

Occupational Hygiene

Occupational Hygiene - Dermal Exposure

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What is meant by dermal exposure?

Dermal refers to the skin. Our skin shields our body and internal organs. Some chemicals can affect our skin directly, while others are able to enter the body by being absorbed through the skin. Once in the body, the chemicals can enter the bloodstream and may cause occupational illnesses by injuring our internal organs and body systems. Skin absorption is one of the four major ways [chemicals can enter the body](#).

What are some possible health effects of dermal exposure?

The health effects will depend on the characteristics of the chemical product or substance, the worker's skin condition, and environmental factors. The general health effects that have been observed are categorized as:

- localized damage (such as irritant, contact dermatitis, and corrosion or skin burns)
- immune system responses (such as allergic contact dermatitis, and lung issues such as occupational asthma or respiratory sensitivity)
- systemic toxicity (such as effects on the nervous system or liver).

The National Institute for Occupational Safety and Health (NIOSH) states that occupational skin diseases are one of the most common types of workplace diseases. Examples include:

- Rash (contact dermatitis) caused by skin irritation
- Rash caused by skin allergies
- Skin cancers
- Skin infections
- Skin injuries
- Other skin diseases

How does a workplace know if a chemical may enter the body through the skin?

There are several classification systems that will indicate if a chemical has the ability to be a dermal concern. A few are described below:

WHMIS

The Workplace Hazardous Materials Information System (WHMIS) is a comprehensive system for providing health and safety information on hazardous products intended for use, handling, or storage in Canadian workplaces.

Reviewing the WHMIS label and safety data sheet (SDS) for the hazardous product can provide important information about the health hazards of a substance to the skin (e.g., acute toxicity through dermal exposure, skin corrosion or irritation, skin sensitization, and systemic health effects).

Dermal or skin concerns will be reported in “Section 8: Exposure controls / Personal protection” of the SDS. Information on skin absorption should also be mentioned in “Section 2: Hazard identification” (see the hazard statements) and “Section 11: Toxicological information”. For example, if a hazardous product causes skin irritation, the following hazard communication elements are required on the label and in “Section 2 Hazard identification” of the SDS:

- Pictogram (for label) or symbol (for SDS): Exclamation mark
- Signal word: Warning
- Hazard statement: Causes skin irritation.
- Precautionary statements: A combination of all applicable precautionary statements for prevention (e.g., Wear protective gloves.) and response (e.g., IF ON SKIN: Wash with plenty of water...).

Note that WHMIS does not have a single health hazard class that corresponds to dermal concerns. The following WHMIS health hazard classes may indicate that dermal exposure is a concern:

- Acute toxicity (dermal)
- Specific target organ toxicity (STOT) – Single exposure
- Specific target organ toxicity (STOT) – Repeated exposure
- Germ cell mutagenicity
- Carcinogenicity
- Reproductive toxicity

American Conference of Governmental Industrial Hygienists (ACGIH)

The American Conference of Governmental Industrial Hygienists (ACGIH) uses a “skin notation to indicate that the chemical can contribute significantly to the overall exposure through the dermal (cutaneous) route. The dermal route includes mucous membranes, eyes, and contact with vapours, liquids and solids.

Note that the ACGIH skin notation **only** includes chemicals where studies have shown a systemic effect after exposure. Systemic toxicity means that the chemical can affect the entire body or many organs rather than a specific site. Chemicals may also affect only specific tissues or organs while not causing damage to the body as a whole.

In other words, the skin notation from ACGIH is not assigned to chemicals that cause local or direct effects such as skin irritation and skin corrosion when there are no other systemic health effects.

National Institute for Occupational Safety and Health (NIOSH)

National Institute for Occupational Safety and Health (NIOSH) assigns multiple skin notations to distinguish between systemic, direct, and sensitizing effects caused by skin exposure to chemicals. They are used as hazard warnings to alert workers and employers to the health risk of skin exposure. NIOSH has notations for:

- SK:SYS - when absorbed by the skin and cause systemic health effects
 - SYS(FATAL) – a notation that the chemical is highly or extremely toxic and may be life-threatening
- SK:DIR - direct effects on the skin, such as at or near the point of contact (e.g., corrosion, irritation, bleaching, staining, harming the skin)
 - SK:DIR (IRR) – indicates a chemical is a skin irritant
 - SK:DIR (COR) – indicates a chemical is corrosive
- SK:SENS – may cause or contribute to allergic contact dermatitis or other immune responses (including airway reactivity conditions)

- ~~SK~~ – there is scientific data that indicates skin exposure does not produce systemic, direct, or sensitizing effects
- ID^(SK) - there is insufficient data to make a determination
- ND - there is no data on skin absorption and the health hazards are unknown

NIOSH provides [skin notation profile](#) documentation for many chemicals on their website.

