OSHA’s Respiratory Protection Program

1. Written program
2. Selection based on hazards involved
3. Operator training
4. Reserved (?)
5. Cleaning and disinfection of respirators
6. Storage of respirators
7. Inspection and maintenance of respirators
8. Surveillance of worker exposures
9. Regular evaluation of respirator program
10. Medical evaluation of respirator users
11. Use of approved respirators
Respiratory Protection

OSHA’s general policy on respirator use:

- Where engineering or administrative controls are not feasible or insufficient
- During the time when engineering or administrative controls are being implemented
- For emergency response situations

Recent changes in regulations

- NIOSH changes to respirator equipment approvals
- Substance specific standards sometimes contain unique requirements
- Federal OSHA issued new 1910.134 standard in February ‘98
  - Consolidates other standards’ requirements
  - APF deferred
  - Some changes in medical qualifications
  - Fit testing required for all tight-fitting respirators
  - Cartridge change-out to be based on objective data
  - Respirator administrator
Determining physical state of airborne contaminant

Listing of contaminant in TLV book is a clue but there are some exceptions.
Guidelines for estimating airborne phase have been developed based on:
- identity of the major constituents
- saturated vapor concentrations of constituents
- estimate of total airborne mass concentration
  (the saturated vapor concentration and total airborne concentration can help predict phase)

Types of respirators

- **Air-purifying respirators**
  - Filters (for particulates)
  - Cartridges (for gases or vapors) - may have filters, too
  - Canisters (used with “gas masks” -- large capacity)
  - Oxygen must be > 19.5%

- **Atmosphere supplying respirators**
  - SCBA's
  - Supplied air respirators (Type C or CE)
  - Combinations of SCBA’s and SAR’s
Aerosol removing respirators

Filters can remove dusts, mists, fumes, others
Cannot protect against gases, vapors, or low O₂
Removal mechanisms:
- interception
- sedimentation
- impaction
- diffusion
- electrostatic attraction

Nine filter types

- 3 levels of filter efficiency:
  - 95% (called “95”)
  - 99% (called “99”)
  - 99.97% (called “100”)

- 3 categories of resistance to filter efficiency degradation:
  - N (Not resistant to oil)
  - R (Resistant to oil)
  - P (oil Proof)
Micron Size Comparison

25,400 microns = 1 inch
1,587.5 microns = 1/16th

Selection of N, R, and P-series filters

- If no oil particles are present in the work environment, use a filter of any series.
- If oil particles are present, use an R- or P-series filter.
- If oil particles are present and the filter is to be used for more than one work shift, use only a P-series filter.
- Selection of filter efficiency depends on how much filter leakage can be accepted.
- Choice of face piece depends on level of protection needed (APF).
Gas and Vapor Removing Respirators

Use sorbents
Housed in cartridges or canisters
Removal mechanisms:
  o adsorption
  o absorption
  o chemisorption
  o catalysis
Designed for specific contaminants or classes

Gas and vapor removing cartridges

Organic vapor cartridges:

- currently tested with CCl₄ at 1000 ppm (only)
- may or may not be very effective for specific vapors
- seek guidance from respirator manufacturer including test data on vapor in use
- only small amount of charcoal in cartridges
- more charcoal in canisters
- color code: black
Service Life of Cartridges or Canisters

Depends on:
- quality and amount of sorbent
- packing uniformity and density
- exposure conditions, breathing rate
- relative humidity
- temperature
- contaminant concentration
- affinity of the gas or vapor for the sorbent
- presence of other gases and vapors

Acid Gas Respirators

- Designed for removing acidic gases
- Limited to fairly low concentrations
- Tested by NIOSH against chlorine, HCl and SO₂ (only)
- Color code: White

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Chlorine</td>
<td>10 ppm</td>
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<tr>
<td>Hydrogen chloride</td>
<td>50 ppm</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>50 ppm</td>
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</table>
Alkaline Gas Cartridges

- Contains chemicals for removing alkaline gases such as:
  - ammonia
  - methylamine

- Color code: green

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<table>
<thead>
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<tbody>
<tr>
<td>Concentrations limited</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>300 ppm</td>
</tr>
<tr>
<td>Methylamine</td>
<td>100 ppm</td>
</tr>
</tbody>
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Air-purifying Respirators

Additional Information

- Replace cartridges:
  - NIOSH: daily or after each use, or even more often if odor, taste, or irritation
  - some canisters may have end of service life indicators

