



# Workplace Exposure Standards

## Consideration Paper on Lowering the Workplace Exposure Standard for Softwood Dust

July 2010

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## TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b> .....	<b>3</b>
<b>EXECUTIVE SUMMARY</b> .....	<b>4</b>
<b>SUBMISSIONS ON THE REPORT</b> .....	<b>4</b>
<b>GLOSSARY OF TERMS</b> .....	<b>5</b>
<b>SECTION 1: WORKPLACE EXPOSURE STANDARDS</b> .....	<b>6</b>
<b>SECTION 2: HEALTH EFFECTS OF WOOD DUST EXPOSURE</b> .....	<b>8</b>
2.1 Non-carcinogenic effects.....	8
2.2 Carcinogenic effects .....	8
<b>SECTION 3: HARDWOOD AND SOFTWOOD DUSTS</b> .....	<b>10</b>
<b>SECTION 4: BASIS FOR PROPOSING AN EIGHT-HOUR WES-TWA OF 1MG/M<sup>3</sup></b> .....	<b>12</b>
4.1 Proposed Department of Labour Workplace Exposure Standard for Softwood Dust.....	12
4.2 DECOS (1992) .....	12
4.3 Demers et al (1997) .....	12
4.4 SCOEL (2003) .....	13
4.5 ACGIH (2005) .....	14
4.6 ECETOC (2009) .....	15
<b>SECTION 5: SAMPLING METHODS</b> .....	<b>17</b>
5.1 Softwood dust sampling .....	17
5.2 Discussion on lowering the WES and implications for sampling ....	17
5.3 Issues in wood dust sampling .....	18
5.4 Comparing results from 'total dust' samples to 'inhalable dust' samples .....	18
<b>SECTION 6: SOFTWOOD DUST OCCUPATIONAL EXPOSURE LIMITS FROM OTHER COUNTRIES</b> .....	<b>20</b>
<b>REFERENCES</b> .....	<b>22</b>

## EXECUTIVE SUMMARY

This paper discusses the proposed lowering of the Workplace Exposure Standard (WES) for softwood dust and the basis for that proposal. The paper also discusses air sampling methodology and lists softwood dust exposure standards from other countries.

The Department of Labour is proposing the following WES for softwood dust:

- **An eight hour WES-TWA (time weighted average) of 1mg/m<sup>3</sup>**
- **A WES-GEL (general excursion limit) of 3mg/m<sup>3</sup>**

A reduction in the WES-TWA or WES-GEL will have no impact on the sampling methodology used for wood dust. The method used in New Zealand has an appropriate quantification limit with sufficient accuracy to determine time-weighted averages at concentrations below the proposed WES.

The softwood dust occupational exposure limits from 21 other countries or standard setting organisations are listed in this paper. The proposed eight-hour WES-TWA of 1mg/m<sup>3</sup> is equivalent to seven of the 21 and more stringent than 14 of the 21.

## SUBMISSIONS ON THE REPORT

In order to assist the Department of Labour make its final decision on the Workplace Exposure Standards for softwood dust, submissions on this report are invited. For further details, please refer to:

<http://www.dol.govt.nz/consultation/index.asp>. The closing date for feedback is Tuesday, 31 August 2010.

## GLOSSARY OF TERMS

**Adenocarcinoma:** Cancer of the cells that line organs e.g. the nasal cavities.

**Cytological modifications:** Changes to cells.

**Extrinsic allergic alveolitis:** an inflammation in the alveoli (small air sacs in the lungs) caused by the allergic reaction of the body to a specific substance originating outside the body.

**FEV<sub>1</sub> (Forced Expiratory Volume in 1 Second):** The volume of air that can be forced out in one second after taking a deep breath.

**FVC (Forced Vital Capacity):** The volume of air that can be forced out after full inspiration.

**Idiopathic pulmonary fibrosis:** Pulmonary fibrosis is a condition in which tissue deep in the lungs becomes thick and stiff, or scarred, over time. The development of the scarred tissue is called fibrosis. Idiopathic means the cause of the fibrosis is not clear.

**Mucociliary clearance:** Fine hair-like projections from cells in the respiratory tract (cilia) "sweep" in unison to remove (or clear) fluids and particles. Ciliated cells and mucus secreting cells in the respiratory tract have been termed the "mucociliary escalator".

