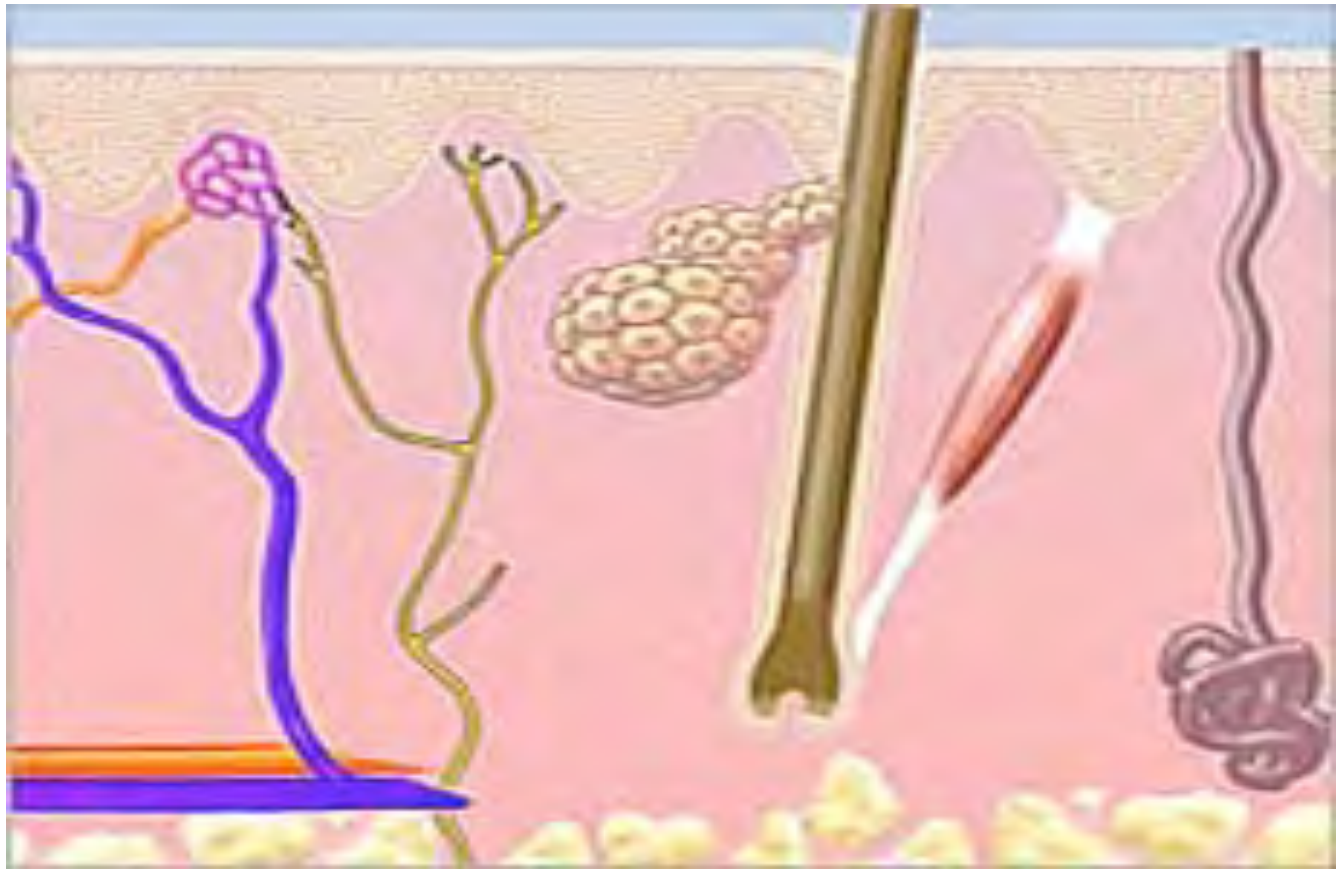
Chemical Protective Clothing

Introduction to
Hazard Assessment, Barrier Materials,
Standards, Selection and Use of CPC

It´s about awareness!

