Chemical Exposure Calculators

Summary

The chemical exposure calculators predicts a worker's exposure based on 6 questions. It is an easy and reasonable approach to performing an assessment. The results are provided as a percent of the Occupational Exposure Limit (OEL). Specifically, the results are shown in exposure bands that are linked to specific actions the workplace should perform to protect workers.

Discussion

Since employers must take all reasonable precautions, to prevent injuries or accidents in the workplace, an assessment must be completed to identify chemical hazards and measures to control exposure from these hazards.

This documents addressed how to estimate the exposure from a particular activity or scenario using exposure calculators.

The goal is to try to estimate a workplace exposure relative to its OEL. The process is not an exact science and requires some estimation on the part of the Safety Professional. The goal is to put the exposure into a category of exposure. The AIHA has created system of exposure ratings. Each category is associated with an exposure range relative to the OEL. The modified version of the exposure categories are shown in the following table.

Exposure Rating	Recommended Action / Follow Up
< 1% of OEL	No Action
1 - 10% of OEL	General WHMIS Training
10 - 20% of OEL	+ Specific training on hazards of product
20 - 100% of OEL	+ periodic exposure monitoring
> 100% of OEL	+ respiratory, engineering or other controls
multiples of OEL	greater respiratory protection or process shutdown, introduce improved engineering controls

To determine if the chemical substances create a risk to workers at the worksite, we need information about both the substances and the processes (how they are used) as well as current controls. An assessment would normally take into account the following:

1. Frequency of use
2. Where and how the product is produced, used, handled, stored and disposed
3. Physical hazards of the substance
4. Health hazards caused by the substance
5. Possible routes of exposure
6. Measures used by the worksite to control exposure under normal and emergency circumstances
7. Number of workers exposed
8. Review of worker complaints or concerns regarding exposure

Can We Narrow the List of indicators?

Some of the factors above can be eliminated because they do not relate to or provide information on how likely a given worker's exposure will compare to the OEL. The largest and most commonly used factors that we will **not** take into account are:

Number of workers exposed

This is not a fair metric for protecting a worker's exposure. It is a consideration when a company is looking at the most significant exposure in its plant but it could leave single workers doing a task at risk. Every worker should be protected so a system should not penalize a worker just because they are the only worker doing a particular job.

Health Effects of the Substance

It is common to see a matrix that shows severity of health effect vs frequency to find the most significant exposure. However, workers must be protected from irritants as well as carcinogens. Some 40 percent of chemicals with a TLV have a TLV based on irritation. This is too large a category to downplay if not outright ignore. Also, the legislation provides no reduction in obligations to protect workers from irritants than they do for systemic toxicants.

Review of Worker Complaints

Some products have good warning properties such as ammonia and other irritants. Workers concern or reports of irritation is a valid indicator of problem for this class of chemicals. However, many products do not have good warning properties. Thus, as a broad indicator, worker complaints are only a good indication of exposure for 40% of chemicals that have OELs based on irritation. As the goal is to protect all workers, the use of this metric may slant efforts towards chemicals that cause irritation and away from chemicals that cause more serious health effects. What we need is a system that assesses all health effects and not just irritation.

The key indicators that should be considered would be the following parameters:

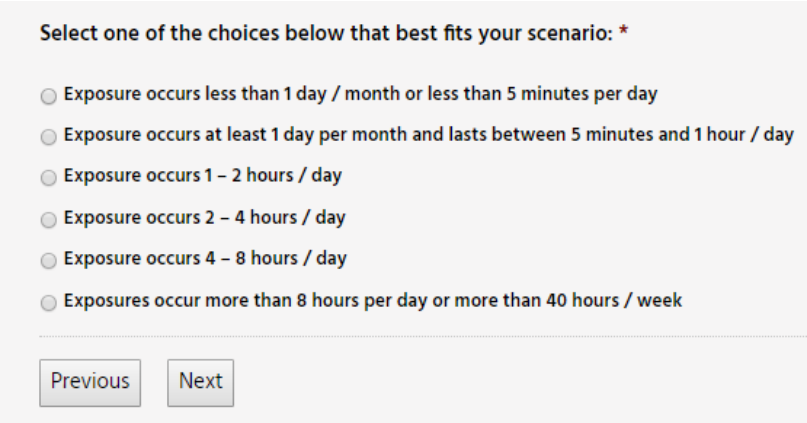
1. Frequency and duration of exposure
2. Proximity of worker to source of exposure
3. The likelihood of emissions generation from the process
4. How low is the occupational exposure limit;
5. The use of personal protective equipment: and
6. The degree to which the emissions are controlled

