Assessing and Controlling Risks from Dermal Exposures

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Dermal Exposure and Risk: Why Do We Care?

- In 2010, **34,400** recordable skin diseases were reported by BLS, compared to only 19,300 respiratory illnesses

- According to NIOSH, "Standardized methods are currently lacking for measuring and assessing skin exposures"

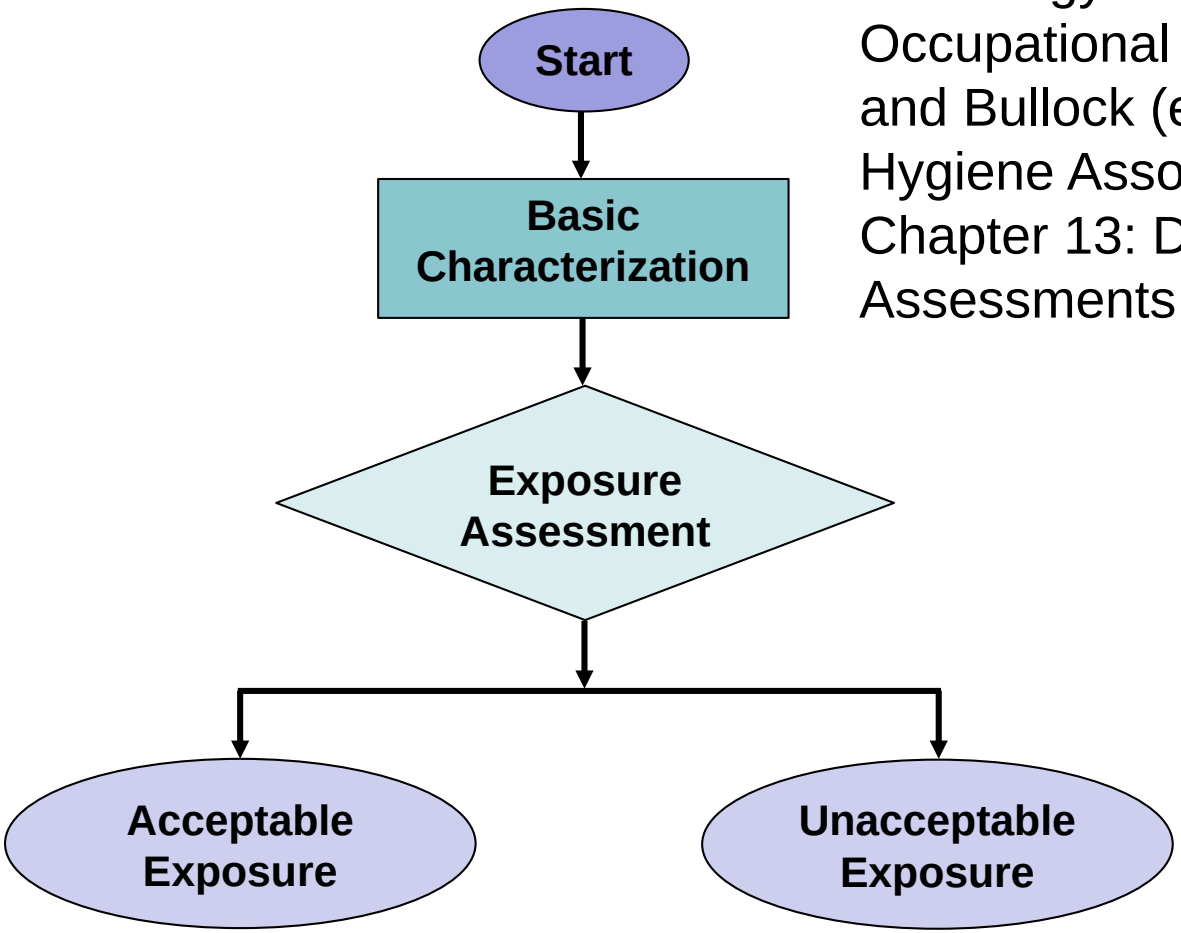
- Dermal exposure needs are noted in a number of the NIOSH NORA goals, including for:
  - Agriculture, Forestry and Fishing Sector
  - Construction
  - Healthcare and Social Assistance
  - Manufacturing
  - Oil and Gas Extraction
  - Immune, Infectious, and Dermal Crossover Sector

National Institute for Occupational Safety and Health
NIOSH

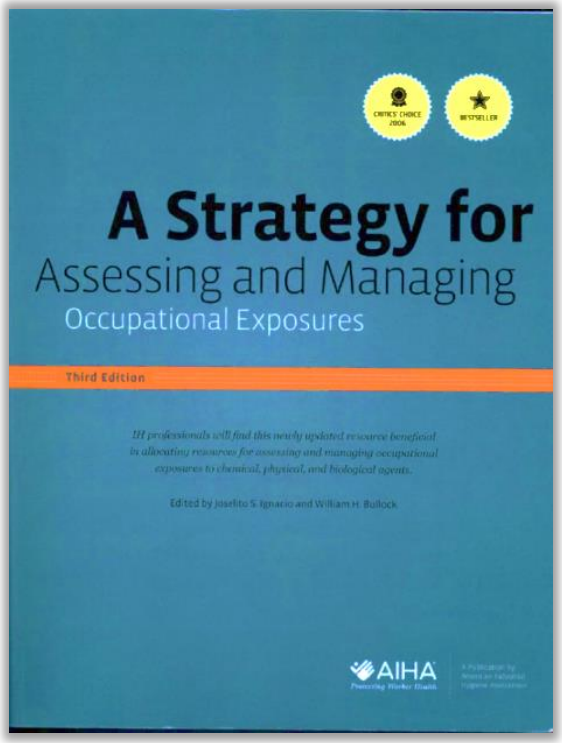
Dermal Risk Management

- What methods do you currently use to make judgments about dermal exposures and risk?
- What are the key criteria that should be used to determine dermal exposure and risk?
- What kinds of factors influence your dermal exposure judgments?
- What are the best controls?

