Introduction to Industrial Hygiene

10-hour General Industry Outreach Training

Introduction

- Health hazards on the job site
- Protect yourself; protect your family

Source: OSHA

Introduction

Lesson objectives:

1. Identify types of health hazards in the workplace.
2. Describe strategies to control chemical hazards.
3. Describe strategies to control biological hazards.
4. Describe strategies to control physical hazards.
5. Describe strategies to control ergonomic hazards.

Introduction

Industrial Hygiene – the science of protecting the health and safety of workers through:

- Anticipation,
- Recognition,
- Evaluation, and
- Control

…of workplace conditions that may cause workers' injury or illness.

Source: OSHA

Types of Health Hazards

Common workplace health hazards:

Chemical

Physical

Biological

Ergonomic

Source of photos: OSHA

Chemical Hazards and Controls

Forms

- Solids
- Liquids
- Gases and vapors
- Aerosols - dust, mist, fumes

Multiple chemical hazards

Spraying mist

Welding fumes

Dust particulates

Source of photos: OSHA

Chemical Hazards and Controls

Effects of chemical exposures:

Health Risks		
Heart Ailments	Lung Damage	Sterility
CNS Damage	Kidney Damage	Burns
Cancer	Liver Damage	Rashes

Safety Risks		
Fire	Explosion	Corrosion

Source of photos: OSHA

Chemical Hazards and Controls

Exposure entry routes:

Inhalation:	**Breathed in (most common route)**
Ingestion:	**Swallowing via eating or drinking**
Absorption:	**Drawn through skin or eye surface**
***Injection:**	**Penetration through the skin**

Source of graphics: OSHA

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Chemical Hazards and Controls

Warning Signs of Potential Chemical Exposure:

- Dust, mist, smoke in the air
- Accumulation of particulates (dust) on surfaces
- Unusual tastes and/or smells
- Eye, nose, throat, upper respiratory, and/or skin irritation

Chemical Hazards and Controls

Examples of chemical exposure symptoms:

- Eye, nose, throat, upper respiratory, skin irritation
- Flu-like symptoms
- Difficulty breathing
- Fatigue
- Loss of coordination
- Memory difficulties
- Sleeplessness
- Mental confusion

Chemical Hazards and Controls

Types of health effects:

Exposure Condition		Exposure	Example
ACUTE	Immediate	Short-term, high concentration	H_2S exposure within a confined space
CHRONIC	Delayed; generally for years	Continuous; for long periods of time	Asbestosis

Acute

Source: U.S. Army Corps of Engineers

Chronic

Source: OSHA

Chemical Hazards and Controls

What is toxicology?

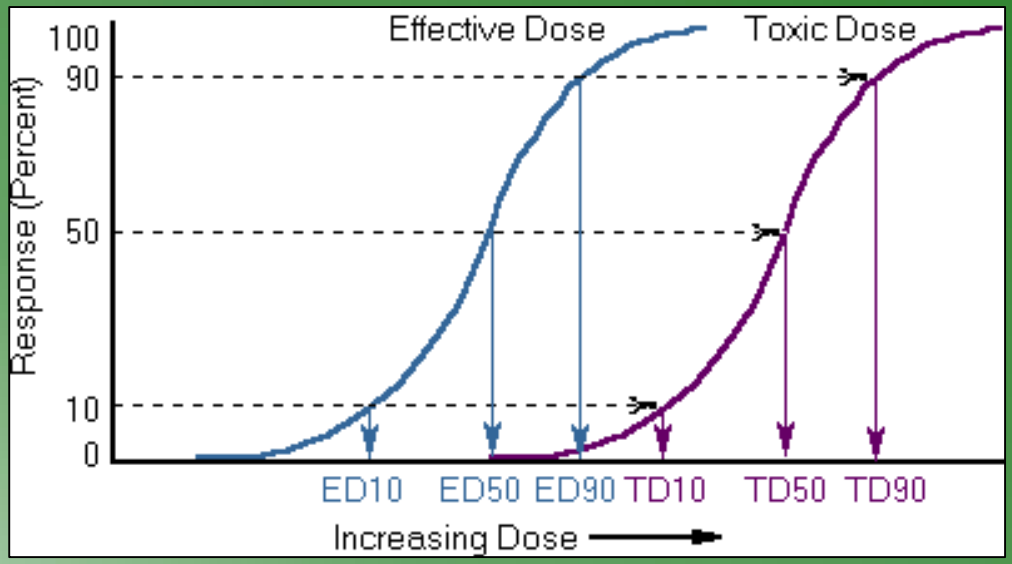
- The science that studies the poisonous or toxic properties of substances

