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Hierarchy of Controls

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Section A

Introduction

Module 4: Control

- ◆ Three lectures
 - Introduce concept of hierarchy of controls
 - Review concepts of ventilation as a control option
 - Discuss other control personal protective equipment and other control options

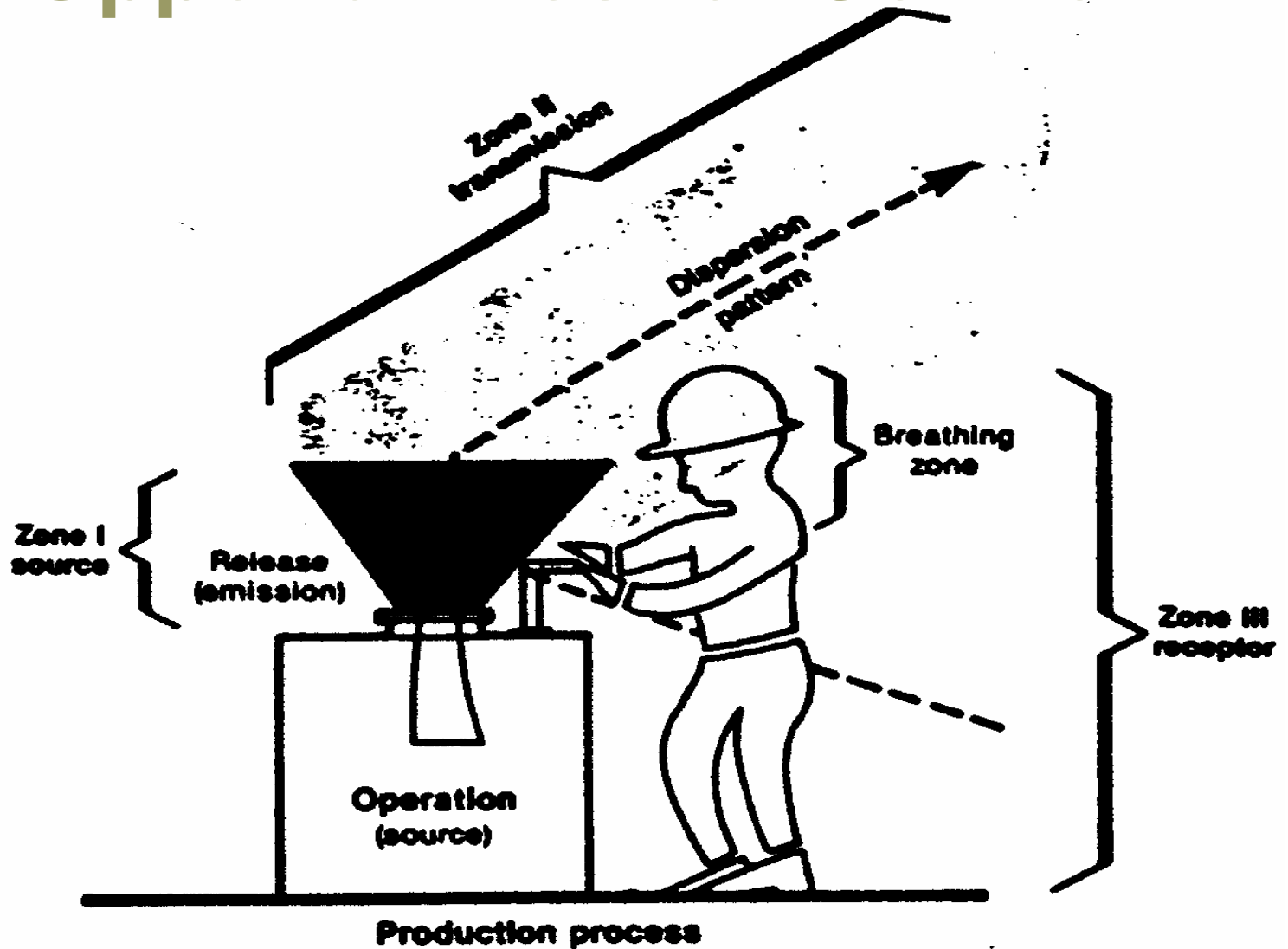
Step 4 of Exposure Assessment: Determine Acceptability

