

Occupational Exposure Limits – One Tool in a Hazard Assessment

Whenever you work with a chemical you need to understand the hazards posed by the chemical in order to perform a proper risk assessment. You might discover that the material is flammable, or explosive, or may react with common substances such as water, air, or bleach. Another piece of information that you may run across is the exposure limits for the chemical. These limits provide very useful information on the health risks associated with the chemical. But you need to understand what the numbers are saying, and know their limitations. Before describing the main occupational exposure values, here are some key points to consider:

- Occupational exposure limits have been set by numerous organizations, but values tend to be reported only for the most common industrial chemicals and these are mainly based on inhalation hazards. The lack of a published exposure limit should not be interpreted as meaning that hazards do not exist.
- Laboratories differ significantly from industrial settings where exposures are often continuous throughout the work period. In labs there is the potential for exposure to a large number of chemicals but exposures, if they do occur, tend to be of short duration.
- Exposure limits, with the exceptions of the legally enforceable PELs (see below), are guidelines and are useful when taking a risk-based approach, but it is prudent to avoid – through proper use of engineering controls, personal protective equipment, and administrative controls – any unnecessary exposure.
- You may find different exposure limits for the same chemicals. Each organization has its own method for developing the exposure values so some will be more conservative than others.

Additional information can be found in the *University of Wisconsin-Madison Campus Chemical Hygiene Plan and Compliance Guide* available at www.chemsafety.wisc.edu. If you have any concerns the Chemical Safety Office can look over your situation. In some cases we may bring in staff from the Occupation Health Office to do sampling for you. Below is some information on the major occupational exposure values.

Permissible Exposure Limits (PELs):

The Occupational Health and Safety Administration (OSHA) has set permissible exposure limits (PELs) on the amount or concentration of a substance in the air. The limits may also contain a skin designation that serves as a warning of potential cutaneous absorption that should be prevented in order to avoid exceeding the absorbed dose received by inhalation at the permissible exposure level (PEL). *These limits are enforceable by law.* Most OSHA PELs are based on an 8-hour work shift of a 40-hour workweek time-weighted average (TWA) exposure that an employee may be exposed to for a working lifetime without adverse effects. In most laboratory settings exposures are of short duration so time-weighted averages are difficult to exceed. Some of the PELs are listed as ceiling values – concentrations above which a worker should never be exposed, or short-term exposure limits (STELs) – average concentrations which should not be exceeded over a 15 minute time period. It is important to note that the PELs tend to be higher than other published values. To locate PELs on specific chemicals go to:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992,

Threshold Limit Value (TLV®):

Threshold Limit Values (TLV) are occupational exposure limits set by the American Conference of Governmental Industrial Hygienists (ACGIH). The Time-Weighted Average TLV (TLV-TWA) is an airborne concentration of a gas or particle to which most workers can be exposed on a daily basis for a working lifetime without adverse effect (assuming an average exposure on the basis of a 8h/day, 40h/week work schedule). In addition ACGIH defines:

- Short-term exposure limits (TLV-STEL) which are concentrations above which a worker should not be exposed (averaged over 15 minutes). Exposures cannot be repeated more than 4 times per day
- Ceiling limits (TLV-C) which are concentrations above which a worker should never be exposed.

For all chemicals for which there are no short-term or ceiling limits the ACGIH has default values called Exclusion Limits. Worker exposure should not exceed 3 times the TLV-TWA for 30 minutes and should never exceed 5 times the TLV-TWA.

The TLV is the regulatory limit in Wisconsin if OSHA does not designate a PEL for that specific gas or particulate. In many laboratories the TLV-STEL or TLV-C of a chemical are more appropriate values unless the individual routinely works with the chemical. Unfortunately values for TLVs are not available on the ACGIH website. Contact EH&S for assistance with TLVs.

