

# THE AUSTRALIAN WORK EXPOSURES STUDY (AWES): FORMALDEHYDE



November 2014

The views in this report should not be taken to represent the views of Safe Work Australia unless otherwise expressly stated.



**SAFE WORK AUSTRALIA**

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# PREFACE

The Australian Work Health and Safety Strategy 2012-2022 (the Strategy) describes work-related cancer as a priority disorder and understanding current hazardous exposures and the effectiveness of controls as a research priority. The Australian Work Exposures Study (AWES) was a national survey that investigated work-related exposures among Australian workers to 38 agents classified by the International Agency for Research on Cancer (IARC) as known or suspected carcinogens.

Formaldehyde is classified as a known human carcinogen by the IARC and the work described in this report uses AWES data to:

- estimate the prevalence of work-related exposure to formaldehyde during relatively common workplace activities
- identify the main circumstances of those exposures, and
- identify the use of workplace control measures designed to decrease those exposures.

This report describes those exposures that occur when typical work activities are carried out by Australian workers—it does not specifically focus on industries suspected of high formaldehyde exposure.

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# KEY MESSAGES

- Approximately 2.5% of workers who participated in the Australian Work Exposures Study (AWES) were probably exposed to formaldehyde when performing common tasks like working with particle board or plywood, fire fighting and back-burning, sterilizing medical equipment or working in pathology laboratories.
- The health risks posed by exposures to formaldehyde, including potential cancer outcomes, have been highlighted in a number of reports by Australian and overseas agencies. Workplace Exposure Standards for formaldehyde are listed in the Australian Hazardous Substances Information System and model Codes of Practice and work health and safety guides identify common tasks where formaldehyde exposure is a potential hazard and provide advice on preventing exposures using the hierarchy of controls.
- However, when information on the use of controls was provided by AWES respondents, only 61% of AWES respondents reported regularly using local exhaust ventilation or personal protective equipment (PPE). A number of these AWES respondents only used paper masks which are unlikely to provide effective protection against formaldehyde exposures.
- Most workers were assessed as having medium or low task-based exposures to formaldehyde. While most of these workers will not develop cancer as a result of work-related exposures to formaldehyde, they are at greater risk.
- Many of the high and medium task-based exposures can be prevented. Awareness-raising and education efforts are required to increase the regular use of well-known and readily available controls to prevent exposures like enclosed systems for sterilising medical equipment, 'on-tool' systems which extract dusts and vapours when working with particle board, local exhaust ventilation systems and appropriate respiratory protective equipment.

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# EXECUTIVE SUMMARY

## Background

Cancer is a priority disorder under the Australian Work Health and Safety Strategy 2012-2022 (the Strategy). Better understanding of current hazardous exposures and the effectiveness of controls is a research priority under the Strategy. While formaldehyde is classified by the International Agency for Research on Cancer (IARC) as a known human carcinogen there is no nationally representative or comprehensive information about the nature of this exposure in Australian workers.

The Australian Work Exposures Study (AWES) is a recently-conducted nationwide survey which investigated the current prevalence of work-related exposure to 38 known or suspected carcinogens, including formaldehyde, among Australian workers. The AWES data provide an opportunity to better understand the extent and circumstance of exposure of the Australian workforce to formaldehyde.

The aim of the work described in this report was to use AWES data to estimate the prevalence of work-related exposure to formaldehyde during relatively common workplace activities, to identify the main circumstances of exposures, and to identify the use of workplace control measures designed to decrease those exposures. This report is concerned with those exposures that occur when typical work activities are carried out by Australian workers—it does not specifically focus on industries suspected of high formaldehyde exposure.

## Approach

The information presented in this report comes primarily from analyses of data from the AWES project. The AWES project involved computer-assisted interviews of approximately 5000 Australian workers. OccIDEAS—an automated process of expert assessment—was used to assess the likelihood of exposures and estimate exposure levels to 38 known or suspected carcinogens based on self-reported information on work tasks and the controls being used by workers. The likelihood of exposure was assessed as none, possible or probable. Data on tasks that could result in formaldehyde exposure were extracted and examined for this report.

Prevalence estimates based on the proportion of workers in the AWES sample probably exposed to formaldehyde were applied to the Australian Bureau of Statistics 2011 Census data to provide prevalence estimates for the Australian working population. The AWES information was supplemented with limited Australian data from other sources, including from the 2008 National Hazard Exposure Worker Surveillance (NHEWS) Survey and the published literature. National level estimates were compared to prevalence estimates found in major overseas studies.

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## Key findings

Of the workers who completed the AWES survey:

- 124 (2.5%) had probable exposure to formaldehyde
- 87% of the workers with probable exposure were male
- just over half of all workers with probable exposure worked in technical and trades occupations, and
- almost half of those with probable exposure worked in the construction industry.

The main tasks associated with probable exposures to formaldehyde were, in decreasing order: working with particle board, fire fighting, fire overhaul and clean-up, sanding prior to painting, sterilising medical equipment, manicuring and working in a pathology laboratory. The majority of tasks (approximately 96%), with the exception of sterilising medical equipment, were assessed as resulting in medium or low exposures.

The main control measures workers reported using were designed to decrease the chance of exposure to formaldehyde by inhalation, for example wearing respiratory protective equipment (RPE) such as face masks or half-face respirators or using area ventilation. In some circumstances the RPE used by workers may not have provided adequate protection. For example, wearing half face paper masks might prevent exposures to dusts when working with timber products but it will not prevent inhalation of formaldehyde vapours or fumes. Overall, the use of control measures could be improved to prevent exposures to formaldehyde.

If AWES estimates are applied to the Australian working population approximately 2.3% of all workers could be considered as probably exposed to formaldehyde at work. This estimate is much higher than that found in major overseas studies, the differences probably due primarily to differences in study methodologies in terms of the type of data collected and the approach used to estimate exposure.

## Limitations

The AWES is a national population-based study providing representative exposure information on relatively common activities. Information will be lacking on most industry sub-sectors, specific occupations and specific tasks which are less common or which are undertaken by a relatively small number of people. This is why some tasks that would usually be viewed as having a high prevalence of formaldehyde exposure, such as manufacturing of timber products, happened not to be included in the study sample of 5023 workers.

Subjects included in the AWES sample were asked a series of questions about their job and the tasks involved. Some information was also obtained on the use of control measures. However, the information that could be collected on controls was somewhat limited. This was because questions asked in AWES primarily assessed if exposure could occur and then, if possible, the level of exposure; and because there were limitations on the number of questions that could be asked while still encouraging people to participate in the project

Exposure assessments were qualitative and refer to task or activity based exposure levels rather than to exposure standards.

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## Policy implications

Approximately 2.3% of Australian workers are estimated to be exposed to formaldehyde when performing relatively common tasks at work. More information is required to understand the level of risk arising from these exposures in terms of cancer outcomes.

Some of the health risks posed by exposures to formaldehyde, the tasks that might result in such exposures and the methods of preventing exposure should be well understood. However, the inconsistency in carcinogenic classifications between some authoritative sources could create uncertainty about some of the risks posed by formaldehyde exposures—future work could consider if revising the current classification information in Hazardous Substances Information System (HSIS) to reflect the findings of the IARC is warranted.

The use of exposure control measures by the workers in the AWES sample appears to have considerable scope for improvement. Where information on the use of controls was collected, many respondents reported using RPE or reported not using any controls to prevent exposures. There is an opportunity to prevent work-related exposures to formaldehyde through efforts to increase the number of workplaces that consistently use high order controls and good work practices to eliminate or reduce these exposures. Based on the results presented in this report, many significant exposures could be lowered by:

- ensuring when workers use power tools while working with particle board or plywood that:
  - power sanders, power saws and drills are equipped with 'on tool' systems which extract dusts and vapours,
  - local exhaust ventilation is installed and functioning, and
  - workers are supplied with and use appropriate RPE such as half-face respirators rather than paper masks, and
- ensuring fire fighters use appropriate breathing apparatus at all relevant times when fighting fires and working on fire overhaul and clean up.

Initial efforts could focus on initiatives that raise awareness or educate persons conducting a business or undertaking (PCBUs) and workers about using alternatives to formaldehyde or using well-known and readily available controls to prevent exposures to formaldehyde.

## Further research

The AWES project provides qualitative information on current exposures to formaldehyde based on job tasks. Quantitative measures of formaldehyde exposure in the workplace may be of use to validate the data collected in AWES and to improve understanding of the absolute levels of exposure to formaldehyde. There was no scope to do this as part of the AWES but this information would be useful for tasks such as carpenters working with power tools on particle board or plywood, painters using power sanders on such material, and fire fighters fighting fires or involved in clean up on the fire ground afterwards.