Source of graphics: OSHA Hazard Communication Pictograms

Chemical Hazards and Controls

Toxic effects:

- Dose
  1. Concentration – amount
  2. Duration of Exposure – time



Source: OSHA

Chemical Hazards and Controls

- Toxic chemicals disrupt the normal functions of the body. Effects can be:
  - **Local** - at the site of exposure
  - **Systemic**
    - Affects the entire body
    - Target organs - organs or systems where symptoms of exposure appear

Chemical Hazards and Controls

Local (direct) effects:

- Irritation (dryness, redness, cracking) - fiberglass
- Corrosion (chemical burn) - acid
- Upper Respiratory Track Infection – inhaling particles

Source: Occupational Dermatoses (CDC)

Chemical Hazards and Controls

Systemic effects:

- Hepatotoxins
  - Cause liver damage
  - Carbon tetrachloride, nitrosamines
- Nephrotoxins
  - Cause kidney damage
  - Uranium, halogenated hydrocarbons
- Neurotoxins
  - Cause nerve damage
  - Mercury, lead, carbon disulfide

Chemical Hazards and Controls

- Hematotoxins
  - Cause blood system damage
  - Carbon monoxide, cyanides
- Anesthetics
  - Depress nervous system
  - Hydrocarbons, propane, isopropyl ethers

Chemical Hazards and Controls

Factors affecting exposures:

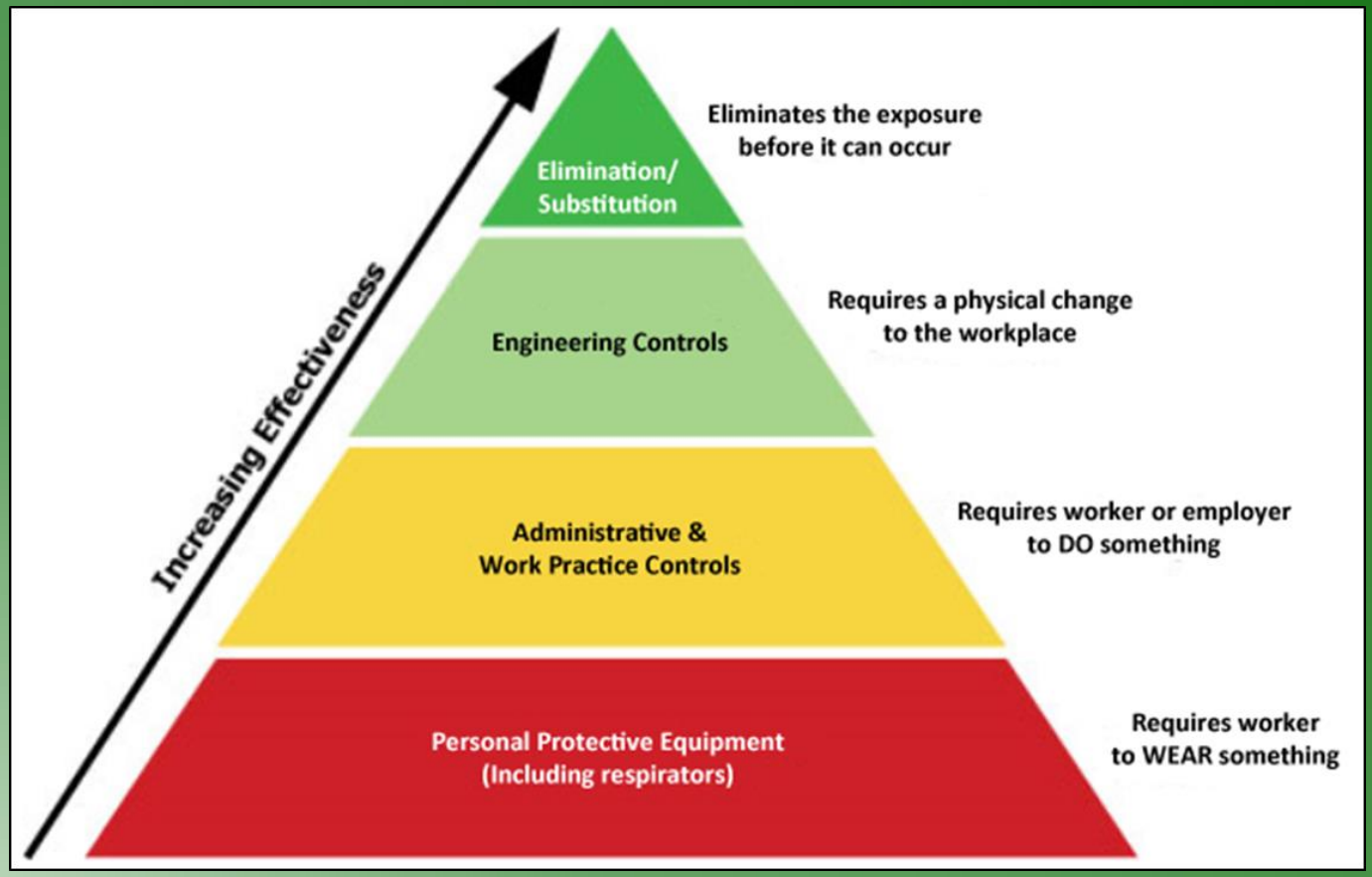
- form and innate chemical activity
- dosage, especially dose-time relationship
- exposure route
- age
- sex
- ability of chemical to be absorbed
- metabolism
- distribution within the body
- excretion
- presence of other chemicals