- ◆ Role of air sampling
 - Used as a tool for estimating risk or hazard
 - Other observations, calculations, discussions with workers, medical data, etc.
- ◆ Comparison with measure of safe or acceptable
- ◆ Professional judgment and other factors

Step 5 of Exposure Assessment: Decision on Appropriate Action

- ◆ Prioritize
- ◆ Develop workplace control plan
 - Short-term
 - PPE
 - Administrative
 - Work practices
 - Long-term
 - Engineering controls

Opportunities for Control



source - transmission - receptor

Zone 1: Source

- ◆ Requires an engineering analysis
- ◆ Quantify emissions

- Emission rates

$$\frac{\text{mass}}{\text{time}} \quad \frac{\text{grams O}_3}{\text{hour}}$$

- Emission factors

$$\frac{\text{mass}}{\text{process variable}} \quad \frac{\text{gms O}_3}{\text{page copied}}$$

Zone II: Transmission

- ◆ Understanding of dispersion of spread after release
- ◆ Physical properties are important
 - State: Gas/vapor vs. particulate
 - Particle size
 - Temperature
- ◆ Can be modeled but usually measured
- ◆ Need understanding of work patterns

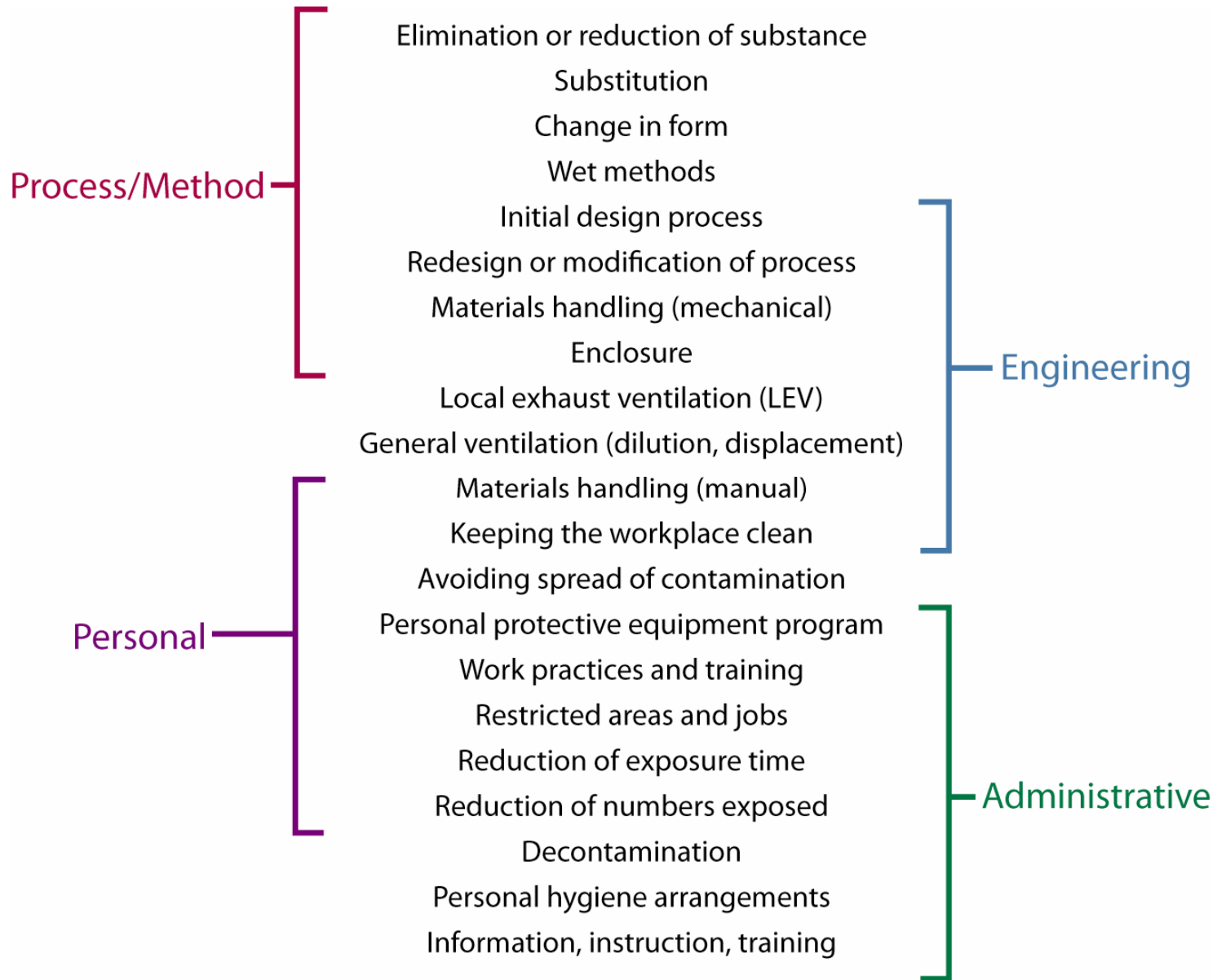
Zone III: Receptor

- ◆ Worker is receptor
- ◆ Can't begin to evaluate control options until you know something exposure
 - Breathing zone
- ◆ Remember, industrial hygiene practices primary prevention

Hierarchy of Controls

- ◆ Philosophy of control
- ◆ Control as close to source as possible
 - Start with source
- ◆ Engineering solutions preferred
 - Reliable, testable
- ◆ Administrative and PPE controls, etc. less desirable





Range of control options



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Section B

*Overview of Control Options;
Process/Method*

Elimination or Reduction

- ◆ Change of technology or process
 - Alteration so that hazardous substances are no longer needed
- ◆ Examples
 - Unbleached paper
 - Removal of asbestos from acoustic ceiling tiles
 - Unpainted metal finishes

Substitution

- ◆ Replacement of hazardous chemicals with less hazardous chemicals
- ◆ Examples
 - Steel shot replaces sand for abrasive blasting
