CHEMICAL HAZARDS
AND
PERSONAL PROTECTIVE EQUIPMENTS

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April 18, 2022

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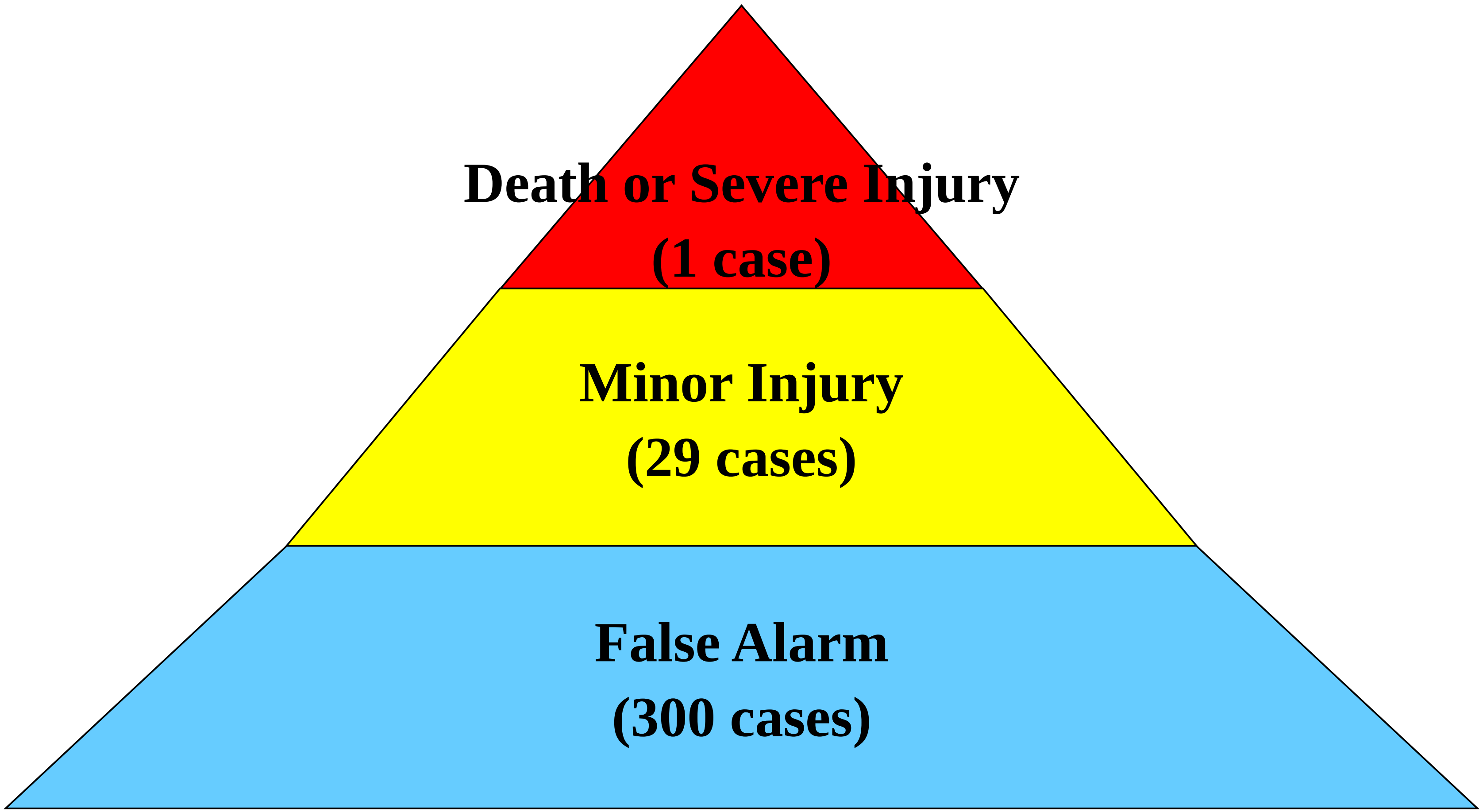
Learning Goals

- Understanding chemical hazards present in the laboratory and strategy of prevention and control
  - Hazard communication for chemical substances
  - Pointers on management of chemical hazards
- Understanding different types of personal protective equipments (PPEs) commonly used in the laboratory and workplace
- Learning how to properly select, use, maintain, and store PPEs

Characteristics of Laboratory as a Workplace

- Presence of miscellaneous hazardous, harmful, or toxic chemicals in significant quantity
- Change in personnel by rotation or entry of new employees at a significant level
- Elevated risk of unknown and uncertain nature owing to development of new technique and research
- High density of technology and equipment

The Risk Pyramid



Significance of Unsafe Behavior and Status

Outlines

Section 1: Chemical Hazards and Strategy of Evaluation and Control

Section 2: Pointers on Management of Chemical Hazards

Section 3: Overview of Personal Protective Equipments and Eye/Facial Protection

Section 4: Respirators

Section 5: Protective Clothing and Hand Protection

Section 1

Chemical Hazards and Strategy of Evaluation and Control

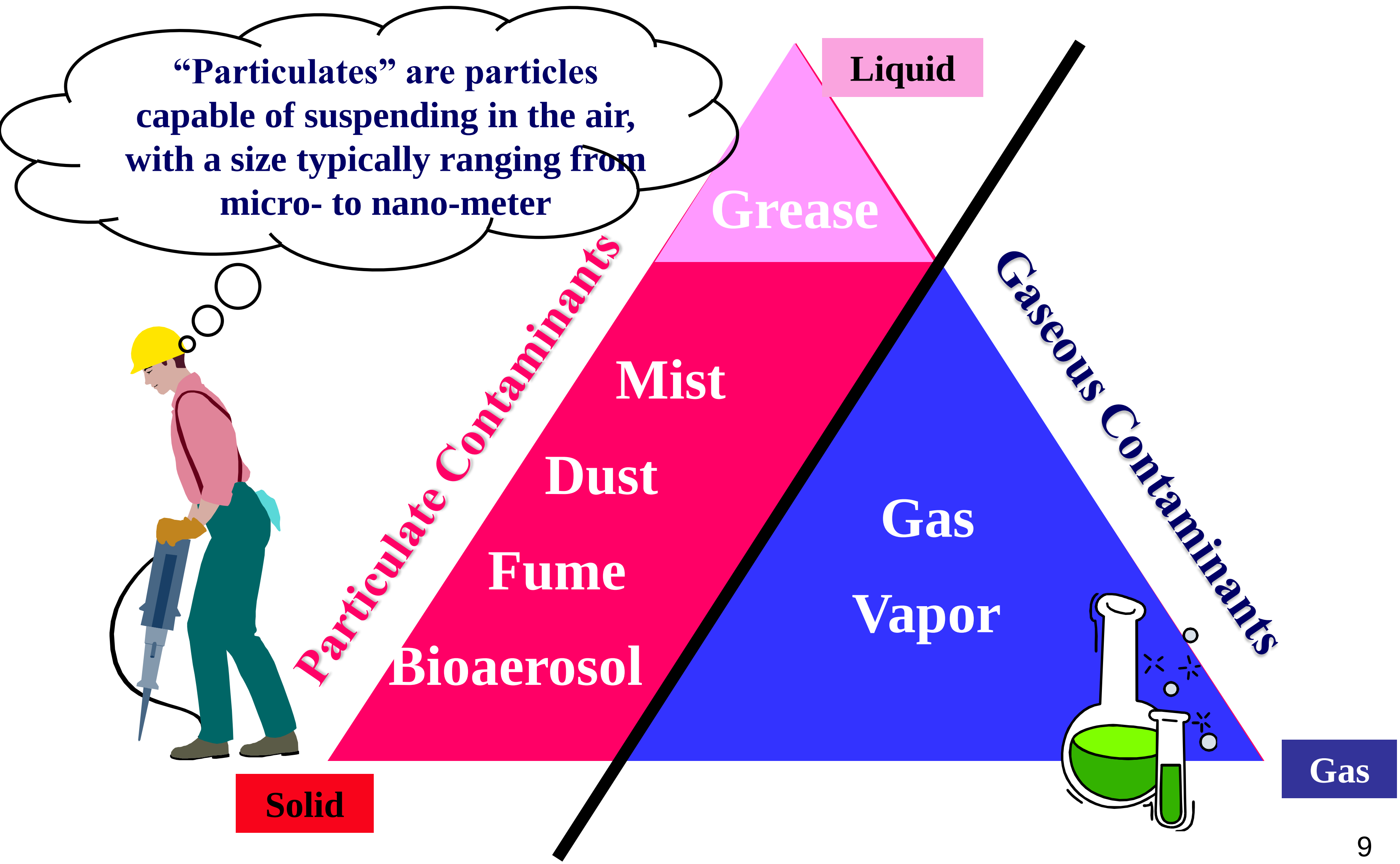
Definition of Hazard

- Hazard: any sources of potential damage, harm or adverse health effects on something or someone under certain conditions
  - A hazard can cause harm or adverse effects to individuals as health effects, or to organizations as property or equipment losses
  - There are five major categories of hazard present in the workplace: chemical, physical, biological, ergonomic and safety hazards

