Respiratory Protection and PPE

Objectives

- List the elements of a respiratory protection program
- Define terms related to respiratory protective equipment
- Understand the limitations of respiratory protective equipment
- List procedures for selecting respiratory protection
- List criteria that must be met prior to using an air-purifying respirator
- Retrieve respiratory equipment selection guidance from the NIOSH pocket guide to chemical hazards

Respiratory Protection

Respirators are the **least preferred method** of worker protection from airborne contaminants

Respiratory Protection

- Respirators are recommended when:
  - Engineering controls are not technically feasible
  - Engineering controls are being installed or repaired
  - Emergency and other temporary situations arise

Respiratory Protection Program**

Minimum requirements:

- Exposure assessment
- Program administration
- Written program
- Medical evaluation
- Selection of proper respiratory protection
- Training
- Fit testing
- Cleaning and maintenance

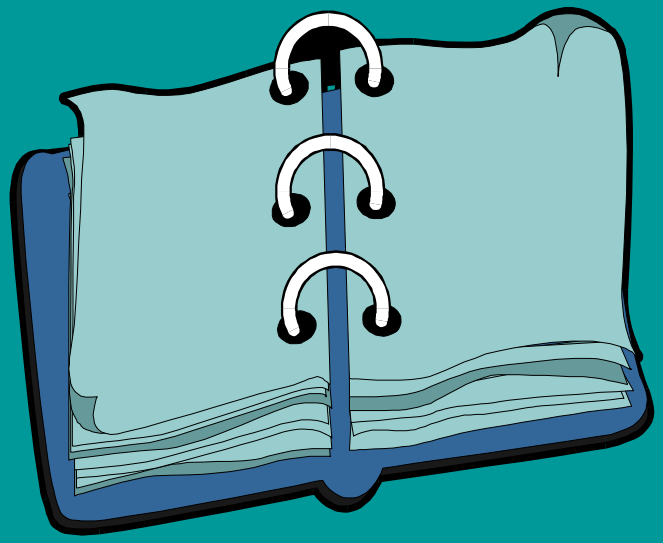
Exposure Assessment

- Identifies the need for respiratory protection
- Identifies the level of protection required
- Identifies when respirators must be used
- Must be performed periodically

Program Administration

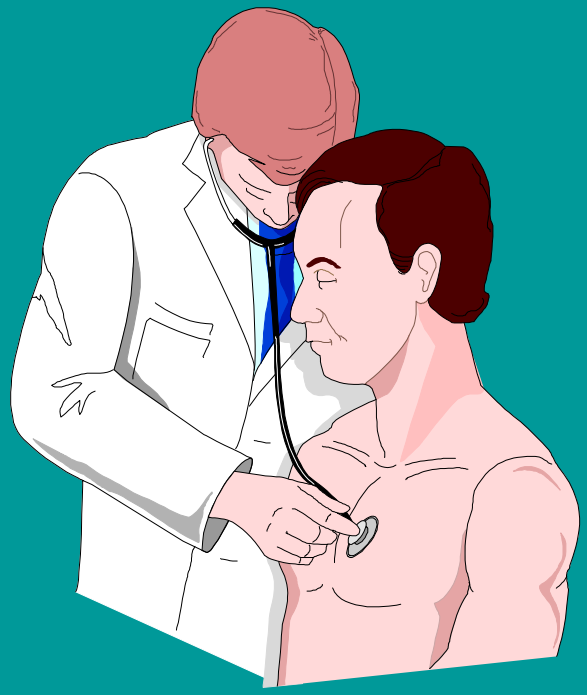
- Responsibility and authority must be assigned to one person
- Person must have sufficient knowledge to supervise the program

Written Program



- Must cover all elements of the respirator protection program
- Copies must be available for employees to read
- Reviewed annually