Large surface area on skin provides a significant route of chemical entry



EU Classification and Labeling

Harmful (Xn)
Irritating (Xi)

Toxic (T)
Very Toxic (T+)

Corrosive (C)
Highly Corrosive (Cx)

Sensitization

Cancer
Genetic

Burns

EU Risk and Safety Phrases

R27 Very toxic in contact with skin

R24 Toxic in contact with skin

R45 May cause cancer

R46 May cause heritable genetic damage

R47 May cause birth defects

R43 May cause sensitization by skin contact

R21 Harmful in contact with skin

R38 Irritating to skin

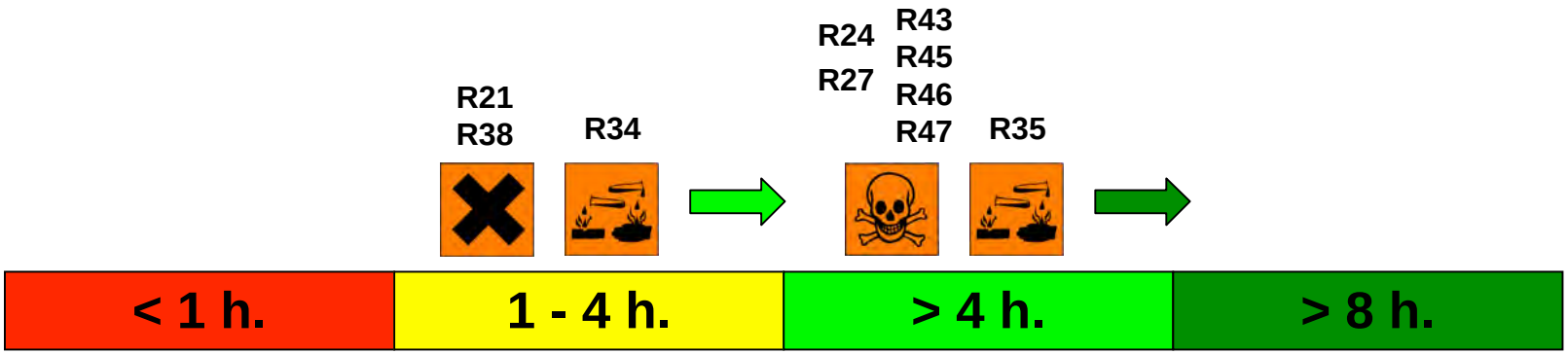
R34 Causes burns

R35 Causes severe burns

S24 Avoid contact with skin

S37 Wear suitable gloves

4 permeation levels balanced with chemical hazards and actual use conditions



B.T.	P.L.	A.U.T.	Hazards	Safety Factor
< 1 h.	1	1 h.	Moderate harmful	1
> 1 h.	2	1 h.	Harmful/Irritant/R34/R21/R38	2
> 4 h.	3	1 h.	Toxic/Highly Toxic/R35-47	4
> 8 h.	4	2 h.	Toxic/Highly Toxic/R35-47	4

B.T. = Breakthrough Time
P.L. = Permeation Level
A.U.T. = Longest Actual Use Time

Analysis of Risk

- Risk = Frequency x Severity
- Must determine acceptable risk from skin absorption and skin effect from burns, sensitization, and other chemical hazards
- Elevated temperature, flexing, pressure and product variation between manufacturers will reduce the chemical resistance significantly
- Determine physical damage
- Must document high risk situations

