



## Exposure Pathways

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### Technical Information Paper No. 39-034-1114

**PURPOSE.** The purpose of this technical information paper (TIP) is to describe what an exposure pathway is and to provide guidance and examples for determining exposure routes and exposure points for the exposure pathway for use in occupational and environmental risk assessments.

### REFERENCES.

1. Berglund M, Elinder C-G, Jarup L. 2001. Human Exposure Assessment: An Introduction. The World Health Organization.
2. U.S. Environmental Protection Agency (EPA). 1992. Guidelines for Exposure Assessment. EPA/600/Z-92/001. Risk Assessment Forum. EPA.
3. Colorado Department of Public Health and Environment (CDPHE). 2011. Rocky Flats Exposure Pathways. Historical Public Exposure Studies. CDPHE.
4. Department of the Navy. 2012. Occupational and Environmental Health Site Assessment. ATP 4-02.82. U.S. Navy.

### INTRODUCTION.

A hazard is a threat to human health only if people are exposed to it. Exposure happens only if the following three conditions are met. It must be

- Released from its containment, or produced from a source.
- Transported by some means (e.g., air, water, the food chain) from its source to human beings.
- Taken into the human body by breathing, eating or drinking, or contact with the skin.

How a hazard moves through space to, and into a human being is defined as its exposure pathway.

### OVERVIEW.

A receptor-based approach to exposure assessments is designed to determine if individuals are actually exposed to hazards, at what level, and (when possible) from what sources. In a risk assessment, the exposure pathway is the means by which the hazard moves through the environment from a source to a point of contact with a receptor.

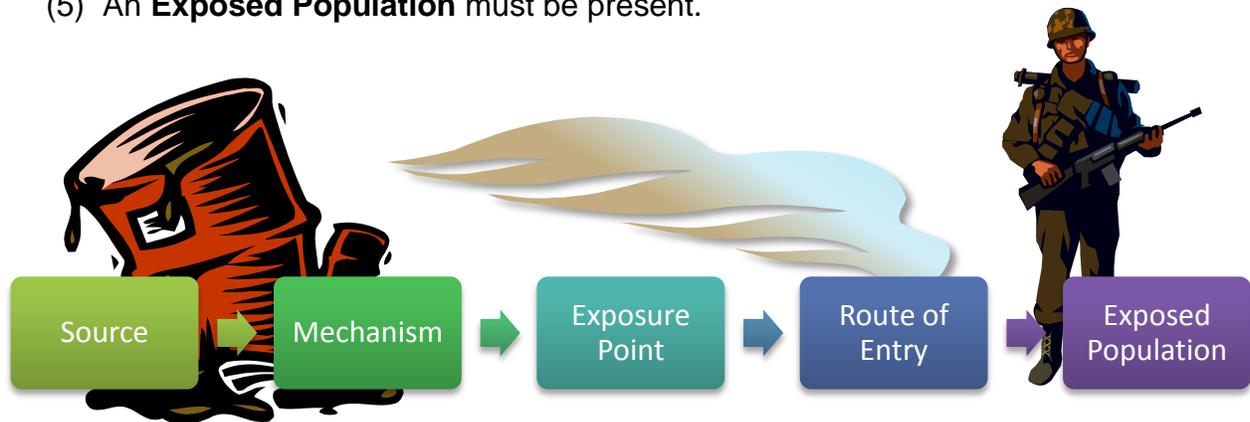
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## EXPOSURE PATHWAYS.

### What is an exposure pathway?

A complete exposure pathway must have five parts:

- (1) **Source** of contamination (e.g., a burn pit, leaking tanks or barrels, spills, waste piles, lagoons, noisy generator)
- (2) **Mechanism** for transport of a substance from the source to the air, surface water, groundwater and/or soil.
- (3) **Exposure point** where people come in contact with the hazard.
- (4) **Route of entry** into the body.
- (5) An **Exposed Population** must be present.



Routes of entry can be any number of things, for example breathing air that contains pollution or naturally occurring dust, eating or drinking food or water contaminated by pesticides, or absorbing a chemical through the skin.

If any part of an exposure pathway parts above is absent, the pathway is said to be incomplete and no exposure or risk is possible. In some cases, although a pathway is complete, the likelihood that significant exposure will occur is very small. Risk assessments must include a "pathway analysis" to identify those pathways that are complete and most likely to produce significant exposure.

### **Exposure routes and exposure points**

Exposure pathways can exist under many different circumstances. One example would be a chemical released from a facility during normal, everyday operations or unintentionally through leaks, spills, fires, or other accidents and that migrates to a nearby base camp, where the population would inhale it.

After a release, a hazard can travel in a variety of ways from its source of release to locations where people can be exposed. For example, air emissions from a burn pit might contain a chemical in the form of gases or small particles. These would be carried by the wind and eventually deposited onto the soil, surface water, and vegetation where they can contact a person in a variety of ways.

Not all hazards in the environment will complete an exposure pathway. Even if a source exists, there will be no risk to human health unless exposure occurs. Existing controls such as barriers, water filtration systems, or fences will reduce or eliminate exposure and thereby decrease the risk of health effects within the population.

Some examples of when exposure occurs:

- **Inhalation:** People breathe particulates or chemicals in the air.
- **Ingestion:** People consume contaminated water or eat contaminated fruits or vegetables. Accidental ingestion of contaminated soil can occur when people work or play in a contaminated area.
- **Dermal:** People can be exposed dermally to a contaminant through skin contact and skin absorption. Skin contact occurs when a chemical comes in contact with the skin. Skin absorption occurs when a chemical passes through the skin and into the body.
- **Direct:** People can be exposed simply by being in the presence of a hazard such as radiation, heat, or noise.

### **Exposure pathways can change over time**

Over time, the receptors might move or the source of contamination can move or stop producing hazards. For example, if a leaking drum is removed from a site and the contaminated soil cleaned up then the source of contamination and the exposure would be removed and the pathway is no longer complete.

A new exposure pathway may be introduced due to a change in conditions. For example, a landfill releasing a chemical into ground water (a hazard) can have an incomplete pathway if there is no exposure to the ground water. However, if a well is

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dug and put into use for showering then there is now an exposure point and route of entry which completes the five parts of the exposure pathway.

Structures such as buildings, roads or underground systems that change the natural environment can affect contaminant movement. Buildings can disrupt air flow; roads can serve as barriers to surface water movement; and pumping of water wells can affect the pattern of groundwater movement. These should be considered in the definition and description of the exposure pathway.

### **IMPORTANCE OF THE EXPOSURE PATHWAY.**

Exposure pathway analysis allows the risk assessor to determine if samples should be collected and to develop a sampling plan to properly assess the potential hazard. The more information provided about the exposure pathway the more complete the sampling plan will be. Samples connected to an exposure pathway can identify the amount of hazards contained in the mechanism for transport. This allows risk assessors to determine the amount of a hazard the population was exposed to and provides a more complete risk assessment.

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