Medical Evaluation



- Determination of medical fitness of employee to wear a respirator

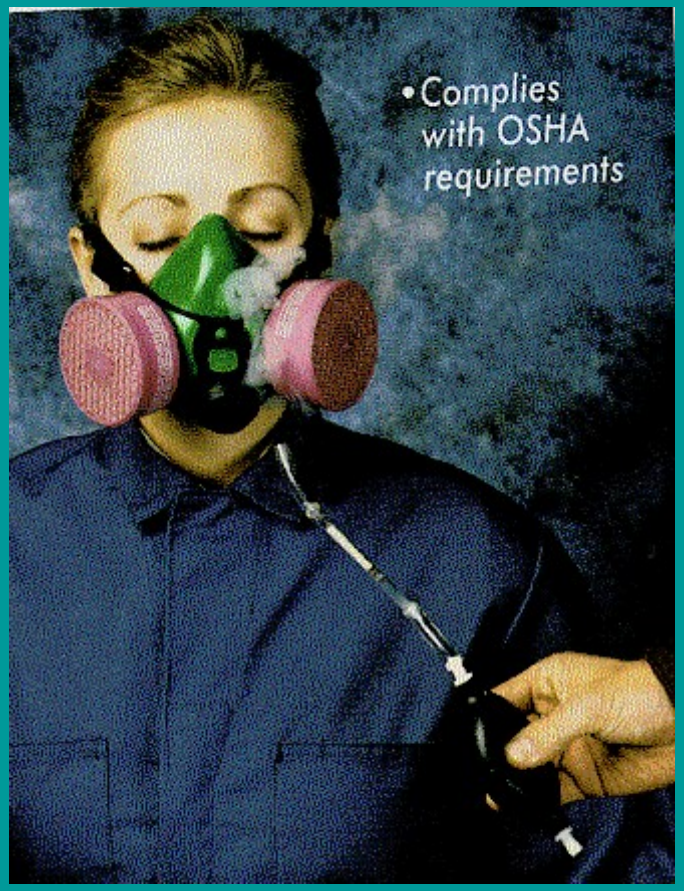
Selection of Proper Respiratory Protection

- NIOSH approved equipment
- Determination of levels of respiratory protection

Training

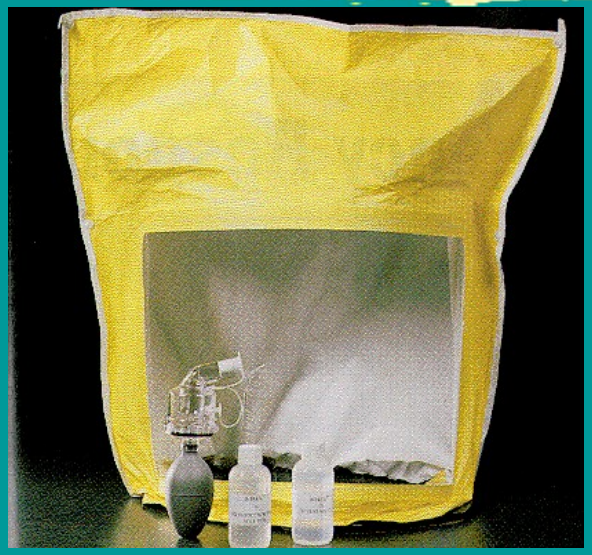
- Respiratory protection limitations
- Proper use of respirator
- Attendance documentation

Fit Testing



- Each program participant must be provided with a respirator that fits
- Workers must perform fit checks prior to entering contaminated areas

Fit Testing



- **Qualitative** - subjective method based on the wearer's response to a test chemical
- **Quantitative** - measures actual leakage of a test agent into the face piece


The alien does experiments
on humans no matter how
they attempt to protect
themselves!!!