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The work presented in this report could be complemented by the collection of more widespread and more detailed information on the use of control measures in those work situations highlighted in this report where probable formaldehyde exposures were identified, especially where they were assessed as being high or medium. Further research could also help understand why appropriate control measures are not used. Such research could examine:

- the extent to which PCBUs and workers understand the hazards and associated potential risks
- the extent to which PCBUs and workers understand the need for various control measures and how they operate
- the extent to which higher order controls are used
- the adequacy of current regulations and guidance for preventing exposures, and
- the efficacy of current methods for providing risk management information and assistance to PCBUs.

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# BACKGROUND

## Introduction

Cancer is a priority disorder under the Australian Work Health and Safety Strategy 2012-2022 (the Strategy) (Safe Work Australia 2012). Better understanding of current hazardous exposures and the effectiveness of controls is a research priority under the Strategy. Formaldehyde is considered carcinogenic to humans and is classified by the International Agency for Research on Cancer (IARC) as a Group 1 agent (carcinogenic to humans)<sup>1</sup> (International Agency for Research on Cancer 2006). Exposure to formaldehyde is known to occur in some Australian workplaces (Jankewicz et al. 2008; National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006) but there is no nationally representative or comprehensive information about the nature of this exposure. Information on the nature of exposure to hazardous substances such as formaldehyde would help inform current workplace chemicals policy development activities.

The early efforts of Australian researchers to estimate the number of workers who might be exposed to known or suspected carcinogens such as formaldehyde relied on applying overseas estimates to Australian labour force data (Australian Bureau of Statistics 2002; Fritschi & Driscoll 2006; Mathers et al. 1999; Morrell et al. 1998; Winder & Lewis 1991). The 2008 National Hazard Exposure Worker Surveillance (NHEWS) Survey attempted to collect information on chemicals used by workers and the controls provided by persons conducting a business or undertaking (PCBUs) to help address this information gap (de Crespigny 2010; MacFarlane et al. 2012). However, the data collected through the NHEWS Survey have limited utility in determining the extent of exposures to specific chemicals or the manner in which workers use controls to prevent exposures. This is because it relied on workers being aware of the specific chemical hazards with which they worked, it provided a low level of detail on controls measures, and the sampling approach meant the results were not representative of the Australian workforce.

The recent work on the Australian Workplace Exposure Study (AWES) (Carey et al. 2014) provided the opportunity to obtain information on the prevalence of formaldehyde exposure during typical work activities at a national level. The main part of this report presents an analysis of relevant AWES data. This is followed by a consideration of the implications of the results for policy activity and future work health and safety research.

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1. The IARC classifications are described briefly in Appendix 1.

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## Formaldehyde as a carcinogen

The most authoritative information on the possible carcinogenic effects of formaldehyde is provided by IARC. Formaldehyde is classified by IARC as a Group 1 agent (carcinogenic to humans). The basis of this classification is described in IARC Monograph 100 (International Agency for Research on Cancer 2012), with further detail in an earlier monograph (International Agency for Research on Cancer 2006). The carcinogenicity classification of formaldehyde is based on strong evidence that it causes cancer of the naso-pharynx and (myeloid) leukaemia in humans, with strong suggestion of a link also with sino-nasal cancer. There was a request in the recent monograph to repeat some leukaemia studies due to the uncertain significance of the research results. The IARC assessment is based on sufficient evidence in humans and sufficient evidence in animals of the carcinogenicity of formaldehyde. Other organisations have classified formaldehyde similarly to IARC (National Toxicology Program 2011).

Under Australian work health and safety regulations manufacturers or importers must determine if a chemical is a hazardous chemical. At the current time, two classification schemes may be used for this purpose—the Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)] (the Approved Criteria) (National Occupational Health and Safety Commission 2004) or the Globally Harmonised System of Classification and Labelling of Chemicals 3rd Revised Edition (the GHS) (United Nations 2009). The Hazardous Substances Information System (HSIS) (Safe Work Australia 2012b) lists substances that have been classified by an authoritative source such as the European Commission or National Industrial Chemicals Notification and Assessment Scheme (NICNAS) in accordance with the Approved Criteria and provides classification details. In July 2012, Safe Work Australia updated the HSIS classification information for formaldehyde from a Category 3 Carcinogen to Category 2 Carcinogen (probable human carcinogen) (Safe Work Australia 2012c). This change was based on the recommendations of the 2006 NICNAS Priority Existing Chemicals report for formaldehyde (National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006).

The main non-carcinogenic health effects of formaldehyde are due to direct irritation of the eyes and mucous membranes of the respiratory tract (National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006). Skin irritation and skin sensitisation might also occur (Cahill et al. 2012; National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006). Whether formaldehyde exposure results in respiratory tract sensitisation is not clear (Paustenbach et al. 1997). As the focus of this report is formaldehyde as a carcinogen, the non-carcinogenic effects of formaldehyde are not considered further.

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## Information on exposure and control measures

### Information from published literature

Very low level exposure to formaldehyde is almost ubiquitous due to the presence of formaldehyde in the environment as a result of natural processes. IARC identifies three main sources of exposure—during production of formaldehyde solutions, during the manufacture and use of products containing formaldehyde (particularly formaldehyde-containing resins), and through the burning of products containing formaldehyde (International Agency for Research on Cancer 2006). Occupational exposure can occur in a wide variety of exposure circumstances, most notably in various types of manufacturing such as formaldehyde manufacture and the manufacture of formaldehyde-based resins, plastics manufacture, manufacture of composite wood such as particle board and plywood, furniture production, and textile manufacture. Other exposure circumstances include fire fighting, embalming, carpentry, pathology laboratory work (International Agency for Research on Cancer 2006; 2012; National Toxicology Program 2011). Most of these exposure circumstances have been or could be suspected to be relevant to Australian workplaces.

The CAREX database provides information on prevalence of exposure to a range of probable and definite carcinogens as classified by the IARC. It contains estimates of the numbers of workers exposed to carcinogens at work by industry in 15 countries of the European Union (EU) (exposure data from 1990-93) and four of the 10 countries that joined the EU in 2004 (exposure data from 1997). It also contains summarised exposure data, definitions of carcinogenic exposure, descriptions of the estimation procedures and bibliographic references. The work was undertaken in two phases. Initially estimates were derived from national workforce data and exposure prevalence estimates from two reference countries (the United States (US) and Finland) which had the most comprehensive data available on carcinogen exposures. The most valid value of prevalence (usually the mean of the US and Finnish values) was used as the default value. There was also some modification of estimates based on data in some individual European countries. The overall CAREX data were produced to reflect exposures in the early 1990s in Europe. Information is only available for males and females combined. The prevalence of work-related exposure to formaldehyde overall in CAREX was 0.7%, with the highest prevalence in Manufacturing (2.1%), Construction (0.5%) and Mining (0.2%) (Finnish Institute of Occupational Health 1998). It is likely that improvements in work practices and approaches to exposure control and changes in industry distribution over the last two decades would have resulted in a decrease in exposure prevalence levels and/or absolute exposure levels in Australia (and elsewhere) compared to the estimates at the time the CAREX database was developed.

A more recent carcinogen exposure database, CAREX Canada, provides more up to date data and it estimates the overall occupational exposure prevalence for formaldehyde to be about 1%. The CAREX Canada database identifies the main occupational exposures (in terms of number of people exposed) as being in wood product manufacturing, particularly furniture manufacturing and related industries for men; and in hospitals, schools, and clothing manufacturing for women. Classified by occupation, exposure was most common (in terms of number of people exposed)

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in furniture and fixture assemblers, cooks, labourers in wood, pulp and paper processing, and machinists. In terms of the proportion of workers exposed, the highest prevalence of exposure was in household and institutional furniture and kitchen cabinet making (21%), other wood product manufacturing (18%), sawmills and wood preservation (11%), building finishing contractors and hospitals (both less than 5%) (CAREX Canada 2012).

A recent major study of the work-related burden of cancer in Great Britain included consideration of leukaemia, nasopharyngeal cancer and sino-nasal cancer in relation to formaldehyde exposure. The study employed a detailed methodology for estimating exposure, focusing on data from Great Britain. High exposure was estimated for workers in manufacture of clothing and in manufacture of textiles. Lower levels of exposure were estimated for workers involved in the manufacture of furniture and fixtures and in manufacture of wood and wood and cork products. The overall prevalence of exposure to formaldehyde was based on the CAREX estimates (Rushton et al. 2012; Van Tongeren et al. 2012).

