To fill the SCBA:

i. Check the date of the hydrostatic testing on the tank to make sure it is current. Check the pressure in the SCBA cylinder by observing the pressure gauge on the main valve. If the cylinder has no gauge, the pressure may be checked by slowly opening the main valve and observing the pressure gauge on the system outlet valve. Close the cylinder man valve.

ii. Open and close each valve in the supply cylinder bank to find the cylinder with the lowest pressure. If the pressure in this cylinder is not greater than in the cylinder to be charged, locate the supply cylinder with a pressure higher than that of the SCBA cylinder but lower than the other supply cylinders.

iii. Slowly open the valve on the SCBA cylinder. Then, slowly open the valve on the supply cylinder with the lowest pressure as determined in step 2. Observe the outlet connection gauge. When the pressure of that gauge stops dropping, the pressures in the two cylinders have equalized. Close the supply cylinder valve. If the desired pressure in the SCBA cylinder has not been reached, repeat the procedure using he cylinder with the next highest pressure.

iv. If the last supply cylinder does not fully recharge the SCBA cylinder, replace the supply cylinder having the lowest pressure with a full cylinder and repeat steps 2 and 3. Once the SCBA cylinder is full, close all valves in the system and disconnect the SCBA cylinder.

The major advantage of SCBA use is the freedom of movement allowed by wearing the supply of breathing air on the back. However the bulk and weight of the unit may prevent strenuous work or confined work. The limited supply of air makes them unsuitable for long, continuous periods unless repeated tank changes can be made.

2. Airline respirators

These devices supply compressed breathing air from a stationary source delivered through a length of hose under pressure. They are available in demand, pressure demand, or continuous flow modes provided through a face piece, helmet, hood, or complete suit.

Breathing air is supplied from cylinder or an air compressor. OSHA specifies that the pressure supplied to the hose not exceed 125 pounds per square inch (psi) and that the hose length be between 25 and 300 feet. For a hood or helmet device with 300 feet of hose OSSA requires at least 170 liters per minute (Lpm) of airflow be delivered to the wearer. For a hood or helmet with 25 feet of hose OSHA would require no more than 425 Lpm. The equivalent airflows to a tight-fitting face piece are 115 and 425 Lpm, respectively. These limitations are given as required specifications in the design of airline respirator systems.

Continuous-flow airline respirators maintain a constant flow of breathing air to the wearer at all times, rather than only on demand. OSHA requires a flow of at least 115 Lpm to a tight fitting mask and 170 Lpm to a hood or helmet. This continuous flow of positive pressure provides high protection, but also requires a larger supply of air.

3. Hose masks

These devices supply air from an uncontaminated source through a strong, large diameter hose. Two types are available. One utilizes an electric or hand powered blower that pushes low-pressure air through the hose to the wearer. If for some reason the blower was to fail, the wearer can still breathe through the large diameter hose. The other type does not have a blower and the wearer must simply breathe through the hose. The hose mask with the blower is classified by OSHA as a Type A supplied-air respirator and is certified for use in atmospheres that are not IDLH. This unit may have up to 300 feet of air hose in multiples of 25 feet and be able to deliver air through the hose at not less than 50 Lpm and not more than 150 Lpm. This device may be fitted to a hood, helmet, or tight-fitting face piece. The hose mask without a blower is a Type B respirator and is also certified for use in non-IDLH atmospheres. The length of hose is limited to 75 feet in multiples of 25 feet. This device may only be fitted to tight-fitting face piece.

Because these units do not provide high pressure inside the face piece they afford a low degree of protection and are not widely used in industrial applications.

4. Combination supplied-air/air-purifying respirators

These devices are available and have been approved for use by NIOSH/MSHA. These units are classified as Type C and are certified under the type of air-purifying element attached as it is the component that affords the least protection to the wearer. The device consists of a face piece, regulator, breathing tube, belt or harness, supplied-air hose, and air-purifying element. This element can be a canister, cartridge, or particulate filter. It is mounted either directly on the face piece or on the belt.

The supplied-air portion of the unit can be either demand or pressure-demand. The advantage of this type of device is the ability to enter and leave an area without the air-supplied portion and the associated hardware. Additionally, should the air supply fail, the unit can be used in the air-purifying mode for escape purposes. Limitations include those common to all air-purifying units such as specific protection against known agents and prohibited use in oxygen deficient and IDLH atmospheres.

Restrictions will also apply depending on the type of air-purifying element used, but may include:

a. No restrictions

b. unit can only be used to enter an area prior to connection to the air

c. supply or exiting an area following disconnection or loss of air supply

c. escape only after loss of air supply.

5. Combination supplied-air/SCBA respirators

These devices are available for use in IDLH atmospheres. This is possible using an airline respirator with the addition of an auxiliary air supply to protect against failure of the primary air supply. The auxiliary air supply is provided by adding a self-contained cylinder of compressed air. This auxiliary air supply may be certified for 3-, 5-, or 10-minute service life spans or for 15 minutes or longer. Because of this short service life, these units are commonly used for escape from IDLH atmospheres or for emergency rescue operations.

The breathing air used in compressed sources such as SCBA's compressors and cylinders must meet minimum quality standards set forth by the Compressed Gas Association (CGA) in Specification G7.1. The breathing air shall be at least a Grade D or equivalent. The following table summarizes the required parameters for Grade D air. OSHA requires that the source of this air be tested every six months for these parameters. EH&S is available for assistance in conducting this testing.