Cleaning and Maintenance

- Proper cleaning
- Proper storage
- Frequent inspection
- Proper repair

Level of Protection

LEVEL OF PROTECTION	RESPIRATORY PROTECTION	CHEMICAL PROTECTIVE
A	SCBA (PP)	Encapsulating Suit (Vapor Protective)
B+	SCBA (PP)	Encapsulating
B	SCBA (PP)	None Specified
C	APR	None Specified
D	none	Work Clothes

PERSONAL PROTECTIVE EQUIPMENT

Objectives

- Identify the four criteria for selecting PPE
- Define terms related to protective clothing breakthrough
- Identify the levels of protection and differences between them
- Understand the limitations of PPE

PPE Selection Criteria

- Chemicals & hazards present
- Physical characteristics of chemicals:
  - physical state
  - flammability/volatility
  - reactivity
  - corrosivity
  - toxicity
- Tasks to be performed
- Cost

Other Selection Considerations

- No protective material is totally impermeable forever
- No one material protects against all chemicals
- For certain contaminants or chemical mixtures, there is no material available that will protect for more than one hour after initial contact

Protective Clothing Breakthrough

- **Breakthrough Time**-the time it takes a chemical to pass through the protective material from initial contact until it can be detected on the opposite side of the material by analytical instrumentation

- **Permeation**- the process by which a chemical dissolves in and /or moves through the material on a molecular level

Protective Clothing Breakthrough

- **Degradation**-the loss of or change in a fabric's chemical resistance or physical properties due to exposure to chemicals, use, or ambient conditions (i.e., sunlight)

- **Penetration**-the movement of chemicals through zippers, stitched seams or imperfections in the material

Fully Encapsulating Suits

(Level A or B+)

- One piece garment
- Boots and gloves may be integral, attached and replaceable, or separate

Fully Encapsulating Suits

- **Level A Suit (FEVP)**
  - Has one-way valve
  - Protects personnel and equipment against splashes, dusts, gases, and vapors
  - Is the most expensive type of suit
- **Level B+ Suit**
  - Does not have one-way valve
  - Is not protective against vapor
  - Protects personnel and equipment against splashes and dusts

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Limitations of Encapsulating Suits

- Do not allow body heat to escape - may contribute to heat stress in wearer
- Impair worker mobility, vision, and communication
- Cost of maintenance may be prohibitive
- Not flame resistant

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S1 SWDL, 8/16/2007

Non-Encapsulating Suits

- One-piece coverall
  - Protects against contact with dry materials, minor splashes and dust
  - Commonly available types are Tyvek® and Saranex®

Tyvek® and Saranex®

- Tyvek®: a proprietary, porous, non-woven fabric for limited use
  - Protects against dust, fibers, and contact with dry materials
  - Inexpensive
  - Not chemical resistant
  - Mainly used for keeping clean
- Saranex®: multi-layer laminate of polyethylene and Saran®
  - Some protection against splashes and vapor
  - Inexpensive
  - Fairly chemical resistant

Limitations of Tyvek & Saranex

- Tyvek does not protect against gases and vapors
- Do not protect against pervasive splashing hazard situations
- May contribute to heat stress in wearer
- Must tape-seal suit connection at gloves and boots
- Not flame resistant