**Nasal Epithelium:** The outside layer of cells of the nasal cavities.

**Respiratory mucosa:** Relating to the mucous membranes lining the respiratory tract including the nasal cavity, the larynx, the trachea and the bronchi.

**Rhinitis:** Inflammation and swelling of the mucous membrane of the nose, characterised by a runny nose and stuffiness.

**Sinusitis:** Inflammation of the lining of the paranasal sinuses.

## SECTION 1: WORKPLACE EXPOSURE STANDARDS

Workplace Exposure Standards (WES) are health-based guidelines for airborne contaminants and are endorsed by the Department of Labour ("The Department"). The current WES publication (Workplace Exposure Standards and Biological Exposure Indices) is available at:

[www.osh.govt.nz/order/catalogue/329.shtml](http://www.osh.govt.nz/order/catalogue/329.shtml)

WES are intended to be used as guidelines for those involved in occupational health practice. Defining a level that will achieve freedom from adverse health effects is a major consideration when setting standards. Compliance with the designated value does not, however, guarantee protection from discomfort or possible ill-health outcomes for all workers. The range of individual susceptibility is wide and it is possible that workers will experience discomfort or develop occupational illness from exposure to substances at levels below the exposure standards.

In all instances the WES relate to exposure that has been measured by personal monitoring that gathers air samples in the worker's breathing zone.

The WES publication defines the following categories of WES:

**Time Weighted Average (WES-TWA)** - The time-weighted average exposure standard is designed to protect the worker from the effects of long-term exposure. This is based on an eight-hour working day and a 40-hour working week.

**Ceiling (WES-Ceiling)** - A concentration that should not be exceeded during any part of the working day.

**Short-Term Exposure Limit (WES-STEL)** - The 15 minute average exposure standard. It applies to any 15-minute period in the working day and is designed to protect the worker against adverse effects of irritation, chronic or irreversible tissue change, or narcosis that may increase the likelihood of accidents. The WES-STEL is not an alternative to the WES-TWA; both the short-term and time-weighted average exposures apply.

**General Excursion Limit (WES-GEL)** - Often there is insufficient toxicological data available for the establishment of a Short Term Exposure Limit. Peak exposure should, however, be controlled even in situations where the Time-Weighted Average level is not exceeded. A 15-minute exposure limit of three times the TWA is recommended. Where a STEL has been assigned, the STEL value takes precedence over the general excursion regardless of whether or not it is a stricter standard.

There is some confusion as to whether the WES apply to air inside or outside respiratory protective equipment. The intention of the WES is to establish a concentration that can be inhaled without causing adverse health effects. If a respirator is worn, the WES applies to the concentration inside the respirator.

As inward leakage of air occurs with respiratory protection (due to poor face seals and valve leakage etc) it is important to consider the reduction in exposure the respirator is likely to provide when choosing one. This reduction, termed 'protection factor', is defined as the ratio of the concentration of the contaminant outside the respirator to the concentration inside it i.e. breathed by the wearer. The protection factor can also be expressed by the following equation (AS/NZS 1715:2009):

$$\text{Protection factor} = \frac{\text{Ambient air concentration}}{\text{Concentration inside respirator}}$$

The protection factor required for a respirator to reduce exposure to an accepted level is called the 'required minimum protection factor'. It can be expressed by the following equation:

$$\text{Required minimum protection factor} = \frac{\text{Ambient air concentration}}{\text{Exposure Standard}}$$

For example, if the air concentration (in the worker's breathing zone) is 10mg/m<sup>3</sup> and the exposure standard is 1mg/m<sup>3</sup>, the required minimum protection factor of a mask is 10. However, in situations where the air concentration in the worker's breathing zone exceeds the exposure standard, all practicable steps must be taken to eliminate or isolate exposure (providing suitable respiratory protection only until this is achieved). However, if elimination or isolation is not practicable, and respiratory protection is used, a respirator with an appropriate protection factor should be worn. In the above example, the required minimum protection factor of a mask is at least 10. However, as exposure should be reduced as much as practicable, then a protection factor greater than 10 should be the aim.

## SECTION 2: HEALTH EFFECTS OF WOOD DUST EXPOSURE

Health effects associated with wood dust are discussed in the following sections.

### 2.1 Non-carcinogenic effects

Acute and chronic respiratory effects are associated with both hard and softwood dust exposure.