AIHA's Exposure Assessment Strategy

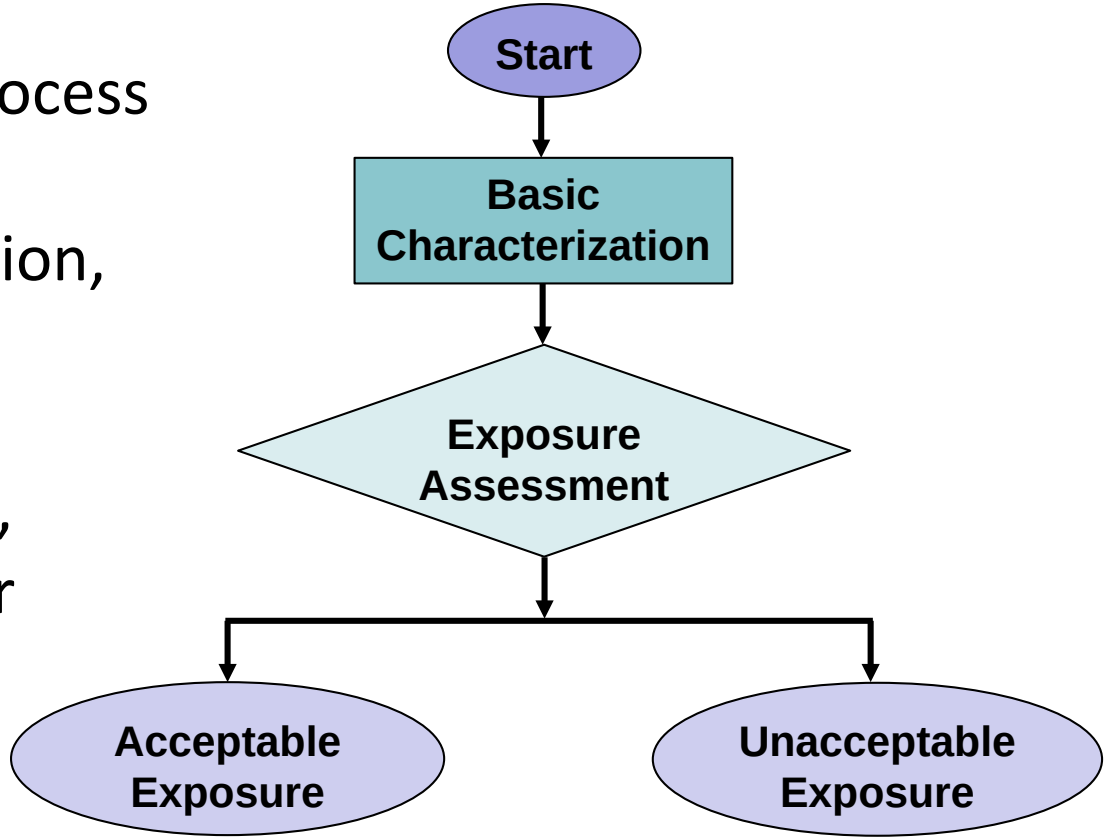


A Strategy for Assessing and Managing Occupational Exposures, 4th ed. Ignacio and Bullock (eds). American Industrial Hygiene Association, Fairfax, VA. 2015. Chapter 13: Dermal Exposure Assessments.



The EAS Strategy: Dermal Exposures

- The EAS process is a systematic, cyclical process for anticipation, identification, evaluation, and control
- For dermal exposures, cycle is incomplete for many agents