Chemical Hazards

- Toxicity: harmful effect such as poisoning or tissue ulceration due to ***contact or uptake of chemical*** by route of inhalation, ingestion, or skin contact
- Hazard: the damage caused by chemical due to ***energy released from chemical reaction***, such as fires and explosions

Classification of Airborne Hazards



Classification of Airborne Hazards

- The airborne hazards can be in the form of solid, liquid, or gas/vapor:
  - Dusts are solid particles suspending in the air; they can be originating from cutting, grinding, or drilling of solid material, and in general are of a size greater than 5 µm
    - Examples include lead dusts present in battery-manufacturing facilities
  - Fumes are solid particles made of metals suspending in the air due to heating and subsequent condensation; in general the particles have a size less than 0.5 µm
    - Examples include tin/manganese fumes generated from welding works

Classification of Airborne Hazards

- A third class of dusts receiving great attention are biological aerosols, such as those of bacteria, viruses, and fungi
  - Some ***bioaerosols*** are capable of entering the lungs at a great depth when inhaled
- Liquid particulates are generally referred to as mists
  - Examples include those formed from droplets of lubricating oil used in metal-cutting work
  - If the originating solution is acidic, then the mists are called ***acidic mists***, such as sulfuric acid mists or chromic acid mists; both acid mists are highly corrosive

Classification of Airborne Hazards

- Gas molecules possess a significant tendency to diffuse, and they evenly occupy the diffused space
  - Examples include carbon dioxide, ethene (used in welding), carbon monoxide from combustion, and etc
- Vapor consists of molecules evaporating from liquid or subliming from solid due to heating or provision of energy; these molecules otherwise stay as liquid or solid under normal temperature and pressure
  - Examples include organic solvents used in paints or other commonly known solvents such as benzene, n-hexane, carbon tetrachloride, all have been reported in industrial accidents and some confirmed as carcinogens

Case study: Fire from flammable solvent destroying laboratory

- A glass container carrying 4 liters of n-hexane ruptured in a university's laboratory
- The chemical might have evaporated when the graduate student mopped off the spill and subsequently came in contact with the temperature control of a furnace, resulting in a fire
- The fire was put off after two and a half hours; three laboratories were directly destroyed, with a loss of approximately 10 million NTD

Hazard Evaluation and Control

- Hazard evaluation
  - A process to determine type and severity of hazard based on the work/experimental process and the equipment/ material used in the process
  - For chemical hazard, the evaluation includes review of chemical's **Safety Data Sheet** to understand physicochemical characteristics of the substance in the environment (e.g. solid/liquid/gas or vapor; corrosivity; volatility; and lipophilicity) as well as its toxicity

Hazard Evaluation and Control

- Priority of hazard prevention

  1) Engineering control

  - ***Substitution***: Replacing highly toxic stock material with those of lower toxicity; substituting high-risk experimental process with low-risk one
  - ***Reduction***: Experimenting with less stock material
  - ***Isolation***: Separating lab workers not directly involved in handling hazard-producing equipment or experimental process from the work zone
  - ***Ventilation***: Local exhaust ventilation or general ventilation (dilute ventilation)

Hazard Evaluation and Control

- Priority of hazard prevention

  2) Administrative control

  - Education and training; personal hygiene; workplace cleaning and maintenance; material labeling; worker rotation; environmental monitoring; and health surveillance

  3) PPEs

  - These are not an alternative to engineering and administrative controls
  - They should be used only as ***the last line of defense***
  - Occupational emphasis has been on respirators and chemical protective clothing (including gloves)

Section 2

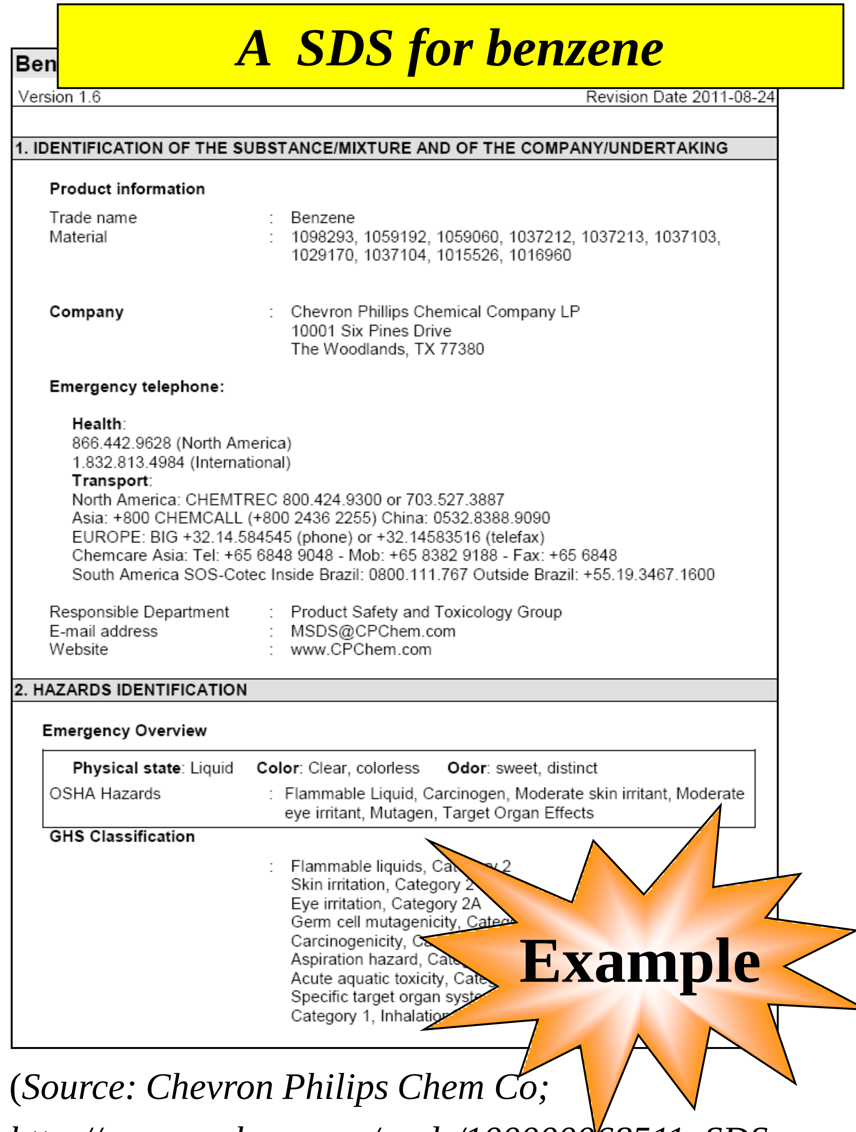
Pointers on Management of Chemical Hazards

Strategy in Hazard Management

- Laboratory personnel should observe the following elements when working in laboratory to facilitate a proper evaluation of potential hazard and take preventive action
  - *Codes of safe laboratory practice*
  - *Material used in the experiment*
  - *Equipment/apparatus and protocol used in the experiment*
- Strategies of hazard prevention adopted in different types of laboratories might vary significantly, in the next slides only examples common to most laboratories are provided to illustrate cautions and strategies for hazard prevention

Safety Data Sheet (SDS)

- SDS are required for display in laboratory handling chemical, and should be displayed at visible locations of easy access
- Contents of SDS in current display should be confirmed for accuracy and updated periodically
  - The updated record should be on file for ***three years***
- Sections of SDS directly relevant to emergency response: *First Aid Measures, Fire-Fighting Measures, Accidental Release Measures, and Exposure Controls/Personal Protection*



(*Source: Chevron Philips Chem Co; http://www.cpchem.com/msds/100000068511_SDS_US_EN.PDF*)

Hazard Communication —Chemical Labeling

- The containers of hazardous material used in laboratory should be labeled with the following information from GHS:
  - *Hazard symbol*
  - Contents, including:
    - *Chemical name*
    - *Signal word* (caution)
    - *Hazard statements* (hazard warning message)
    - *Precautionary statements* (prevention, response, storage, and disposal)

Example

Benzene

Version 1.6 Revision Date 2011-08-24

Symbol(s) :

Signal Word : Danger

Hazard Statements :
H225: Highly flammable liquid and vapor.
H304: May be fatal if swallowed and enters airways.
H315: Causes skin irritation.
H319: Causes serious eye irritation.
H340: May cause genetic defects.
H350: May cause cancer.
H401: Toxic to aquatic life.
H372: Causes damage to organs through prolonged or repeated exposure.