Are there specific occupational exposure limits for chemical products that are assigned a “skin notation”?

Specific dermal occupational exposure limits are often not specified by ACGIH, NIOSH, or Canadian jurisdictions. The agencies and jurisdictions use expert scientific judgment to assign a skin notation. This notation is generally based on human experience and toxicity studies.

Be aware that respiratory occupational exposure limits are often for airborne exposure (only) and may not apply to skin exposure. For example, the American Conference of Governmental Industrial Hygienists (ACGIH) states: “Where dermal application studies have shown absorption that could cause systemic effects following exposure, a Skin notation would be considered. The Skin notation also alerts the industrial hygienist that overexposure may occur following dermal contact with liquid or aerosols, even when airborne exposures are at or below the TLV®.”

(Source: 2022 TLVs® and BEIs® - Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati: American Conference of Governmental Industrial Hygienists (ACGIH). p. 77-78)

What occupations or industries may be at risk?

Dermal exposure occurs in various occupations ranging from agriculture, manufacturing to service sectors (e.g., painters, hairdressers, mechanics, etc.). Millions of workers are exposed to organic solvents which are used widely, such as in the manufacturing of surface coating (paints, varnishes, and printing inks), the cleaning sector, the cosmetic and beauty industry, and the construction industry.

Products often associated with dermal exposure include:

- Solvents such as benzene, dichloromethane, carbon tetrachloride, xylene, toluene, white spirit, etc.
- Pesticides such as polychlorinated biphenyls (PCBs), paraquat, malathion, parathion
- Polycyclic aromatic hydrocarbons (PAHs) Acrylamide

Examples of occupations at risk of [irritant contact dermatitis](#) or [allergic contact dermatitis](#) are provided in other OSH Answers documents.

Examples of products that cause dermatitis only when they contact the skin in the presence of ultraviolet light include:

- Protoxins: creosote and asphalt
 - Photoallergic materials: certain perfumes and specific medications
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What factors will determine how much of the product will be absorbed by the skin?

Many factors will influence the amount of a product that will be absorbed by the skin or whether the extent of exposure will be significant during a particular task. They include:

- Exposure factors such as:
 - Type of task
 - Whether or not the skin is protected
 - Concentration of the product
 - How long the product is in contact with the skin (exposure time)
 - Frequency of skin contact
 - Amount of skin exposed to the product (dermal contact area)
 - Hygiene: washing and wearing of contaminated clothing
 - Factors such as physical and chemical properties of the product (e.g., molecular weight, solubility in water or oils, chemical structure, etc.)
 - Skin factors such as skin thickness, skin type and condition, skin metabolism, skin perfusion, occlusion, and anatomical location of exposure. Environmental conditions such as temperature and humidity.
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How can the workplace be monitored?

Monitoring should be done by a health and safety professional, such as an occupational hygienist. Dermal exposure evaluation methods are broadly categorized into direct and indirect methods.

- Direct means assessing what is deposited onto the skin. The most common direct method is the use of dermal dosimeters in the form of either patches or whole-body suits. Other direct evaluation methods include skin washes and wipes and the video detection of fluorescent tracers.
- Indirect means estimating dermal dose either as attributable to some biological indicator that is actually measured or that which could potentially result from a contaminant measured on an accessible surface. Indirect methods refer primarily to measuring a biologic response such as cholinesterase activity in blood or urinary excretion but also include measuring surface contamination

There are number of exposure and risk assessment tools that can be used by competent persons such as industrial hygienists or health and safety specialists. Some of these are*:

- American Industrial Hygiene Association (AIHA)'s [IHSkinPermTM](#)
- [RISKOFDERM](#)
- United States Environmental Protection Agency (EPA) [Exposure Assessment Tools by Routes - Dermal](#)
- National Institute of Occupational Safety and Health (NIOSH)' s [Finite Dose Skin Permeation Calculator](#)

(*We have mentioned these organizations as a means of providing a potentially useful referral. You should contact the organization(s) directly for more information about their services. Please note that mention of these organizations does not represent a recommendation or endorsement by CCOHS of these organizations over others of which you may be aware.)