New EU rules for Safety Sheets

”The breakthrough time for recommended glove material is stated,

with regard to

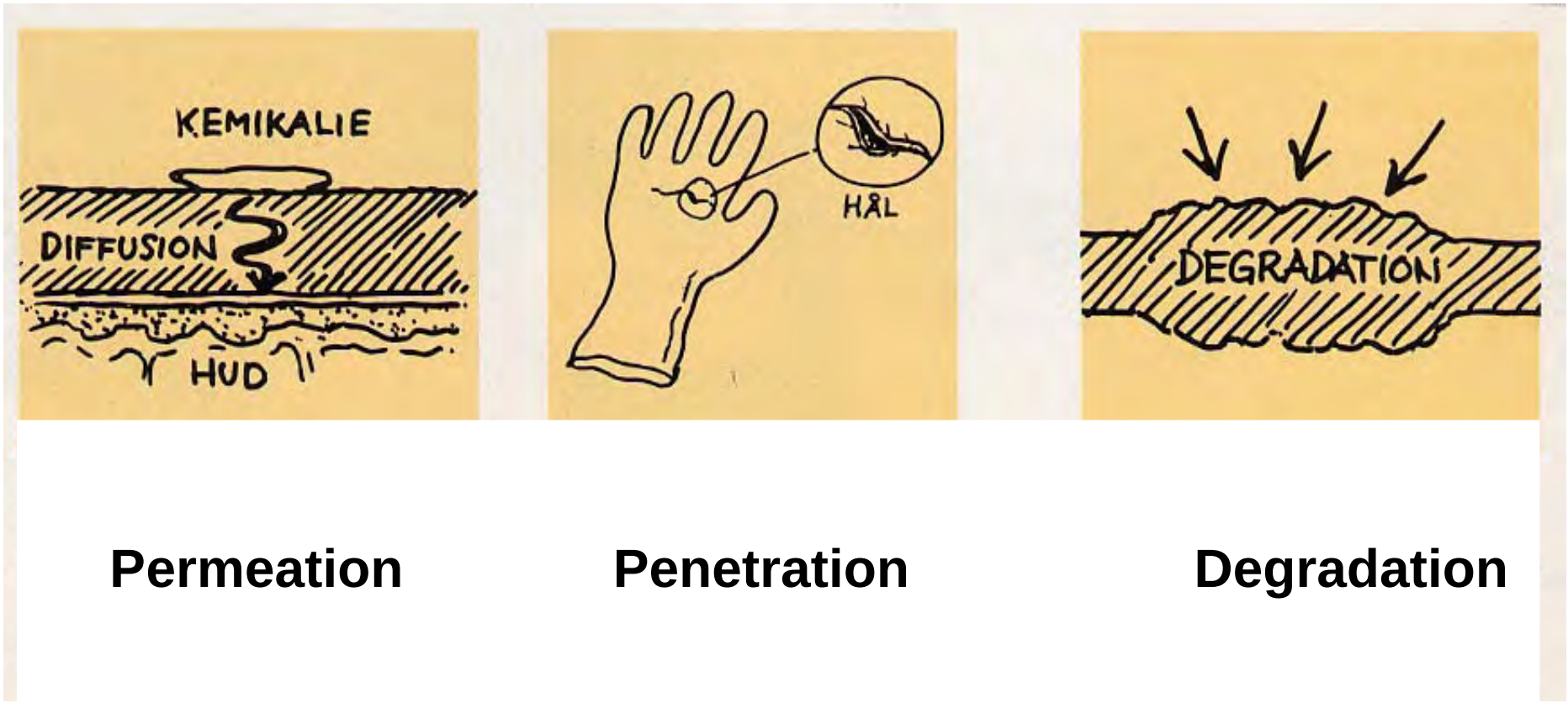
the amount of dermal exposure”

Requirements

- Chemical resistance
- Minimum of heat stress
- Physical and mechanical resistance properties
- Fit
- Resistance to heat and cold
- Etc.

