Who understands the concept of the exposure standard?

Associate Professor Chris Winder, Sydney

In a recent case in the Supreme Court in New South Wales, lawyers for the defendant argued that as workplace exposure to a chemical had probably occurred below the exposure standard for the chemical, that no harm should have occurred to a worker, and that any disease the worker may have contracted at or about the same time of the exposure was not due to occupational exposure to chemicals.

Further, in a recent submission in support of an application for the location of a petrol station in New South Wales, a professor of chemical engineering made the startling admission that "danger to humans is assessed by a value called the threshold limit, which varies from compound to compound. The American levels are accepted world-wide."

Both these cases make inappropriate assumptions about the role of the exposure standard. In the first, an assumption is made that the exposure standard is a no effect level, and in the second, an assumption is made that the exposure standard can be used for non-occupational exposures to chemicals. Both are wrong.

It is apparent that the term exposure standard is poorly understood and is subject to misuse.

History of the exposure standard in Australia

Prior to 1985, responsibility for occupational health and safety at the federal level in Australia resided partly with the Occupational Health Section of the Commonwealth Department of Health and partly with the Work Environment Branch of the Commonwealth Department of Industrial Relations. The former of these, under the collective authorship of the National Health and Medical Research Council, issued a range of "Approved Occupational Health Guides", and the latter published the "Working Environment Series" of publications. One NHMRC publication was the Approved Occupational Health Guide *Threshold Limit Values*, which was last published in 1983.[1]

The term "threshold limit value" (TLV) is proprietary to the American Conference of Governmental Industrial Hygienists (ACGIH), a non-government organisation located in Cincinnati, USA. The ACGIH issue a list of TLVs every year, and ACGIH TLVs are revised using a well-established process of "notice of intended changes" and review of relevant information.[2] The ACGIH were also the first exposure standards setting body to issue comprehensive documentation for their TLVs, which summarise the toxicology, industrial hygiene and epidemiological information available for the chemical, and provide a justification for the TLV.

Permission to reproduce the list (but only in its entirety) was granted to the NHMRC by the ACGIH. While the 1983 NHMRC publication includes the full list of ACGIH TLVs "in its entirety", this did not stop the NHMRC issuing "Australian variations" in values for nitro-glycerin, ethylene glycol dinitrate, anaesthetic gases, ethylene oxide, asbestifom minerals, nonfibrous talc dust and mica dust, coal dust, siliceous dusts, quartz bearing dusts, cristobalite and tridymite. However apart from these, the ACGIH 1983-4 list of threshold limit values was used in Australia to establish levels for atmospheric contaminants in the workplace.

Although a publication of the Australian government, the NHMRC noted that "TLVs have no legal status in Australia, except where specifically incorporated into law by reference".

In 1985, federal government responsibility for occupational health and safety was transferred to the National Occupational Health and Safety Commission (also occasionally called Worksafe Australia). Worksafe took some time in developing a list of exposure standards, and in the interim, the 1983 NHMRC list of ACGIH TLVs remained the *de facto* list of exposure standards for Australia. This presented some problems in Australia, as the 1983 list of TLVs became progressively more and more out of date.

The first list of exposure standards was eventually issued by Worksafe in May 1990. Worksafe decided not to adopt the NHMRC approach of using the ACGIH TLVs, and developed its own standards, which were given the generic name "exposure standards". Common to many lists created internationally, Worksafe used the ACGIH TLV list as a source in developing the Australian list. Worksafe also used other lists available internationally, such as those of the US OSHA, the United Kingdom, Sweden, Germany and the Netherlands. However, many of these also used the ACGIH list as a source for their own national recommendations, so in many ways the ACGIH have dominated development of national exposure standards lists around the world.

Since 1990, Worksafe has reissued their list of exposure standards twice, once in 1991 and once in 1995.[3] There are occasional releases of recommendations for exposure standards for contaminants under review or undergoing revision, but largely the "list" is whatever happens to be the latest edition.

Types of Exposure Standards

Occupational exposure to chemicals can vary substantially, depending on the process, work tasks and available controls. Therefore, establishing the level of exposure can be problematic. There are two main approaches to measuring exposure:

- ignoring the variability of exposure and averaging out the exposure over the entire work shift, taking into account the concentration during the shift and the length of time at each

concentration - this is called the time weighted average (TWA approach); or
- ignoring the low level exposure and using peaks concentrations to measure exposure.

The first of these is used for workplace contaminants which do not have acute effects, and the second is used for chemicals that are irritant or toxic following single or short term exposures. These approaches have corresponding TLVs. The TLV-TWA is an exposure standard to be used for exposures averaged over an entire work shift, the TLV-STEL (short term exposure standard) is used for short term exposures (not more than fifteen minutes in duration, not more than four times a day, separated by at least one hour) or the TLV-C (ceiling values) is a measure which should not be exceeded, even instantaneously.