Upper respiratory tract adverse effects include a cough, nasal irritation, obstruction and discharge (rhinitis), sinusitis and long lasting colds. Other adverse effects include cytological modifications of the nasal epithelium and other respiratory mucosa, and reduction in mucocilliary clearance. Eye irritation is also reported (SCOEL, 2003).

Lower respiratory tract findings include impaired lung function tests, such as reduced FEV<sub>1</sub> and FEV<sub>1</sub>/FVC ratio (characteristic of an 'obstructive' defect), and/or increased bronchial responsiveness (*bronchial hyper-responsiveness*), such as occurs in cases of occupational asthma. Other adverse respiratory effects include chronic airflow obstruction, chronic bronchitis, idiopathic pulmonary fibrosis and extrinsic allergic alveolitis (SCOEL, 2003).

Many studies have shown a strong link with occupational asthma and exposure to Western Red Cedar dust (ACGIH, 2005). For this reason some standard setting organisations or jurisdictions list wood dust as a sensitiser or have specific standards for certain, or some allergenic species.

### 2.2 Carcinogenic effects

Wood dust is classified as a Group 1 Carcinogen (carcinogenic to humans) by the International Agency for Research on Cancer (IARC, 1997). The IARC states:

*The excess [a clearly increasing risk with increasing estimated levels of exposure to wood dust] appears to be attributable to wood dust per se, rather than to other exposures in the workplace, since the excess was observed in various countries during different periods and among different occupational groups, and because direct exposures to other chemicals do not produce relative risks of the magnitude associated with exposure to wood dust. (IARC, 1997).*

The IARC Monograph does not make a distinction between hardwoods and softwoods, although reference was made to a significant risk of sino-nasal cancer observed in workers exposed primarily to hardwood dusts. The IARC states:

*Adenocarcinoma of the nasal cavities and paranasal sinuses is clearly associated with exposure to hardwood dust; in several series of cases*

*of adenocarcinoma from different countries, a high proportion of cases had been exposed to hardwood, and these findings were confirmed in several case-control studies as well. There were too few studies of any type to evaluate cancer risks attributable to exposure to softwood alone. In the few studies in which exposure was primarily to softwood, the risk for cancer of the nasal cavities and paranasal sinuses was elevated but considerably lower than that in studies of exposure to hardwood or to mixed wood types; furthermore, in the studies of exposure to softwood, exposure to hardwood could not clearly be ruled out. (IARC, 1997).*

The association between hardwood dust and sino-nasal adenocarcinoma is well documented (SCOEL, 2003). The European Union Scientific Committee on Occupational Exposure Limit Values (SCOEL) states:

*Adenocarcinoma represents a variable proportion of sino-nasal cancers (between 10% and 50% depending on the country); the link between the onset of this histological form and exposure to wood dust is very clear, more so than in the case of the squamous cell form. The association seems particularly strong with dust from hardwood. A large proportion of the adenocarcinoma cases included in the studies published were related to exposure to hardwood dusts and the case-control investigations in which the type of wood used was noted confirm the stronger association with hardwood dust than with softwood dust. It is virtually impossible, however, to distinguish the respective role of each type of wood in the genesis of sino-nasal cancer. On the one hand, few studies have recorded the necessary information and, on the other, most often both types of wood are used in furniture factories and in carpentry and cabinet-making workshops, the fields of activity in which the risks are highest. The results of some studies with workers exposed solely or mostly to softwood dusts are conflicting, but it seems that such exposure is associated with a smaller increase in the risk of sino-nasal cancer, relating mainly to squamous cell cancers or cancer forms other than adenocarcinoma.*

Jayaprakash et al (2008) studied wood-dust exposure and risk of upper aero-digestive and respiratory cancers. The study found a statistically significant association for lung and tracheal cancers. An association between wood-dust exposure and adenocarcinoma of the lung was also found.

Barcenas et al (2005) observed an increased risk of lung cancer for combined wood-dust occupations.

Ramroth et al (2008) found excess risk of laryngeal cancer associated with high hardwood and softwood-dust exposures.

## SECTION 3: HARDWOOD AND SOFTWOOD DUSTS

Trees are generally classified as gymnosperms or angiosperms. Gymnosperms generally have needle or scale-like leaves and are usually evergreen. Angiosperms are usually deciduous and broadleaf. Temperate gymnosperms are often referred to as 'softwoods'. Examples include pine, firs, Kauri, Rimu, Matai, Totara, spruces and cedars. Temperate angiosperms are often referred to as hardwoods. Examples include Oak, Beech, Southern Rata, Northern Rata, Tawa and Southern New Zealand Beech. A hardwood is not necessarily comprised of harder material (more dense) than a softwood.