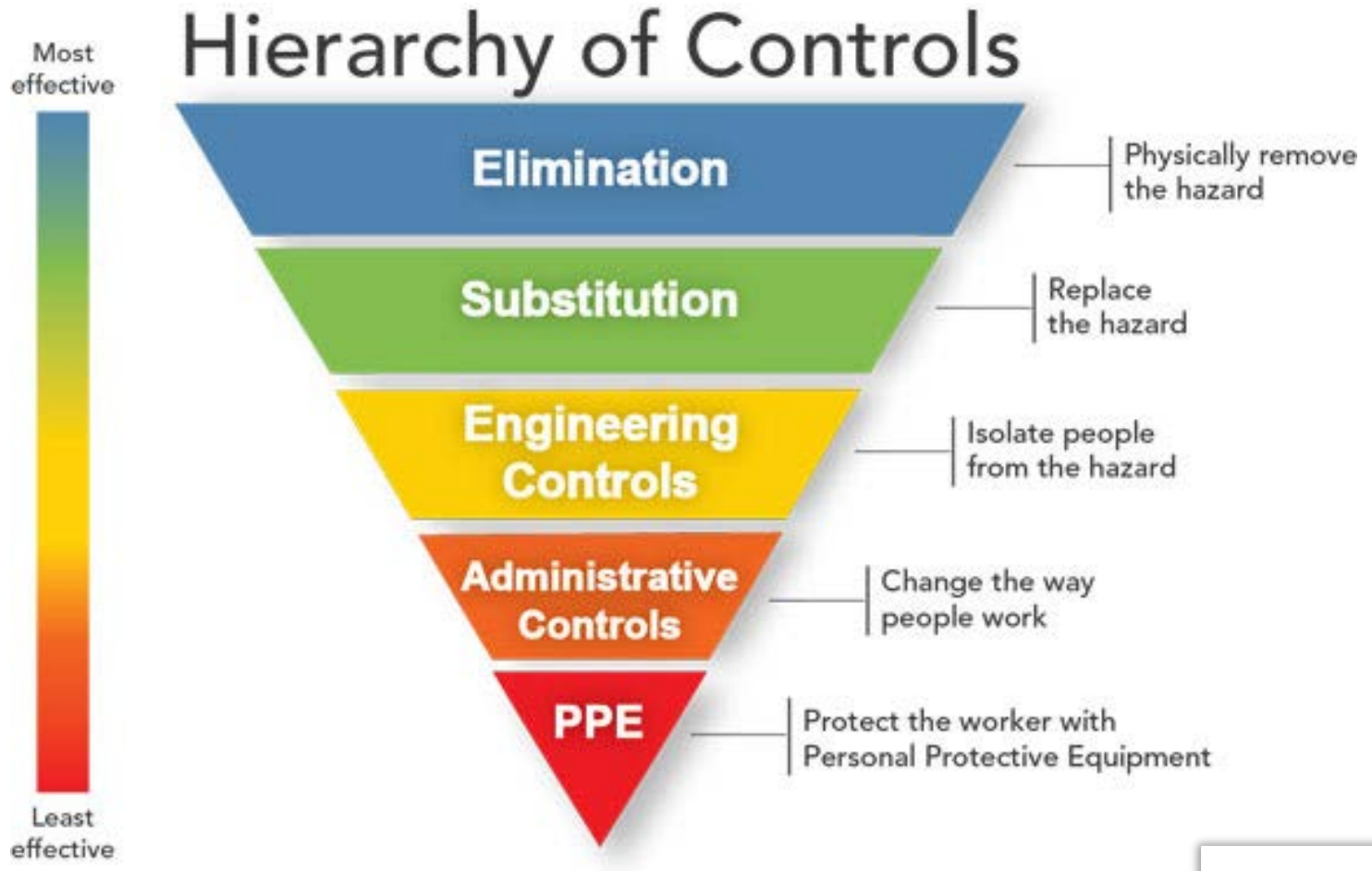


The EAS Strategy: Dermal Exposures

- Dermal exposures should be evaluated in the same manner as inhalation exposures:

1. Basic characterization – systematic approach
2. Definition of Similar Exposure Groups (SEGs) using dermal exposure factors
3. Determination of criteria for judging acceptability of dermal exposures (acceptable, unacceptable, uncertain)
4. Methods for collecting data to evaluate uncertain exposures

Dermal Exposures: The SAME Hierarchy of Controls



National Institute for Occupational Safety and Health
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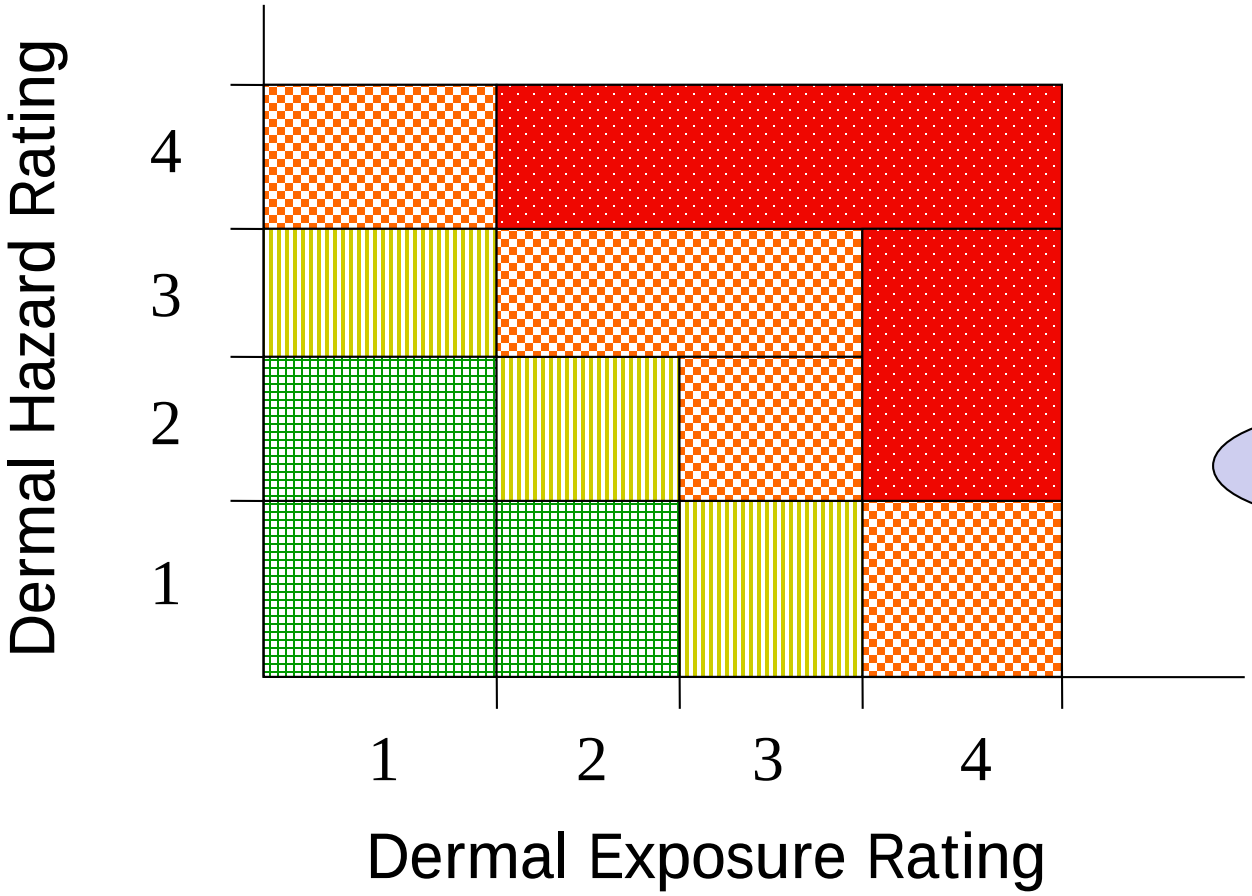
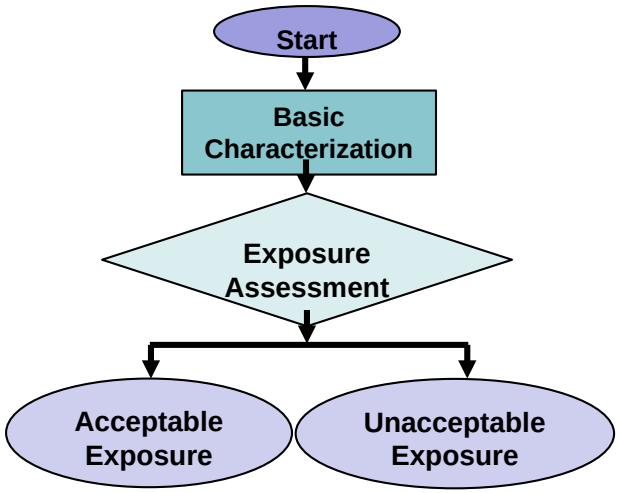
Some Common Dermal Exposure Assessment Models