Precautionary Statements :
Prevention:
P202: Do not handle until all safety precautions have been read and understood.
P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233: Keep container tightly closed.
P240: Ground/bond container and receiving equipment.
P241: Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242: Use only non-sparking tools.
P243: Take precautionary measures against static discharge.
P260: Do not breathe dust/fume/gas/mist/vapor/spray.
P264: Wash skin thoroughly after handling.
P270: Do not eat, drink or smoke when using this product.
P273: Avoid release to the environment.
P280: Wear protective gloves/ protective clothing/ eye protection/ face protection.
Response:
P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P303 + P361 + P353: IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313: IF exposed or concerned: Get medical advice/ attention.
P321: Specific treatment (see supplemental first aid instructions on this label).
P331: Do NOT induce vomiting.
P332 + P313: If skin irritation occurs: Get medical advice/ attention.
P337 + P313: If eye irritation persists: Get medical advice/

A GHS display for benzene containing elements required for labeling

(*Source: Chevron Philips Chem Co; http://www.cpchem.com/msds/100000068511_SDS_US_EN.PDF*)

Storage of Chemical

- Hazardous material should be stored in accordance with its properties (e.g., *volatility*, *flammability*, and *compatibility*)
- The exhaust ventilation system installed in the storage facility should receive periodic inspection and maintenance
- Facilities storing a significant level of volatile, flammable liquid should be installed with *flammable gas detectors*

Exhaust ventilation

Fire and explosion safety cabinet

Fire and explosion safety cabinet for storage of hydrogen cylinders

Hydrogen detector

Alarming device

Ventilation Equipments

- Volatile chemical should be processed and handled in a ventilation hood
- Samples containing microorganisms of airborne capability should be processed and handled in a biosafety cabinet
- Ventilation hood for chemical processing and biosafety cabinet for handling micro-organism are different in functions and the ways they function—don't mix-use them
- Do not leave material/tool in the hood unless necessary; they may influence stability of air flow for ventilation

Ventilation hood

Local exhaust ventilation

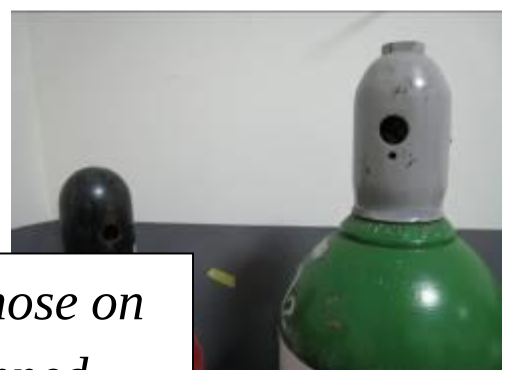
Ventilation Equipments

- If toxic gas may be released from scientific equipment during its operation, the point of gas emission should be covered in local exhaust ventilation
- Local exhaust ventilation, ventilation hood, and relevant equipments are required to be annually checked (e.g. for *transport velocity*)
- Stop your experiments immediately when the followings occur and seek help to check/repair:
  - Damage in exhaust pipeline
  - Abnormal operation of driving motor
  - Blocking of filtration device
  - Any other signs of abnormality (e.g. irregular sounds)

Gas Cylinders

- When using a high-pressure gas cylinder, observe the followings:
  - Cylinder transversely fixed?
  - All ***gauge pressures*** normal?
  - Inflammable objects present in the cylinder storage room?
  - Constituents of gas in cylinder clearly labeled?
  - Leakage from connection points?
  - Temperature in the storage room ***over 40°C***?

Do not leave a wrench on cylinder-regulating valve!



Empty cylinders or those on reserve should be capped

Use and Management of Toxic Chemical Substances

- Containers and packaging of toxic chemical substances (TCS) should be labeled as required and attached with a copy of SDS
- Entrance of facility where chemical is handled should be labeled with the sign "*Handling Premises of Toxic Chemicals*"
- Mechanism preventing release or leakage of TCS should be activated and operated when chemical is processed; emergency response equipment should be made available

Use and Management of Toxic Chemical Substances

- TCS should be stored in airtight, sturdy containers or packaging
  - Storage room or storage facility for TCS needs to be locked when the chemical are stored in the room
- Emergency response equipments and detecting/alarming devices should be periodically checked and calibrated
- The amounts of TCS in storage need to be in consistence with those on record
- The record of operation for TCS should remain on file for three years at the location of operation

Laboratory Waste

- Arbitrary disposal of laboratory waste including those of radioactivity, toxicity, corrosivity, inflammability, and infectious nature may pose a threat to health of those who work in the laboratory as well as to the environment
  - Arbitrary disposal of laboratory waste is subject to lawful punishment
- The collection, classification, labeling, and storage of laboratory waste and the transfer of waste to the management unit for temporary storage and final shipment for disposal should abide by the Institute's regulations

Section 3

Overview of Personal Protective Equipments and Eye/Facial Protection

Overview of PPEs

- **Types of PPEs for non-emergency use**

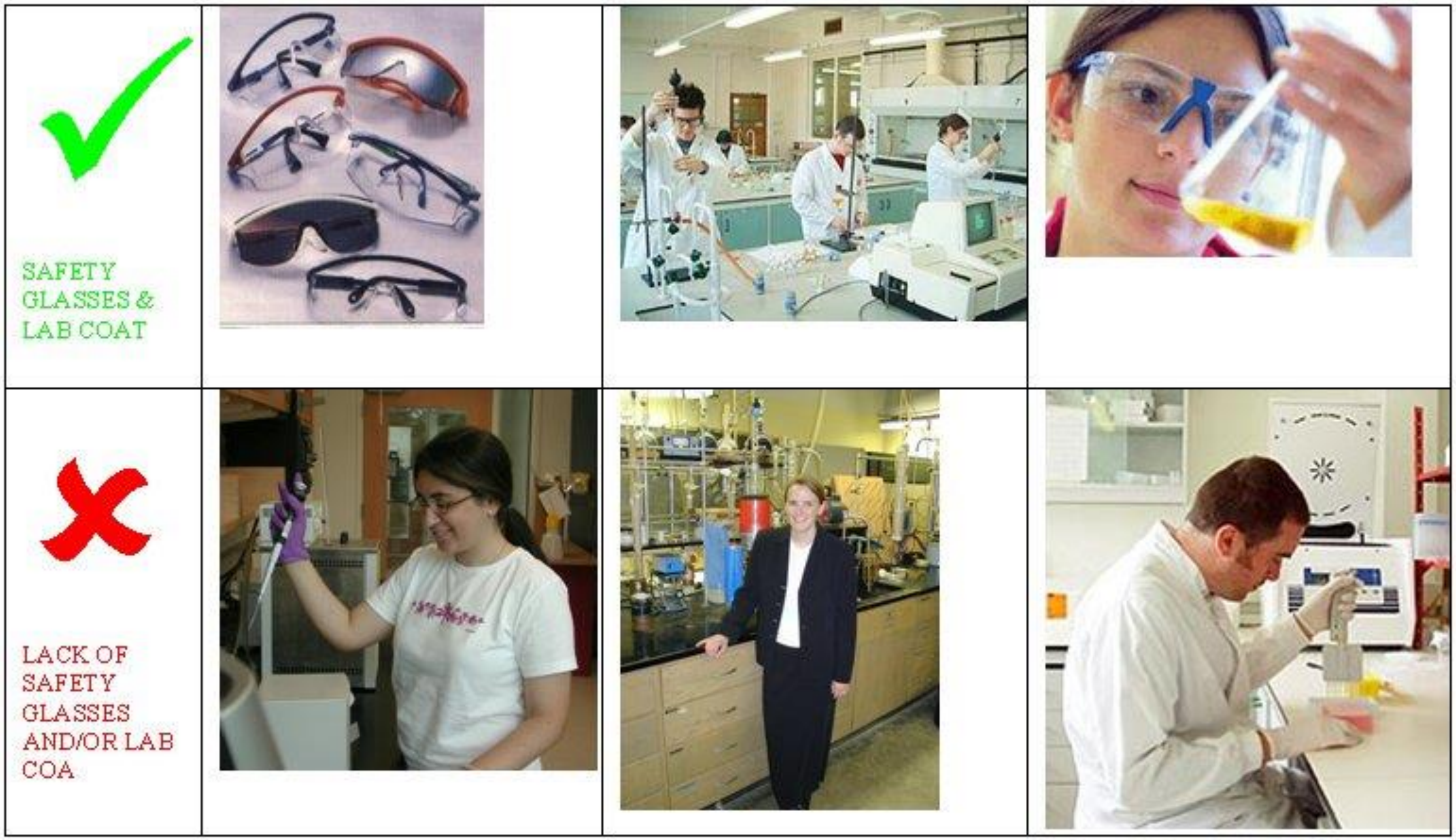
- ***Eye and facial protection***: Safety glasses and face shields
- ***Respirators***: Disposal dust masks and gas masks (for non-emergency use)
- ***Chemical protective clothing***: Lab coat and safety apron
- ***Hand and foot protection***: Gloves and safety shoes/boots
- ***Hearing protection***: Earplugs and earmuffs
- ……