Oxygen content:	19% - 23%

Carbon Monoxide:	10 ppm
Carbon Dioxide:	1000 ppm
Oil mist:	0.005 mg/1
Total Hydrocarbons:	25 ppm
Halogenated solvents:	0.2 ppm
Total moisture:	0.3 mg/1

When an air compressor is used for breathing air, a trap and carbon filter must be installed to remove oil, water, scale, odor and taste; a pressure reducing valve must be installed to reduce air pressure to respirator requirements; and an automatic shut-off must be in place to either sound an alarm or stop the compressor in the event of overheating. Specially designed breathing air compressors are commercially available with the above criteria.

Compressed gas cylinders may also be used in the absence of a compressor with the air quality requirements remaining the same.

A regulator must be in-line to reduce the pressure to respirator requirements. However, constant flow respirators are not recommended, as the air supply is limited to the volume of the cylinder.

C. Respirator Selection Criteria

Respirators must be selected on the basis of the hazards to which employees may be exposed. The following information is provided to assist in the decision process for selecting the proper respirator type and assuring adequate protection.

In cases where OSHA has specified a specific respirator be used for a certain task or substance (such as asbestos or other carcinogens) that respirator or one providing equal or better protection must be used. This can be determined by reference to the specific health standard or reviewing the Material Safety Data Sheet (MSDS) for that substance. In all cases where respirator selection or use is questioned, contact EH&S.

Decision Considerations

1. What is the contaminant concentration expected through estimation or air monitoring? This will aid in determining the need for APR's or ASR's.

2. What is the permissible exposure limit (PEL), threshold limit value (TLV), or short-term exposure limit (STEL) of the contaminant. Also note the potential for skin absorption as indicated on the MSDS, TLV or PEL lists. Used to determine the need for respiratory or other protective equipment.

3. Is the contaminant a gas, vapor, mist, dust or fume? This can be obtained from the MSDS and the properties of the raw material. This is used to determine the type and availability of the removal method the respirator will need.

4. Could the contaminant concentration reach that immediately dangerous to life and health (IDLH)? This information can be obtained from the MSDS and should include the possibility of occurrence during a spill or release. Will be used in emergency response procedures.

5. If the contaminant is flammable, does the estimated working concentration approach the lower explosive limit (LEL) as given on the MSDS? Does the dust create an explosion potential? In most cases concentrations approaching the LEL are also IDLH. Consideration should also be given to potential explosive conditions during spills.

6. Does the contaminant have good warning properties? Information on odor, taste and irritations can be obtained from the manufacturer or the MSDS. These properties should be known to recognize leakage and potential exposure during APR use.

7. Will the contaminant irritate the eyes at the expected working concentration? This information can be obtained from the MSDS or previous experience and is used in the selection of full-face or half-face APR's.

8. What respirator(s) will give the required maximum use concentration (MUC)? Determination is made by multiplying the contaminant PEL by the protection factor (PF) for the respirator of choice (as given in the following table). IF the maximum expected working concentration of the contaminant is less than the MUC for that respirator then an acceptable choice has been made.

$$MUC = PEL \times PF$$

TABLE I. ASSIGNED RESPIRATOR PROTECTION FACTORS PER ANSI Z88.2 1992

Protection Factor	Type of Respirator
10	Single-use or Quarter-mask APR
10	Half-mask APR or Half-mask ASR in demand mode

25	PAPR with hood/helmet, continuous flow ASR with hood/helmet (loose fitting)
50	Half-face PAPR, Half-face ASR in pressure demand mode, half-mask ASR in continuous flow mode
100	Full-face APR, Full-face ASR in demand mode
1,000	Full-face ASR in pressure demand mode or continuous flow mode, Full-face and loose fitting PAPR with HEPA-filter
10,000	Full-face SCBA in pressure demand or positive pressure mode, full-face ASR with auxiliary SCBA in pressure demand or positive pressure mode.

Respirators should be assigned on an individual basis. Employees should be responsible for assuring that their equipment is kept clean, sanitary and in good working condition. The respirators should be marked with the employee's I.D.

Routine use of respirators means daily or frequent use on a regular basis. For such use, a respirator of low initial cost, simple maintenance, minimal wearing discomfort and compact construction should be considered.

A respirator used non-routinely is used for hazardous situations that occur occasionally. For such applications, initial costs and maintenance costs are less important than for routine applications. The degree of protection and the useful service life provided are important.

A manufacturers' equipment is acceptable if it has been approved for use by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) for the exposure of concern. Reputable distributors should be contacted for pricing and availability to ensure that outdated or unapproved equipment is not purchased. Purchasers should specify to vendors that only NIOSH/MSHA approved equipment will be accepted. Such equipment will have a special logo on the packaging material along with an approval number (TC-number). Most laboratory equipment suppliers carry personal protective equipment or you may contact EH&S for additional suppliers.

All component and replacement parts must also carry this approval. In addition, respirators are approved as a system. Cartridges, canisters, filters, air lines, and regulators cannot be interchanged between manufactures.