- Other cartridges available:
  - pesticides
  - carbon monoxide
  - ethylene oxide
  - formaldehyde
  - hydrogen fluoride
  - hydrogen sulfide
  - mercury
  - phosphine
  - vinyl chloride
Colors for AP Elements

- Acid gas: white
- Organic vapors: black
- Ammonia gas: green
- Carbon monoxide: blue
- Acid gases and organic vapors: yellow
- Acid gas, ammonia, and OV: brown
- Acid gas, ammonia, CO, and OV: red
- Other vapors and gases: olive
- Radioactive materials (HEPA): purple *
- Dusts, fumes, mists (non-radio): orange *

“ADEQUATE WARNING PROPERTIES”

NIOSH permits air purifying respirators only if the contaminant has adequate warning properties:
- reliable detection of the contaminant below the PEL by user’s sense of smell, taste, or irritation
- only applies to gases and vapors -- not particulate
- Exception is if AP element has an ESLI.
- Remember that odor thresholds vary substantially from one individual to another

OSHA: respirator cartridge changeout based on odors or taste unacceptable (new standard)
NIOSH/MSHA Certification

- Testing and certification codes issued (TC #)
- NIOSH personnel do actual testing
- List of approved respirators published

- TC 13F + 2-3 digits SCBA
- TC 14G + 2-3 digits AP gas mask
- TC 19C + 2-3 digits SAR
- TC 21C + 2-3 digits Particulate AP
- TC 23C + 2-3 digits Gas or vapor AP

Atmosphere-Supplying Respirators

- Air-line respirators
- Self-contained breathing apparatus (SCBA)
- Combination SCBA and SAR

Must be supplied with Grade D breathing air, usually from bottles or compressors
Supplied Air Respirators

- Airline respirators
  - called "Type C" or "Type CE"
  - hose can be up to 300 feet
  - 4 cfm required for tight-fitting mask, 6 cfm for hoods and helmets
  - available in demand, pressure demand, and continuous flow arrangements

- Hose masks
  - Type A (motor or hand-operated blower)
  - Type B (no blower)
  - large diameter hoses

Sources of Breathing Air

- Compressors
  - Subject to failure
  - If oil-lubricated, can overheat changing oil mist into CO
  - Carbon vane type are available and oil-less
  - Can run continuously
  - Can be fitted with CO sensor and/or adsorption units
  - Air intake location is critical

- Compressed gas cylinders (breathing air)
  - Can be up to 3500 psi
  - Finite air supply...for limited time spans
  - Do not rely on utility services

- Blowers used for hose masks
Criteria for Grade D Compressed Air

- Oxygen
  19.5% to 23.5% oxygen (vol)
- Hydrocarbons
  ≤ 5mg/M³ (oil mist)
- Carbon dioxide
  ≤ 1000 ppm
- Carbon monoxide
  ≤ 10 ppm
- Odor
  no pronounced odor

Self-Contained Breathing Apparatus (SCBA)

- Open-circuit type
  - bottled air from 2000 to 4500 psi typically
  - time from 15 min to 60 min typically
  - demand or pressure demand or continuous flow
  - can be combined with supplied air respirator
  - escape-only type available in 5, 7, 10 or 15 minute size
- Closed-circuit type (also called re-breathers)
  - could be either negative or positive pressure type
  - possible to "over breathe"
  - more complicated to maintain
  - requires more training
  - longer use period ... sometimes up to 4 hours
Respirator Selection

Routine use vs. non-routine use
Workplace hazards
Physical Characteristics
Physical demands of the work
Respirator capabilities and limitations

Exposure Assessments

- Identify airborne contaminants where possible
- Match up specifications and limitations of respirators
- Consider abnormal conditions that may cause concentrations to rise
- Think in terms of “worst case” exposures
- Apply substance-specific requirements
- Communicate information to employees; discuss signs, symptoms of overexposure
- Keep good records
Respirator Capabilities/Limitations

Protection Factors

- Protection factor: \( p_f = \frac{C_o}{C_i} \)
- Assigned protection factor (APF) \( APF \geq \frac{C_{\text{air}}}{TLV} \)
- Penetration:
  \[ P = \frac{1}{PF} \]
- Fit factor is the PF observed during a quantitative fit test (usually only 5 to 10 min)
- Workplace protection factor (WPF)
  - time up to 8 hours
  - the \( C_i \) value is the average contaminant value inside the respirator

Protection Factors Cont...

