

# **ALTERED WORKSHIFTS: AMENDMENTS TO THE GUIDANCE NOTE ON THE INTERPRETATION OF EXPOSURE STANDARDS FOR ATMOSPHERIC CONTAMINANTS IN THE OCCUPATIONAL ENVIRONMENT (June 1996)**

## **ALTERED WORKSHIFTS**

### ***INTRODUCTION***

#### ***Adjustment of 8-hour Time Weighted Average Exposure Standards for Altered Workshifts***

Exposure standards for airborne contaminants are assigned for conventional workshifts, that is, eight-hour working day, five-day working week. These standards may be inappropriate where there are altered workshifts. To provide people working altered workshifts with at least an equivalent degree of protection as there is for people working conventional workshifts, the 8-hour Time Weighted Average (TWA) exposure standard may need to be reduced by a suitable factor.

Considering whether to reduce exposure standards by a suitable factor is part of the duty of care of an employer and should be considered during the assessment and control processes as required by hazardous substances regulations implemented by jurisdictions in accordance with the National Occupational Health and Safety Commission's Model Regulations for Control of Workplace Hazardous Substances.

#### ***Substances Assigned Peak Limitation or Short Term Exposure Limit (STEL) Values***

No adjustment is necessary for Peak Limitation and Short Term Exposure Limit (STEL) values. This is because adverse effects due to acute over-exposure are already accounted for by existing STEL or Peak Limitations.

#### ***Short Exposure Periods Or Shifts***

8-hour TWA exposure standards should not be adjusted upwards when considering shorter exposure periods or shifts (for example, exposure to 8 times the TWA for one hour and zero exposure for the remainder of the shift). This is because data on the mode of action of the substance, its target organ, absorption and excretion rates may not be fully understood for high exposures of short duration.

In circumstances where short exposure periods or shifts are encountered the general excursion limitations described in Chapter 6, paragraph 6.8 still apply and adherence to these general limitations should be maintained. The general limitations do not supersede any STEL or Peak Limitation value which may be assigned.

## MODELS FOR ADJUSTING 8-HOUR TWA EXPOSURE STANDARDS

Several mathematical models have been proposed for adjusting exposure standards for use during altered work shifts. These models include the 'Brief and Scala Model'<sup>(1)</sup>, the US 'Occupational Safety and Health Administration (OSHA) Model'<sup>(2)</sup> and the 'Pharmacokinetic Model' of Hickey and Reist<sup>(3)</sup>. All models provide valid methods for adjusting exposure standards. The main difference is the degree of conservatism. Selection of a model will depend on the information available and the expertise of the practitioner. It should be emphasised that adjustment of exposure standards may be complex and there is no scientific consensus on a universal adjustment regime.

It should be noted that exposure standard values do not represent a fine line between safe and dangerous exposures and therefore the application of precise adjustments is not appropriate.

Where an exposure standard is set close to the Limit of Detection there may be difficulties in measuring exposure and demonstrating compliance if the value of the exposure standard is adjusted downwards.

**The Exposure Standards Expert Working Group recommends the Brief and Scala Model be used for calculating adjustments to the exposure standards.**

### *1. Brief and Scala Model*

The Brief and Scala Model<sup>(1)</sup> is based on the number of hours worked per 24 hour day and the period of time between exposures. This model is intended to ensure that the daily dose of the toxicant under an altered workshift is below that for a conventional shift to take account of the lessened time for elimination.

Information required: hours worked per 24 hour day.

Features include:        involves a simple calculation;  
                                     most conservative model;  
                                     no detailed knowledge about the substance is needed.