V. EMERGENCY SELECTION AND USE

In general, there are three conditions which may require emergency use of respirators. These include:

1. For an employee's self-rescue when process excursion, spills, etc., create a sudden release of hazardous materials;

2. For the rescue of personnel trapped or overcome in a hazardous environment;

3. To shut down or repair an operation that is creating a hazardous environment.

The equipment used for emergency purposes is no different than that used for routine respiratory protection and the guidelines given previously should be implemented during use.

The following types of respirators are acceptable for emergency use:

1. Mouthpiece respirators

2. Standard chemical cartridge/canister, filter APR's or gas masks

3. SCBA with 5 to 15 minute supply.

APR's must be equipped with the cartridges/canisters specific for the known contaminant. Mouthpiece respirators are available for protection from carbon monoxide, chlorine, ammonia, organic vapors and organic vapors/acid gases.

Where eye irritation is possible a full-face piece respirator is required.

When concentrations encountered during emergency situations cannot be determined quickly and easily, the only type of respirators acceptable for working (other than escape) in such areas are pressure demand SCBA's or a positive pressure air-line respirator with and auxiliary air tank for escape. Only pressure demand SCBA's should be used for rescue.

Respirators used for emergency use should be stored in a conspicuous and accessible place. These units should be inspected monthly and inspections should be recorded in a logbook kept at the storage area.

All employees working in areas where possible releases could occur must be thoroughly trained in the use of escape respirators, escape routes, process shut down procedures, indications of a release, health hazards of the release and designated rescue personnel and procedures.

Table II Emergency Respirator Selection Options

CONDITIONS	TYPE OF RESPIRATOR
Escape- short and direct route to exit no oxygen deficiency	Mouthpiece, APR, 5-minute SCBA
Escape- long and/or indirect route to exit, no oxygen deficiency	Gas mask/APR, 15-minute SCBA
Rescue, repair and/or shutdown, and/or entry into unknown conditions or oxygen deficiency	Pressure demand SCBA

VI. MEDICAL MONITORING AND CONSIDERATIONS

The use of respiratory protection places unusual stresses on the wearer. These are inherent in the devices and can restrict the abilities of the wearer by taxing the cardiovascular and pulmonary system.

Therefore, any employee required to use respiratory protection shall undergo physical examination according to the guidelines below. All medical evaluations are performed through an approved service.

The supervisor shall ensure that Form I Respirator Use Record is completed and provided to the Physician at the time of examination.

This examination shall meet the criteria as set forth by NIOSH and OSHA including physiological and psychological parameters. Further these evaluations shall be made on a pre-placement, periodic and post-employment basis as recommended by a competent, licensed physician with knowledge of pulmonary disease and respiratory protection.

Table IV provides the recommended frequency of periodic examination. This includes every five years up to age 35, every two years up to age 45 and annually thereafter. Once the physician has completed the examination, the attached Form III, Medical Surveillance Record, shall be completed. Copies of the form shall be retained by the physician and by the employee for file in the department office.

The purpose of the exam will be to screen employees for pre-existing conditions not conducive to respirator use, confirm the individual can handle the additional stresses caused by the devices and to periodically re-evaluate for changes in health or abilities.

Contents of the examination shall include:

a. Medical history with family background. Identified employees with a history of asthma, emphysema, or chronic lung disease.

b. Work history including past occupational exposures to asbestos, silica, cotton dust, beryllium, etc. Also includes information on previous occupations, breathing difficulties during normal duties, and past problems with respirator use.

c. Other medical information including psychological problems or claustrophobia, physical abnormalities that may interfere with respirator fit, past and current medical, tolerance to increased heart and breathing rates, and heat stress.

d. Where appropriate, periodic routine medical examinations should be made to determine whether exposure to harmful levels of respiratory hazards has occurred. The results of this monitoring should be compared to per-employment exams to determine body burden and respirator effectiveness.

e. Physical exam with an emphasis on respiratory and cardiovascular systems.

f. Pulmonary function tests by a clinician who has completed a NIOSH spirometry course.

g. A per-placement 14 x 17 inch PA chest X-ray interpreted by a Board Certified Radiologist.

h. Upon completion of the evaluation, the Physician shall provide a written opinion to EH&S and the employee's department utilizing Form III, Medical Monitoring Record. The opinion shall include comments on any applicable restrictions to respirator use.

Approval for respirator use involves certain restrictions including:

1. No restriction on use

b. Specific restrictions on use (supplied air devices only, air purifying devices only)

c. No respirator use under any circumstances

Conditions that may prevent an employee from wearing a respirator, and thus from working in a contaminated area, including:

a. Diabetes, insipidus or mellitus

b. Epilepsy, Grand mal or petit mal

c. Alcoholism

d. Use of certain medications

e. Punctured eardrum

f. Skin sensitivities

g. Impaired or nonexistent sense of smell

h. Emphysema

i. Chronic pulmonary obstructive disease

j. Bronchial asthma

k. X-ray evidence of pneumoconiosis

l. Evidence of reduced pulmonary function

m. Coronary artery disease or cerebral blood vessel disease

n. Severe or progressive hypertension

o. Anemia, pernicious

p. Deformities of mouth or sinus cavities compromising respirator seal

q. Breathing difficulties during respirator use

r. Claustrophobia

s. Any other condition that the University Physician determines may impair employee abilities or safety.

Diminished Senses: respirators may reduce visual fields, decrease voice clarity and loudness, and decrease hearing ability. Besides the potential for reduced productivity, these effects may result in reduced safety. These factors may also contribute to the feeling of stress.