Chemical Hazards and Controls

Interactions with multiple chemicals:

- Additive effects 2 + 2 = 4
- Synergistic effects 2 + 3 > 5
- Potentiation effects 2 + 0 > 2
- Antagonistic effects 4 + 6 < 10

Chemical Hazards and Controls
Hierarchy of control:



Source: OSHA

Chemical Hazards and Controls

- Elimination and substitution

Source: OSHA

Chemical Hazards and Controls

- Engineering controls
  - Ventilation – local (hood) / general (dilution)
  - Process and equipment modification
  - Isolation/automation

Example: Replacing transfer belts with screw augers on sand movers used in hydraulic fracturing will help contain sand and reduce dust release (lowering exposure to silica).

Source: NIOSH

Chemical Hazards and Controls

- Administrative controls
  - Establish written programs & policies
  - Training
  - Monitor/measure exposure levels
  - Inspections and maintenance
  - Restricted area signage
  - Develop SOPs

Source of photos: OSHA

Chemical Hazards and Controls

- PPE
  - Respirators
  - Gloves
  - Safety glasses
  - Long clothing

Source of photos: OSHA

Chemical Hazards and Controls

Worksite analysis – assessing exposures:

- Air monitoring – personal and area
- Noise monitoring
- Observation – PPE use and work practices
- Ventilation measurements
- Wipe samples – surfaces and personnel

Source: OSHA

Chemical Hazards and Controls

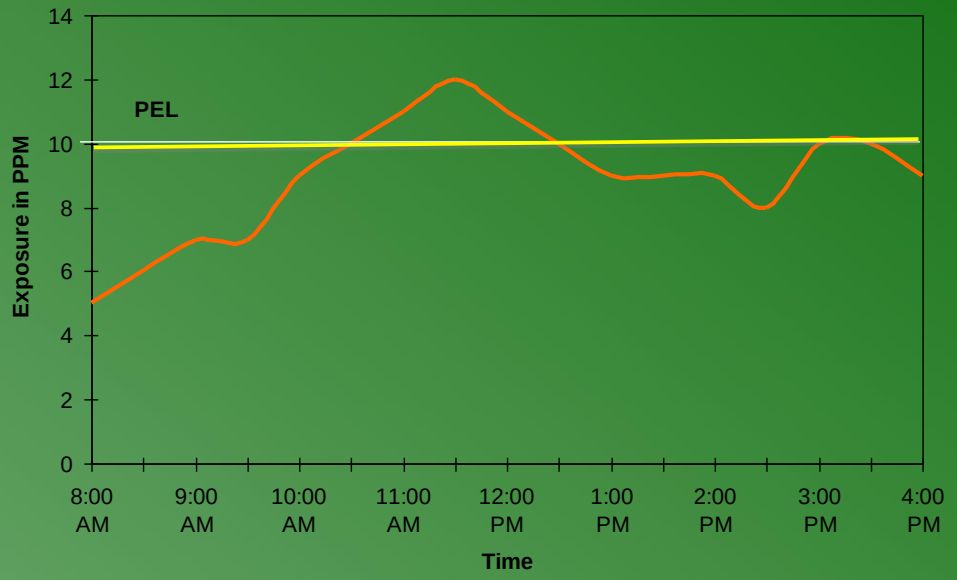
- PELs, or permissible exposure limits:
  - OSHA's regulations that establish the acceptable amount or concentration of a substance in the workplace
  - Intended to protect workers from adverse health effects related to hazardous chemical exposure

Chemical Hazards and Controls

Exposure limits:

- TWA = Time - Weighted Average

- Levels vary over the shift duration

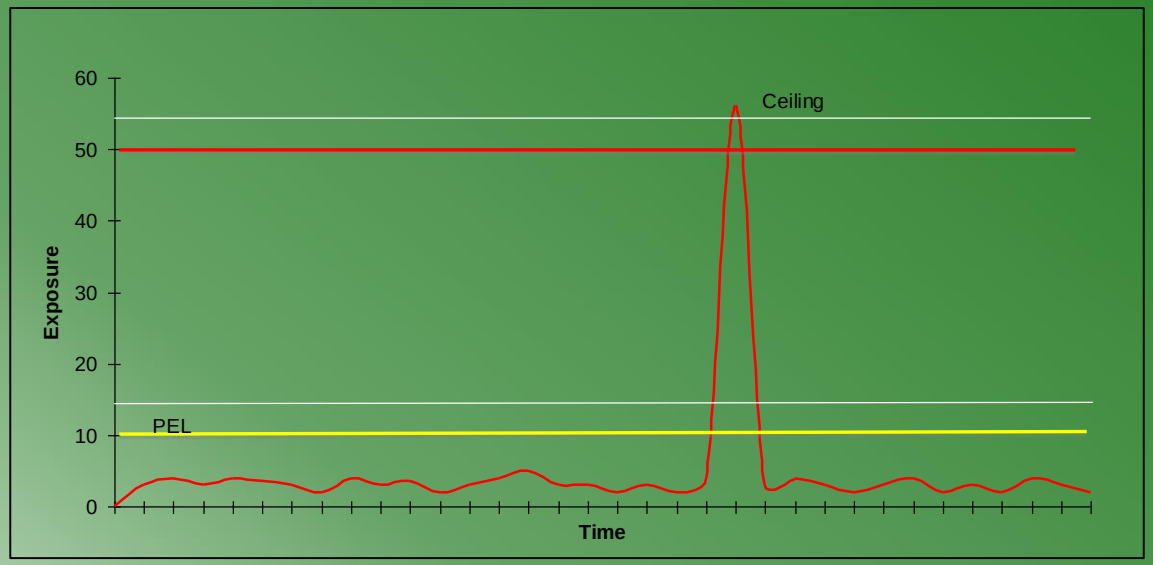


- These limits protect from chronic diseases

Chemical Hazards and Controls

"C" = ceiling limit:

- Level never to be exceeded during the work shift
- Protect from acute disease or health effects



Chemical Hazards and Controls

Substance-specific standards:

- Established by OSHA to identify specific requirements
- Potentially exposed workers must be monitored and protected

Source: NIOSH

Chemical Hazards and Controls

- Components of substance specific standards: (in general)
  - Air monitoring
  - Control of exposure
    - Engineering controls
    - Work practices
    - Respiratory protection
  - Medical surveillance / removal (lead)
  - Recordkeeping
  - Worker training

Chemical Hazards and Controls

Hexavalent chromium:

- Toxic form of chromium;
- Known to cause cancer
- Compounds are man-made and widely used
- Major source of exposure during "hotwork" on stainless steel and other alloy steels containing Cr(VI)

Source: OSHA

Chemical Hazards and Controls

Asbestos:

Source: OSHA

- Mineral fibers – chrysotile, amosie, crocidolite, tremolite, anthophylite, actinolite, and chemically treated/ altered forms
- Known carcinogen;
  can cause chronic lung disease, as well as lung and other cancers
- Used in numerous building materials and vehicle products
- Exposure potential during construction and ship repair; as well as manufacturing of products containing asbestos

Chemical Hazards and Controls

Silica:

- Important industrial material found abundantly in the earth's crust; most common form is quartz
- Can cause lung diseases, including silicosis and lung cancer, as well as kidney disease
- Exposure to respirable crystalline silica
  - Inhalation of small particles in air
  - Common with operations such as cutting, sawing, and drilling

Source: NIOSH

Chemical Hazards and Controls

Lead:

- Blue-gray, heavy metal occurring naturally in Earth's crust
- Can harm many of the body's organ systems; variety of ailments
- Exposure
  - Inhalation and/or ingestion of airborne particles containing lead
  - Occurs in most industry sectors, including manufacturing, wholesale trade, transportation, construction, remediation, and even recreation

Source of photos: OSHA

Chemical Hazards and Controls

Welding fumes:

Source: OSHA

- Content depends on components of base metal, coatings, and/or filler materials; and welding temperatures
- Potential health effects
  - Acute exposure: eye, nose, and throat irritation; dizziness; nausea
  - Prolonged exposure: lung damage; various types of cancer, including lung, larynx, and urinary tract
  - Certain fumes and gases can lead to additional health issues