The concepts are reproduced in the Australian list of exposure standards. The TLV-TWA became the "exposure standard"; the TLV-STEL became the "short term exposure limit"; and the TLV-C became the "peak limitation". For most purposes, the Australian derivatives are the same as their ACGIH precursors.

Definition of exposure standard

The Australian definition of exposure standard is:

"the exposure standard represents airborne concentrations of individual chemical substances which, according to current knowledge, should neither impair the health of, nor cause undue discomfort to, nearly all workers. Additionally, the exposure standards are believed to guard against narcosis or irritation which could precipitate industrial accidents. Exposure standards apply to long term exposure to a substance or agent over an eight hour day for a normal working week, over an entire working life."

The critical words in this definition are "nearly all workers", which are not defined quantitatively or qualitatively. There has been some debate by occupational hygienists about what these words mean, and it is concluded that the term nearly all workers does not include all workers, and that therefore exposure standards must be used with caution.[4] Further, because of the inclusion of the words "nearly all workers" in the definition of the exposure standard, it cannot be assumed that they are no observable effect levels (NOELs). Indeed, with inclusion of such words, they must be considered effect levels, at least for some workers.

The words "nearly all workers" are therefore sufficiently imprecise to assist the occupational health practitioner to establish what is a safe exposure, without helping individuals who show susceptibility or sensitivity to certain exposures. In this, the definition of exposure standard is flawed.

At the workplace level, the nature of the standard setting process for recommended concentrations of many workplace occupational contaminants has been questioned.[5]

If a chemical does not have an exposure standard

Most substances used in Industry do not have exposure standards. Worksafe Australia makes the point that "This does **not** imply that these substances are safe or ▶

non-hazardous" (emphasis added by Worksafe). The reasons for this are that there may be insufficient evidence on the health effects of such unlisted chemicals, or that the use of the substance does not produce significant airborne levels, or that the chemicals use is so restricted that an exposure standard is not warranted.

In all such cases, Worksafe recommend that "it is good policy to keep exposure to any substance as low as workable, irrespective of whether present information indicates it is hazardous or not. Some substances previously thought to be comparatively safe have been shown to pose serious long term health risks."

Exposure Standards for Sensitisers

While TWA approaches to estimating exposure are relevant for many exposures, they may not be appropriate for all exposures. Exposures standards may be limited by (among other things) peak limitation, short term exposure and sensitisation considerations:

- the importance of the peak limitation is that the conventional time weighted approach to estimating exposure over an eight hour period is inappropriate. Exposure to some substances may induce acute effects after relatively brief exposure to high concentrations so that the exposure standard for such substances represents a maximum or peak concentration to which workers may be exposed;
- the sensitisation notation indicates those substances which are known to act as sensitisers. Worksafe points out that following the induction of sensitisation:
  "compliance with the recommended exposure standard may not provide adequate protection for a hypersensitive individual"; and
  "persons who are sensitised to a particular substance should not be further exposed to that substance"; and
  "such a designation indicates that caution should be exercised in the use of such substances".

Proper use of exposure standards

A number of cautions are made by the National Occupational Health and Safety Commission in the use of exposure standards:[3]

- "exposure standards do not represent 'no effect levels' which guarantee protection to every worker." The nature of biological variation and individual susceptibility indicates that some workers exposed "around or below the exposure standard may suffer mild and transitory discomfort. An even smaller number may exhibit symptoms of illness";
- "exposure standards are not fine dividing lines between satisfactory and unsatisfactory working conditions, but rather that they are best used to assess the quality of the working environment and indicate where appropriate control measures are required". Further, the "persons responsible for such assessments are fully aware of all the issues canvassed in this document and have appropriate qualifications and experience in occupational hygiene";
- exposure standards "only consider absorption via inhalation and are valid only on the condition that significant skin absorption cannot occur";
- "the relationship between various exposure standard should not be used as a general measure of their toxicity";
- "exposure standards should not be used as a basis for the evaluation of community air quality, or for long term non-occupational exposures";
- the exposure standard covers the situation where there is exposure to one chemical. This hardly ever occurs. Mostly, people are exposed to more than one chemical at work, or in outside interests (such as hobbies) or even lifestyle activities (alcohol, smoking) can produce exposure to a range of chemicals;
- some physical factors, such as strenuous work, extremes of temperature or humidity, or work at altitude may make operation of exposure standards problematic.

These words are similar to the words in the preamble to the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH) upon which many exposure standard setting systems are based (including those in Australia). The ACGIH further disavow any liability if their TLVs are not used in the manner in which they recommend.[2]

Both Worksafe and the ACGIH provide strong cautions for the inappropriate use of exposure standards, and these must be adhered to if exposure standards are to be used properly.