Psychologic: There is little doubt that virtually every one suffers some discomfort when wearing a respirator. The large variability and the subjective nature of these psychological aspects make recommendations subject to physician discretion based on interviews and employee experience in respirator use. This further stresses the need to prevent over-exposure through engineering controls.

Local irritation: Allergic skin reaction may occur occasionally from wearing a respirator and use may exacerbate preexisting conditions.

The following summarizes recommendations from the National Institute of Occupational Safety and Health (NIOSH) for use by the physician during medial evaluations. While some of these recommendations apply to any medical examination, others are identified as being applicable to specific situations.

The final determination of fitness to wear a respirator should be made by the physician based on the employee's health, the type of respirator to be used, and the conditions of respirator usage.

Routine chest X-ray and spirometry are not recommended solely as data for determining if a respirator should be worn. In most cases, a normal physical examination is sufficient and the X-ray would be an unnecessary source of radiation exposure. Current information suggests that mild to moderate pulmonary impairment detected by spirometry would not preclude the wearing of respirators in most cases. Thus chest X-ray and/or spirometry are only recommended when clinically indicated.

Federal regulations require an employee's health status to be reviewed periodically. Therefore the guidelines for most conditions of respirator use are given below.

The more frequent evaluations with advancing age relate to the increased prevalence of most diseases in older people. More frequent exams are recommended for those performing strenuous work involving the use of self-contained breathing apparatus (SCBA).

TABLE III. SUGGESTED FREQUENCY OF MEDICAL EXAMINATIONS

Condition	Worker Age in Years		
	<35	35-45	>45
Most working conditions requiring respirators	Every 5 yrs.	Every 2 yrs.	1-2 yrs
Strenuous work conditions with SCBA	Every 3 yrs.	Every 18 mos.	yearly

In addition to the physical effects of wearing a respirator, the physician should determine if wearing a given respirator would cause extreme anxiety or claustrophobic reaction in the individual. This could be done during training, while the employee is wearing the respirator and is engaged in some

exercise that approximates the actual work setting. This trial period should also be used to evaluate the employee's ability and tolerance to respirator use.

The supervisor shall maintain employee records pertaining to medical examination and air monitoring results for the duration of employment and 30 years following.

FORM III

MEDICAL MONITORING RECORD

I have examined _____, and find indications/no indications preventing the use of respiratory protective equipment.

This includes: (circle all acceptable apparatus)

a. Air Purifying Respirators

b. Powered Air Purifying Respirators

c. Self-Contained Breathing Apparatus

d. Airline breathing apparatus.

Have you ever had any of the following:	YES	NO
1. Lung Disease	____	____
2. Persistent cough	____	____
3. Heart trouble	____	____
4. Shortness of breath	____	____
5. History of dizziness or fainting	____	____
6. High blood pressure	____	____
7. Diabetes	____	____
8. Claustrophobia	____	____
9 Heat exhaustion or stroke	____	____
10. Ruptured eardrum	____	____
11. Defective Vision	____	____
12. Defective hearing	____	____
13. Contact lenses/glass	____	____
14. Taking medication	____	____

Physician's Signature:_____ Date: _____

Restrictions: 1. No restrictions on respirator use.
2. Some restrictions (see below).
3. No respirator use permitted (see below).

Comments:_____

cc: Dept. File
Human Resources
Environmental Health & Safety

VII. TRAINING REQUIREMENTS

In compliance with the Respiratory Protection Standard, UNF requires all supervisors and their employees who wear respirators to undergo annual training in the proper selection, use, care and maintenance of respiratory protective equipment.

The minimum contents of this training shall include:

1. The opportunity to handle and wear the respirator prior to actual use
2. Proper fitting, including demonstrations and practice in donning, adjusting and determining the fit of the unit
3. Testing the face-to-face piece seal
4. A familiarization period under normal conditions
5. Wearing the unit under test conditions.

Additional, recommended training should include:

1. Discussion of the engineering controls in place and the need for respiratory protection in addition to these controls
2. Explanation of the respiratory hazard and what happens in the event an exposure occurs
3. Explanation as to why a particular type of respirator has been selected
4. Recognition, evaluation and control of potential emergencies.

Supervisors should have a comprehensive knowledge of respirators and respiratory protection practices. Their training should include at a minimum:

1. Basic respiratory protection practices
2. Selection and use of the various respirators used
3. The nature and extent of the respiratory hazards to which employees may be exposed
4. The structure and operation of the entire Respiratory Protection Program, supervisor responsibilities, employee responsibilities, and program evaluations.

The extent and frequency of training will depend primarily on the nature and severity of the hazards. At a minimum the contents shall be as above and the frequency annual. As new personnel are

acquired and new hazards develop, the training will be repeated and modified. Training should be as specific and complete as possible. Information on hazards severity and associated training aids can be obtained from EH&S.

The basic training common to supervisors and employees shall include:

1. Instruction in the nature of the hazards, whether acute, chronic, or both and the consequences of failure to use respiratory protection

2. Explanations to why engineering controls are not feasible to limit the exposure and recognition that every effort is being made to educe or eliminate the need for respirators

3. Discussion of why a particular type of respirator has been chosen

4. Discussion of the respirator's capabilities and limitations

5. Instructions, training, and actual use of the respirator (especially emergency use devices) close, frequent supervision to ensure proper use

6. Classroom and field training in recognizing and handling emergencies

7. Specific training applicable to the equipment, research project or specialized process as needed.

The major thrust of the training is toward explanation of the need and reasons for wearing a respirator. This aids in motivating the employee to accept that the device is necessary and instill the desire to wear and maintain the unit property.