The IARC states:

*Wood dust is composed mainly of cellulose, polyoses and lignin and a large and variable number of substances of lower relative molecular mass which may significantly affect the properties of the wood. These include non-polar organic extractives (fatty acids, resin acids, waxes, alcohols, terpenes, sterols, steryl esters and glycerols), polar organic extractives (tannins, flavonoids, quinones and lignans) and water-soluble extractives (carbohydrates, alkaloids, proteins and inorganic material). (IARC, 1997).*

In the past many jurisdictions have had a lower occupational exposure guideline for hardwood dusts compared to softwood dusts. This is likely due to the 1995 (updated 1997) IARC classification of wood dust as a known carcinogen. The IARC document did not make a distinction between hard and softwoods in assigning this classification. However, it referred to a clear association between adenocarcinoma of the nasal cavities and paranasal sinuses and exposure to some hardwood dusts.

In more recent years, there has been a move towards identical treatment for hard and softwood dusts from a health risk assessment point of view. Table 1 in Section Six lists wood-dust occupational exposure guidelines from other countries and organisations. The majority do not have a different exposure guideline value for hard versus softwood dusts. Some have a guideline specifically for Western Red Cedar, Oak or Beech, and some have separate guidelines for allergenic versus non-allergenic wood dusts.

Countries or organisations that do not have a different exposure guideline value for hardwood versus softwood dusts include:

- ACGIH (The American Conference of Governmental Industrial Hygienists)
- Belgium
- The Canadian provinces of Alberta, British Columbia, Newfoundland, Nova Scotia, Manitoba and Quebec
- Denmark
- France
- Japan

- The Netherlands
- NIOSH (The United States National Institute of Occupational Safety and Health)
- OSHA (The United States Occupational Safety and Health Administration)
- Spain
- Sweden
- Switzerland
- United Kingdom.

Countries that currently have a softwood-dust exposure guideline value different than the hardwood dust guideline include:

- Argentina
- Australia
- Canada (Ontario only)
- New Zealand.

Finland, the European Union and South Africa only have occupational exposure guidelines for hardwood dust (all 5mg/m<sup>3</sup>).

The SCOEL in its 2003 report *Recommendation from the Scientific Committee in Occupational Exposure Limits: Risk Assessment for Wood Dust* state:

*...the results of experimental studies in animals provide no conclusive argument to justify a distinction between [health] effects specific to softwood dusts and other effects specific to hardwood dusts. With regard to currently available data and with a view to protecting the health of workers, all in all it does not seem pertinent to distinguish between softwood and hardwood dusts.*

The Health Council of the Netherlands in its report *Hardwood and Softwood Dust; Evaluation of the Carcinogenicity and Genotoxicity* concluded that toxicology-based exposure limits for hardwood and softwood should be derived identically, considering that hardwood dust is proven to be carcinogenic and softwood dust is suspected to be (2000).

There is clear evidence that accelerated pulmonary function decline is associated with exposure to wood dust from a variety of tree species (both hard and soft) (ACGIH, 2005).

## **SECTION 4: BASIS FOR PROPOSING AN EIGHT-HOUR WES-TWA OF 1mg/m<sup>3</sup>**

### **4.1 Proposed Department of Labour Workplace Exposure Standard for Softwood Dust**

The Department proposes to reduce the eight-hour WES-TWA from 5mg/m<sup>3</sup> to 1mg/m<sup>3</sup> for softwood dust.

The Department's WES publication says where there is insufficient toxicological data for the establishment of a Short Term Exposure Limit (WES-STEL), a 15-minute exposure limit of three times the eight-hour TWA is recommended. This value is called a WES-GEL (General Excursion Limit). For this review, the detailed toxicological data was insufficient to readily determine a WES-STEL. Thus a WES-GEL of 3 times the eight-hour TWA is proposed i.e. a WES-GEL of 3mg/m<sup>3</sup>.

Various organisations have reviewed toxicological data with a view to developing a wood-dust exposure guideline. Their work is summarised in the following sections and has led to a decision to reduce the softwood dust WES and bring it into line with the current hardwood dust WES.