Summarising remarks

The use of Exposure Standards in Australia must be carried out appropriately:

- Exposure standards have no legal status in Australia, unless incorporated into occupational health and safety legislation.
- Many exposure standards are based on practical experience from small groups of exposed workers and do not consider the toxicological nature of the chemical. Indeed, the toxicological basis of many exposure standards is uncertain.
- Many exposure standards are based on acute effects from short term exposures. Most especially, there is a lack of information on effects from long term exposure.
- Many exposure standards do not take account of skin exposure, either from skin absorption of vapour (can be 20% or total exposure for some volatile organic compounds) or skin absorption following contact with the liquid. Ignoring skin exposure can result in a false sense of security when estimating exposure.
- For some chemicals, exposure to intermittent and fluctuating exposures can be more hazardous than steady state exposures, making interpretation of a time weighted average exposure standard problematic.
- Exposure standards should not be used as relative indexes of toxicity.
- Exposure standards may not be valid where mixed exposures to chemicals occur.
- Internationally, different agencies can establish different exposure standards for the same chemical, suggesting different approaches to the standard setting process.
- Exposure standards do not guarantee protection to every worker.
- Exposure standards should not be used as fine lines between safe and dangerous concentrations.
- Exposure standards should be used

as guides in the control of health hazards.
- Exposure standards should form part of the safe systems of work for the control of hazardous substances in the workplace.
- Some exposure standards offer relatively little protection to workers, and average exposure should be kept low enough to ensure that the time weighted average is not exceeded.
- Exposure standards should not be used as proof or disproof of an existing disease or physical condition.

In conclusion, there is a lack of scientific validity underpinning many exposure standards and the best practice is to maintain concentrations of all atmospheric contaminants in the workplace to levels as low as is reasonably practicable. ■

Chris Winder is an Associate Professor in the Department of Safety Science at the University of New South Wales, **phone** 02 9385 4144, **fax** 02 9385 6190

Notes:

1 NHMRC. *Threshold Limit Values: Approved Occupational Health Guide, 1983-84*. National Health and Medical Research Council, Canberra, 1983.
2 ACGIH. *Threshold Limit Values and Biological Exposure Indices 1996-7*. American Conference of Governmental Industrial Hygienists, Cincinnati, 1994.
3 WORKSAFE. *Exposure Standards for Atmospheric Contaminants in the Workplace Environment*. National Occupational Health and safety Commission/AGPS, Canberra, 1995.
4 DE SILVA, P. TLVs to protect nearly all workers. *Applied Industrial Hygiene* **1**: 49-53, 1986.
5 CASTLEMAN B.I., ZEIM G.E. Corporate influences on Threshold Limit Values. *American Journal of Industrial Medicine* **13**: 531-559, 1988.

Radiation in our back yard!

Judy Teizel, Brisbane


Judy Teizel

In 1960 the University of Queensland won a major coup in securing a contract to process 10 tonnes of uranium ore from Anderson's lode at Mary Kathleen. MIM Ltd would provide them with a grant for equipment and the University would build the buildings to house it at their experimental mine site at Indooroopilly, an inner city suburb in Brisbane. The newspapers of the day printed stories about this. It was news!

What they were unable to print at the time as it was unknown to the newspapers, were the consequences of these events.

The ore was duly processed and the University embarked on their new enterprise. As the processed ore lay on the grounds at the mine site emitting radioactivity, the workers passed over it during their working day. Children came home from school and in the relatively safe days of the 1960's were sent out to play. The children in this area loved to play in the tonnes of discarded waste from the mine site. They dug tunnels and made mud pies in the "dirt" and they came home covered in it.

Apart from the radioactivity the material emitted radon gas. The combination of the two made their way into the homes of the residents. In the 1960's many women stayed at home and husbands came back to a safe haven at the end of their working day.

This lifestyle carried on for many decades, children grew up and married, moved away from home. During this time some people began to develop illnesses, many of which were some form of cancer including thyroid cancer, leukaemia, bone and lung cancer and other tumours.

Many of the residents by this time had dispersed so it was not always someone in the neighbourhood who was struck down. Indeed at least two workers from the mine site who did not live in the immediate area were struck by illness including one who died of bone cancer leaving a wife a four small children.

Our firm's initial involvement with this case was through a 70 year old lady with a history of thyroid cancer and lung problems who approached us. This lady was a resident of one of the streets which ran directly behind the mine. She had lived in the street behind as a child and then when she married she and her husband bought a house at the rear of her mother's home. From the time she was thirty years of age she began having difficulties coping with her family and especially her two last born children. Later she was diagnosed with thyroid cancer and had it removed in the 1970s following which she had the usual treatment.

As plaintiff lawyers would know, any claim of such a nature and in isolation is not a case. It was then necessary to look for some evidence. Everyone knows what they are looking for in radiation claims don't they?

The one thing she could tell us was that in approximately 1984 the area where the children played was fenced off and in 1985/86 there was a lot of material removed from the site. This was also reported in the news at the time.

The first point of call was to look at ▶