Overview of PPEs

- **Types of PPEs for non-emergency use**
  - PPEs can protect you only when you use them: Many PPEs were bought, displayed in the safety equipment cabinet, and never used
  - PPEs may bring you more harm than safety when they are improperly used: PPEs have to fit the user's anthropometric characteristics such as the body shape, body size, and even facial characteristics in order to be protective
    - The risk from being exposed to toxic substance when using PPEs may be greater than when not using PPEs, e.g., dermal absorption of chemical is typically one-to-two magnitude greater than expected when the skin is moist

Laboratory Safety and Health Essentials…

- **Safety glasses and lab coat**



（http://www.ecm.auckland.ac.nz/safety/safety.html）

Laboratory Safety and Health Essentials…

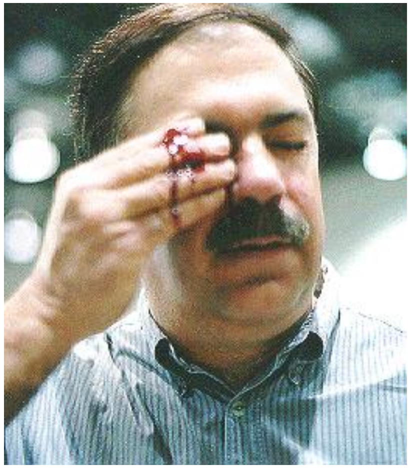
- **Closed shoes**

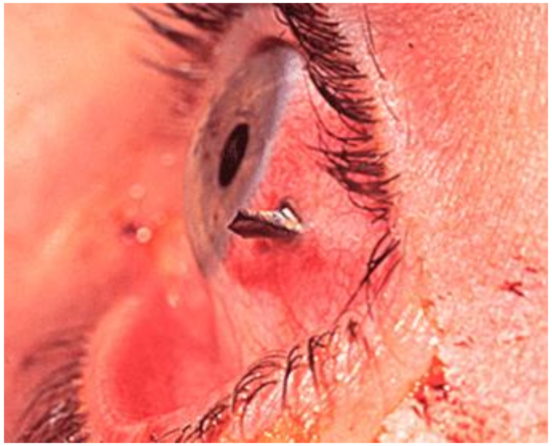
（http://www.ecm.auckland.ac.nz/safety/safety.html）

Eye and Facial Protection

- *If these protective gears were not in place…*

- *The consequences would be…*





Eye and Facial Protection

- *Factors prone to hurting your eyes and face in a laboratory*

Hazard Type	High-Risk Task
Impact	Cutting, slicing, grinding, sculpturing, and any other tasks producing objects or debris capable of flying with sufficient momentum
Heat	Operating high-temp furnace/oven, melting/welding work, and any other tasks producing high temp
Chemical	Handling and treatment of chemical or specimen
Dust	Woodwork
Light	Welding, melting and cutting, and laser operation

Eye and Facial Protection

- The protection offered by safety glasses
  - ➢ Mechanical harms, e.g. flying objects and spilled liquid
    - ✓ The shields on the side arms of safety glasses are designed to prevent entry of foreign objects
  - ➢ Radiation, e.g. ultraviolet and visible light radiation
    - ✓ Many facilities handling biotechnology use ultraviolet light as a tool for DNA observation; the ultraviolet light may cause damage to the cornea when a worker is continuously exposed to

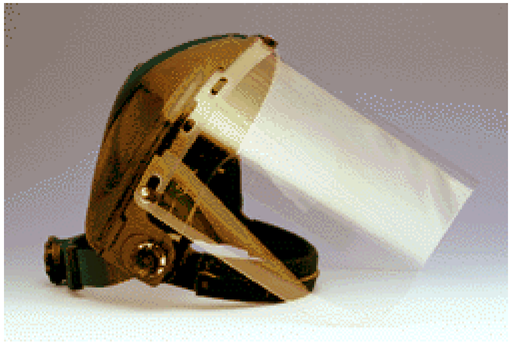
Eye and Facial Protection

- Types of eye and facial protection

Safety Glasses

Goggles

Face Shields

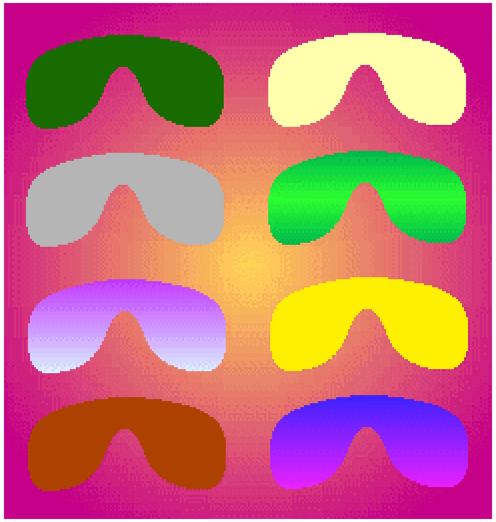


Eye and Facial Protection

- Types of eye and facial protection

Welding Face Shields and Helmets

Light-Filtering Lens



➢ Aiming to protect against light of high intensity

Eye and Facial Protection

- *Something about contact lenses*
  - In laboratory:
    1) Wearing contact lenses is prohibited (as the most conservative intervention approach)
    2) Evaluating risk of using contact lenses is a must-do
    3) Using airtight goggles for additional protection if you must use contact lenses
  - If by accident chemical is spilled in the eyes:
    1) Rinsing the eyes with clean water and removing contact lenses immediately
    2) Continuing to rinse for at least ***15-30 minutes***
    3) Transferring the wounded to hospital

Eye and Facial Protection

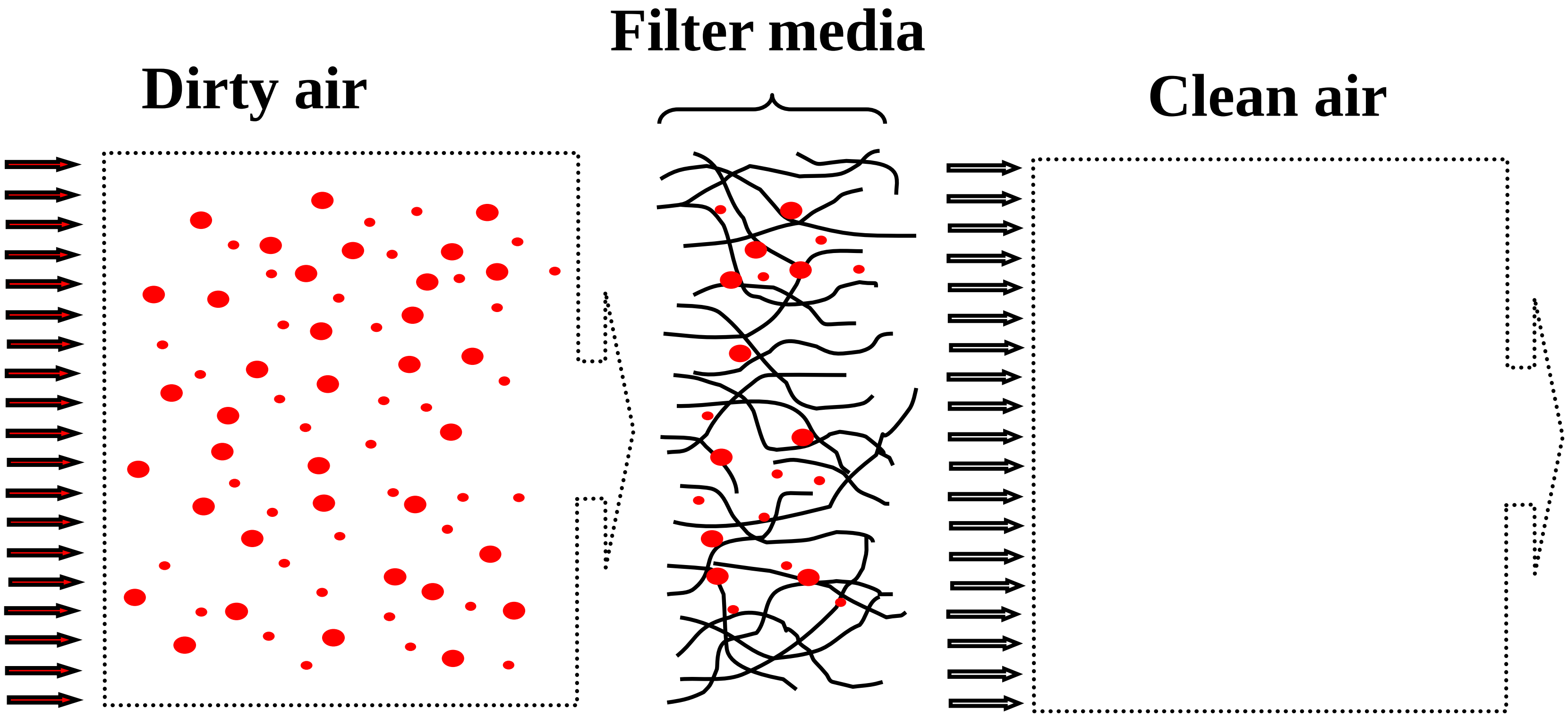
- *Contact lenses are not intended for use as PPEs*
  - Contact lenses are prohibited in the lab because:
    1) The reflective shutting of the eyelids when foreign objects enter makes removal of contact lenses difficult, unnecessarily delaying emergency treatment and medical attention required for the wounded
    2) Some chemical in the form of vapor are capable of permeating through the lenses, and interacting extensively with ocular tissues due to occlusion effect
    3) Long-term use of contact lenses may reduce sensitivity of cornea and secretion of tears, and thus weakening the eyes' natural defense