### **4.2 DECOS (1992)**

In 1992, the Dutch Expert Committee for Occupational Standards (DECOS) advised the adoption of a health-based recommended occupational exposure limit of 0.2mg/m<sup>3</sup> (total dust) (DECOS, 1992). No distinction was made between different types of wood in setting this exposure limit. This limit was expected to prevent irritation of the eyes and of the respiratory tract, and impaired ciliary clearance, as well as to minimise the risk of occupational asthma and nasal allergies. This level was also considered to minimise the risk of nasal cancers as *absence of mechanical and chemical irritation of the nasal mucosa is considered a prerequisite for minimising the risk of nasal cancer from exposure to wood dust* (DECOS, 1992).

A discussion on comparing 'total dust' to 'inhalable dust' results is given in Section 5.4. It should be kept in mind when considering the DECOS recommended occupational exposure limit.

### **4.3 Demers et al (1997)**

In 1997, Demers et al from the Occupational Hygiene Programme at the University of British Columbia Department of Health Care and Epidemiology wrote a paper reviewing the respiratory effects of softwood dust exposure and giving recommendations regarding exposure limits (Demers, et al, 1997).

Based on studies up to 1997, they concluded based on epidemiologic evidence, there may be a risk of sino-nasal cancer associated with softwood dust exposure. They considered this risk much smaller than that for

hardwood dusts. They concluded that studies up to that time did not have enough data for standard setting in regard to cancer risk.

Demers et al state:

*The results of studies of non-malignant respiratory disease among woodworkers clearly indicate that health effects are occurring at "non-allergenic" softwood dust concentrations well below 5mg/m<sup>3</sup>. The available evidence seems to indicate that to prevent these non-malignant effects the level of occupational exposure to all softwood dust should be at least as low as 2mg/m<sup>3</sup>. It is unlikely that such a standard would provide a safety margin to protect more sensitive workers; a standard of 1mg/m<sup>3</sup> may be more appropriate to achieve such protection. (Demers et al, 1997).*

The paper acknowledges that the sampling methods used in the studies varied considerably, making comparisons difficult. It is also likely that (given the dates and sources) that the studies used 'total dust' sampling methods rather than 'inhalable dust' methods. A discussion on comparing total dust to inhalable dust is given in Section 5.4 and should be kept in mind when considering recommendations in this paper.

#### **4.4 SCOEL (2003)**

The European Union Scientific Committee on Occupational Exposure Limit Values (SCOEL) is mandated to advise the European Commission on occupational exposure limits for chemicals in the workplace.

In 2003, SCOEL published a report *Recommendation from the Scientific Committee in Occupational Exposure Limits: Risk Assessment for Wood Dust*. In this report SCOEL reviewed 21 toxicological papers studying human exposure in wood working environments. The papers presented data on airborne concentration ranges and reported adverse health effects. SCOEL concluded in their report that: *Overall workers exposed to wood dust concentrations between 0.5 and 1mg/m<sup>3</sup> (Note 1) exhibited significant health impairments; this was demonstrated by several studies conducted among workers exposed to dust from various species of wood. For exposures higher than or equal to 1mg/m<sup>3</sup> (Note 1), the effects on health are clear and include various symptoms of the disturbances of the upper respiratory tract, a significant alteration of respiratory function parameters and asthma.*

They went on to say: *In general, the published studies clearly indicate that the frequency of allergenic and non-allergenic respiratory manifestations due to exposure to wood dust, whether to softwood or to hardwood, is significantly elevated in workers exposed to concentrations of 1mg/m<sup>3</sup>\* (Note 1) and upwards but still well below 5mg/m<sup>3</sup>\* (Note 1)''.*

Note 1 – In the majority of studies reviewed by SCOEL, air concentrations of wood dust were measured using the 'total dust' method rather than an

'inhalable dust' method (explained in Section 5.4). Using available data, SCOEL devised the following conversions from a total dust concentration to an inhalable dust concentration (SCOEL, 2003):

<i>Total dust concentration (mg/m<sup>3</sup>)</i>	<i>Concentration equivalent, expressed as the inhalable fraction (mg/m<sup>3</sup>)</i>
<i>0.5</i>	<i>1.0 to 1.5</i>
<i>1.0</i>	<i>2 to 3</i>
<i>5.0</i>	<i>10 to 15</i>

Based on the above table, and SCOEL's conclusion that significant health impairments are reported between 0.5 and 1mg/m<sup>3</sup> (total dust), then the inhalable concentration equivalent would be *significant health impairments are reported between 1 to 3mg/m<sup>3</sup> (inhalable dust)*.