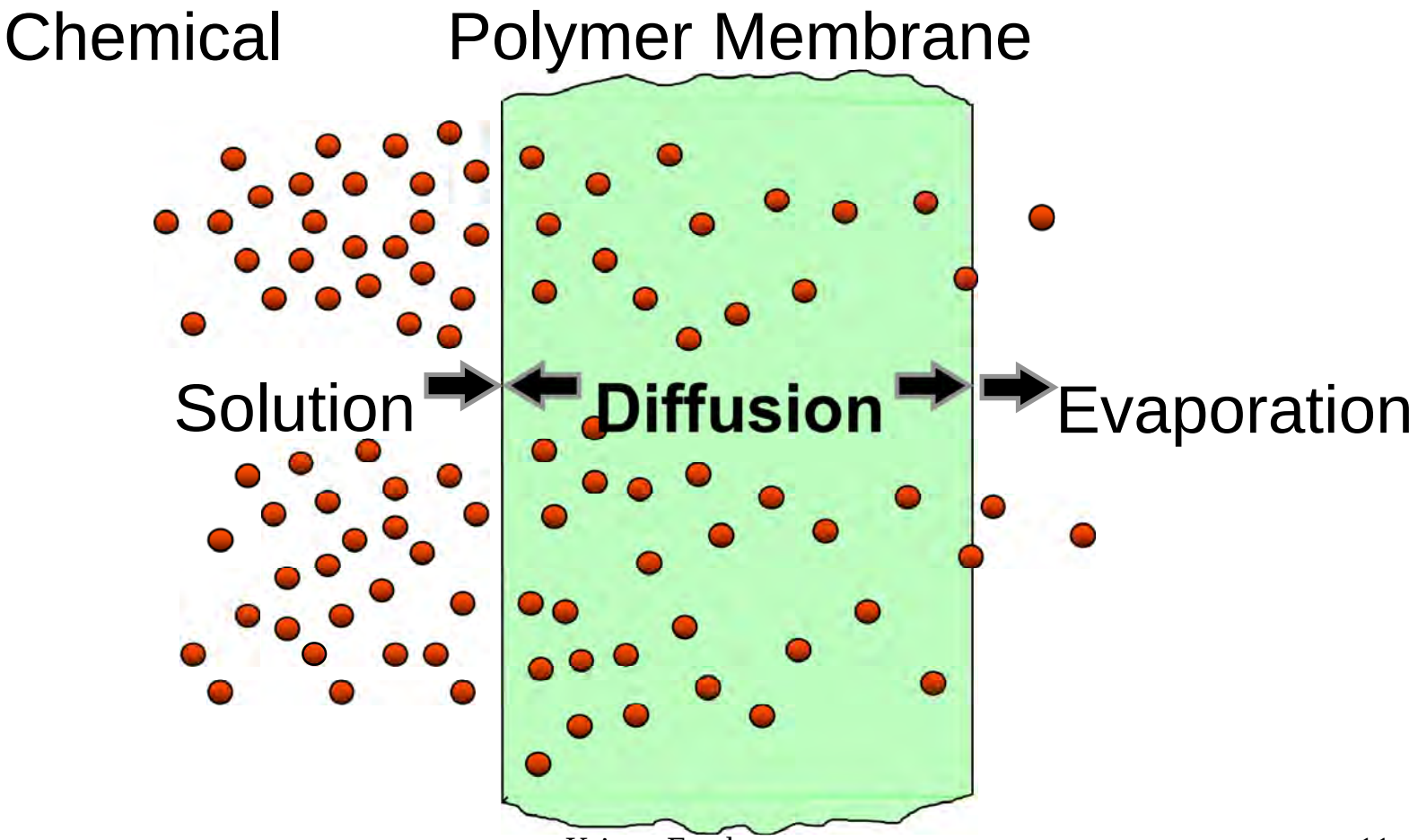
- Chemical resistance
- Minimum of allergy reaction
- Physical and mechanical resistance properties
- Fit, dexterity and tactility
- Resistance to heat and cold
- Etc.