### **Information on Australian workplaces**

Exposure circumstances in Australian workplaces are reviewed in detail in the NICNAS Priority Existing Chemical report on formaldehyde (National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006). The main documented occupational exposure circumstances were:

- formaldehyde manufacture
- importation and transportation of formaldehyde and formaldehyde-containing products
- formulation and repackaging of formaldehyde products such as formaldehyde-containing resins and other formaldehyde products, and
- the end use of formaldehyde products such as wood products containing resins, in forensic and hospital mortuaries and pathology laboratories, embalming, photographic film processing, leather tanning using formalin solutions and sanitising treatment.

(National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006)(National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006)The level and frequency of exposure varies considerably across these occupations, from regular and potentially significant, to occasional and likely to be only at low level.

A report published in 2008 included consideration of available information on formaldehyde exposure in Australian workplaces for certain industries (manufacturing industries involving wood and wood products) and tasks. Most of the identified measurements of gaseous formaldehyde showed levels below the time-weighted average standard of 1 part per million (ppm). The median of 166 measurements was 0.1 ppm, with an arithmetic mean of 0.3 and a range of <0.01 – 11 ppm. However, the significance of these results is hard to assess because of the considerable selection and reporting bias. Relevant suggestions for additional work included undertaking targeted sampling to obtain information on controls and work practices, focusing on the manufacture of reconstituted wood products. This was because the available data suggested exposures in secondary wood

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industries (furniture and cabinet making) were low when compared to the current Australian workplace exposure standard of 1.0 ppm (Jankewicz et al. 2008).

### **Information from NHEWS**

The NHEWS study (Australian Safety and Compensation Council 2008; 2009) was a study of Australian workers designed to examine the frequency of exposure to a range of hazards, including workplace chemicals. The study initially focused on key industries (Agriculture, Forestry and fishing; Manufacturing; Construction; Transport, postal and warehousing; and Health and community services) but included all industries in the second phase of data collection. Some information on provision of exposure controls was also collected.

The survey was conducted in 2008 via telephone. All information on exposure to specific hazards and on controls was from self-report. The nature of the data collection meant that the data could not be considered representative of the whole Australian working population, or even necessarily quantitatively representative of the specific industries included. However, it did provide useful qualitative information and some quantitative information.

Potentially relevant reports published from NHEWS examined exposures to chemicals through skin contact (MacFarlane et al. 2012) and on airborne exposures (de Crespigny 2010) but neither report has useable information specifically on formaldehyde exposures. Examination of the unit record data for this study identified only two persons who reported occupational exposure to formaldehyde. One was a registered nurse and one was a cleaner.

### **Australian regulation and guides**

In Australia work health and safety requirements for working with hazardous chemicals are set out in Part 7.1 of the model Work Health and Safety Regulations 2011 (model WHS Regulations) (Safe Work Australia 2011)<sup>2</sup>. These include requirements for airborne contaminants and persons with control of a business or undertaking (PCBUs) must ensure the workers are not exposed to formaldehyde at concentrations higher than the relevant exposure standard. PCBUs would be expected to follow the hierarchy of control when controlling exposures to formaldehyde. Information on meeting work health and safety requirements is provided in the model Code of Practice: Managing Risks of Hazardous Chemicals in the Workplace (model Hazardous Chemicals Code) (Safe Work Australia 2012a).

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2. Victoria and Western Australia have not adopted the model WHS Regulations and specific regulatory requirements in these jurisdictions may differ

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# METHODS

## Australian Workplace Exposure Study

The analysis presented in this report uses AWES data (Carey et al. 2014)<sup>1</sup>. The AWES project is a nationwide survey which investigated the current prevalence of work-related exposure to 38 known or suspected carcinogens, including formaldehyde, among Australian workers (Carey et al. 2014).

### Study Population

The sample for the AWES was obtained from a commercial survey sampling firm and consisted of household contact details compiled from various public domain data sources such as telephone directories. Both landline and mobile phone numbers were included and the sample was stratified to reflect the approximate distribution of the Australian work force by state and territory as reported by the Australian Bureau of Statistics (ABS) Labour Force Survey from March 2011 (Australian Bureau of Statistics 2011a). Within these households currently employed residents aged between 18 and 65 were eligible to participate. Those with insufficient English language ability and those who were too ill to participate were ineligible. One eligible person within each household was selected for interview.

Of the 19 896 households telephoned during the course of this study, 2452 did not respond, 10 485 were ineligible, and 1936 refused to participate. Five thousand and twenty-three interviews were completed and the response rate (excluding ineligible households) was 53%.

### Data Collection

Interviews commenced in October 2011 and were completed in late 2012. All interviews were conducted by trained interviewers using computer-assisted telephone interviews. Respondents provided oral informed consent prior to any data being collected. Demographic information collected included age, gender, postcode of residence, country of birth, language spoken at home, and highest level of education.

The respondent's main job was then categorised as either exposed or unexposed to any of the 38 carcinogens by the use of a simple screening tool. Respondents whose job fitted into one of 13 predetermined categories of unexposed jobs such as white-collar professional or customer service were classified as unexposed and their interview completed. A total of 2532 respondents were categorised as unexposed at this point (minimal information was collected on these persons). Basic job information (job title, main tasks at work, industry, frequency of work in terms of hours per week and weeks per year) was then collected from the remaining 2491 respondents with the aim of using this information to assign them to one of 58 job specific modules (JSMs). These modules included questions about

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1. A detailed overview of the AWES study and the prevalence of exposures to the 38 carcinogens has been published —see Carey, R, Driscoll, T, Peters, S, Glass, D, Reid, A, Benke, G, et al. (2014). Estimated prevalence of exposure to occupational carcinogens in Australia (2011-2012). *Occupational and Environmental Medicine*, 71(1):55-62. This section of the report summarises the research methodology.

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the completion of tasks likely to involve exposure to carcinogens, and were developed by a team of occupational hygienists and epidemiologists. Examples are provided in Appendix 2.

All modules were completed using OccIDEAS (Fritschi et al. 2009), an online tool to manage interviews and exposure assessments, with each full interview taking approximately 15 minutes. Following the interviews, each job was coded according to the Australian and New Zealand Standard Classification of Occupations (ANZSCO) 2006 (Australian Bureau of Statistics 2006) and then categorised into one of 30 occupational groups, with each group containing occupations which were judged to be relatively homogeneous in terms of exposure (Carey et al. 2014). Thirty respondents reported jobs with insufficient information to be classified and were thus excluded from further analysis, resulting in a final sample of 4993 respondents.

### **Exposure Assessment**

Automatic assessments of the probability ('none', 'possible' or 'probable') and level ('low', 'medium', 'high') of exposure to formaldehyde were provided by OccIDEAS using predetermined rules developed on the basis of expert opinion. These rules were based on occupational hygienists' practical experience of workplace exposures and available exposure measures in the literature. These rules took into account the amount of time spent working on relevant tasks and the use of exposure control measures where this information was available. All automatic assessments were reviewed by project staff for consistency. The assessments were qualitative and referred to:

- exposure levels relevant to suspected carcinogenic outcomes—i.e. they do not necessarily correlate to exposures standards, and
- the level of exposure while undertaking the relevant task—they are not an assessment of the time-weighted average exposure of that person.

Two thousand, four hundred and ninety-one respondents completed a JSM. Fifteen of these modules (and two additional sub-modules) included questions relevant to formaldehyde exposure such as using power tools with particle board (chipboard) or plywood, work as a fire fighter, and work as a health worker or in a laboratory. One hundred and twenty-four respondents were judged to have probable exposure to formaldehyde in their current occupation, and 50 more were assessed to have possible exposure to formaldehyde in their current occupation.

### **Statistical Analysis**

All statistical analyses were conducted using SAS version 9.3 and Excel. Confidence intervals for proportions were also calculated using an on-line tool (Lowry 2013). Only those persons designated as having probable work-related exposure to formaldehyde were included in the main analysis. Assessments were extrapolated with reference to the 2011 Census (Australian Bureau of Statistics 2011a) to calculate an estimate of the number of Australian workers currently exposed to formaldehyde in the course of their work. These extrapolations were stratified by gender and conducted separately by occupational group in order to account for potential differences in exposure. The results are presented in text, figures

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and tables. The main body of the report has primarily text and figures. Most of the tables are included in Appendix 3. Confidence intervals are not included in the figures and text for ease of understanding but, where appropriate, are included in the tables. Categories with less than three subjects are not separately described or presented.