#### **4.5 ACGIH (2005)**

In their 2005 review of the Threshold Limit Value for wood dusts, the American Conference of Governmental Industrial Hygienists (ACGIH) recommended an eight-hour TLV-TWA (Threshold Limit Value-Time Weighted Average) of 1mg/m<sup>3</sup> inhalable dust for all species of wood (soft and hard) - excluding Western Red Cedar - based on preventing decreases in pulmonary function. The Western Red Cedar TLV-TWA was recommended as 0.5mg/m<sup>3</sup> (inhalable dust) to protect exposed workers from developing occupational asthma. These TLVs were adopted in 2005 and have remained unchanged since then.

In their review, the ACGIH considered studies where wood dust was the predominant exposure and where there were no significant exposures to other chemicals known to have respiratory effects, e.g. formaldehyde. At least 28 papers describing respiratory disease with wood-dust exposure were reviewed by the ACGIH. These papers were from a variety of industries with wood exposure and included a variety of tree species. A further eight papers looked at respiratory symptoms where predominant wood-dust exposure came from Western or Eastern Red Cedar. The ACGIH also reviewed cancer associated with wood dust exposure.

Its review concluded that: *A number of studies have observed these effects [impaired lung function and both lower and upper respiratory symptoms] at levels between approximately 1 and 5mg/m<sup>3</sup> inhalable particulate mass.* (ACGIH, 2005).

In regards to cancer, it stated that: *No studies have thus far examined the risk of sino-nasal cancer in relationship to quantitative estimates of wood dust exposure.*

Based on current evidence, the ACGIH assigned an A1 (confirmed human carcinogen) notation to Beech and Oak. They assigned an A2 (suspected human carcinogen) notation to Birch, Mahogany, Teak and Walnut. The

remaining trees species are assigned an A4 (not classifiable as a human carcinogen).

The ACGIH goes on to say: *While the very high risks of sino-nasal cancer may have been associated with exposure levels greater than 2mg/m<sup>3</sup> inhalable dust, it is not clear whether relative risks of 2 to 5, which have been observed in more recent studies, may be associated with lower exposures. Recent data suggest that occupational wood dust levels <1mg/m<sup>3</sup> (inhalable particulate mass) may substantially decrease the risk of nasal cancer.* (ACGIH, 2005).

#### **4.6 ECETOC (2009)**

The scientific trade association European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) published a report in 2009 called *Framework for the Integration of Human and Animal Data in Chemical Risk Assessment* (Technical report 104).

The report provides guidance on how human data can be used and integrated into chemical risk assessment and management processes. The framework for doing this, as proposed in the document, is illustrated by a number of examples (Appendix B of the report). One of the examples is for wood dust (Appendix B.3) which refers to three studies using inhalable-dust data and concludes that:

1. *The critical effect is pulmonary function decline,*
2. *There is clear evidence of respiratory effects from inhalable wood dust in the exposure range of 1.6mg/m<sup>3</sup> and above,*
3. *The studies reviewed were of relatively good quality and confounding factors such as smoking were taken into account,*
4. *Pulmonary effects can be anticipated from wood dust exposures in the 2mg/m<sup>3</sup> range and above,*
5. *There is not enough data to describe a full dose-response curve,*
6. *A Danish study in 2002 showed minimal effects at 1.2mg/m<sup>3</sup>,*
7. *"An assessment factor of 2<sup>(Note 1)</sup> seems appropriate to extrapolate from the minimal effect level to a NOAEL, resulting in a value of 0.6mg/m<sup>3</sup> inhalable wood dust".*

Although not clearly stated in Appendix B.3, the Department's interpretation of the above is that a Derived No Effects Level <sup>(Note 2)</sup> of 0.6mg/m<sup>3</sup> inhalable wood dust is recommended by ECETOC.

*Note 1:* Various assessment factors (also called safety or uncertainty factors) are applied to toxicological data to account for differences between individuals; adjusting from a Lowest Observable Adverse Effects Level (LOAEL) to a No Observable Adverse Effects level (NOAEL); and for uncertainties in experimental data. Paustenbach states that *the uncertainty factor approach has been and continues to be used by FDA, EPA OSHA and virtually all agencies and scientific bodies who set acceptable levels of exposure to toxic substances.* (Perkins, 2000).