Initial training efforts may be accomplished with the assistance of EH&S and can then be turned over to individual departmental control. Form IV, Respirator Training Record, shall be used to document these efforts and a copy shall be kept in each departmental office for one year after the employee's last day.

FORM IV

RESPIRATOR TRAINING RECORD

This will confirm that, _____
(Print Full Name)

has received training on _____in the proper selection, use and care of the respirator assigned to him/her.

The contents of the training I received were: (check items covered)

_____Description of Respiratory Protection Program

_____Responsibilities

_____Respirator selection principles

_____No contacts, facial hair allowed (that can interfere with seal)

_____Hazards of expected contaminants

_____Medical monitoring principles

_____Emergency procedures

_____Respirator donning and use

_____Respirator care and storage

_____Cartridge/filter change out schedule

Further, I understand the importance of this program and agree to abide by its contents.

Trainee:_____

Instructor:_____

cc: Dept. File
Environmental Health and Safety

VIII. FIT TESTING

Improper respirator adjustment and fit will negate all the efforts provided in assuring employee protection. The face-to-face piece seal between the respirator and the wearer must be maintained at all times to ensure maximum respiratory protection.

There are two primary conditions that must be met in respirator fitting. These include choosing the proper size of face piece for the individual and ensuring that the wearer knows when the proper fit is attained. These can best be achieved by means of a fit test which is required by this program and OSHA.

The basic requirement of fit testing is that the employee be allowed to determine the seal in a test atmosphere. It is important to remember that during this test the wearer must adjust the straps to a comfortable point. Tightening the straps beyond this may decrease leakage, but can make the respirator unbearable to wear.

Each time a respirator is donned, the wearer should conduct a quick fit check. This ensures the respirator is adjusted properly and sealed against the face. The advantages are that the wearer can do this alone in the field and the test can be repeated any time the seal is in question. There are two types of quick fit checks, the negative fit check and the positive fit check.

The negative fit check consists of merely closing off the inhalation area(s) of the face piece with the palms of the hands. The wearer then inhales creating negative pressure in the face piece and causing the mask to collapse slightly. Holding the breath for 10 seconds, the wearer listens and feels for leakage into the mask. If the face piece remains collapsed and no inward leakage is detected, the respirator is deemed fit.

The positive fit check is very similar to the negative fit check except the wearer covers the exhalation area of the mask. Gently breathing out causes positive pressure in the face piece and the wearer listens and feels for leakage. If the pressure is maintained without leakage, then the respirator is considered fit.

On some units, the wearer must remove the exhalation valve cover to ensure an adequate seal. This cover must then be replaced after the test or a loss of the seal can result. Therefore on such units this test should be used sparingly. For other units this test is as effective as the negative fit check and should also be conducted just before entering a contaminated atmosphere.

If leakage is detected during either quick fit check, the straps should be readjusted, and the check repeated.

On a semiannual basis a more stringent fit test shall be conducted. This can be either a quantitative or qualitative fit test.

Quantitative fit testing is best suited for large respiratory protection programs where respirators

are used for highly toxic or radioactive materials. The fit is all the more crucial and therefore the associated test equipment is more sophisticated. This method measures the actual leakage of the respirator and does not depend on the wearer's sense of smell or irritation to make the determination. Because of the specialized equipment involved and differing manufacturers instructions, detailed descriptions will be provided on a case-by-case basis. Due to the added expense and sophistication of these devices, EH&S should be contacted before a quantitative fit test apparatus is purchased.

General respirator use warrants qualitative fit testing. This should be conducted prior to entering a contaminated atmosphere and is especially prudent if use is infrequent. It involves exposing the wearer to a test agent that can be easily detected by odor, irritation, or taste. If an APR is being tested, the proper purifying element must first be chosen. If the wearer is unable to detect the test agent upon exposure, then the respirator is considered fit. If a sensation is detected upon exposure, then the fit is adjusted or another size/make of respirator is chosen.

The following procedures should be followed in selecting a respirator.

1. The subject should be allowed to select the most comfortable respirator from three sizes and two manufacturers.

2. The subject should be shown how to put on the respirator, how to position it on the face, how to adjust the strap tension and how to assess a comfortable fit. A mirror may aid the subject in evaluating the positioning and fit of the mask.

3. The subject should understand that they are being asked to select a respirator that it is the most comfortable for them as they may have to wear the unit for extended periods. Each respirator represents a different size and shape, and if fitted properly, will provide adequate protection for the anticipated conditions.

4. The subject should hold the unit up to the face and eliminate those which will obviously not fit. Selection may begin with a half-mask and if a fit cannot be obtained here a full-face unit may be necessary.

5. The most appropriate unit chosen, donned and worn for at least five minutes to assess comfort. If the subject has never worn a respirator before the donning procedure should be repeated to ensure ease of handling and adjustment.

6. Assessment of comfort should include the following:

    - chin positioned in the mask properly
    - positioning of the unit on the nose
    - strap tension
    - fit across the bridge of the nose (half-mask)
    - room for safety glasses (half-mask)
    - distance from the nose to the chin

- room to talk
- tendency of the unit to slip
- cheeks puffed out
- adequate time for assessment.