- EPA 1992: dermal uptake based on simple molecule properties (Potts and Guy; revised Robinson)
- RISKOFDERM 2002: dermal contact and uptake based on description of workplace using default descriptors
- DREAM 2003: semi-quantitative model based on dermal contact and uptake characteristics
- EPA models by office: various approaches to dermal exposure, mainly to soil and water
- AIHA models: qualitative model and simple additive quantitative loading model
- Dermal DNELs: worst case surface area and uptake model

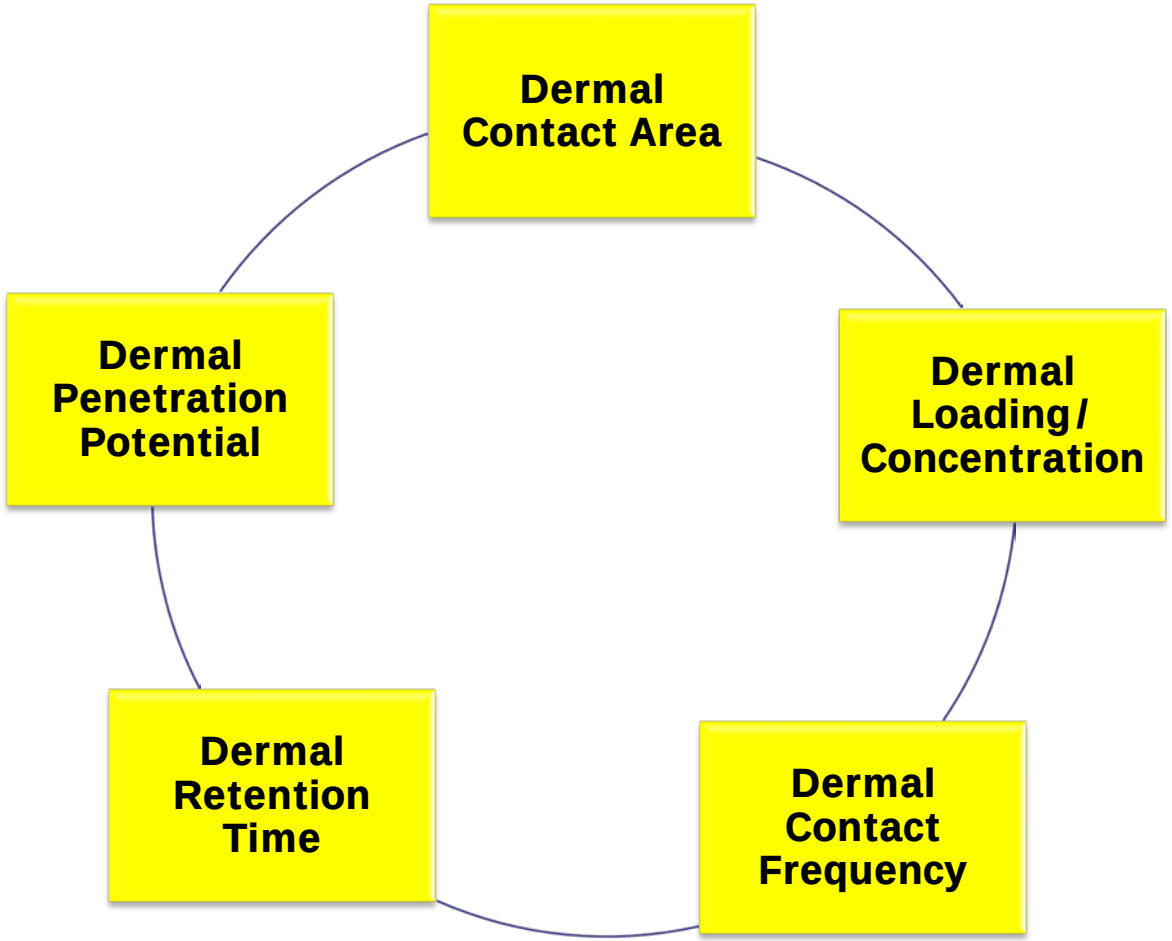
Qualitative Dermal Exposure Assessment





Dermal Exposure Assessment Heuristics

Use a ***Heuristics*** approach to characterize the following five dermal exposure determinants:



AIHA: Qualitative Dermal Judgment Tool

Dermal Exposure Assessment Summary Form

Dermal Hazard Rating
○1 ○2 ○3 ◉4

Category **4**

Dermal Contact Area

Contact possible to hands and forearms

*Exposure Rating = CA * C * CF * RT * PP* **24**

Dermal Concentration

Low concentration of agent likely to contact or load onto the skin

Dermal Contact Frequency

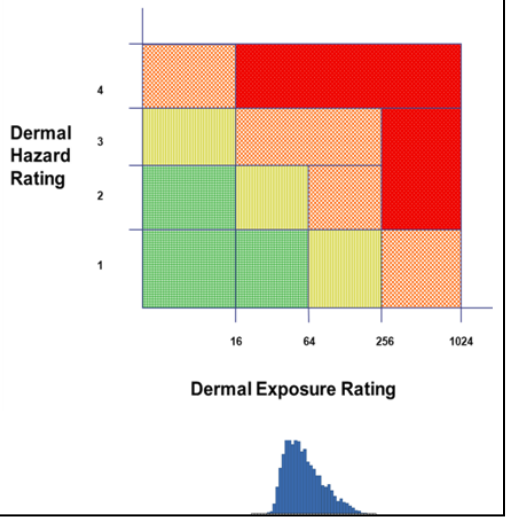
Up to 10 incidental contacts with skin; contact during less than 10% of work shift

Dermal Retention Time

Amount transferred may remain on skin for some time (i.e., some volatility or adherence to skin)

Dermal penetration Potential

Rare (large, insoluble particles)



Dermal Exposure Assessment Summary Form

Dermal Hazard Rating

100%	
50%	Reversible or very low skin or systemic toxicity
35%	Moderate but reversible skin or systemic toxicity
15%	Irreversible/chronic skin or systemic toxicity or sensitization
0%	Life threatening skin or systemic toxicity or sensitization

Dermal Contact Area

100%	
15%	Unexpected/unlikely
45%	Very small area of skin contact
40%	Contact possible to hands and forearms
0%	Contact possible to significant area of skin

Dermal Concentration or Loading

100%	
15%	Negligible concentration of agent likely to contact or load onto the skin
70%	Low concentration of agent likely to contact or load onto the skin
10%	Moderate concentration of agent likely to contact or load onto the skin
5%	High concentration of agent likely to contact or load onto the skin

Dermal Contact Frequency

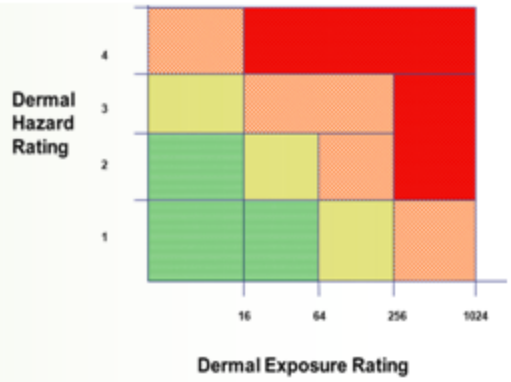
100%	
15%	Minimal contact with skin; one or two incidental contacts; contact during less than 5% of work shift
25%	Up to 10 incidental contacts with skin; contact during less than 10% of work shift
35%	Up to 50 incidental contacts with skin; contact during less than 50% of work shift
25%	Routine incidental contact with skin throughout shift; contact during 50-100% of work shift

Dermal Retention Time

100%	
10%	Amount transferred unlikely to remain on skin for any period of time (i.e., high volatility, dry and powdery)
20%	Amount transferred may remain on skin for some time (i.e., some volatility or adherence to skin)
45%	Amount transferred is likely to remain on skin for a significant period of time (i.e., low volatility, high MW, sticky or consolidated on skin even if not visible)
25%	Amount transferred very likely to remain on skin (i.e., substance not volatile, MW > 100, substance very likely to stick to skin)

Dermal Penetration Potential

100%	
10%	Rare (large, insoluble particles)
40%	Less likely (small insoluble particle > 1 micron in size, or both poor lipid solubility and poor water solubility)
35%	Possible or slow (very small insoluble particles < 1 micron, or some lipid solubility and some water solubility, or marginal skin health)
15%	Probable or likely (good lipid solubility and good water solubility, or poor skin health)



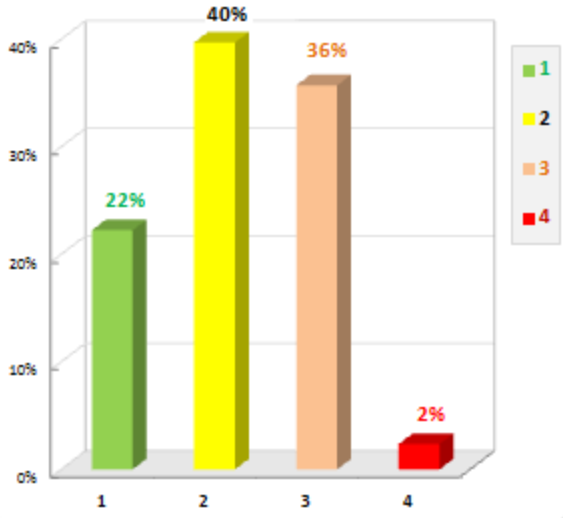
Monte Carlo simulation

Start

iterations 4096

0 min 5 sec

Dermal assessment category probabilities



This file was done by Jennifer Sahmel, Susan F. Arnold and Daniel Drolet

Quantitative Exposure Judgment

Category	OEL vs. Dermal Estimate (X)
1	X < 10% of OEL
2	10% of OEL < X < 50% of OEL
3	50% of OEL < X < OEL
4	OEL < X