*Note 2:* Derived No Effects Level: EU Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), obliges registrants to develop Derived No Effects Levels (DNELs) for registered substances. A DNEL is defined as a level of exposure above which humans should not be exposed. The DNEL acts as a benchmark for determining adequate control of exposure for specified chemicals and exposure scenarios.

## SECTION 5: SAMPLING METHODS

### 5.1 Softwood dust sampling

The inhalable dust fraction is considered the best convention for measuring airborne wood dusts (SCOEL, 2003). Inhalable dust is the fraction of total airborne particulate which is inhaled through the nose and mouth.

The current Workplace Exposure Standards and Biological Exposure Indices publication (2002) requires that particulate monitoring for inhalable dust be carried out in accordance with Australian Standard AS 3640:2009 *Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Inhalable Dust*. AS 3640:2009 defines inhalable dust as *The dust fraction consisting of those airborne particles that are taken in through the nose or mouth during breathing and which has been so defined in ISO 7708 as the percentage of inhalable matter collected by a device conforming to a sampling efficiency curve which passes through the points shown in Table 1* (Note 1).

Note 1: Table 1 is reproduced in part on page 55 of the 2002 Workplace Exposure Standards and Biological Exposure Indices publication, although some values differ from those given in AS 3640:2009. The values given in AS 3640:2009 will be reproduced in the 2010 version of the WES publication which is due out within the next few months.

AS 3640:2009 refers to two sampling devices that “generally satisfy” the ISO 7708 criteria. These are:

1. The UK Institute of Occupational Medicine ‘IOM’ sampling head, and
2. The modified personal United Kingdom Atomic Energy Authority (UKAEA) sampling head, also called the ‘7-hole head’.

These methods are commonly used in New Zealand for measuring airborne wood dust and have been for at least 16 years (based on guidance provided in the 1994 version of the New Zealand Workplace Exposure Standards (Department of Labour, 1994). Various other inhalable sampling heads are also available. A collaborative European study compared how well different sampling heads met the ISO inhalable criteria (Kenny et al, 1997). This study showed that the IOM and GSP (Note 2) samplers were the two that best followed the sampling convention for inhalable dust.

Note 2: Gesamt Staub Probenahme an der Person sampling head as used in Germany.

### 5.2 Discussion on lowering the WES and implications for sampling

A lower softwood dust WES is not a problem for quantification levels. The quantification level of the analytical method as defined in AS 3640:2009 is sufficient to achieve concentrations well below 1mg/m<sup>3</sup>.

Having the same exposure standard for both hard and softwoods is more practical where mixed wood dusts are present, as the sampling method does not distinguish between wood types.

### **5.3 Issues in wood dust sampling**

Some issues currently exist with wood dust sampling, and these issues will continue to be present whether the WES is lowered or not. These issues include:

- The method uses gravimetric analysis to determine airborne concentration i.e. a total mass of particulate is measured. In workplaces other dusts may be present that contaminate the sample e.g. diesel particulate. Thus, a false high concentration for wood dust may result;
- A large variety in exposure patterns can occur in wood working and wood dust exposed industries;
- Projectile particles that would normally be too large to breathe in may enter the sample head and give a false high result.

Some of these issues can be managed by good sample design and detailed observation of work tasks. Demers et al (2000) evaluated wood-dust content in particulate. He concluded that systematic observations of job tasks and proximity to dust sources were more accurate indicators of wood dust content than visual inspections of dust colour or morphology of the samples.

### **5.4 Comparing results from 'total dust' samples to 'inhalable dust' samples**

In the US, Canada and some European countries, the predominant wood-dust sampling method used has been 'total dust' sampling as per the National Institute for Occupational Safety and Health (NIOSH) method 0500 (ACGIH, 2005). This method uses a closed face cassette with a 4mm inlet and a pre-weighed 37mm filter. In New Zealand, Australia and most European countries, 'inhalable dust' sampling methods are used for measuring wood dust. These methods include the IOM, UKAEA and GSP sampling heads as discussed in Section 5.1.

Most studies assessing exposure to inhalable wood dust and reported health effects have used the 'total dust' method. Studies comparing the sampling efficiency of various dust samplers have shown that the mass of dust gathered by inhalable samplers (i.e. IOM, UKAEA, GSP) in side-by-side tests, was greater than the mass sampled by the total dust sampler (37mm cassette) by a factor of 1.2 to 4.2. In some studies, higher factors have been reported. However, these may be due to larger particles contaminating samples (ACGIH, 2005). This factor (of 1.2 to 4.2) depends on the size distribution of the dust sampled and cannot be described by a simple linear relationship.