7. The subject is now ready for the quick fit checks described above and should seat the mask by moving the head rapidly from side to side and taking a few deep breaths.

8. If after the first few weeks of use, the employee finds the unit unacceptably uncomfortable, they should be given the opportunity to select a different face piece.

The following procedures shall be implemented in conducting the qualitative fit test.

1. The test should be conducted in a clear, plastic trash bag hung on a clothes hanger or similar enclosure in a well-ventilated room to maintain the test atmosphere and prevent the test administrator from continually being exposed to the test agents. This also prevents exposing test subjects to the agents prior to testing causing sensory fatigue/recall during testing.

2. Two types of agents are commonly used and available from the respirator supplier. These include isoamyl acetate (banana oil) and irritant smoke (stannic chloride or titanium tetrachloride). When fit testing APR's organic vapor cartridges are required for the banana oil test and HEPA filters are required for the irritant smoke test. However it is important to replace these elements with ones designed to remove the contaminants in the work setting following the test.

3. After selecting, donning and properly adjusting the respirator, the subject shall wear the unit into the chamber and be provided with a copy of the following instructions.

Test Exercises

i. Normal breathing.

ii. Deep breathing. Be certain breaths are deep and regular.

iii. Turn the head from side-to-side and inhale at each side. Be certain motions are complete and assertive. Do not bump the respirator on the shoulders.

iv. Nod the head up-and-down with complete determined motion and inhale while head is up. Do not bump the respirator on the chest.

v. Talk aloud and slowly for several minutes. The following passage known as the Rainbow Passage can be used and is designed to simulate the majority of potential facial movements during speech. Other passages can be used which will serve the

same purpose.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long arch, with its path high above the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one has ever found it. When a person looks for something beyond their reach, friends say they are looking for the pot of gold at the end of the rainbow.

vi. Normal breathing.

4. Each subject shall wear a respirator for at least 10 minutes before starting the fit test.

5. Upon entering the test chamber the subject is informed of the reasons fro the fit test, the test procedures and demonstrations. In the meantime, the banana oil is introduced by ampule or a treated paper towel allowing the vapors to fill the chamber.

6. The exercises in number 3 above are now preformed for at last one minute. If irritant smoke is used as the test agent, then it is introduced by squeeze bulb at this time. The smoke should e directed at the face-to-face piece seal of the respirator.

7. If at any time during the test, the subject detects the banana odor or has an involuntary sensation to cough, they shall exit the chamber and leave the area with the respirator on to avoid sensory fatigue.

8. The subject shall then remove the respirator and do one of the following:

   a. adjust the fit of the current unit,

   b. try another size,

   c. try another brand.

   These shall be repeated, preferably in order, until a satisfactory fit is obtained.

9. It may be necessary for the subject to wait 5-10 minutes before repeating the test to ensure odor sensitivity has returned.

10. If the subject still is not able to obtain a satisfactory fit, a full-face respirator shall be included in the fitting process. Once the subject passes the test, the fit can be demonstrated by breaking the face-to-face piece seal in the chamber and allowing the subject to experience the odor/sensation.

11. Used ampules, smoke tubes or saturated paper towels shall be disposed of in sealed bags to prevent contamination of the test area.

12. Employees who have passed this test procedure and obtained a satisfactory fit can be assigned a protection factor (PF) of no greater than 10 with the test respirator. This means that the unit shall not be used in atmospheres where the contaminant concentration exceeds 10 times the PEL.

Each time a qualitative fit test is conducted, the supervisor shall complete Form VII, Fit Test Record, and maintain a copy at the departmental office.

FORM V

QUALITATIVE FIT TEST RECORD

Name:_____

Social Security No.:_____Date_____

Type/Brand of Respirator:_____

_____

Model:_____

Size:_____

Respirator Approval Number (TC-Number):_____

Test Agent:	Irritant Smoke	Banana Oil
Results (circle)	Pass Fail	Pass Fail

Name of Test Conductor:_____

Duties requiring respirator:_____

_____

cc: Depart. File
Environmental Health & Safety

IX. INSPECTION, CLEANING, MAINTENANCE AND STORAGE

Respirator maintenance shall be an integral part of the overall Respirator Program. Manufacturer's instructions for inspection, cleaning and maintenance of respirators shall be followed to ensure that the unit continues to function property. Wearing poorly maintained or malfunctioning respirators can be more dangerous than not wearing one at all. The employee wearing a defective device may falsely assume that protection is being provided and continue to work and be exposed. Emergency escape and rescue devices are particularly vulnerable to inadequate inspection and maintenance because they are rarely used, but are relied upon during the most hazardous and demanding circumstances. The consequences of wearing a defective emergency escape and rescue device are lethal.

The minimum requirements of the maintenance program shall include:

a. Inspection for defects (including a leak check)

One of the most important parts of the program is frequent inspection of the devices themselves. If conscientiously performed, inspections will identify damaged or malfunctioning respirators before they can be used. OSHA requires two primary types of inspection. These include visual inspection before respirator use and component inspection during cleaning. In a small operation, where employees will maintain their own respirators, the two types of inspection are essentially the same. In a large organization with a central respirator supply facility, the inspections will be separate.