 - Water-based paint vs. solvent-based paint
 - Fiberglass replaces asbestos

Change of Form

- ◆ Alteration of the physical state or particle size of a substance to reduce possibility of inhalation
- ◆ Examples
 - Pelletizing fine powders
 - Use of slurries or suspensions for addition of fine powders
 - Use of dry powder paints

Wet Methods

- ◆ Use of water to reduce or eliminate mechanical or gravity dust generation
- ◆ Examples
 - Wet sweeping of floors
 - Wet drilling or cutting of rock or concrete
 - Wet asbestos-containing materials before removal

Initial Design of Process

- ◆ Comprehensive/integrated incorporation of control options in coordinated fashion to eliminate hazardous substances, reduce emissions, and minimize worker contact
- ◆ Examples
 - Work organization
 - Automation
 - Facility design

Process/Equipment Modification

- ◆ Addition of control options to existing process to eliminate hazardous substances, reduce emissions, and minimize worker contact
- ◆ Examples
 - Change of production rate
 - Change of production efficiency
 - Bulk packaging

Materials Handling

- ◆ Use of equipment or mechanical techniques to move bulk materials between locations
- ◆ Examples
 - Pneumatic conveying of bulk powders
 - Automated unloading/loading of rail cars



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Section C

*Overview of Controls;
Engineering and Ventilation*

Enclosure/Isolation

- ◆ Separation of source from worker by a physical barrier
 - Isolation of source or isolation of worker
- ◆ Examples
 - Abrasive blasting cabinet
 - Glove box for biological or radioactive materials
 - Control room

Local Exhaust Ventilation

- ◆ Removal of air and contaminant from close to the contaminant source before it can spread through the workplace
- ◆ His need to know basics of engineering design
- ◆ Design knowledge is important for system testing and maintenance

Local Exhaust Ventilation

- ◆ Examples of local exhaust ventilation
 - Laboratory hood
 - Paint spray booth
 - Ventilated hand tools
- ◆ Basic components
 - Hood
 - Duct
 - Fan (air mover)
 - Air cleaner