Section 4

Respirators

Respirators

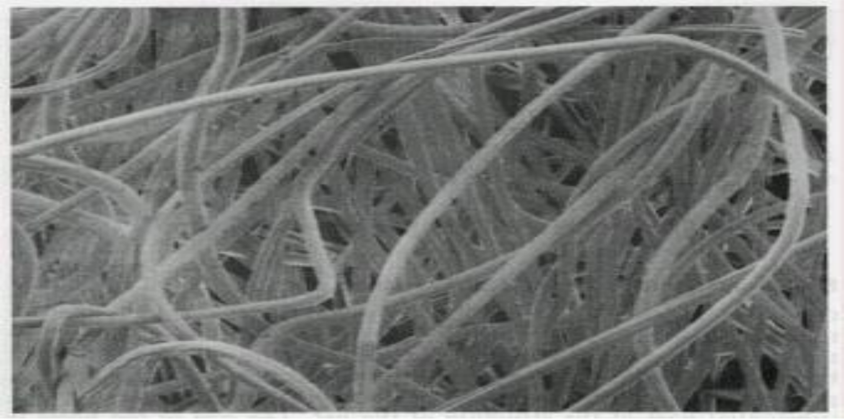
- *"Dust masks"—removal of solid/liquid particulates*



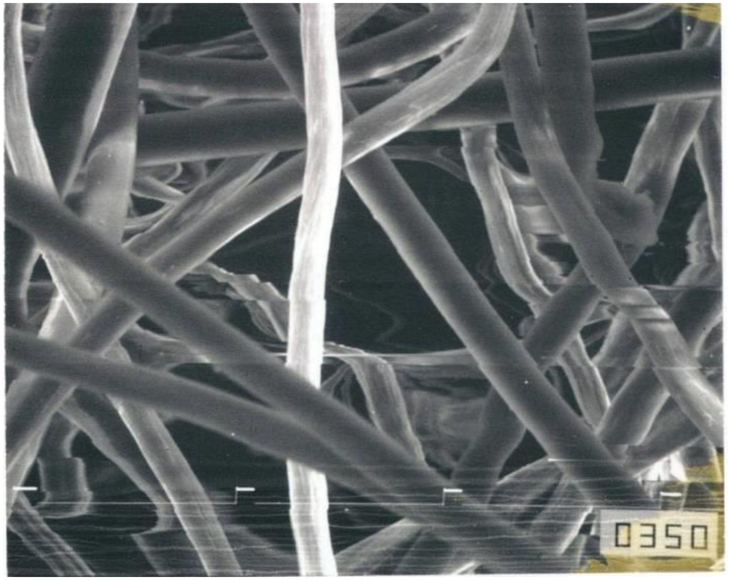
(Source: Organic solvent loading in canisters; Nelson, 1976)

Respirators

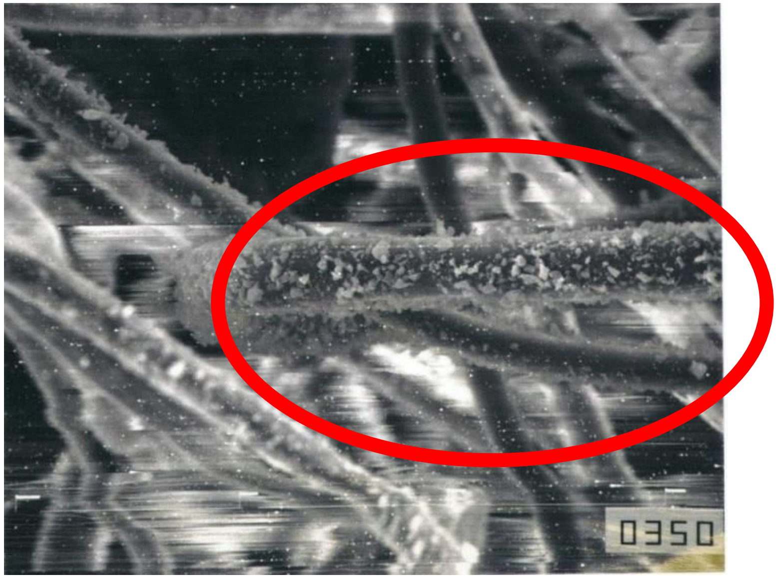
- *Filtration of particulates by fibers and aging effect for mechanical filters*



(Source: Air Filtration by R.C. Brown, Pergamon Press)



Clean fibers



Used fibers

Respirators

- *"Gas masks"—removal of gaseous/vapor contaminants*

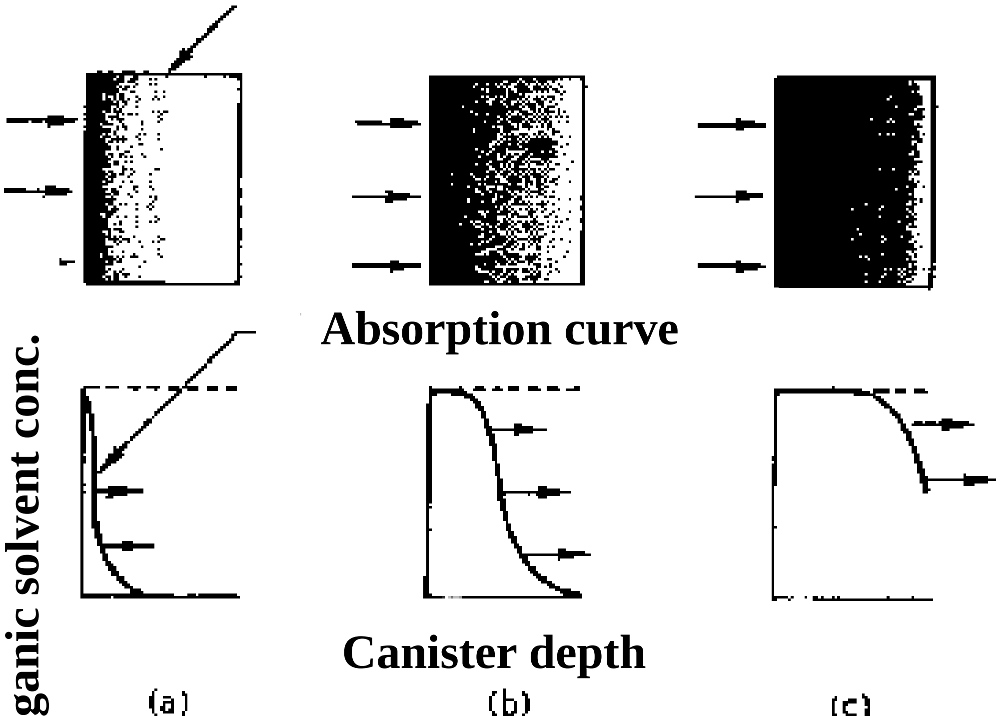
Canister with adsorbent for organic solvent

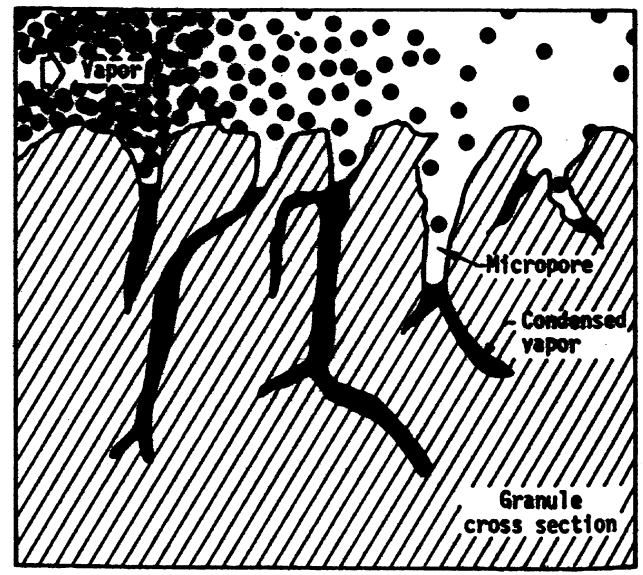
Organic solvent

Absorption curve

Organic solvent conc.

