

Health and Safety Fact File - Chemical Safety

Occupational Exposure Limits

Exposure to many airborne contaminants may be tolerated if the extent of exposure does not lead to an absorption in excess of the minimum amount required to produce an adverse effect.

Based on an assessment of the toxicology of substances, including past experience of personal exposures, values such as maximum no-adverse-effect level (NOAEL) airborne concentrations have been estimated for a large number of substances. These concentrations relate to the average person in good health.

None of these limits is a sharp dividing line between safe and unsafe levels - nor do they relate to continuous uninterrupted exposure such as occurs from the general environment. These limits also do not indicate the actual or relative toxicities of substances.

The *Control of Substances Hazardous to Health Regulations* (COSHH) require that exposure to substances hazardous to health is either prevented or where this is not reasonably practicable is adequately controlled. From 2005, the COSHH Regulations, as amended, define only one type of occupational exposure limit for use in determining the adequacy of control of exposure by inhalation - the **Workplace Exposure Limit (WEL)**. A WEL is the maximum concentration of an airborne substance averaged over a specified period of time, to which employees may be exposed by inhalation.

Workplace Exposure Limits are set by the Health and Safety Commission and published annually with updates by the Health and Safety Executive in Guidance Note EH40 *Workplace Exposure Limits*. The work in establishing WELs is undertaken by the Advisory Committee on Toxic Substances (ACTS) and its scientific subcommittee.

How are Workplace Exposure Limits set?

The practical relevance of NOAELs in setting WELs is generally limited to those substances or toxicological mechanisms that have a 'threshold' of effect. For example, eye irritation caused by an acid vapour will only occur above a certain threshold exposure concentration, and thus a NOAEL will apply. In contrast, for substances such as DNA-reactive chemicals that cause cancer by a genotoxic mechanism, although in theory a threshold may exist, (because of biochemical defence and repair mechanisms) currently available techniques do not allow the reliable identification of a clear threshold or NOAEL. The NOAEL, if available, is taken as a starting point for estimating the highest level of occupational exposure at which no adverse health effects would be expected to occur in workers or their progeny following exposure over a working lifetime. However, the latter value is usually higher as a 'safety factor' may have been applied, for example, to allow for the source of data, often from experiments on animals with possible species differences in response, and variations in human responsiveness. Having determined the highest level of occupational exposure at which no adverse health effects would be predicted to occur, ACTS then considers current experience of control of exposure and whether the proposed level of control of exposure is reasonably practicable to achieve, taking into account the potential for improvement, if any, from available controls.

The NOAEL method cannot be used in setting WELs in the following categories of substance:

- (a) Genotoxic carcinogens: there are no currently available techniques for establishing NOAELs.
- (b) Asthmagens: the quality of the available data means that it is generally not possible to identify a threshold level of occupational exposure below which there would be no risk of developing the disease.
- (c) Mixtures of variable composition such as metalworking fluids (MWFs): The variable composition means that MWFs pose a variable hazard.
- (d) Any other substance for which the balance of doubt and uncertainty about likely human health effects is such that a NOAEL or threshold for effect cannot be confidently identified or predicted.
- (e) For some substances, a NOAEL may be identifiable from which it is possible to estimate a level of exposure at which no adverse human health effects would be predicted to occur. However, after due consideration of the costs and efficacy of available control solutions, ACTS may consider that it would not be reasonably practical to control below this desired level of

exposure across all industry sectors.

For substances belonging in one of the above categories (a)-(e), the approach is to identify a level of exposure that represents a standard of control commensurate with good occupational hygiene practice. In determining this level, the severity of the likely health effects, and the cost and efficacy of control solutions would be taken into account. In agreeing what represents a good standard of control, ACTS and its scientific subcommittee are informed by:

- (i) knowledge of the standards of control currently being achieved in different industry sectors using the substance;
- (ii) the potential for improving standards; and
- (iii) the potential health impact of the substance.

Criteria for setting Workplace Exposure Limits

In conclusion, WELs are derived by the following criteria:

- (1) the WEL value is set at a level at which no adverse effects on human health would be expected to occur based on the known and/or predicted effects of the substance. However, if such a level cannot be identified with reasonable confidence (categories (a)-(d) above), or if this level is not reasonably achievable (category (e)); then,
- (2) the WEL value is based at a level corresponding to what is considered to represent good control, taking into account the severity of the likely health hazards and the costs and efficacy of control solutions. Wherever possible, the WEL would not be set at a level at which there is evidence of adverse effects on human health.

For a more detailed description of the WEL setting process see "Setting Exposure Limits" in *Workplace Exposure Limits* Guidance Note EH40, Health and Safety Executive.

European Occupational Exposure Limits

Whereas all WELs are British limits, in some cases (63 at present) the values also reflect the Indicative Occupational Exposure Limit Values (IOELVs) set under the Chemical Agents Directive (98/24/EC) and applicable in all European Union (EU) member states. Additionally, three values, for benzene, hardwood dusts and vinyl chloride monomer, derive from the EU Carcinogens Directive (2004/37/EC).

Reference Periods

The health effects of exposure to hazardous substances can vary considerably depending on the nature of the substance and the pattern of exposure. Some effects result from prolonged or cumulative exposure. Other effects arise after brief exposures. For many substances both long-term and short-term occupational exposure limits are listed, each being expressed as a time-weighted average (TWA). Unless otherwise specified, the long-term TWA is for a period of 8 hours, and the short-term TWA is for a period of 15 minutes. Where EH40 does not list a short term limit for a substance, a level three times the long term limit is recommended for controlling short term peaks in exposure. Where frequent much higher peak exposures may occur without exceeding either TWA limits these can have the potential to cause harm, exposure will need to be controlled to a level at which the risk assessment concludes there is no risk to health.

In some situations such as in submarines and saturation diving the occupational exposure is essentially continuous. In these cases HSE recommend a continuous exposure limit should be derived by dividing the 8-hour TWA value by 5.

Concentration Units

The limits for gases and vapours are expressed either as parts per million by volume of air (ppm) or in milligramme per cubic metre (mg/m^3 or mgm^{-3}) of air. The limits for airborne particles (of fume or dust) are expressed in mgm^{-3} . The limits for asbestos are expressed as fibres per millilitre of air ($\text{fibres}/\text{ml}^{-1}$).

Skin Absorption

Certain substances have the ability to be absorbed through the intact skin. EH40 is annotated to indicate which substances are also harmful by this route. Absorption through the skin can result from contaminated clothing or direct splashing of the skin, or in certain cases from skin exposure to high air concentrations of vapour. Skin absorption can make a significant additional contribution to the systemic toxicity of inhaled substances.

Workplace Exposure Limits may also be found in the University's [HAZDAT](#) database of hazardous substances.

Inhaled substances not assigned WELs

From the explanation of the WEL setting procedure it should be clear that it is wrong to assume that a substance not assigned a WEL is therefore safe to use without any controls. The risk assessment will need to consider and determine what standard of control is required using available information from, e.g. substance suppliers, industry associations, the Health and Safety Executive.