Chemical Hazards and Controls

- Exposure to welding fumes affected by:
  - Welding process
  - Materials used
  - Location (outside, enclosed space)
  - Work practices
  - Air movement
  - Use of ventilation

Source: OSHA

Chemical Hazards and Controls

Toxic atmospheres:

- Confined spaces – storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, open-top spaces more than 4’ in depth (pits, tubs, vaults)
- Hazardous atmospheres
  - Oxygen-deficient
  - Hydrogen sulfide
  - Carbon monoxide

Source: OSHA

Biological Hazards and Controls

Insects

Source: OSHA

Animals

Source: OSHA

Contaminated Soil

Source: CDC

Poisonous Plants

Source: OSHA

Water/Sewage

Source: OSHA

Bloodborne Pathogens

Source: OSHA

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Biological Hazards and Controls

- Possible effects of exposure to biological hazards:
  - Mild, allergic reactions
  - Serious medical conditions
  - Death
  - Most virulent and prevalent biological agents

Source of photos: CDC

Biological Hazards and Controls

Protection against biological hazards:

- Practice universal precaution with:
  - Blood
  - Bodily fluids
- Practice personal hygiene
- Provide proper first aid
  - Cuts/Scratches
- Vaccinations
- Wear proper PPE/clothing

Source of photos: OSHA

Biological Hazards and Controls

- Practice precaution with:
  - Animals
  - Insects
- Use insect repellent
- Provide proper ventilation or other appropriate environmental controls

Certain species of fruit bats are thought to be the natural reservoir for Ebola virus. EHF outbreaks are believed to start as a result of contact with infected animals or animal carcasses.
Source: OSHA; photo courtesy of National Park Service, U.S. Dept. of Interior.

The best way to protect yourself from Zika, as well as other mosquito-borne illnesses, is to prevent mosquito bites by using insect repellent, wearing long sleeves and pants, and reducing mosquito breeding grounds, such as standing water. Source: OSHA; photos courtesy of CDC.

Physical Hazards and Controls

Types of physical hazards:

Temperature

Radiation

Vibration

Noise

Source of photos: OSHA

Physical Hazards and Controls

Effects of exposure to physical hazards:

Temperature	Radiation	Vibration	Noise
Rash; Cramps	Burns	Fatigue	Interferences
Exhaustion	Sickness	Strains	Stress
Stroke	Aging	Carpal Tunnel	Tinnitus
Hypothermia	Cancer	HAVS	Headaches
Frostbite	DNA Mutations	Raynaud's	Hearing Loss

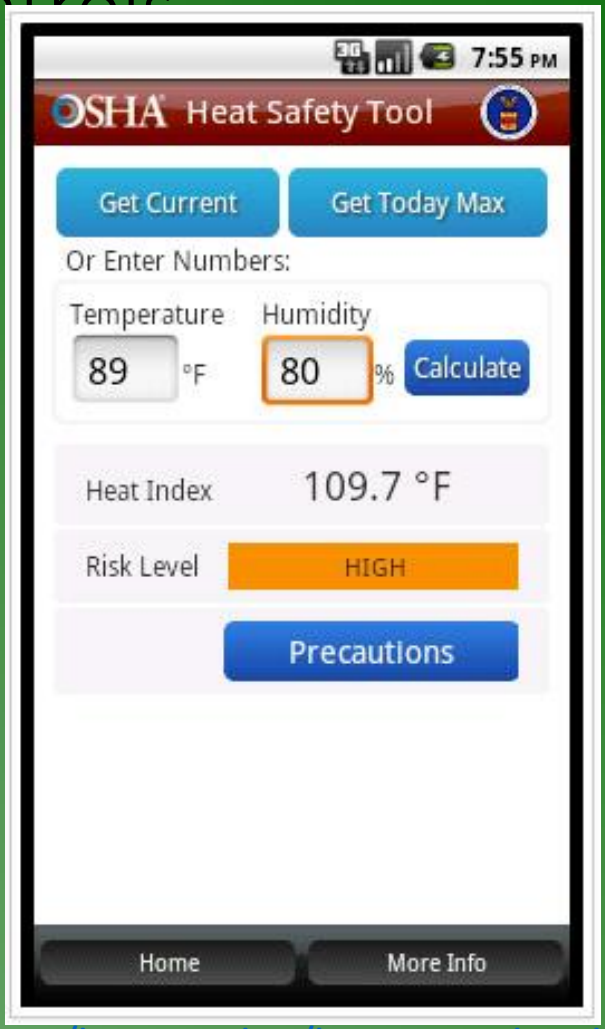
Physical Hazards and Controls

Exposure to heat:

Health Effects	Cause	Symptoms
Rash; Cramps	Heavy sweating	Red cluster of bumps/blisters; Muscle pains or spasms
Exhaustion	Loss of body fluids/salts	Dizziness, light-headedness, weakness, heavy sweating, pale skin, sick to stomach
Stroke	Rapid body temperature rise	≥104F body temperature. Red, hot, dry skin; dizziness; confusion; unconscious

Physical Hazards and Controls

OSHA's Heat Safety Tool



https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html

Physical Hazards and Controls

Protection against heat:

Engineering	Administrative	PPE
• Air conditioning • Ventilation • Cooling fans • Local exhaust ventilation • Reflective shields • Insulation • Eliminate steam leaks	• Emergency plan • Acclimatization • Adequate water • Work/rest cycles • Avoid hottest times; adjust work demands • Rotate job functions • Buddy system • Monitoring	• Insulated PPE, in some work places • Thermal clothing (cool vests)

Eliminate or substitute hazard, whenever feasible

Physical Hazards and Controls

Exposure to cold:

Health Effects	Cause	Symptoms
Hypothermia	Body temperature drops ≤95F	Uncontrolled shivering; slurred speech; memory loss; blue/purple skin
Frostbite	Exposed to ≤0F air	Pale, cold, waxy-white skin; tingling; stinging

Physical Hazards and Controls

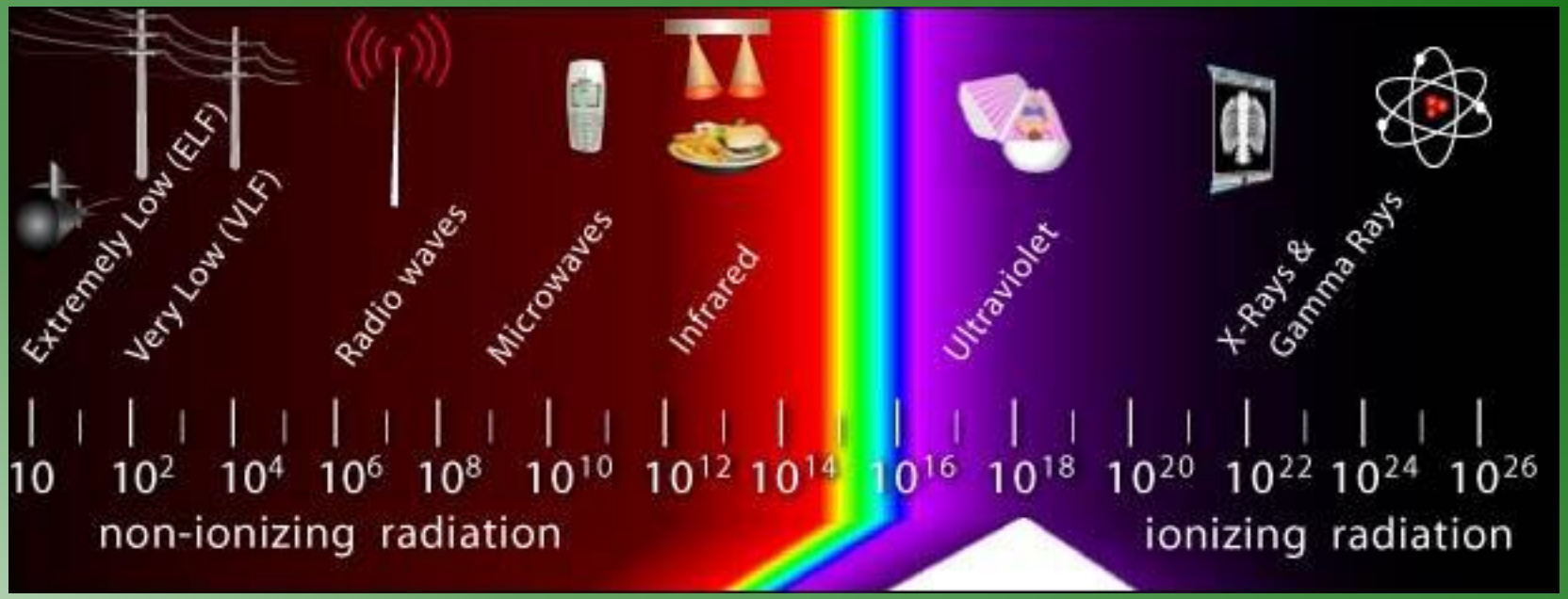
Protection against cold:

Engineering	Administrative	PPE
• Heaters • Shield work areas (windbreaks)	• Warm liquids • Adjust work schedule • Buddy system • Monitoring • Frequent breaks in warm areas • Acclimatization	• Layered clothing • Hat or hood, face cover, gloves • Clothing out of fabric that retains insulation even when wet • Insulated and waterproof boots