Recommended Exposure Limits (RELs)

Recommended Exposure Limits (RELs) were developed the National Institute for Occupational Safety and Health (NIOSH). NIOSH is the principal federal agency engaged in research, education, and training related to occupational safety and health. The REL is a level that NIOSH believes would be protective of worker safety and health over a working lifetime if used in combination with engineering and work practice controls, exposure and medical monitoring, posting and labeling of hazards, worker training and personal protective equipment. RELs are not legally enforceable.

NIOSH is well known for its *NIOSH Pocket Guide to Chemical Hazards*. In addition to containing RELs, it also has information on incompatibilities and reactivity, exposure routes, symptoms of exposure, target organs, potential cancer site, PPE, and first aid. A searchable version of the guide can be found at <http://www.cdc.gov/niosh/npg/>. The pocket guide can also be downloaded from this site.

Workplace Environmental Exposure Levels (WEELs)

Let's look at an example. Say you plan on using benzene in a lab. A quick review of available information shows the following:

- OSHA lists a PEL of 1.0 ppm and a STEL of 5 ppm;
- NIOSH indicates a REL of only 0.1 ppm with a short-term exposure of 1.0 ppm and also designates it as a potential carcinogen. An immediate danger to life or health (IDLH) of 500 ppm is shown;
- The ACGIH has adopted a TWA of 0.5 ppm and a STEL of 2.5 ppm. It also notes it as a confirmed human carcinogen and notes that exposure through the skin (or eyes or mucous membranes) can contribute significantly to the effects;
- A quick look at SAX's shows a large amount of toxicity data (including LD50s, LC50s) indicating that benzene has moderate acute toxicity.

Overall the health data indicates a significant health risk and efforts must be taken to prevent inhalation, ingestion, and skin exposure to this solvent. Also, your research on the physical hazards of benzene will show that it is a flammable liquid.

The American Industrial Hygiene Association (AIHA) develops worker exposure levels for health-based chemicals. Since most of the other worker protection limits are for commonly used industrial chemicals AIHA began developing Workplace Environmental Exposure Levels to meet a specific need. WEELs are air concentration guide values for agents in a healthy worker's breathing zone. WEELs are not enforceable but provide a good guideline when no other guidance exists. The latest WEELs can be found at:

[http://www.aiha.org/insideaiha/GuidelineDevelopment/weel/Documents/2011 WEEL Values.pdf](http://www.aiha.org/insideaiha/GuidelineDevelopment/weel/Documents/2011_WEEL_Values.pdf)

Immediately Dangerous to Life or Health (IDLH)

NIOSH also provides concentrations for chemicals that it considers Immediately Dangerous to Life or Health (IDLH). These values are more useful for emergency planning and response and under no circumstances should anyone be exposed to concentrations near the IDLH. NIOSH defines an IDLH condition as a situation "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." IDLH values can be found in the *NIOSH Pocket Guide to Chemical Hazards* (see link above). The purpose for establishing this IDLH value was to determine a concentration from which a worker could escape without injury or without irreversible health effects. In determining IDLH values, the ability of a worker to escape without loss of life or irreversible health effects was considered along with severe eye or respiratory irritation and other effects (e.g., disorientation or incoordination) that could prevent escape. As a safety margin IDLH values were based on the effects that might occur as a consequence of a 30-minute exposure.

Final Thoughts

The published exposure limits described above are only one tool in your hazard assessment toolbox. Resources such as the Toxnet® website (which contains a searchable database system of hazardous chemicals, toxic releases and environmental health) and Sax's Dangerous Properties of Industrial Materials (containing concise information on over 26,000 substances) are also available to help in your assessment. These resources can provide information such as safety profiles of chemicals, lists of organs effected by the chemicals, and LD50s and LC50s ("lethal dose, 50%" and "lethal concentration, 50%" - the dose/concentration required to kill half the members of a tested population after a specified test duration) which can be used as a general indicator of a substance's acute toxicity. With this information you can then determine what steps you need to take to protect yourself and your co-workers.

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