How can skin exposure be eliminated or reduced?

Employers should consult available information such as safety data sheets, manufacturer's technical literature, and scientific publications to determine if any product can affect the skin, or enter the body through dermal exposure. Employers should follow the [hierarchy of controls](#) to protect workers:

- Elimination: Where possible, eliminate the product from the workplace.
- Substitution: Where possible, replace the product with a less hazardous one.

- Engineering: Use engineering controls to minimize exposure, such as local exhaust ventilation (if the product is hazardous by inhalation, or if there is a possibility for exposure to dust and aerosols by deposition from the air), enclosures to prevent contact (e.g., glove box) to avoid contact with highly toxic substances (e.g., sodium cyanides), use of automated equipment, designing special tools for handling the products to prevent direct contact with the skin, etc.
- Administrative:
 - Check the jurisdiction’s health and safety regulations for substance-specific requirements. Medical monitoring may be required for some products, such as isocyanates.
 - When a product has an acute effect (e.g., may result in dizziness, poor concentration, fatigue, unconsciousness, etc.), do not allow workers to work alone and restrict access to trained workers only.
 - Prepare safe work procedures for handling products.
 - Train workers on the safe work procedures for the safe handling of the product and on the safe use and maintenance of PPE.
 - Use job rotation to minimize exposure.
 - Reduce the length of exposure.
 - Reduce the exposed area, such as providing a tool to avoid skin contact.
 - Provide an [emergency eyewash and shower](#).
 - Use disposable work surface covers (“bench protectors”) to prevent contamination of the work surface.
 - Implement good hygiene practices. Make sure there are washing stations nearby for workers to practice good personal hygiene. Workers must wash up before taking breaks or going home. Practices of washing skin with solvents such as methyl ethyl ketone must be forbidden.
 - Use good housekeeping practices for frequent cleaning of surfaces.
- Personal Protective Equipment (PPE): Select the appropriate PPE according to health and safety legislation or industry safe practices. Use PPE such as head shields, goggles, glasses, gloves, coveralls, and boots. Remember that there is not a single type of material that is resistant to all products. Select the specific type of PPE to use based on the product present, the type of work completed, and the length of exposure. Get information from the manufacturer about how well their PPE performs against different products.

Use as many controls as possible to protect the worker’s skin. More specific recommendations are available in the following OSH Answers documents:

- [Dermatitis, Irritant Contact](#)
- [Dermatitis, Allergic Contact](#)
- [Skin Cancer and Sunlight](#)
- [How to Work Safely with - Hazardous Products using the "Health Hazard" Pictogram](#)
- [How to Work Safely with - Hazardous Products using the "Exclamation Mark" Pictogram](#)
- [How to Work Safely with - Hazardous Products using the "Corrosion" Pictogram](#)
- [How to Work Safely with - Hazardous Products using the "Skull and Crossbones" Pictogram](#)
- [Chemical Protective Clothing – Glove Selection](#)
- [First Aid for Chemical Exposures](#)

Worker responsibilities include making sure they have received training and understand:

- How to look up, understand, and follow the safe operating or safe work practices or SDS for the product they are using.
- How to use, wear, and maintain any required PPE.
- How to locate information related to WHMIS, emergency response, spill procedures, etc.
- Who to ask for help as needed
- The personal hygiene practices that must be followed. Examples are:
 - washing the skin regularly
 - washing contaminated clothing before wearing it or only wearing clothing that is not soaked by product
 - not washing product-soaked clothing with regular clothing
 - not eating or drinking in work areas.
- How to clean and maintain any PPE according to the employer's safe work practices or safety standards.
- When to report health and safety issues (e.g., rash or skin burns), concerns, or emergencies to your supervisor or employer

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