# RESULTS: INFORMATION ON EXPOSURE AND CONTROL MEASURES FROM THE AUSTRALIAN WORKPLACE EXPOSURE STUDY

## Overall results

Of the 4993 subjects with useable data, 124 (2.5%) had probable exposure to formaldehyde. Another 40 had possible exposure but they are not considered further in this analysis. Overall, 108 (3.9%) males and 16 (0.7%) females in the AWES sample were assessed as probably being exposed to formaldehyde. The level of exposure was deemed to be high for 6 (4.8%), medium for 73 (58.9%) and low for 45 (36.3%) for those exposed.

Just over half (67, 54.0%) of the exposed respondents worked in technical and trades occupations, with 25 (20.2%) working as community and personal service workers and 19 (15.3%) as labourers (Figure 1)<sup>1</sup>.

**Figure 1: Occupation of all respondents exposed to formaldehyde—per cent**



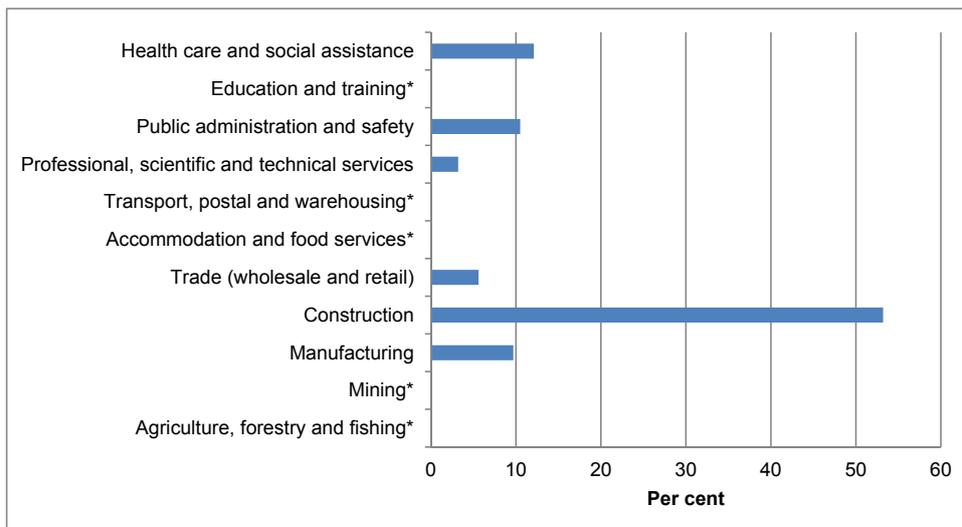
\* These categories had at least one but less than three respondents exposed to formaldehyde.

Construction was the industry of employment of almost half the exposed respondents (66, 53.2%), with Health care and social assistance (15, 12.1%), Public administration and safety<sup>2</sup> (13, 10.5%) and Manufacturing (12, 9.7%) the next highest-represented industries (Figure 2).

1. Tables providing data on which Figures are based are in Appendix 3.

2. This industry classification includes Australian Defence Force personnel, and public order, safety, and regulatory services staff such as fire fighters.

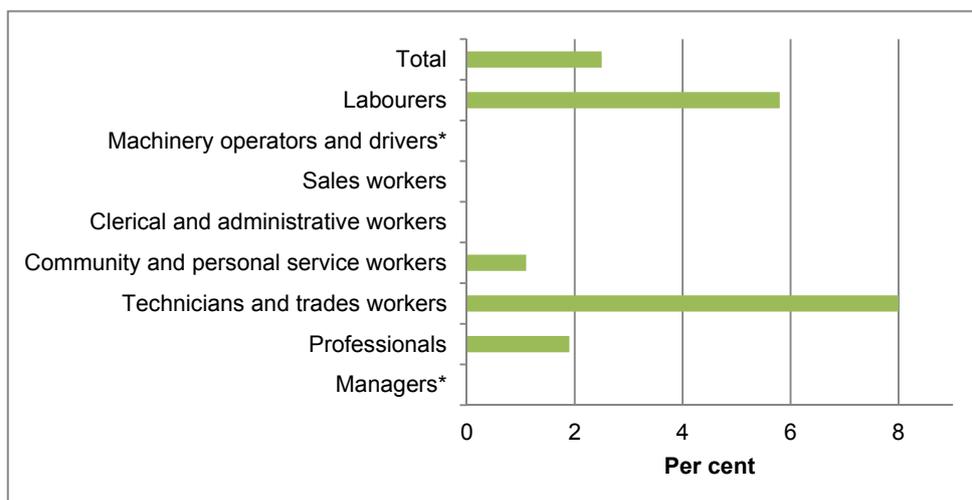
**Figure 2: Industry of all respondents exposed to formaldehyde—per cent**



\* These categories had at least one but less than three respondents exposed to formaldehyde.

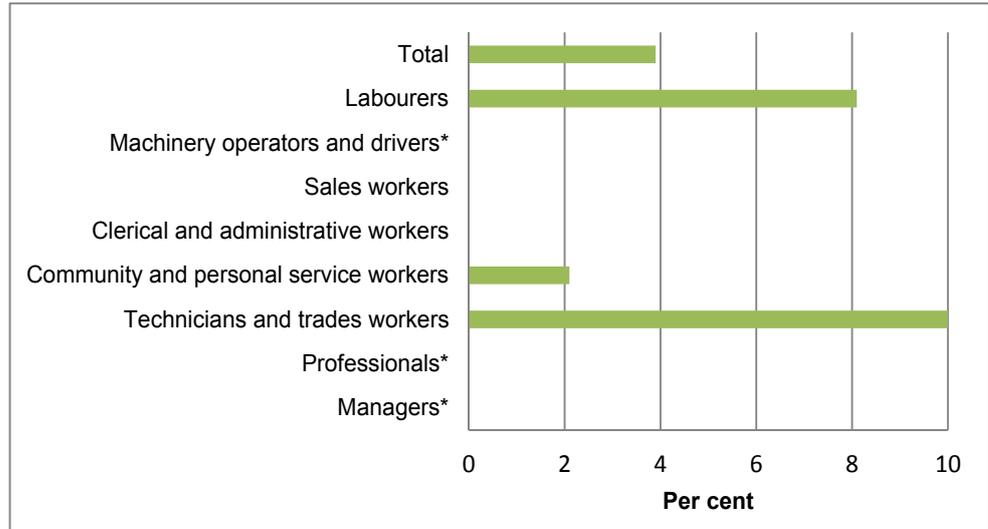
The proportion of respondents within a given occupation or industry who were exposed to formaldehyde was estimated by dividing the number of exposed respondents in a given occupation or industry by the total number of AWES respondents within that occupation or industry. Occupations with the highest proportion of respondents exposed were technicians and trades workers (8.0%) and labourers (5.8%)—this was true overall and for males (Figures 3 and 4).

**Figure 3: Proportion of respondents in each occupation exposed to formaldehyde—per cent**



\* These categories had at least one but less than three respondents exposed to formaldehyde.

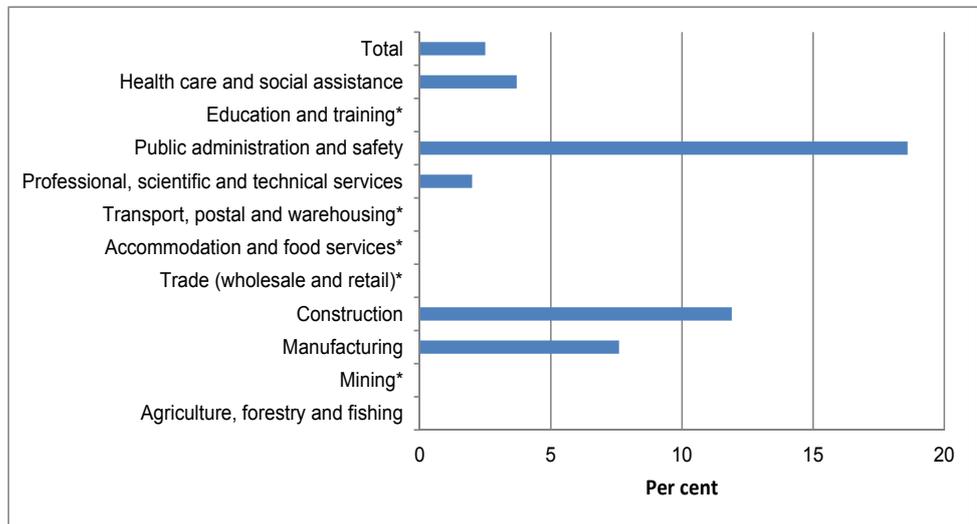
**Figure 4: Proportion of male respondents in each occupation exposed to formaldehyde—per cent**



\* These categories had at least one but less than three respondents exposed to formaldehyde.