Chemical Protective Gloves

- Inner (surgical)
- Outer (chemical protective)
- Work gloves

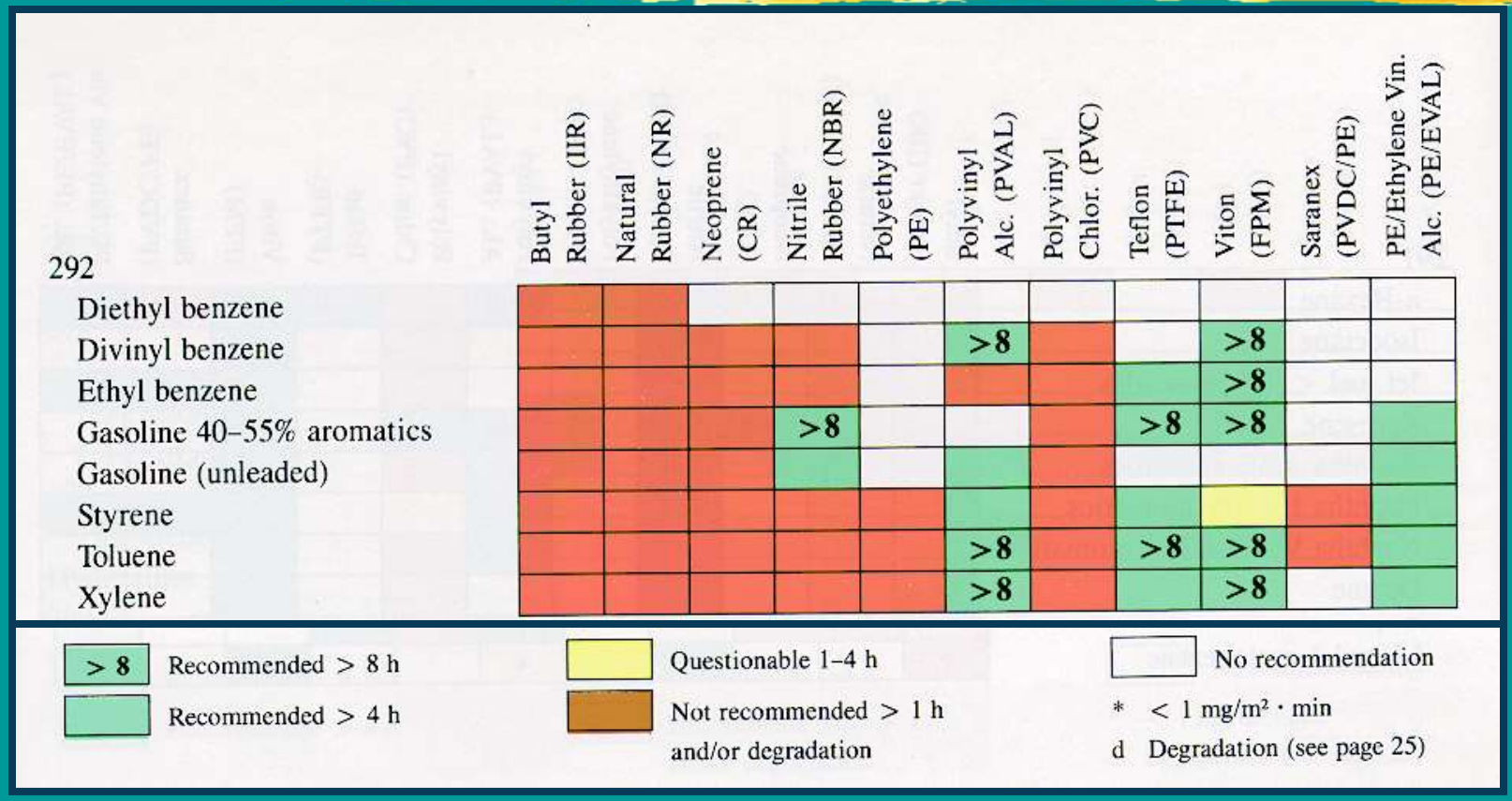
Glove Selection Considerations

- Degree of dexterity needed
- Length of exposure to chemical
- Chemical concentration
- Temperature
- Cut and abrasion hazards

Suit & Glove Material Selection

- Base suit & glove material selection on the manufacturer's chemical resistance guide
- When protecting against chemical mixtures, a material should be selected on the basis of the chemical component with the shortest breakthrough time

Chemical Resistance Guide



Flame/Fire Retardant Coveralls

- Protect against flash fires
- Nomex®, PBI, Kevlar®
- Do not provide protection against chemicals
- Add bulk which impairs mobility
- May contribute to heat stress

Safety Boots

- Chemical resistant
- Steel toe/steel shank
- Nonconductive/ Nonsparking
- Decontamination creates liquid hazardous waste
- Comply with ANSI Z41-1991


CUC-0012

Other Safety Equipment

- Head Protection (Hard Hat)
  - Comply with ANSI standards
- Eye Protection
  - Spectacles, side shields, goggles, face shield
  - Comply with ANSI standards
- Hearing Protection
  - OSHA established PELs

Other Safety Equipment (continued)

- Cooling vest
- Aprons, leggings, sleeve protectors, boot covers
- Sidearm and bullet-proof vest
- Fall protection (knee and elbow pads)