- Effective protection factor
  - over unspecified length of time
  - supposed to represent total protection afforded worker including times worn and not worn.
  - Used in OSHA’s lead standard

- Program protection factor
  - sometimes used with lead aerosols

- Assigned protection factor
  - NIOSH: minimum anticipated WPF provided by a properly functioning respirator or class of respirators
Protection Factors Cont…

- Maximum use concentration (MUC)
  - the product of the APF and the exposure limit
  - must not be > IDLH or in excess of the cartridge limits
  - Based on several factors: APF, IDLH concentrations, and regulatory limits

Fit Testing

- Qualitative fit testing (QLFTs)
  - isoamyl acetate (IAA)
  - irritating smoke (usually titanium and stannic chloride)
  - Saccharin/Bitrex aerosol (taste test)
    - denatonium benzoate (Bitrex)
    - must verify wearer can respond
    - wearer must be truthful

- Quantitative fit testing (QNFTs)
  - dioctyl phthalate aerosol (DOP)
  - corn oil
  - sodium chloride
  - DEHS
  - ambient air (with submicron particulate counting)
  - ambient air (pressure differential)
Non-Routine Use of Respirators

Three situations require careful consideration:
- entry into confined spaces
- entry into oxygen-deficient atmospheres
- emergencies

IDLH
ANSI: "...any atmosphere that poses an immediate, irreversible debilitating effects on health..." (acute effects vs chronic exposures)
New OSHA standard requires atmospheres to be considered IDLH unless shown otherwise

IDLH Cont...

NIOSH: IDLH based on two factors:
- worker must be able to escape within 30 min without losing life or suffering permanent health damage, and
- worker must be able to escape without severe eye or respiratory irritation or other reactions that could inhibit escape

also, atmospheres > LEL are IDLH
NIOSH Respirator Decision Logic

IDLH atmospheres -- Only 2 types allowed:
- SCBA in pressure-demand mode (>15 minute air supply)
- Type C airline respirator, pressure-demand or continuous flow mode, with auxiliary escape bottle (minimum service life of 3 minutes)

IDLH atmospheres (low oxygen)
- Can use demand (negative pressure) airline respirator

Respirator Standards

Respirator *testing, approval* standards:
42 CFR 84 (NIOSH), formerly NIOSH/MSHA

Respirator *use* standards:
- OSHA - 29 CFR 1910.134 (and others)
- ANSI Z88.2 - 1992
- MSHA
- NRC
New OSHA Respirator Standard

- Use engineering controls where feasible
- Employer supplies respirators and establishes a program
- Program must be written with work-site specific procedures and elements for required respirator use
- Program must have an administrator
- Medical evaluations
- Fit testing for tight-fitting respirators

New OSHA Respirator Standard

- New procedures where respirator is worn voluntarily
- Appropriate selection of respirators - NIOSH certification and within certification limits
- Evaluate exposures - assume IDLH if unable to evaluate
- Selection to include sufficient number...to get a good fit
- Change-out of cartridges - ESLI or “objective data”
New OSHA Respirator Standard

Medical evaluations:
- PLHCP
- Screening questionnaire
- Follow-up examination if any positive answers
- Supply PLHCP with respirator info, work conditions, other PPE, duration and frequency or respirator use, copy of written program and OSHA standard
- Must supply PAPR if negative pressure respirator is unacceptable

Additional Medical evaluations required when:
- Report of related medical signs or symptoms
- PLHCP, supervisor or program administrator informs the employer that a reevaluation is needed
- Information from program, fit-testing suggest need for reevaluation
- Change in workplace increases physiological burden on worker
New OSHA Respirator Standard

Fit testing:
- Qualitative or quantitative methods used for tight-fitting respirators
- Must be re-fitted when respirator changed and annually
- Qualitative can only be used with fit factors of 100 or less; quantitative required when FF > 100
- Must use methods in Appendix A
- Atmosphere-supplying respirator must be tested when in negative pressure mode

Other things …
- No facial hair that can interfere with seal
- User seal test
- Cannot base cartridge change-outs on odor, smell or taste
- Seal check whenever donning respirator
- In IDLH areas, must have standby outside equipped and trained for rescuing
- Structural firefighting: 2 in and 2 out (buddy)
Respirator Inspection

**Inspection Procedures**

The respirator should be inspected before and after each use. The following should be checked:

- Facemask/check for integrity, cracks/burns/bleed, distortion, excessive dirt, cracks/burns in the facemask, badly worn threads on the facemask holder
- Head strap/head harness	check for breaks, loss of elasticity, broken buckles
- Exhalation valve check for cracks/tears/damage in valve material, improper insertion of valve guard, foreign material on valve
- Inhalation valve check for cracks/tears/damage in valve material
- Lenses (full-face) check for cracks, bad scratches and excessive dirt
- Cartridge/Filter gasket check that gaskets in the filter housing are present and in good condition
- Cartridge/Filter check for incorrect cartridge, incorrect installation, expired shelf life date, cracks/dents on outside of cartridge
- Cartridges must be replaced when the employee detects the chemical odor or taste or when the employee experiences nose or throat irritation.