Definitions of Chemical Resistance



Permeation **Penetration** **Degradation**

Permeation Process



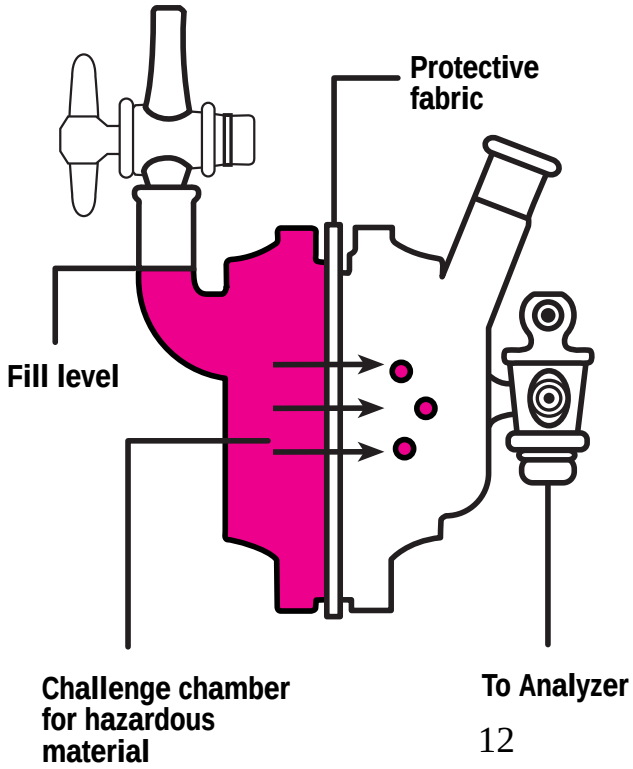
ASTM Permeation Test Method

F739-99a Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact

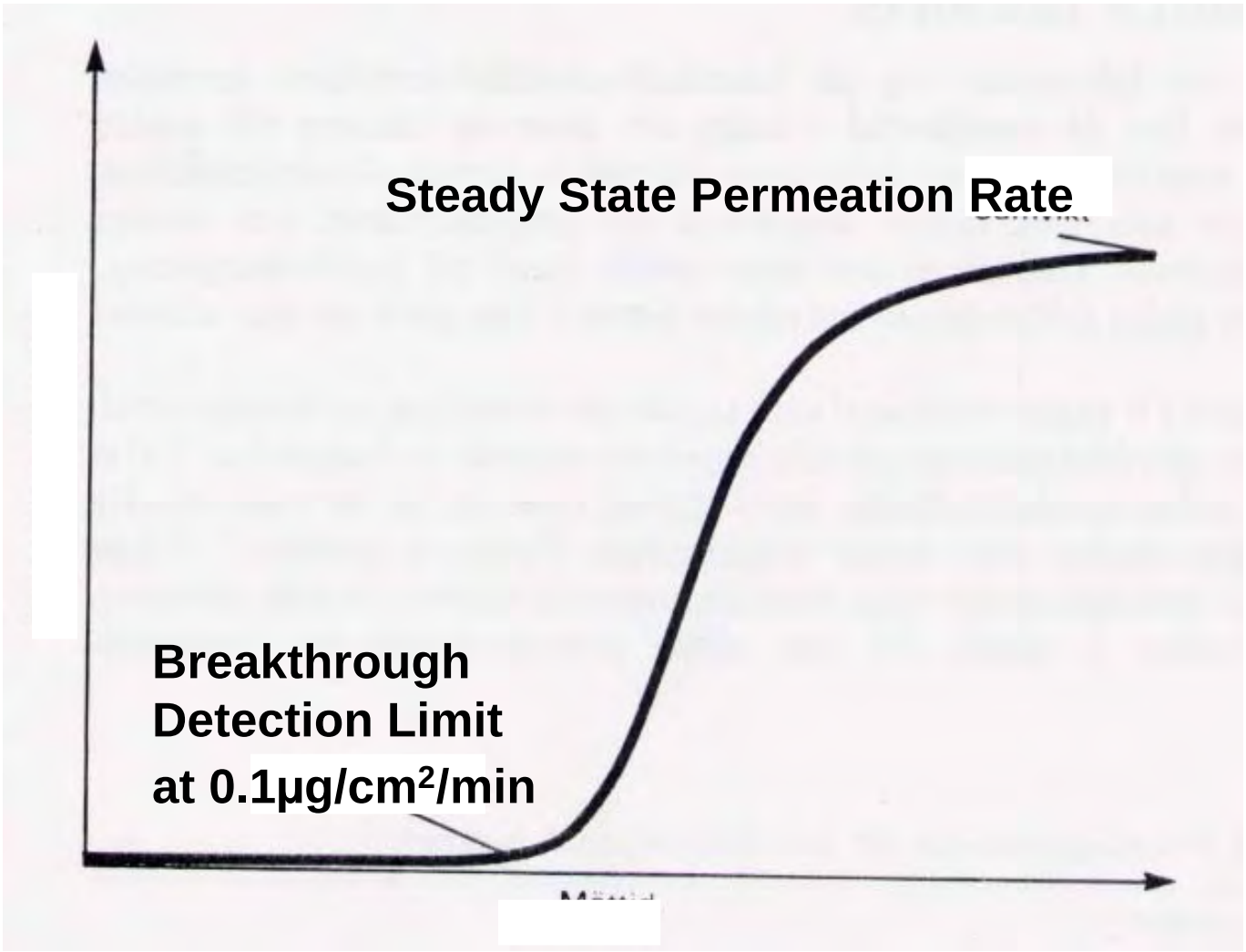
Results expressed as two numbers

1. **Breakthrough time**
2. **Steady-state permeation rate**

Permeation Test Cell (Introduced by ASTM 1981)



Reporting of permeation resistance in accordance to ASTM F739



EN 374-3

Permeation resistance to chemicals tested according to method EN 374-3
Each combination of **glove/chemical** is classified according to the time the glove resists permeation of the chemical.

Breakthrough time *1)* **performance level**

> 10 min	class 1
> 30 min	class 2
> 60 min	class 3
> 120 min	class 4
> 240 min	class 5
> 480 min	class 6

1) The breakthrough time is defined as the time when the detection level reaches 1 μ g/min.cm².

ISO 6529

Determination of resistance of protective clothing materials to permeation by liquids and gases

Same reporting requirements as stated in ASTM F739

Minimum detection limit
1 μ g/min.cm²

Degradation Tests

- Immersion 30, 60 and 240 minutes
- Measure weight change in percent
- Look for obvious physical changes

Sources for Selection of CPC

Target Groups of the Field Guide are:

Spill responders
Safety engineers and Industrial hygienists
Chemists and Chemical engineers
Purchase agents and Sales people
Line managers and Supervisors
Workers in all industries

How to Use The Quick Selection Guide

A three-step process in this guide completes the selection of the barriers offering the best chemical resistance.