Each of these factors will be assessed and a score will be given to each factor. These individual scores will later be combined to produce a total cumulative score that takes into account all of these factors. That score is then in the exposure bands described above.

Essentially, the exposure calculators walk you through 6 questions that collect the key elements of an exposure. The questions are all multiple choice. You simply click on the choice that best fits the scenario you are trying to assess.

Frequency / Duration Exposure

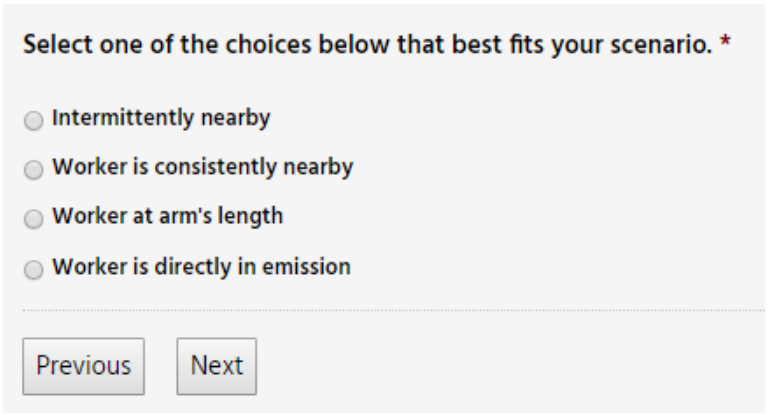
It would seem obvious that the shorter and more infrequently a product is used, the less likely it is that the product represents a significant occupational exposure.



Proximity to Emissions

A worker's proximity (closeness) to a point of emission is an important factor in worker exposure. In some process, workers are simply nearby such as a printing press. In some cases, workers are hunched over the point of generation such as welding. This makes a large difference to the worker's exposure. You simply select the choice that best fits the scenario you are trying to assess.

Worker is Nearby | Arm's length | Directly in Emission



There are 4 additional questions that inquire about the OEL for the product, respiratory protection used, presence of ventilation and/or administrative controls, etc. Each question is explained as you go along.

The input of the various questions are weighted and combined to provide a score. This score is in proportion to the magnitude of the exposure as a percentage of the occupational exposure limit (OEL). To make it easy for the user, the exposures are placed in exposure bands that are linked to recommended actions. An example of the output from an exposure calculator is shown below.

Example of Prediction of Exposure Calculator

Estimated exposure is	Action to take
<1 % of the OEL	No Action Recommended
1 - 10% of OEL	General WHMIS Training
10 - 20% of OEL	plus specific training on hazards of products
20 - 100% of OEL	plus periodic exposure monitoring
> 100% of OEL	plus respiratory, engineering or other controls
Multiples of OEL	greater respiratory protection, improved controls or process shutdown

In this example, the predicted exposure lies between 1 and 10% of the OEL.

The advantages of the system are numerous:

1. Limited industrial hygiene knowledge or experience needed to use the chemical exposure calculator.
2. Virtually instant prediction of exposure. Someone familiar with the industrial process can typically run through the chemical exposure calculator in a couple of minutes.
3. Results expressed in easy to understand terms.
4. No cost to perform an assessment. In comparison to performing air sampling, this is basically a no-cost assessment. Even if not sure about one of the parameters, a company can run a couple of different scenarios (most likely, worst-case, etc.).
5. An easy way to explore substitution. Think using a different chemical would results in a (significantly) lower exposure? Run the exposure scenario with the new product under consideration. It can help you identify (or confirm) that the proposed chemical is safer.