Canister depth





Respirators

- *Particulate respirators*
  (Filtering-facepiece respirators)

N95 half mask

N95 half mask with exhalation valve

(Source: 3M Company, USA)

Respirators

- *Particulate respirators*
  (Filtering-facepiece respirators)

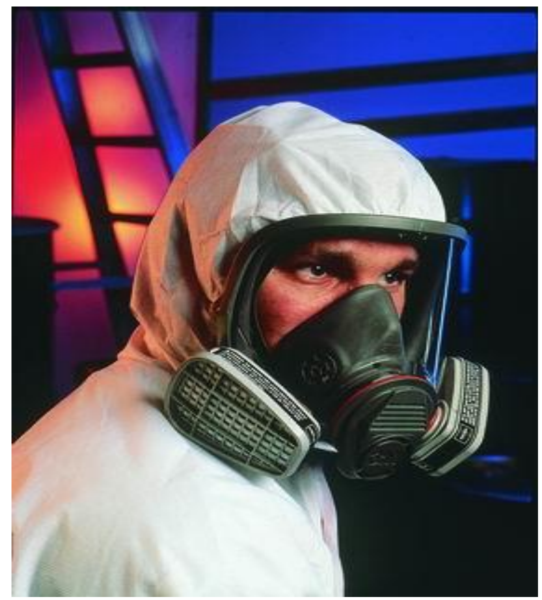
Half facepiece with
P100 filter

Half facepiece with
P95 filter

(Source: 3M Company, USA)

Respirators

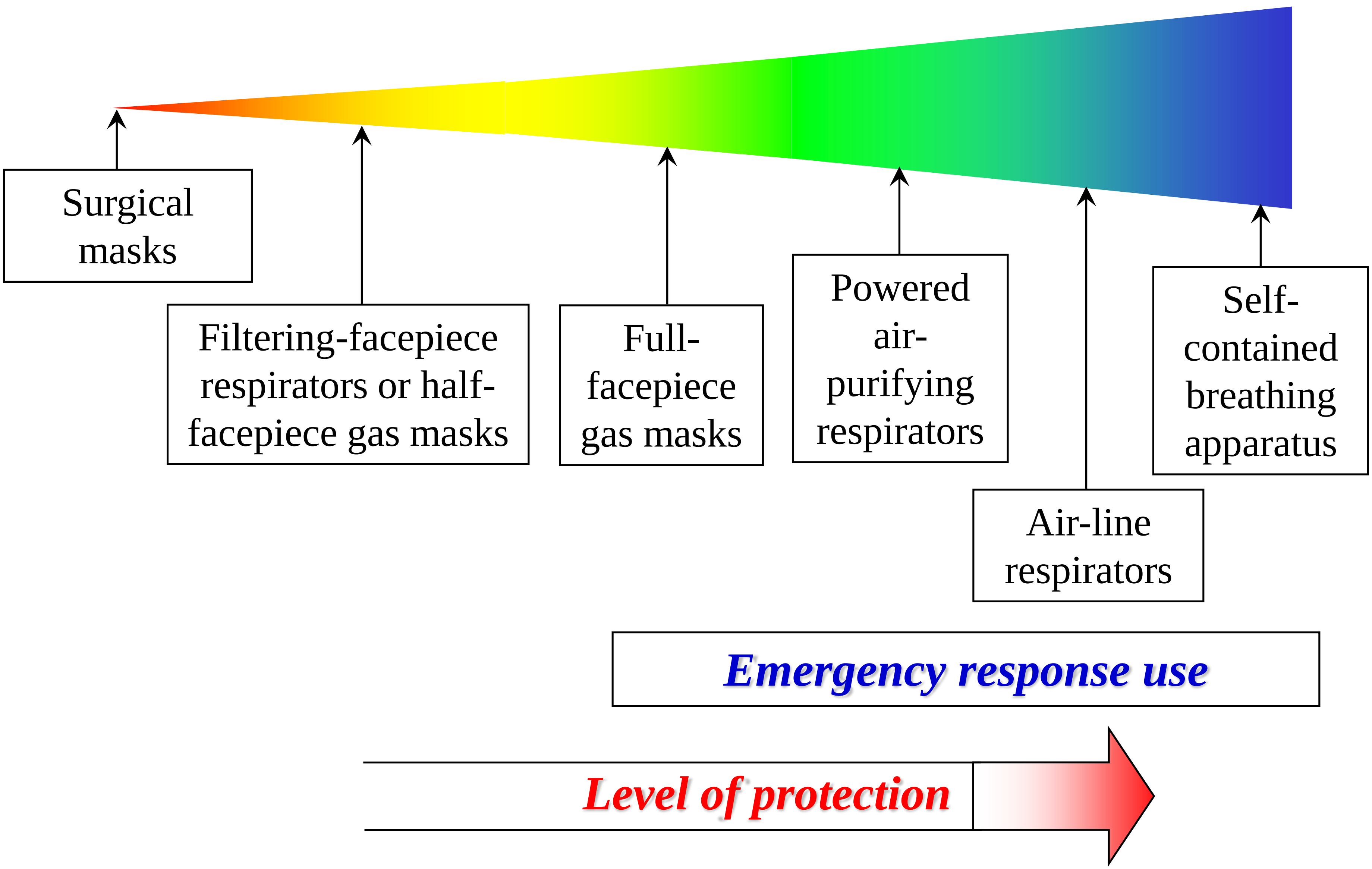
- *Gas masks (Half- and full-facepiece respirators)*
  - Facepiece and canister/cartridge combined
  - Air driven by negative pressure developed from respiration

Half-facepiece (left) and full-facepiece (right) gas mask with cartridge

(Source: 3M Company, USA)

Level of protection provided by respirators…



Classification of particulate respirators by US National Institute for Occupational Safety and Health

Series	Level	Efficiency of Filtration (%)	Targeted Contaminants	Time of Use
N	N100	99.7	Particulates and ***non-oil-based aerosols***	Varied by use condition
	N99	99		
	N95	95		
R	R100	99.7	Particulates (including oil-based aerosols)	A working day (8 hours)
	R99	99		
	R95	95		
P	P100	99.7	Particulates (including oil-based aerosols)	Varied by use condition
	P99	99		
	P95	95		

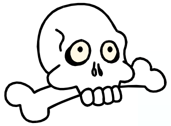
Respirators

- Selection of respirators

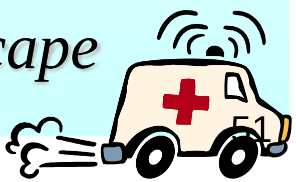
1) Type of respirator and level of protection required?
2) Not everyone can use the same type of respirator
3) Level of reduction in contaminant concentration by the respirator?
4) “Protection factor” vs. “fit factor”

Respirators

- Presence of airborne hazard: A result of air being unsafe to breath (e.g. insufficient oxygen content) or being contaminated by a hazardous material
- Understanding IDLH (Immediately Dangerous to Life or Health concentration)—***only air-supplying respirators may be used under IDLH condition***

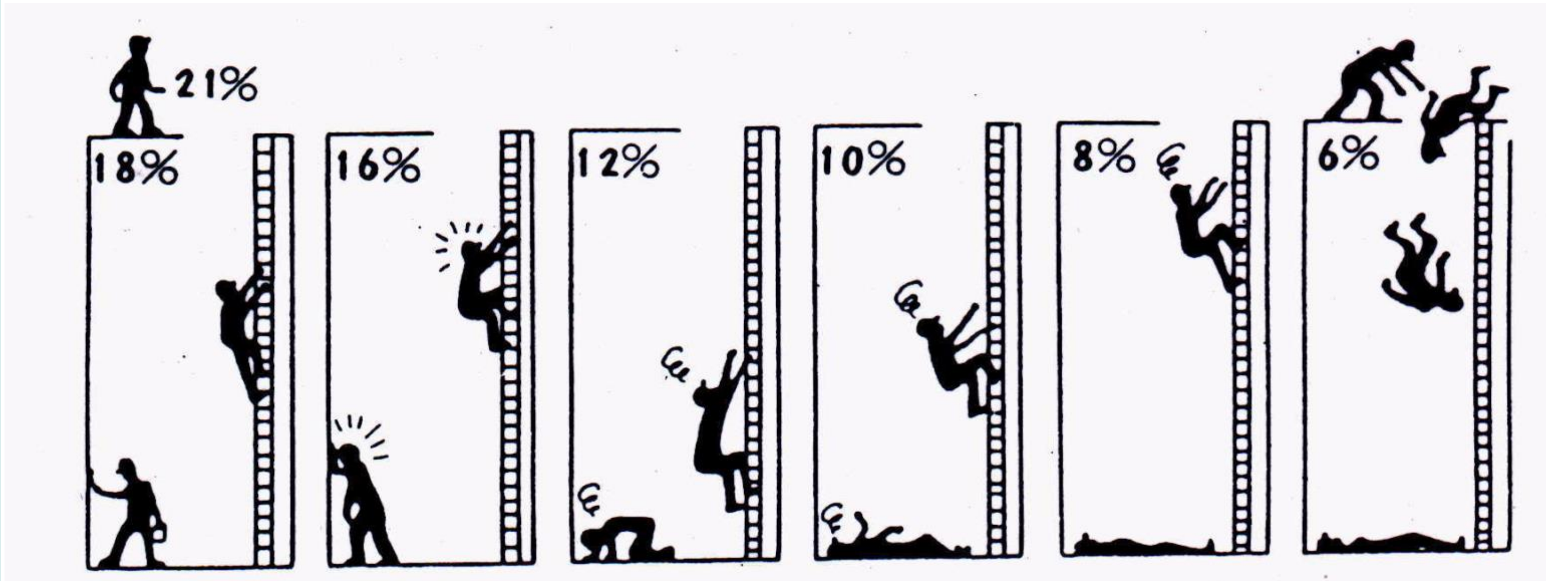


IDLH is a threshold concentration developed to prevent acute toxicity arising from inhalational exposure to hazardous material; when exposed to a target chemical at concentration beyond IDLH a person may suffer: 1) death; 2) irreversible health effect; or 3) loss of ability to escape