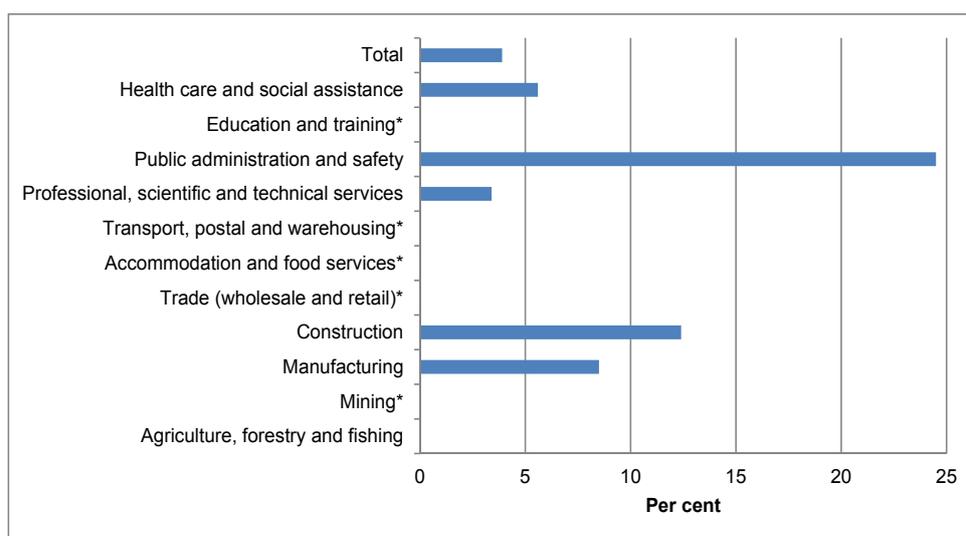
Industries with the highest proportion of respondents exposed were Public administration and safety (18.6%), Construction (11.9%), Trade (8.0%) and Manufacturing (7.6%). The industries with the highest prevalence of exposure were similar for men except that for men health care and social assistance was the fourth highest industry and trade had a low proportion (Figures 5 and 6).

**Figure 5: Proportion of respondents in each industry exposed to formaldehyde—per cent**



\* These categories had at least one but less than three respondents exposed to formaldehyde.

**Figure 6: Proportion of male respondents in each industry exposed to formaldehyde—per cent**



\* These categories had at least one but less than three respondents exposed to formaldehyde.

## The prevalence of exposure to formaldehyde in the Australian workforce

Using 2011 Census data (Australian Bureau of Statistics 2011b) and the estimated proportions of respondents exposed in each major occupation group, stratified by gender, the numbers of exposed respondents in each major occupation group and overall were estimated and are presented in Table 1. Estimates are only provided for groups with at least three exposed respondents in the study population.

These estimates suggest about 230 000 Australian workers, or 2.3% of the workforce, are probably exposed to formaldehyde when undertaking relatively common activities at work. The estimated exposure occurs predominantly in men. Approximately 193 000 men or 3.6% of the male workforce and approximately 42 000 women or 0.9% of the female workforce are estimated to be exposed.

**Table 1: Estimated number of Australian workers exposed to formaldehyde—by occupation.**

Occupation <sup>1</sup>	Male <sup>2</sup>	95% CI <sup>3</sup>	Total	95% CI
Managers	-	-	-	-
Professionals	-	-	43 465	22 000–82 000
Technicians and trades workers	121 317	95 000–154 000	125 413	99 000–158 000
Community and personal service workers	6328	4000–9800	8475	5600–13 000
Machinery operators and drivers	-	-	-	-
Labourers	49 712	31 000–77 000	49 712	31 000–78 000
Total <sup>4</sup>	192 714	159 000–232 000	234 661	196 000–280 000

Notes:

- 1: There was at least one person from each of the managers and machinery operators and drivers occupation categories. Estimates are not provided for these occupation categories as there were less than three exposed persons in the study population. There were no exposed persons from occupation categories not included in the table.
- 2: Separate data are not presented for females because there were too few exposed female respondents to allow occupation-specific estimates. The overall estimate of exposed women based on occupation was 41 947 (95% confidence interval 25 000 – 69 000).
- 3: 95% confidence interval.
- 4: The total is greater than the sum of the columns because estimates are not included in the table for those occupations with insufficient subjects (identified with '-' in the column).

## Circumstances of exposure

The assessed formaldehyde exposure occurred in a variety of circumstances. The main exposure circumstances are summarised in Table 2. The main exposure circumstance was working with particle board or plywood typically through carpentry work, building maintenance or sanding prior to painting. Other common exposure circumstances were firefighters involved in fighting fires, fire overhaul and clean-up or back-burning and health workers using formaldehyde when sterilising equipment or in a pathology laboratory setting. Some respondents had more than one exposure circumstance and some less common exposure circumstances are not included in Table 2.

**Table 2: Main circumstances resulting in exposure to formaldehyde**

Exposure circumstance	High	Medium	Low	Total
Working with particle board	-	52	16	68
Fire-fighting	-	12	9	21
Fire overhaul and clean-up	-	7	11	18
Sanding (as painter)	-	-	10	10
Sterilising	5	2	-	7
Manicure	-	-	5	5
Work in pathology lab	-	4	-	4

Note: This table does not include all exposed respondents and respondents could be exposed through more than one activity.

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The main circumstances resulting in assessed **high** exposures were:

- sterilising with formaldehyde in a health care setting.

The main circumstances resulting in assessed **medium** exposures were:

- working with particle board as a carpenter
- fire fighting and fire fighters involved in fire overhaul and clean-up without adequate respiratory protection, and
- working with formaldehyde in a pathology laboratory.

The main circumstances resulting in assessed **low** exposures were:

- working with particle board in a maintenance setting
- fire fighting and fire fighters involved in fire overhaul and clean-up with adequate respiratory protection
- sanding particle board, and
- manicure work.

Each of the main tasks involving formaldehyde exposure is considered in more detail below.

### **Working with particle board**

There were 68 respondents who were exposed to formaldehyde through working with particle board. Fifty-two of these respondents were carpenters in the Construction industry. They regularly worked with particle board materials or plywood and were deemed to have medium exposure as a result. The remaining 16 respondents occasionally worked with particle board materials or plywood, often in a building maintenance capacity or as a builder. The probable less frequent exposure and some uncertainty about the degree of exposure meant that the exposure in these circumstances was assessed as being low. Nearly all were employed in the Construction industry.

### **Fire fighting, fire overhaul and clean-up and back-burning**

There were 21 fire fighters deemed to have probable exposure to formaldehyde as a result of fire fighting, 18 of whom also undertook overhaul, clean up, or sifting through the remains of a fire, and 11 who were involved in back-burning. Nineteen were career fire fighters and the other two were volunteers. On the basis of their fire-fighting activities and pattern of use of breathing apparatus, 12 were deemed to have medium exposure and nine to have low exposure.

### **Sanding**

Ten painters were deemed to have low exposure on the basis of sanding particle board as part of their work. Nearly all worked in the Construction industry.

### **Sterilising**

Seven health care workers were exposed to formaldehyde due to sterilising equipment as part of their work. Two were deemed to have medium exposure as they used an autoclave. The other five were deemed to have high exposure as the sterilising occurred in a more open system. Three of the seven were nurses and the other four worked in other capacities in the health system.

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## Manicure

Five respondents were deemed to have low exposure due to their manicure work, four as hairdressers and one as a pet groomer. All worked in the Retail trade industry.

## Pathology lab workers

Four respondents were deemed to have medium exposure on the basis of their work in a pathology laboratory, three in the Health care industry and one in the Professional, scientific and technical services industry.

## Other exposure circumstances

Other reported circumstances of exposure were:

- cleaning a food processing area with formaldehyde
- teachers using formaldehyde-containing paints
- moulding melamine
- printing using diazo dyes
- working in a timber mill near sawn plywood, and
- working with wood preserved with urea that was sprayed onto the wood.

## The use of ventilation systems and respiratory protection equipment

Appropriate controls when potentially exposed to formaldehyde would usually include using effective local exhaust ventilation and/or half face respirators. Information from AWES on the use of these types of controls by workers probably exposed to formaldehyde is summarised in this section and in Table 3.