#### **Formula:**

$$\text{Adjusted exposure standard (TWA)} = \frac{8 \times (24 - \mathbf{h}) \times \text{Exposure Standard (8-hour TWA)}}{16 \times \mathbf{h}}$$

where **h** = hours worked/day

#### **Worked examples:**

Example 1

Substance:                Ethyl alcohol  
Exposure Standard:    1000 ppm, 8 -hour TWA  
Workshift:                12 hours  
Solution

$$\begin{aligned}
 \frac{\text{Adjusted exposure standard for TWA}}{12\text{-hour workshift}} &= \frac{8 \times (24 - 12) \times \text{Exposure Standard (8-hour)}}{16 \times 12} \\
 &= \frac{8 \times (24 - 12) \times 1000 \text{ ppm}}{16 \times 12} \\
 &= 500 \text{ ppm (12-hour TWA)}
 \end{aligned}$$

#### Example 2

Substance: Chlorine  
 Exposure Standard: 1 ppm, Peak Limitation  
 Workshift: 12 hours

#### Solution

No adjustment of the exposure standard is made for substances assigned with a Peak Limitation.

#### Example 3

Substance: Methyl ethyl ketone  
 Exposure Standard: 150 ppm, 8-hour TWA; 300 ppm STEL  
 Workshift: 12 hours

#### Solution

No adjustment of the STEL is made. The 12 hour TWA will reduce to 75 ppm using a similar calculation to that used for ethyl alcohol.

## 2. OSHA Model

The US Occupational Safety and Health Administration (OSHA) Model<sup>(2)</sup> categorises air contaminants into one of six categories based on their toxic effects. Depending on the type of toxic effect, an appropriate adjustment procedure (including no adjustment) is selected and applied to the substance's exposure limit. This model is intended to ensure that for substances with acute or chronic toxicity, the daily dose or the weekly dose, respectively, during an altered workshift does not exceed the dose obtained in a conventional 8-hour workshift<sup>(2)</sup>. This model is not recommended for use in Australia as it relies on a substance categorisation system and exposure standards used in the United States.

## 3. Pharmacokinetic Model (of Hickey And Reist)

There are several different pharmacokinetic models. These models take into account the expected behaviour of the hazardous substance in the body based on knowledge of the properties of the substance. The Hickey and Reist model<sup>(3)</sup> requires knowledge of the substance's biological half-life. Pharmacokinetic models are less conservative than the Brief & Scala or OSHA Models, usually recommending less reduction of the established exposure. Whereas pharmacokinetic models are theoretically more exact than the simpler models, their lack of conservatism may not allow adequately for the unknown adverse effects on the body from nightwork or extended shifts that might affect how well the body metabolises and eliminates the substance.

## **PREFERRED MODEL FOR ADJUSTMENT OF 8-HOUR TWA EXPOSURE STANDARDS**

The Exposure Standards Expert Working Group recommends the Brief and Scala Model be used for calculating adjustments to the exposure standards. The Brief and Scala Model is preferred because it is simple to use, takes into account both increased hours of exposure and decreased exposure free time, is more conservative than the OSHA Model or Pharmacokinetic Model of Hickey and Reist and is suitable for the Australian exposure standards of the National Occupational Health and Safety Commission.

The Working Group, however, have not excluded the use of the Pharmacokinetic Model of Hickey and Reist but are of the view that this model is less conservative, requires more involved calculations and should only be used by practitioners with appropriate expertise, that is, occupational hygienists. Moreover, the practitioner, in applying the Pharmacokinetic Model of Hickey and Reist, should have a good understanding of the toxicology and pharmacokinetics of that substance as well as the rationale for the exposure standard. The OSHA model is not recommended for use in Australia as it relies on a substance categorisation system and exposure standards used in the United States.

## **REFERENCES**

1. Brief R, Scala R. Occupational Exposure Limits for Novel Work Schedules. American Industrial Hygiene Association Journal. 36:467-469, 1975.
2. Paustenbach D. Occupational Exposure Limits, Pharmacokinetics and Unusual Work Shifts. In Patty's Industrial Hygiene and Toxicology, Vol III, Eds Cralley & Cralley, New York, John Wiley & Sons, 11-277, 1985.
3. Hickey J, Reist P. Application of Occupational Exposure Limits to Unusual Work Schedules. American Industrial Hygiene Association Journal. 38:613-621, 1977.

## **FURTHER READING**

Department of Minerals and Energy Western Australia. Discussion Paper Unusual Work Shifts and Occupational Exposure Standards. J Oosterhof, 1993.

Roach S. Threshold Limit Values for Extraordinary Work Schedules. American Industrial Hygiene Association Journal. 39:345-348, 1978.

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