Although it might seem contradictory that the total-dust method actually samples less dust than the inhalable samplers, the difference in efficiency is

due to the design of the sampling heads. The total dust 37mm sampling cassette was not designed to sample a conventional aerosol fraction (i.e. respirable, inhalable or thoracic) (Kauffer et al, 2010). In addition, the total dust cassette significantly underestimates the inhalable fraction when aerodynamic diameter exceeds 20 to 25µm (Kauffer et al, 2010).

There is no widely accepted method for converting total dust values into inhalable dust values (SCOEL, 2003). SCOEL (2003) reviewed studies comparing total dust to inhalable sampling methods and concluded:

*Available data suggest that a numerical value of an OEL\* expressed as 'inhalable dust' may be set at approximately twice the numerical value of what would have been the corresponding limit value for 'total' dust. Assuming [this], the threshold concentrations (OELs) for wood dust considered in [this document] are expressed as the total dust fraction. Applying a ratio of inhalable dust/total dust of 2 or 3 to 1, the new threshold concentrations (OELs) expressed as inhalable dust would be as follows:*

<i>Total dust concentration (mg/m<sup>3</sup>)</i>	<i>Concentration equivalent, expressed as the inhalable fraction (mg/m<sup>3</sup>)</i>
<i>0.5</i>	<i>1.0 to 1.5</i>
<i>1.0</i>	<i>2 to 3</i>
<i>5.0</i>	<i>10 to 15</i>

\* OEL (Occupational Exposure Limit).

The ACGIH reviewed studies comparing total dust and inhalable dust methods and used a ratio of 2.5 as a conversion factor for reviewing studies with measurements based on total dust sampling (ACGIH, 2005). They highlighted that differences between total and inhalable results will depend on particle size and mass concentration.

## SECTION 6: SOFTWOOD DUST OCCUPATIONAL EXPOSURE LIMITS FROM OTHER COUNTRIES

Country	Eight hour exposure limit	Short term exposure limit
Argentina	5mg/m <sup>3</sup>	
Australia	5mg/m <sup>3</sup>	10mg/m <sup>3</sup>
Belgium	3mg/m <sup>3</sup>	
Canada – Alberta	allergenic wood dusts 2.5mg/m <sup>3</sup> non-allergenic softwood 5mg/m <sup>3</sup>	allergenic wood dusts 5mg/m <sup>3</sup> non-allergenic softwood 10mg/m <sup>3</sup>
Canada – British Columbia	1mg/m <sup>3</sup> (all species except Western Red Cedar)	3mg/m <sup>3</sup> (excursion limit)
Canada – Newfoundland	1mg/m <sup>3</sup> (all species except Western Red Cedar)	3mg/m <sup>3</sup> (excursion limit)
Canada – Nova Scotia	1mg/m <sup>3</sup> (all species except Western Red Cedar)	3mg/m <sup>3</sup> (excursion limit)
Canada – Manitoba	1mg/m <sup>3</sup> (all species except Western Red Cedar)	3mg/m <sup>3</sup> (excursion limit)
Canada – Ontario	5mg/m <sup>3</sup>	10mg/m <sup>3</sup>
Canada - Quebec	5mg/m <sup>3</sup> (except red cedar)	
Denmark	2mg/m <sup>3</sup>	
France	1mg/m <sup>3</sup>	
Japan	1mg/m <sup>3</sup> (respirable) 4mg/m <sup>3</sup> (total)	
the Netherlands	2mg/m <sup>3</sup>	
Spain	5mg/m <sup>3</sup>	
Sweden	2mg/m <sup>3</sup>	
Switzerland	2mg/m <sup>3</sup>	
United Kingdom	5mg/m <sup>3</sup>	

Country	Eight hour exposure limit	Short term exposure limit
United States - ACGIH	1mg/m <sup>3</sup> (all species except Western Red Cedar)	3mg/m <sup>3</sup> (excursion limit)
United States - NIOSH	1mg/m <sup>3</sup> (<10 hour TWA)	
United States - OSHA	15mg/m <sup>3</sup> (total dust, except red cedar) 5mg/m <sup>3</sup> (respirable dust, except Red Cedar)	

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