Fifty-two respondents reported using power tools (usually sanding or cutting) while working with particle board or plywood in their role as carpenters. Of these, 17 (33%) reported usually using a simple half face paper mask, seven (13%) used ventilation (probably mainly local exhaust ventilation), 14 (27%) used both the paper mask and ventilation and 14 (27%) reported not using any form of respiratory protection in the workplace. The use of a paper mask probably would not provide effective protection from formaldehyde exposure, because workers could be exposed to formaldehyde gas released from timber products in addition to exposure via wood dust particles that deposit in the respiratory tract. This means about 40% of carpenters exposed to formaldehyde through the use of power tools on particle board or plywood appeared to be using appropriate respiratory protection. Of the 10 painters who reported sanding particle board or plywood, seven (70%) said they usually used a powered sander. Only two reported using a respirator while sanding. There was no information on respiratory protection for the 16 people who occasionally worked with particle board or plywood in a maintenance or building capacity.

**Table 3: The reported use of controls when performing tasks with probable exposure to formaldehyde.**

Exposure circumstance	Use ventilation systems or respiratory protection		Total
	Yes	No	
Builders working with power tools	38	14	52
Painters working with (power) sanders	2	8	10
Fire fighter	9	12	21
Forestry and mill workers	2	1	3
Printer	0	1	1
<b>Sub-total (those with information on the use of respiratory protection)</b>	53	34	87
Use of respirator/ventilation not known			37
<b>Total</b>			<b>124</b>

Note: Respondents who reported always or usually using ventilation systems or wearing respiratory protection during relevant work activities were grouped as 'yes'. Those respondents who reported sometimes or never using ventilation systems or wearing respiratory protection during relevant work activities were grouped as 'no'.

Twenty-one fire fighters were deemed to have been exposed through fire fighting activities, primarily through front-line fire-fighting or through fire overhaul and clean-up or back-burning. Sixteen (76%) reported either always or usually wearing breathing apparatus, four respondents (19%) sometimes wore breathing apparatus and one respondent never wore breathing apparatus while fighting fires. Of the 18 fire fighters involved in fire overhaul and clean-up, 11 (61%) always or usually wore breathing apparatus, five sometimes (28%) wore breathing apparatus and two (11%) never used breathing apparatus whilst they worked on fire overhaul and clean-up. Of the 11 fire fighters involved in back-burning, one (9%) always or usually wore breathing apparatus, three sometimes (33%) wore breathing apparatus and seven (77%) never used breathing apparatus while they worked on back-burning. Overall, nine of the 21 firefighters reported using breathing apparatus always or usually when undertaking any firefighting activity.

Two of the three timber mill workers exposed to sawn plywood reported that a ventilation system was fitted to the machine closest to them.

Information on the use of personal protective equipment (PPE) or ventilation was not available for respondents exposed to formaldehyde when manicuring, sterilising medical equipment, working in a pathology laboratory and teaching.

Overall, 59% of the exposed respondents for whom information was available on controls either used PPE regularly or worked where area or local exhaust ventilation was in place. Taking into account that 17 respondents used only a paper mask that is unlikely to have provided effective protection against formaldehyde exposure, this means that about 39% of the workers probably exposed to formaldehyde appeared to use appropriate respiratory controls while working.

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# DISCUSSION AND INTERPRETATION OF THE STUDY FINDINGS

## Exposures

The main formaldehyde exposure circumstances identified in the AWES project were working with particle board or plywood, typically through carpentry work, maintenance or sanding prior to painting. Other common exposure circumstances were fire fighters fighting fires or involved in fire overhaul and health care workers using formaldehyde to sterilise equipment or in a pathology laboratory setting. These exposure circumstances cover many of those traditionally associated with formaldehyde exposure. However, the AWES project did not identify workers in some 'traditional' industries or occupations typically associated with formaldehyde exposures such as manufacturing formaldehyde solutions, manufacturing timber products or embalming. This is because AWES is not a study of specific 'formaldehyde' industries but is a population-based study that attempts to identify if exposures to formaldehyde occur in the course of general work activities. These are two very different areas, although clearly with some overlap. This is an unavoidable aspect of any such large scale survey. Studies such as AWES are not designed to provide detailed information about exposure circumstances in a specific industry sector known to have formaldehyde exposure. That information can be obtained much more efficiently from a small study designed specifically to provide such information. Instead, AWES indicates that formaldehyde exposure is common in a range of occupations and industries.

Qualitative information on exposure was collected, based on job tasks. This approach should have provided a good qualitative understanding of exposures but there is no scope in the current design to validate the estimates by taking quantitative measures in workplaces. Nevertheless, the questions asked and the coding logic of the AWES database are based on published studies that provide semi-quantitative estimates of formaldehyde exposure.

Based on AWES results and national employment data, it is estimated that about 230 000 workers—approximately 2.3% of the Australian workforce—are likely to be exposed to formaldehyde at least some of the time in their current job. The exposure prevalence was higher in men (3.6%) than women (0.9%), presumably reflecting that a higher proportion of men than women work in occupations and industries where formaldehyde exposure is more likely.

The exposure prevalence in this study was higher than the 0.7% exposure prevalence found in the CAREX study (Finnish Institute of Occupational Health 1998) and the 1% exposure prevalence found in the CAREX Canada study (CAREX Canada 2012). However, many of the occupations and industries with higher exposure prevalence were similar between the studies. Some of the differences in the prevalence estimates between the three studies probably reflect the different industry proportions in the countries in which the three studies were based. The studies also used quite different methods, AWES being the only study that surveyed workers about what tasks they actually performed at work and took into account

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the use or non-use of control measures. CAREX estimates and CAREX Canada estimates were based on workplace measures taken for a range of reasons and on expert opinion. The definition of exposure in the studies also appears to have been different, although it is difficult to make a direct comparison. It may also be that the AWES project accepted lower exposures, or a lower probability of exposure in exposed subjects, than did the other two studies. The level of exposure in the AWES project was based on exposure while undertaking the relevant task and was not intended to necessarily relate to an assessment of the time-weighted average exposure of that person. The definition of what is High, Medium and Low exposure is certainly important, but was only possible in a qualitative sense. The methods used in the AWES project suggest it is more likely to provide a nationally representative estimate of exposure than are the other two studies. However, the other two studies did, to some extent, incorporate levels of workplace exposure estimates as part of their methodology.

## Use of control measures

The analysis of AWES data showed inconsistent use of control measures in circumstances that entailed probable exposure to formaldehyde. The main control measures used related to decreasing the chance of inhalation and included face masks, half-face respirators and area ventilation such as local exhaust ventilation. None of the respondents reported using gloves or overalls to prevent dermal exposure, but meaningful dermal exposures were not likely in the majority of exposure circumstances for which information on protective measures was available. Overall, about 60% of the exposed respondents for who information was available on the use of controls used PPE or worked where ventilation—probably local exhaust ventilation—was in place. A little less than half the respondents appeared to use appropriate respiratory protection while working.

Using power tools on particle board or similar wooden products was found to be the most common form of exposure to formaldehyde and most respondents reported usually using some form of respiratory exposure control measures. However, a paper mask is unlikely to be fully effective when using power tools while working with particle board and plywood. About 40% of fire fighters reported always or usually using breathing apparatus while working meaning that about 60% were commonly not protected for some of their tasks.

## Gaps, strengths and weaknesses

This report focuses primarily on data from the AWES project because there are few other relevant data sources that include information on work practices and exposure estimates. The AWES project provides population-based information on current workplace exposure to a range of definite and probable carcinogens when relatively common workplace activities are carried out. It also provides evidence on which to base estimates of future burden arising from current exposures and on which to base estimates of future avoidable burden if exposures are better controlled. This information can be used for prioritising work to decrease exposures to formaldehyde. However, like any such survey, it has some limitations.

Data were collected through a telephone survey, with attendant time restraints in terms of maintaining the respondent's cooperation. In practical

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terms, telephone-based surveys involve a compromise between covering the essential questions and including questions that are important but not required for the primary purpose of the study. As the AWES covered a range of potential exposures a limited number of specific questions could be asked about any particular exposure. There were similar issues with the NHEWS project.

The sample was selected to be representative of the workforce and the occupation and industry within the workforce of each state and territory and therefore of the national workforce. The final sample on whom the results are based may not have been fully representative of the workforce due to people declining to be interviewed or being ineligible, but it was known that most of the general characteristics were similar between the final included sample and the general Australian population of working age. The primary study results of prevalence of exposure in the Australian workforce are based on the prevalence of exposure in the occupations that had the possibility of being exposed. This provided information on the prevalence of exposure to each carcinogen of interest in each occupation. This information was extrapolated to the Australian workforce, taking into account (that is, weighting by) the occupational distribution. If there is error in these prevalence estimates, it will have come primarily because certain specific occupations in a broader occupation group were not accurately represented in the sample because a higher proportion of their members declined to be included or were ineligible—e.g. because they did not speak English—and/or because those who participated did not accurately report their exposure.