Selection Considerations

- Durability:
  - sufficient strength for task
  - resists tears, punctures, and abrasions
  - withstands repeated use
- Flexibility:
  - comfort to perform tasks
  - size of person
- Temperature effects:
  - heat stress

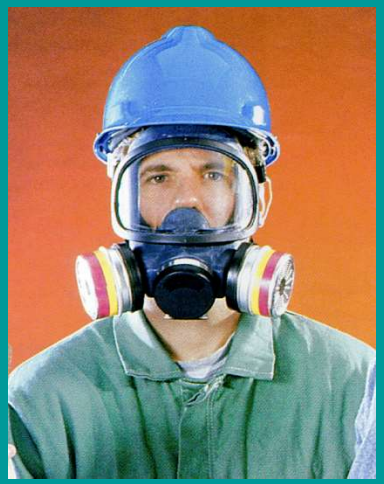
Selection Considerations (continued)

- Ease of decontamination:
  - decon available on site
  - maintains protective integrity
  - disposable clothing
- Compatibility with other equipment (i.e. firearms, bullet-proof vest, SCBA, cooling vest)
- Chemical resistance/ breakthrough time
- Fire hazard
- Cost

Options to Reduce Exposure

- Reduce number of workers needed in the hot zone
- Use tools or technology to reduce the amount of time spent in the hot zone
- Prepare and plan prior to entry in order to reduce time spent in the hot zone
- Re-design tasks to eliminate the need to be in close proximity to areas of contamination

Respiratory Protection



- **Two basic types of respirators:**
  - Air-purifying respirator (APR)
  - Atmosphere-supplying respirator: SAR and SCBA

Air-purifying Respiratory Protection Requirements*

- Need oxygen
- Not above IDLH
- Need good warning properties
- Limited to specific contaminants
- Contaminant must be known
- Negative pressure design
- Physical effort to breath/speech distortion

Limitations of Air-purifying Respirators (APR)

PERCENT OF OXYGEN	PHYSIOLOGICAL REACTION
21-16%	No abnormal reaction
16-12%	Loss of peripheral vision Rapid breathing/heart rate Impaired coordination/attention/thinking
12-10%	Poor judgment/coordination Excessive fatigue/sparse breathing Permanent heart damage
10-6%	Nausea/loss of movement Unconsciousness (followed by death)
BELOW 6	Spasmodic breathing Convulsive movements Death!!!!!!!!!!!!!!

Air-purifying Respiratory Protection Requirements*

- Need oxygen
- Not above IDLH
- Need good warning properties
- Limited to specific contaminants
- Contaminant must be known
- Negative pressure design
- Physical effort to breath/speech distortion

Limitations of Air-purifying Respirators (APR)

Immediately Dangerous to Life and Health (IDLH) - the concentration of a chemical from which a worker can self rescue within 30 minutes and not suffer loss of life or irreversible health effects if their respirator fails.

Respirator Selection Factors

Assigned protection factor (APF) - indicates the relative difference in concentrations that a respirator can maintain of a contaminant outside versus inside the facepiece

- General APF - determined experimentally by measuring the seal of the facepiece and exhalation valve leakage

Respirator Selection Factors

Assigned protection factor (cont)

- Personal APF - determined on an individual wearing a specific respirator using quantitative fit testing methods

$$\text{Apf} = \frac{\text{concentration on the outside of apr}}{\text{Concentration on the inside of apr}}$$

Assigned Protection Factors

PROTECTION FACTOR	TYPE OF RESPIRATOR
5	Single-use or quarter mask respirator
25	1. Any powered air-purifying respirator equipped with a loose-fitting hood or helmet. 2. Any supplied-air respirator equipped with a hood or helmet and operated in a continuous flow mode.
50	Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges in combination with a high efficiency filter or an appropriate canister incorporating a high efficiency filter
50	Any supplied-air respirator equipped with a full facepiece and operated in a demand (negative pressure) mode.
50	Any self-contained respirator equipped with a full facepiece and operated in a demand (neg. pres.) mode

Assigned Protection Factors

PROTECTION FACTOR	TYPE OF RESPIRATOR
2,000	Any supplied-air respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
10,000	Any self-contained respirator equipped with a full facepiece and operated in a pressure demand or other positive pressure mode.
10,000	Any supplied-air respirator equipped with a full facepiece operated in a pressure demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure demand or other positive pressure mode.