All respirator units shall be inspected before and after each use. Those devices used infrequently, such as for emergency escape, shall be inspected after each use and at least monthly. However, NIOSH recommends that all stored SCBA's be inspected weekly, as it is highly unlikely and risky to take the time to inspect a unit during an emergency.

OSHA requires that the inspection include a check of connections, the face piece, valves, connecting tubes and canisters, and checking the regulator and warning devices on SCBA's for proper functions.

Routinely used APR's should be checked for:

i. excessive dirt

ii. cracks, tears, holes or distorted parts

iii. inflexible parts including head straps

iv. cracked/badly scratched lenses (full-face)

v. incorrectly mounted full-face lens or broken/missing mounting hardware

vi. cracked/broken buckles, air-purifying element holders, badly worn threads, missing gaskets

vii. examine exhalation valve for: foreign material, cracks, tears, distortion, improper insertion, missing/defective valve covers

viii. examine air-purifying elements for: correct cartridge/filter for hazards anticipated, correct installation, loose connections, missing/worn gaskets, cross-threading in holder, expired shelf-life damaged cartridge/filter housing, evidence of prior element use

ix. examine breathing tubes for: broken/missing end connectors, gaskets or o-rings, missing/loose hose clamps, tube cracking/deterioration

x. examine the harness of belt mounted cartridges/filters for: damage to wear in the canister holder preventing it from being properly seated, broken straps or fasteners

Routinely used air-supplying respirator s shall be checked for all of the above including:

i. examination of protective headgear protective faceshield, hood, blouse or suite for rips/tears,

ii. integrity of air supply lines/hoses, attachments and fittings,

iii. correct operation of all regulators and valves

iv. SCBA's shall be inspected to ensure: the high-pressure cylinder if full before use and refilled after use, and that the cylinder has been hydro-tested as required (every five years for steel, every three years for composite)

v. If defects are found during inspection they should either be repaired/adjusted on the spot or the unit should be removed from service until repairs can be completed. Under no circumstances should a defective unit be put back in service or stored for future use until repairs are made.

b. Cleaning and disinfecting

Because respirator cleaning requires some disassembly this presents a good chance to examine it for damage and wear. The procedures outlined above should be applied and respirators should be reinspected after cleaning and reassembly. OSHA further requires that the units be leak checked following reassembly. This can be accomplished by a quick fit check (negative and positive) after reinspection.

i. OSHA also requires that routinely used respirators shall be collected, cleaned and disinfected as frequently as necessary to ensure proper protection is provided and that emergency use respirators shall be cleaned and disinfected after each use. When used occasionally, respirators should be cleaned weekly or monthly. Employees cleaning their own units shall be briefed on the proper techniques and assembly procedures. The generally accepted procedure involves washing with detergent and warm water using a brush, thoroughly rising in clean water and air-drying in a clean place. Precautions should be taken to prevent damage from rough handling during this procedure.

   In areas/departments where large numbers of respirators are used, it is recommended that a centralized cleaning and maintenance facility with specialized equipment and trained personnel be established.

ii. Disinfection is not absolutely necessary if the same employee reuses the respirator. However, where individual use is not practiced disinfection is required. Reliable, effective disinfectants can be made by adding two tablespoons (two milliliters) of bleach to one gallon (one liter) of water. A two-minute immersion should be sufficient. To prevent damage to the respirator and sufficient cleaning the water temperature should be around 120 degrees Fahrenheit.

iii. Rinsing should also be conducted in hot water to remove all traces of detergent and disinfectant. This is crucial in preventing skin reaction and dermatitis.

iv. Drying should be conducted in room air on a clean surface. Respirators may also be hung from a horizontal position, but care must be taken not to damage or distort the face piece. Another method is to equip a standard metal storage cabinet with a built in fan and steel mesh shelves.

v. The clean, dry respirators shall be reassembled and inspected in an area separate from the disassembly area to prevent contamination. The inspection procedures discussed above shall be implemented with special emphasis given to inspection for detergent residue. This can appear under the exhalation valve and cause the vale to stick during operation. The assembled unit shall be leak tested as above and new cartridges/filters installed. For SCBA's the face piece shall be combined with the tested regulator and fully charged cylinder, and the entire unit operationally checked.

b. Repair

OSHA mandates that experienced personnel shall do replacement or repair with parts designed for the respirator. Substitution of parts from different brands invalidates the warranty and approval number of the unit. Employees must be thoroughly trained and aware of the limitations and never try to replace components or make repairs and

adjustments beyond the manufacturer's recommendations. These restrictions apply primarily to more complicated devices, especially SCBA's and air-line apparatus.

An important aspect of any maintenance program is having enough spare parts on hand. Only continual surveillance of replacement rates will determine what part and guantities must be kept in stock. It is recommended that a recording system be implemented to indicate spare parts usage and the inventory on hand.

d. Proper storage

OSHA requires that respirators be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, damaging chemicals, and mechanical damage.

Storage areas to avoid include workbenches, tool boxes/cabinets, among heavy tools, grease and dirt. Freshly cleaned respirators shall be placed in sealed bags until reissue. They shall be stored in a clean, dry location away form direct sunlight. They shall be placed such that the face piece and exhalation valve is in an undistorted position to prevent permanent distortion. APR's kept for non-routine use shall be stored in a cabinet should be readily accessible and all employees shall be aware of its location.