First, the chemical name or synonym is found in the alphabetically sorted CHEMICAL INDEX.
The second step is to use the Chemical Class number to search the SELECTION RECOMMENDATIONS.
The final step is to find the chemical within the class listing and note the color-coded recommendations by barrier material.

Chemical Index
including 800 chemicals

Class#	Chemical Names (and Synonyms)	CAS #	Risk Code	Spec. Notes
121	Acetaldehyde (Ethanal)	75-07-0	X	
102	Acetic acid	64-19-7	Cx	Caution
161	Acetic anhydride (Acetyl oxide)	108-24-7	C	Caution
	(Acetomethoxane) see Dimethoxane			
391	Acetone (2-Propanone)	67-64-1	V	
431	Acetone cyanohydrin	75-86-5	Tx	Skin
431	Acetonitrile (Methyl cyanide)	75-05-8	T Cancer	
…….				

Factors to Consider!

- Permeation takes place without visible evidence
- Even the best CPC will not perform properly if torn, cut, damaged, degraded or contaminated
- A barrier may protect against one chemical properly, but perform poorly against another or a mixture of chemicals
- Higher temperature usually decreases the breakthrough time, whereas lower temperature increases the time
- Degradation may be the most important factor in chemical resistance for many chemicals (acids, etc.)
- Generally, thicker barrier material increases the time to break through, but reduces glove tactility and dexterity
- Once a chemical has been absorbed by the barrier material, it continues to permeate through the material

Pre-use

- Read user's instruction
- Awareness of risks
- Chemical resistance required
- Physical resistance required
- Usability required