Air-purifying Respirators (APR)

- Disposable (dust/nuisance mask)
- 1/4-mask
- 1/2-mask

Air-purifying Respirators (APR) North

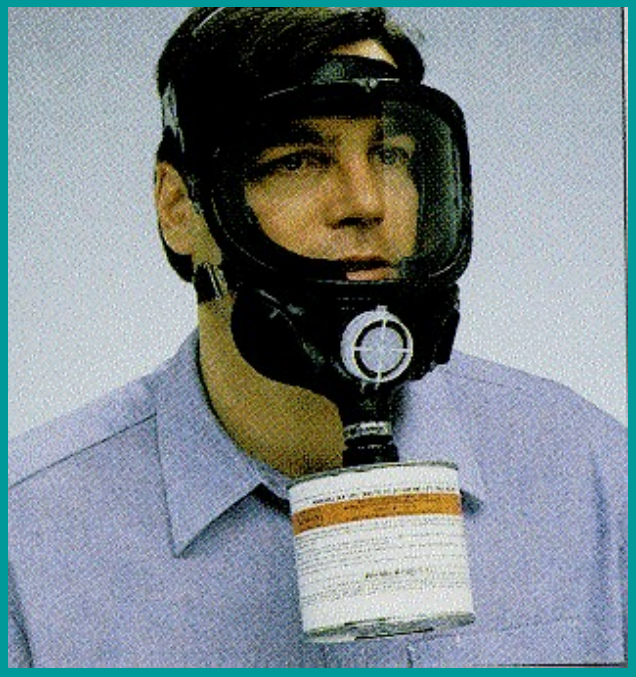
- Full-facepiece
- Mouthpiece

Air-purifying Respirators (APR)

- Powered air purifying respirators (PAPR)
  - Tight fitting
  - Loose fitting/hood

Air-purifying Respirators (APR)

Cartridge vs. Canister



Canister or Cartridge Selection

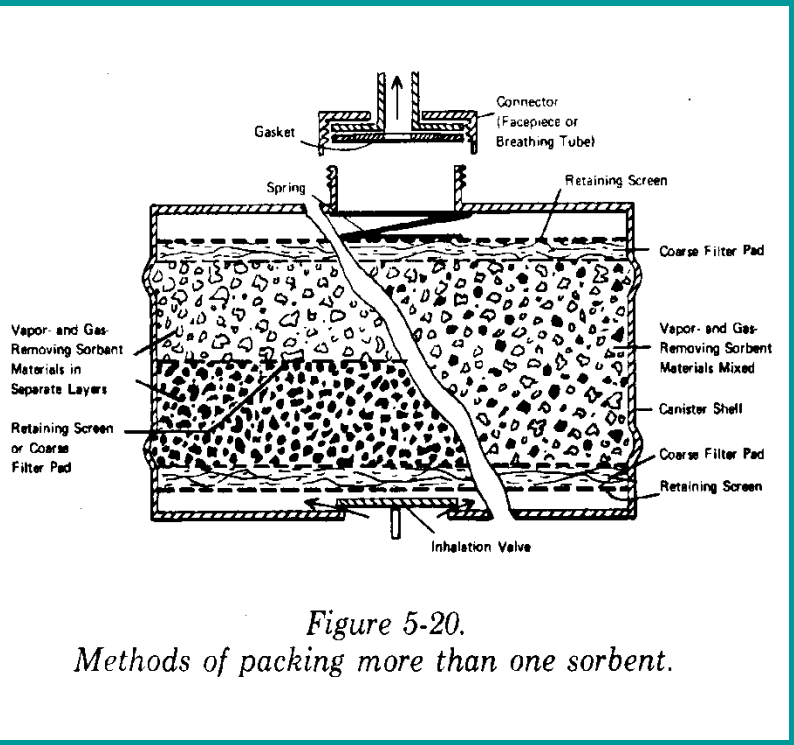


Figure 5-20.
Methods of packing more than one sorbent.