The study relied on self-report data which is likely to introduce some error into the exposure assessment. However, the exposure assessment relied on subjects describing their current job tasks, guided by the questions in the relevant job-specific modules, rather than the workers having to recognise and recall specific exposures. This makes it less likely that exposure will be missed and less likely that specific exposures will be erroneously reported (Parks et al. 2004).

As a population-based study, AWES can only be expected to provide representative exposure information on relatively common activities. Information will be lacking on most industry sub-sectors, specific occupations and specific tasks which are less common or which are undertaken by a relatively small number of people. This is why workers undertaking tasks that would usually be viewed as having a high prevalence of formaldehyde exposure, such as manufacturing of timber products, but which do not comprise a significant proportion of the workforce, were not found in the study sample. If detailed information is required about a specific sector of the workforce or a specific activity, this would require a targeted, specific research project to be undertaken.

As noted previously, exposure assessments were qualitative and referred to:

- exposure levels relevant to suspected carcinogenic outcomes—i.e. they do not necessarily correlate to airborne exposure standards or to blood lead removal levels, and
- the level of exposure whilst undertaking the relevant task—i.e. they are not an assessment of the time-weighted average exposure of that person.

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The AWES project provided some information on the use of control measures but the information that could be collected in this area was somewhat limited. The questions asked in AWES were aimed primarily to allow assessment of the fact of exposure and, if possible, the level of exposure.

Non-response is also an issue for any survey approach such as that used for AWES. This raises the possibility that those who did participate had a different prevalence of exposure and different approach to the use of exposure control measures than those who did not participate. Since there is no employment information available on non-participants it is not possible to assess this potential problem in detail.

There is uncertainty in the estimated overall number of workers exposed to formaldehyde. This is because the number of exposed respondents was low in some gender-specific and occupation-specific groups, meaning the estimate for that group had considerable uncertainty. The overall estimate based on occupation is likely to be reasonably accurate, and the confidence intervals around the estimates give a guide as to the likely range in which the true value probably lies.

## Policy implications

This study estimated approximately 2.3% of the Australian workforce is likely to be exposed to formaldehyde when performing relatively common activities at work. The estimated prevalence is higher than results of some other studies. As noted, the differences probably reflect differences in the industry distribution and in the methodology used in the various studies, with the AWES using a task-based assessment process.

The probability of any increased risk of work-related cancer in exposed workers will depend on the type of cancer and the level, duration and frequency of exposure. Since formaldehyde is a known human carcinogen, exposure to formaldehyde must be minimised to as low a level as is reasonably practicable.

In general, some of the health risks posed by exposures to formaldehyde, the tasks that might result in such exposures and the methods of preventing exposure should be well understood by employers and workers. However, the inconsistency in carcinogenic classifications between some authoritative sources could create uncertainty about the risks posed by formaldehyde exposures. While outside the scope of this report, future work could consider if revising the current classification information in HSIS is warranted, based on the recent work of the IARC.

The use of controls by workers in the AWES sample was not good. Where information on the use of controls was collected less than half of respondents reported using what appeared to be adequate controls and many reported not using any controls to prevent exposures. There is an opportunity to prevent and to decrease work-related exposures to formaldehyde and thereby reduce the potential for work-related cancer cases. This could be achieved through efforts to increase the number of workplaces that eliminate where possible the use of products that contain or release formaldehyde or consistently use high order controls and good work practices to eliminate or reduce exposures to formaldehyde when relatively common activities are carried out. This may simply require

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initiatives that raise awareness or educate PCBU's and workers about using alternative products, systems of work or known controls to prevent or minimise exposures to formaldehyde. In particular, efforts could be focused on lowering exposures in those activities where a significant number of workers were assessed as having high exposures in the AWES. For example:

- PCBU's should be encouraged to:
  - equip power sanders, power saws and drills with effective 'on tool' systems which extract dusts and vapours
  - install and maintain local exhaust ventilation systems, and
  - supply workers with and ensure they use appropriate RPE such as half-face respirators rather than paper masks, and
- fire fighters should be encouraged to use appropriate breathing apparatus when fighting fires and working on fire overhaul and clean up if inhalation of chemicals such as formaldehyde are likely.

Initial efforts could focus on initiatives that raise awareness or educate PCBU's and workers about using alternatives to formaldehyde or using well-known and readily available controls to prevent exposures to formaldehyde.

## Research opportunities

### Exposures

The AWES project provides qualitative information on current exposures to formaldehyde based on job tasks. Some limited data on exposure to formaldehyde in Australian manufacturing workers is available (Jankewicz et al. 2008; National Industrial Chemicals Notification and Assessment Scheme (NICNAS) 2006), but quantitative measures of formaldehyde exposure in the workplace may be of use to validate the data collected in AWES and to help better understand the absolute levels of exposure to formaldehyde. There was no scope to do this as part of the AWES but this information would be useful for tasks such as carpenters working with power tools on particle board or plywood, painters using power sanders on such material, and fire fighters fighting fires or involved in clean up on the fire ground afterwards.

### The use of control measures

More detailed information on the use of control measures should be considered in those work situations highlighted in this report where probable formaldehyde exposures were identified, especially where they were assessed as being high or medium. It would also be helpful to understand why appropriate control measures are not used where they should be. Work health and safety policy-makers and practitioners might be interested in aspects such as identifying the extent to which:

- PCBU's and workers understand the hazards and associated potential risks
- PCBU's and workers understand the need for various control measures and how they operate
- higher order controls are used
- current regulations and guidance are adequate for preventing exposures, and

- 
- current methods for providing risk management information and assistance to PCBU are effective.

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# REFERENCES

- Australian Bureau of Statistics (2002). National Health Survey, Summary of Results, Australia(Report No. 4364.0). Canberra.
- Australian Bureau of Statistics (2006). Australian and New Zealand Standard Classification of Occupations. Canberra: Australian Bureau of Statistics.
- Australian Bureau of Statistics (2011a). Labour Force Australia. Canberra.
- Australian Bureau of Statistics (2011b). Census of Population and Housing. Canberra: Australian Bureau of Statistics.
- Australian Safety and Compensation Council (2008). National Hazard Exposure Worker Surveillance (NHEWS): Survey Handbook. Canberra.
- Australian Safety and Compensation Council (2009). National Hazard Exposure Worker Surveillance (NHEWS) Survey: 2008 Results (updated March 2009). Canberra.
- Cahill, J, Williams, J, Matheson, M, Palmer, A, Burgess, J, Dharmage, S, et al. (2012). Occupational Contact Dermatitis: A review of 18 years of data from an occupational dermatology clinic in Australia. Canberra: Occupational Dermatology Research and Education Centre, Skin and Cancer Foundation Inc.
- CAREX Canada (2012). Formaldehyde <[http://www.carexcanada.ca/en/formaldehyde/occupational\\_estimate/](http://www.carexcanada.ca/en/formaldehyde/occupational_estimate/)>. Viewed February, 2014.
- Carey, R, Driscoll, T, Peters, S, Glass, D, Reid, A, Benke, G, et al. (2014). Estimated prevalence of exposure to occupational carcinogens in Australia (2011-2012). Occupational and Environmental Medicine, 71(1):55-62.
- de Crespigny, F (2010). National Hazard Exposure Worker Surveillance. Exposure to dust, gases, vapours, smoke and fumes and the provision of controls for these airborne hazards in Australian workplaces. Canberra.
- Finnish Institute of Occupational Health (1998). CAREX database. Helsinki.
- Fritschi, L & Driscoll, T (2006). Cancer due to occupation in Australia. Australia and New Zealand Journal of Public Health, 30(3):213-219.
- Fritschi, L, Friesen, M, Glass, D, Benke, G, Girschik, J & Sadkowsky, T (2009). OccIDEAS: retrospective occupational exposure assessment in community-based studies made easier. Journal of Environmental and Public Health:Epub: 2009:957023. doi: 10.1155/2009/957023.
- International Agency for Research on Cancer (2006). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 88. Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol: World Health Organization.
- International Agency for Research on Cancer (2012). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 100F. Chemical agents and related occupations: World Health Organization.