Perform visual Inspections of CPC integrity by:

- ✓ Pre-use and Post-use Inspection of gloves and suites by the Users
- ✓ Check: Maintenance and Repairs of suits following manufacturers recommendations are performed properly
- ✓ Periodical Inspections of suites
- ✓ Check: Proper Storage of suites

Disposal and re-use

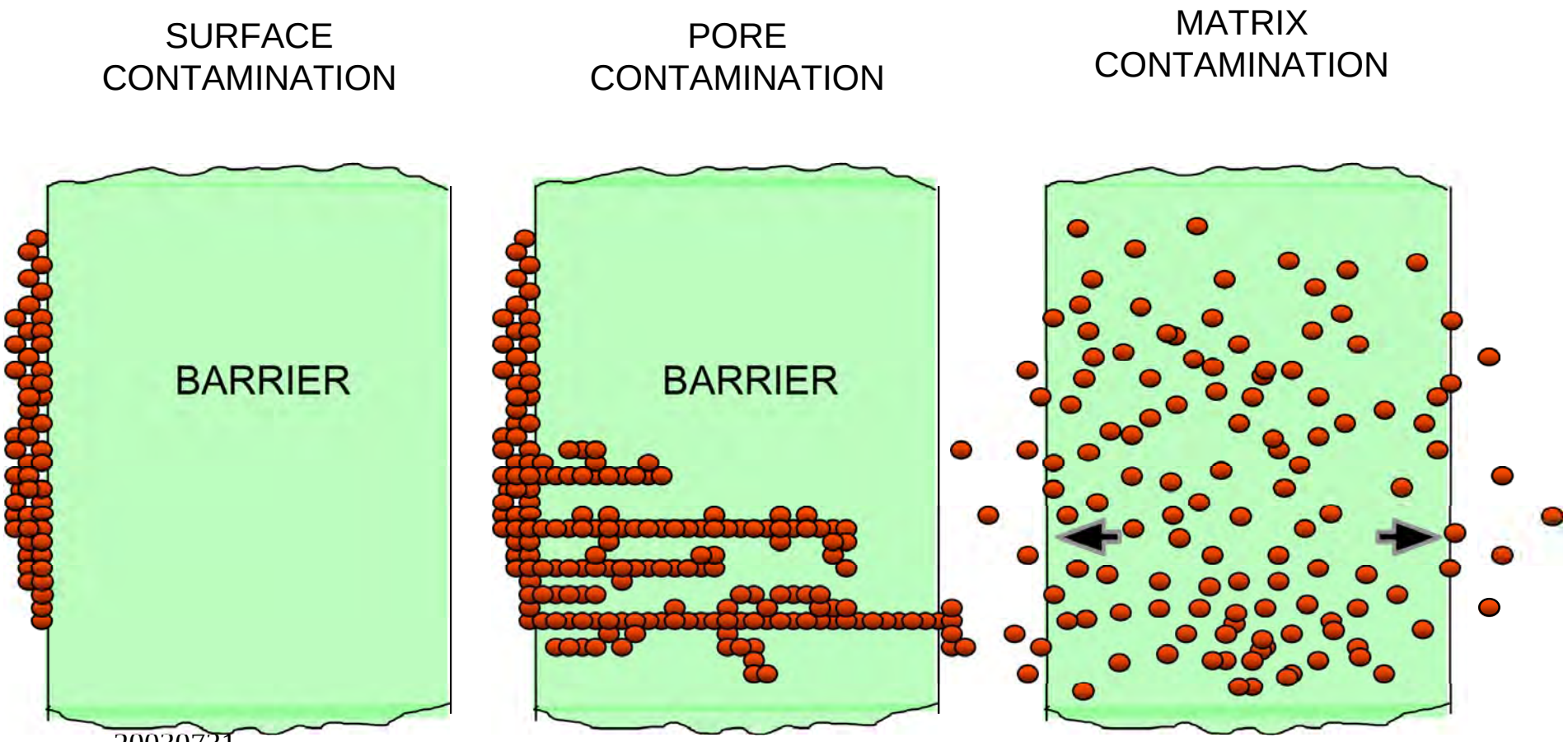
Dispose of gloves in designated containers