Eliminate or substitute hazard, whenever feasible

Physical Hazards and Controls

Exposure to radiation:



Source: OSHA

Physical Hazards and Controls

Protection against radiation:

Engineering	Administrative	PPE
• Enclose/Shield work areas to minimize stray radiation • Interlocked doors on devices that can produce acute thermal injuries • Remote operation of radiation-producing devices	• Clearly mark controlled spaces • Minimize exposure times • Location/ installation of devices • Proper maintenance	• RF/MW protective suits, including head and eye protection • Safety glasses, goggles, welding helmets, or welding face shields with appropriate filter lenses

Eliminate or substitute hazard, whenever feasible

Physical Hazards and Controls

Exposure to vibration:

Health Effects	Early Signs and Symptoms	Later Signs and Symptoms
• Circulatory disturbances, such as VWF and HAVS • Sensory nerve damage • Muscle, bone, and joint injury	• Intermittent tingling of one or more fingers • Blanching of fingertips • Pain in fingers	• Loss of sense of touch; numbness • Blanching of entire fingers • Loss of grip strength • Sever pain • Carpal tunnel syndrome • Pain and loss of strength in arms • Loss of finger dexterity or coordination

Physical Hazards and Controls

Protection against vibration:

Engineering	Administrative	PPE
• Vibration reduction equipment • Vibration dampeners or shields to isolate source of vibration from employee	• Proper positioning and grip; let the machine do the work • Job rotation • Limit duration of task • Proper maintenance	• Anti-vibration gloves

Eliminate or substitute hazard, whenever feasible

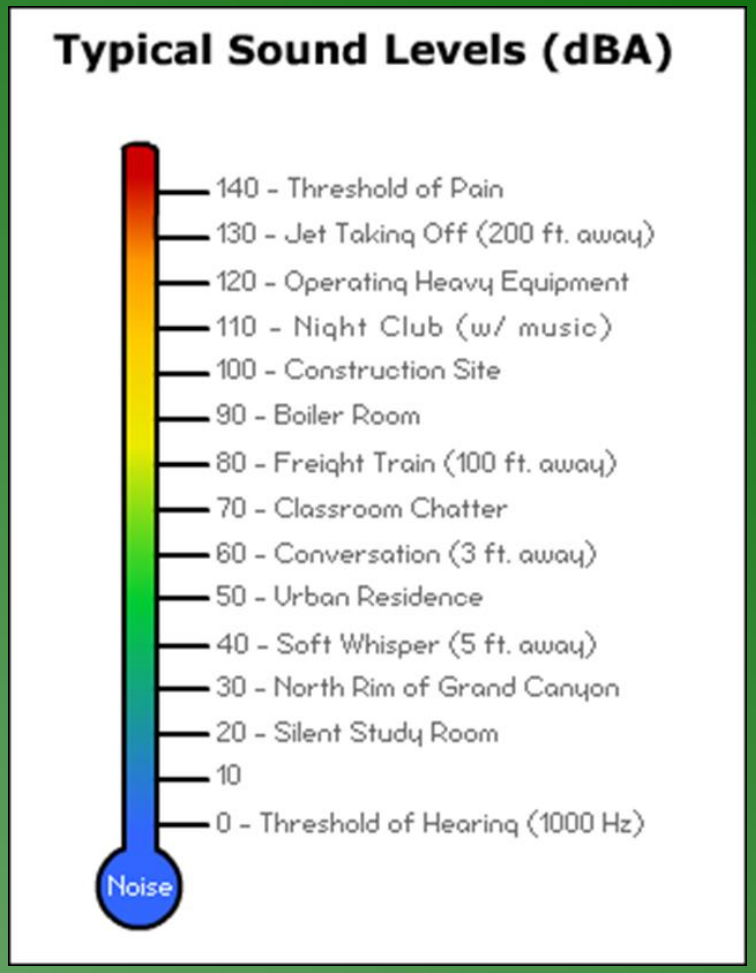
Physical Hazards and Controls

Exposure to noise:

Health Effects	Signs and Symptoms
• Tinnitus • Permanent hearing loss • Physical stress • Psychological stress	• Ears feel stuffed up • Ringing in the ears • Limited ability to hear high frequency sounds, understand speech, and communicate

Physical Hazards and Controls

- **Noise –** prolonged exposures to 85 dB can lead to hearing loss



Source: OSHA

Physical Hazards and Controls

Protection against noise:

