PH466A: Personal Protection

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EOH 466A
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Personal Protective Equipment

• Online component:
  – Visit the web sites, and learn what resources you have available online
  – Answer questions posted on assignment page
  – Supplement lecture notes
  – Prepare to ask questions or request clarification in class
Industrial Hygiene Practice

• Substitution
• Process change
• Engineering control
• Administrative changes
• Personal protective equipment

PPE Program (29 CFR 1932)

• Employers must evaluate the work place to determine if PPE is needed.
  – Determine type of hazards likely to occur.
  – Determine adverse effects unprotected.
  – Other control options.
  – What type of protection is needed.
  – Decontamination issues
  – Ergonomic constraints
  – Cost of options.
  – Selection.
  – Establish a written program.
PPE Program (29 CFR 1932 or Title 8, Section 3380)

• Employers must provide to workers training and equipment.
  – Training should teach workers:
    • When ppe is needed
    • What ppe is needed
    • How to use the ppe.
    • Limitations of use
    • Proper care, maintenance and use.
    • Employer must document that training has occurred and was effective (written test) where eye, hand, foot or head protection is worn.

Head Protection
What are some of the causes of head injuries?

• Falling objects
• Bumping head against fixed objects, such as exposed pipes or beams
• Contact with exposed electrical conductors
• California Title 8, Section 3381

Classes of Hard Hats

**Class A**
- General service (e.g., mining, building construction, shipbuilding, lumbering, and manufacturing)
- Good impact protection but limited voltage protection

**Class B**
- Electrical work
- Protect against fire, cuts and high-voltage shock and burns

**Class C**
- Designed for comfort, offer limited protection
- Protects heads that may bump against fixed objects, but do not protect against falling objects or electrical shock
Respiratory Protection

• Online advisor:
  http://www.osha.gov/SLTC/respiratory_advisor/mainpage.html

• E tool is available
  • http://www.osha.gov/dts/osta/oshasoft/index.html

• California Regulations
  – Section 5144
  – Guide is here:
    http://www.dir.ca.gov/DOSH/dosh_publications/Respiratory.pdf

Respiratory Protection

• Respiratory protection may be used in limited circumstances:
  – Routine operations, while engineering controls are being designed and implemented.
  – When engineering controls are not feasible or cannot reduce exposure levels to the PEL.
  – For non-routine operations that occur so infrequently that engineering controls are impractical.
  – For emergency use.
Respiratory Protection

• Respirators depend on actions of many people: maintenance, selection, repair, inspection, cleaning, proper use, affect respirator performance.

• Engineering controls can be installed and monitored, require action of a few experts, alarms can warn of potential failure.

Respiratory Protection

• Problems with the use of respirators:
  – obtaining adequate fit may be difficult
  – respirator may interfere with communication.
  – respirator may interfere with line of sight and wear of glasses.
  – respirator wear may increase fatigue, workers may tire more easily.
  – some workers may not wear respirators for medical reasons.
Respiratory Protection

• Types of respirators
  – Air-purifying, negative pressure
    • particulate-removing.
    • organic vapors activated charcoal
    • acid gas
    • ammonia
    • other

Air-Purifying Respirator

A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.
Filter

A component used in respirators to remove solid or liquid aerosols from the inspired air. Also called air purifying element.

Filtering Facepiece (Dust Mask)

A negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.
High Efficiency Particulate Air Filter (HEPA)

Filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter.

Equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Canister or Cartridge

A container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.
**Service Life**

The period of time that a respirator, filter or sorbent, or other respiratory equipment provides adequate protection to the wearer

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**Respiratory Protection**

- **Classes of Filters**
  - There are nine classes of filters (three levels of filter efficiency, each with three categories of resistance to filter efficiency degradation)
  - Levels of filter efficiency are 95%, 99%, and 99.97%
  - Categories of resistance to filter efficiency degradation are labeled N, R, and P
  - Use of the filter will be clearly marked on the filter, filter package, or respirator box (e.g., N95 means N-series filter at least 95% efficient)
Respiratory Protection

• Selection

• If no oil particles are present, use any series (N, R, or P)
• If oil particles are present, use only R or P series
• If oil particles are present and the filter is to be used for more than one work shift, use only P series

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

Tight-Fitting Coverings

- Quarter Mask
- Half Mask
- Full Facepiece
- Mouthpiece/Nose Clamp (no fit test required)
Loose-Fitting Coverings

<table>
<thead>
<tr>
<th>Hood</th>
<th>Helmet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose-Fitting Facepiece</td>
<td>Full Body Suit</td>
</tr>
</tbody>
</table>

Negative Pressure Respirator

A respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.
Positive Pressure Respirator

A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Powered Air-Purifying Respirator (PAPR)

An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.
Atmosphere-Supplying Respirator

- A respirator that supplies the user with breathing air from a source independent of the ambient atmosphere
- Includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units

Classes of Atmosphere-Supplying Respirators

- **Continuous Flow.** Provides a continuous flow of breathing air to the respiratory inlet covering
- **Demand.** Admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation
- **Pressure Demand.** Admits breathing air to the facepiece when the positive pressure inside the facepiece is reduced by inhalation
Supplied Air Respirator (SAR)

An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user. Also called airline respirator.

Self Contained Breathing Apparatus (SCBA)

An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.
Escape-Only Respirator

A respirator intended to be used only for emergency exit.

User Seal Check

An action conducted by the respirator user to determine if the respirator is properly seated to the face.

Positive Pressure Check

Negative Pressure Check
Qualitative Fit Test (QLFT)

A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual’s response to the test agent.

Quantitative Fit Test (QNFT)

An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.
Fit Factor

A quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio:

$$\text{Fit Factor} = \frac{C_{\text{outside}}}{C_{\text{inside}}}$$

Respiratory Protection

- Protection factor
  - Ratio of concentration outside the mask to the concentration inside the mask. May be measured in several ways: laboratory study, in the workplace, on a worker but in a laboratory (QNFT, QLFT)
  - Assigned Protection Factor (APF): The minimum anticipated protection provided by a properly functioning respirator or class of respirators to a given percentage of properly fitted and trained users. (Usually 95% of users will achieve APF.)
  - Assigned protection factor (APF) means the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program as specified by this section.
Respiratory Protection

- Quarter-Mask 5
- Half-Mask or Single use dust 10
- Air-line, hood or helmet, cont. flow 25
- PAPR w/ hood or helmet, any filter 25
- Full-face with high efficiency filter 50
- Air-line, full face piece, demand 50
- SCBA, full face piece, demand 50
- Air-line, full face piece, cont. flow 1000
- SCBA, full face, pressure demand 10000

Respiratory Protection

- Workplace Protection Factor (WPF): A measure of the protection provided in the workplace by a properly functioning respirator when correctly worn and used.
- Effective Protection Factor (EPF): A measure of the protection provided in the workplace by a respirator under actual use conditions.
- Fit Factor (FF): Respirator fit measured under controlled conditions, using a standard test protocol. FF is assigned to an individual worker/respirator combination. FF should not be greater than APF for a respirator.
Respiratory Protection

• Relation between FF, WPF and EPF, from published studies:

<table>
<thead>
<tr>
<th>Mask Size</th>
<th>QNFT (FF)</th>
<th>WPF</th>
<th>EPF</th>
<th>APF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half face mask</td>
<td>87-2631</td>
<td>142 (GM)</td>
<td>5.6 (p)</td>
<td>10</td>
</tr>
<tr>
<td>Full Face Mask</td>
<td>435 – 15 000</td>
<td>No Data</td>
<td>No Data</td>
<td>50</td>
</tr>
<tr>
<td>PAPR</td>
<td>&lt; 1,000</td>
<td>54-380</td>
<td>6.5</td>
<td>25</td>
</tr>
</tbody>
</table>

Respiratory Protection

• Maximum Use Concentration (MUC)
  – APF * PEL
  – IDLH An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.
  – Oxygen Deficiency (less than 19.5 %)
Respiratory Protection Program

– Respirators must be used in a manner that will ensure they are effective. In order to do this, if respirators are used, a Respiratory Protection Program must be established. OSHA Regulation recently revised. Instructions in internet.
– Must be administered by a 'suitably trained' person.