- 
- Jankewicz, G, Lee, S, Pisaniello, D & Tkaczuk, M (2008). Benchmarking of exposures to wood dust and formaldehyde in selected industries in Australia. Canberra: Adelaide Research & Innovation Pty Ltd.
- Lowry, R (2013). Confidence interval of a proportion <<http://www.vassarstats.net/prop1.html>>. Viewed February, 2014.
- MacFarlane, E, Benke, G & Keegel, T (2012). National Hazard Exposure Worker Surveillance: Chemical exposure and the provision of chemical exposure control measures in Australian workplaces. Canberra.
- Mathers, C, Vos, T & Stevenson, C (1999). The burden of disease and injury in Australia(AIHW Catalogue No.: PHE 17). Canberra.
- Morrell, SK, C, Driscoll, T, Taylor, R, Salkeld, G & Corbett, S (1998). Best estimate of the magnitude of mortality due to occupational exposure to hazardous substances. Occupational and Environmental Medicine, 55(9):634-641.
- National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2006). Priority Existing Chemical Assessment Report No. 28. Formaldehyde. Canberra.
- National Occupational Health and Safety Commission (2004). Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)] 3rd Edition. Canberra.
- National Toxicology Program (2011). Report on Carcinogens 12th Edition. Formaldehyde. Research Triangle Park, NC.
- Parks, C, Cooper, G, Nylander-French, L, Hoppin, J, Sanderson, W & JM, D (2004). Comparing questionnaire-based methods to assess occupational silica exposure. Epidemiology, 15(4):433-441.
- Paustenbach, D, Alarie, Y, Kulle, T, Schachter, N, Smith, R & Swenberg, J (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health, 50(3):217–263.
- Rushton, L, Hutchings, S, Fortunato, L, Young, C, Evans, G, Brown, T, et al. (2012). Occupational cancer burden in Great Britain. British Journal of Cancer, 103:S3-S7.
- Safe Work Australia (2011). Model Work Health and Safety Regulations. Canberra.
- Safe Work Australia (2012). Australian Work Health and Safety Strategy 2012-2022. Canberra.
- Safe Work Australia (2012a). Managing Risks of Hazardous Chemicals in the Workplace - Code of Practice. Canberra.
- Safe Work Australia (2012b). Hazardous Substances Information System (HSIS) <<http://www.hsis.safeworkaustralia.gov.au/>>. Viewed March, 2014.
- Safe Work Australia (2012c). Hazardous Substances Information System (HSIS). Formaldehyde <<http://www.hsis.safeworkaustralia.gov.au/ExposureStandards/Details?exposureStandardID=289>>. Viewed February, 2014.

---

United Nations (2009). Globally Harmonised System of Classification and Labelling of Chemicals 3rd Revised Edition. Geneva: United Nations.

Van Tongeren, M, Jimenez, A, Hutchings, S, MacCalman, L, Rushton, L & Cherrie, J (2012). Occupational cancer in Britain - Exposure assessment methodology. *British Journal of Cancer*, 107:S18 – S26.

Winder, C & Lewis, S (1991). A thousand a year: an estimate of deaths in Australia from cancer associated with occupation. *Cancer Forum*, 15:70-76.

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# GLOSSARY

95% CI	95% confidence interval
ABS	Australian Bureau of Statistics
ANZSCO	Australian and New Zealand Standard Classification of Occupations
Approved Criteria	Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004) 3rd Edition
AWES	Australia Workplace Exposure Study
CAREX	Carcinogen Exposure (study)
IARC	International Agency for Research on Cancer
JSM	Job-specific module
NHEWS	National Hazard Exposure Worker Surveillance (study)
OccIDEAS	An online tool to manage interviews and exposure assessments
NICNAS	National Industrial Chemical Notification and Assessment Scheme
PCBU	Persons conducting a business or undertaking
WHO	World Health Organization
WHS	Work health and safety

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# APPENDIX 1: Classification of carcinogens

## IARC classification of carcinogens

The following information is taken from the [IARC web site](#) describing the IARC classification.

Group 1	The agent is carcinogenic to humans.
Group 2A	The agent is probably carcinogenic to humans.
Group 2B	The agent is possibly carcinogenic to humans.
Group 3	The agent is not classifiable as to its carcinogenicity to humans.
Group 4	The agent is probably not carcinogenic to humans.

## Approved Criteria Classifications

The Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)] (the Approved Criteria) uses the following classification categories for carcinogens:

Category 1	Substances known to be carcinogenic to man.
Category 2	Substances that should be regarded as if they are carcinogenic to man.
Category 3	Substances that cause concern for man owing to possible carcinogenic effects.

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## APPENDIX 2: Relevant questions and exposure coding rules for some Job-Specific Modules

### Job-specific module for fire fighting

What activities do you mainly perform as a fire fighter?

- frontline fire fighting
- search and rescue including motor vehicle accidents
- respond to Incidents involving hazardous materials
- natural disaster response
- overhaul, clean up, and/or sifting through the remains of a fire
- support, education, prevention, communications, or management activities
- other, please specify

How often do you wear breathing apparatus during frontline fighting?

- always
- more than 50% of the time
- less than 50% of the time
- never

How often do you wear breathing apparatus during overhaul or clean up?

- always
- more than 50% of the time
- less than 50% of the time
- never

For overall or clean up, code as **medium** exposure if BA [breathing apparatus] used less than 50%; code as **low** if BA used more than 50% of the time or always.

### Job-specific module for carpentry/cabinetry

When you do carpentry work using power tools, what type of wood do you generally work with? (allow multiple)

- hardwood
- softwood
- particle board, pressed wood or plywood
- other (please specify)

When you use power tools, what type of respiratory protection do you normally use?

- simple half face paper mask
- rubber half face mask with cartridges
- other (please specify)
- none

Is there usually a ventilation system that removes the wood dust from where you work?

- yes
- no
- don't know

## APPENDIX 3: Tables relevant to Figures presented in Chapter 3

**Table 4: Occupations of all formaldehyde-exposed persons—numbers and percentages**

Occupation	Number	Per cent
Professionals	10	8.1
Technicians and trades workers	67	54.0
Community and personal service workers	25	20.2
Labourers	19	15.3
Other <sup>1</sup>	3	2.4
<b>Total<sup>2</sup></b>	<b>124</b>	<b>100.0</b>

Note: There was at least one person from each of the managers and machinery operators and drivers occupation categories. Numbers and percentages for these are not shown because there were less than three persons in each category. There were no exposed persons from other occupation categories not shown.

**Table 5: Industries of all formaldehyde-exposed persons—numbers and percentages**

Industry	Number	Per cent
Manufacturing	12	9.7
Construction	66	53.2
Trade (wholesale and retail)	7	5.6
Professional, scientific and technical services	4	3.2
Public administration and safety	13	10.5
Health care and social assistance	15	12.1
Other	7	5.6
<b>Total</b>	<b>124</b>	<b>100.0</b>

Notes: There was at least one person from each of the agriculture, forestry and fishing; mining; accommodation and food services; transport, postal and warehousing; and education and training industry categories. Numbers and percentages for these are not shown because there were less than three persons in each category. There were no exposed persons from other industry categories not shown.

**Table 6: Proportions of respondents in each occupation who were exposed to formaldehyde—per cent**

Occupation <sup>1</sup>	Male	Female <sup>1</sup>	Total
Professionals <sup>2</sup>	*	3.1	1.9
Technicians and trades workers	10.0	-	8.0
Community and personal service workers	2.1	-	1.1
Labourers	8.1	-	5.8
<b>Total</b>	<b>3.9</b>	<b>0.7</b>	<b>2.5</b>

Notes:

1: There was at least one person from each of the managers and machinery operators and drivers occupation categories. Percentages for these are not shown because there were less than three persons in each category. There were no exposed persons from other occupation categories not shown.

2: There was at least one male from the professionals occupation category. The percentage for this is not shown because there were less than three persons in the category.

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**Table 7: Proportions of respondents in each industry who were exposed to formaldehyde—per cent**

<b>Industry</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
Manufacturing	8.5	-	7.6
Construction	12.4	-	11.9
Trade (wholesale and retail)	-	18.8	8.0
Professional, scientific and technical services	3.4	-	2.0
Public administration and safety	24.5	-	18.6
Health care and social assistance	5.6	3.0	3.7
<b>Total</b>	<b>3.9</b>	<b>0.7</b>	<b>2.5</b>

Note: There was at least one person from each of the agriculture, forestry and fishing; mining; accommodation and food services; transport, postal and warehousing; and education and training industry categories. Percentages for these are not shown because there were less than three persons in each category. There were no exposed persons from other industry categories not shown.