General Ventilation

- ◆ Supply and exhaust of large volumes of air to dilute and displace contaminants and for ensuring thermal comfort
 - Use for contaminants with low toxicity
 - Passive systems that rely on natural air movement distribute dilution air
 - Active systems use fans and other mechanical air-moving equipment

General Ventilation

- ◆ Examples of general ventilation
 - Open windows, doors, etc.
 - Build large partially open factory buildings
 - Heating ventilation and air conditioning (HVAC) systems in buildings



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Section D

*Overview of Controls;
Other Control Options*

Housekeeping

- ◆ Procedures to minimize contaminant dissemination through cleaning and decontamination activities
- ◆ Examples
 - Surface cleaning (vacuum cleaning, wet mopping)
 - Spill clean-up



Maintenance of Equipment

- ◆ Proper maintenance will minimize leaks and other sources of generation of hazardous contaminants to the atmosphere
- ◆ Examples
 - Preventive repair of valve gaskets and seals
 - Adjustment of process equipment
 - Calibration of gauges, etc.

Personal Protective Equipment

- ◆ Use of devices worn by worker to reduce or eliminate exposure
 - Last resort
- ◆ Examples
 - Respirators
 - Tinted welding glasses
 - Earplug-type hearing protectors



Source: NIOSH

Work Practices

- ◆ Techniques to minimize the generation, release, and spread of contaminants into workplace along with techniques to minimize the conditions/extent of exposure
- ◆ Examples
 - Closing liquid containers after use
 - Positioning of work
 - No eating, drinking, or smoking in workplace

Restricted Areas and Jobs

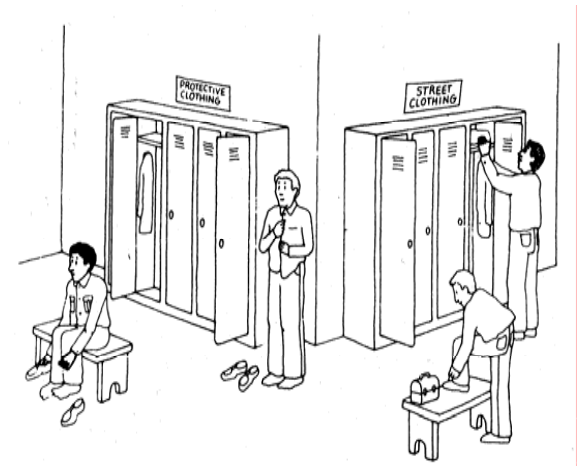
- ◆ Designation of specified areas/jobs requiring specialized training or equipment
 - Exclude or restrict other personnel
- ◆ Examples
 - Noise-control areas
 - Asbestos removal containment
 - RF heat sealer areas

Reduction of Exposure Time

- ◆ Reduction in exposure through limitation of exposure time or change in job to decrease the amount of time required
- ◆ Examples
 - Radiation exposure/clean-up
 - Increase in process efficiency or automation
 - Job rotation in noisy areas

Personal Hygiene Arrangements

- ◆ Provision of facilities to reduce exposure through contaminated clothing, skin, etc., and to prevent spread of contaminants from workplace
- ◆ Examples
 - Providing work clothes
 - Locker rooms/shower
 - Eating facilities



Source: NIOSH

Surveillance

- ◆ Use of medical and environmental measurement methods to detect possible exposures before they occur or before harm is done
- ◆ Examples
 - Blood-lead monitoring
 - Air-quality monitoring
 - Ventilation-system inspection

Information, Instruction, Training

- ◆ Integrated program to raise worker knowledge and awareness of hazards and procedures to reduce exposure
- ◆ Examples
 - Hazard communication programs
 - Material Safety Data Sheets
 - Labeling

Control Program

- ◆ Successful control of exposure will depend on the development of a control strategy utilizing multiple complementary control options
 - Written control plan
 - Management tool

Control Program Example

- ◆ Installation of a new painting station would require:
 - Development of local exhaust ventilation
 - Worker training on paints and solvents
 - Provision of personal protective equipment
 - Exposure measurement

Control Program Example

- Development of SOPs (cleaning spray booth and disposal of waste, etc.) with specific work practices
- Evaluate materials handling
- Medical surveillance (depending on the hazard)
- Development of maintenance procedures