Note: PVC > > Environmental issue

On re-use of ”expensive” gloves and suites:

Used item are contaminated and need to be ”ventilated” in a heated storage and ”cleaned”, i.e. decontaminated before re-usage

Contamination types



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Skin Care

Wash hands after work

Add cream to the skin after hand washing

Barrier Materials

Butyl Rubber, IIR: Copolymer of 97-95% isoprene and 0,5-3% butylene. High price of gloves due to polymer and production method (solvent dipping). Used in gloves and suits.

Natural Rubber, NR: Rubber derived naturally from trees. Highly elastic. Used in gloves and boots.

Neoprene, CR: Polymer of chloroprene. Highly elastic with good physical properties. Also called Chloroprene. Used in gloves, boots and suites. Trade name of DuPont Company.

Nitrile, NBR: Copolymer of 35-45% acrylonitrile and 65-55% butadiene. Relatively good resistance to cut, puncture and abrasion. Used in gloves and boots.

Polyethylene, PE: Ethylene plastic used as a thin film in gloves and coveralls. The polyethylene film is also used in laminates with other plastic films. See PE/EVAL/PE or PE/PA/PE.

Polyvinyl alcohol, PVAL: Vinyl alcohol plastic (soluble in water) dipped on textile glove. PVA is Ansell's trade mark.

Polyvinyl chloride, PVC: Vinyl chloride plastic with relatively high degree of plasticizers. Used in gloves, boots and suits.

Fluoroelastomer, FKM or **Viton®**: Copolymer of ca 70% vinylidene fluoride and ca. 30% hexafluoropropyolene. High price of polymer and glove due to production method (solvent dipping). Trade name of DuPont Dow Elastomers. Viton is also used in suits.

PE/PA/PE: Laminates of plastic films of polyethylene and polyamide welded together. **Barrier** is Ansell's product name for the laminate glove. The glove has a support liner of Tyvek® .

PE/EVAL/PE: Laminates of plastic films of polyethylene and ethene-vinyl alcohol welded together. **Silvershield-4H®** is North's trade mark. The aprons, gloves, booties and sleeves are unsupported. EVAL was earlier called EVOH.

Barrier materials used in suits

Responder®, Tychem® and **Tyvek®** are registered trade marks owned by E. I. du Pont de Nemours and Company.

Tychem® BR/LV, F, SL, TK, QC and

Tychem® CPF 1, CPF 2, CPF 3, CPF 4 & Responder are product names of E. I. du Pont de Nemours and Company.

SL = Saran coated Tyvek®

QC = Poyethylene coated Tyvek®

Trellchem® registered trade mark owned by Trelleborg AB.

Trellchem® Super, HPS, VPS, TLU are product names of Trelleborg AB.

Known materials used in the suits are:

Butyl, Chloroprene and Viton®.

The Trellchem® HPS, VPS and TLU meet the requirements of the US standard NFPA 1991, including the test criteria for flammability and abrasion resistance (HPS and VPS does not need any extra protection layer to meet the requirements).

Respirex Ltd. uses Bromobutyl, Hypalon/Neoprene/Butyl, Neoprene, Poyurethane, PVC, Viton®/Butyl, Viton/Butyl/Viton® and du Pont's barrier materials in manufacturing suits.

ILC Dover Inc. uses CPE (Chlorinated Polyethylene) as barrier material in manufacturing suits.

NOTE: Users may have problem to understand the differences among reusable, disposable and limited use garments.

Many suit materials have good barrier properties, but are only intended for disposable use.

Eye and Face Protection

- Chemical Goggles
- Face Shield
- TECP Suit Lens
- Full-face Respirator
- Safety Glasses

Face shield materials

Diethylene glycol-bis-allylcarbonate (CR-39)

Polycarbonate

Glass

FEP