- One type of canister or cartridge will not protect against all chemicals
- Can be used in layers
- NIOSH/MSHA approvals are given for respirator/ cartridge assemblies

Limitations of Air-purifying Respirators (APR)

- A canister or cartridge begins working as soon as it is removed from its plastic wrap

Limitations of Air-purifying Respirators (APR)

- **Maximum use concentration (MUC)** - calculated maximum concentration of a contaminant that a respirator will protect against

MUC = APF X PEL(REL)

Limitations of Air-purifying Respirators (APR)

- Need good warning properties
- Limited to specific contaminants
- Contaminant must be known (concentration and agent)

⚠ WARNING

Below is a partial list of gaseous materials for which chemical cartridge respirators must not be used for respiratory protection (for routine use) regardless of concentration or time of exposure. Failure to follow this warning can result in serious personal injury or death. This partial list is far from complete and is offered as a guide to many of the contaminants found in the industry.

Contact MSA for further information on specific materials.

- **Acrolein**
- **Aniline**
- **Arsine**
- **Bromine**
- **Carbon Monoxide**
- **Diisocyanates**
- **Dimethyl Sulfate**
- **Hydrogen Cyanide**
- **Hydrogen Selenide**
- **Methanol**
- **Methyl Bromide**
- **Methyl Chloride**
- **Methylene Chloride**
- **Nickel Carbonyl**
- **Nitric Acid**
- **Nitro Compounds:**
  - **Nitrogen Oxides**
  - **Nitroglycerin**
  - **Nitromethane**
- **Phosgene**
- **Phosphine**
- **Phosphorus Trichloride**
- **Stibine**
- **Sulfur Chloride**
- **Urethane or other Diisocyanate-containing paints**
- **Vinyl Chloride**

Limitations of Air-purifying Respirators (APR)

- Negative pressure design
- Physical effort to breathe
- Speech distortion, visual restrictions

Mine Safety Appliances MSA (APR)

- Inspection items
- Cleaning methods
- Review MSA Advisories at /

Atmosphere-supplying Respirator

Air-line respirator

- Air is supplied to the facepiece through a hose from a compressor or compressed air cylinder

Atmosphere-supplying Respirator

Self-contained breathing apparatus (SCBA)

Open-circuit- exhaled air is released to the surrounding environment after use

Closed-circuit - exhaled air is scrubbed and re-breathed

Atmosphere-supplying Respirator

- Pressure-demand (positive-pressure) type regulator
- Positive pressure is maintained inside the facepiece during both inhalation and exhalation

Atmosphere Supplying (SCBA)

Open systems - self-contained breathing apparatus (SCBA)

- Positive pressure type regulator
  - Pressure-demand regulator
  - Continuous flow

Atmosphere Supplying (SCBA)

- Vision
- Communication
- Time
- Bulkiness
- Heavy
- Heat stress
- Claustrophobia
- Balance
- Buddy system

Other Information about SCBA

- DOT Hydrostatic Testing Date (Steel Tanks – 5 years)
  - (Composite Tanks – 3 years)
- Grade D Air
- Cylinder Lifespan
- Check Safety Advisories

Other Information about SCBA

- Face Mounted Regulator (MMR)
- Inspections/Documentation
  - Daily
  - Monthly
- Aluminum Cylinder

North by Honeywell

- http://www.northsafety.com
- **Technical Advisories**


Serial Number
Hydro Date
month / year
TC-SU 5134-310
DOT-E 10915-4500
OK 7507
LUXFER
12 98
REE: 78
Luxfer Part Number L45M
WARNING!! Do not fill if damage has caused strand unraveling.
MADE IN USA

We Don’t Need a Safety Officer!!