Engineering	Administrative	PPE
• Use low-noise tools and machinery • Place a barrier between noise source and worker • Enclose or isolate noise • Weld parts rather than rivet • Use acoustical materials • Install silencers, mufflers, or baffles	• Increase distance between source and worker • Alter work schedule • Limit time of noise exposure • Provide quiet areas for breaks	• Ear plugs • Ear muffs • Hearing bands

Eliminate or substitute hazard, whenever feasible

Physical Hazards and Controls

- When to wear hearing protection
  - Noise or sound level exceeds 90 dBA (OSHA)
  - Recommended when exceeds 85 dBA (NIOSH)

- What to wear
  - Personal comfort preference
  - Long-term/Single use (plugs)
  - Short-term/On and off (muffs)
  - Consider NRR

Source of photos: OSHA

Physical Hazards and Controls

Dual hearing protection:

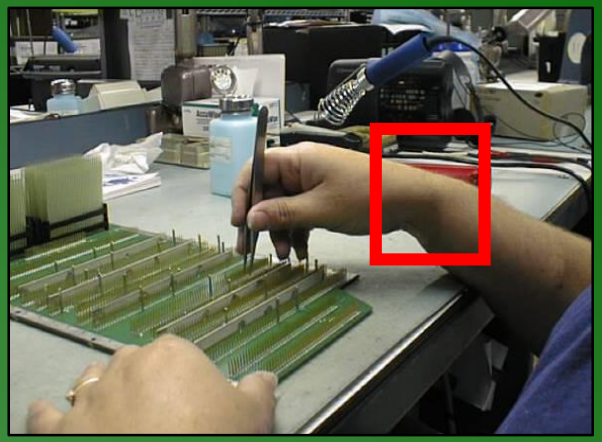
Formable Ear Plugs
Listed NRR = 29
Adjusted NRR (29 – 7) = 22

Earmuffs
Listed NRR = 16
Adjusted NRR for Dual Protection = 5

22 (adjusted NRR) + 5 (Dual Protection NRR) = 27

Source of graphics: OSHA

Ergonomic Hazards and Controls



Source of photos: OSHA

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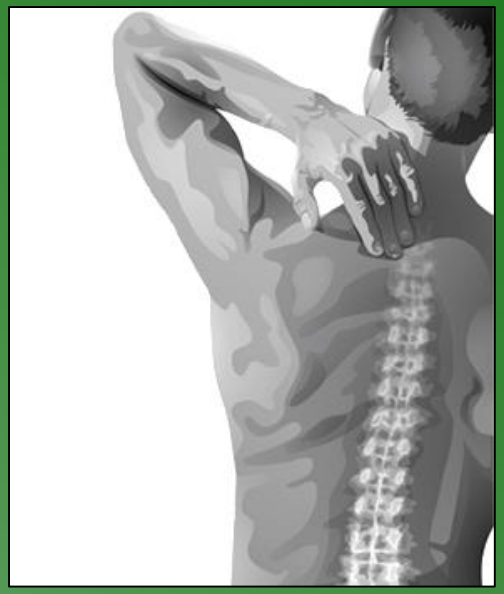
Ergonomic Hazards and Controls

Effects of exposure to ergonomic hazards:

- Musculoskeletal Disorders (MSDs)
  - Exposure to ergonomic risk factors for MSDs increases a worker's risk of injury
    - Repetition
    - High force
    - Awkward postures
  - Work-related MSDs are among the most frequently reported causes of lost or restricted work time.



Source: OSHA

Ergonomic Hazards and Controls

Risk factors for MSDs:

- Overexertion
- Repetitive tasks
- Awkward posture/positions
- Localized pressure
- Cold temperatures
- Vibration
- Combined exposure

Source of photos: OSHA

Ergonomic Hazards and Controls

Protection against ergonomic hazards:

- Use ergonomically designed tools
- Use correct work practices
  - Proper lifting techniques
- Ask for help when handling:
  - Heavy loads
  - Bulky/Awkward materials
- Properly fitting PPE

Source: NIOSH

Discussion

- What are examples of health hazards at your worksite?

- How are they controlled?

Knowledge Check

1. Which of the following is an example of an industrial hygiene health hazard?
   a. Chemical hazards
   b. Economic hazards
   c. Electrical hazards
   d. Fall hazards

Answer: a. Chemical hazards

Knowledge Check

2. Which of the following is an example of a physical health hazard?
   a. Asbestos
   b. Noise
   c. Silica
   d. Lead

Answer: b. Noise

Knowledge Check

3. Which of the following controls is an example of an engineering control for protection against chemicals?
   a. Ventilation
   b. Respirators
   c. Training
   d. Signage

Answer: a. Ventilation

What questions do you have?

Thank You!