SCBA's shall be stored either in a chest or a wall mounted cabinet for quick access during emergencies. The location should be well known, remain uncontaminated and clearly marked. The procedure for use should be escape to the clean area, don the SCBA and re-enter the hazardous area for necessary task/rescue.

Adequately trained employees will develop a respect for respirators which will ensure proper use and protect them from damage thereby reducing maintenance costs. An effective maintenance program ensures that respirators remain as effective as when they were new.

FORM VI

X. PROGRAM MONITORING AND SELF EVALUATION

The following questions were developed to evaluate the Respiratory Protection Program. The numbers found in the parenthesis after each question, key it to the section(s) in the program that can help answer the question or correct the deficiency. Each department impacted by this program shall conduct this evaluation on a yearly basis and provide a copy of the questionnaire to EH&S.

		YES	NO	SECTION
1.	Are engineering controls being used when feasible to control atmospheric contamination?	____	____	I
2.	Is respiratory equipment provided when necessary?	____	____	I, III, VI
3.	Do employees use the equipment in accordance with the instructions provided in this program?	____	____	II, VII
4.	Are there written operating procedures governing the selection and use of the respirators?	____	____	II
5.	Are the respirators selected for the particular hazard expected?	____	____	IV
6.	Do employees receive training in the use of the respirator and it's limitations?	____	____	II, VII
7.	Are respirators assigned on an individual basis?	____	____	IV, VIII
8.	Are respirators cleaned and disinfected on a regular basis?	____	____	IX
9.	Are respirators stored in a convenient, clean and sanitary location?	____	____	IX
10.	Are respirators checked during cleaning and bad parts replaced?	____	____	IX
11.	Are respirators used for emergencies checked on a monthly basis and after			

each use?	____	____	V

(PROGRAM MONITORING AND SELF EVALUATION)

	YES	NO	SECTION
12. Is there appropriate surveillance of work area?	____	____	III
13. Is the level of exposure to an employee recorded?	____	____	III
14 Is there a continual evaluation of the effectiveness of the respiratory program?	____	____	X
15. Before employees are assigned a task requiring respirators, are they checked to confirm medical monitoring has been conducted to ensure they can handle the stress?	____	____	VI
16. Are the respirators approved NIOSH/MSHA?	____	____	II, VI
17. Are respirators selected according to the guidelines given in the program?	____	____	VI
18. When breathing air is used, does it meet the requirements for Grade D air?	____	____	VI
19. Is the compressor used to provide breathing air equipped wit the necessary alarms and filters?	____	____	VI
20. Is the compressor designed/used so that the exhaust does not enter the air system?	____	____	VI
21. Is the reservoir large enough to allow the user to escape in the event of a failure?	____	____	VI
22. Are there alarms in the system to indicate			

	compressor failure or over-heating?	____	____	VI
23.	Is the compressor oil-lubricated?	____	____	VI

(PROGRAM MONITORING AND SELF EVALUATION)

		YES	NO	SECTION
24.	Does it then have a carbon monoxide alarm?	____	____	VI
25.	If only a high temperature alarm is installed are tests conducted to ensure that the carbon monoxide level remains less than 20 ppm?	____	____	VI
26.	Is the airline coupling compatible with outlets from other gas systems?	____	____	VI
27.	Are breathing gas containers properly marked?	____	____	VI
28.	Are respirators marked with the wearer's identification?	____	____	IV, VIII
29.	Is a record maintained showing the date of respirator issuance?	____	____	VI
30.	Are personnel familiar with the written procedures governing the use of respirators during emergencies and routine operations?	____	____	VI , V
31.	Are steps taken to insure that there is at least one additional person present when a person wearing a respirator could be overcome by toxic or oxygen-deficient atmospheres?	____	____	VI, V
32.	Are communications maintain between personnel present in contaminated atmospheres?	____	____	VI
33.	Are emergency plans and rescue equipment present?	____	____	V

(PROGRAM MONITORING AND SELF EVALUATION)

		YES	NO	SECTION
34.	Are there frequent inspections to assure that respirators are properly selected, used, cleaned and maintained?	____	____	V, IX
35.	Does training include proper fit testing, wearing for familiarity and in test atmospheres?	____	____	VII, VIII
36	Are employees instructed not to grown beards, sideburns, wear skull caps or temple pieces on glasses if respirators are to be worn?	____	____	IV
37	Do employees conduct quick fit checks after respirators are donned?	____	____	VIII
38.	Are employees instructed not to wear contact lenses with respirators?	____	____	IV
39	Are SCBA's inspected every month?	____	____	VI, IX
40.	Are inspection records maintained with mention of findings?	____	____	IX
41.	Are replacement/repairs made by trained personnel with authorized parts?	____	____	XI
42.	Are emergency respirator locations clearly marked?	____	____	V
43.	Are employees instructed as to the correct way to store respirators?	____	____	IX
44.	Are inspections made to ensure proper storage?	____	____	IX
45.	Are inspections made to insure that the proper cartridges re chosen for the hazards expected?	____	____	IV, IX

XI. REFERENCES

1) U. S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational safety and Health. Respirator Decision Logic, Publication No. 87-108. May 1987.

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4) American National Standards Institute, Inc, New York, New York. ANSI Standard Practices for Respiratory Protection, ANSI Z88.2-1980, May 1980.

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