Respirators

- Oxygen content and physiological response



18%	16%	12%	10%	8%	6%
Safe but continuous ventilation required	**Increase in respiration and pulse rate; headache; nausea**	**Dizziness; nausea; weakness in muscle strength resulting in falling**	**Paleness; unconscious -ness**	**Unconscious -ness and faint; death in 7-8 mins**	**Instan- taneous faint; stop of breathing; spasm; death in 6 mins**

Protection Factor (PF)

$$PF = \frac{\text{Avg. conc. of contaminant in air}}{\text{Avg. conc. of contaminant inside respirator}}$$

PF = FF (fit factor) when filtration efficiency reaching 100%

Filter efficiency + Facepiece leakage

Filter efficiency testing

- ☞ 42 CFR Part 84
- ☞ EN 149:2001
- ☞ CNS 14755 Z2125

Fit testing

Fit Factor (PF)

- *Fit of facepiece varies by model as well as by user…*

	Surgical mask 1	Surgical mask 2	Surgical mask 3	N95 mask 1	N95 mask 2
Mean	**3.9**	**5.7**	**4.0**	**21.6**	**80.9**
Std. Dev.	**2.1**	**4.4**	**3.0**	**27.7**	**70.7**
Maximum	**8.4**	**23.3**	**17.0**	**112.6**	**200.0**
Minimum	**1.2**	**2.0**	**1.4**	**1.6**	**4.4**
FF > 100	**0.0%**	**0.0%**	**0.0%**	**6.5%**	**35.5%**

What fits you may not fit me

Respirators

- Proper use of respirators

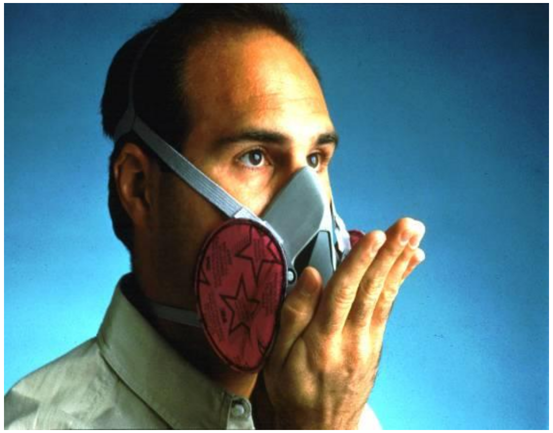
1) Select a correct and effectively working respirator

2) Perform ***fit check*** before use

3) ***Fit test*** (qualitative and quantitative) vs. ***fit check*** (positive pressure and negative pressure)

Respirators

- Fit check ensures fit of respirator and ***should be performed every time you put a respirator on***
- Demonstrated below are proper ways to perform fit check



Positive-pressure fit check

Negative-pressure fit check

Simplified fit check for disposable mask

Respirators

- <u>Fit test</u> ensures fitting of a selected model to the user's facial characteristics and ***should be performed when a new respirator is selected and also on a routine basis***

Qualitative fit test
- Dust masks: Using saccharin or Bitrex solution
- Gas masks: Using banana oil

Quantitative fit test
- Measuring concentrations present inside and outside of facepiece

Respirators

- Storage of respirators
  1) Respirators should be prevented from
     - Physical damage
     - Chemical contact
     - Dust contact
     - Sunlight exposure
     - Extreme temperature
     - Excessive moisture

  2) Respirators for emergency use should be clearly labeled with user instructions and stored in adequate, accessible places

Section 5

Chemical Protective Clothing and Hand Protection

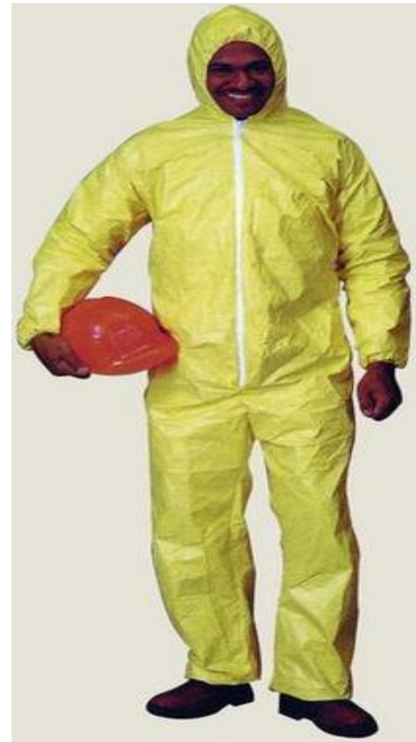
Chemical Protective Clothing in Common Use…

Level A Ensemble

- Airtight clothing
- Self-contained breathing apparatus (SCBA) or air-line respirator

Level B

- Non-airtight clothing, gloves, boots
- SCBA or air-line respirator



Level C

- Clothing, gloves, boots
- Half-/full-facepiece respirator

Level D

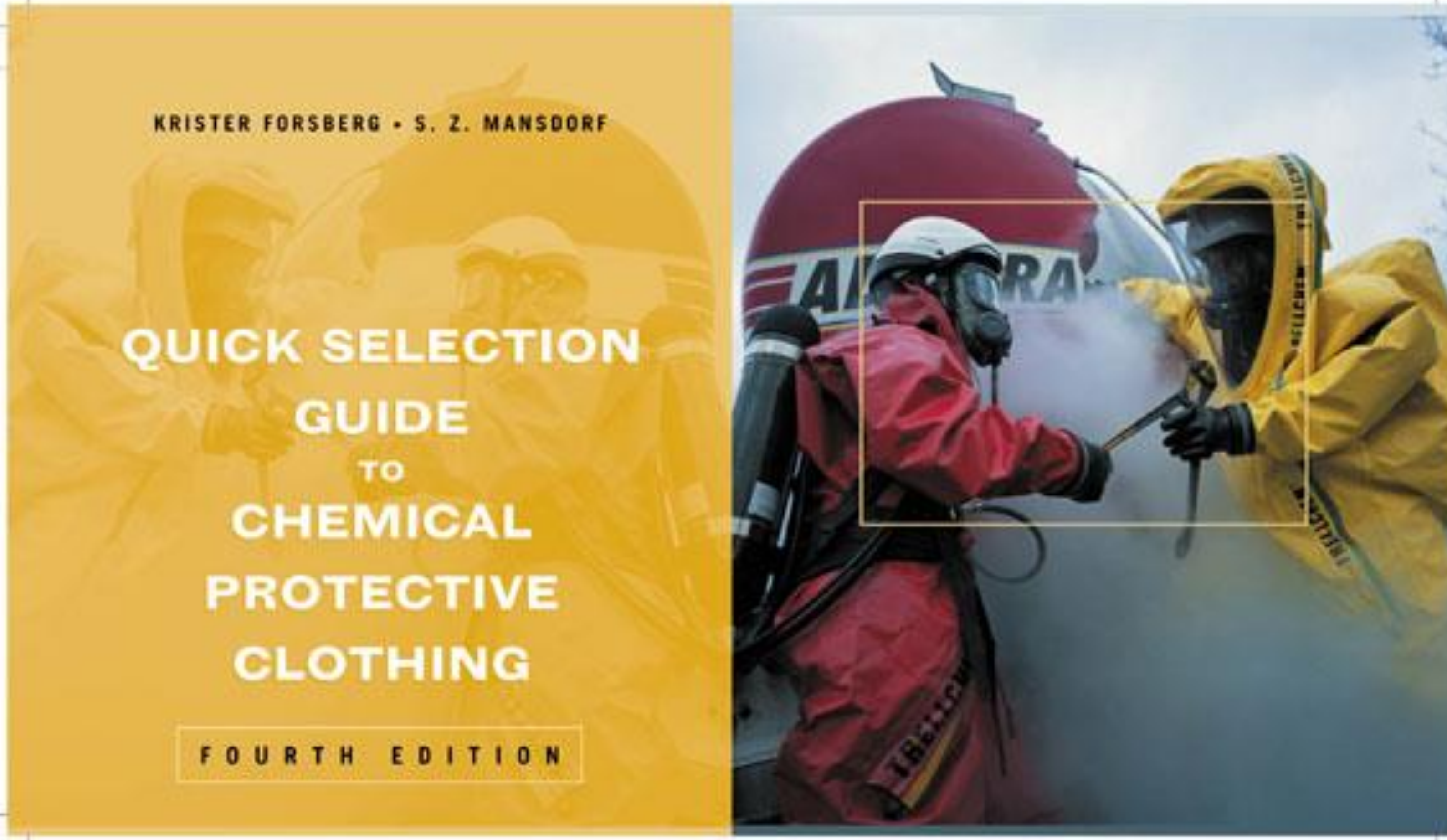
- Boots
- No respirator required

Protective Clothing

- Laboratory coat

1) Lab coat are required when staying in laboratory handling or storing chemical
2) Lab coat should be removed immediately if contaminated; white coat are preferred, and should be kept clean
3) Long pants and closed shoes of low heel are the preferred personal clothing; baggy clothes and long hairs are prone to accidents in a laboratory