AIHA's EASC Model for Dermal Exposure

$$D = (S)(Q)(WF)(FQ)(ABS)$$

D = potential dose (mg/day)
S = surface area of contact (cm^2)
Q = amount retained on the skin (mg/cm^2)
WF = C = concentration of chemical (percent by weight)
FQ = number of contact events per day (**additive**)
ABS = absorption (default 100% absorption into skin; or empirically derived data may be appropriate)

Ignacio and Bullock, eds. A Strategy for Assessing and Managing Occupational Exposures, 3rd ed. Fairfax, VA: AIHA Press, 2006. Appendix II: Dermal Exposure Assessments.

AIHA Dermal Default Model Parameters

1. Frequency of contact (FQ) can be readily counted or estimated through observation
2. Weight fraction (WF) of the chemical may be listed on the MSDS or can be estimated
3. Surface area (S) can be estimated using the EPA's Exposure Factors Handbook (EFH)
4. Amount retained/loading (Q) can be measured through dermal sampling
5. Absorption (ABS) can be estimated using a tool called IH SkinPerm

Dermal OEL Equivalent: Calculation

- In some cases, an existing airborne OEL can be used to evaluate semi-quantitative data for dermal exposures

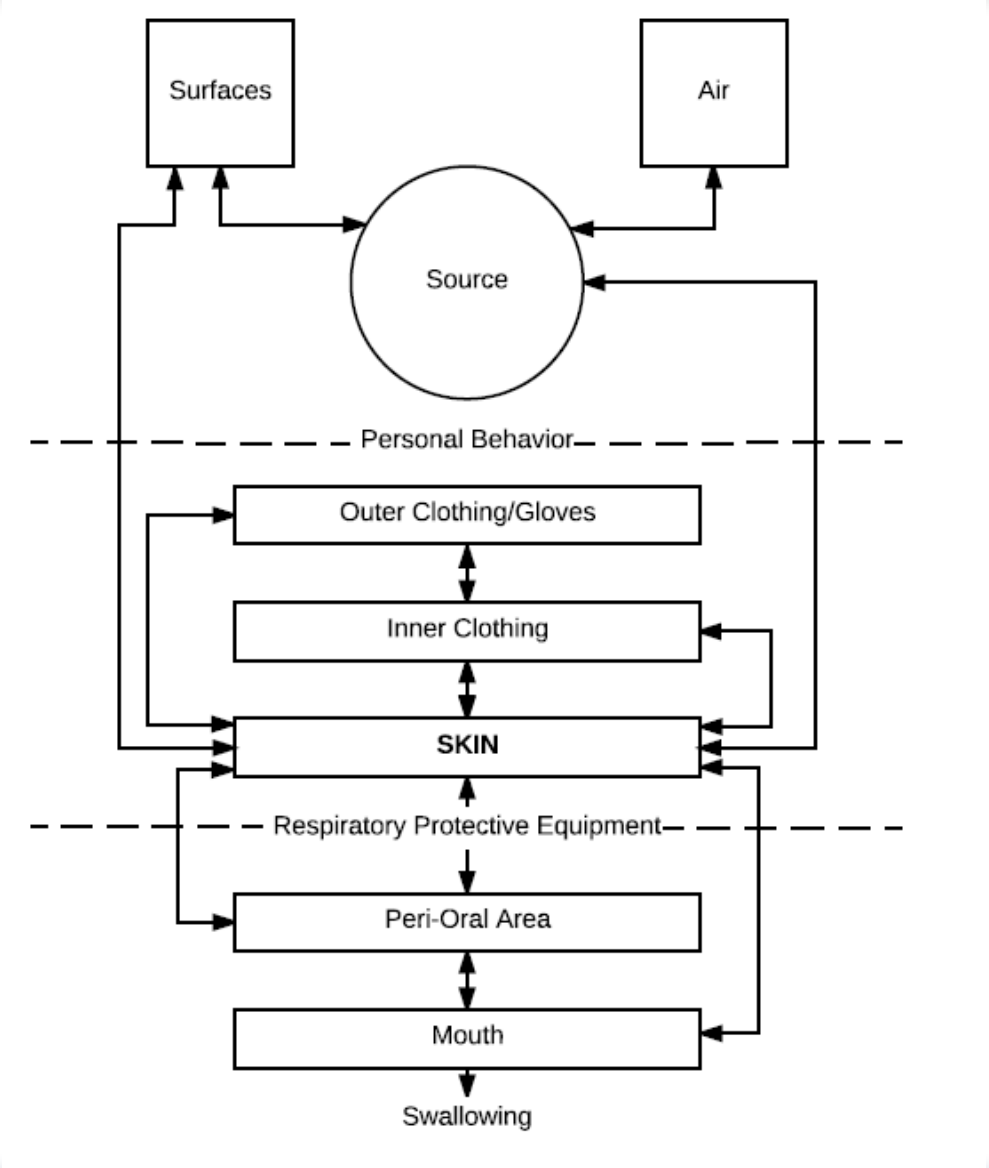
- Inhalation rates: 11-19 m^3 air inhaled/day (moderate activity – U.S. EPA Exposure Factors Handbook); 10 m3/day is a conservative value

OEL (mg/m^3) x 10 m^3 air inhaled/day = mg/day

Conceptual Model for Dermal Exposure Assessment

Schneider et al.1999 (updated by Gorman Ng et al. in 2012)

conceptual model for dermal exposure assessment



Schneider: Pathways for Dermal Transfer

1. Object-to-skin
2. Skin-to-skin
3. Skin-to-clothing
4. Skin-to-surface
5. Skin-to-gloves
6. Skin-to-saliva

Schneider et al. (1999): Some Key Conclusions

- "With the model structure, limited or non-existing methods for measuring relevant compartment mass or transport processes have been identified."