Respirator Fit-Testing

- **The fit-test can NOT be conducted on employees if they have any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, mustache or sideburns which cross the respirator sealing surface. NO EXCEPTIONS!**
Respirator Fit-Testing Procedures

Respirator Fit-Testing Procedures

Acceptable

Acceptable

NOT ACCEPTABLE

RESPIRATORY PROTECTION EIH 005

15 minutes prior to fit-test

OR

Chewing Gum

NO SMOKING, EATING OR DRINKING

RESPIRATORY PROTECTION EIH 005
Respirator Fit-Testing Procedures

Prior to Fit-Test

- Show employee how to put on respirator, how to position the respirator on their face, how to set the strap tension and how to determine an acceptable fit. Provide a mirror so that employee can evaluate fit and respirator position.
- Inform the employee that he/she is being asked to select the respirator that provides the most acceptable fit. Employees should be instructed to let us know if the respirator fit is unacceptable.
- Allow the employee to wear the respirator for at least 5 minutes to assess comfort prior to fit-testing.
- Assess the comfort of the respirator by reviewing the following with the employee:
  - Position of the mask on the nose
  - Room for eye protection
  - Room to talk
  - Position of mask on face and cheeks
  - Assess the fit of the respirator by observing the following:
  - Chin properly placed

Respirator Fit-Testing Procedures

- Adequate strap tension, not overly tightened
- Fit across nose bridge
- Respirator proper size to span distance between nose to chin
- Tendency of respirator to slip
- Employee observation of respirator fit in mirror
- Have employee “seat” the respirator on their face. This is done by moving the head from side to side and up and down slowly while taking a few slow deep breaths.
Respirator Fit-Testing Procedures

- Have employee conduct a user seal check.
- **Positive Pressure Check.** Close off exhalation valve and exhale gently into the facepiece. Fit is acceptable if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage at the seal.
- **Negative Pressure Check.** Close off the inlet opening of the cartridges by covering with the palm of the hands (if hands cannot cover cartridges use latex or nitrile glove to cover), inhale gently so that the facepiece collapses slightly, and hold breath for 10 seconds. Fit is acceptable if the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected.

Bitrex Qualitative Fit-test Procedure

1. **Taste threshold (sensitivity) screening**
   - Performed without wearing a respirator
   - Have employee open mouth with tongue extended
   - Spray threshold check (sensitivity) solution onto the employees tongue
   - If employee tastes the Bitrex, record number of squeezes
   - If employee does not taste Bitrex, add ten more squeezes of Bitrex.
   - If employee now tastes the Bitrex, record number of squeezes (twenty no matter how many actually squeezed)
   - Continue until reach 30 squeezes, if employee cannot taste the Bitrex, they have no sensitivity to it, therefore cannot be fit tested with it, fit test with different solution (saccharin)
   - Have employee remember the taste for reference during the fit test
Bitrex Qualitative Fit-test Procedure

2. Aerosol fit test procedure
- Insure employee has not eaten, drank, chewed gum, or smoked for at least 15 minutes before the test
- Have employee don respirator and hood
- Have employee breathe through mouth with tongue extended
- Employee to notify tester if the taste of Bitrex is detected during any phase of the testing
- Squeeze Bitrex into hood using same number of squeezes necessary during taste threshold screening (sensitivity testing) i.e., Sensitivity level of 10 = 10 squeezes for 1st exercise and half that amount for all other exercises

Have employee perform the following exercises:
1. Normal breathing - 1 minute
2. Deep breathing - 1 minute
3. Turn head from side to side - 1 minute
4. Move head up and down - 1 minute
5. Talk – Read “Rainbow Passage” out loud
6. Jogging in place - 1 minute
7. Normal breathing - 1 minute
- If employee does not report the taste of Bitrex, the test is passed.
- If the taste of Bitrex is detected, the test is failed and the employee must start over (threshold screening AND fit testing) with a new respirator