Selection of chemical protective clothing…



(Source: Forsberg and Mansdorf, 2004)

Color-Coded Recommendations

“Green” indicates “recommended > 4 h or > 8 h”

>8 (green)	Recommended >8 h.
(green)	Recommended >4 h.
(yellow)	Caution 1–4 h.
(red)	Not recommended <1 h. (Degradation may occur)
(white)	Not Tested

292 Hydrocarbons, Aromatic

	Butyl Rubber	Natural Rubber	Neoprene Rubber	Nitrile Rubber	Polyethylene (PE)	Polyvinylalcohol	Polyvinylchloride	Viton®	Viton®/Butyl Rubber	Barrier (PE/PA/PE)	Silver Shield/4H® (PE/EVAL/PE)	Responder®	Trellchem® HPS	Tychem® BR/LV	Tychem® SL	Tychem® TK
Benzene	Red	Red	Red	Red	Red	Green >8	Red	Green	Green >8	Green >8	Green >8	Green >8		Green >8	Red	Green >8
p-tert-Butyltoluene	Red	Red	Red	Green		Green >8		Green >8			Green >8					
m-Cresol	Green >8	Red	Green	Yellow	Red		Yellow	Green >8								
p-Cresol	Green >8	Red	Green >8					Green >8			Green					
Cresols, isomeric mixture	Green >8	Red	Green	Yellow	Red		Yellow	Green >8				Green >8		Green >8	Green >8	Green >8
Cumene	Red	Red	Red	Yellow				Green >8						Green >8		Green >8
Diethylbenzene	Red	Red														
Divinylbenzene	Red	Red	Red	Red		Green >8	Red	Green >8				Green >8				
Ethylbenzene	Red	Red	Red	Red	Red	Red	Red	Green >8	Green >8			Green >8		Green >8	Red	Green >8
Gasoline, 40–55% aromatics	Red	Red	Red	Green >8			Red	Green >8			Green	Green >8		Green >8		Green >8
Gasoline, unleaded	Red	Red	Red	Green >8		Green	Red	Green >8	Green >8	Yellow	Green	Green		Green >8	Red	Green >8
Isobutylbenzene												Green >8				
alpha-Methylstyrene	Red	Red	Red	Red		Yellow		Green >8								
Styrene	Red	Red	Red	Red	Red	Green	Red	Green >8	Green >8	Green >8	Green >8	Green >8	Green >8	Green >8	Red	Green >8
Toluene	Red	Red	Red	Red	Red	Green >8	Red	Green >8	Green	Green >8	Green >8	Green >8	Green >8	Green >8	Red	Green >8

CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

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Hand Protection

- Death of Dr. Wetterhahn—absorption of dimethylmercury following its permeation through latex gloves
- ***There is no glove material that can completely stop permeation of all chemicals; the difference lies in how long it takes for chemical to break through***

(Exposure of skin to hydro-fluoric acid. Source: Taiwan Institute of Occupational Safety and Health)

Hand Protection

- Gloves commonly used in laboratory
  - Gloves made of cottons and asbestos for protection against heat and sometimes covered in alumina for protection against chemical and water
  - Plastic gloves made from mold-dipping for protection in tasks handling chemical or oil/grease
  - Gloves made of leather for protection in welding works
  - Gloves supported by metal net to prevent finger-cutting when handling knifes or sharp objects

Gloves in Common Use

Natural rubber

Neoprene rubber

Nitrile rubber

Polyvinyl chloride

Polyvinyl alcohol

Butyl rubber

Rating of gloves for permeation and degradation resistance

Permeation/Degradation Resistance Guide for Ansell Gloves

The first square in each column for each glove type is color coded. This is an easy-to-read indication of how we rate this type of glove in relation to its applicability for each chemical listed. The color represents an overall rating for both degradation and permeation. The letter in each square is for Degradation alone…

- GREEN: The glove is very well suited for application with that chemical.
- YELLOW: The glove is suitable for that application under careful control of its use.
- RED: Avoid use of the glove with this chemical.

	LAMINATE FILM			NITRILE			UNSUPPORTED NEOPRENE			SUPPORTED POLYVINYL ALCOHOL			POLYVINYL CHLORIDE (Vinyl)			NATURAL RUBBER			NEOPRENE/ NATURAL RUBBER BLEND		
	BARRIER			SOL-VEX			29-865			PVA			SNORKEL			CANNERS AND HANDLERS*			CHEMI-PRO*		
CHEMICAL	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
1. Acetaldehyde	■	380	E	P	—	—	E	10	F	NR	—	—	NR	—	—	E	7	F	E	10	F
2. Acetic Acid	■	150	—	G	270	—	E	60	—	NR	—	—	F	180	—	E	110	—	E	260	—
3. Acetone	▲	>480	E	NR	—	—	E	10	F	P	—	—	NR	—	—	E	10	F	G	10	G
4. Acetonitrile	▲	>480	E	F	30	F	E	20	G	■	150	G	NR	—	—	E	4	VG	E	10	VG
5. Acrylic Acid	—	—	—	G	120	—	E	390	—	NR	—	—	NR	—	—	E	80	—	E	65	—
6. Acrylonitrile	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Allyl Alcohol	▲	>480	E	F	140	F	E	140	VG	P	—	—	P	60	G	E	>10	VG	E	20	VG
8. Ammonia Gas	■	19	E	▲	>480	—	▲	>480	—	—	—	—	■	6	VG	—	—	—	■	27	VG
9. Ammonium Fluoride, 40%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
10. Ammonium Hydroxide	E	30	—	E	>360	—	E	250	—	NR	—	—	E	240	—	E	90	—	E	240	—

(Source: Ansell Occupational Healthcare 2003)

Hand Protection

- Indices applied in selection of gloves

☑ Chemical to handle

☑ Duration of exposure

☑ Material in gloves

☑ Dexterity and thickness

☑ Comfort

☑ Temperature at work

☑ Anti-aging characteristics

☑ Permeation rate

☑ Mechanical strength

☑ Level of voltage encountered

☑ Work process

☑ Certification of glove inspection

☑ Manufacturer

☑ Cost

Hand Protection

- Cautions on using gloves
  - The barrier material used in constructing the gloves should not allow for skin absorption of chemical or become a source of dermatoses
  - If you use barrier creams, keep in mind they do not offer a complete resistance to chemical permeation
  - When operating a machine, take the gloves off before you work; the gloves may be tangled and rolled into the operating or moving machine
  - Do not mix-use different gloves
  - The protective gloves should fit the user's hands and not interfere with capability holding objects

Hand Protection

- Inspection
  - ➢ The status of protective gloves must be checked before they are used
    - ☑ Any change in color?
    - ☑ Any puncture or sign of tearing?
    - ☑ If defect is suspected, change the gloves

Hand Protection

- Usage and limitations
  1) Proper donning and doffing of gloves
  2) Proper use of disposal vs. non-disposal gloves
  3) Wash hands immediately once gloves are removed
  4) Gloves are not to be used in tasks where drills and cutting tools are involved and finger-cutting is a risk
  5) Review ***Safety Data Sheet*** when organic solvent is used in task so to determine efficacy of barrier material

Hand Protection

- Steps to remove disposal gloves

1.


3.


2.


4.


Acknowledgements

- This slideshow was compiled and edited by Chen-Peng Chen of Department of Occupational Safety and Health (DOSH), China Medical University (CMU), based on the information originally presented in the following teaching materials:
  - "Management of Laboratory Safety and Health" and "Personal Protective Equipments", Examination Center for Laboratory Safety and Health, National Taiwan University (2011)
  - "Industrial Toxicology" and "Personal Protective Equipments", Chen-Peng Chen, DOSH, CMU (2020)