- "A clear distinction must be made between mass in a compartment and transport of mass. Direct measurement of mass transport must be based on an appropriate theoretical model."

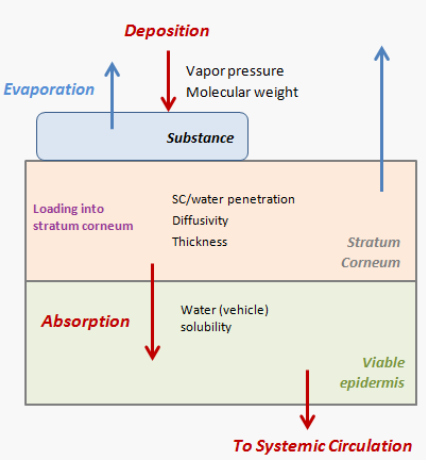
Qualitative vs. Quantitative Dermal Models

- Qualitative and semi-quantitative models currently use rating schemes or exposure/transfer indices to characterize exposure
- Qualitative: 1-4
- Semi-quantitative: 0 - >1000

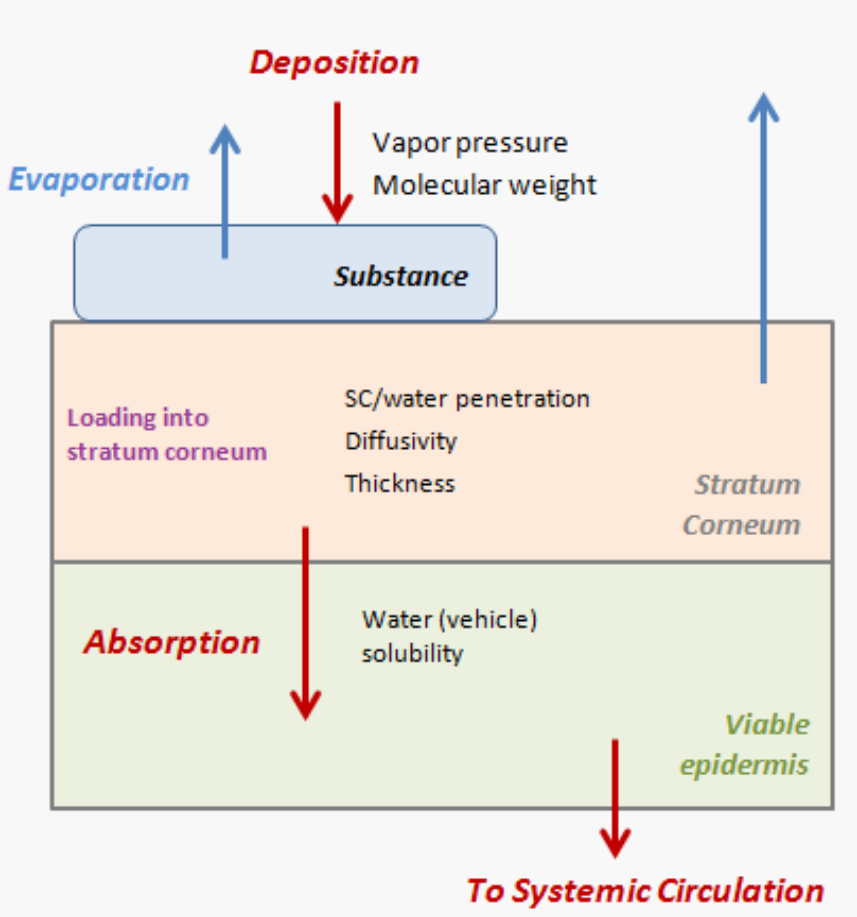
- Quantitative estimates of dermal exposure:
- Loading on the skin:
  $\mu g/cm^2$
- Absorption or uptake into the skin:
  $\mu g/cm^2$-hr

More Advanced Models Exist to Estimate Skin Absorption and Penetration

- Penetration of chemicals through the skin is complex, so models are extremely helpful to assist us in getting an estimate of the mass which may be systemically available
- IH SkinPerm is available to help run these models
- It is important to understand the principles and limitations behind the models



AIHA's IH SkinPerm: Tools to Estimate Skin Absorption and Penetration



Dermal Judgments Workshop: Key Findings

- Results indicated that model-predicted judgment category output improved most significantly following **training and use of dermal loading measurement data**

- Addition of dermal uptake training and modeling tool did not decrease accuracy in the model-predicted judgment category

- With scenario and agent-specific quantitative dermal loading data, a majority of participants were able to select the correct exposure category

Risk Management and Design of Controls

Chris Packham and Enviroderm (UK): "Eliminate the Obvious"

- No Contact = No Problem
- Shield to control splashes, splatters
- Limit use of sprays
- Use containment
- Don't put their hands in it
- Don't expose skin to contaminants

Examples: Design of Dermal Controls

- Use of a toilet plunger cap to prevent dripping from above

Dermal Controls

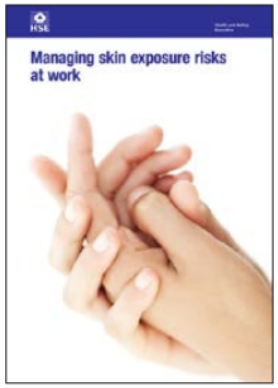
- Think Beyond Personal Protective Equipment!
- Isolation
- Substitution
- Housekeeping

HSE Dermal Exposure Prevention

HSE

Health and Safety Executive

Managing skin exposure risks at work



HSG262 (Second edition)
Published 2015

Many materials used at work can affect the skin or can pass through the skin and cause diseases elsewhere in the body. If you are an employer, health and safety adviser, trainer or safety representative, this book provides practical advice to help you prevent these disabling diseases. It covers the protective role of the skin, ill health arising from skin exposure, recognising potential skin exposure in your workplace, and managing skin exposure to prevent disease.