Respiratory Protection Program

• Must establish and implement a written program:
  – procedures for selecting respirators
  – medical evaluations of persons required to wear respirators.
  – fit testing procedures. Annual retest minimum.
  – proper use guidelines. Includes when to change filters (this is key and important)
  – cleaning, disinfecting, storing, etc.
  – adequate air supply for supplied air respirators
  – training of employees in respiratory hazards (annual)
  – training of employees in proper respirator use.
  – procedures to regularly evaluate the program.
Respirators: Voluntary Use

- medical evaluation
- ensure proper maintenance

Protective Clothing (1910.138 - hand protection)

Minimal Discussion in Class.
The Permeation Process

ASTM Permeation Test Cell

- Glass stirrer: replaceable stirring rod to allow continuous monitoring with air or refrigeration
- Inlet
- Chamber retaining vessel
- Stopcock adapter
- Sample material
- Challenge chamber for hazardous materials

Minimal Discussion in Class.
Levels of Protection

• Level A
  – Encapsulating suit, SCBA
• Level B
  – Chemical protective suit, SCBA
• Level C
  – Chemical protective suit, negative pressure respirator
• Level D
  – Regular Work Clothes
Level B

Source: Draeger

Source: Vantex

Source: Swedish Rescue Services Agency (Jens Cylindhoff)

Level C

Source: Draeger

Minimal Discussion in Class.
Eye Protection

• OSHA etool: http://www.osha.gov/SLTC/eyeandface_etool/index.html

What are some of the causes of eye injuries?

• Dust and other flying particles, such as metal shavings or sawdust
• Molten metal that might splash
• Acids and other corrosive liquid chemicals that might splash
• Blood and other potentially infectious body fluids that might splash, spray, or splatter
• Intense light such as that created by welding and lasers
Safety Spectacles

- Made with metal/plastic safety frames
- Most operations require side shields
- Used for moderate impact from particles produced by such jobs as carpentry, woodworking, grinding, and scaling

Goggles

- Protect eyes, eye sockets, and the facial area immediately surrounding the eyes from impact, dust, and splashes
- Some goggles fit over corrective lenses
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Welding Shields</strong></td>
<td>Protect eyes from burns caused by infrared or intense radiant light, and protect face and eyes from flying sparks, metal spatter, and slag chips produced during welding, brazing, soldering, and cutting.</td>
</tr>
<tr>
<td><strong>Laser Safety Goggles</strong></td>
<td>Protect eyes from intense concentrations of light produced by lasers.</td>
</tr>
</tbody>
</table>
Face Shields

- Protect the face from nuisance dusts and potential splashes or sprays of hazardous liquids
- Do **not** protect employees from impact hazards

Foot Protection

**Minimal Discussion in Class.**
What are some of the causes of foot injuries?

- Heavy objects such as barrels or tools that might roll onto or fall on employees’ feet
- Sharp objects such as nails or spikes that might pierce the soles or uppers of ordinary shoes
- Molten metal that might splash on feet
- Hot or wet surfaces
- Slippery surfaces

Safety Shoes

- Have impact-resistant toes and heat-resistant soles that protect against hot surfaces common in roofing, paving, and hot metal industries
- Some have metal insoles to protect against puncture wounds
- May be designed to be electrically conductive for use in explosive atmospheres, or nonconductive to protect from workplace electrical hazards
Metatarsal Guards

A part of the shoes or strapped to the outside of shoes to protect the instep from impact and compression.