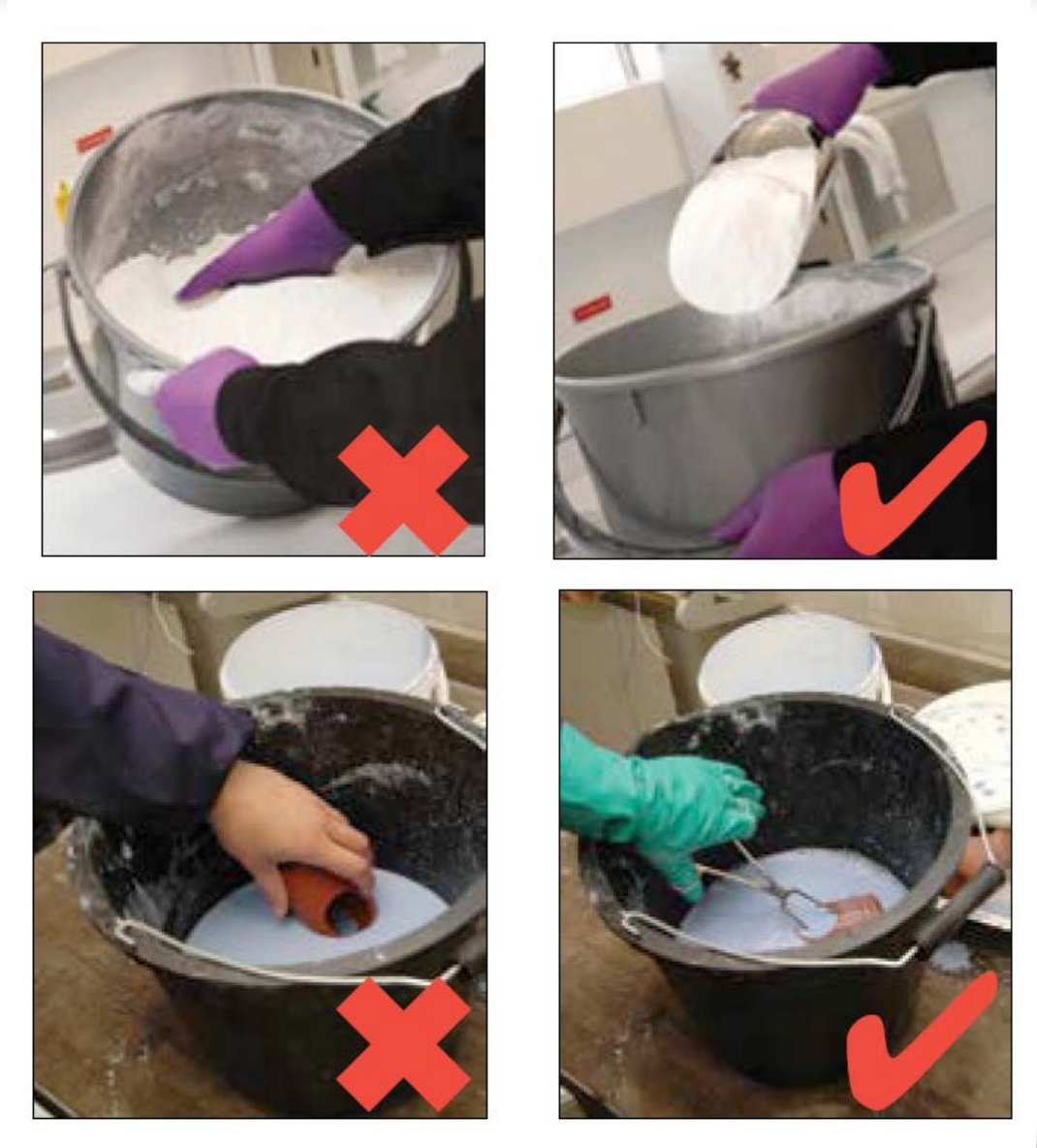
Many employers don't realise they have legal duties to assess the health risks from skin exposure to hazardous substances at work. This book can help you comply with those duties by preventing or controlling exposure to the hazards by using and maintaining suitable controls.

There is advice on assessing and managing risks, reducing contact with harmful materials, choosing the right protective equipment and skincare products, and checking for early signs of skin disease.

The document also contains a series of case studies drawn from a wide range of industries.

The guidance in this edition has been refreshed and references updated.

HSE: Dermal Hazard Controls



HSE: Dermal Hazard Controls

Figure 6 A floor coating being applied by a worker who is kneeling down and using a short-handled spreader

Figure 7 With the help of a long-handled spreader, an adequate safe working distance has been applied, reducing the likelihood of contact with the coating. It reduces the potential for back problems too

Combinations of Controls

- PPE will often be required to supplement engineering controls
- Training and Education
- PPE must be appropriate
- Not just any glove will do
- Biological monitoring

Questions?

- Thank You!
- Jennifer.Sahmel@Insightrisk.com